National Semiconductor

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Discrete POWER and Signal Technologies

National Discrete Diode, Bipolar Transistor and JFET Products Databook

Introduction to the Diode, Bipolar Transistor and JFET Products Databook

National Semiconductor has been a major supplier of discrete semiconductor devices for the wide-ranging consumer, automotive, computer and industrial electronics market places for many years. The addition of a zener diode line and new surface mount package options has enhanced the discrete product depth outlined in this databook. This volume contains electrical and mechanical specifications in a broad range of diode, JFET and bipolar transistor products in a vast array of leaded and surface mount package options, and includes datasheets applicable to the most common preferred part types within the categories. These include:

- Small signal and switching diodes in glass, leadless and surface mount packages
- Zener diodes in glass, leadless and surface mount packages
- NPN and PNP bipolar transistors in plastic leaded and surface mount packages
- N-Channel, P-Channel and Dual JFETs in plastic leaded and surface mount packages
- Dual diodes in various surface mount packages
- Quad and Dual bipolar transistors in various surface mount packages
- A large number of surface mount package options, which include: LL34; SOT23 (TO-236); SOT223 (TO-261); 6-leaded version of SOT23; options of the common SOIC-8 and SOIC-16 outlines configured for multiple die-use; and TO-263 (surface mount version of TO-220 commonly referred to as "D^2PAK")

The selection guide in this databook is designed to provide an easy reference to the many standard discrete parts offered by National Semiconductor. The DMOS Power MOSFET Databook contains electrical and mechanical specifications of N-Channel and P-Channel DMOS-based power and small signal products in a wide range of leaded and surface mount package options up to 150 W. If your needs are not satisfied by any of the devices listed, please contact your nearest National Semiconductor sales office or the factory for other options or special selections that are available.

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Discrete POWER & Signal Technologies

DISCRETE SEMICONDUCTOR PRODUCTS

DIODE, BIPOLAR TRANSISTOR AND JFET PRODUCTS DATABOOK

1996 Edition

National Semiconductor

Discrete POWER & Signal Technologies

Discrete Product Line
Alphanumeric List of Available Parts

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MMBZ5249B	4-11	2-43
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MMBZ5252B	4-11	2-43
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Additional Available Devices
See DMOS Power MOSFET Databook

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2N7000	NDC632P	NDP7060L	NDS9952A
2N7002	NDC651N	NDP7061	NDS9953A
BS170	NDC652P	NDS331N	NDS9955
BS270	NDC7001C	NDS332P	NDS9956A
BSS84	NDC7002N	NDS335N	NDS9957
BSS100	NDC7003P	NDS336P	NDS9958
BSS110	NDF0610	NDS351N	NDS9959
BSS123	NDH831N	NDS352P	NDT014
BSS138	NDH832P	NDS355N	NDT014L
MMBF170	NDH8302P	NDS356P	NDT410EL
NDB408A	NDH8436	NDS0605	NDT451AN
NDB410A	NDH8447	NDS0610	NDT451N
NDB506A	NDM3000	NDS7002A	NDT452AP
NDB506B	NDP408A	NDS8410	NDT452P
NDB506AL	NDP410A	NDS8426	NDT453N
NDB506BL	NDP506A	NDS8433	NDT454P
NDB508A	NDP506B	NDS8434	NDT455N
NDB510A	NDP506AL	NDS8435	NDT456P
NDB603AL	NDP506BL	NDS8839H	NDT2955
NDB608A	NDP508A	NDS8852H	NDT3055
NDB610A	NDP510A	NDS8858H	NDT3055L
NDB708A	NDP603AL	NDS8926	
NDB710A	NDP608A	NDS8928	
NDB4050	NDP610A	NDS8934	
NDB4050L	NDP708A	NDS8936	
NDB4060	NDP710A	NDS8947	
NDB4060L	NDP4050	NDS8958	
NDB6030L	NDP4050L	NDS9400A	
NDB6050	NDP4060	NDS9405	
NDB6050L	NDP4060L	NDS9407	
NDB6051	NDP6030L	NDS9410A	
NDB6060	NDP6050	NDS9430	
NDB6060L	NDP6050L	NDS9435A	
NDB7050	NDP6051	NDS9933	
NDB7050L	NDP6060	NDS9936	
NDB7051	NDP6060L	NDS9942	
NDB7060	NDP7050	NDS9943	
NDB7060L	NDP7050L	NDS9945	
NDB7061	NDP7051	NDS9947	
NDC631N	NDP7060	NDS9948	

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Cross Reference and Selection Guide

Section 1 Contents

National Semiconductor™

Discrete POWER & Signal Technologies

Diode Cross-Reference Guide

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1N100A	1N4448	1N1510A	1N4736A	1N190	1N4148
1N101	1N3070	1N1511A	1N4738A	1N191	1N4148
1N102	1N3070	1N1512A	1N4740A	1N192	1N4148
1N103	1N4448	1N1513A	1N4742A	1N194	1N4148
1N104	1N4448	1N1514A	1N4744A	1N194A	1N4148
1N108	1N4448	1N1515A	1N4746A	1N195	1N4148
1N111	1N4148	1N1516A	1N4748A	1N196	1N4148
1N112	1N4148	1N1517A	1N4750A	1N198	1N4148
1N113	1N4454	1N1518A	1N4730A	1N198	1N4148
1N114	1N4454	1N1519A	1N4732A	1N198A	1N4148
1N115	1N4454	1N1520A	1N4734A	1N198B	1N4454
1N116	1N4454	1N1521A	1N4736A	1N198M	1N4148
1N116A	1N4454	1N1522A	1N4738A	1N251	1N4148
1N117	1N4454	1N1523A	1N4740A	1N251A	1N4148
1N1170	1N4148	1N1524A	1N4742A	1N252	1N4148
1N117A	1N4454	1N1525A	1N4744A	1N252A	1N4148
1N118	1N4454	1N1526A	1N4746A	1N265	1N4148
1N118A	1N4448	1N1527A	1N4748A	1N266	1N4148
1N119	1N4148	1N1528A	1N4750A	1N267	1N4148
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1N126	1N4148	1N175	1N3070	1N270	FDH444
1N126A	1N4148	1N1765A	1N4734A	1N273	1N4448
1N127	1N3070	1N1766A	1N4735A	1N276	1N4454
1N127A	1N3070	1N1767A	1N4736A	1N277	1N3070
1N128	1N4148	1N1768A	1N4737A	1N277M	1N4448
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1N132	1N4148	1N1770A	1N4739A	1N279	1N4448
1N133	1N4148	1N1771A	1N4740A	1N281	1N4448
1N134	1N4454	1N1772A	1N4741A	1N282	1N4448
1N135	1N4148	1N1773A	1N4742A	1N283	FDH444
1N1374	1N5229B	1N1774A	1N4743A	1N287	1N4148
1N139	1N4148	1N1775A	1N4744A	1N288	1N4148
1N140	1N4448	1N1776A	1N4745A	1N289	1N4148
1N141	1N4148	1N1777A	1N4746A	1N290	1N3070
1N142	1N4938	1N1778A	1N4747A	1N291	1N3070
1N143	1N4938	1N1779A	1N4748A	1N292	1N4448
1N144	1N4454	1N1780A	1N4749A	1N294	1N4148
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1N297	1N4148
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1N298	1N4148
1N298A	1N4148
1N299	1N4305
1N300	1N457
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1N301	1N457
1N3016B	1N4736A
1N3017B	1N4737A
1N3018B	1N4738A
1N3019B	1N4739A
1N301A	1N457
1N301B	1N457
1N3020B	1N4740A
1N3021B	1N4741A
1N3022B	1N4742A
1N3023B	1N4743A
1N3024B	1N4744A
1N3025B	1N4745A
1N3026B	1N4746A
1N3027B	1N4747A
1N3028B	1N4748A
1N3029B	1N4749A
1N303	1N458
1N3030B	1N4750A
1N3031B	1N4751A
1N3032B	1N4752A
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1N303B	1N458A
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1N3063	1N4035
1N3064	1N3064
1N3065	1N4035
1N3066	1N4035
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1N3068	1N4148
1N3069	1N4148
1N307	1N4938
1N3070	1N3070
1N3071	1N3070
1N309	1N4148
1N3097	1N4305
1N310	1N4148
1N3110	1N4305
1N312	1N4448

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1N3122	1N4305
1N3123	1N4305
1N3124	1N4151
1N3125	1N4305
1N313	1N4148
1N314	1N4148
1N3144	1N4305
1N3145	1N4305
1N3146	1N4151
1N3147	1N4448
1N3160	1N4305
1N3179	1N3070
1N3180	1N3070
1N3181	1N5237B
1N3197	1N4148
1N3203	1N4305
1N3204	1N4305
1N3215	1N4152
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1N35	1N4454
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1N3535	1N3070
1N3536	1N457
1N355	1N4148
1N3550	1N3070
1N3559	FDH444
1N3564	1N4448
1N3567	1N4448
1N3568	1N4448
1N3575	1N483B
1N3576	1N483B
1N3593	1N4148
1N3594	FDH600
1N3595	1N3595
1N3596	1N4448
1N3597	1N3070
1N3598	1N4152
1N3599	1N4938
1N36	1N4148

Industry Part Number	Recommended National Device
1N3600	1N4148
1N3601	1N4149
1N3602	1N4151
1N3603	1N4151
1N3604	1N4151
1N3605	1N4152
1N3606	1N4153
1N3607	1N4151
1N3608	1N4152
1N3609	1N4153
1N3625	1N3070
1N3638B	1N4744A
1N3653	FDH400
1N3654	1N4448
1N3666	1N4305
1N3668	1N4305
1N3675B	1N4736A
1N3676B	1N4737A
1N3677B	1N4738A
1N3678B	1N4739A
1N3679B	1N4740A
1N3680B	1N4741A
1N3681B	1N4742A
1N3682B	1N4743A
1N3683B	1N4744A
1N3684B	1N4745A
1N3685B	1N4746A
1N3686B	1N4747A
1N3687B	1N4748A
1N3688B	1N4749A
1N3689B	1N4750A
1N3690B	1N4751A
1N3691B	1N4752A
1N373	1N5227B
1N375	1N5230B
1N376	1N5233B
1N377	1N4148
1N378	1N5238B
1N38	1N4148
1N385	1N4148
1N386	1N4148
1N3864	1N458
1N3865	1N4148
1N387	1N4148
1N3872	FDH444
1N3873	FDH444
1N388	1N4148
1N389	1N4148
1N38A	1N3070
1N38B	1N3070

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Industry Part Number	Recommended National Device
1N39	1N3070
1N390	1N4148
1N391	1N4148
1N392	1N4148
1N393	1N3070
1N394	1N3070
1N3944	1N4305
1N3952	1N3070
1N3953	1N4148
1N3954	1N4150
1N3956	1N4305
1N3991	1N4305
1N39A	1N3070
1N39B	1N3070
1N40	1N4148
1N4008	1N4305
1N4043	1N4154
1N4086	FDH444
1N4088	1N4148
1N41	1N4454
1N4147	1N914
1N4148	1N4148
1N4149	1N4149
1N4150	1N4150
1N4152	1N4152
1N4153	1N4153
1N4154	1N4154
1N4158B	1N4736
1N4159B	1N4737
1N4160B	1N4738
1N4161B	1N4739
1N4162B	1N4740
1N4163B	1N4741
1N4164B	1N4742
1N4165B	1N4743
1N4166B	1N4744
1N4167B	1N4745
1N4168B	1N4746
1N4169B	1N4747
1N417	1N4448
1N4170B	1N4748
1N4171B	1N4749
1N4172B	1N4750
1N4173B	1N4751
1N418	1N4148
1N419	FDH444
1N42	1N3070
1N4244	1N4244
1N43	1N4148
1N4305	1N4305

Industry Part Number	Recommended National Device
1N431	1N3070
1N432	1N4148
1N4323B	1N4736A
1N4324B	1N4737A
1N4325B	1N4738A
1N4326B	1N4739A
1N4327B	1N4740A
1N4328B	1N4741A
1N4329B	1N4742A
1N432A	1N4446
1N432B	1N4448
1N433	1N3070
1N4330B	1N4743A
1N4331B	1N4744A
1N4332B	1N4745A
1N4333B	1N4746A
1N4334B	1N4747A
1N4335B	1N4748A
1N4336B	1N4749A
1N4337B	1N4750A
1N4338B	1N4751A
1N4339B	1N4752A
1N433A	1N3070
1N433B	1N3070
1N434	1N3070
1N434A	1N3070
1N434B	1N3070
1N435	1N4148
1N4376	1N4376
1N44	1N3070
1N4443	1N4148
1N4445	1N4151
1N4446	1N4446
1N4447	1N4447
1N4448	1N4448
1N4449	1N4449
1N4454	1N4454
1N4455	1N4305
1N4456	1N4150
1N4457	1N4150
1N447	1N4448
1N448	1N4448
1N45	1N4454
1N450	1N4151
1N4502	1N4305
1N451	1N3070
1N452	1N4448
1N4523	1N4305
1N453	1N3070
1N4531	1N4148

Industry Part Number	Recommended National Device
1N4532	FDH600
1N4533	1N4152
1N4534	1N4153
1N4536	1N4154
1N4537	1N4151
1N454	FDH444
1N4548	1N4154
1N456	1N456A
1N456A	1N456A
1N457	1N457
1N457A	1N457A
1N457M	1N457
1N458	1N458A
1N458A	1N458A
1N458M	1N458A
1N459	1N459
1N459A	1N459A
1N459M	1N459
1N46	1N4454
1N4608	FDH444
1N4610	1N4154
1N4728A	1N4728A
1N4729A	1N4729A
1N4730A	1N4730A
1N4731A	1N4731A
1N4732A	1N4732A
1N4733A	1N4733A
1N4734A	1N4734A
1N4735A	1N4735A
1N4736A	1N4736A
1N4737A	1N4737A
1N4738A	1N4738A
1N4739A	1N4739A
1N4740A	1N4740A
1N4741A	1N4741A
1N4742A	1N4742A
1N4743A	1N4743A
1N4744A	1N4744A
1N4745A	1N4745A
1N4746A	1N4746A
1N4747A	1N4747A
1N4748A	1N4748A
1N4749A	1N4749A
1N4750A	1N4750A
1N4751A	1N4751A
1N4752A	1N4752A
1N478	1N4148
1N479	1N4148
1N48	1N4454
1N480	1N4148

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Industry Part Number	Recommended National Device
1N483	1N483B
1N483A	1N483B
1N483B	1N4148
1N483C	1N485B
1N485	1N485B
1N485A	1N485B
1N485B	1N485B
1N49	1N4148
1N490	1N4148
1N4938	1N4938
1N497	1N4448
1N498	1N4448
1N499	1N4448
1N50	1N4148
1N500	1N4448
1N501	1N4448
1N502	1N3070
1N51	1N4454
1N52	1N4454
1N520B	1N457
1N5223A	1N523B
1N5223B	1N523B
1N5226A	1N5226B
1N5226B	1N5226B
1N5227A	1N5227B
1N5227B	1N5227B
1N5228A	1N5228B
1N5228B	1N5228B
1N5229A	1N5229B
1N5229B	1N5229B
1N5230A	1N5230B
1N5230B	1N5230B
1N5231A	1N5231B
1N5231B	1N5231B
1N5232A	1N5232B
1N5232B	1N5232B
1N5233A	1N5233B
1N5233B	1N5233B
1N5234A	1N5234B
1N5234B	1N5234B
1N5235A	1N5235B
1N5235B	1N5235B
1N5236A	1N5236B
1N5236B	1N5236B
1N5237A	1N5237B
1N5237B	1N5237B
1N5238A	1N5238B
1N5248B	1N5248B
1N5249A	1N5249B
1N5249B	1N5249B

Industry Part Number	Recommended National Device
1N5250A	1N5250B
1N5250B	1N5250B
1N5251A	1N5251B
1N5251B	1N5251B
1N5252A	1N5252B
1N5252B	1N5252B
1N5253A	1N5253B
1N5253B	1N5253B
1N5254A	1N5254B
1N5254B	1N5254B
1N5255A	1N5255B
1N5255B	1N5255B
1N5256A	1N5256B
1N5256B	1N5256B
1N5257A	1N5257B
1N5257B	1N5257B
1N527	1N4305
1N5282	1N5282
1N52A	1N4454
1N5315	1N4153
1N5316	1N4153
1N5317	1N4150
1N5318	1N4150
1N5319	1N4350
1N54	1N4148
1N541	1N4305
1N542	1N4305
1N5427	1N4148
1N5428	1N3070
1N5430	FDH400
1N5431	FDH400
1N5432	FDH777
1N5449	1N485B
1N54A	1N4148
1N55	1N3070
1N5559B	1N4736A
1N5560B	1N4737A
1N5561B	1N4738A
1N5562B	1N4739A
1N5563B	1N4740A
1N5564B	1N4741A
1N5565B	1N4742A
1N5566B	1N4743A
1N5567B	1N4744A
1N5568B	1N4745A
1N5569B	1N4746A
1N5570B	1N4747A
1N5571B	1N4748A
1N5572B	1N4749A
1N5573B	1N4751A

Industry Part Number	Recommended National Device
1N5574B	1N4752A
1N5575B	1N4753A
1N55A	1N3070
1N55B	1N3070
1N56	1N4148
1N566	1N3070
1N567	1N3070
1N568	1N4305
1N569	1N4305
1N56A	1N4148
1N57	1N4454
1N571	FDH444
1N57A	1N4454
1N58	1N3070
1N58A	1N3070
1N5913B	1N4728A
1N5914B	1N4729A
1N5915B	1N4730A
1N5916B	1N4731A
1N5917B	1N4732A
1N5918B	1N4733A
1N5919B	1N4734A
1N5920B	1N4735A
1N5921B	1N4736A
1N5922B	1N4737A
1N5923B	1N4738A
1N5924B	1N4739A
1N5925B	1N4740A
1N5926B	1N4741A
1N5927B	1N4742A
1N5928B	1N4743A
1N5929B	1N4744A
1N5930B	1N4745A
1N5931B	1N4746A
1N5932B	1N4747A
1N5933B	1N4748A
1N5934B	1N4749A
1N5935B	1N4750A
1N5936B	1N4751A
1N5937B	1N4752A
1N5988A	1N5226B
1N5988B	1N5226B
1N5989A	1N5227B
1N5989B	1N5227B
1N5990A	1N5228B
1N5990B	1N5228B
1N5991A	1N5229B
1N5991B	1N5229B
1N5992A	1N5230B
1N5992B	1N5230B

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Industry Part Number	Recommended National Device
1N5993A	1N5231B
1N5993B	1N5231B
1N5994A	1N5232B
1N5994B	1N5232B
1N5995A	1N5234B
1N5995B	1N5234B
1N5996A	1N5235B
1N5996B	1N5235B
1N5997A	1N5236B
1N5997B	1N5236B
1N5998A	1N5237B
1N5998B	1N5237B
1N5999A	1N5239B
1N5999B	1N5239B
1N6000A	1N5240B
1N6000B	1N5240B
1N6001A	1N5241B
1N6001B	1N5241B
1N6002A	1N5242B
1N6002B	1N5242B
1N6003A	1N5243B
1N6003B	1N5243B
1N6004A	1N5245B
1N6004B	1N5245B
1N6005A	1N5246B
1N6005B	1N5246B
1N6006A	1N5248B
1N6006B	1N5248B
1N6007A	1N5250B
1N6007B	1N5250B
1N6008A	1N5251B
1N6008B	1N5251B
1N6009A	1N5252B
1N6009B	1N5252B
1N6010A	1N5254B
1N6010B	1N5254B
1N6011A	1N5256B
1N6011B	1N5256B
1N6012A	1N5257B
1N6012B	1N5257B
1N6099	1N3595
1N61	1N3070
1N616	1N4148
1N617	1N4148
1N618	1N4148
1N619	1N4148
1N62	1N3070
1N622	1N4148
1N63	1N4148
1N631	1N4148

Industry Part Number	Recommended National Device
1N632	1N4148
1N633	1N3070
1N634	1N3070
1N635	1N3070
1N636	1N4448
1N63A	1N4148
1N64	1N4148
1N64A	1N4148
1N65	1N4454
1N66	1N4454
1N664	1N5237B
1N665	1N5242B
1N666	1N5245B
1N667	1N5248B
1N668	1N5251B
1N669	1N5245B
1N66A	1N4454
1N67	1N4148
1N67A	1N4148
1N68	1N3070
1N68A	1N3070
1N69	1N4454
1N695	1N4148
1N695A	1N4148
1N696	1N4148
1N698	1N4305
1N699	1N4448
1N69A	1N4454
1N70	1N3070
1N703	1N5227B
1N703A	1N5227B
1N704	1N5229B
1N704A	1N5229B
1N705	1N5230B
1N705A	1N5230B
1N706	1N5232B
1N706A	1N5232B
1N707	1N5236B
1N707A	1N5236B
1N708	1N5232B
1N708A	1N5232B
1N709	1N5234B
1N709A	1N5234B
1N70A	1N4148
1N710	1N5235B
1N710A	1N5235B
1N711	1N5236B
1N711A	1N5236B
1N712	1N5237B
1N712A	1N5237B

Industry Part Number	Recommended National Device
1N713	1N5239B
1N713A	1N5239B
1N714	1N5240B
1N714A	1N5240B
1N715	1N5241B
1N715A	1N5241B
1N716	1N5242B
1N716A	1N5242B
1N717	1N5243B
1N717A	1N5243B
1N718	1N5245B
1N718A	1N5245B
1N719	1N5246B
1N719A	1N5246B
1N720	1N5248B
1N720A	1N5248B
1N721	1N5250B
1N721A	1N5250B
1N722	1N5251B
1N722A	1N5251B
1N723	1N5252B
1N723A	1N5252B
1N724	1N5254B
1N724A	1N5254B
1N725	1N5256B
1N725A	1N5256B
1N726	1N5257B
1N726A	1N5257B
1N74	1N4148
1N746	1N746A
1N746A	1N746A
1N747	1N747A
1N747A	1N747A
1N748	1N748A
1N748A	1N748A
1N749	1N749A
1N749A	1N749A
1N75	1N3070
1N750	1N750A
1N750A	1N750A
1N751	1N751A
1N751A	1N751A
1N752	1N752A
1N752A	1N752A
1N753	1N753A
1N753A	1N753A
1N754	1N754A
1N754A	1N754A
1N755	1N755A
1N755A	1N755A

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Industry Part Number	Recommended National Device
1N756	1N756A
1N756A	1N756A
1N757	1N757A
1N757A	1N757A
1N758	1N758A
1N758A	1N758A
1N759	1N759A
1N759A	1N759A
1N761A	1N5230B
1N762A	1N5231B
1N763A	1N5238B
1N764A	1N5238B
1N765A	1N5240B
1N766A	1N5243B
1N767A	1N5246B
1N768A	1N5249B
1N769A	1N5252B
1N771	1N4448
1N771A	FDH444
1N772	1N4448
1N772A	FDH444
1N773	1N4448
1N773A	FDH444
1N774	1N4448
1N774A	FDH444
1N775	1N4448
1N776	1N4448
1N777	1N4448
1N778	1N4148
1N779	1N3070
1N781	1N4305
1N781A	1N4305
1N788	1N4448
1N789	1N4148
1N789M	1N4148
1N790	1N4148
1N790M	1N4448
1N791	1N4448
1N791M	1N4448
1N792	1N4448
1N792M	1N4448
1N793	1N4148
1N793M	1N4148
1N794	1N4148
1N795	1N4448
1N796	1N4448
1N797	1N3070
1N798	1N3070
1N799	1N3070
1N800	1N3070

Industry Part Number	Recommended National Device
1N801	1N3070
1N802	1N3070
1N803	1N3070
1N804	1N3070
1N805	1N4148
1N806	1N4148
1N807	1N3070
1N808	1N4448
1N809	1N3070
1N81	1N4148
1N810	1N4148
1N811	1N4148
1N811M	1N4148
1N812	1N4149
1N812M	1N4149
1N813	1N4148
1N813M	1N4148
1N814	1N4148
1N814M	1N4148
1N815	1N4448
1N815M	1N4448
1N817	1N3070
1N818	1N4148
1N818A	1N4148
1N835	1N4305
1N837	FDH444
1N837A	FDH444
1N838	1N3070
1N839	1N3070
1N84	1N4148
1N840	FDH444
1N840M	1N3070
1N841	1N3070
1N842	1N3070
1N843	1N3070
1N844	1N3070
1N845	1N3070
1N86	1N4148
1N87	1N4148
1N87A	1N4148
1N87S	1N4148
1N87T	1N4148
1N88	1N3070
1N89	1N4454
1N890	1N4447
1N891	1N4448
1N892	1N4448
1N893	1N3070
1N897	1N4148
1N898	1N4448

Industry Part Number	Recommended National Device
1N899	1N3070
1N90	1N4454
1N900	1N3070
1N901	1N3070
1N902	1N3070
1N903	1N4148
1N903A	1N4154
1N904	1N4154
1N904A	1N4154
1N904AM	1N4154
1N904M	1N4154
1N905	1N4154
1N905A	1N4154
1N905AM	1N4154
1N905M	1N4154
1N906	1N4149
1N906A	1N4447
1N906AM	1N4447
1N906M	1N4447
1N907	1N4149
1N907A	1N4448
1N907AM	1N4447
1N907M	1N4149
1N908	1N3070
1N908A	1N4447
1N908AM	1N4447
1N908M	1N4149
1N909	1N4448
1N910	1N4448
1N911	1N4448
1N914	1N914
1N914A	1N914A
1N914B	1N914B
1N914M	1N914
1N915	1N3070
1N916	1N916
1N916A	1N916A
1N916B	1N916B
1N918	1N914
1N919	1N3070
1N920	FDH400
1N921	FDH400
1N922	FDH400
1N923	FDH400
1N924	1N483B
1N925	1N4148
1N926	1N4148
1N927	1N4148
1N928	1N3070
1N930	1N4446

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Industry Part Number	Recommended National Device
1N931	1N3070
1N932	1N3070
1N933	1N3070
1N934	1N3070
1N948	1N4448
1N949	1N4305
1N95	1N4148
1N957	1N957B
1N957A	1N957B
1N957B	1N957B
1N958	1N958B
1N958A	1N958B
1N958B	1N958B
1N959	1N959B
1N959A	1N959B
1N959B	1N959B
1N96	1N4447
1N960	1N960B
1N960A	1N960B
1N960B	1N960B
1N961	1N961B
1N961A	1N961B
1N961B	1N961B
1N962	1N962B
1N962A	1N962B
1N962B	1N962B
1N963	1N963B
1N963A	1N963B
1N963B	1N963B
1N964	1N964B
1N964A	1N964B
1N964B	1N964B
1N965	1N965B
1N965A	1N965B
1N965B	1N965B
1N966	1N966B
1N966A	1N966B
1N966B	1N966B
1N967	1N967B
1N967A	1N967B
1N967B	1N967B
1N968	1N968B
1N968A	1N968B
1N968B	1N968B
1N969	1N969B
1N969A	1N969B
1N969B	1N969B
1N96A	1N4148
1N97	1N4448
1N970	1N970B

Industry Part Number	Recommended National Device
1N970A	1N970B
1N970B	1N970B
1N971	1N971B
1N971A	1N971B
1N971B	1N971B
1N972	1N972B
1N972A	1N972B
1N972B	1N972B
1N973	1N973B
1N973A	1N973B
1N973B	1N973B
1N97A	1N4447
1N98	1N4454
1N98A	1N4448
1N99	1N4148
1N993	1N4447
1N994	1N4151
1N995	1N4305
1N997	1N4148
1N999	1N914
1N99A	1N4454
1S920	1S921
1S921	1S921
1S922	1S922
1S923	1S923
AA113	1N4151
AA114	1N916
AA116	1N916
AA129	1N916
AA131	1N916
AA137	1N916
AA138	1N916
AA139	BAV21
AAY10	1N916
AAY48	1N916
AAZ13	1N916
AAZ18	1N916
BA127	1N4151
BA128	1N4151
BA130	1N4454
BA136	1N4151
BA152	1N4150
BA154	1N4150
BA165	1N4150
BA166	1N4454
BA167	1N4454
BA192	FDH400
BA193	FDH400
BA194	FDH400
BA197	FDH400

Industry Part Number	Recommended National Device
BA198	FDH400
BA200	1N4148
BA217	1N4148
BA218	1N4148
BAS13	FDH400
BAS16	BAS16
BAS19	BAS19
BAS20	BAS20
BAS21	BAS21
BAS29	BAS29
BAS31	BAS31
BAS35	BAS35
BAV102	BAV102
BAV103	BAV103
BAV19	BAV19
BAV20	BAV20
BAV21	BAV21
BAV68	BAY72
BAV69	BAV69
BAV70	BAV70
BAV74	BAV74
BAV99	BAV99
BAW10	1N4150
BAW11	BAV19
BAW12	BAV20
BAW24	1N4150
BAW33	BAY72
BAW46	BAY72
BAW47	BAY72
BAW50	FDH400
BAW51	BAY72
BAW52	FDH400
BAW53	1N4150
BAW54	1N4150
BAW55	BAY72
BAW56	BAW56
BAW62	BAW62
BAW75	1N4150
BAW76	BAW76
BAW77	BAY72
BAX13	1N4449
BAX15	FDH400
BAX16	BAX16
BAX17	FDH400
BAX20	FDH444
BAX21	FDH444
BAX83	BAY72
BAY17	BAY72
BAY18	BAY72
BAY19	BAY72

Diode Cross-Reference Guide (continued)

Industry Part Number	Recommended National Device	Industry Part Number	Recommended National Device	Industry Part Number	Recommended National Device
BAY20	FDH400	BZX55C20	BZX55C20	BZX84C5V1	BZX84C5V1
BAY43	1N4148	BZX55C22	BZX55C22	BZX84C5V6	BZX84C5V6
BAY60	1N4150	BZX55C24	BZX55C24	BZX84C6V2	BZX84C6V2
BAY61	1N4150	BZX55C27	BZX55C27	BZX84C6V8	BZX84C6V8
BAY63	1N4150	BZX55C30	BZX55C30	BZX84C7V5	BZX84C7V5
BAY68	1N4150	BZX55C33	BZX55C33	BZX84C8V2	BZX84C8V2
BAY69	1N4150	BZX55C3V3	BZX55C3V3	BZX84C9V1	BZX84C9V1
BAY71	BAY71	BZX55C3V6	BZX55C3V6	BZX84C10	BZX84C10
BAY72	BAY72	BZX55C3V9	BZX55C3V9	BZX84C11	BZX84C11
BAY73	BAY73	BZX55C4V3	BZX55C4V3	BZX84C12	BZX84C12
BAY74	1N4150	BZX55C4V7	BZX55C4V7	BZX84C13	BZX84C13
BAY80	BAY80	BZX55C5V1	BZX55C5V1	BZX84C15	BZX84C15
BAY82	BAY82	BZX55C3V3	BZX55C3V3	BZX84C16	BZX84C16
BZX55B10	BZX55C10	BZX55C3V6	BZX55C3V6	BZX84C18	BZX84C18
BZX55B11	BZX55C10	BZX55C3V9	BZX55C3V9	BZX84C20	BZX84C20
BZX55B12	BZX55C10	BZX55C4V3	BZX55C4V3	BZX84C22	BZX84C22
BZX55B13	BZX55C10	BZX55C4V7	BZX55C4V7	BZX84C24	BZX84C24
BZX55B15	BZX55C10	BZX55C5V1	BZX55C5V1	BZX84C27	BZX84C27
BZX55B16	BZX55C10	BZX55C5V6	BZX55C5V6	BZX84C30	BZX84C30
BZX55B18	BZX55C10	BZX55C6V2	BZX55C6V2	BZX84C33	BZX84C33
BZX55B20	BZX55C10	BZX55C6V8	BZX55C6V8	BZX85C10	BZX85C10
BZX55B22	BZX55C10	BZX55C7V5	BZX55C7V5	BZX85C11	BZX85C11
BZX55B24	BZX55C10	BZX55C8V2	BZX55C8V2	BZX85C12	BZX85C12
BZX55B27	BZX55C10	BZX55C9V1	BZX55C9V1	BZX85C13	BZX85C13
BZX55B30	BZX55C10	BZX79C10	BZX79C10	BZX85C15	BZX85C15
BZX55B33	BZX55C10	BZX79C11	BZX79C11	BZX85C16	BZX85C16
BZX55B3V3	BZX55C10	BZX79C12	BZX79C12	BZX85C18	BZX85C18
BZX55B3V6	BZX55C10	BZX79C13	BZX79C13	BZX85C20	BZX85C20
BZX55B3V9	BZX55C10	BZX79C15	BZX79C15	BZX85C22	BZX85C22
BZX55B4V3	BZX55C10	BZX79C16	BZX79C16	BZX85C24	BZX85C24
BZX55B4V7	BZX55C10	BZX79C18	BZX79C18	BZX85C27	BZX85C27
BZX55B5V1	BZX55C10	BZX79C20	BZX79C20	BZX85C30	BZX85C30
BZX55B3V3	BZX55C10	BZX79C22	BZX79C22	BZX85C33	BZX85C33
BZX55B3V6	BZX55C10	BZX79C24	BZX79C24	BZX85C3V3	BZX85C3V3
BZX55B3V9	BZX55C10	BZX79C27	BZX79C27	BZX85C3V6	BZX85C3V6
BZX55B4V3	BZX55C10	BZX79C30	BZX79C30	BZX85C3V9	BZX85C3V9
BZX55B4V7	BZX55C10	BZX79C33	BZX79C33	BZX85C4V3	BZX85C4V3
BZX55B5V1	BZX55C10	BZX79C3V3	BZX79C3V3	BZX85C4V7	BZX85C4V7
BZX55B5V6	BZX55C10	BZX79C3V6	BZX79C3V6	BZX85C5V1	BZX85C5V1
BZX55B6V2	BZX55C10	BZX79C3V9	BZX79C3V9	BZX85C5V6	BZX85C5V6
BZX55B6V8	BZX55C10	BZX79C4V3	BZX79C4V3	BZX85C6V2	BZX85C6V2
BZX55B7V5	BZX55C10	BZX79C4V7	BZX79C4V7	BZX85C6V8	BZX85C6V8
BZX55B8V2	BZX55C10	BZX79C5V1	BZX79C5V1	BZX85C7V5	BZX85C7V5
BZX55C10	BZX55C10	BZX79C5V6	BZX79C5V6	BZX85C8V2	BZX85C8V2
BZX55C11	BZX55C11	BZX79C6V2	BZX79C6V2	BZX85C9V1	BZX85C9V1
BZX55C12	BZX55C12	BZX79C6V8	BZX79C6V8	DA1701	1N4148
BZX55C13	BZX55C13	BZX79C7V5	BZX79C7V5	DA1702	1N4148
BZX55C15	BZX55C15	BZX79C8V2	BZX79C8V2	DA1703	1N4148
BZX55C16	BZX55C16	BZX79C9V1	BZX79C9V1	DA1704	1N4148
BZX55C18	BZX55C18	BZX84C4V7	BZX84C4V7	FD666	FDH600

Diode Cross-Reference Guide (continued)

Industry Part Number	Recommended National Device
FD700	FD700
FD777	FD777
FDH300	FDH300
FDH300A	FDH300A
FDH333	FDH333
FDH400	FDH400
FDH444	FDH444
FDH600	FDH600
FDH666	FDH600
FDH900	FDH600
FDH999	1N4148
FDLL300	FDLL300
FDLL300A	FDLL300A
FDLL333	FDLL333
FDLL3595	FDLL3595
FDLL4148	FDLL4148
FDLL4150	FDLL4150
FDLL4151	FDLL4151
FDLL4152	FDLL4152
FDLL4153	FDLL4153
FDLL4448	FDLL4448
FDLL463A	FDLL463A
FDLL485B	FDLL485B
FDLL600	FDLL4150
FDLL914	FDLL914
FDLL922	FDLL922
FDLL923	FDLL923
FDN400	FDH400
FDN444	FDH444
FDN666	FDH600
FDSO1201	MMBD1201
FDSO1203	MMBD1203
FDSO1204	MMBD1204
FDSO1205	MMBD1205
FDSO1401	MMBD1401
FDSO1403	MMBD1403
FDSO1404	MMBD1404
FDSO1405	MMBD1405
FDSO1501	MMBD1501
FDSO1503	MMBD1503
FDSO1504	MMBD1504
FDSO1505	MMBD1505
FDSO1701	MMBD1701
FDSO1703	MMBD1703
FDSO1704	MMBD1704
FDSO1705	MMBD1705
FDSO4148	MMBD4148
FDSO914	MMBD914
FJT1100	FJT1100
FJT1101	FJT1101

Industry Part Number	Recommended National Device
FJT1102	FJT1102
FMMD2835	MMBD1205
FMMD2836	MMBD1205
FMMD2837	MMBD1204
FMMD2838	MMBD1204
FMMD6100	MMBD4148
FMMD914	MMBD914
FMMZ5232	MMBZ5232B
FMMZ5233	MMBZ5233B
FMMZ5234	MMBZ5234B
FMMZ5235	MMBZ5235B
FMMZ5236	MMBZ5236B
FMMZ5237	MMBZ5237B
FMMZ5238	MMBZ5238B
FMMZ5239	MMBZ5239B
FMMZ5241	MMBZ5241B
FMMZ5242	MMBZ5242B
FMMZ5243	MMBZ5243B
FMMZ5244	MMBZ5244B
FMMZ5245	MMBZ5245B
FMMZ5246	MMBZ5246B
FMMZ5247	MMBZ5247B
FMMZ5248	MMBZ5248B
FMMZ5249	MMBZ5249B
FMMZ5250	MMBZ5250B
FMMZ5251	MMBZ5251B
FMMZ5252	MMBZ5252B
FMMZ5253	MMBZ5253B
FMMZ5254	MMBZ5254B
FMMZ5255	MMBZ5255B
FMMZ5256	MMBZ5256B
FMMZ5257	MMBZ5257B
MMBD1201	MMBD1201
MMBD1203	MMBD1203
MMBD1204	MMBD1204
MMBD1205	MMBD1205
MMBD1401	MMBD1401
MMBD1403	MMBD1403
MMBD1404	MMBD1404
MMBD1405	MMBD1405
MMBD1501	MMBD1501
MMBD1501A	MMBD1501A
MMBD1503	MMBD1503
MMBD1503A	MMBD1503A
MMBD1504	MMBD1504
MMBD1504A	MMBD1504A
MMBD1505	MMBD1505
MMBD1505A	MMBD1505A
MMBD1701	MMBD1701
MMBD1701A	MMBD1701A

Industry Part Number	Recommended National Device
MMBD1703	MMBD1703
MMBD1703A	MMBD1703A
MMBD1704	MMBD1704
MMBD1704A	MMBD1704A
MMBD1705	MMBD1705
MMBD1705A	MMBD1705A
MMBD2837	MMBD2837
MMBD2838	MMBD2838
MMBD4148	MMBD4148
MMBD7000	MMBD7000
MMBD914	MMBD914
MMBZ5221B	MMBZ5221B
MMBZ5223B	MMBZ5223B
MMBZ5226	MMBZ5226B
MMBZ5226B	MMBZ5226B
MMBZ5227	MMBZ5227B
MMBZ5227B	MMBZ5227B
MMBZ5228	MMBZ5228B
MMBZ5228B	MMBZ5228B
MMBZ5229	MMBZ5229B
MMBZ5229B	MMBZ5229B
MMBZ5230	MMBZ5230B
MMBZ5230B	MMBZ5230B
MMBZ5231	MMBZ5231B
MMBZ5231B	MMBZ5231B
MMBZ5232B	MMBZ5232B
MMBZ5233	MMBZ5233B
MMBZ5233B	MMBZ5233B
MMBZ5234	MMBZ5234B
MMBZ5234B	MMBZ5234B
MMBZ5235	MMBZ5235B
MMBZ5235B	MMBZ5235B
MMBZ5236	MMBZ5236B
MMBZ5236B	MMBZ5236B
MMBZ5237	MMBZ5237B
MMBZ5237B	MMBZ5237B
MMBZ5238	MMBZ5238B
MMBZ5238B	MMBZ5238B
MMBZ5239	MMBZ5239B
MMBZ5239B	MMBZ5239B
MMBZ5241	MMBZ5241B
MMBZ5241B	MMBZ5241B
MMBZ5242	MMBZ5242B
MMBZ5242B	MMBZ5242B
MMBZ5243	MMBZ5243B
MMBZ5243B	MMBZ5243B
MMBZ5244	MMBZ5244B
MMBZ5244B	MMBZ5244B
MMBZ5245	MMBZ5245B
MMBZ5245B	MMBZ5245B

Diode Cross-Reference Guide (continued)

Industry Part Number	Recommended National Device
MMBZ5246	MMBZ5246B
MMBZ5246B	MMBZ5246B
MMBZ5247	MMBZ5247B
MMBZ5247B	MMBZ5247B
MMBZ5248	MMBZ5248B
MMBZ5248B	MMBZ5248B
MMBZ5249	MMBZ5249B
MMBZ5249B	MMBZ5249B
MMBZ5250B	MMBZ5250B
MMBZ5251B	MMBZ5251B
MMBZ5252B	MMBZ5252B
MMBZ5253B	MMBZ5253B
MMBZ5254B	MMBZ5254B
MMBZ5255B	MMBZ5255B
MMBZ5256B	MMBZ5256B
MMBZ5257B	MMBZ5257B
PMBZ5226B	MMBZ5226B
PMBZ5227B	MMBZ5227B
PMBZ5228B	MMBZ5228B
PMBZ5229B	MMBZ5229B
PMBZ5230B	MMBZ5230B
PMBZ5231B	MMBZ5231B
PMBZ5232B	MMBZ5232B
PMBZ5233B	MMBZ5233B
PMBZ5234B	MMBZ5234B
PMBZ5235B	MMBZ5235B
PMBZ5236B	MMBZ5236B
PMBZ5237B	MMBZ5237B
PMBZ5238B	MMBZ5238B
PMBZ5239B	MMBZ5239B
PMBZ5241B	MMBZ5241B
PMBZ5242B	MMBZ5242B
PMBZ5243B	MMBZ5243B
PMBZ5244B	MMBZ5244B
PMBZ5245B	MMBZ5245B
PMBZ5246B	MMBZ5246B
PMBZ5247B	MMBZ5247B
PMBZ5248B	MMBZ5248B
PMBZ5249B	MMBZ5249B
PMBZ5250B	MMBZ5250B
PMBZ5251B	MMBZ5251B
PMBZ5252B	MMBZ5252B
PMBZ5253B	MMBZ5253B
PMBZ5254B	MMBZ5254B
PMBZ5255B	MMBZ5255B
PMBZ5256B	MMBZ5256B
PMBZ5257B	MMBZ5257B
SMD3020001	BZX84C5V1
SMD3020002	BZX84C5V6
SMD3020003	BZX84C6V2
SMD3020004	BZX84C6V8
SMD3020005	BZX84C7V5
SMD3020006	BZX84C12
TMBD2835	MMBD1205
TMBD2836	MMBD1205
TMBD2837	MMBD2837
TMBD2838	MMBD2838
TMBD6100	MMBD4148
TMBD914	MMBD914
TMPZ5230	MMBZ5230B
TMPZ5231	MMBZ5231B
TMPZ5232	MMBZ5232B
TMPZ5233	MMBZ5233B
TMPZ5234	MMBZ5234B
TMPZ5235	MMBZ5235B
TMPZ5236	MMBZ5236B
TMPZ5237	MMBZ5237B
TMPZ5238	MMBZ5238B
TMPZ5239	MMBZ5239B
TMPZ5240	MMBZ5240B
TMPZ5241	MMBZ5241B
TMPZ5242	MMBZ5242B
TMPZ5243	MMBZ5243B
TMPZ5244	MMBZ5244B
TMPZ5245	MMBZ5245B
TMPZ5246	MMBZ5246B
TMPZ5247	MMBZ5247B
TMPZ5248	MMBZ5248B
TMPZ5249	MMBZ5249B
TMPZ5250	MMBZ5250B
TMPZ5251	MMBZ5251B
TMPZ5252	MMBZ5252B
TMPZ5253	MMBZ5253B
TMPZ5254	MMBZ5254B
TMPZ5255	MMBZ5255B
TMPZ5256	MMBZ5256B
TMPZ5257	MMBZ5257B

Bipolar Cross-Reference Guide

Industry Part Number	Recommended National Device
2N1051	TN2219A
2N1074	TN2219A
2N1075	TN2219A
2N1076	TN2219A
2N1077	TN2219A
2N1105	TN3019A
2N1117	TN3019A
2N1206	TN3019A
2N1267	PN2369A
2N1268	PN2369A
2N1269	PN2369A
2N1270	PN2369A
2N1271	PN2369A
2N1272	PN2369A
2N1335	TN2219A
2N1336	TN2219A
2N1337	TN2219A
2N1338	TN2219A
2N1339	TN3019A
2N1340	TN3019A
2N1341	TN3019A
2N1342	TN3019A
2N1369	PN2907
2N1386	PN2222
2N1387	PN2222
2N1388	PN2222
2N1389	PN2222
2N1390	PN2222
2N1439	PN2907A
2N1440	PN2907A
2N1441	PN2907A
2N1442	PN2907A
2N1443	PN2907A
2N1474	PN2907A
2N1474A	PN2907A
2N1475	PN2907A
2N1491	TN2219A
2N1492	TN2219A
2N1505	TN2219A
2N1506	TN2219A

Industry Part Number	Recommended National Device
2N1507	TN2219A
2N1508	TN3019A
2N1509	TN3019A
2N1528	TN2219A
2N1564	TN3019A
2N1565	TN3019A
2N1566	TN3019A
2N1566A	TN3019A
2N1572	TN3019A
2N1573	TN3019A
2N1574	TN3019A
2N1613	TN2219A
2N1613B	TN3019A
2N1623	PN2907
2N1704	TN2219A
2N1711	TN2219A
2N1711A	TN2219A
2N1711B	TN2219A
2N1764	PN2369A
2N1837	TN2219A
2N1837A	TN2219A
2N1837B	TN2219A
2N1838	TN2219A
2N1840	TN2219A
2N1890	TN3019A
2N1893	TN3019A
2N1923	TN3019A
2N1941	TN2219A
2N1943	TN2219A
2N1944	TN2219A
2N1945	TN2219A
2N1946	TN2219A
2N1953	TN2219A
2N1990	TN3019A
2N2017	TN3019A
2N2033	TN3019A
2N2038	TN3019A
2N2039	TN3019A
2N2040	TN3019A
2N2041	TN3019A

Industry Part Number	Recommended National Device
2N2049	TN2219A
2N2086	TN3019A
2N2087	TN3019A
2N2102	TN3019A
2N2106	TN3019A
2N2107	TN3019A
2N2108	TN3019A
2N2193	TN3019A
2N2193A	TN3019A
2N2194	TN2219A
2N2194A	TN2219A
2N2194B	TN2219A
2N2195	TN2219A
2N2195B	TN2219A
2N2198	TN3019A
2N2206	PN2369A
2N2217	TN2219A
2N2218	TN2219A
2N2218A	TN2219A
2N2219	TN2219A
2N2219A	TN2219A
2N2220	PN2222
2N2221	PN2222
2N2221A	PN2222A
2N2222	PN2222
2N2222A	PN2222A
2N2222B	PN2222A
2N2236	TN2219A
2N2237	TN2219A
2N2240	TN2219A
2N2241	TN2219A
2N2243	TN3019A
2N2243A	TN3019A
2N2270	TN6705A
2N2272	PN2222
2N2297	TN2219A
2N2309	TN2219A
2N2310	TN3019A
2N2312	TN3019A
2N2316	TN3019A

Bipolar Cross-Reference Guide (continued)

Industry Part Number	Recommended National Device
2N2317	TN2219A
2N2350	PN2222A
2N2350A	PN2222A
2N2364	TN3019A
2N2364A	TN3019A
2N2369	PN2369
2N2369A	PN2369A
2N2380	TN2219A
2N2380A	TN2219A
2N2389	TN2219A
2N2395	TN2219A
2N2396	TN2219A
2N2397	TN2219A
2N2405	TN3019A
2N2433	TN2219A
2N2435	TN3019A
2N2436	TN3019A
2N2437	TN3019A
2N2438	TN3019A
2N2439	TN3019A
2N2440	TN3019A
2N2475	PN2369A
2N2478	TN2219A
2N2479	TN2219A
2N2484	PN2484
2N2486	PN2484
2N2601	PN2907A
2N2602	PN2907A
2N2603	PN2907A
2N2695	PN2907
2N2709	PN2907
2N2711	2N4123
2N2712	2N4124
2N2713	2N4123
2N2714	2N4124
2N2787	TN2219A
2N2788	TN2219A
2N2789	TN2219A
2N2792	PN2222A
2N2837	PN2907A
2N2863	TN2219A
2N2864	TN2219A
2N2886	TN2219A
2N2904	TN2905A
2N2904A	TN2905A
2N2905	TN2905A
2N2905A	TN2905A
2N2906	PN2907
2N2906A	PN2907A
2N2907	PN2907

Industry Part Number	Recommended National Device
2N2907A	PN2907A
2N2926	2N4124
2N2938	PN2369A
2N2939	TN3019A
2N2940	TN3019A
2N2951	TN2219A
2N2959	TN2219A
2N2960	TN2219A
2N2961	TN2219A
2N3011	PN2369
2N3012	PN2369
2N3014	PN2369
2N3019	TN3019A
2N3020	TN3019A
2N3053	TN3019A
2N3053A	TN3019A
2N3056	TN3019A
2N3057	TN3019A
2N3057A	TN3019A
2N3073	PN2907A
2N3077	PN2484
2N3081	TN3019A
2N3095	PN2907A
2N3107	TN3019A
2N3108	TN3019A
2N3109	TN3019A
2N3115	PN2222A
2N3116	PN2222A
2N3117	2N5210
2N3119	TN3019A
2N3122	TN2219A
2N3123	TN2219A
2N3133	PN2907
2N3134	PN2907
2N3135	PN2907
2N3136	PN2907
2N3227	PN2369
2N3241	PN2222
2N3242	PN2222
2N3244	TN3467A
2N3246	PN2484
2N3247	PN2484
2N3248	PN3640
2N3249	PN2907
2N3250	PN2907A
2N3250A	PN2907A
2N3299	TN2219A
2N3301	PN2222A
2N3302	PN2222A
2N3341	PN2907A

Industry Part Number	Recommended National Device
2N3350	PN2907A
2N3351	PN2907A
2N3352	PN2907A
2N3374	TN3019A
2N3390	2N3390
2N3391A	2N3391A
2N3392	2N3392
2N3393	2N3393
2N3394	2N3393
2N3395	2N3392
2N3396	2N3392
2N3397	2N3393
2N3398	2N3393
2N3402	2N3393
2N3415	2N3415
2N3416	2N3416
2N3417	2N3417
2N3436	PN4302
2N3437	PN3684
2N3438	PN4303
2N3439	TN3440A
2N3440	TN3440A
2N3451	2N5771
2N3464	TN2219A
2N3467	TN3467A
2N3478	TN3467A
2N3485	PN2907
2N3485A	PN2907A
2N3486	PN2907A
2N3486A	PN2907
2N3503	TN2905A
2N3505	PN2907A
2N3508	PN2369A
2N3509	PN2369A
2N3545	PN2907A
2N3546	2N5771
2N3548	2N5086
2N3549	PN918
2N3563	PN3563
2N3566	PN3566
2N3567	PN3567
2N3569	PN3569
2N3576	2N5771
2N3605	PN2369
2N3605A	PN2369
2N3606	PN2369
2N3606A	PN2369A
2N3607	PN2369A
2N3638	PN3638
2N3638A	PN3638A

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Industry Part Number	Recommended National Device	Industry Part Number	Recommended National Device	Industry Part Number	Recommended National Device
2N3639	PN3640	2N4032	TN4033A	2N4423	PN2369
2N3640	PN3640	2N4033	TN4033A	2N4424	BC337
2N3641	PN3642	2N4036	TN4033A	2N4449	PN2369A
2N3642	PN3642	2N4037	TN4033A	2N4450	PN2222
2N3643	2N4401	2N4062	MPS6518	2N4452	PN2907
2N3644	PN3644	2N4086	MPS6514	2N4867	PN4303
2N3645	PN3645	2N4087	MPS6514	2N4872	PN2369A
2N3647	PN2369	2N4087A	MPS6515	2N4873	PN2369A
2N3663	2N3663	2N4121	PN4121	2N4888	2N5401
2N3671	TN2219A	2N4122	PN4122	2N4916	PN4917
2N3672	PN2907A	2N4123	2N4123	2N4917	PN4917
2N3673	PN2907A	2N4124	2N4124	2N4943	TN3019A
2N3678	TN2219A	2N4125	2N4125	2N4944	PN3567
2N3700	TN3019A	2N4126	2N4126	2N4951	PN2222
2N3702	2N3702	2N4140	2N4400	2N4952	PN2222
2N3703	2N3703	2N4141	PN4141	2N4953	2N4953
2N3704	2N3704	2N4142	2N4402	2N4954	PN2222
2N3825	2N4400	2N4143	PN4143	2N4964	2N5087
2N3830	TN2219A	2N4207	PN3640	2N4966	PN2484
2N3831	TN2219A	2N4208	PN3640	2N4967	PN2484
2N3843	2N3903	2N4209	PN3640	2N4968	PN3565
2N3843A	2N3903	2N4227	2N4400	2N4969	2N4400
2N3844	2N3903	2N4228	2N4402	2N4970	2N4401
2N3844A	2N3903	2N4234	T3019A	2N4971	2N4402
2N3845	2N3903	2N4256	2N3904	2N4972	2N4403
2N3845A	2N3903	2N4274	PN4275	2N5026A	MPSA14
2N3854	2N3903	2N4284	2N5087	2N5030	PN2369A
2N3854A	2N3903	2N4285	2N5087	2N5055	PN4258
2N3855	2N3903	2N4286	MPS6515	2N5056	2N5771
2N3855A	2N3903	2N4287	2N3859A	2N5057	2N5771
2N3856	2N3904	2N4288	MPS6518	2N5086	2N5086
2N3858A	TN3019A	2N4294	PN2369A	2N5087	2N5087
2N3859A	2N3859A	2N4295	PN2369	2N5088	2N5088
2N3877	2N5551	2N4354	PN4355	2N5089	2N5089
2N3901	2N5088	2N4355	PN4356	2N5106	TN2219A
2N3903	2N3903	2N4356	PN4357	2N5107	PN2222
2N3904	2N3904	2N4400	2N4400	2N5134	PN5134
2N3905	2N3905	2N4401	2N4401	2N5135	PN2222
2N3906	2N3906	2N4402	2N4402	2N5136	PN2222
2N3917	D44C8	2N4403	2N4403	2N5137	PN2222
2N3962	2N5086	2N4404	TN4033A	2N5138	PN5138
2N3973	2N4400	2N4405	TN4033A	2N5139	PN4917
2N3974	2N4400	2N4406	TN4033A	2N5140	PN3640
2N3975	2N4401	2N4407	TN4033A	2N5141	PN3640
2N3976	2N4401	2N4410	2N4410	2N5142	PN2907
2N3981	TN2219A	2N4418	PN2369A	2N5143	PN2907
2N3982	TN2219A	2N4419	PN2369A	2N5172	2N5172
2N4008	TN4033A	2N4420	PN2369A	2N5175	2N5830
2N4030	TN4033A	2N4421	PN2369A	2N5179	MPS5179
2N4031	TN4033A	2N4422	PN2369A	2N5186	PN2369

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Industry Part Number	Recommended National Device	Industry Part Number	Recommended National Device	Industry Part Number	Recommended National Device
2N5209	2N5210	2N5771	2N5771	2N706	PN2369
2N5210	2N5210	2N5772	2N5772	2N706C	PN2369
2N5219	2N3904	2N5830	2N5830	2N708	PN3646
2N5220	MPS6531	2N5961	2N5961	2N709	PN2369A
2N5221	MPS3702	2N5962	2N5962	2N721A	PN2907
2N5223	MPS6521	2N5999	2N5087	2N722A	PN2907
2N5224	PN2369	2N6000	2N4401	2N730	PN2222A
2N5225	2N4401	2N6001	2N4402	2N734	PN2484
2N5226	2N4402	2N6004	2N4402	2N734A	PN2484
2N5227	PN4249	2N6009	2N5087	2N735	PN2484
2N5228	PN3640	2N6010	2N4401	2N735A	PN2484
2N5306	2N5306	2N6011	2N4402	2N736	PN2484
2N5307	2N5307	2N6021	D45C11	2N736A	PN2484
2N5308	2N5308	2N6076	2N6076	2N736B	PN2484
2N5308A	MPSA14	2N6426	2N6426	2N742	PN2484
2N5309	2N5210	2N6427	2N6427	2N742A	PN2484
2N5310	2N5210	2N6548	2N6548	2N744	PN2369A
2N5311	2N5210	2N6549	2N6549	2N744A	PN2369A
2N5320	TN5322A	2N6551	2N6551	2N756A	PN2484
2N5322	TN5322A	2N6553	TN6705A	2N757A	PN2484
2N5323	TN5322A	2N6554	TN6705A	2N758A	PN2484
2N5354	PN3638	2N6555	2N6555	2N759A	PN2484
2N5355	PN3638	2N669B	TN3019A	2N759B	PN2484
2N5365	PN3638	2N6706	TN6705A	2N834A	PN2369A
2N5366	2N5366	2N6707	TN6705A	2N847	PN2369A
2N5368	2N4400	2N6709	TN6728A	2N850	PN2369A
2N5369	2N4401	2N6710	TN6728A	2N852	PN2369A
2N5371	2N4400	2N6714	TN6714A	2N858	PN2907
2N5372	2N4402	2N6715	TN6715A	2N859	PN2907
2N5373	2N4403	2N6716	TN6715A	2N860	PN2907
2N5375	2N4402	2N6717	TN6717A	2N861	PN2907
2N5380	2N3903	2N6718	TN6717A	2N862	PN2907
2N5381	2N3904	2N6719	TN6719A	2N863	PN2907
2N5382	2N3905	2N6724	TN6725A	2N864	PN2369A
2N5383	2N3906	2N6725	TN6725A	2N864A	PN2369A
2N5400	2N5400	2N6726	TN6726A	2N865	PN2907
2N5401	2N5401	2N6727	TN6726A	2N865A	PN2907
2N5415	TN5415A	2N6728	TN6729A	2N867	PN2907
2N5418	2N4400	2N6729	TN6729A	2N869	PN3640
2N5419	2N4401	2N6730	TN6729A	2N869A	PN3640
2N5420	PN3566	2N6731	TN6705A	2N914	PN2369A
2N5447	MPS3702	2N6732	TN6729A	2N914A	PN2369A
2N5448	MPS3703	2N696	TN2219A	2N918	PN918
2N5449	MPS3704	2N697	TN2219A	2N923	PN2907
2N5450	MPS3704	2N699	TN3019A	2N924	PN2907
2N5525	MPSA13	2N699A	TN3019A	2N925	PN2907
2N5550	2N5551	2N7008	2N7008	2N926	PN2907
2N5551	2N5551	2N7051	2N7053	2N927	PN2907
2N5769	2N5769	2N7052	2N7052	2N928	PN2907
2N5770	2N5770	2N7053	2N7053	2N929	PN930

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Industry Part Number	Recommended National Device
2N929A	PN2484
2N930	PN930
2N930A	PN2484
2N930B	PN2484
2N935	PN2907
2N936	PN2907
2N937	PN2907
2N938	PN2907
2N939	PN2907
2N940	PN2907
2N941	PN2907
2N942	PN2907
2N943	PN2907
2N944	PN2907
2N945	PN2907
2N946	PN2907
2N958	PN2369A
2N959	PN2369A
A5T2192	PN2222A
A5T2222	PN2222A
A5T2243	MPSA06
A5T2604	2N5087
A5T2605	2N5087
A5T2907	PN2907
A5T3392	PN100
A5T3504	PN2907
A5T3506	PN2907
A5T3638	MPS6534
A5T3638A	MPS6534
A5T3644	PN2907
A5T3646	PN2907
A5T3903	2N3903
A5T3904	2N3904
A5T3905	2N3905
A5T3906	2N3906
A5T4058	2N5087
A5T4059	2N3905
A5T4060	2N3905
A5T4061	2N3906
A5T4123	2N4123
A5T4124	2N4124
A5T4125	2N4125
A5T4126	2N4126
A5T4248	PN4249
A5T4249	PN4249
A5T4402	2N4402
A5T4403	2N4403
A5T5058	MPSA42
A5T5059	MPSA42
A5T5086	2N5087

Industry Part Number	Recommended National Device
A5T5087	2N5087
A5T5172	2N4124
A5T5220	MPS6531
A5T5223	MPS6521
A5T5225	2N4401
A5T5226	2N4402
A5T5227	PN4249
A5T5400	2N5400
A5T5550	2N5551
A5T5551	2N5551
A7T3392	PN100
A7T5172	PN100
A8T3702	MPS3702
A8T3703	MPS3703
A8T3704	MPS3704
A8T3705	MPS3704
A8T4058	2N5087
A8T4059	2N3905
A8T4060	2N3905
A8T4061	2N3906
A8T5172	PN100
BC182	BC182
BC182B	BC182B
BC182L	BC182L
BC182LA	BC182LA
BC182LB	BC182LB
BC183	BC183
BC183L	BC183L
BC184	BC184
BC184C	BC184C
BC184L	BC184L
BC184LC	BC184LC
BC212	BC212
BC212B	BC212B
BC212L	BC212L
BC212LB	BC212LB
BC213	BC213
BC213L	BC213L
BC214	BC214
BC214L	BC214L
BC214LB	BC214LB
BC214LC	BC214LC
BC237	BC237
BC237A	BC237A
BC237B	BC237B
BC238	BC238
BC238A	BC238A
BC238C	BC238C
BC239	BC239
BC239C	BC239C

Industry Part Number	Recommended National Device
BC307	BC307
BC307B	BC307B
BC308	BC308
BC308A	BC308A
BC308C	BC308C
BC309	BC309
BC309C	BC309C
BC327	BC327
BC327-16	BC327-16
BC327-25	BC327-25
BC327A	BC327A
BC328	BC328
BC328-25	BC328-25
BC337	BC337
BC337-16	BC337-16
BC337-25	BC337-25
BC337A	BC337A
BC338	BC338
BC368	BC368
BC369	BC369
BC516	BC516
BC517	BC517
BC546	BC546
BC546A	BC546A
BC546B	BC546B
BC547	BC547
BC547A	BC547A
BC547B	BC547B
BC547C	BC547C
BC548	BC548
BC548A	BC548A
BC548B	BC548B
BC548C	BC548C
BC549	BC549
BC549B	BC549B
BC549C	BC549C
BC550	BC550
BC550B	BC550B
BC556B	BC556B
BC557	BC557
BC557B	BC557B
BC558	BC558
BC558B	BC558B
BC558C	BC558C
BC559	BC559
BC559B	BC559B
BC560	BC560
BC560C	BC560C
BC635	BC635
BC636	BC636

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Industry Part Number	Recommended National Device
BC637	BC637
BC638	BC638
BC639	BC639
BC639-16	BC639-16
BC640	BC640
BC807-16	BC807-16
BC807-25	BC807-25
BC807-40	BC807-40
BC817	BC817
BC817-25	BC817-25
BC817-40	BC817-40
BC818-40	BC818-40
BC846A	BC846A
BC846B	BC846B
BC847	BC847
BC847A	BC847A
BC847B	BC847B
BC847C	BC847C
BC848A	BC848A
BC848B	BC848B
BC848C	BC848C
BC849C	BC849C
BC850B	BC850B
BC850C	BC850C
BC856B	BC856B
BC857A	BC857A
BC857B	BC857B
BC857C	BC857C
BC858A	BC858A
BC858B	BC858B
BC858C	BC858C
BC859B	BC859B
BC859C	BC859C
BC860C	BC860C
BCF29	BC857
BCF30	BC857
BCF32	BC847
BCF33	BC847
BCF70	BC857
BCF81	BC847
BCP52	BCP52
BCP53	BCP53
BCP54	BCP54
BCP55	BCP55
BCP56	BCP56
BCV26	BCV26
BCV27	BCV27
BCV71	BCV71
BCV72	BCV72
BCW29	BC857

Industry Part Number	Recommended National Device
BCW30	BCW30
BCW31	BCW31
BCW32	BCW32
BCW33	BCW33
BCW60A	BCW60A
BCW61A	BCW61A
BCW61B	BCW61B
BCW61C	BCW61C
BCW65C	BCW65C
BCW68G	BCW68G
BCW69	BCW69
BCW70	BC857
BCW71	BCW71
BCW72	BC847
BCW81	BC847
BCW89	BCW89
BCX17	BCX17
BCX18	BCX18
BCX19	BCX19
BCX20	BCX20
BCX58	BCX58
BCX59	BCX59
BCX70G	BCX70G
BCX70H	BCX70H
BCX70J	BCX70J
BCX71G	BCX71G
BCX71J	BCX71J
BCX71K	BCX71K
BCX78	BCX78
BCX79	BCX79
BD370CB	BD370CB
BD370C-16B	BD370C-16B
BD371CB	BD371CB
BD371C-16B	BD371C-16B
BD373DB	BD373DB
BF199	BF199
BF240	BF240
BF494	BF494
BS170	BS170
BS250F	BS250F
BSR13	BSR13
BSR14	BSR14
BSR15	BSR15
BSR16	BSR16
BSR17A	BSR17A
BSR18	BSR18A
BSR18A	BSR18A
BSR19	MMBT5550
BSR19A	MMBT5551
BSR20	MMBT5400

Industry Part Number	Recommended National Device
BSR20A	MMBT5401
BSS63	BSS63
BSS64	BSS64
BSS79C	BSS79C
BSS84	BSS84
BSV52	BSV52
CS9011I	CS9011I
CS9012D	CS9012D
CS9012F	CS9012F
CS9012G	CS9012G
CS9013D	CS9013D
CS9013E	CS9013E
CS9013G	CS9013G
CS9013H	CS9013H
CS9013J	CS9013J
CS9014C	CS9014C
CS9015C	CS9015C
CS9016F	CS9016F
CS9016H	CS9016H
CS9018D	CS9018D
CS9018F	CS9018F
CS9018G	CS9018G
CS9018I	CS9018I
D29E1	MPS6534
D29E10	PN2907
D29E2	MPS6534
D29E4	2N4402
D29E5	2N4402
D29E6	2N4403
D29E7	2N4403
D29E9	PN2907
D29F1	MPS6534
D29F2	MPS6534
D29F4	2N5087
D29F5	PN2907
D29F6	PN2907
D32H1	MPSA05
D32H4	MPSA06
D32J1	MPSA55
D32J3	MPSA56
D32L1	MPSA13
D32L2	MPSA14
D32L4	MPSA13
D32L5	MPSA14
D32S1	2N5089
D32V1	MPSA42
D32V2	MPSA42
D32V3	MPSA42
D33D21	MPSA05
D33D22	MPSA05

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Industry Part Number	Recommended National Device
D33D23	MPSA05
D33D24	MPSA05
D33D25	MPSA05
D33D26	MPSA05
D33D27	2N4401
D33D28	MPSA06
D33D29	MPSA06
D33E30	MPSA06
D43C8	D43C8
D44C1	D44C8
D44C8	D44C8
D44C10	D44C8
D44C11	D44C8
D44H1	D44H1
D44H11	D44H11
D44H7	D44H7
D45C10	D45C10
D45C11	D45C11
D45C8	D45C8
D45H11	D45H11
D45H8	D45H8
FMMT2222	MMBT2222
FMMT2222A	MMBT2222A
FMMT2369	MMBT2369
FMMT2369A	MMBT2369A
FMMT2907	MMBT2907
FMMT2907A	MMBT2907A
FMMT3903	MMBT3904
FMMT3904	MMBT3904
FMMT3905	MMBT3906
FMMT3906	MMBT3906
FMMT4123	MMBT3904
FMMT4124	MMBT4124
FMMT4125	MMBT3906
FMMT4126	MMBT4126
FMMT4400	MMBT4400
FMMT4401	MMBT4401
FMMT4402	MMBT4403
FMMT4403	MMBT4403
FMMT5086	MMBT5086
FMMT5087	MMBT5087
FMMT5088	MMBT5088
FMMT5089	MMBT5089
FMMTA05	MMBTA05
FMMTA06	MMBTA06
FMMTA13	MMBTA13
FMMTA14	MMBTA14
FMMTA20	MMBT3904
FMMTA42	MMBTA42
FMMTA43	MMBTA43

Industry Part Number	Recommended National Device
FMMTA55	MMBTA55
FMMTA56	MMBTA56
FMMTA70	MMBT5086
FMMTA92	MMBTA92
FMMTA93	MMBTA93
FT3903	2N3903
FT3904	2N3904
FT3905	2N3905
FT3906	2N3906
GE-10	PN2222
GE-17	MPSA05
GE-20	2N4401
GET2221	PN2222
GET2221A	PN2222A
GET2222	PN2222
GET2222A	PN2222A
GET2369	PN2369
GET2907	PN2907
GET3638	MPS6534
GET3638A	MPS6534
GET3646	PN3646
GET5305	MPSA13
GET5306	MPSA14
GET5307	MPSA13
GET5308	MPSA14
GET5308A	MPSA14
GET929	MPS6514
GET930	MPS6514
MM2055-2	PN2907
MM2270	PN100
MM3005	TN3019A
MM3006	TN3019A
MM3019	TN3019A
MM3020	TN3019A
MM3053	PN3568
MM4005	TN4033A
MM4006	TN4033A
MM4007	TN4033A
MM4009	TN4033A
MM4030	TN4033A
MM4031	TN4033A
MM4032	TN4033A
MM4033	TN4033A
MM4036	TN4033A
MM4037	TN4033A
MM4208	2N5771
MM4209	2N5771
MM4257	2N5771
MM5005	TN4033A
MM5006	TN4033A

Industry Part Number	Recommended National Device
MMBT100	MMBT100
MMBT100A	MMBT100A
MMBT200	MMBT200
MMBT2222	MMBT2222
MMBT2222A	MMBT2222A
MMBT2369	MMBT2369
MMBT2369A	MMBT2369A
MMBT2905	MMBT2907
MMBT2905A	MMBT2907A
MMBT2907	MMBT2907
MMBT2907A	MMBT2907A
MMBT3393	MMBT2222
MMBT3640	MMBT3640
MMBT3642	MMBT100
MMBT3646	MMBT3646
MMBT3702	MMBT3702
MMBT3904	MMBT3904
MMBT3906	MMBT3906
MMBT4123	MMBT3904
MMBT4124	MMBT4124
MMBT4125	MMBT3906
MMBT4126	MMBT4126
MMBT4209	MMBT4209
MMBT4258	MMBT4258
MMBT4400	MMBT4400
MMBT4401	MMBT4401
MMBT4402	MMBT4403
MMBT4403	MMBT4403
MMBT5086	MMBT5086
MMBT5087	MMBT5087
MMBT5088	MMBT5088
MMBT5089	MMBT5089
MMBT5179	MMBT5179
MMBT5401	MMBT5401
MMBT5550	MMBT5551
MMBT5551	MMBT5551
MMBT5770	MMBT5770
MMBT5771	MMBT5771
MMBT5962	MMBT5962
MMBT6427	MMBT6427
MMBT6515	MMBT6515
MMBT918	MMBT918
MMBTA05	MMBTA05
MMBTA06	MMBTA06
MMBTA13	MMBTA13
MMBTA14	MMBTA14
MMBTA20	MMBT3904
MMBTA42	MMBTA42
MMBTA43	MMBTA43
MMBTA55	MMBTA55

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Industry Part Number	Recommended National Device
MMBTA56	MMBTA56
MMBTA64	MMBTA64
MMBTA70	MMBT5086
MMBTA92	MMBTA92
MMBTA93	MMBTA93
MMBTH10	MMBTH10
MMBTH11	MMBTH11
MMBTH20	MMBTH20
MMBTH24	MMBTH24
MMBTH34	MMBTH34
MMBTH81	MMBTH81
MMPQ2222	MMPQ2222
MMPQ2369	MMPQ2369
MMPQ2907	MMPQ2907
MMPQ3467	MMPQ3467
MMPQ3725	MMPQ3725
MMPQ3906	MMPQ3906
MMPQ3904	MMPQ3904
MMPQ6502	MMPQ6502
MMPQ6700	MMPQ6700
MMST2222	MMBT2222
MMST2222A	MMBT2222A
MMST2907	MMBT2907
MMST2907A	MMBT2907A
MMST3904	MMBT3904
MMST3906	MMBT3906
MMST4124	MMBT4124
MMST4126	MMBT4126
MMST4401	MMBT4401
MMST4403	MMBT4403
MMST5086	MMBT5086
MMST5087	MMBT5087
MMST5088	MMBT5088
MMST5089	MMBT5089
MMSTA06	MMBTA06
MMSTA13	MMBTA13
MMSTA14	MMBTA14
MMSTA20	MMBT3904
MMSTA56	MMBTA56
MMSTA70	MMBTA5086
MPE910	2N7000
MPS2222	PN2222
MPS2222A	PN2222A
MPS2369	PN2369
MPS2369A	PN2369A
MPS2713	2N3904
MPS2714	PN2369
MPS2907	PN2907
MPS2907A	PN2907A
MPS2923	2N4123

Industry Part Number	Recommended National Device
MPS2924	2N4124
MPS2925	2N4124
MPS2926	2N4124
MPS3392	PN2222
MPS3393	PN2222
MPS3394	PN2222
MPS3395	PN2222
MPS3564	PN2369
MPS3638	PN3638
MPS3639	PN3640
MPS3640	PN3640
MPS3644	PN3644
MPS3645	PN3645
MPS3646	PN3646
MPS3702	MPS3702
MPS3703	MPS3703
MPS3704	PN100
MPS3705	PN100
MPS3706	PN930
MPS3707	PN930
MPS3708	PN930
MPS3709	PN930
MPS3710	PN930
MPS3711	PN930
MPS3904	2N3904
MPS3905	2N3905
MPS3906	2N3906
MPS4888	2N5401
MPS4889	2N5401
MPS5134	PN2369
MPS5172	PN2222
MPS5179	MPS5179
MPS5551	2N5551
MPS6512	MPS6513
MPS6513	MPS6513
MPS6514	MPS6514
MPS6515	MPS6515
MPS6516	PN4121
MPS6518	MPS6518
MPS6520	MPS6521
MPS6521	MPS6521
MPS6522	2N3904
MPS6523	MPS6523
MPS6530	2N3904
MPS6531	MPS6531
MPS6532	2N3904
MPS6533	2N3906
MPS6534	MPS6534
MPS6535	2N3906
MPS6543	MPS6543

Industry Part Number	Recommended National Device
MPS6562	MPS6562
MPS6571	2N5088
MPS6573	PN100
MPS6574	PN100
MPS6575	PN100
MPS6576	PN100
MPS706	PN2369
MPS706A	PN2369
MPS708	PN2369
MPS8050	MPS8050
MPS8098	MPS8098
MPS834	PN2369
MPS836	PN2369
MPS8550	MPS8550
MPS929A	PN2369
MPS930	PN2369
MPSA05	MPSA05
MPSA06	MPSA06
MPSA09	2N5088
MPSA10	PN2222A
MPSA12	MPSA12
MPSA13	MPSA13
MPSA14	MPSA14
MPSA18	MPSA18
MPSA20	MPSA20
MPSA25	2N7053
MPSA26	2N7053
MPSA27	MPSA27
MPSA28	MPSA28
MPSA29	MPSA29
MPSA42	MPSA42
MPSA43	MPSA43
MPSA55	MPSA55
MPSA56	MPSA56
MPSA62	MPSA63
MPSA63	MPSA63
MPSA64	MPSA64
MPSA65	MPSA65
MPSA70	2N5087
MPSA77	MPSA77
MPSA92	MPSA92
MPSA93	MPSA93
MPSD01	MPSA42
MPSD02	2N5550
MPSD03	2N5550
MPSD04	MPSA12
MPSD05	MPSA06
MPSD06	2N4400
MPSD51	MPSA92
MPSD52	2N5401

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Industry Part Number	Recommended National Device
MPSD53	2N5550
MPSD56	2N3906
MPSH10	MPSH10
MPSH11	MPSH11
MPSH20	MPSH20
MPSH24	MPSH24
MPSH34	MPSH34
MPSH81	MPSH81
MPSL01	MPSL01
MPSL51	MPSL51
NMT2222	NMT2222
NMT2907	NMT2907
NZT44H8	NZT44H8
NZT45H8	NZT45H8
NZT651	NZT651
NZT6714	NZT6714
NZT6715	NZT6715
NZT6717	NZT6717
NZT6726	NZT6726
NZT6728	NZT6728
NZT6729	NZT6729
NZT7053	NZT7053
NZT751	NZT751
PMBT2219	MMBT2222
PMBT2219A	MMBT2222A
PMBT2222	MMBT2222
PMBT2222A	MMBT2222A
PMBT2369	MMBT2369
PMBT2905	MMBT2907
PMBT2905A	MMBT2907A
PMBT2907	MMBT2907
PMBT2907A	MMBT2907A
PMBT3640	MMBT3640
PMBT3903	MMBT3904
PMBT3904	MMBT3904
PMBT3905	MMBT3906
PMBT3906	MMBT3906
PMBT4400	MMBT4401
PMBT4401	MMBT4401
PMBT4402	MMBT4403
PMBT4403	MMBT4403
PMBT5086	MMBT5086
PMBT5087	MMBT5087
PMBT5088	MMBT5088
PMBT5089	MMBT5089
PMBT5401	MMBT5401
PMBT5550	MMBT5550
PMBT5551	MMBT5551
PMBTA05	MMBTA05
PMBTA06	MMBTA06

Industry Part Number	Recommended National Device
PMBTA13	MMBTA13
PMBTA14	MMBTA14
PMBTA20	MMBTA20
PMBTA42	MMBTA42
PMBTA43	MMBTA43
PMBTA55	MMBTA55
PMBTA56	MMBTA56
PMBTA70	MMBTA70
PMBTA92	MMBTA92
PMBTA93	MMBTA93
PMBTH10	MMBTH10
PMBTH81	MMBTH81
PN100	PN100
PN100A	PN100A
PN200	PN200
PN200A	PN200A
PN2222	PN2222
PN2222A	PN2222A
PN2369	PN2369
PN2369A	PN2369A
PN2484	PN2484
PN2907	PN2907
PN2907A	PN2907A
PN3563	PN3563
PN3565	PN3565
PN3566	PN3566
PN3567	PN3567
PN3568	PN3568
PN3569	PN3569
PN3638	PN3638
PN3638A	PN3638A
PN3640	PN3640
PN3642	PN3642
PN3643	PN3643
PN3644	PN3644
PN3645	PN3645
PN3646	PN3646
PN4121	PN4121
PN4122	PN4122
PN4141	PN4141
PN4143	PN4143
PN4248	2N5087
PN4249	PN4249
PN4250	PN4250
PN4250A	PN4250A
PN4258	PN4258
PN4275	PN4275
PN4355	PN4355
PN4356	PN4356
PN4888	2N5401

Industry Part Number	Recommended National Device
PN4917	PN4917
PN5134	PN5134
PN5135	PN3643
PN5136	PN3643
PN5137	PN3643
PN5138	PN5138
PN5139	PN5138
PN5142	2N3905
PN5143	2N3905
PN5415	MPSA92
PN5416	MPSA92
PN5855	MPSA55
PN5857	MPSA56
PN5965	2N5551
PN918	PN918
PN930	PN930
PZT2222A	PZT2222A
PZT2907A	PZT2907A
PZT3904	PZT3904
PZT3906	PZT3906
PZTA06	PZTA06
PZTA14	PZTA14
PZTA42	PZTA42
PZTA56	PZTA56
PZTA64	PZTA64
PZTA92	PZTA92
SMBT2222	MMBT2222
SMBT2222A	MMBT2222A
SMBT2907	MMBT2907
SMBT2907A	MMBT2907A
SMBT3904	MMBT3904
SMBT3906	MMBT3906
SMBTA13	MMBTA13
SMBTA14	MMBTA14
SMBTA42	MMBTA42
SMBTA43	MMBTA43
SMBTA92	MMBTA92
SMBTA93	MMBTA93
SO2222	MMBT2222
SO2222A	MMBT2222A
SO2369	MMBT2369
SO2907	MMBT2907
SO2907A	MMBT2907A
SO3904	MMBT3904
SO3906	MMBT3906
SO5401	MMBT5401
SO5550	MMBT5550
ST5771-1	ST5771-1
TMPT2221	MMBT2222
TMPT2221A	MMBT2222A

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Industry Part Number	Recommended National Device
TMPT2222	MMBT2222
TMPT2222A	MMBT2222A
TMPT2906	MMBT2907
TMPT2906A	MMBT2907A
TMPT2907	MMBT2907
TMPT2907A	MMBT2907A
TMPT3903	MMBT3904
TMPT3904	MMBT3904
TMPT3905	MMBT3906
TMPT3906	MMBT3906
TMPT4401	MMBT4401
TMPT4402	MMBT4403
TMPT4403	MMBT4403
TMPT5086	MMBT5086
TMPT5087	MMBT5087
TMPT5088	MMBT5088
TMPT5089	MMBT5089
TMPT5401	MMBT5401
TMPT5550	MMBT5550
TMPT5551	MMBT5551
TMPTA05	MMBTA05
TMPTA06	MMBTA06
TMPTA13	MMBTA13
TMPTA14	MMBTA14
TMPTA20	MMBT3904
TMPTA42	MMBTA42
TMPTA43	MMBTA43
TMPTA55	MMBTA55
TMPTA56	MMBTA56
TMPTA70	MMBT5086
TMPTA92	MMBTA92
TMPTA93	MMBTA93
TN2219	TN2219A
TN2219A	TN2219A
TN2905	TN2905A
TN2905A	TN2905A
TN3019	TN3019A
TN3019A	TN3019A
TN3440	TN3440A
TN3440A	TN3440A
TN3467	TN3467A
TN3467A	TN3467A
TN3724	TN3725A
TN3725	TN3725A
TN3725A	TN3725A
TN4032	TN4033A
TN4033	TN4033A
TN4033A	TN4033A
TN4037	TN4033A
TN5320A	TN5320A

Industry Part Number	Recommended National Device
TN5322A	TN5322A
TN5415A	TN5415A
TN6705A	TN6705A
TN6714A	TN6714A
TN6715A	TN6715A
TN6717A	TN6717A
TN6719A	TN6719A
TN6725	TN6725A
TN6725A	TN6725A
TN6726A	TN6726A
TN6728	TN6728A
TN6728A	TN6728A
TN6729A	TN6729A
TN6730	TN6729A
TN6732	TN6729A

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Industry Part Number	Recommended National Device
2N2608	2N5460
2N3330	2N5461
2N3331	PN4360
2N3458	J203
2N3459	J202
2N3460	J201
2N3684	PN3684
2N3685	2N3685
2N3686	J201
2N3687	2N3687
2N3819	2N3819
2N3820	2N3820
2N3822	2N5458
2N3823	PN4416
2N3955	NPDS3955
2N3956	NPDS3956
2N3958	NPDS3958
2N3966	PN4392
2N3967	PN3684
2N3967A	PN3684
2N3968	2N5457
2N3968A	2N5457
2N3969	2N5458
2N3969A	2N5458
2N3970	PN4391
2N3971	PN4392
2N3972	PN4393
2N4091	PN4091
2N4092	PN4092
2N4093	PN4093
2N4117	PN4117A
2N4117A	PN4117A
2N4118	PN4118
2N4118A	PN4118A
2N4338	2N4338
2N4339	2N4339
2N4340	2N4340
2N4391	PN4391
2N4392	PN4392
2N4393	PN4393

Industry Part Number	Recommended National Device
2N4416	PN4416
2N4416A	PN4416
2N4856	PN4856
2N4856A	PN4391
2N4857	PN4857
2N4857A	PN4391
2N4858	PN4858
2N4858A	PN4392
2N4859	PN4859
2N4859A	PN4391
2N4860	PN4860
2N4860A	PN4391
2N4861	PN4861
2N4861A	PN4392
2N5018	P1086
2N5019	P1087
2N5103	PN3684
2N5104	PN3684
2N5114	J174
2N5115	J175
2N5116	J176
2N5245	2N5245
2N5246	2N5246
2N5247	2N5247
2N5358	PN3684
2N5359	PN3684
2N5360	PN3684
2N5361	PN3684
2N5397	J310
2N5432	PN5432
2N5433	PN5433
2N5434	PN5434
2N5457	2N5457
2N5458	2N5458
2N5459	2N5459
2N5460	2N5460
2N5461	2N5461
2N5462	2N5462
2N5484	2N5484
2N5485	2N5485

Industry Part Number	Recommended National Device
2N5486	2N5486
2N5555	2N5555
2N5556	PN4393
2N5557	PN4393
2N5558	PN4393
2N5564	NPDS5564
2N5565	NPDS5565
2N5566	NPDS5566
2N5592	2N5457
2N5593	BF244A
2N5594	BF244B
2N5638	2N5638
2N5639	2N5639
2N5640	2N5640
2N5904	2N5904
2N5949	2N5949
2N5950	2N5950
2N5951	2N5951
2N5952	2N5952
2N5953	2N5953
BF244A	BF244A
BF244B	BF244B
BF244C	BF244C
BF245A	BF245A
BF245B	BF245B
BF245C	BF245C
BF256A	BF256A
BF256B	BF256B
BF256C	BF256C
BS170	BS170
BS270	BS270
BSR111	MMBFJ111
BSR112	MMBFJ112
BSR113	MMBFJ113
BSR174	MMBFJ174
BSR175	MMBFJ175
BSR176	MMBFJ176
BSR177	MMBFJ177
BSR50	BSR50
BSR56	BSR56

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Industry Part Number	Recommended National Device
BSR57	BSR57
BSR58	BSR58
J105	J105
J106	J106
J107	J107
J108	J108
J109	J109
J110	J110
J111	J111
J112	J112
J113	J113
J174	J174
J175	J175
J176	J176
J177	J177
J201	J201
J202	J202
J203	J203
J210	J210
J211	J211
J212	J212
J270	J270
J271	J271
J300	J300
J304	J304
J305	J305
J308	J309
J309	J309
J310	J310
MMBF102	MMBF102
MMBF170	MMBF170
MMBF4091	MMBF4091
MMBF4092	MMBF4092
MMBF4093	MMBF4093
MMBF4117	MMBF4117
MMBF4118	MMBF4118
MMBF4119	MMBF4119
MMBF4391	MMBF4391
MMBF4392	MMBF4392
MMBF4393	MMBF4393
MMBF4416	MMBF4416
MMBF4859	MMBF4859
MMBF4860	MMBFJ112
MMBF4861	MMBF4861
MMBF5103	MMBF5103
MMBF5104	MMBF5104
MMBF5114	MMBF5114
MMBF5115	MMBF5115
MMBF5116	MMBF5116
MMBF5457	MMBF5457

Industry Part Number	Recommended National Device
MMBF5458	MMBF5458
MMBF5459	MMBF5459
MMBF5460	MMBF5460
MMBF5461	MMBF5461
MMBF5462	MMBF5462
MMBF5484	MMBF5484
MMBF5486	MMBF5486
MMBFJ111	MMBFJ111
MMBFJ112	MMBFJ112
MMBFJ113	MMBFJ113
MMBFJ174	MMBFJ174
MMBFJ175	MMBFJ175
MMBFJ176	MMBFJ176
MMBFJ177	MMBFJ177
MMBFJ201	MMBFJ201
MMBFJ202	MMBFJ202
MMBFJ203	MMBFJ203
MMBFJ270	MMBFJ270
MMBFJ271	MMBFJ271
MMBFJ304	MMBFJ304
MMBFJ305	MMBFJ305
MMBFJ308	MMBFJ308
MMBFJ309	MMBFJ309
MMBFJ310	MMBFJ310
MMBFU310	MMBFJ310
MPF102	BF245A
MPF108	BF245
MPF111	BF245
MPF256	J210
MPF4391	PN4391
MPF4392	PN4392
MPF4416	PN4416
MPF4856A	2N4856
MPF4857A	2N4856
MPF4858A	2N4858
MPF4859A	2N4859
MPF4860A	2N4860
MPF4861A	2N4861
MPF970	J174
MPF971	J176
P1086	P1086
P1087	P1087
PF5101	PF5101
PF5102	PF5102
PF5103	PF5103
PF5301	PF5301
PF5301-1	PF5301-1
PF5301-2	PF5301-2
PF5301-3	PF5301-3
PMBF4391	MMBF4391

Industry Part Number	Recommended National Device
PMBF4392	MMBF4392
PMBF4393	MMBF4393
PMBF4416	MMBF4416
PMBFJ174	MMBFJ174
PMBFJ175	MMBFJ175
PMBFJ176	MMBFJ176
PMBFJ177	MMBFJ177
PMBFJ308	MMBFJ308
PMBFJ309	MMBFJ309
PMBFJ310	MMBFJ310
PN3684	PN3684
PN4091	PN4091
PN4092	PN4092
PN4093	PN4093
PN4117	PN4117
PN4117A	PN4117A
PN4118	PN4118
PN4118A	PN4118A
PN4119	PN4119
PN4119A	PN4119A
PN4120	PN4120
PN4120A	PN4120A
PN4302	PN4302
PN4303	PN4303
PN4304	PN4304
PN4360	PN4360
PN4391	PN4391
PN4392	PN4392
PN4393	PN4393
PN4416	PN4416
PN4856	PN4856
PN4857	PN4857
PN4858	PN4858
PN4859	PN4859
PN4860	PN4860
PN4861	PN4861
PN5033	PN5033
PN5432	PN5432
PN5433	PN5433
PN5434	PN5434
NPDS402	NPDS402
NPDS403	NPDS403
NPDS404	NPDS404
NPDS406	NPDS406
NPDS5565	NPDS5565
NPDS5565	NPDS5565
NPDS5911	NPDS5911
NPDS5912	NPDS5912
NPDS8301	NPDS8301
NPDS8302	NPDS8302

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Industry Part Number	Recommended National Device
NPDS8303	NPDS8303
NPDS8304	NPDS8304
SST111	MMBFJ111
SST112	MMBFJ112
SST113	MMBFJ113
SST174	MMBFJ174
SST175	MMBFJ175
SST176	MMBFJ176
SST177	MMBFJ177
SST308	MMBFJ308
SST309	MMBFJ309
SST310	MMBFJ310
SST4391	MMBF4391
SST4392	MMBF4392
SST4393	MMBF4393
SST4416	MMBF4416
TIS74	TIS74
TIS75	TIS75
TIS93	TIS93
TIS97	TIS97
TIS98	TIS98
TMBF4091	MMBF4391
TMBF4092	MMBF4392
TMBF4093	MMBF4393
TMBF4391	MMBF4391
TMBF4392	MMBF4392
TMBF4393	MMBF4393
TMBFB24A	BSR58
TMBFB24B	BSR58
TMBFB24C	BSR58
TMPFJ111	MMBFJ111
TMPFJ112	MMBFJ112
TMPFJ113	MMBFJ113
TMPFJ174	MMBFJ174
TMPFJ175	MMBFJ175
TMPFJ176	MMBFJ176
TMPFJ177	MMBFJ177
U1897	U1897
U1898	U1898
U1899	U1899
U257	NPDS5922
U309	MMBFJ309
U310	MMBFJ310
U401	NPDS5584
U403	NPDS5585
U406	NPDS5586

National Semiconductor

Device Selection Guide

Process	Preferred Part Number(s)	Device Type
03	MPSA28	NPN Darlington
05	MPSA14	NPN Darlington
06	2N7053	NPN Darlington
07	2N5088	NPN GPA
10	PN100A	NPN GPA
12	TN3019A	NPN GPA
16	2N5551	NPN GPA
19	PN2222A	NPN GPA
21	PN2369A	NPN Switch
23	2N3904	NPN GPA
25	TN3725A	NPN Switch
30	MPS8050	NPN GPA
33	MPSA06	NPN GPA
36	TN3440A	NPN GPA
37	TN6714A	NPN GPA
38	TN6715A	NPN GPA
39	TN6717A	NPN GPA
40	MPS5179	NPN RF Transistor
42	MPSH10	NPN RF Transistor
43	PN918	NPN RF Amplifier
47	MPSH11	NPN RF Transistor
48	MPSA42	NPN High Voltage
49	MPSH20	NPN RF Transistor
50	2N5484-5486	N-Channel RF Amp
51	J111-113/PN4391	N-Channel Switch
52	J201/202	N-Channel GPA
53	PN4117-4119	N-Channel Switch
55	2N5457-5459	N-Channel GPA
58	J108-110	N-Channel Switch

Process	Preferred Part Number(s)	Device Type
59	J105-107	N-Channel Switch
60	MPS8550	PNP GPA
61	MPSA64	PNP Darlington
62	2N5086	PNP GPA
63	PN2907A	PNP GPA
65	PN4258	PNP Switch
66	2N3906	PNP GPA
67	TN4033A	PNP GPA
68	PN200A	PNP GPA
70	TN3467A	PNP Switch
73	MPSA56	PNP GPA
74	2N5401	PNP GPA
75	MPSH81	PNP RF Transistor
76	MPSA92	PNP High Voltage
77	TN6726A	PNP GPA
78	TN6728A	PNP GPA
79	TN6729A	PNP GPA
83	NPDS8301-8303	N-Chan Dual GPA
88	J174-177	P-Channel Switch
89	2N5460-5462	P-Channel GPA
90	J211/212	N-Channel GPA
92	J309/310	N-Channel RF Amp
93	NPDS5911/5912	N-Chan Dual GPA
96	NPDS5565/5566	N-Chan Dual GPA
98	NPDS402-404	N-Chan Dual GPA
4P	NZT651	NPN Power Amp
4Q	D44H8	NPN Current Driver
5P	NZT751	PNP Power Amp
5Q	D45H8	PNP Current Driver

TABLE 1: Preferred Part Numbers By Process

Switching Selection Guide

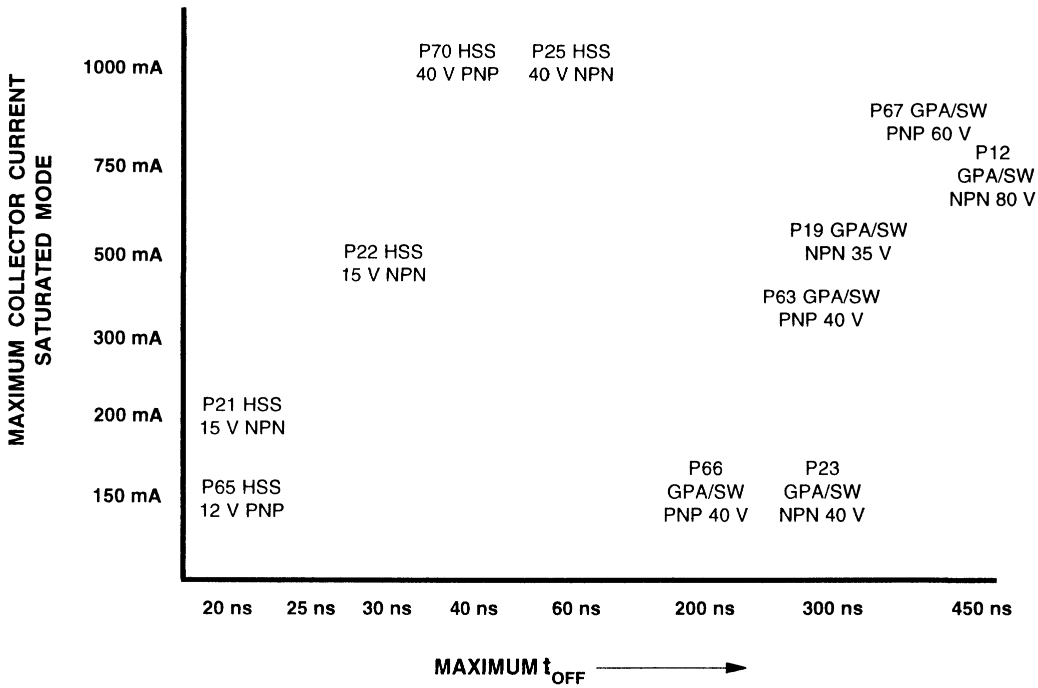

FIGURE 1: Transistor Processes for High Speed Switching

National Semiconductor™

NPN GPA Selection Guide

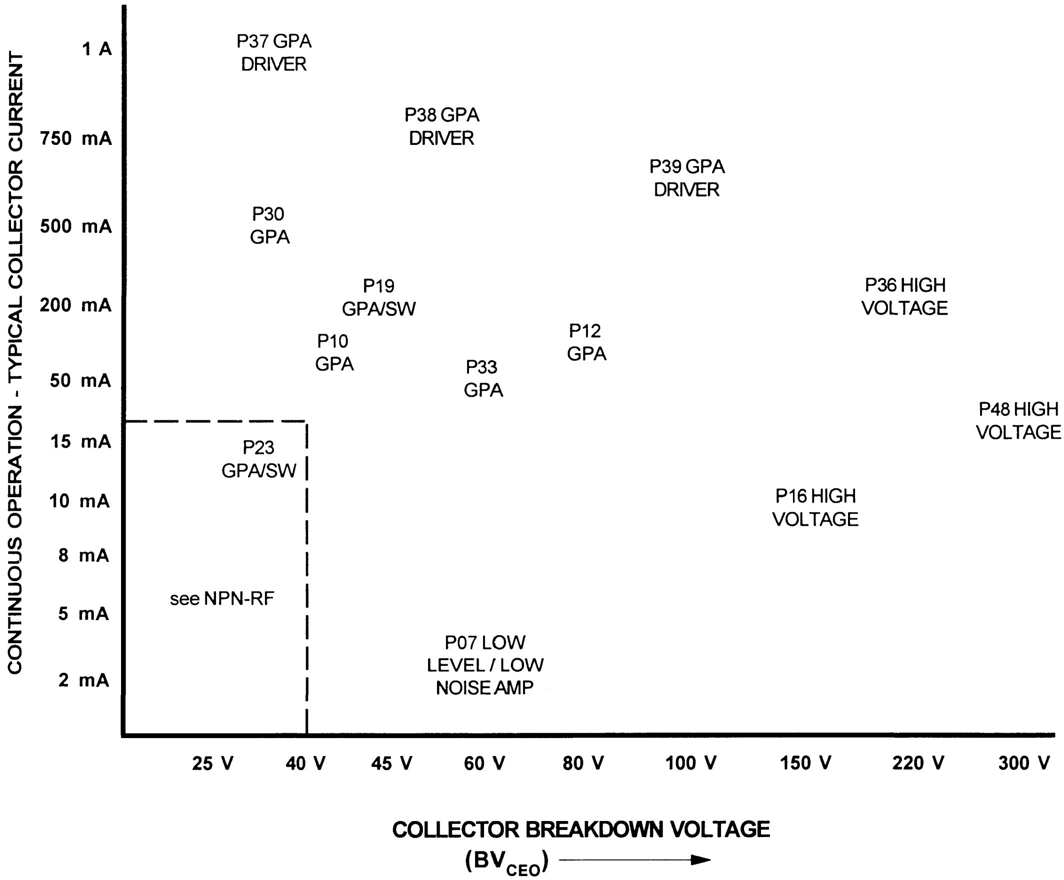

FIGURE 1: Transistor Processes By Dynamic Capability

PNP GPA Selection Guide

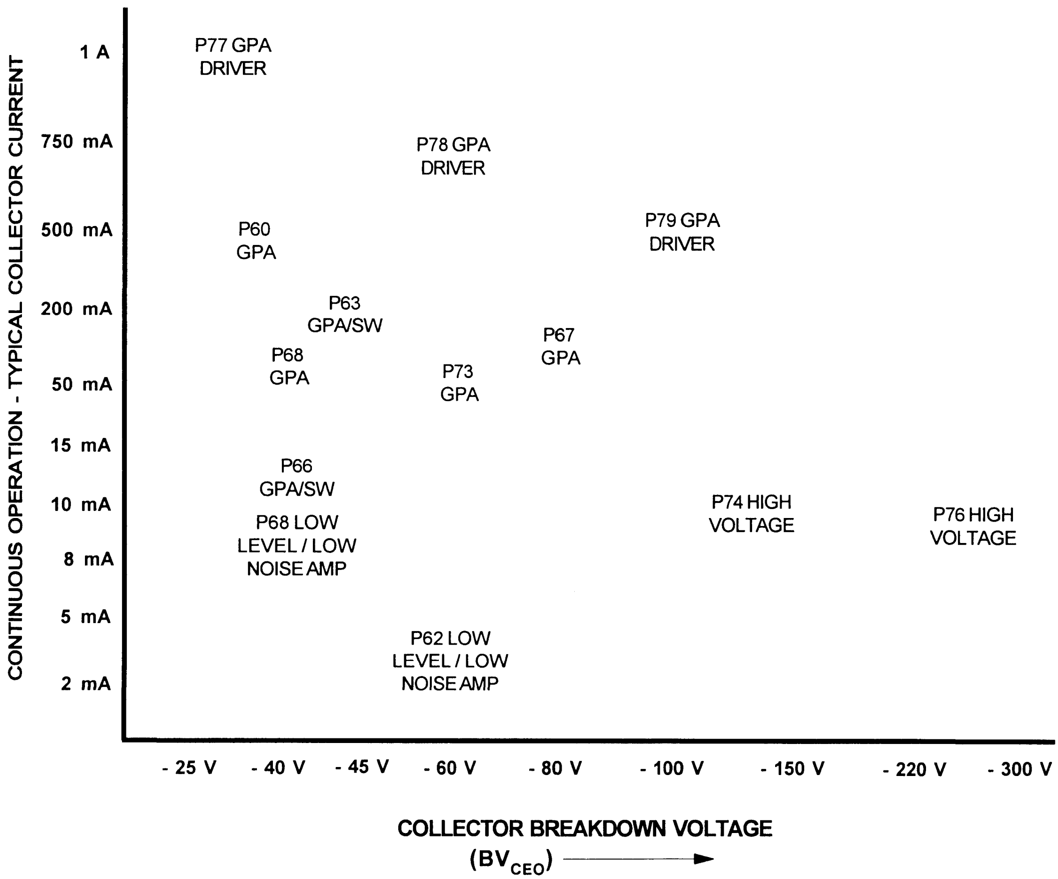

FIGURE 1: Transistor Processes By Dynamic Capability

RF Selection Guide

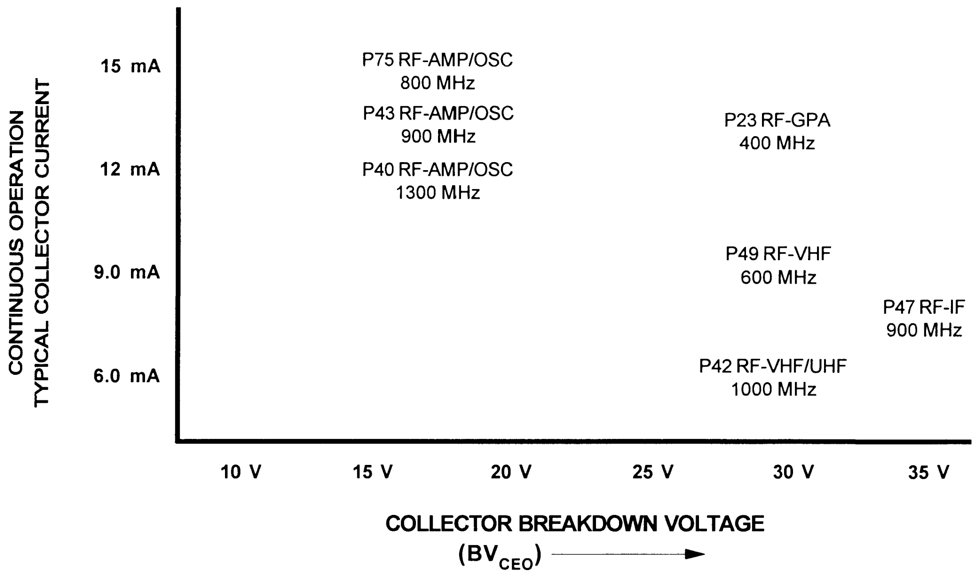

FIGURE 1: Transistor Processes For Radio Frequency

RF Selection Guide (continued)

	Bipolars						JFETs		
	40	42	43	47	49	75	50	90	92
PREAMPLIFIERS									
> 500 MHz	•								
200 MHz - 500 MHz	•	•					•	•	
50 MHz - 250 MHz		•		•		•	•	•	•
20 MHz - 120 MHz				•	•	•	•	•	•
MIXERS									
Input > 500 MHz	•								
Input 200 MHz - 500 MHz	•	•		•			•	•	
Input 50 MHz - 250 MHz	•	•		•	•		•	•	
Input 20 MHz - 120 MHz		•		•	•		•	•	
LOC OSC									
> 500 MHz Mech. Tuned	•	•	•						
> 500 MHz Varactor	•	•							
200 MHz - 500 MHz Mech. Tuned		•	•	•					
200 MHz - 500 MHz Varactor	•	•		•					
50 MHz - 250 MHz		•	•	•		•			
20 MHz - 120 MHz			•	•		•			
IF AMPS									
< 75 MHz	•	•		•	•		•	•	
< 15 MHz			•	•	•		•		
< 75 MHz Last Stage				•	•				•
< 25 MHz Last Stage					•		•		•
SPECIAL USES									
200 MHz - 500 MHz < 1.0 mA Bias	•	•							
50 MHz - 250 MHz < 1.0 mA Bias	•	•		•		•			
200 MHz - 500 MHz, 5.0 mA - 15 mA Linear IF	•								
50 MHz - 250 MHz, 5.0 mA - 15 mA Linear IF	•			•					•
< 120 MHz / 15 mA Wideband RF				•	•	•			•
VHF Freq. Generator and/or Multiplier to 75 mW levels	•		•						

TABLE 1: Transistor Processes For Radio Frequency

National Semiconductor

JFET Selection Guide

N-CHANNEL SINGLES

General Purpose
p50 - g_{fs} 3 to 7 mmhos
I_{DSS} 1 to 20 mA
p52 - g_{fs} 0.5 to 3 mmhos
I_{DSS} 0.1 to 10 mA
p55 - g_{fs} 0.8 to 5 mmhos
I_{DSS} 0.5 to 17 mA

RF / VHF / UHF
p50 - G_{ps} 12 dB @ 400 MHz
g_{fs} 5.5 mmhos
p90 - G_{pt} 11 dB @ 450 MHz
g_{fs} 8 mmhos
p92 - G_{pg} 12 dB @ 450 MHz
g_{fs} 19 mmhos

Ultra-Low Leakage
p50 - I_{GSS} 5 pA @ 20 V
g_{fs} 3 to 7 mmhos
p53 - I_{GSS} 0.3 pA @ 20 V
g_{fs} 0.08 to 0.3 mmhos

Low Freq-Low Noise
p50 - e_n 8 nV / $\sqrt{Hz}$ @ 10 Hz
C_{is} 3 pF
p51 - e_n 6 nV / $\sqrt{Hz}$ @ 10 Hz
g_{fs} 20 mmhos

Switch / Chopper
p50 - r_{DS} 100 to 500 Ω
$I_{D(OFF)}$ 5 pA
p51 - r_{DS} 20 to 100 Ω
$I_{D(OFF)}$ 15 pA
p58 - r_{DS} 3 to 20 Ω
$I_{D(OFF)}$ 5 pA
p59 - r_{DS} 2 to 10 Ω
$I_{D(OFF)}$ 15 pA

P-CHANNEL SINGLES

General Purpose
p88 - g_{fs} 4 to 17 mmhos
I_{DSS} 5 to 90 mA
p89 - g_{fs} 1 to 4 mmhos
I_{DSS} 0.3 to 20 mA

Switch / Chopper
p88 - r_{DS} 50 to 200 Ω
$I_{D(OFF)}$ 50 pA
p89 - r_{DS} 450 Ω
$I_{D(OFF)}$ 20 pA

N-CHANNEL DUALS

General Purpose
p83 - I_G 3 pA @ 20 V
g_{fs} 0.85 mmho @ 0.2 mA
p94 - I_G 1 pA @ 35 V
CMRR 125 dB

Ultra-Low Input
p91 - I_G 1pA @ 25 V
g_{fs} 175 μmhos

Wide Band-Low Noise
p93 - g_{fs} 6 mmhos @ 5 mA
C_{is} 4.2 pF
p96 - g_{fs} 9 mmhos @ 2 mA
C_{is} 10 pF

Low Freq Low Noise
p95 - e_n 8 nV / $\sqrt{Hz}$ @ 10 Hz
g_{fs} 1 to 4 mmhos
p96 - e_n 7 nV / $\sqrt{Hz}$ @ 10 Hz
g_{fs} 10 to 22 mmhos

FIGURE 1: FET Family Tree

Section 2

Short Form Specifications

Section 2 Contents

Section 2 Contents (continued)

Switching Diodes

Computer Diodes (Glass Package)

Device No.	Package No.	V_{RRM} (V) Min	I_R (nA) Max	@ V_R (V)	V_F (V) Min	V_F (V) Max	@ I_F (mA)	C (pF) Max	t_{rr} (ns) Max	Test Cond.	Process No.
1N914	DO-35	100	25 5000	20 75		1	10	4	4	(Note 2)	D3
1N914A	DO-35	100	25 5000	20 75		1	20	4	4	(Note 2)	D3
1N914B	DO-35	100	25 5000	20 75	0.62	0.72 1	5 100	4	4	(Note 2)	D3
1N916	DO-35	100	25 5000	20 75		1	10	2	4	(Note 2)	D3
1N916A	DO-35	100	25 5000	20 75		1	20	2	4	(Note 2)	D3
1N916B	DO-35	100	25 5000	20 75	0.63	0.73 1	5 30	2	4	(Note 2)	D3
1N3064	DO-35	75	100	50	0.505 0.55 0.61	0.575 0.65 0.71 1	0.25 1 2 10	2	4	(Note 1)	D3
1N4148	DO-35	100	25 5000	20 75		1	10	4	4	(Note 2)	D3
1N4149	DO-35	100	25 5000	20 75		1	10	2	4	(Note 2)	D3
1N4150	DO-35	75	100	50	0.54 0.66 0.76 0.82 0.87	0.62 0.74 0.86 0.92 1	1 10 50 100 200	2.5	4	(Note 4)	1R
1N4151	DO-35	75	50	50		1	50	2	4	(Note 1)	D4
1N4152	DO-35	40	50	30	0.49 0.53 0.59 0.62 0.7 0.74	0.55 0.59 0.67 0.7 0.81 0.88	0.1 0.25 1 2 10 20	2	2	(Note 2)	D4
1N4153	DO-35	75	50	50	0.49 0.53 0.59 0.62 0.7 0.74	0.55 0.59 0.67 0.7 0.81 0.88	0.1 0.25 1 2 10 20	2	2	(Note 2)	D4
1N4154	DO-35	35	100	25		1	30	4	4	(Note 2)	D4

Computer Diodes (Glass Package) (continued)

Device No.	Package No.	V_{RRM} (V) Min	I_R (nA) Max @	V_R (V)	V_F (V) Min	V_F (V) Max @	I_F (mA)	C (pF) Max	t_{rr} (ns) Max	Test Cond.	Process No.
1N4244	DO-7	20	100 250	10 15		1	20	0.8	0.75	(Note 1)	1S
1N4305	DO-35	75	100	50	0.505 0.55 0.61 0.7	0.575 0.65 0.71 0.85	0.25 1 2 10	2	2 4	(Note 2) (Note 1)	D3
1N4446	DO-35	100	25	20		1	20	4	4	(Note 2)	D3
1N4447	DO-35	100	25	20		1	20	4	4	(Note 2)	D3
1N4448	DO-35	100	25	20		1	100	2	4	(Note 2)	D3
1N4454	DO-35	75	100	50		1	10	2	4	(Note 1)	D3
1N5282	DO-35	80	100	55	0.45 0.55 0.67 0.8 0.92 1.05	0.49 0.6 0.725 0.9 1.1 1.3	0.1 1 10 100 300 500	2.5	2 4	(Note 2) (Note 4)	1R
FD700	DO-7	30	50	20	0.42 0.52 0.64 0.76 0.81 0.89	0.5 0.61 0.74 0.88 0.95 1.1	0.01 0.1 1 10 20 50	1	0.7	(Note 1)	1S
FD777	DO-7	15	100	8	0.42 0.52 0.64 0.76 0.81 0.89	0.53 0.64 0.79 0.94 1 1.35	0.01 0.1 1 10 20 50	1.3	0.75	(Note 1)	1S
FDH600	DO-35	75	100	50		0.65 0.79 0.86 0.92 1	1 10 50 100 200	2.5	4 6	(Note 1) (Note 3)	1R

TEST CONDITIONS

Note 1: $I_F = I_R = 10$ mA, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$.

Note 2: $I_F = 10$ mA, $V_R = 6.0$ V, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$.

Note 3: $I_F = I_R = 200$ mA, $I_{RR} = 20$ mA, $R_L = 100\Omega$.

Note 4: $I_F = I_R = 10$ to 200 mA, $R_L = 100\Omega$.

Low Leakage Diodes (Glass Package)

Device No.	Package No.	V_{RRM} (V) Min	I_R (nA) Max	@ V_R (V)	V_F (V) Min	V_F (V) Max	@ I_F (mA)	C (pF) Max	Process No.
1N456	DO-35	30	25	25		1	40	10	1M
1N456A	DO-35	30	25	25		1	100		1M
1N457	DO-35	70	25	60		1	20	8	1M
1N457A	DO-35	70	25	60		1	100		1M
1N458	DO-35	150	25	125		1	7	6	1M
1N458A	DO-35	150	25	125		1	100		1M
1N459	DO-35	200	25	175		1	3	6	1M
1N459A	DO-35	200	25	175		1	100		1M
FDH300	DO-35	150	1	125		0.68 0.75 0.8 0.88 0.92 1	1 5 10 50 100 200	6	1M
FDH300A	DO-35	150	1	125		0.68 0.76 0.8 0.89 0.92 1	1 5 10 50 100 200	6	1M
FDH333	DO-35	150	3	125	0.8 0.83 0.86 0.87 0.88 0.9	0.89 0.94 0.97 1.05 1.08 1.15	50 100 150 200 250 300	6	1M
FDH3595	DO-35	150	1	125	0.52 0.60 0.65 0.75 0.79 0.83	0.68 0.76 0.80 0.89 0.92 1.0	1 5 10 50 100 200	8	1M
FJT1100	DO-7	30	0.001 0.01	5 15		1.05	50	1.5	1D
FJT1101	DO-7	20	0.005 0.015	5 15		1.1	50	1.8	1D
FJT1102	DO-7	30	0.015	15	0.5 0.65 0.75	0.6 0.75 0.85 1.1	0.001 0.1 1 50	3.5	1D

High Voltage Diodes (Glass Package)

Device No.	Package No.	V_{RRM} (V) Min	I_R (nA) Max	@ V_R (V)	V_F (V) Min	V_F (V) Max	@ I_F (mA)	C (pF) Max	t_{rr} (ns) Max	Test Cond.	Process No.
1N3070	DO-35	200	100	175		1	100	5	50	(Note 1)	1J
1N4938	DO-35	200	100	175		1	100	5	50	(Note 1)	1J
FDH400	DO-35	200	100	150		1.1	300	2	50	(Note 2)	1J
FDH444	DO-35	150	50	100		1.2	300	2.5	60	(Note 2)	1J

TEST CONDITIONS

Note 1: $I_F = I_R = 30$ mA, $R_L = 100\Omega$.

Note 2: $I_F = 30$ mA, $I_{RR} = 3.0$ mA, $R_L = 100\Omega$.

General Purpose Diodes (Glass Package)

Device No.	Package No.	V_{RRM} (V) Min	I_R (nA) Max	@ V_R (V)	V_F (V) Min	V_F (V) Max	@ I_F (mA)	C (pF) Max	t_{rr} (ns) Max	Test Cond.	Process No.
1N462A	DO-35	70	500	60		1	100				1M
1N463A	DO-35	200	500	175		1	100				1M

National Semiconductor™

Discrete POWER & Signal Technologies

Zener Diodes

Device No.	Package No.	V_Z (V) Nom	Tol. ± V_Z %	Z_Z (Ω) Max	@ I_Z (mA)	I_R (µA) Max	@ V_R (V)	T.C. % / °C Typ / Max	P_D (mW) T_A = 25°C	Process No.
1N746A	DO-35	3.3	5	28	20	10	1	- 0.07	500	D13
1N747A	DO-35	3.6	5	24	20	10	1	- 0.65	500	D13
1N748A	DO-35	3.9	5	23	20	10	1	-0.6	500	D13
1N749A	DO-35	4.3	5	22	20	2	1	- 0.055	500	D13
1N750A	DO-35	4.7	5	19	20	2	1	-0.043	500	D13
1N751A	DO-35	5.1	5	17	20	1	1	+/- 0.03	500	D13
1N752A	DO-35	5.6	5	11	20	1	1	+/- 0.028	500	D13
1N753A	DO-35	6.2	5	7	20	0.1	1	+ 0.045	500	D13
1N754A	DO-35	6.8	5	5	20	0.1	1	+ 0.05	500	D13
1N755A	DO-35	7.5	5	6	20	0.1	1	+ 0.058	500	D13
1N756A	DO-35	8.2	5	8	20	0.1	1	+ 0.062	500	D13
1N757A	DO-35	9.1	5	10	20	0.1	1	+ 0.068	500	D13
1N758A	DO-35	10	5	17	20	0.1	1	+ 0.075	500	D13
1N759A	DO-35	12	5	30	20	0.1	1	+ 0.077	500	D13
1N957B	DO-35	6.8	5	4.5	18.5	150	5.2	+ 0.05	500	D13
1N958B	DO-35	7.5	5	5.5	16.5	75	5.7	+ 0.058	500	D13
1N959B	DO-35	8.2	5	6.5	15	50	6.2	+ 0.062	500	D13
1N960B	DO-35	9.1	5	7.5	14	25	6.9	+ 0.068	500	D13
1N961B	DO-35	10	5	8.5	12.5	10	7.6	+ 0.072	500	D13
1N962B	DO-35	11	5	9.5	11.5	5	8.4	+ 0.073	500	D13
1N963B	DO-35	12	5	11.5	10.5	5	9.1	+ 0.076	500	D13
1N964B	DO-35	13	5	13	9.5	5	9.9	+ 0.079	500	D13
1N965B	DO-35	15	5	16	8.5	5	11.4	+ 0.082	500	D13
1N966B	DO-35	16	5	17	7.8	5	12.2	+ 0.083	500	D13
1N967B	DO-35	18	5	21	7	5	13.7	+ 0.085	500	D13
1N968B	DO-35	20	5	25	6.2	5	15.2	+ 0.086	500	D13
1N969B	DO-35	22	5	29	5.6	5	16.7	+ 0.087	500	D13
1N970B	DO-35	24	5	33	5.2	5	18.2	+ 0.088	500	D13

Zener Diodes (Glass Package) (continued)

Device No.	Package No.	V_Z (V) Nom	Tol. ± V_Z %	Z_Z (Ω) Max	@ I_Z (mA)	I_R (μA) Max	@ V_R (V)	T.C. % / °C Typ / Max	P_D (mW) T_A = 25°C	Process No.
1N971B	DO-35	27	5	41	4.6	5	20.6	+ 0.090	500	D13
1N972B	DO-35	30	5	49	4.2	5	22.8	+ 0.091	500	D13
1N973B	DO-35	33	5	58	3.8	5	25.1	+ 0.092	500	D13
1N4728A	DO-41	3.3	5	10	76	100	1		1000	D14
1N4729A	DO-41	3.6	5	10	69	100	1		1000	D14
1N4730A	DO-41	3.9	5	9	64	50	1		1000	D14
1N4731A	DO-41	4.3	5	9	58	10	1		1000	D14
1N4732A	DO-41	4.7	5	8	53	10	1		1000	D14
1N4733A	DO-41	5.1	5	7	49	10	1		1000	D14
1N4734A	DO-41	5.6	5	5	45	10	2		1000	D14
1N4735A	DO-41	6.2	5	2	41	10	3		1000	D14
1N4736A	DO-41	6.8	5	3.5	37	10	4		1000	D14
1N4737A	DO-41	7.5	5	4	34	10	5		1000	D14
1N4738A	DO-41	8.2	5	4.5	31	10	6		1000	D14
1N4739A	DO-41	9.1	5	5	28	10	7		1000	D14
1N4740A	DO-41	10	5	7	25	10	7.6		1000	D14
1N4741A	DO-41	11	5	8	23	5	8.4		1000	D14
1N4742A	DO-41	12	5	9	21	5	9.1		1000	D14
1N4743A	DO-41	13	5	10	19	5	9.9		1000	D14
1N4744A	DO-41	15	5	14	17	5	11.4		1000	D14
1N4745A	DO-41	16	5	16	15.5	5	12.2		1000	D14
1N4746A	DO-41	18	5	20	14	5	13.7		1000	D14
1N4747A	DO-41	20	5	22	12.5	5	15.2		1000	D14
1N4748A	DO-41	22	5	23	11.5	5	16.7		1000	D14
1N4749A	DO-41	24	5	25	10.5	5	18.2		1000	D14
1N4750A	DO-41	27	5	35	9.5	5	20.6		1000	D14
1N4751B	DO-41	30	5	40	8.5	5	22.8		1000	D14
1N4752A	DO-41	33	5	45	7.5	5	25.1		1000	D14
1N5226B	DO-35	3.3	5	28	20	25	1	- 0.07	500	D13
1N5227B	DO-35	3.6	5	24	20	15	1	- 0.065	500	D13

Zener Diodes (Glass Package) (continued)

Device No.	Package No.	V_Z (V) Nom	Tol. $\pm V_Z$ %	Z_Z (Ω) Max @	I_Z (mA)	I_R (µA) Max @	V_R (V)	T.C. % / °C Typ / Max	P_D (mW) T_A = 25°C	Process No.
1N5228B	DO-35	3.9	5	23	20	10	1	- 0.6	500	D13
1N5229B	DO-35	4.3	5	22	20	5	1	0.055	500	D13
1N5230B	DO-35	4.7	5	19	20	5	2	0.03	500	D13
1N5231B	DO-35	5.1	5	17	20	5	2	0.03	500	D13
1N5232B	DO-35	5.6	5	11	20	5	3	0.038	500	D13
1N5233B	DO-35	6	5	7	20	5	3.5	0.038	500	D13
1N5234B	DO-35	6.2	5	7	20	5	4	+ 0.045	500	D13
1N5235B	DO-35	6.8	5	5	20	3	5	+ 0.05	500	D13
1N5236B	DO-35	7.5	5	6	20	3	6	+ 0.058	500	D13
1N5237B	DO-35	8.2	5	8	20	3	6.5	+ 0.062	500	D13
1N5238B	DO-35	8.7	5	8	20	3	6.5	+ 0.065	500	D13
1N5239B	DO-35	9.1	5	10	20	3	7	+ 0.068	500	D13
1N5240B	DO-35	10	5	17	20	3	8	+ 0.075	500	D13
1N5241B	DO-35	11	5	22	20	2	8.4	+ 0.076	500	D13
1N5242B	DO-35	12	5	30	20	1	9.1	+ 0.077	500	D13
1N5243B	DO-35	13	5	13	9.5	0.5	9.9	+ 0.079	500	D13
1N5244B	DO-35	14	5	15	9	0.1	10	+ 0.082	500	D13
1N5245A	DO-35	15	5	16	8.5	0.1	11	+ 0.082	500	D13
1N5246B	DO-35	16	5	17	7.8	0.1	12	+ 0.083	500	D13
1N5247B	DO-35	17	5	19	7.4	0.1	13	+ 0.084	500	D13
1N5248B	DO-35	18	5	21	7	0.1	14	+ 0.085	500	D13
1N5249B	DO-35	19	5	23	6.6	0.1	14	+ 0.086	500	D13
1N5250B	DO-35	20	5	25	6.2	0.1	15	+ 0.086	500	D13
1N5251B	DO-35	22	5	29	5.6	0.1	17	+ 0.087	500	D13
1N5252B	DO-35	24	5	33	5.2	0.1	18	+ 0.088	500	D13
1N5253B	DO-35	25	5	5	5	0.1	19	+ 0.089	500	D13
1N5254B	DO-35	27	5	41	4.6	0.1	21	+ 0.090	500	D13
1N5255B	DO-35	28	5	44	4.5	0.1	21	+ 0.091	500	D13
1N5256B	DO-35	30	5	49	4.2	0.1	23	+ 0.091	500	D13
1N5257B	DO-35	33	5	58	3.8	0.1	25	+ 0.092	500	D13

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NPN Saturated Switches

Device No.	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (mA) $(I_B = \frac{I_C}{10})$	C_{ob} (pF) Max	f_T (MHz) Min	@ I_C (mA)	$t_{(off)}$ (ns) Max	Test Conditions	Process No.
2N5769	TO-92 (92)	40	15	4.5	400	20	20		100	1	0.2	0.7	0.85	10	4	500	10	18	(Note 1)	21
							30		30	0.4	0.25		1.5	30						
							40	120	10	0.35	0.5		1.6	100						
PN2369	TO-92 (92)	40	15	4.5	400	20	20		100	2	0.25	0.7	0.85	10	4	500	10	18	(Note 1)	21
							40	120	10	1										
PN2369A	**TO-92 (92)**	**40**	**15**	**4.5**	**400**	**20**	**20**		**100**	**1**	**0.2**	**0.7**	**0.85**	**10**	**4**	**500**	**10**	**18**	**(Note 1)**	**21 (5-24)**
							30		**30**	**0.4**	**0.2**		**1.15**	**30**						
							40	**120**	**10**	**1**										
							40		**10**	**0.35**	**0.5**		**1.6**	**100**						
PN4275	TO-92 (92)	40*	15	4.5	500	20	18		100	1	0.2	0.72	0.85	10	4	400	10	12	(Note 2)	21
							30		30	0.4	0.25		1.15	30						
							35	120	10	1	0.5		1.6	100						
PN5134	TO-92 (92)	20*	10	3.5	100	15	15		30	0.4	0.25	0.7	0.9	10	4	250	10	18	(Note 2)	21
							20	150	10	1										
TN3725A	**TO-226 (99)**	**60**	**50**	**6**	**1.7**	**60**	**25**		**1A**	**5**	**0.25**		**0.76**	**10**	**10**	**300**	**50**	**60**	**(Note 4)**	**25 (5-59)**
							20		**800**	**2**	**0.26**		**0.86**	**100**						
							35		**500**	**1**	**0.4**		**1.1**	**300**						
							40		**300**	**1**	**0.25**	**0.9**	**1.2**	**500**						
							60	**150**	**100**	**1**	**0.8**		**1.5**	**800**						
							30		**10**	**1**	**0.95**		**1.7**	**1A**						

TEST CONDITIONS

Note 1: $V_{CC} = 3V$, $I_C = 10$ mA, $I_B^1 = 3$ mA, $I_B^2 = 1.5$ mA.

Note 2: $V_{CC} = 3V$, $I_C = 10$ mA, $I_B^1 = I_B^2 = 3.3$ mA.

Note 3: $V_{CC} = 10V$, $I_C = 300$ mA, $I_B^1 = I_B^2 = 30$ mA.

Note 4: $V_{CC} = 30V$, $I_C = 500$ mA, $I_B^1 = I_B^2 = 50$ mA.

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

NPN Low Level Amplifiers

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	NF (dB) Max	Test Conditions	Process No.
MPSA18	TO-92 (92)	45	45	6.5	50	30	400		0.01	5	0.3			50	3	100	1	1.5	(Note 4)	07
							500		0.1	5										
							500		1	5										
							500	150	10	5										
2N5088	**TO-92 (92)**	**35**	**30**	**5**	**50**	**20**	**300**		**10**	**5**	**0.5**			**10**	**4**			**3**	**(Note 3)**	**07 (5-102)**
							350		**1**	**5**										
							300	**900**	**0.1**	**5**										
2N5089	**TO-92 (92)**	**30**	**25**	**4.5**	**50**	**15**	**400**		**10**	**5**	**0.5**			**10**	**4**			**2**	**(Note 3)**	**07 (5-102)**
							450		**1**	**5**										
							400	**120**	**0.1**	**5**										
2N5210	TO-92 (92)	50	50		50	35	250		10	5	0.7			10	4	30	0.5	3	(Note 4)	07
							250		1	5										
							250	600	0.1	5										
2N5961	TO-92 (92)	60	60	8	2	45	100		0.01	5	0.2			10	4	100	10	6	(Note 7)	07
							120		0.1	5										
							135		1	5								3	(Note 5)	
																		3	(Note 2)	
							150	700	10	5										
2N5962	TO-92 (92)	45	45	8	2	30	450		0.01	5	0.2			10	4	100	10	6	(Note 6)	07
							500		0.1	5								4	(Note 7)	
							550		1	5								8	(Note 8)	
																		3	(Note 5)	
							600	140	10	5								3	(Note 2)	
PN2484	TO-92 (92)	60	60	6	10	45		800	10	5	0.35			10	6			3	(Note 1)	07
							250		1	5										
							200		0.5	5										
							175		0.1	5										
							100	500	0.01	5										
							30		0.001	5										

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

NPN Low Level Amplifiers (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	NF (dB) Max	Test Conditions	Process No.
PN930	TO-92 (92)	45	45	5	10	45		600	10	5	1	0.6	1	10	8	30	0.5	3	(Note 1)	07
							150		0.5	5										
							100	300	0.1	5										
2N3859A	TO-92 (94)	60	60	6	500	18	100	200	10	1					4	90	2			10
							75		1	1										
MPS6521	TO-92 (92)		25	4	50	30	300	600	2	10	0.5			50	3.5			3	(Note 1)	10
							150		0.1	10										
TIS97	TO-92 (97)		40		10	40	250	700	0.1	5								3	(Note 4)	10

TEST CONDITIONS

Note 1: I_C = 10 µA, V_{CE} = 5V, f = 10 Hz - 15.7 kHz.
Note 2: I_C = 10 µA, V_{CE} = 5V, f = 10 kHz - 10 Hz, R_S = 10 kΩ.
Note 3: I_C = 5 µA, V_{CE} = 5V, f = 1 kHz.
Note 4: I_C = 100 µA, V_{CE} = 5V, f = 10 Hz - 15.7 kHz.
Note 5: I_C = 10 µA, V_{CE} = 5V, f = 1 kHz, R_S = 10 kΩ.
Note 6: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz, R_S = 1 kΩ.
Note 7: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz, R_S = 10 kΩ.
Note 8: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz, R_S = 100 kΩ.

NPN RF Amplifiers and Oscillators

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob}/C_{re} (pF) Min	C_{ob}/C_{re} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	NF (dB) Max @	Freq (MHz)	Process No.
MPS517	**TO-92 (92)**	**20**	**12**	**2.5**	**2**	**15**	**25**	**250**	**3**	**1**	**0.4**	**1**	**10**		**1**	**900**	**2000**	**5**	**5**	**200**	**40 (5-108)**
MPSH10	**TO-92 (96)**	**30**	**25**	**3**	**100**	**25**	**60**		**4**	**10**	**0.5**		**4**	**0.35**	**0.65**	**650**		**4**			**42 (5-190)**
2N3663	TO-92 (94)	30	12	3	500	15	20		8	10				0.8	1.7	700	2100	5	6.5	60	43
2N5770	TO-92 (92)	30	15	4.5	10	15	50 20	200	8 3	10 1	0.4	1	10	0.7	1.1	900	1800	8	6	60	43
PN918	**TO-92 (92)**	**30**	**15**	**3**	**10**	**15**	**20**		**3**	**1**	**0.4**	**1**	**10**		**1.7**	**600**		**4**	**6**	**60**	**43 (5-9)**
PN3563	TO-92 (92)	30	15	2	50	15	20	200	8	10					1.7	600	1500	8			43
MPS6543	TO-92 (96)	35	25	3	100	25	25		4	10	0.35	0.9	10		1	750		4			47
MPSH11	**TO-92 (96)**	**30**	**25**	**3**	**100**	**25**	**60**		**4**	**10**	**0.5**		**4**	**0.6**	**0.9**	**650**		**4**			**47 (5-196)**
MPSH24	TO-92 (96)	40	30	4	50	15	30		8	10					0.36	400		8			47
MPSH34	TO-92 (96)	40	40	4	50	30	15 40		20 7	2 15	0.5		7		0.32	500		15			47
MPSH20	**TO-92 (96)**	**40**	**30**	**4**	**50**	**15**	**25**		**4**	**10**					**0.65**	**400**		**4**			**49 (5-204)**

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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NPN General Purpose Amplifiers and Switches

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
2N3390	TO-92 (94)	25	25	5	100	18	400	800	2	4.5					10						10
2N3391A	TO-92 (94)	25	25	5	100	18	250	500	2	4.5					10				5	(Note 5)	10
2N3392	TO-92 (94)	25	25	5	100	18	150	300	2	4.5					10						10
2N3393	TO-92 (94)	25	25	5	100	18	90	180	2	4.5					10						10
2N3415	TO-92 (94)	25	25	5	100	25	180	540	2	4.5	0.3	0.6	1.3	50							10
2N3416	TO-92 (94)	50	50	5	100	25	75	225	2	4.5	0.3	0.6	1.3	50							10
2N3417	TO-92 (94)	50	50	5	100	25	180	540	2	4.5	0.3	0.6	1.3	50							10
2N3704	TO-92 (94)	50	30	5	100	20	100	300	50	2	0.6			100	12	100	50				10
2N5172	TO-92 (94)	25	25	5	100	25	100	500	10	10	0.25			10	10						10
MPS8098	TO-92 (92)	60	60	6	100	60	100 100 75	300	1 10 100	5 5 5	0.3			100	6	150	10				10
MPSA20	TO-92 (92)		40	4	100	30	40	400	5	10					4	125	5				10

NPN General Purpose Amplifiers and Switches (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}^{*} I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max	@ I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
PN100	**TO-92**	**75**	**45**	**6**	**50**	**60**	**80**		**0.1**	**1**	**0.2**	**0.85**	**10**	**4.5**	**250**		**20**		**5**	**(Note 3)**	**10**
	(92)						**100**	**450**	**10**	**1**											**(5-1)**
							100		**100**	**1**	**0.4**	**1**	**200**								
							100	**350**	**150**	**5**											
PN100A	**TO-92**	**75**	**45**	**6**	**50**	**60**	**240**		**0.1**	**1**	**0.2**	**0.85**	**10**	**4.5**	**250**		**20**		**4**	**(Note 3)**	**10**
	(92)						**300**	**600**	**10**	**1**											**(5-1)**
							100		**100**	**1**	**0.4**	**1**	**200**								
							100		**150**	**5**											
PN3565	TO-92	30	25	6	50	25	150	600	1	10	0.35		1	4	40	240	1				10
	(92)																				
PN3642	TO-92	60	45	5	50*	50	15		500	10	0.22		150	8	150		50				10
	(92)						40	120	150	10											
PN3643	TO-92	60	30	5	50*	50	20		500	10	0.22		150	8	250		50				10
	(92)						100	300	150	10											
PN4141	TO-92	60	30	5			30		500	10	0.4	1.3	150	8	250		20	310		(Note 2)	10
	(92)						50		150	1											
							100	300	150	10	1.6	2.6	500								
							75		10	10											
							50		1	10											
							35		0.1	10											
TIS98	TO-92		60		10	40	100	300	1	5	0.5		100		2		10				10
	(97)																				
2N4410	TO-92	120	80	5	10	100	60	400	10	1	0.2	0.8	1	12	60	300	10				16
	(92)						60		1	1											
2N5551	**TO-92**	**180**	**160**	**6**	**50**	**120**	**30**		**50**	**5**	**0.15**	**1**	**10**	**6**	**100**	**300**	**10**		**8**	**(Note 4)**	**16**
	(92)						**80**	**250**	**10**	**5**											**(5-118)**
							80		**1**	**5**	**0.2**	**1**	**50**								
2N5830	TO-92	120	100	5	50	100	60		1	5	0.15	0.8	1		100	500	10				16
	(92)						80	500	10	5		1	10								
							80		50	5	0.2	1	50								

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

NPN General Purpose Amplifiers and Switches (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
MPSL01	TO-92 (92)	140	120	6	10	40	50	300	10	5	0.2		1.2	10	8	60	10				16
											0.3		1.4	50							
2N4400	TO-92 (92)	60	40	6			20		500	2	0.4	0.75	0.95	150	6.5	200	20	255		(Note 2)	19
							50	150	150	1											
							40		10	1	0.75		1.2	500							
							20		1	1											
2N4401	TO-92 (92)	60	40	6			40		500	2	0.4	0.75	0.95	150	6.5	250	20	255		(Note 2)	19
							100	300	150	1											
							80		10	1	0.75		1.2	500							
							40		1	1											
							20		0.1	1											
2N4953	TO-92 (94)	60	30	5	50	40	200	600	150	10	0.3		1.3	150	8	250	20	400		(Note 2)	19
							150		10	10											
							75		1	10											
MPS6531	TO-92 (92)	60	40	5	50	40	50		500	10	0.3		1	100	5						19
							90	270	100	1											
							60		10	1											
PN2222	TO-92 (92)	60	30	5	10	50	30		500	10	0.4		1.3	150	8	250	20				19
							50		150	1											
							100	300	150	10	1.6		2.6	500							
							75		10	10											
							50		1	10											
							35		0.1	10											
PN2222A	**TO-92 (92)**	**75**	**40**	**6**	**10**	**60**	**40**		**500**	**10**	**0.3**	**0.6**	**1.2**	**150**	**8**	**300**	**20**	**285**		**(Note 2)**	**19 (5-18)**
							50		**150**	**1**											
							100	**300**	**150**	**10**	**1**		**2**	**500**					**4**	**(Note 8)**	
							75		**10**	**10**											
							50		**1**	**10**											
							35		**0.1**	**10**											

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

NPN General Purpose Amplifiers and Switches (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	@ I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
TN2219A	TO-226 (99)	75	40	6	10	60	40		500	10		0.6	1.2	150	8	300	20			(Note 2)	19
							50		150	1			2	500							
							100	300	150	10											
							75		10	10											
							50		1	10											
							35		0.01	10											
2N3903	TO-92 (92)	60	40	6			15		100	1	0.2	0.6	0.85	10	4	250	10	255		(Note 6)	23
							30		50	1											
							50	150	10	1	0.3		0.95	50					6	(Note 7)	
							35		1	1											
							20		0.1	1											
2N3904	**TO-92 (92)**	**60**	**40**	**6**			**30**		**100**	**1**	**0.2**	**0.65**	**0.85**	**10**	**4**	**300**	**10**	**250**		**(Note 6)**	**23 (5-65)**
							60		**50**	**1**											
							100	**300**	**10**	**1**	**0.3**		**0.95**	**50**					**5**	**(Note 7)**	
							70		**1**	**1**											
							40		**0.01**	**1**											
2N4123	TO-92 (92)	40	30	5	50	20	25		50	1	0.3		0.95	50	4	250	10		6	(Note 7)	23
							50	150	2	1											
2N4124	TO-92 (92)	30	25	5	50	20	60		50	1	0.3		0.95	50	4	300	10		5	(Note 7)	23
							120	360	2	1											
MPS6513	TO-92 (92)	40	30	4	50	30	60		100	10	0.5			50	3.5						23
							90	180	2	10											
MPS6514	TO-92 (92)	40	25	4	50	30	90		100	10	0.5			50	3.5						23
							150	300	2	10											
MPS6515	TO-92 (92)	40	25	4	50	30	150		100	10	0.5			50	3.5						23
							250	500	2	10											

TEST CONDITIONS

Note 1: I_C = 10 µA, V_{CE} = 5V, f = 10 Hz - 15.7 kHz.
Note 2: I_C = 150 mA, V_{CC} = 30V, I_B^1 = I_B^2 = 15 mA.
Note 3: I_C = 200 µA, V_{CE} = 5V, f = 1 kHz.
Note 4: I_C = 250 µA, V_{CE} = 5V, f = 10 Hz - 15.7 kHz.
Note 5: I_C = 100 µA, V_{CE} = 4.5V, f = 10 Hz - 15.7 kHz.
Note 6: I_C = 10 mA, V_{CC} = 3V, I_B^1 = I_B^2 = 1 mA.
Note 7: I_C = 100 µA, V_{CE} = 5V, f = 10 Hz - 15.7 kHz.
Note 8: I_C = 100 µA, R_S = 1.0 kΩ, f = 1.0 kHz.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Discrete POWER & Signal Technologies

NPN Medium Power

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	$t_{(off)}$ (µs) Max	Test Conditions	Process No.
PN3568	TO-92 (92)	80	60	5	50	40	40		30	1	0.25			150	20	60	600	50			12
							40	120	150	1											
TN3019A	**TO-226 (99)**	**140**	**80**	**7**	**10**	**90**	**50**		**1**	**10**	**0.2**			**150**	**12**	**100**		**50**			**12 (5-39)**
							90		**10**	**10**			**1.1**	**1.0**							
							100	**300**	**150**	**10**	**0.5**			**500**							
							50		**500**	**10**											
							15		**1A**	**10**											
MPS805	**TO-92 (92)**	**40**	**25**	**6**	**100**	**35**	**45**		**5**	**1**	**0.5**		**1.2**	**800**	**9**	**100**		**50**			**30 (5-154)**
							80	**300**	**100**	**1**											
							40		**800**	**1**											
MPSA05	TO-92 (92)	60	60	4	100	60	100		10	1	0.25			100		100		10			33
							100		100	1											
MPSA06	**TO-92 (92)**	**80**	**80**	**4**	**100**	**80**	**100**		**10**	**1**	**0.25**			**100**		**100**		**10**			**33 (5-160)**
							100		**100**	**1**											
TN5320A	TO-226 (99)	100	80				30	130	500	4	0.5			500					1.8	(Note 1)	34
							10		1A	2											
TN3440A	**TO-226 (99)**	**300**	**250**	**7**	**200**	**250**	**30**		**2**	**10**	**0.5**		**1.3**	**50**	**10**	**15**		**10**			**36 (5-45)**
							40	**160**	**20**	**10**											
TN6714A	**TO-226 (99)**	**40**	**30**	**5**	**100**	**40**	**55**		**10**	**1**	**0.5**			**1A**	**30**						**37 (5-126)**
							60		**100**	**1**											
							50	**250**	**1A**	**1**											
TN6705A	TO-226 (99)	60	45	5	100	100	40		50	2	0.5			500	30						38
							40	250	250	2	1			1A							
							25		500	2											
TN6715A	**TO-226 (99)**	**40**	**50**	**5**	**100**	**50**	**60**		**10**	**1**	**0.5**			**1A**	**30**						**38 (5-130)**
							50	**250**	**100**	**1**											

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

NPN Medium Power (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max	@ I_C (mA)	$t_{(off)}$ (ns) Max	Test Conditions	Process No.
TN6717A	**TO-226 (99)**	**80**	**80**	**5**	**100**	**60**	**80**		**50**	**1**	**0.5**			**250**	**30**						**39 (5-134)**
							50	**250**	**250**	**1**											
							20		**500**	**1**											
MPSA42	**TO-92 (92)**	**300**	**300**	**6**	**100**	**200**	**25**		**1**	**10**	**0.5**		**0.9**	**20**	**3**	**50**		**10**			**48 (5-172)**
							40		**10**	**10**											
							40		**30**	**10**											
MPSA43	TO-92 (92)	200	200	6	100	160	25		1	10	0.4		0.9	20	4	50		10			48
							40		10	10											
							50	200	30	10											
TN6719A	TO-226 (99)	300	300	7	100	200	25		1	10						30	300	15			48
							40		10	10											
							40	200	30	10											

TEST CONDITIONS

Note 1: I_C = 500 mA, V_{CC} = 30V, I_B^1 = I_B^2 = 50 mA.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Discrete POWER & Signal Technologies

NPN Darlington Transistors

Device No.	Case Style	V_{CBO} (V) Min	V_{CES} (V) Min	V_{EBO} (V) Min	I_{CBO} (µA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) @	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	Process No.
MPSA27	TO-92 (92)	60	60		0.1	50	10,000 10,000		10 100	5 5	1.5		2	100		125	10	03
MPSA28	**TO-92 (92)**	**80**	**80**	**12**	**0.1**	**60**	**10,000 10,000**		**10 100**	**5 5**	**1.2 1.5**		**2**	**10 100**	**8**	**125**	**10**	**03 (5-168)**
MPSA29	TO-92 (92)	100	100	12	0.1	80	10,000 10,000		10 100	5 5	1.2 1.5		2	10 100	8	125	10	03
2N5306	TO-92 (94)	25	25	12	0.1	25	7000	70,000	2	5	1.4			200	10	60	2	05
2N5307	TO-92 (94)	40	40	12	0.1	40	2000	20,000	2	5	1.4			200	10	60	2	05
2N5308	TO-92 (94)	40	40	12	0.1	40	7000	70,000	2	5	1.4			200	10	60	2	05
2N6426	TO-92 (92)	40	40	12	0.05	30	20,000 30,000 20,000	200,000 300,000 300,000	10 100 500	5 5 5	1.2 1.5		 2	50 500	7	150	10	05
2N6427	TO-92 (92)	40	40	12	0.05	30	10,000 20,000 14,000	100,000 200,000 140,000	10 100 500	5 5 5	1.2 1.5		 2	50 500	7	130	10	05
MPSA12	TO-92 (92)		20	10	100	15	20,000		10	5	1			10				05
MPSA13	TO-92 (92)		30	10	100	30	10,000 5000		100 10	5 5	1.5			100		125	10	05

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

NPN Darlington (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CES} (V) Min	V_{EBO} (V) Min	I_{CBO} (µA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) @	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	Process No.
MPSA14	**TO-92 (92)**	**30**	**30**	**10**	**0.1**	**30**	**20,000** **10,000**		**100** **10**	**5** **5**	**1.5**			**100**		**125**	**10**	**05 (5-164)**
TN6725A	TO-226 (99)	50		12	0.1	40	25,000 15,000 10,000	 40,000	200 500 1A	5 5 5	1			200				05
2N7052	TO-92 (92)	100	100	12	0.1	80	20,000 1000	 20,000	100 1A	5 5	1.5			100	10	100	100	06
2N7053	**TO-92 (92)**	**100**	**100**	**12**	**0.1**	**80**	**10,000** **1000**	 **20,000**	**100** **1A**	**5** **5**	**1.5**			**100**	**8**	**100**	**100**	**06 (5-150)**

NPN Bipolar Power Transistors

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (µA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (A) @	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (A)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	Process No.
D44C8	TO-220 (37)		60	5	100	70	40 20	120	0.2 1	1 1	0.5		1.3	1	100	3	0.02	4P
D44H1	TO-220 (37)		30	5	10	30	35 20		2 4	1 1	1		1.5	8				4Q
D44H8	**TO-220 (37)**		**60**	**5**	**10**	**60**	**60** **40**		**2** **4**	**1** **1**	**1**		**1.5**	**8**		**50**	**0.5**	**4Q (5-216)**
D44H11	TO-220 (37)		80	5	10	80	60 40		2 4	1 1	1		1.5	8				4Q

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Discrete POWER & Signal Technologies

PNP Saturated Switches

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	$t_{(off)}$ (nA) Max	Test Conditions	Process No.
2N5771	TO-92 (92)	15	15	4.5	10	8	50	120	10	0.3	0.15		0.8	1	3	700		10	20	(Note 1)	65
							40		50	1	0.18	0.8	0.95	10							
							35		1	0.5	0.6		1.5	50							
PN3640	TO-92 (92)	12	12	4	10*	6	20		50	1	0.2	0.8	1	10	3.5	300		10	75	(Note 2)	65
							30	120	10	0.3	0.6		1.5	50							
PN4258	**TO-92 (92)**	**12**	**12**	**4.5**	**10***	**6**	**30**		**50**	**1**	**0.15**	**0.75**	**0.95**	**10**	**3**	**700**		**10**	**20**	**(Note 1)**	**65 (5-86)**
							30	**120**	**10**	**3**											
							15		**1**	**0.5**	**0.5**		**1.5**	**50**							
ST5771-1	TO-92 (92)	15	15	4.5	10	8	30	150	10	0.3	0.15		0.8	1	3	700		10	30	(Note 1)	65
							30		1	0.5	0.18	0.8	0.95	10							
							20		50	1	0.6		1.5	50							
TN3467A	**TO-226 (99)**	**40**	**40**	**5**	**100**	**30**	**40**		**150**	**1**	**0.3**		**1**	**150**	**25**	**175**		**50**	**90**	**(Note 3)**	**70 (5-49)**
							40	**120**	**500**	**1**	**0.5**		**1.2**	**500**							
							40		**1A**	**5**	**1**	**0.8**	**1.6**	**1A**							

TEST CONDITIONS

Note 1: I_C = 10 mA, V_{CC} = 1.5 V, $I_B^1 = I_B^2$ = 1 mA.

Note 2: I_C = 10 mA, V_{CC} = 1.5 V, $I_B^1 = I_B^2$ = 500 µA.

Note 3: I_C = 500 mA, V_{CC} = 30 V, $I_B^1 = I_B^2$ = 50 mA.

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Discrete POWER & Signal Technologies

PNP Low Level Amplifiers

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	NF (dB) Max	Test Conditions	Process No.
2N5086	**TO-92 (92)**	**50**	**50**	**5**	**50**	**35**	**150 150 150**	 **500**	**10 1 0.1**	**5 5 5**	**0.3**			**10**	**4**	**40**		**0.5**	**3**	**(Note 1)**	**62 (5-96)**
2N5087	**TO-92 (92)**	**50**	**50**	**5**	**50**	**35**	**250 250 250**	 **800**	**10 1 0.1**	**5 5 5**	**0.3**			**10**	**4**	**40**		**0.5**	**2**	**(Note 1)**	**62 (5-96)**
MPS6523	TO-92 (92)		25	4	50	20	300 150	600	2 0.1	10 10	0.5			50	4				3		68
PN4249	TO-92 (92)	60	60	5	10	40	100	300	0.1	5	0.25			10	6						68
PN4250	TO-92 (92)	40	40	5	10	40	250	700	0.1	5	0.25			10	6				2	(Note 1)	68
PN4250A	TO-92 (92)	60	60	5	10	50	250	300	0.1	5	0.25			10	6				2	(Note 1)	68

TEST CONDITIONS

Note 1: I_C = 100 µA, V_{CE} = 5V, f = 10 Hz - 15.7 kHz.

PNP RF Amplifiers and Oscillators

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{cb} (pF) Min	C_{cb} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	NF (dB) Max @	Freq (MHz)	Process No.
MPSH81	**TO-92 (92)**	**20**	**20**	**3**	**100**	**20**	**60**		**5**	**10**	**0.5**		**5**		**0.85**	**600**		**5**			**75 (5-212)**

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

PNP General Purpose Amplifiers and Switches

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	$t_{(off)}$ (ns) Max	Test Conditions	Process No.
2N4402	TO-92 (92)	40	40	5			20		500	2	04	0.7	0.95	150	10	150		20	255	(Note 4)	63
							50	150	150	2											
							50		10	1	.75										
							30		1	1											
2N4403	TO-92 (92)	40	40	5			20		500	2					10	200		20	255	(Note 4)	63
							100	300	150	2	0.4	0.75	0.95	150							
							100		10	1											
							60		1	1	0.75		1.3	500							
							30		0.1	1											
MPS3702	TO-92 (92)	40	25	5	100	20	60	300	50	5	0.25			50	12	100		50			63
MPS3703	TO-92 (92)	50	30	5	100	20	30	150	50	5	0.25			50	12	100		50			63
MPS6534	TO-92 (92)	40	40	4	50	30	50		500	10	0.3		1	100	6						63
							90	270	100	1											
							60		10	1											
PN2907	TO-92 (92)	60	40	5	20	50	30		500	10	0.4		1.3	150	8	200		50	100	(Note 2)	63
							100	300	150	10											
							75		10	10	1.6		2.6	500							
							60		1	10											
							35		0.1	10											
PN2907A	**TO-92 (92)**	**60**	**60**	**5**	**20**	**50**	**50**		**500**	**10**	**0.4**		**1.3**	**150**	**8**	**200**		**50**	**100**	**(Note 2)**	**63 (5-32)**
							100	**300**	**150**	**10**											
							100		**10**	**10**	**1.6**		**2.6**	**500**							
							100		**1**	**10**											
							75		**0.1**	**10**											

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

PNP General Purpose Amplifiers and Switches (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max	@ I_C (mA)	$t_{(off)}$ (ns) Max	Test Conditions	Process No.
PN3638	TO-92	25	25	4	35*	15	20		300	2	0.25		1.1	50	20	100		50	170	(Note 1)	63
	(92)						20		50	1											
							30		10	10	1	0.8	2	300							
PN3638A	TO-92	25	25	4	35*	15	20		300	2	0.25		1.1	50	10	150		50	170	(Note 1)	63
	(92)						100		50	1											
							100		10	10	1	0.8	2	300							
							80		1	10											
PN3644	TO-92	45	45	5	35*	30	20		300	2	0.25		1	50	8	200		20	100	(Note 4)	63
	(92)						100	300	150	10											
							80	240	50	1	0.4		1.3	150							
							100		10	10											
							80		1	10	1	0.8	2	300							
							40		0.1	10											
PN3645	TO-92	60	60	5	35*	50	20		300	2	0.25		1	50	8	200		20	100	(Note 4)	63
	(92)						100	300	150	10											
							80	240	50	1	0.4		1.3	150							
							100		10	10											
							80		1	10	1	0.8	2	300							
							40		0.1	10											
PN4143	TO-92	60	40	5			30		500	10	0.4		1.3	150	8	200		50	100	(Note 6)	63
	(92)						50		150	1											
							100	300	150	10	1.6		2.6	500							
							75		10	10											
							50		1	10											
							35		0.1	10											
TIS93	TO-92	40	40	5	100	20	100	300	50	2	0.25			50							63
	(97)																				
TN2905A	TO-226	60	60	5	10	50	50		500	10	0.4		1.3	150	8	200		50	100	(Note 2)	63
	(99)						100	300	150	10											
							100		10	10	1.6		2.6	500							
							100		1	10											
							75		0.1	10											

PNP General Purpose Amplifiers and Switches (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	@ I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
2N3905	TO-92	40	40	5			15		100	1	0.25	0.65	0.85	10	4.5	200	10	260		(Note 5)	66
	(92)						30		50	1											
							50	150	10	1	0.4		0.95	50					5	(Note 8)	
							40		1	1											
							30		0.1	1											
2N3906	**TO-92**	**40**	**40**	**5**			**30**		**100**	**1**	**0.25**	**0.65**	**0.85**	**10**	**4.5**	**250**	**10**	**300**		**(Note 5)**	**66**
	(92)						**60**		**50**	**1**											**(5-72)**
							100	**300**	**10**	**1**	**0.4**		**0.95**	**50**					**4**	**(Note 8)**	
							80		**1**	**1**											
							60		**0.1**	**1**											
2N4125	TO-92	30	30	4	50	20	25		50	1	0.4		0.95	50	4.5	200	10		5	(Note 8)	66
	(92)						60	150	2	1											
2N4126	TO-92	25	25	4	50	20	60		50	1	0.4		0.95	50	4.5	250	10		4	(Note 8)	66
	(92)						120	360	2	1											
MPS6518	TO-92		40	4	500	30	90		100	10	0.5			50	4						66
	(92)						150	300	2	10											
PN4121	TO-92	40	40	5	25*	30	15		50	1	0.13		0.75	1	4.5	400	10	150		(Note 7)	66
	(92)						70	200	10	1	0.14	0.7	0.9	10							
							60		1	1	0.3		1.1	50					4	(Note 8)	
							40		0.1	1											
PN4122	TO-92	40	40	5	25*	30	30		50	1	0.13		0.75	1	4.5	450	10	150		(Note 7)	66
	(92)						150	300	10	1											
							150		1	1	0.14	0.7	0.9	10					4	(Note 8)	
							100		0.1	1	0.3		1.1	50							
PN4917	TO-92	30	30	5	25*	15	30		50	1	0.13		0.75	1	4.5	450	10	150		(Note 3)	66
	(92)						150	300	10	1	0.14	0.75	0.9	10							
							150		1	1	0.3		1.1	50					4	(Note 8)	
							100		0.1	1											

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

PNP General Purpose Amplifiers and Switches (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max	@ I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
2N3702	TO-92 (94)	40	25	5	100	20	60	300	50	5	0.25		50	12	100		50				68
2N3703	TO-92 (94)	50	30	5	100	20	30	150	50	5	0.25		50	12	100		50				68
PN200	**TO-92 (92)**	**60**	**45**	**6**	**50**	**50**	**80 100 100 100**	** 450 350**	**0.1 10 100 150**	**1 1 1 5**	**0.2 0.4**	**0.85 1**	**10 200**	**6**	**250**		**20**		**5**	**(Note 8)**	**68 (5-5)**
PN200A	**TO-92 (92)**	**60**	**45**	**6**	**50**	**50**	**300 100 200**	**600**	**10 100 0.1**	**1 1 1**	**0.2 0.4**	**0.85 1**	**10 200**	**6**	**250**		**20**		**4**	**(Note 8)**	**68 (5-5)**
PN5138	TO-92 (92)	30	30	5	50	20	50 50 50	 800	10 1 0.1	10 10 10	0.3	1	10	7	30		0.5				68
2N5400	TO-92 (92)	130	120	5	100	100	40 40 30	 180	50 10 1	5 5 5	0.2 0.5	1 1	10 50	6	100	400	10		8	(Note 9)	74
2N5401	**TO-92 (92)**	**160**	**150**	**5**	**50**	**120**	**50 60 50**	** 240**	**50 10 1**	**5 5 5**	**0.2 0.5**	**1 1**	**10 50**	**6**	**100**	**300**	**10**		**8**	**(Note 9)**	**74 (5-114)**
MPSL51	TO-92 (92)	100	100	4	1 µA	50	40	250	50	5	0.25 0.3	1.2 1.2	10 50	8	60		10				74

TEST CONDITIONS

Note 1: I_C = 300 mA, V_{CC} = 10V, $I_B^1 = I_B^2$ = 30 mA.
Note 2: I_C = 150 mA, V_{CC} = 6V, $I_B^1 = I_B^2$ = 15 mA.
Note 3: I_C = 50 mA, V_{CE} = 10V, $I_B^1 = I_B^2$ = 5 mA.
Note 4: I_C = 300 mA, V_{CC} = 30V, $I_B^1 = I_B^2$ = 30 mA.
Note 5: I_C = 10 mA, V_{CC} = 3V, $I_B^1 = I_B^2$ = 1 mA.
Note 6: I_C = 150 mA, V_{CC} = 30V, $I_B^1 = I_B^2$ = 15 mA.
Note 7: I_C = 50 mA, V_{CC} = 30V, $I_B^1 = I_B^2$ = 5 mA.
Note 8: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz.
Note 9: I_C = 250 µA, V_{CE} = 5V, f = 1 kHz.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Discrete POWER & Signal Technologies

PNP Medium Power

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
MPS855	**TO-92 (92)**	**40**	**25**	**6**	**100**	**35**	**45 85 40**	** 300 **	**5 100 800**	**1 1 1**	**0.5**	**1.2**	**800**	**15**	**100**		**50**				**60 (5-157)**
MPS6562	TO-92 (92)	25	25	5	100	20	50 50 35	200	500 100 10	1 1 1	0.5		500	30	60		10				67
PN4355	TO-92 (92)	60	60	5	50	50	75 75 100 75 60	 400 	500 100 10 1 0.1	10 10 10 10 10	0.15 0.5	0.9 1.1	150 500	30	100	500	50	400	3		67
PN4356	TO-92 (92)	80	80	5	50	50	30 40 50 40 25	 250 	500 100 10 1 0.1	10 10 10 10 10	0.15 0.5	0.9 1.1	150 500	30	100	500	50	400	3		67
TN4033A	**TO-226 (99)**	**80**	**80**	**5**	**50**	**60**	**75 100 70 25**	** 300 **	**0.1 100 500 1A**	**5 5 5 5**	**0.15 0.5**	**0.9**	**150 500**	**20**	**150**	**500**	**50**	**400**		**(Note 1)**	**67 (5-78)**
TN5322A	TO-226 (99)		75				30 10	130	500 1A	4 2	0.7		500		50		50	100		(Note 1)	71
MPSA55	TO-92 (92)		60	4	100	60	100 100		100 10	1 1	0.25		100		50		100				73
MPSA56	**TO-92 (92)**		**80**	**4**	**100**	**80**	**100 100**		**100 10**	**1 1**	**0.25**		**100**		**50**		**100**				**73 (5-178)**

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

PNP Medium Power (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max	@ I_C (mA)	$t_{(off)}$ (ns) Max	Test Conditions	Process No.
MPSA92	**TO-92 (92)**	**300**	**300**	**5**	**250**	**200**	**25** **40** **25**		**1** **10** **30**	**10** **10** **10**	**0.5**		**0.9**	**20**	**6**	**50**		**10**			**76 (5-186)**
MPSA93	TO-92 (92)	200	200	5	250	160	25 40 25	 150	1 10 30	10 10 10	0.4		0.9	20	8	50		10			76
TN5415A	TO-226 (99)	200	200	4	50K	175	30	150	50	10	2.5			50	15	15		5			76
TN6726A	**TO-226 (99)**	**40**	**30**	**5**	**100**	**40**	**55** **60** **50**	 **200**	**10** **100** **1A**	**1** **1** **1**	**0.5**			**1A**	**30**	**50**		**50**			**77 (5-138)**
TN6728A	**TO-226 (99)**	**60**	**60**	**5**	**100**	**40**	**80** **50** **20**	 **250** 	**50** **250** **500**	**1** **1** **1**	**0.35**			**250**	**30**	**50**		**50**			**78 (5-142)**
TN6729A	**TO-226 (99)**	**80**	**80**	**5**	**100**	**60**	**80** **50** **20**	 **250** 	**50** **250** **500**	**1** **1** **1**	**0.35**			**250**	**30**	**50**		**50**			**79 (5-146)**

TEST CONDITIONS

Note 1: I_C = 500 mA, I_B[1] 30 mA.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of process characteristics.

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Discrete POWER & Signal Technologies

PNP Darlington Transistors

Device No.	Case Style	V_{CBO} (V) Min	V_{CES} (V) Min	V_{EBO} (V) Min	I_{CBO} (µA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) @	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	Process No.
MPSA63	TO-92 (92)		30		0.1	30	10,000 5000		100 10	5 5	1.5			100		125	10	61
MPSA64	**TO-92 (92)**		**30**		**0.1**	**30**	**20,000** **10,000**		**100** **10**	**5** **5**	**1.5**			**100**		**125**	**10**	**61 (5-182)**
MPSA65	TO-92 (92)		30		0.1	30	50,000 20,000		0.01 0.1	5 5	1.5			100		100	10	61

PNP Bipolar Power Transistors

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (µA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (A) @	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (A)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (A)	Process No.
D43C8	TO-202 (56)		60	5	10	70	40 20	120	0.2 1	1 1	0.5		1.3	1	100	3	0.02	5P
D45C8	TO-220 (37)		60	5	10	70	20 40	 120	1 0.2	1 1	0.5		1.3	1	125	3	0.02	5P
D45C10	TO-220 (37)		80	5	10	90	10		1	1	0.5		1.3	1	125	3	0.02	5P
D45H8	**TO-220 (37)**		**60**	**5**	**10**	**60**	**40** **60**		**4** **2**	**1** **1**	**1**		**1.5**	**8**		**40**	**0.5**	**5Q (5-220)**
D45H11	TO-220 (37)		80	5	10	80	40 80		4 2	1 1	1		1.5	8		40	0.5	5Q

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

N-Channel JFETs

Switches / Choppers

Device No.	Case Style	BV_{GSS} BV_{GDO} (V) Min	@ I_G (µA)	I_{GSS} $*I_{DGO}$ (nA) Max	@ V_{DG} (V)	$I_{D(off)}$ (nA) Max	@ V_{DS} (V)	V_{GS} (V)	V_P (V) Min	V_P (V) Max	@ V_{DS} (V)	I_D (nA)	I_{DSS} (mA) Min	I_{DSS} (mA) Max	@ V_{DS} (V)	$r_{ds(on)}$ (Ω) Max	@ I_D (mA)	C_{iss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	C_{rss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	$t_{(on)}$ (ns) Max	Process No.	Pkg. No.
2N5555	TO-92	25	10	1	15	10	12	-10		10			15		15	150		5	15	0	1.2	0	-10	25	50	92
2N5638	TO-92	30	10	1	15	1	15	-12		12			50		20	30	1	10	0	-12	4	0	-12		51	92
2N5639	TO-92	30	10	1	15	1	15	-8		8			25		20	60	1	10	0	-12	4	0	-8		51	92
2N5640	TO-92	30	10	1	15	1	15	-6		6			5		20	100	1	10	0	-12	4	0	-6		51	92
J105	**TO-92**	**25**	**10**	**3**	**15**	**3**	**5**	**10**	**4.5**	**10**	**15**	**10**	**500**		**15**	**3**									**59 (7-1)**	**92**
J106	**TO-92**	**25**	**10**	**3**	**15**	**3**	**5**	**10**	**2**	**6**	**15**	**10**	**200**		**15**	**6**	**17**								**59 (7-1)**	**92**
J107	**TO-92**	**25**	**10**	**3**	**15**	**3**	**5**	**10**	**0.5**	**4.5**	**15**	**10**	**100**		**15**	**8**	**13**								**59 (7-1)**	**92**
J108	**TO-92**	**25**	**10**	**3**	**15**	**3**	**5**	**-10**	**3**	**10**	**15**	**10**	**80**		**15**	**8**	**10**								**58 (7-5)**	**92**
J109	**TO-92**	**25**	**10**	**3**	**15**	**3**	**5**	**-10**	**2**	**6**	**15**	**10**	**40**		**15**	**12**	**10**								**58 (7-5)**	**92**
J110	**TO-92**	**25**	**10**	**3**	**15**	**3**	**5**	**-10**	**0.5**	**4**	**15**	**10**	**10**		**15**	**18**	**10**								**58 (7-5)**	**92**
J111	**TO-92**	**35**	**1**	**10**	**15**	**1**	**5**	**-10**	**3**	**10**	**5**	**1000**	**20**		**15**	**30**	**1**								**51 (7-9)**	**92**
J112	**TO-92**	**35**	**1**	**10**	**15**	**1**	**5**	**-10**	**1**	**5**	**5**	**1000**	**5**		**15**	**50**	**1**								**51 (7-9)**	**92**
J113	**TO-92**	**35**	**1**	**10**	**15**	**1**	**5**	**-10**	**0.5**	**3**	**5**	**1000**	**2**		**15**	**100**	**1**								**51 (7-9)**	**92**
PN4091	TO-92	40	1	0.2*	20	0.2	20	-12	5	10	20	1	30		20	30		16	20	0	5	20	0	40	51	92
PN4092	TO-92	40	1	0.2*	20	0.2	20	-8	2	7	20	1	15		20	50		16	20	0	5	20	0	60	51	92
PN4093	TO-92	40	1	0.2*	20	0.2	20	-6	1	5	20	1	8		20	80		16	20	0	5	20	0	80	51	92
PN4391	TO-92	40	1	0.1	20	0.1	20	-12	4	10	20	1	50		20	30		14	20	0	3.5	0	-12	35	51	92
PN4392	TO-92	40	1	0.1	20	0.1	20	-7	2	5	20	1	25	150	20	60		14	20	0	3.5	0	-7	80	51	92
PN4393	TO-92	40	1	0.1	20	0.1	20	-5	0.5	3	20	1	5	75	20	100		14	20	0	3.5	0	-5	130	51	92
PN4856	TO-92	40	1	0.25	20	0.25	15	-10	4	10	15	1	50	30	15	25		18	0	-10	8	0	-10	25	51	92
PN4857	TO-92	40	1	0.25	20	0.25	15	-10	2	6	15	0.5	20	100	15	40		18	0	-10	8	0	-10	50	51	92
PN4858	TO-92	40	1	0.25	20	0.25	15	-10	0.8	4	15	0.5	8	80	15	60		18	0	-10	8	0	-10	100	51	92
PN4859	TO-92	30	1	0.25	15	0.25	15	-10	4	10	15	0.5	50		15	25		18	0	-10	8	0	-10	25	51	92
PN4860	TO-92	30	1	0.25	15	0.25	15	-10	2	6	15	0.5	20	100	15	40		18	0	-10	8	0	-10	50	51	92
PN4861	TO-92	30	1	0.25	15	0.25	15	-10	0.8	4	15	0.5	8	80	15	60		18	0	-10	8	0	-10	100	51	92

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

N-Channel Switches / Choppers (continued)

Device No.	Case Style	BV_{GSS} BV_{GDO} (V) Min	@ I_G (µA)	I_{GSS} $*I_{DGO}$ (nA) Max	@ V_{DG} (V)	$I_{D(off)}$ (nA) Max	@ V_{DS} (V)	V_{GS} (V)	V_P (V) Min	V_P (V) Max	@ V_{DS} (V)	I_D (nA)	I_{DSS} (mA) Min	I_{DSS} (mA) Max	@ V_{DS} (V)	$r_{ds(on)}$ (Ω) Max	@ I_D (mA)	C_{iss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	C_{rss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	$t_{(on)}$ (ns) Max	Process No.	Pkg. No.
PN5432	TO-92	25	1	0.2	15	0.2	5	-10	4	10	5	3	150		15	5	10	30	0	-10	15	0	-10	36	58	92
PN5433	TO-92	25	1	0.2	15	0.2	15	-10	3	9	5	3	100		15	7	10	30	0	-10	15	0	-10	36	58	92
PN5434	TO-92	25	1	0.2	15	0.2	5	-10	1	4	5	3	30		15	10	10	30	0	-10	15	0	-10	36	58	92
TIS73	**TO-92**	**30**	**1**	**2**	**15**	**10**	**15**	**-10**	**4**	**10**	**15**	**4**	**50**		**15**	**25**		**18**	**0**	**-10**	**8**	**0**	**-10**	**25**	**54** (7-71)	**97**
TIS74	**TO-92**	**30**	**1**	**2**	**15**	**10**	**15**	**-10**	**2**	**6**	**15**	**4**	**20**	**100**	**15**	**40**		**18**	**0**	**-10**	**8**	**0**	**-10**	**50**	**54** (7-71)	**97**
TIS75	TO-92	30	1	2	15	10	15	-10	0.8	4	20	4	8	80	15	60		18	0	-10	8	0	-10		54	97
U1897	TO-92	40	1	0.2*	20				5	10	20	1	30		20	30	1	16	20	0	5	0	-20	40	51	92
U1898	TO-92	40	1	0.2*	20				2	7	20	1	15		20	50	1	16	20	0	5	0	-20	60	51	92
U1899	TO-92	40	1	0.2*	20				1	5	20	1	8		20	80	1	16	20	0	5	0	-20	80	51	92

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

N-Channel JFETs

RF, VHF, UHF Amplifiers

Device No.	Case Style	BV_{GSS} (V) @ Min	I_G (µA)	I_{GSS} (nA) @ Max	V_{DG} (V)	V_P (V) @ Min	V_P (V) @ Max	V_{DS} (V)	I_D (nA)	I_{DSS} (mA) @ Min	I_{DSS} (mA) @ Max	V_{DS} (V)	$R_e\|Y_{fs}\|$ (mmho) @ Min	Fq. (MHz)	C_{iss} (pF) @ Max	V_{DS} (V)	V_{GS} (V)	C_{rss} (pF) @ Max	V_{DS} (V)	V_{GS} (V)	NF (dB) @ R_G = 1k Max	Freq (MHz)	Process No.	Pkg. No.
2N3819	TO-92	25	1	2	15		8	15	2	2	20	15	1.6	100	8	15	0	4	15	0			50	94
2N5245	TO-92	30	1	1	20	1	6	15	10	5	15	15	4	400	4.5	15	0	1	15	0	4	400	90	97
2N5246	TO-92	30	1	1	20	0.5	4	15	10	1.5	7	15	2.5	400	4.5	15	0	1	15	0			90	97
2N5247	TO-92	30	1	1	20	1	8	15	10	8	24	15	4	400	4.5	15	0	1	15	0			90	97
2N5248	TO-92	30	1	5	20	1.5	8	15	10	4	20	15	3	200	6	15	0	2	15	0			50	94
2N5484	**TO-92**	**25**	**1**	**1**	**20**	**0.3**	**3**	**15**	**10**	**1**	**5**	**15**	**2.5**	**100**	**5**	**15**	**0**	**1**	**15**	**0**	**3**	**100**	**50 (7-51)**	**92**
2N5485	**TO-92**	**25**	**1**	**1**	**20**	**0.5**	**4**	**15**	**10**	**4**	**10**	**15**	**3**	**400**	**5**	**15**	**0**	**1**	**15**	**0**	**4**	**400**	**50 (7-51)**	**92**
2N5486	**TO-92**	**25**	**1**	**1**	**20**	**2**	**6**	**15**	**10**	**8**	**20**	**15**	**3.5**	**400**	**5**	**15**	**0**	**1**	**15**	**0**	**4**	**400**	**50 (7-51)**	**92**
2N5949	TO-92	30	1	1	15	3	7	15	100	12	18	15	3	100	6	15	0	2	15	0	5	100	50	97
2N5950	TO-92	30	1	1	15	2.5	6	15	100	10	15	15	3	100	6	15	0	2	15	0	5	100	50	97
2N5951	TO-92	30	1	1	15	2	5	15	100	7	13	15	3	100	6	15	0	2	15	0	5	100	50	97
2N5952	TO-92	30	1	1	15	1.8	3.5	15	100	4	8	15	1	100	6	15	0	2	15	0	5	100	50	97
2N5953	TO-92	30	1	1	15	0.8	3	15	100	2.5	5	15	1	100	6	15	0	2	15	0	5	100	50	97
J300	TO-92	25	1	0.5	15	1	6	10	1	6	30	10	4.5	0.001	5.5	10	5mA	1.7	10	5mA			90	92
J304	TO-92	30	1	0.1	20	2	6	15	1	5	15	15	t4.2	100									50	92
J305	TO-92	30	1	0.1	20	0.5	3	15	1	1	8	15	t3	100									50	92
J309	**TO-92**	**25**	**1**	**1**	**15**	**1**	**4**	**10**	**1**	**12**	**30**	**10**	**t12**	**100**	**5**	**0**	**-10**	**2.5**	**0**	**-10**			**92 (7-27)**	**92**
J310	**TO-92**	**25**	**1**	**1**	**15**	**2**	**6.5**	**10**	**1**	**24**	**60**	**10**	**t12**	**100**	**5**	**0**	**-10**	**2.5**	**0**	**-10**			**92 (7-27)**	**92**
PN4416	TO-92	30	1	0.1	20	2.5	6	15	1	5	15	15	4	400	4	15	0	0.8	15	0	4	400	50	92

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

t = typical value

National Semiconductor™

Discrete POWER & Signal Technologies

N-Channel JFETs

Low Frequency - Low Noise Amplifiers

Device No.	Case Style	BV_{GSS} (V) @	I_G	I_{GSS} (nA)@	V_{DG}	$V_{GS(off)}$ (V) @		V_{DS}	I_D	I_{DSS} (mA) @		V_{DS}	$g_{fs}(R_e\|Y_{fs})$ (mmho)		V_{DS}	f	C_{iss} (pF)	V_{DS}	V_{GS}	C_{rss} (pF)	V_{DS}	NF $nV/\sqrt{H_z}$ @	f	Process No.	Pkg. No.
		Min	(µA)	Max	(V)	Min	Max	(V)	(nA)	Min	Max	(V)	Min	Max	(V)	(MHz)	Max	(V)	(V)	Max	(V)	Max	(Hz)		
PF5101	TO-92	40	1	0.2	15	0.5	1.1	15	1	1	12	15	3.5		15	0.001	t12	15	0	t4	15	3.5	1000	51	92
PF5102	TO-92	40	1	0.2	15	0.7	1.6	15	1	4	20	15	7.5		15	0.001	t12	15	0	t4	15	3.5	1000	51	92
PF5103	TO-92	40	1	0.2	15	1.2	2.7	15	1	10	40	15	7.5		15	0.001	t12	15	0	t4	15	3.5	1000	51	92
PN4393	TO-92	40	1	0.1	20	0.5	3	20	1	5	30	20	t12		20	0.001	14	20	0	3.5	5	t8	10	51	92

t = typical value

Ultra Low Input Current Amplifiers

Device No.	Case Style	BV_{GSS} (V) @	I_G	I_{GSS} (pA)@	V_{DG}	V_P (V) @		V_{DS}	I_D	I_{DSS} (µA) @		V_{DS}	G_{fs} (µmho) @		V_{DS}	C_{iss} (pF) @	V_{DS}	V_{GS}	C_{rss} (pF) @	V_{DS}	V_{GS}	Process No.	Pkg. No.
		Min	(µA)	Max	(V)	Min	Max	(V)	(nA)	Min	Max	(V)	Min	Max	(V)	Max	(V)	(V)	Max	(V)	(V)		
PF5301	TO-92	30	1	1	15	0.6	3	10	1	30	500	10	70	300	10	3	10	0	1.5	10	0	53	92
PF5301-1	TO-92	30	1	1	15	0.6	1.8	10	1	30	500	10	70	300	10	3	10	0	1.5	10	0	53	92
PF5301-2	TO-92	30	1	1	15	1.7	3	10	1	30	500	10	70	300	10	3	10	0	1.5	10	0	53	92
PF5301-3	TO-92	30	1	1	15	1	2.4	10	1	30	500	10	70	300	10	3	10	0	1.5	10	0	53	92
PN4117	**TO-92**	**40**	**10**	**10**	**20**	**0.6**	**1.8**	**10**	**1**	**30**	**90**	**10**	**70**	**210**	**10**	**3**	**10**	**0**	**1.5**	**10**	**0**	**53 (7-37)**	**92**
PN4117A	TO-92	40	1	1	20	0.6	1.8	10	1	30	90	10	70	210	10	3	10	0	1.5	10	0	53	92
PN4118	**TO-92**	**40**	**10**	**10**	**20**	**1**	**3**	**10**	**1**	**80**	**240**	**10**	**80**	**250**	**10**	**3**	**10**	**0**	**1.5**	**10**	**0**	**53 (7-37)**	**92**
PN4118A	TO-92	40	1	1	20	1	3	10	1	80	240	10	80	250	10	3	10	0	1.5	10	0	53	92
PN4119	**TO-92**	**40**	**10**	**10**	**20**	**2**	**6**	**10**	**1**	**200**	**600**	**10**	**100**	**330**	**10**	**3**	**10**	**0**	**1.5**	**10**	**0**	**53 (7-37)**	**92**
PN4119A	TO-92	40	1	1	20	2	6	10	1	200	600	10	100	330	10	3	10	0	1.5	10	0	53	92
PN4120	TO-92	40	1	20	20	0.6	3	10	1	30	300	10	70	300	10	3	10	0	1.5	10	0	53	92
PN4120A	TO-92	40	1	5	20	0.6	3	10	1	30	300	10	70	300	10	3	10	0	1.5	10	0	53	92

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

N-Channel JFETs

General Purpose Amplifiers

Device No.	Case Style	BV_{GSS} (V) @	I_G (µA)	I_{GSS} (nA)@	V_{DG} (V)	V_P (V) @ Min	V_P Max	V_{DS} (V)	I_D (nA)	I_{DSS} (mA) @ Min	I_{DSS} Max	V_{DS} (V)	G_{fs} (mmho) @ Min	G_{fs} Max	V_{DS} (V)	C_{iss} (pF)@ Max	V_{DS} (V)	V_{GS} (V)	C_{rss} (pF)@ Max	V_{DS} (V)	V_{GS} (V)	NF nV / $\sqrt{H_Z}$ @ f Max	f (Hz)	Process No.	Pkg. No.
		Min		Max																					
2N5457	**TO-92**	**25**	**10**	**1**	**15**	**0.5**	**6**	**15**	**10**	**1**	**5**	**15**	**1**	**5**	**15**	**7**	**15**	**0**	**3**	**15**	**0**			**55 (7-43)**	**92**
2N5458	**TO-92**	**25**	**10**	**1**	**15**	**1**	**7**	**15**	**10**	**2**	**9**	**15**	**1.5**	**5.5**	**15**	**7**	**15**	**0**	**3**	**15**	**0**			**55 (7-43)**	**92**
2N5459	**TO-92**	**25**	**10**	**1**	**15**	**2**	**8**	**15**	**10**	**4**	**16**	**15**	**2**	**6**	**15**	**7**	**15**	**0**	**3**	**15**	**0**			**55 (7-43)**	**92**
J201	**TO-92**	**40**	**1**	**0.1**	**20**	**0.3**	**1.5**	**20**	**10**	**0.2**	**1**	**20**	**0.5**		**20**									**52 (7-18)**	**92**
J202	**TO-92**	**40**	**1**	**0.1**	**20**	**0.8**	**4**	**20**	**10**	**0.9**	**4.5**	**20**	**1**		**20**									**52 (7-18)**	**92**
J203	TO-92	40	1	0.1	20	2	10	20	10	4	20	20	1.5		20									52	92
J210	TO-92	25	1	0.1	15	1	3	15	1	2	15	15	4	12	15									90	92
J211	**TO-92**	**25**	**1**	**0.1**	**15**	**2.5**	**4.5**	**15**	**1**	**7**	**20**	**15**	**6**	**12**	**15**									**90 (7-22)**	**92**
J212	**TO-92**	**25**	**1**	**0.1**	**15**	**4**	**6**	**15**	**1**	**15**	**40**	**15**	**7**	**12**	**15**									**90 (7-22)**	**92**
PN4302	TO-92	30	1	1	10		4	20	10	0.5	5	20	1		20	6	20	0	3	20	0	100	1000	52	92
PN4303	TO-92	30	1	1	10		6	20	10	4	10	20	2		20	6	20	0	3	20	0	100	1000	52	92
PN4304	TO-92	30	1	1	10		10	20	10	0.5	15	20	1		20	6	20	0	3	20	0	125	1000	52	92

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Discrete POWER & Signal Technologies

General Purpose Dual JFETs

Device No.	Case Style	Op. Char. V_{DG} (V)	@ I_D (μA)	$\lvert V_{GS1-2}\rvert$ V_{OS} (mV) Max	Drift (μV/°C) ΔV_{GS} Max	G_{fs} μmhos Min	G_{fs} μmhos Max	G_{os} (μmho) Max	CMRR (dB) Min	V_{gs} (V) Min	V_{gs} (V) Max	V_P (V) Min	V_P (V) Max	I_{DSS} (mA) Min	I_{DSS} (mA) Max	G_{fs} (mmho) Min	G_{fs} (mmho) Max	I_{GSS} (pA) Max	@ V_{DS} (V)	C_{iss} (pF) Max	C_{rss} (pF) Max	BV (V)	NF $nV/\sqrt{H_Z}$ Max	@ f (Hz)	Pro. No.	Pkg. No.
NPDS402	T0-69	10	200	10	10	1000	2000	2	95		2.3	0.5	2.5	0.5	10	2	7	25	30	8	3	50	20	10	98	69
NPDS403	T0-69	10	200	10	25	1000	2000	2	95		2.3	0.5	2.5	0.5	10	2	7	25	30	8	3	50	20	10	98	69
NPDS404	T0-69	10	200	15	25	1000	2000	2	95		2.3	0.5	2.5	0.5	10	2	7	25	30	8	3	50	20	10	98	69
NPDS406	T0-69	10	200	40	80	1000	2000	2	95		2.3	0.5	2.5	0.5	10	2	7	25	30	8	3	50	20	10	98	69
NPDS5565	T0-69	15	2000	10	25	7500	12.5K					0.5	3	5	30			100	20	12	3	40	50	10	96	69
NPDS5566	T0-69	15	2000	20	50	7500	12.5K					0.5	3	5	30			100	20	12	3	40	50	10	96	69
NPDS5911	T0-69	10	5000	10	20	5000	10K			0.3	4	1	5	7	40			100	15	5	1.2	25	20	10K	93	69
NPDS5912	T0-69	10	5000	15	40	5000	10K			0.3	4	1	5	7	40			100	15	5	1.2	25	20	10K	93	69
NPDS8301	T0-69	20	200	5	10	700	1200	5		0.3	3.5	0.5	3.5	0.5	6	1	4	100	20	4.5	1.2	40	50	100	83	69
NPDS8302	T0-69	20	200	10	15	700	1200	5		0.3	3.5	0.5	3.5	0.5	6	1	4	100	20	4.5	1.2	40	50	100	83	69
NPDS8303	T0-69	20	200	15	25	700	1200	5		0.3	3.5	0.5	3.5	0.5	6	1	4	100	20	4.5	1.2	40	50	100	83	69
NPDS8304	T0-69	20	200	20	30	700	1200	5		0.3	3.5	0.5	3.5	0.5	6	1	4	100	20	4.5	1.2	40	50	100	83	69

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P-Channel JFETs

Switches / Choppers

Device No.	Case Style	BV_{GSS} BV_{GDO} (V) @ Min	I_G (µA)	I_{GSS} (nA) @ Max	V_{DG} (V)	$I_{D(off)}$ (nA) @ Max	V_{DS} (V)	V_{GS} (V)	V_P (V) @ Min	Max	V_{DS} (V)	I_D (nA)	I_{DSS} (mA) @ Min	Max	V_{DS} (V)	$r_{ds(on)}$ (Ω) @ Max	I_D (mA)	C_{iss} (pF) @ Max	V_{DS} (V)	I_{GS} (V)	C_{rss} (pF) @ Max	V_{DS} (V)	V_{GS} (V)	$t_{(off)}$ (ns) Max	Process No.	Pkg. No.
J174	TO-92	30	1	1	20	1	-15	10	5	10	-15	0.01	20	100	15	85	1	11	0	10	5.5	0	10	5	88 (7-14)	94
J175	TO-92	30	1	1	20	1	-15	10	3	6	-15	0.01	7	60	15	125	0.5	11	0	10	5.5	0	10	10	88 (7-14)	94
J176	TO-92	30	1	1	20	1	-15	10	1	4	-15	0.01	2	25	15	250	0.25	11	0	10	5.5	0	10	15	88 (7-14)	94
J177	TO-92	30	1	1	20	1	-15	10	0.8	2.5	-15	0.01	1.5	20	15	300	0.1	11	0	10	5.5	0	10	20	88 (7-14)	94
P1086	TO-92	30	1	2	15	10	-15	12		10	-15	1	10		20	75	1	45	-15	0	10	0	12	65	88	92
P1087	TO-92	30	1	2	15	10	-15	7		5	-15	1	5		20	150	1	45	-15	0	10	0	7	125	88	92

General Purpose Amplifiers

Device No.	Case Style	BV_{GSS} BV_{GDO} (V) @ Min	I_G (µA)	I_{GSS} (nA)@ Max	V_{DG} (V)	V_P (V) @ Min	Max	V_{DS} (V)	I_D (nA)	I_{DSS} (mA) @ Min	Max	V_{DS} (V)	G_{fs} (mmho) @ Min	Max	V_{DS} (V)	C_{iss} (pF) @ Max	V_{DS} (V)	V_{GS} (V)	C_{rss} (pF) @ Max	V_{DS} (V)	V_{GS} (V)	NF $nV/\sqrt{H_Z}$ @ Max	f (Hz)	Process No.	Pkg. No.
2N3820	TO-92	20	10	20	10		8	-10	10	0.3	15	10	0.8	5	10	32	-10	0	16	-10	0			89	94
2N5460	**TO-92**	**40**	**10**	**5**	**20**	**0.75**	**6**	**-15**	**1**	**1**	**5**	**10**	**1**	**4**	**15**	**7**	**-15**	**0**	**2**	**-15**	**0**	**115**	**100**	**89 (7-47)**	**92**
2N5461	**TO-92**	**40**	**10**	**5**	**20**	**1**	**7.5**	**-15**	**1**	**2**	**9**	**10**	**1.5**	**5**	**15**	**7**	**-15**	**0**	**2**	**-15**	**0**	**115**	**100**	**89 (7-47)**	**92**
2N5462	**TO-92**	**40**	**10**	**5**	**20**	**1.8**	**9**	**-15**	**1**	**4**	**16**	**10**	**2**	**6**	**15**	**7**	**-15**	**0**	**2**	**-15**	**0**	**115**	**100**	**89 (7-47)**	**92**
J270	TO-92	30	1	0.2	20	0.5	2	-15	0.001	2	15	15	6	15	15	t20	-15	0	t5	-15	0	t10	1000	88	94
J271	TO-92	30	1	0.2	20	1.5	4.5	-15	0.001	6	50	15	8	18		t20	-15	0	t5	-15	0	t10	1000	88	94
PN4360	TO-92	10	10	10	15	0.7	10	-10	1	3	30	10	2	8	10	25	-10	0	5	-10	0	190	100	89	92
PN5033	TO-92	10	10	10	15	0.3	2.5	-10	1	0.3	3.5	10	1	5	10	20	-10	0	7	-10	0	100	100	89	92

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

t = typical value

National Semiconductor™

Discrete POWER & Signal Technologies

Surface Mount Diodes

Computer Diodes (by Descending B_V)

LEADLESS GLASS PACKAGE

Device No.	Package No.	B_V (V) Min	I_R (nA) Max @	V_R (V)	V_F (V) Min	V_F (V) Max @	I_F (mA)	C (pF) Max	t_{rr} (ns) Max	Test Conditions	Process Family
FDLL914	LL-34	100	25	20		1	10	4	4	(Note 2)	D3
FDLL914A	LL-34	100	25	20	0.62	0.72	5	4	4	(Note 2)	D3
FDLL914B	LL-34	100	25	20		1	100	4	4	(Note 2)	D3
FDLL916	LL-34	100	25	20		1	10	4	4	(Note 2)	D3
FDLL916A	LL-34	100	25	20		1	20	2	4	(Note 2)	D3
FDLL916B	LL-34	100	25	20		1	30	2	4	(Note 2)	D3
FDLL4148	LL-34	100	25	20		1	10	4	4	(Note 2)	D3
FDLL4448	LL-34	100	25	20	0.63	0.73	5	2	4	(Note 1)	D3
FDLL600	LL-34	75	100	50		0.65 0.79 0.86 0.92 1.0	1 10 50 100 200	2.5	4	(Note 1)	1P
FDLL4150	LL-34	75	100	50	0.87	1	200	2.5	4	(Note 3)	1R
FDLL4151	LL-34	75	50	50		1	50	2	4	(Note 1)	D3
FDLL4153	LL-34	75	50	50	0.74	0.88	20	2	2	(Note 2)	D4
FDLL4152	LL-34	40	50	30	0.74	0.88	20	2	2	(Note 2)	D3

TEST CONDITIONS

Note 1: $I_F = I_R = 10$ mA, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$.

Note 2: $I_F = 10$ mA, $V_R = 6.0$ V, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$.

Note 3: $I_F = I_R = 10$ mA to 200 mA, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$,

Surface Mount Diodes

Low Leakage Diodes (by Descending B_V)

LEADLESS GLASS PACKAGE

Device No.	Package No.	B_V Min	I_R (nA) Max	@ V_R (V)	V_F (V) Max	@ I_F (mA)	C (pF) Max	Process Family
FDLL463A	LL-34	200	500	175	1	100		1M
FDLL459	LL-34	200	25	175	1	3		1M
FDLL459A	LL-34	200	25	175	1	100		1M
FDLL485B	LL-34	200	25	175	1	100		1M
FDLL300	LL-34	150	1	125	0.75 0.88 1	5 50 200	6	1M
FDLL300A	LL-34	150	1	125	0.76 0.89 1	5 50 200	6	1M
FDLL333	LL-34	150	3	125	0.89 0.97 1.15	50 150 300	6	1M
FDLL458	LL-34	150	25	125	1	7	6	1M
FDLL458A	LL-34	150	5	125	1	100		1M
FDLL457	LL-34	70	25	60	1	20	8	1M
FDLL457A	LL-34	70	25	60	1	100		1M
FDLL462A	LL-34	70	500	60	1	100		1M
FDLL456	LL-34	30	25	25	1	40	10	1M
FDLL456A	LL-34	30	25	25	1	100		1M

National Semiconductor™

Discrete POWER & Signal Technologies

Surface Mount Diodes

High Voltage Diodes (by Descending B_V)

LEADLESS GLASS PACKAGE

Device No.	Package No.	B_V Min	I_R (nA) Max	@ V_R (V)	V_F (V) Max	@ I_F (mA)	C (pF) Max	t_{rr} (ns) Max	Test Conditions	Process Family
FDLL400	LL-34	200	100	150	1 1.1	200 300	2	50	(Note 1)	1J
FDLL922	LL-34		100	150	1.2	200	6.5			1J
FDLL923	LL-34		100	200	1.2	200	6.5			1J
FDLL444	LL-34	150	50	50	1.2	300	2.5	60	(Note 1)	1J

TEST CONDITIONS

Note 1: $I_F = 30$ mA, $I_R = 30$ mA, $I_{RR} = 3.0$ mA, $R_L = 100\Omega$.

Surface Mount Diodes

General Purpose & Specialty Diodes

PLASTIC PACKAGE

Device (Mark)	Description (Configuration)	Pkg. No.	Pin Out	B_V Min	I_R (nA) Max	@ V_R (V)	V_F (V) Max	@ I_F (mA)	C (pF) Max	t_{rr} (ns) Max	Test Conditions	Process Family
MMBD 1200 FAMILY												
MMBD914 (5D)	Single (1)	TO-236 (49)	1	100	25	20	1	10	4	4	(Note 2)	1P
MMBD1201 (24)	Single (1)	TO-236 (49)	1	100	25 50	20 50	1 1.1	200 300	2	4	(Note 1)	1P
MMBD1203 (26)	Series (3)	TO-236 (49)	3	100	25 50	20 50	1 1.1	200 300	2	4		1P
MMBD1204 (27)	Common Cathode (4)	TO-236 (49)	4	100	25 50	20 50	1 1.1	200 300	2	4		1P
MMBD1205 (28)	Common Anode (5)	TO-236 (49)	5	100	25 50	20 50	1 1.1	200 300	2	4		1P
MMBD2837 (A5)	Common Cathode (4)	TO-236 (49)	4	35	100	30	1 1.2	50 100	4	4	(Note 2)	1P
MMBD2838 (A6)	Common Cathode (4)	TO-236 (49)	4	35	100	50	1 1.2	50 100	4	4		1P
MMBD4148 (5H)	Single (1)	TO-236 (49)	1	100	25	20	1	10	4	4	(Note 2)	1P
MMBD7000 (5C)	Series (3)	TO-236 (49)	3	100	500	100	1.1	50	1.5	4	(Note 2)	1P
MMBD 1400 FAMILY												
MMBD1401 (29)	Single (1)	TO-236 (49)	1	200	40 100	120 175	1 1.1	200 300	2	50	(Note 4)	1H
MMBD1403 (32)	Series (3)	TO-236 (49)	3	200	40 100	120 175	1 1.1	200 300	2	50	(Note 4)	1H

General Purpose & Specialty Surface Mount Diodes (continued)

PLASTIC PACKAGE

Device (Mark)	Description (Configuration)	Pkg. No.	Pin Out	B_V Min	I_R (nA) Max	@ V_R (V)	V_F (V) Max	@ I_F (mA)	C (pF) Max	t_{rr} (ns) Max	Test Conditions	Process Family
MMBD 1400 FAMILY (continued)												
MMBD1404 (33)	Common Cathode (4)	TO-236 (49)	4	200	40 100	120 175	1 1.1	200 300	2	50	(Note 4)	1H
MMBD1405 (34)	Common Anode (5)	TO-236 (49)	5	200	40 100	120 175	1 1.1	200 300	2	50	(Note 4)	1H
MMBD 1500 FAMILY												
MMBD1501 (11)	Single (1)	TO-236 (49)	1	200	1 1.1	125 180	1 1.15	100 200	4	50		1L
MMBD1501A (A11)	Single (1)	TO-236 (49)	1	200	1 1.1	125 180	1	100 200	4	50		1L
MMBD1503 (12)	Series (3)	TO-236 (49)	3	200	1 1.1	125 180	1	100 200	4	50		1L
MMBD1503A (A12)	Series (3)	TO-236 (49)	3	200	1 1.1	125 180	1	100 200	4	50		1L
MMBD1504 (13)	Common Cathode (4)	TO-236 (49)	4	200	1 1.1	125 180	1	100 200	4	50		1L
MMBD1504A (A13)	Common Cathode (4)	TO-236 (49)	4	200	1 1.1	125 180	1	100 200	4	50		1L
MMBD1505 (14)	Common Anode (5)	TO-236 (49)	5	200	1 1.1	125 180	1	100 200	4	50		1L
MMBD1505A (A14)	Common Anode (5)	TO-236 (49)	5	200	1 1.1	125 180	1	100 200	4	50		1L

General Purpose & Specialty Surface Mount Diodes (continued)

PLASTIC PACKAGE

Device (Mark)	Description (Configuration)	Pkg. No.	Pin Out	B_V Min	I_R (nA) Max @	V_R (V)	V_F (V) Max @	I_F (mA)	C (pF) Max	t_{rr} (ns) Max	Test Conditions	Process Family
MMBD 1700 FAMILY												
MMBD1701 (85)	Single (1)	TO-236 (49)	1	30	50	20	1.1	50	1	0.7	(Note 1)	1T
MMBD1701A (85A)	Single (1)	TO-236 (49)	1	30	50	20	1.1	50	1	1	(Note 1)	1T
MMBD1703 (87)	Series (3)	TO-236 (49)	3	30	50	20	1	50	1	0.7	(Note 1)	1T
MMBD1703A (87A)	Series (3)	TO-236 (49)	3	30	50	20	1.1	50	1	1	(Note 1)	1T
MMBD1704 (88)	Common Cathode (4)	TO-236 (49)	4	30	50	20	1.1	50	1	0.7	(Note 1)	1T
MMBD1704A (88A)	Common Cathode (4)	TO-236 (49)	4	30	50	20	1.1	50	1	1	(Note 1)	1T
MMBD1705 (88)	Common Anode (5)	TO-236 (49)	5	30	50	20	1.1	50	1	0.7	(Note 1)	1T
MMBD1705A (88A)	Common Anode (5)	TO-236 (49)	5	30	50	20	1.1	50	1	1	(Note 1)	1T

TEST CONDITIONS

Note 1: $I_F = I_R = 10$ mA, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$

Note 2: $I_F = 10$ mA, $V_R = 6.0$V, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$.

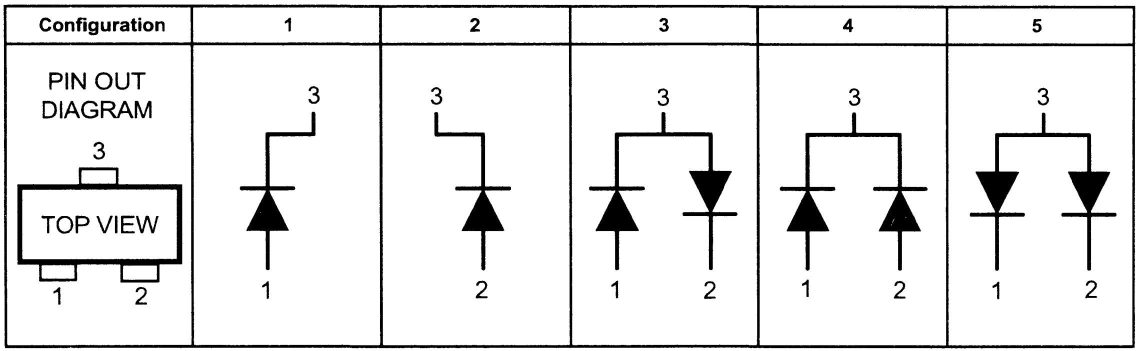
Note 3: $I_F = I_R = 30$ mA, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$.

Note 4: $I_F = I_R = 30$ mA, $I_{RR} = 3.0$ mA, $R_L = 100\Omega$.

General Purpose & Specialty Surface Mount Diodes (continued)

The National "MMBD" Series provides the SOT-23 electrical equivalent of the standard devices listed. Each family is available in 5 configurations.

MMBD 1200 FAMILY		MMBD 1400 FAMILY	MMBD 1500 FAMILY	MMBD 1700 FAMILY
1N914	1N4446	1N3070	1N456A	1N4244
1N914A	1N4448	FDH400	1N457	FDH700
1N916	FDH600	FDH444	1N457A	FDH777
1N916A			1N458A	
1N3064			1N459	
1N4148			1N462A	
1N4149			1N483B	
1N4151			1N485B	
1N4154			FDH300	
1N4305			FDH333	



Surface Mount Zener Diodes

TO-236 PLASTIC PACKAGE (National preferred devices in **bold**)

Device No.	Mark	V_Z (V) Nom.	Z_Z (Ω) Max	I_{ZT} (mA)	Z_{ZK} (Ω) Max	I_{ZK} (μA)	I_R (μA) Max	V_R (V) Max	V_F (mV)	I_F (mA)	Temp Coeff. % / °C	Process Family
MMBZ5226B	8A	3.3	28	20	1,600	250	25	1	900	10	- 0.070	AY
MMBZ5227B	8B	3.6	24	20	1,700	250	15	1	900	10	- 0.065	BY
MMBZ5228B	**8C**	**3.9**	**23**	**20**	**1,900**	**250**	**10**	**1**	**900**	**10**	**- 0.060**	**CY**
MMBZ5229B	8D	4.3	22	20	2,000	250	5	1	900	10	+ / - 0.055	DY
MMBZ5230B	8E	4.7	19	20	1,900	250	5	2	900	10	+ / - 0.030	EY
MMBZ5231B	**8F**	**5.1**	**17**	**20**	**1,600**	**250**	**5**	**2**	**900**	**10**	**+ / - 0.030**	**FY**
MMBZ5232B	**8G**	**5.6**	**11**	**20**	**1,600**	**250**	**5**	**3**	**900**	**10**	**+ 0.038**	**GY**
MMBZ5233B	**8H**	**6**	**7**	**20**	**1,600**	**250**	**5**	**3.5**	**900**	**10**	**+ 0.038**	**HY**
MMBZ5234B	**8J**	**6.2**	**7**	**20**	**1,600**	**250**	**5**	**4**	**900**	**10**	**+ 0.045**	**IY**
MMBZ5235B	8K	6.8	5	20	750	250	3	5	900	10	+ 0.050	JY
MMBZ5236B	**8L**	**7.5**	**6**	**20**	**500**	**250**	**3**	**6**	**900**	**10**	**+ 0.058**	**KY**
MMBZ5237B	8M	8.2	8	20	500	250	3	6.5	900	10	+ 0.062	LY
MMBZ5238B	8N	8.7	8	20	600	250	3	6.5	900	10	+ 0.065	NY
MMBZ5239B	8P	9.1	10	20	600	250	3	7	900	10	+ 0.068	PY
MMBZ5240B	**8Q**	**10**	**17**	**20**	**600**	**250**	**3**	**8**	**900**	**10**	+ 0.075	**RY**
MMBZ5241B	8R	11	22	20	600	250	2	8.4	900	10	+ 0.076	SY
MMBZ5242B	**8S**	**12**	**30**	**20**	**600**	**250**	**1**	**9.1**	**900**	**10**	**+ 0.077**	**TY**
MMBZ5243B	8T	13	13	9.5	600	250	0.5	9.9	900	10	+ 0.079	UY
MMBZ5244B	8U	14	15	9	600	250	0.1	10	900	10	+ 0.082	VY
MMBZ5245B	**8V**	**15**	**16**	**8.5**	**600**	**250**	**0.1**	**11**	**900**	**10**	**+ 0.082**	**WY**
MMBZ5246B	8W	16	17	7.8	600	250	0.1	12	900	10	+ 0.083	XY
MMBZ5247B	8X	17	19	7.4	600	250	0.1	13	900	10	+ 0.084	YY
MMBZ5248B	**8Y**	**18**	**21**	**7**	**600**	**250**	**0.1**	**14**	**900**	**10**	**+ 0.085**	**ZY**
MMBZ5249B	8Z	19	23	6.6	600	250	0.1	15	900	10	+ 0.086	MY
MMBZ5250B	81A	20	25	6.2	600	250	0.1	16	900	10	+ 0.086	QY
MMBZ5251B	81B	22	29	5.6	600	250	0.1	17	900	10	+ 0.087	3Y
MMBZ5252B	**81C**	**24**	**33**	**5.2**	**600**	**250**	**0.1**	**18**	**900**	**10**	**+ 0.088**	**4Y**
MMBZ5253B	81D	25	35	5	600	250	0.1	19	900	10	+ 0.089	5Y
MMBZ5254B	**81E**	**27**	**41**	**4.6**	**600**	**250**	**0.1**	**21**	**900**	**10**	**+ 0.090**	**6Y**
MMBZ5255B	81F	28	44	4.5	600	250	0.1	21	900	10	+ 0.091	7Y
MMBZ5256B	81G	30	49	4.2	600	250	0.1	23	900	10	+ 0.091	8Y
MMBZ5257B	**81H**	**33**	**58**	**3.8**	**700**	**250**	**0.1**	**25**	**900**	**10**	**+ 0.092**	**9Y**

National Semiconductor™

Discrete POWER & Signal Technologies

Surface Mount Transistors

NPN Saturated Switches

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Max @	I_C (mA) $(I_B = \frac{I_C}{10})$	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	$t_{(off)}$ (ns) Max	Test Conditions	Process No.
MMBT2369 (1J)	TO-236 (49)	40	15	4.5	400	20	20		100	2	0.25	0.85	10	4	500	10	18	(Note 1)	21
							40	120	10	1									
MMBT2369A (1S)	**TO-236 (49)**	**40**	**15**	**4.5**	**400**	**20**	**20**		**100**	**1**	**0.2**	**0.85**	**10**	**4**	**500**	**10**	**18**	**(Note 1)**	**21 (5-24)**
							30		**30**	**0.4**	**0.2**	**1.15**	**30**						
							40	**120**	**10**	**1**									
							40		**10**	**0.35**	**0.5**	**1.6**	**100**						
MMPQ2369	**SO-16 (S3)**	**40**	**15**	**4.5**	**400**	**20**	**20**		**100**	**1**	**0.2**	**0.85**	**10**	**4**	**500**	**10**			**21 (5-24)**
							30		**30**	**0.4**	**0.2**	**1.15**	**30**						
							40	**120**	**10**	**1**									
							40		**10**	**0.35**	**0.5**	**1.6**	**100**						
MMPQ3725	**SO-16 (S3)**	**60**	**40**	**6**	**1700**	**60**	**25**		**1A**	**5**	**0.25**	**0.76**	**10**	**10**	**300**	**50**			**25 (5-59)**
							20		**800**	**2**	**0.26**	**0.86**	**100**						
							35		**500**	**1**	**0.4**	**1.1**	**300**						
							40		**300**	**1**	**0.25**	**1.2**	**500**						
							60	**150**	**100**	**1**	**0.8**	**1.5**	**800**						
							30		**10**	**1**	**0.95**	**1.7**	**1A**						

TEST CONDITIONS

Note 1: V_{CC} = 3V, I_C = 10 mA, I_B^1 = 3 mA, I_R^2 = 1.5 mA.

Note 2: V_{CC} = 10V, I_C = 300 mA, I_B^1 = I_B^2 = 30 mA.

Note 3: V_{CC} = 30V, I_C = 500 mA, I_B^1 = I_B^2 = 50 mA.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

Surface Mount Transistors

NPN Low Level Amplifiers

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	NF (dB) Max	Test Conditions	Process No.
MMBT5088 (1Q)	**TO-236 (49)**	**35**	**30**	**5**	**50**	**20**	**300**		**10**	**5**	**0.5**			**10**	**4**			**3**	**(Note 2)**	**07 (5-102)**
							350		**1**	**5**										
							300	**900**	**0.1**	**5**										
MMBT5089 (1R)	**TO-236 (49)**	**30**	**25**	**4.5**	**50**	**15**	**400**		**10**	**5**	**0.5**			**10**	**4**			**2**	**(Note 2)**	**07 (5-102)**
							450		**1**	**5**										
							400	**120**	**0.1**	**5**										
MMBT5962 (117)	TO-236 (49)	45	45	8	2	30	450		0.01	5	0.2			10	6	100	10	6	(Note 3, 7)	07
							500		0.1	5								4	(Note 4)	
							550		1	5								8	(Note 5)	
							600	140	10	5								3	(Note 6)	
																		3	(Note 1)	

TEST CONDITIONS

Note 1: I_C = 10 µA, V_{CE} = 8V, f = 10 Hz - 16.7 kHz.
Note 2: I_C = 5 µA, V_{CE} = 5V, f = 1 kHz.
Note 3: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz, R_S = 1 kΩ.
Note 4: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz, R_S = 10 kΩ.
Note 5: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz, R_S = 100 kΩ.
Note 6: I_C = 10 µA, V_{CE} = 5V, f = 1 kHz, R_S = 10 kΩ.
Note 7: I_C / I_B = 20

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

Surface Mount Transistors

NPN RF Amplifiers and Oscillators

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Min	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max	@ I_C (mA)	NF (dB) Max	@ Freq (MHz)	Process No.
MMBT5179 (3C)	**TO-236 (49)**	**20**	**12**	**2.5**	**2**	**15**	**25**	**250**	**3**	**1**	**0.4**	**1**	**10**		**1**	**900**	**2000**	**5**	**5**	**200**	**40 (5-108)**
MMBTH10 (3E)	**TO-236 (49)**	**30**	**25**	**3**	**100**	**25**	**60**		**4**	**10**	**0.5**		**4**	**0.35**	**0.65**	**650**		**4**			**42 (5-190)**
MMBT918 (3B)	**TO-236 (49)**	**30**	**15**	**3**	**10**	**15**	**20**		**3**	**1**	**0.4**	**1**	**10**		**1.7**	**600**		**4**	**6**	**60**	**43 (5-9)**
MMBTH11 (3G)	**TO-236 (49)**	**30**	**25**	**3**	**100**	**25**	**60**		**4**	**10**	**0.5**		**4**	**0.6**	**0.9**	**650**		**4**			**47 (5-196)**
MMBTH24 (3A)	TO-236 (49)	40	30	4	50	15	30		8	10					0.36	400		8			47
MMBTH34 (3K)	TO-236 (49)	45	45	4	50	30	15 40		20 7	2 15	0.5		20		0.32	500		15			47
MMBTH20 (3L)	**TO-236 (49)**	**40**	**30**	**4**	**50**	**15**	**25**		**4**	**10**		**0.95**	**10**		**0.65**	**400**		**4**			**49 (5-204)**

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Surface Mount Transistors

NPN General Purpose Amplifiers and Switches

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
MMBT100 (N1)	**TO-236 (49)**	**75**	**45**	**6**	**50**	**60**	**80**		**0.1**	**1**	**0.2**	**0.85**	**10**	**4.5**	**250**		**20**		**5**	**(Note 1)**	**10 (5-1)**
							100	**450**	**10**	**1**											
							100		**100**	**1**	**0.4**	**1**	**200**								
MMBT100A (N1A)	**TO-236 (49)**	**75**	**45**	**6**	**50**	**60**	**240**		**0.1**	**1**	**0.2**	**0.85**	**10**	**4.5**	**250**		**20**		**4**	**(Note 1)**	**10 (5-1)**
							300	**600**	**10**	**1**											
							100		**100**	**1**	**0.4**	**1**	**200**								
MMBTA05 (1H)	TO-236 (49)	60	60	4	100	60	50		100	1	0.25		100		50		100				10
							50		10	1											
MMBT5551 (3S)	**TO-236 (49)**	**180**	**160**	**6**	**50**	**120**	**30**		**50**	**5**	**0.15**	**1**	**10**	**6**	**100**	**300**	**10**		**8**	**(Note 5)**	**16 (5-118)**
							80	**250**	**10**	**5**											
							80		**1**	**5**	**0.2**	**1**	**50**								
MMBT2222 (1B)	TO-236 (49)	60	30	5	10	50	35		0.1	10	0.4	1.2	150	8	250		20				19
							50		1	10											
							75		10	10											
							100	300	150	10											
							30		500	10											
							50		150	1	1.6	2.6	500								
MMBT2222A (1P)	**TO-236 (49)**	**75**	**40**	**6**	**10**	**60**	**40**		**500**	**10**	**0.3**	**1.2**	**150**	**8**	**300**		**20**	**285**		**(Note 2)**	**19 (5-18)**
							50		**150**	**1**											
							100	**300**	**150**	**10**	**1**	**2**	**500**						**4**	**(Note 6)**	
							75		**10**	**10**											
							50		**1**	**10**											
							35		**0.1**	**10**											
MMBT4400 (83)	TO-236 (49)	60	40	6			20		1	1	0.4	0.95	150	6.5							19
											0.75	1.2	500								

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

NPN Surface Mount General Purpose Amplifiers and Switches (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
MMBT4401 (2X)	TO-236 (49)	60	40	6			20		0.1	1	0.4	0.75	0.95	150	6.5	250	20				19
							40		1	1											
							80		10	1											
							100	300	150	1											
							40		500	2	0.75		1.2	500							
MMPQ2222	**SO-16 (S3)**	**75**	**40**	**6**	**10**	**60**	**40**		**500**	**10**	**0.3**	**0.6**	**1.2**	**150**	**8**						**19 (5-18)**
							50		**150**	**1**											
							100	**300**	**150**	**10**	**1**		**2**	**500**							
							75		**10**	**10**											
							50		**1**	**10**											
							35		**0.1**	**10**											
MMPQ6502**	SO-16 (S3)	60	30	5	30	50	50		1	10	0.4		1.3	150	8	200	50				19
							75		10	10	1.4		2	300							
							100		150	10											
							30		300	10											
NMT2222	**SOT-6 (31)**	**75**	**40**	**6**	**10**	**60**	**40**		**500**	**10**	**0.3**	**0.6**	**1.2**	**150**	**8**						**19 (5-18)**
							50		**150**	**1**											
							100	**300**	**150**	**10**	**1**		**2**	**500**							
							75		**10**	**10**											
							50		**1**	**10**											
							35		**0.1**	**10**											
PZT2222A	**TO-261 (47)**	**75**	**40**	**6**	**10**	**60**	**40**		**500**	**10**	**0.3**	**0.6**	**1.2**	**150**	**8**	**300**	**20**	**285**		**(Note 2)**	**19 (5-18)**
							50		**150**	**1**											
							100	**300**	**150**	**10**	**1**		**2**	**500**					**4**	**(Note 6)**	
							75		**10**	**10**											
							50		**1**	**10**											
							35		**0.1**	**10**											
MMBT3904 (1A)	**TO-236 (49)**	**60**	**40**	**6**			**30**		**100**	**1**	**0.2**	**0.65**	**0.85**	**10**	**4**	**300**	**10**	**250**		**(Note 4)**	**23 (5-65)**
							60		**50**	**1**											
							100	**300**	**10**	**1**	**0.3**		**0.95**	**50**					**5**	**(Note 7)**	
							70		**1**	**1**											
							40		**0.01**	**1**											

**Complimentary Quad listed as Process 63 in PNP Surface Mount Devices.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

NPN Surface Mount General Purpose Amplifiers and Switches (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
MMBT4124 (ZC)	TO-236 (49)	30	25	5	50	20	60		50	1	0.3		0.95	50	4	300	10		5	(Note 3)	23
							120	360	2	1											
MMBT6515 (3J)	TO-236 (49)	40	25	4	50	30	250	500	2	10	0.5			50	3.5						23
							150		100	10											
MMPQ3904	**SO-16 (S3)**	**60**	**40**	**6**			**30**		**100**	**1**	**0.2**	**0.65**	**0.85**	**10**	**4**	**300**	**10**		**5**	**(Note 7)**	**23 (5-65)**
							60		**50**	**1**											
							100	**300**	**10**	**1**	**0.3**		**0.95**	**50**							
							70		**1**	**1**											
							40		**0.01**	**1**											
MMPQ6700**	SO-16 (S3)	40	40	5	50	30	30		0.1	1	0.25		0.9	5	4.5	200	20				23
							50		1	1											
							70		10	1											
PZT3904	**TO-261 (47)**	**60**	**40**	**6**			**30**		**100**	**1**	**0.2**	**0.65**	**0.85**	**10**	**4**	**300**	**10**	**250**		**(Note 4)**	**23 (5-65)**
							60		**50**	**1**											
							100	**300**	**10**	**1**	**0.3**		**0.95**	**50**					**5**	**(Note 7)**	
							70		**1**	**1**											
							40		**0.01**	**1**											

TEST CONDITIONS

Note 1: I_C = 300 mA, V_{CC} = 10V, $I_B^1 = I_B^2$ = 30 mA.
Note 2: I_C = 300 mA, V_{CC} = 15V, $I_B^1 = I_B^2$ = 30 mA.
Note 3: I_C = 30 µA, V_{CE} = 5V, f = 1 kHz.
Note 4: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz.
Note 5: I_C = 250 µA, V_{CE} = 5V, f = 10 Hz - 15.7 kHz.
Note 6: I_C = 100 µA, R_S = 1.0 kΩ, f = 1 kHz.
Note 7: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz.
Note 5: I_C = 10 mA, V_{CC} = 3V, $I_B^1 = I_B^2$ = 1 mA.

**Complimentary Quad listed as Process 66 in PNP Surface Mount Devices.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

Surface Mount Transistors

NPN Medium Power

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	Process No.
MMBTA06 (1G)	TO-236 (49)	80	80	4	100	80	100 100		10 100	1 1	0.25		100		100		10	33 (5-160)
PZTA06	TO-261 (47)	80	80	4	100	80	100 100		10 100	1 1	0.25		100		100		10	33 (5-160)
NZT6714	TO-261 (47)	40	30	5	100	40	55 60 50	 250	10 100 1A	1 1 1	0.5		1A	30				37 (5-126)
NZT6715	TO-261 (47)	40	50	5	100	50	60 50	 250	10 100	1 1	0.5		1A	30				38 (5-130)
NZT6717	TO-261 (47)	80	80	5	100	60	80 50 20	 250 	50 250 500	1 1 1	0.5		250	30	50	500	200	39 (5-134)
MMBTA42 (1D)	TO-236 (49)	300	300	6	100	200	25 40 40		1 10 30	10 10 10	0.5	0.9	20	3	50		10	48 (5-172)
MMBTA43 (1E)	TO-236 (49)	200	200	6	100	160	25 40 40	 200	1 10 30	10 10 10	0.5	0.9	20	4	50		10	48
PZTA42	TO-261 (47)	300	300	6	100	200	25 40 40		1 10 30	10 10 10	0.5	0.9	20	3	50		10	48 (5-172)

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Discrete POWER & Signal Technologies

Surface Mount Transistors

NPN Darlington Transistors

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (µA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) @	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	Process No.
MMBTA28 (3SS)	**TO-236 (49)**	**80**	**80**	**12**	**0.1**	**60**	**10,000 10,000**		**10 100**	**5 5**	**1.2 1.5**		**2**	**10 100**	**8**	**125**	**10**	**03 (5-168)**
PZTA28	**TO-261 (47)**	**80**	**80**	**12**	**0.1**	**60**	**10,000 10,000**		**10 100**	**5 5**	**1.2 1.5**		**2**	**10 100**	**8**	**125**	**10**	**03 (5-168)**
MMBT6427 (1V)	TO-236 (49)	40	40	12	0.05	30	10,000 20,000 14,000	100,000 200,000 140,000	10 100 500	5 5 5	1.2 1.5		2	50 500	7	130	10	05
MMBTA13 (1M)	TO-236 (49)	30		10	0.1	30	5,000 10,000		10 10	5 5	1.5			100		125	10	05
MMBTA14 (1N)	**TO-236 (49)**	**30**	**30**	**10**	**0.1**	**30**	**20,000 10,000**		**100 10**	**5 5**	**1.5**			**100**		**125**	**10**	**05 (5-164)**
PZTA14	**TO-261 (47)**	**30**	**30**	**10**	**0.1**	**30**	**20,000 10,000**		**100 10**	**5 5**	**1.5**			**100**		**125**	**10**	**05 (5-164)**
NZT7053	**TO-261 (47)**	**100**	**100**	**12**	**0.1**	**80**	**10,000 1000**	**20,000**	**100 1A**	**5 5**	**1.5**			**100**	**8**	**100**	**100**	**06 (5-150)**

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

Surface Mount Transistors

NPN Bipolar Power Transistors

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (µA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (A)	@ V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (A)	f_T (MHz) Min	@ I_C (A)	Process No.
NZT44H8	TO-261 (47)		60	5	10	60	60 40		2 4	1 1	1		1.5	8	50	0.5	4Q (5-216)
NZT651	TO-261 (47)	80	60	5	1	80	75 40		1 2	2 2	0.3		1.2	1	75	0.05	4P (5-224)

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Surface Mount Transistors

PNP Saturated Switches

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Max	@ I_C (mA) ($I_B = \frac{I_C}{10}$)	C_{ob} (pF) Max	f_T (MHz) Min	@ I_C (mA)	$t_{(off)}$ (ns) Max	Test Conditions	Process No.
MMBT3640 (2J)	TO-236 (49)	12	12	4	10*	6	20 30	 120	50 10	1 0.3	0.2 0.6	1 1.5	10 50	3.5	500	10	75	(Note 2)	65
MMBT4258 (78)	**TO-236 (49)**	**12**	**12**	**4.5**	**10***	**6**	**30** **15** **30**	**120**	**10** **1** **50**	**3** **0.5** **1**	**0.15** **0.5**	**0.95** **1.5**	**10** **50**	**3**	**500**	**10**	**20**	**(Note 1)**	**65 (5-86)**
MMBT5771 (3R)	TO-236 (49)	15	15	4.5	10	8	50 40 35	120	10 50 1	0.3 1 0.5	0.15 0.18 0.6	0.8 0.95 1.5	1 10 50	3	700	10	20	(Note 1)	65
MMPQ3467	**SO-16 (S3)**	**40**	**40**	**5**	**100**	**30**	**40** **40** **40**	 **120**	**150** **500** **1A**	**1** **1** **5**	**0.3** **0.5** **1**	**1** **1.2** **1.6**	**150** **500** **1A**	**25**	**175**	**50**			**70 (5-49)**

TEST CONDITIONS

Note 1: V_{CC} = 25V, I_C = 600 mA, I_B^1 = I_B^2 = 50 mA.

Note 2: V_{CC} = 30V, I_C = 500 mA, I_B^1 = I_B^2 = 50 mA.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

Surface Mount Transistors

PNP Low Level Amplifiers

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	NF (dB) Max	Test Conditions	Process No.
MMBT5086 (2P)	TO-236 (49)	50	50	5	50	35	150 150 150	 500	10 1 0.1	5 5 5	0.3			10	4	40	0.5	3	(Note 1)	62 (5-96)
MMBT5087 (2Q)	TO-236 (49)	50	50	5	50	35	250 250 250	 800	10 1 0.1	5 5 5	0.3			10	4	40	0.5	2	(Note 1)	62 (5-96)

TEST CONDITIONS

Note 1: I_C = 100 µA, V_{CE} = 5V, f = 10 Hz - 15.7 kHz.

PNP RF Amplifiers and Oscillators

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Min	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	NF (dB) Max	Freq (MHz)	Process No.
MMBTH81 (3D)	TO-236 (49)	20	20	3	100	20	60		5	10	0.5		5		0.85	600		5			75 (5-212)

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

Surface Mount Transistors

PNP General Purpose Amplifiers and Switches

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
MMBT2907 (2B)	TO-236 (49)	60	40	5	20	50	30 100 75 50 35	 300	500 150 10 1 0.1	10 10 10 10 10	0.4 1.6		1.3 2.6	150 500	8	200	50				63
MMBT2907A (2F)	**TO-236 (49)**	**60**	**60**	**5**	**20**	**50**	**50 100 100 100 75**	** 300**	**500 150 10 1 0.1**	**10 10 10 10 10**	**0.4 1.6**		**1.3 2.6**	**150 500**	**8**	**200**	**50**	**100**		**(Note 1)**	**63 (5-32)**
MMBT3702 (137)	TO-236 (49)	40	25	5	100	20	60	300	50	5	0.25			50	12	100	50				63
MMBT4403 (2T)	TO-236 (49)	40	40	5			20 100 100 60 30	 300	500 150 10 1 0.1	2 2 1 1 1	0.4 0.75	0.75	0.95 1.3	150 500	8.5	200	20	255		(Note 2)	63
MMPQ2907	**SO-16 (S3)**	**60**	**60**	**5**	**20**	**50**	**50 100 100 100 75**	** 300**	**500 150 10 1 0.1**	**10 10 10 10 10**	**0.4 1.6**		**1.3 2.6**	**150 500**	**8**						**63 (5-32)**
MMPQ6502**	SO-16 (S3)	60	30	5	30	50	50 75 100 30		1 10 150 300	10 10 10 10	0.4 1.4		1.3 2	150 300	8	200	50				63

**Complimentary Quad listed as Process 19 in NPN Surface Mount Devices.

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

PNP Surface Mount General Purpose Amplifiers and Switches (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
NMT2907	**SOT-6 (31)**	**60**	**60**	**5**	**20**	**50**	**50 100 100 100 75**	 **300**	**500 150 10 1 0.1**	**10 10 10 10 10**	**0.4 1.6**		**1.3 2.6**	**150 500**	**8**						**63 (5-32)**
PZT2907A	**TO-261 (47)**	**60**	**60**	**5**	**20**	**50**	**50 100 100 100 75**	 **300**	**500 150 10 1 0.1**	**10 10 10 10 10**	**0.4 1.6**		**1.3 2.6**	**150 500**	**8**	**200**	**50**	**100**		**(Note 1)**	**63 (5-32)**
MMBT3906 (2A)	**TO-236 (49)**	**40**	**40**	**5**			**30 60 100 80**	 **300**	**100 50 10 1**	**1 1 1 1**	**0.25 0.4**	**0.65**	**0.85 0.95**	**10 '50**	**4.5**	**250**	**10**	**300**	 **4**	**(Note 5) (Note 3)**	**66 (5-72)**
MMBT4126 (ZF)	TO-236 (49)	25	25	4	50	20	60 120	 300	50 2	1 1	0.4		0.95	50	4.5	250	10		4	(Note 3)	66
MMPQ3906	**SO-16 (S3)**	**40**	**40**	**5**			**30 60 100 80**	 **300**	**100 50 10 1**	**1 1 1 1**	**0.25 0.4**	**0.65**	**0.85 0.95**	**10 50**	**4.5**	**250**	**10**		**4**	**(Note 3)**	**66 (5-72)**
MMPQ6700**	SO-16 (S3)	40	40	5	50	30	30 50 70		0.1 1 10	1 1 1	0.25		0.9	5	4.5	200	20				66
PZT3906	**TO-261 (47)**	**40**	**40**	**5**			**30 60 100 80 60**	 **300**	**100 50 10 1 0.1**	**1 1 1 1 1**	**0.25 0.4**	**0.65**	**0.85 0.95**	**10 50**	**4.5**	**250**	**10**	**300**	 **4**	**(Note 5) (Note 3)**	**66 (5-72)**
MMBTA55 (2H)	TO-236 (49)	60	60	4	100	60	100 100		10 100	1 1	0.25			100		50	100				67

**Complimentary Quad listed as Process 23 in NPN Surface Mount Devices.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

PNP Surface Mount General Purpose Amplifiers and Switches (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	NF (dB) Max	Test Conditions	Process No.
MMBT200 (N2)	TO-236 (49)	60	45	6	50	50	80		0.1	1	0.2		0.85	10	6	250		20	5	(Note 3)	68 (5-5)
							100	450	10	1											
							100		100	1	0.4		1	200							
							100	350	150	5											
MMBT200A (N2A)	TO-236 (49)	60	45	6	50	50	300	600	10	1	0.2		0.85	10	6	250		20	4	(Note 3)	68 (5-5)
							100		100	1											
							200		0.1	1	0.4		1	200							
MMBT5401 (2L)	TO-236 (49)	160	150	5	50	120	50		50	5	0.2		1	10	6	100	300	10	8	(Note 4)	74 (5-114)
							60	240	10	5											
							50		1	5	0.5		1	50							

TEST CONDITIONS

Note 1: I_C = 300 mA, V_{CC} = 5V, I_B^1 = I_B^2 = 15 mA.

Note 2: I_C = 300 mA, V_{CC} = 30V, I_B^1 = I_B^2 = 30 mA.

Note 3: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz.

Note 4: I_C = 250 µA, V_{CE} = 5V, f = 1 kHz.

Note 5: I_C = 10 mA, V_{CC} = 3V, I_B^1 = I_B^2 = 1 mA.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Surface Mount Transistors

PNP Medium Power

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	$t_{(off)}$ (ns) Max	Test Conditions	Process No.
MMBTA56 (2G)	**TO-236 (49)**		**80**	**4**	**100**	**80**	**100** **100**		**100** **10**	**1** **1**	**0.25**			**100**		**50**		**100**			**73 (5-178)**
PZTA56	**TO-261 (47)**		**80**	**4**	**100**	**80**	**100** **100**		**100** **10**	**1** **1**	**0.25**			**100**		**50**		**100**			**73 (5-178)**
MMBTA92 (2D)	**TO-236 (49)**	**300**	**300**	**5**	**250**	**200**	**25** **40** **25**		**1** **10** **30**	**10** **10** **10**	**0.5**		**0.9**	**20**	**6**	**50**		**10**			**76 (5-186)**
MMBTA93 (2E)	TO-236 (49)	200	200	5	250	200	25 40 25		1 10 30	10 10 10	0.5		0.9	20	6	50		10			76
PZTA92	**TO-261 (47)**	**300**	**300**	**5**	**250**	**200**	**25** **40** **25**		**1** **10** **30**	**10** **10** **10**	**0.5**		**0.9**	**20**	**6**	**50**		**10**			**76 (5-186)**
NZT6726	**TO-261 (47)**	**40**	**30**	**5**	**100**	**40**	**55** **60** **50**	 **200**	**10** **100** **1A**	**1** **1** **1**	**0.5**			**1A**	**30**	**50**		**50**			**77 (5-138)**
NZT6728	**TO-261 (47)**	**60**	**60**	**5**	**100**	**40**	**80** **50** **20**	 **250** 	**50** **250** **500**	**1** **1** **1**	**0.35**			**250**	**30**	**50**		**50**			**78 (5-142)**
NZT6729	**TO-261 (47)**	**80**	**80**	**5**	**100**	**60**	**80** **50** **20**	 **250** 	**50** **250** **500**	**1** **1** **1**	**0.35**			**250**	**30**	**50**		**50**			**79 (5-146)**

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Surface Mount Transistors

PNP Darlington Transistors

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (µA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	@ V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	@ I_C (mA)	Process No.
MMBTA64 (2V)	SO-16 (S3)		30		0.1	30	20,000 10,000		100 10	5 5	1.5			100		125	10	61 (5-182)
PZTA64	TO-261 (47)		30		0.1	30	20,000 10,000		100 10	5 5	1.5			100		125	10	61 (5-182)

PNP Bipolar Power Transistors

Device No. (SOT-23 Mark)	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (µA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (A)	@ V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (A)	f_T (MHz) Min	@ I_C (A)	Process No.
NZT45H8	TO-261 (47)		60	5	10	60	60 40		2 4	1 1	1		1.5	8	40	0.5	5Q (5-220)
NZT751	TO-261 (47)	80	60	5	1	80	75 40		1 2	2 2	0.3		1.2	1	75	0.05	5P (5-228)

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Surface Mount JFETs

N-Channel Switches / Choppers

Device No. (SOT-23 Mark)	Case Style	BV_{GSS} BV_{GDO} (V) Min	@ I_G (µA)	I_{GSS} $*I_{DGO}$ (nA) Max	@ V_{DG} (V)	$I_{D(off)}$ (nA) Max	@ V_{DS} (V)	V_{GS} (V)	V_P (V) Min	V_P (V) Max	@ V_{DS} (V)	I_D (nA)	I_{DSS} (mA) Min	I_{DSS} (mA) Max	@ V_{DS} (V)	$r_{ds(on)}$ (Ω) Max	@ I_D (mA)	C_{iss} (pF) Max	@ V_{DS} (V)	I_{GS} (V)	C_{rss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	$t_{(off)}$ (ns) Max	Process No.
MMBF4091	TO-236 (49)	40	1	0.2*	20	0.2	20	-12	5	10	20	1	30		20	30		16	20	0	5	20	0	40	51
MMBF4092	TO-236 (49)	40	1	0.2*	20	0.2	20	-8	2	7	20	1	15		20	50		16	20	0	5	20	0	60	51
MMBF4093	TO-236 (49)	40	1	0.2*	20	0.2	20	-6	1	5	20	1	8		20	80		16	20	0	5	20	0	80	51
MMBF4391 (6J)	TO-236 (49)	40	1	0.1	20	0.1	20	-12	4	10	20	1	50	150	20	30		14	20	0	3.5	0	-12	35	51
MMBF4392 (6K)	TO-236 (49)	40	1	0.1	20	0.1	20	-7	2	5	20	1	25	75	20	60		14	20	0	3.5	0	-7	80	51
MMBF4393 (6G)	TO-236 (49)	40	1	0.1	20	0.1	20	-5	0.5	3	20	1	5	30	20	100		14	20	0	3.5	0	-5	130	51
MMBFJ111 (6H)	**TO-236 (49)**	**35**	**1**	**10**	**15**	**1**	**5**	**-10**	**3**	**10**	**5**	**100**	**20**		**15**	**30**	**1**								**51 (7-9)**
MMBFJ112 (6P)	**TO-236 (49)**	**35**	**1**	**10**	**15**	**1**	**5**	**-10**	**1**	**5**	**5**	**100**	**5**		**15**	**50**	**1**								**51 (7-9)**
MMBFJ113 (6R)	**TO-236 (49)**	**35**	**1**	**10**	**15**	**1**	**5**	**-10**	**0.5**	**3**	**5**	**100**	**2**		**15**	**100**	**1**								**51 (7-9)**
NDSJ105	**TO-236 (49)**	**25**	**1**	**3**	**15**	**3**	**5**	**10**	**4.5**	**10**	**5**	**100**	**500**		**3**	**3**									**59 (7-1)**

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

Surface Mount JFETs

N-Channel RF, VHF, UHF Amplifiers

Device No. (SOT-23 Mark)	Case Style	BV_{GSS} (V) Min	@ I_G (μA)	I_{GSS} (nA) Max	@ V_{DG} (V)	V_P (V) Min	V_P (V) Max	@ V_{DS} (V)	I_D (nA)	I_{DSS} (mA) Min	I_{DSS} (mA) Max	@ V_{DS} (V)	$R_e\|Y_{fs}\|$ (mmho) Min	@ Fq. (MHz)	C_{iss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	C_{rss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	NF (dB) @ R_G = 1k Max	Freq (MHz)	Process No.
MMBF5484 (6B)	TO-236 (49)	25	1	1	20	0.3	3	15	10	1	5	15	2.5	100	5	15	0	1	15	0	3	100	50 (7-51)
MMBF5485 (6M)	TO-236 (49)	25	1	1	20	0.5	4	15	10	4	10	15	3	400	5	15	0	1	15	0	4	400	50 (7-51)
MMBF5486 (6H)	TO-236 (49)	25	1	1	20	2	6	15	10	8	20	15	3.5	400	5	15	0	1	15	0	4	400	50 (7-51)
MMBFJ309 (6U)	TO-236 (49)	25	1	1	15	1	4	10	1	12	30	10	t12	100	5	0	-10	2.5	0	-10			92 (7-27)
MMBFJ310 (6Z)	TO-236 (49)	25	1	1	15	2	6.5	10	1	24	60	10	t12	100	5	0	-10	2.5	0	-10			92 (7-27)

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

t = typical value

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Surface Mount JFETs

N-Channel General Purpose Amplifiers

Device No. (SOT-23 Mark)	Case Style	BV_{GSS} (V) @ Min	I_G (µA)	I_{GSS} (nA)@ Max	V_{DG} (V)	V_P (V) @ Min	V_P Max	V_{DS} (V)	I_D (nA)	I_{DSS} (mA) @ Min	I_{DSS} Max	V_{DS} (V)	G_{fs} (mmho) @ Min	G_{fs} Max	V_{DS} (V)	C_{iss} (pF)@ Max	V_{DS} (V)	V_{GS} (V)	C_{rss} (pF) @ Min	C_{rss} Max	V_{DS} (V)	Process No.
MMBF4117 (61A)	**TO-236 (49)**	**40**	**10**	**10**	**20**	**0.6**	**1.8**	**10**	**1**	**30**	**90**	**10**	**70**	**210**	**10**	**3**	**10**	**0**	**1.5**	**10**	**0**	**53 (7-37)**
MMBF4118 (61C)	**TO-236 (49)**	**40**	**10**	**10**	**20**	**1**	**3**	**10**	**1**	**80**	**240**	**10**	**80**	**250**	**10**	**3**	**10**	**0**	**1.5**	**10**	**0**	**53 (7-37)**
MMBF4119 (61E)	**TO-236 (49)**	**40**	**10**	**10**	**20**	**2**	**6**	**10**	**1**	**200**	**600**	**10**	**100**	**330**	**10**	**3**	**10**	**0**	**1.5**	**10**	**0**	**53 (7-37)**
MMBF5103 (66A)	TO-236 (49)	40	1	0.2	15	1.2	2.7	15	1	10	40	15	7.5		15	t12	15	0		t4	15	51
MMBF5457 (6D)	**TO-236 (49)**	**25**	**10**	**1**	**15**	**0.5**	**6**	**15**	**10**	**1**	**5**	**15**	**1**	**5**	**15**	**7**	**15**	**0**	**3**	**15**	**0**	**55 (7-43)**
MMBF5458 (61S)	**TO-236 (49)**	**25**	**10**	**1**	**15**	**1**	**7**	**15**	**10**	**2**	**9**	**15**	**1.5**	**5.5**	**15**	**7**	**15**	**0**	**3**	**15**	**0**	**55 (7-43)**
MMBF5459 (6L)	**TO-236 (49)**	**25**	**10**	**1**	**15**	**2**	**8**	**15**	**10**	**4**	**16**	**15**	**2**	**6**	**15**	**7**	**15**	**0**	**3**	**15**	**0**	**55 (7-43)**
MMBFJ201 (62P)	**TO-236 (49)**	**40**	**1**	**0.1**	**20**	**0.3**	**1.5**	**20**	**10**	**0.2**	**1**	**20**	**0.5**		**20**							**52 (7-18)**
MMBFJ202 (62Q)	**TO-236 (49)**	**40**	**1**	**0.1**	**20**	**0.8**	**4**	**20**	**10**	**0.9**	**4.5**	**20**	**1**		**20**							**52 (7-18)**
MMBFJ210 (62V)	TO-236 (49)	25	1	0.1	15	1	3	15	1	2	15	15	4	12	15							90
MMBFJ211 (62V)	**TO-236 (49)**	**25**	**1**	**0.1**	**15**	**2.5**	**4.5**	**15**	**1**	**7**	**20**	**15**	**6**	**12**	**15**							**90 (7-22)**
MMBFJ212 (62W)	**TO-236 (49)**	**25**	**1**	**0.1**	**15**	**4**	**6**	**15**	**1**	**15**	**40**	**15**	**7**	**12**	**15**							**90 (7-22)**

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Surface Mount JFETs

P-Channel Switches / Choppers

Device No. (SOT-23 Mark)	Case Style	BV_{GSS} BV_{GDO} (V) Min	@ I_G (µA)	I_{GSS} (nA) Max	@ V_{DG} (V)	$I_{D(off)}$ (nA) Max	@ V_{DS} (V)	V_{GS} (V)	V_P (V) Min	V_P (V) Max	@ V_{DS} (V)	I_D (µA)	I_{DSS} (mA) Min	I_{DSS} (mA) Max	@ V_{DS} (V)	$r_{ds(on)}$ (Ω) Max	@ I_D (mA)	C_{iss} (pF) Max	@ V_{DS} (V)	I_{GS} (V)	C_{rss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	$t_{(off)}$ (ns) Max	Process No.
MMBFJ175 (6W)	TO-236 (49)	30	1	1	20	1	15	10	3	6	15	0.01	7	60	15	125	0.5	11	0	10	5.5	0	10	10	88 (7-14)
MMBFJ176 (6X)	TO-236 (49)	30	1	1	20	1	15	10	1	4	15	0.01	2	25	15	250	0.25	11	0	10	5.5	0	10	15	88 (7-14)
MMBFJ177 (6Y)	TO-236 (49)	30	1	1	20	1	15	10	0.8	2.25	15	0.01	0.5	20	15	300	0.1	11	0	10	5.5	0	10	20	88 (7-14)

P-Channel General Purpose Amplifiers

Device No. (SOT-23 Mark)	Case Style	BV_{GSS} (V) Min	@ I_G (µA)	I_{GSS} (nA) Max	@ V_{DG} (V)	V_P (V) Min	V_P (V) Max	@ V_{DS} (V)	I_D (nA)	I_{DSS} (mA) Min	I_{DSS} (mA) Max	@ V_{DS} (V)	G_{fs} (mmho) Min	G_{fs} (mmho) Max	@ V_{DS} (V)	C_{iss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	C_{rss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	NF nV / $\sqrt{H_Z}$ Max	@ f (Hz)	Process No.
MMBF5460 (6E)	TO-236 (49)	40	10	5	20	0.75	6	-15	1	1	5	10	1	4	15	7	-15	0	2	-15	0	115	100	89 (7-47)
MMBF5461 (61U)	TO-236 (49)	40	10	5	20	1	7.5	-15	1	2	9	10	1.5	5	15	7	-15	0	2	-15	0	115	100	89 (7-47)

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Pro Electron Diode Series

Leaded Switching Diodes

Device No.	V_{rrm} (V) Min	I_{rrm} (nA) Min	V_{fm} (V) Max @	I_f (mA)	t_{rr} (ns) Max	Package No.	Process No.
BAV19	**100**	**100**	**1**	**100**	**50**	**DO-35**	**1J (3-13)**
BAV20	**150**	**100**	**1**	**100**	**50**	**DO-35**	**1J (3-13)**
BAV21	**200**	**100**	**1**	**100**	**50**	**DO-35**	**1J (3-13)**
BAV102	150	100	1	100	50	DO-213AC	1J
BAV103	200	100	1	100	50	DO-213AC	1J
BAW62	75	5000	1	100	4	DO-35	D3
BAW76	50	100	1	100	4	DO-35	D3
BAX13	50	200	1	20	6	DO-35	1R
BAX16	150	100	1.3	100	120	DO-35	1J
BAY19	100	100	1	100	50	DO-35	1J
BAY71	35	100	1	20	4	DO-35	D3
BAY72	100	100	1	100	50	DO-35	1J
BAY73	100	5	1	200	1000	DO-35	1M
BAY80	120	100	1	150	60	DO-35	1J
BAY82	12	100	1	20	0.75	DO-7	1S

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Pro Electron Leaded Zeners

Device No.	I_{ZT} = 5.0 mA; pulse width: V_Z = 26 mS V_Z (V) Min	V_Z (V) Max	Z_Z (Ω) Max
BZX55C 3V3	3.1	3.5	85
BZX55C 3V6	3.4	3.8	85
BZX55C 3V9	3.7	4.1	85
BZX55C 4V3	4	4.6	75
BZX55C 4V7	4.4	5	60
BZX55C 5V1	4.8	5.4	35
BZX55C 5V6	5.2	6	25
BZX55C 6V2	5.8	6.6	10
BZX55C 6V8	6.4	7.2	8
BZX55C 7V5	7	7.9	7
BZX55C 8V2	7.7	8.7	7
BZX55C 9V1	8.5	9.6	10
BZX55C 10	9.4	10.6	15
BZX55C 11	10.4	11.6	20
BZX55C 12	11.4	12.7	20
BZX55C 13	12.4	14.1	26
BZX55C 15	13.8	15.6	30
BZX55C 16	15.3	17.1	40
BZX55C 18	16.8	19.1	50
BZX55C 20	18.8	21.2	55
BZX55C 22	20.8	23.3	55
BZX55C 24	22.8	25.6	80

Device No.	I_{ZT} = 5.0 mA; pulse width: V_Z = 26 mS V_Z (V) Min	V_Z (V) Max	Z_Z (Ω) Max
BZX55C 27	25.1	28.9	80
BZX55C 30	28	32	80
BZX55C 33	31	35	80

Device No.	I_{ZT} = 5.0 mA; pulse width: V_Z = 300 µS V_Z (V) Min	V_Z (V) Max	Z_Z (Ω) Max
BZX79C 3V3	3.1	3.5	85
BZX79C 3V6	3.4	3.8	85
BZX79C 3V9	3.7	4.1	85
BZX79C 4V3	4	4.6	75
BZX79C 4V7	4.4	5	60
BZX79C 5V1	4.8	5.4	35
BZX79C 5V6	5.2	6	25
BZX79C 6V2	5.8	6.6	10
BZX79C 6V8	6.4	7.2	8
BZX79C 7V5	7	7.9	7
BZX79 C8V2	7.7	8.7	7
BZX79 C9V1	8.5	9.6	10
BZX79 C10	9.4	10.6	15
BZX79 C11	10.4	11.6	20
BZX79 C12	11.4	12.7	20
BZX79 C13	12.4	14.1	26
BZX79 C15	13.8	15.6	30
BZX79 C16	15.3	17.1	40
BZX79 C18	16.8	19.1	45
BZX79 C20	18.8	21.2	55
BZX79 C22	20.8	23.3	55
BZX79 C24	22.8	25.6	70

Device No.	I_{ZT} = 2.0 mA; pulse width: V_Z = 300 µS V_Z (V) Min	V_Z (V) Max	Z_Z (Ω) Max
BZX79C 27	25.1	28.9	80
BZX79C 30	28	32	80
BZX79C 33	31	35	80

Device No.	V_Z (V) Nom @	I_{ZT} (mA)	Z_Z (Ω) Max
BZX85C 3V3	3.3	80	20
BZX85C 3V6	3.6	70	20
BZX85C 3V9	3.9	60	15
BZX85C 4V7	4.7	45	13
BZX85C 5V1	5.1	45	10
BZX85C 5V6	5.6	45	7
BZX85C 6V2	6.2	35	4
BZX85C 6V8	6.8	35	3.5
BZX85C 7V5	7.5	35	3
BZX85C 8V2	8.2	25	5
BZX85C 9V1	9.1	25	5
BZX85C 10	10	25	7
BZX85C 11	11	20	8
BZX85C 12	12	20	9
BZX85C 13	13	20	10
BZX85C 15	15	15	15
BZX85C 16	16	15	15
BZX85C 18	18	15	20
BZX85C 20	20	10	24
BZX85C 22	22	10	25
BZX85C 24	24	10	25

Device No.	V_Z (V) Nom @	I_{ZT} (mA)	Z_Z (Ω) Max
BZX85C 27	27	8	30
BZX85C 30	30	8	30
BZX85C 33	33	8	35

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Pro Electron Bipolar Devices

Device No.	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	H_{FE} h_{fe} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max	@ I_C (mA)	NF (dB) Max	Test Conditions	Process No.
BC327	TO-92 (97)	50*	45	5	100*	45	40 100	 600	300 100	1 1	0.7		 1.2*	500 300							67
BC327A	TO-92 (97)	60*	60	5	100*	45	40 100	 400	300 100	1 1	0.7		 1.2*	300 500							67
BC327-16	TO-92 (97)	50*	45	5	100*	45	40 100	 250	300 100	1 1	0.7		 1.2*	500 300							67
BC327-25	TO-92 (97)	50*	45	5	100*	45	40 160	 400	300 100	1 1	0.7		 1.2*	500 300							67
BC328	TO-92 (97)	30*	25	5	100*	25	40 100	 600	100 100	1 1	0.7		 1.2	500 300							67
BC328-25	TO-92 (97)	30*	25	5	100*	25	40 160	 400	100 100	1 1	0.7		 1.2	500 300							67
BC337	TO-92 (97)	50*	45	5	100	20	100 40	600	100 500	1 1	0.7			500							12
BC337A	TO-92 (97)	60*	60	5	100	20	100 40	400	100 500	1 1	0.7			500							12
BC337-16	TO-92 (97)	50*	45	5	100	20	100 40	250	100 500	1 1	0.7			500							12
BC337-25	TO-92 (97)	50*	45	5	100	20	160 40	400	100 500	1 1	0.7			500							12
BC338	TO-92 (97)	30*	20	5	100	20	100 40	600	100 500	1 1	0.7			500							12
BC368	**TO-92 (94)**	**25***	**20**	**5**	**10K**	**25**	**50 85 60**	** 375**	**5 500 1A**	**10 1 1**	**0.5**			**1A**		**40**		**10**			**37 (6-1)**

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Pro Electron Bipolar Devices (continued)

Device No.	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	Max	@ I_C (mA)	NF (dB) Max	Test Conditions	Process No.
BC369	**TO-92 (94)**	**25***	**20**	**5**	**10K**	**25**	**50 85 60**	 **375**	**5 500 1A**	**10 1 1**	**0.5**			**1A**		**40**		**10**			**77 (6-5)**
BC516	TO-92 (97)	40	30	10	100	30		30K	20	2	1		 1.4*	100 10							61
BC517	TO-92 (97)	40	30	10	100	30		30K	20	2	1		 1.4*	100 10							05
BC546	TO-92 (97)	80	65	6	15	30	110	800	2	5	0.25 0.6			10 100					10	(Notes 1, 2)	11
BC546A	TO-92 (97)	80	65	6	15	30	110	 220	0.01 2	5 5	0.25 0.6			10 100					10	(Notes 1, 2)	11
BC546B	TO-92 (97)	80	65	6	15	30	200	 450	0.01 2	5 5	0.25 0.6			10 100					10	(Notes 1, 2)	11
BC547	TO-92 (97)	50	45	6	10	20	 125	 900*	 2	 5	0.25 0.6	 0.55	0.77* 0.7*	10 100 2	4.5				10	(Notes 1, 2)	10
BC547A	TO-92 (97)	50	45	6	10	20	 125	 260*	 2	 5	0.25 0.6	 0.55	0.77* 0.7*	10 100 2	4.5				10	(Notes 1, 2)	10
BC547B	TO-92 (97)	50	45	6	10	20	 240	 500*	 2	 5	0.25 0.6	 0.55	0.77* 0.7*	10 100 2	4.5				10	(Notes 1, 2)	10
BC547C	TO-92 (97)	50	45	5	15	30	 420	 900*	 2	 5	0.25 0.6	 0.55	0.77* 0.7*	10 100 2	4.5				10	(Notes 1, 2)	10
BC548	TO-92 (97)	30	30	5	10	20	 125	 900*	 2	 5	0.25 0.6	 0.55	0.77* 0.7*	10 100 2	4.5				10	(Note 1)	10

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Pro Electron Bipolar Devices (continued)

Device No.	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	H_{FE} h_{fe} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max	@ I_C (mA)	NF (dB) Max	Test Conditions	Process No.
BC548A	TO-92 (97)	30	30	5	10	20	125	260*	2	5	0.25 0.6	0.55	0.77* 0.7*	10 100 2	4.5				10	(Note 1)	10
BC548B	TO-92 (97)	30	30	5	10	20	240	500*	2	5	0.25 0.6	0.55	0.77* 0.7*	10 100 2	4.5				10	(Note 1)	10
BC548C	TO-92 (97)	30	30	5	10	20	450	900*	2	5	0.25 0.6	0.55	0.77* 0.7*	10 100 2	4.5				10	(Note 1)	10
BC549	TO-92 (97)	30	30	5	10	20	240	900*	2	5	0.25 0.6	0.55	0.77* 0.7*	10 100 2	4.5				10	(Note 1)	10
BC549B	TO-92 (97)	30	30	5	10	20	240	500*	2	5	0.25 0.6	0.55	0.77* 0.7*	10 100 2	4.5				4	(Note 1)	10
BC549C	TO-92 (97)	30	30	5	10	20	450	900*	2	5	0.25 0.6	0.55	0.77* 0.7*	10 100 2	4.5				4	(Note 1)	10
BC550	TO-92 (97)	50	45	5	10	45	240	900*	2	5	0.25 0.6	0.55	0.77* 0.7*	10 100 2	4.5				3	(Note 1)	10
BC550B	TO-92 (97)	50	45	5	10	45	240	500*	2	5	0.25 0.6	0.55	0.77* 0.7*	10 100 2	4.5				3	(Note 1)	10
BC556B	TO-92 (97)	80	65	5	15	30	220	475	2	5	0.3 0.65			10 100					10	(Note 1)	69
BC557	TO-92 (97)	50	45	5	100	20	75	900*	2	5	0.3 0.65	0.6	0.82* 0.75*	10 100 2					10	(Note 1)	68

Pro Electron Bipolar Devices (continued)

Device No.	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	Max	@ I_C (mA)	NF (dB) Max	Test Conditions	Process No.
BC557B	TO-92 (97)	50	45	5	100	20	240	500*	2	5	0.3 0.65	0.6	0.82* 0.75*	10 100 2					10	(Note 1)	68
BC558	TO-92 (97)	30	25	5	100	20	75	500*	2	5	0.3 0.65	0.6	0.82* 0.75*	10 100 2					10	(Note 1)	68
BC558B	TO-92 (97)	30	25	5	100	20	240	500*	2	5	0.3 0.65	0.6	0.82* 0.75*	10 100 2					10	(Note 1)	68
BC558C	TO-92 (97)	30	25	5	100	20	450	900*	2	5	0.3 0.65	0.6	0.82* 0.75*	10 100 2					10	(Note 1)	68
BC559	TO-92 (97)	25	20	5	100	20	125	500*	2	5	0.3 0.65	0.6	0.82* 0.75*	10 100 2					4	(Note 1)	68
BC559B	TO-92 (97)	25	20	5	100	20	240	500*	2	5	0.3 0.65	0.6	0.82* 0.75*	10 100 2					4	(Note 1)	68
BC560	TO-92 (97)	50	45	5	100	45	125	500*	2	5	0.3 0.65	0.6	0.82* 0.75*	10 100 2					3	(Note 1)	68
BC560C	TO-92 (97)	50	45	5	100	45	450	900*	2	5	0.3 0.65	0.6	0.82* 0.75*	10 100 2					3	(Note 1)	68
BC635	TO-92 (94)	45	45	5			25 40 25	250	5 150 500	2 2 2	0.5			500							38
BC636	TO-92 (94)	45	45	5	100	30	25 40 25	250	5 150 500	2 2 2	0.5			500							78

Pro Electron Bipolar Devices (continued)

Device No.	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max @	V_{CB} (V)	H_{FE} h_{fe} Min	Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min @	I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
BC637	TO-92 (94)	60	60	5			25 40 25	 250 	5 150 500	2 2 2	0.5			500							38
BC638	TO-92 (94)	60	60	5	100	30	25 40 25	 250 	5 150 500	2 2 2	0.5			500							78
BC639-16	TO-92 (94)	100	80	5			25 40 25	 250 	5 150 500	2 2 2	0.5			500							39
BC640	TO-92 (94)	100	80	5	100	30	25 40 25	 250 	5 150 500	2 2 2	0.5			500							79
BCX58	TO-92 (97)		32	7	10	32	120 80 40	630 1000 	2 10 100	5 1 1						125	10	800	6	(Notes 3, 4)	10
BCX59	TO-92 (97)		45	7			120 80	630 1000	2 10	5 1	0.5		1	100		125	10	800		(Note 5)	10
BCX78	TO-92 (97)		32	5			120 80 40	630 1000 	2 10 100	5 1 1	0.6		1	100	4.5	200	10		6	(Note 1)	68
BCX79	TO-92 (97)		45	5			120 80	630 1000	2 10	5 1	0.6		1	100	4.5	200	10		6	(Note 1)	68
BF199	TO-92 (98)	40	25	4																	47
BF240	TO-92 (98)	40	40	4	100	20	65 6	225 	1 12	10 7		0.65	0.74*	1	0.34		1		3.5	(Note 6)	47
BF494	TO-92 (98)	30	20	5			65	220	1	10											49

TEST CONDITIONS

Note 1: I_C = 200 µA, V_{CE} = 5V, f = 1 kHz.
Note 2: I_C / I_B = 20.
Note 3: I_C = 200 µA, V_{CE} = 2V, f = 1 kHz.
Note 4: I_C = 100 mA, V_{CC} = 10V, $I_B^1 = I_B^2$ = 10 mA.
Note 5: I_C = 10 mA, V_{CC} = 3V, $I_B^1 = I_B^2$ = 1 mA.
Note 6: I_C = 1 mA, V_{CE} = 10V, f = 200 MHz.

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Pro Electron Surface Mount Diodes

Device No.	V_{rrm} (V) Min	I_{rrm} (nA) Min	V_{fm} (V) Max	@ I_f (mA)	t_{rr} (ns) Max	Package No.	Process No.
BAS16	75	1000	1	100	50	TO-236AB	1R
BAS19	100	100	1	100	50	TO-236AB	1J
BAS20	150	100	1	100	50	TO-236AB	1J
BAS21	200	100	1	100	50	TO-236AB	1J
BAS29	90	100	1	200	50	TO-236AB	1J
BAS31	90	100	1	200	50	TO-236AB	1J
BAS35	90	100	1	200	50	TO-236AB	1J
BAV70	70	2500	1	50	6	TO-236AB	1R
BAV74	50	100	1	100	4	TO-236AB	1R
BAV99	**70**	**2500**	**1**	**50**	**6**	**TO-236AB**	**1R (3-19)**
BAW56	70	2500	1	50	6	TO-236AB	1R

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Pro Electron Surface Mount Zeners

TO-236 PLASTIC PACKAGE*

Device No.	Mark	V_Z (V) Nom	I_{ZT1} = 5.0 mA V_Z (V) Min	I_{ZT1} = 5.0 mA V_Z (V) Max	I_{ZT1} = 5.0 mA Z_Z (Ω) Max	I_{ZT2} = 1.0 mA V_Z (V) Min	I_{ZT2} = 1.0 mA V_Z (V) Max	I_{ZT2} = 1.0 mA Z_Z (Ω) Max	I_{ZT3} = 20 mA V_Z (V) Min	I_{ZT3} = 20 mA V_Z (V) Max	I_{ZT3} = 20 mA Z_Z (Ω) Max	I_R (nA) Max	V_R (V)	C_O (pF) Max	I_{ZT1} = 5.0 mA d_{VZ} / dt (mV / k) Min	I_{ZT1} = 5.0 mA d_{VZ} / dt (mV / k) Max	Process Family
BZX84C4V7	Z1	4.7	4.4	5	80	3.7	4.7	500	4.5	5.4	15	3,000	2	260	- 3.5	0.2	FY
BZX84C5V1	Z2	5.1	4.8	5.4	60	4.2	5.3	480	5	5.9	15	2,000	2	225	- 2.7	1.2	FY
BZX84C5V6	Z3	5.6	5.2	6	40	4.8	6	480	5.2	6.3	10	1,000	1	200	- 2	2.5	GY
BZX84C6V2	Z4	6.2	5.8	6.6	10	5.6	6.6	150	5.8	6.8	6	3,000	4	185	0.4	3.7	IY
BZX84C6V8	Z5	6.8	6.4	7.2	15	6.3	7.2	80	6.4	7.4	6	2,000	4	155	1.2	4.5	JY
BZX84C7V5	Z6	7.5	7	7.9	15	6.9	7.9	80	7	8	6	1,000	5	140	2.5	5.3	KY
BZX84C8V2	Z7	8.2	7.7	8.7	15	7.6	8.7	80	7.7	8.8	6	700	5	135	3.2	6.2	LY
BZX84C9V1	Z8	9.1	8.5	9.6	15	8.4	9.6	100	8.5	9.7	8	500	6	130	3.8	7	PY
BZX84C10	Z9	10	9.4	10.6	20	9.3	10.6	150	9.4	10.7	10	200	7	130	4.5	8	RY
BZX84C11	Y1	11	10.4	11.6	20	10.2	11.6	150	10.4	11.8	20	100	8	130	5.4	9	SY
BZX84C12	Y2	12	11.4	12.7	25	11.2	12.7	150	11.4	12.9	10	100	8	130	6	10	TY
BZX84C13	Y3	13	12.4	14.1	30	12.3	14	170	12.5	14.2	15	100	8	120	7	11	UY
BZX84C15	Y4	15	13.8	15.6	30	13.7	15.5	200	13.9	15.7	20	50	10.5	110	9.2	13	WY
BZX84C16	Y5	16	15.3	17.1	40	15.2	17	200	15.4	17.2	20	50	11.2	105	10.4	14	XY
BZX84C18	Y6	18	16.8	19.1	45	16.7	19	225	16.9	19.2	20	50	12.6	100	12.4	16	ZY
BZX84C20	Y7	20	18.8	21.2	55	18.7	21.1	225	18.9	21.4	20	50	14	85	14.4	18	QY
BZX84C22	Y8	22	20.8	23.3	55	20.7	23.2	250	20.9	23.4	25	50	15.4	85	16.4	20	3Y
BZX84C24	Y9	24	22.8	25.6	70	22.7	25.5	250	22.9	25.7	25	50	16.8	80	18.4	22	4Y

Device No.	Mark	V_Z (V) Nom	I_{ZT1} = 2.0 mA V_Z (V) Min	I_{ZT1} = 2.0 mA V_Z (V) Max	I_{ZT1} = 2.0 mA Z_Z (Ω) Max	I_{ZT2} = 100 µA V_Z (V) Min	I_{ZT2} = 100 µA V_Z (V) Max	I_{ZT2} = 100 µA Z_Z (Ω) Max	I_{ZT3} = 10 mA V_Z (V) Min	I_{ZT3} = 10 mA V_Z (V) Max	I_{ZT3} = 10 mA Z_Z (Ω) Max	I_R (nA) Max	V_R (V)	C_O (pF) Max	I_{ZT1} = 2.0 mA d_{VZ} / dt (mV / k) Min	I_{ZT1} = 2.0 mA d_{VZ} / dt (mV / k) Max	Process Family
BZX84C27	Y10	27	25.1	28.9	80	25	28.9	300	25.2	29.3	45	50	18.9	70	21.4	25.3	6Y
BZX84C30	Y11	30	28	32	80	27.8	32	300	28.1	32.4	50	50	21	70	24.4	29.4	8Y
BZX84C33	Y12	33	31	35	80	30.8	35	325	31.1	35.4	55	50	23.1	70	27.4	33.4	9Y

***Forward voltage for all BZX84C devices :** 200 µA, I_F = 10 mA, V_F = 900 mV Max.

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Pro Electron Surface Mount Bipolar Devices

Device No. (SOT-23 Mark)	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	Max	@ I_C (mA)	NF (dB) Max	Test Conditions	Process No.
BC807-16 (5A)	**TO-236 (49)**	**50***	**45**	**5**	**100**	**20**	**100** **40**	**250**	**100** **500**	**1** **1**	**0.7**			**500**		**100**		**10**			**78 (6-9)**
BC807-25 (5B)	**TO-236 (49)**	**50***	**45**	**5**	**100**	**20**	**160** **40**	**400**	**100** **500**	**1** **1**	**0.7**			**500**		**100**		**10**			**78 (6-9)**
BC807-40 (5C)	**TO-236 (49)**	**50***	**45**	**5**	**100**	**20**	**250** **40**	**600**	**100** **500**	**1** **1**	**0.7**			**500**		**100**		**10**			**78 (6-9)**
BC817-25 (6B)	**TO-236 (49)**	**30***	**25**	**5**	**100**	**20**	**160** **40**	**400**	**100** **500**	**1** **1**	**0.7**			**500**		**200**		**10**			**38 (6-13)**
BC817-40 (6C)	**TO-236 (49)**	**30***	**25**	**5**	**100**	**20**	**250** **40**	**600**	**100** **500**	**1** **1**	**0.7**			**500**		**200**		**10**			**38 (6-13)**
BC818-25 (6F)	TO-236 (49)	30*	25	5	100	20	160 40	400	100 500	1 1	0.7			500		200		10			38
BC818-40 (6G)	TO-236 (49)	30*	25	5	100	20	250 40	600	100 500	1 1	0.7			500		200		10			38
BC846A (1A)	**TO-236 (49)**	**80***	**65**	**6**	**15**	**30**	**110**	**220**	**2**	**5** **5**	**0.25** **0.6**		**0.77***	**10** **100**	**4.5**	**100**		**10**	**10**	**(Note 1)**	**07 (6-19)**
BC846B (1B)	**TO-236 (49)**	**80***	**65**	**6**	**15**	**30**	**200**	**450**	**2**	**5** **5**	**0.25** **0.6**		**0.77***	**10** **100**	**4.5**	**100**		**10**	**10**	**(Note 1)**	**07 (6-19)**
BC847A (1E)	**TO-236 (49)**	**50***	**45**	**6**	**15**	**30**	**110**	**220**	**2**	**5** **5**	**0.25** **0.6**		**0.77***	**10** **100**	**4.5**	**100**		**10**	**10**	**(Note 1)**	**07 (6-19)**
BC847B (1F)	**TO-236 (49)**	**50***	**45**	**6**	**15**	**30**	**200**	**450**	**2**	**5** **5**	**0.25** **0.6**		**0.77***	**10** **100**	**4.5**	**100**		**10**	**10**	**(Note 1)**	**07 (6-19)**
BC847C (1G)	**TO-236 (49)**	**50***	**45**	**6**	**15**	**30**	**420**	**800**	**2**	**5** **5**	**0.25** **0.6**		**0.77***	**10** **100**	**4.5**	**100**		**10**	**10**	**(Note 1)**	**07 (6-19)**

NOTE: National preferred device for each process in **bold**. Number shown in parentheses indicates location **(section-page)** of device datasheet.

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Pro Electron Surface Mount Bipolar Devices (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	Max	@ I_C (mA)	NF (dB) Max	Test Conditions	Process No.
BC848A (1J.)	TO-236 (49)	30	30	5	15	30	110	220	2	5 5	0.25 0.6			10 100					10	(Note 1)	10
BC848B (1K.)	TO-236 (49)	30	30	5	15	30	200	450	2	5 5	0.25 0.6			10 100					10	(Note 1)	10
BC848C (1L.)	TO-236 (49)	30	30	5	15	30	420	800	2	5 5	0.25 0.6			10 100					10	(Note 1)	10
BC849C (2C.)	TO-236 (49)	30	30	5	15	30	420	800	2	5 5	0.25 0.6			10 100					4	(Note 1)	10
BC850B (2F.)	TO-236 (49)	50	45	5	15	30	200	450	2	5 5	0.25 0.6			10 100						(Note 1)	10
BC850C (2G.)	TO-236 (49)	50	45	5	15	30	420	800	2	5 5	0.25 0.6			10 100						(Note 1)	10
BC856B (3B.)	TO-236 (49)	80	65	5	15	30	220	475	2	5	0.3 0.65			10 100					10	(Note 1)	69
BC857A (3E.)	**TO-236 (49)**	**50**	**45**	**5**	**15**	**30**	**125**	**250**	**2**	**5**	**0.3 0.65**		**0.82***	**10 100**	**4.5**	**100**		**10**	**10**	**(Note 1)**	**68 (6-24)**
BC857B (3F.)	**TO-236 (49)**	**50**	**45**	**5**	**15**	**30**	**220**	**475**	**2**	**5**	**0.3 0.65**		**0.82***	**10 100**	**4.5**	**100**		**10**	**10**	**(Note 1)**	**68 (6-24)**
BC857C (3G.)	**TO-236 (49)**	**50**	**45**	**5**	**15**	**30**	**420**	**800**	**2**	**5**	**0.3 0.65**		**0.82***	**10 100**	**4.5**	**100**		**10**	**10**	**(Note 1)**	**68 (6-24)**
BC858A (3J.)	TO-236 (49)	30	30	5	15	30	125	250	2	5	0.3 0.65		0.82*	10 100					10	(Note 1)	68
BC858B (3K.)	TO-236 (49)	30	30	5	15	30	220	475	2	5	0.3 0.65		0.82*	10 100					10	(Note 1)	68
BC858C (3L.)	TO-236 (49)	30	30	5	15	30	420	800	2	5	0.3 0.65		0.82*	10 100					10	(Note 1)	62
BC859B (4B.)	TO-236 (49)	30	30	5	15	30	220	475	2	5	0.65		0.82*	100					4	(Note 1)	68

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Pro Electron Surface Mount Bipolar Devices (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	Max	@ I_C (mA)	NF (dB) Max	Test Conditions	Process No.
BC859C (4C)	TO-236 (49)	30	30	5	15	30	420	800	2	5	0.65			100					4	(Note 1)	68
BC860C (4G)	TO-236 (49)	50	45	5	15	30	420	800	2	5	0.3 0.65			10 100					3	(Note 1)	68
BCP52	**TO-261 (47)**	**60**	**60**	**5**	**100**	**30**	**25 40**	 **250**	**5 150**	**2 2**	**0.5**		***1**	**500**							**78 (6-28)**
BCP53	TO-261 (47)	100	80	5	100	30	25 40	 250	5 150	2 2	0.5		*1	500							78
BCP54	**TO-261 (47)**	**45**	**45**	**5**	**100**	**30**	**25 40**	 **250**	**5 150**	**2 2**	**0.5**		***1**	**500**							**38 (6-32)**
BCP55	TO-261 (47)	60	60	5	100	30	25 40	 250	5 150	2 2	0.5		*1	500							38
BCP56	TO-261 (47)	100	80	5	100	30	25 40	 250	5 150	2 2	0.5		*1	500							38
BCV26 (FD)	**TO-236 (49)**	**40**	**30**	**10**	**100**	**30**	**4,000 10,000 20,000**		**1 10 100**	**5 5 5**	**1**		**1.5**	**100**							**61 (6-35)**
BCV27 (FF)	**TO-236 (49)**	**40**	**30**	**10**	**100**	**30**	**4,000 10,000 20,000**		**1 10 100**	**5 5 5**	**1**		**1.5**	**100**							**05 (6-39)**
BCV71 (K7)	TO-236 (49)	80	60	5	100	20	110	220	2	5	0.25			10					10	(Note 1)	10
BCV72 (K8)	TO-236 (49)	80	60	5	100	20	200	450	2	5	0.25			10					10	(Note 1)	10
BCW30 (C2)	TO-236 (49)	32	32	5	100	32	215	 500	0.01 2	5 5	0.3			10					10	(Note 1)	68
BCW31 (D1)	TO-236 (49)	32	32	5	100	32	150	 270	0.01 2	5 5	0.25			10					10	(Note 1)	10

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Pro Electron Surface Mount Bipolar Devices (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	@ I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
BCW32 (D2)	TO-236 (49)	32	32	5	100	32	200	 420	0.01 2	5 5	0.25			10					10	(Note 1)	10
BCW33 (D3)	TO-236 (49)	32	32	5	100	32	450	 800	0.01 2	5 5	0.25			10					10	(Note 1)	10
BCW60A (AA)	TO-236 (49)	32*	32	5	20	32	50 120	 630	50 2	1 5	0.35	0.6	0.85	50		125	10		6	(Note 1)	10
BCW61A (BA)	TO-236 (49)	32*	32	5	20	32	50 120	 630	50 2	1 5	0.25	0.6	0.85	50					6	(Note 1)	68
BCW61B (BB)	TO-236 (49)	32*	32	5	20	32	80 140	 310	50 2	1 5	0.25	0.6	0.85	50					6	(Note 1)	68
BCW61C (BC)	TO-236 (49)	32*	32	5	20	32	100 250	 460	50 2	1 5	0.25	0.6	0.85	50					6	(Note 1)	68
BCW65C (ED)	**TO-236 (49)**	**60**	**32**	**5**	**20***	**32**	**80 180 250 50**	** 630 630 **	**0.1 10 100 500**	**10 1 1 1**	**0.7 0.3**		**2**	**500 100**	**12**	**100**	**20**	** 400**	**10**	**(Note 1) (Note 7)**	**19 (6-45)**
BCW68G (DG)	**TO-236 (49)**	**60**	**45**	**5**	**20***	**45**	**120 160 60**	** 400 **	**10 100 300**	**1 1 1**	** 1.5**		**2**	**500 300**	**18**	**100**	**20**		**10**	**(Note 1)**	**63 (6-50)**
BCW69 (H1)	TO-236 (49)	50	45	5	100	20	120	260	2	5	0.3			10					10	(Note 1)	68
BCW71 (K1)	**TO-236 (49)**	**50**	**45**	**5**	**100**	**20**	**110**	**220**	**2**	**5**	**0.25**			**10**	**4**				**10**		**10 (6-55)**
BCW89 (H3)	TO-236 (49)	80	60	5	100	20	120	260	2	5	0.3			10					10	(Note 1)	68
BCX17 (T1)	TO-236 (49)	50*	45	5	100	20	100 70 40	600	100 300 500	1 1 1	0.62			500							67

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Pro Electron Surface Mount Bipolar Devices (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	@ I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
BCX18 (T2)	TO-236 (49)	30*	25	5	100	20	100 70 40	600	100 300 500	1 1 1	0.62			500							67
BCX19 (U1)	TO-236 (49)	50*	45	5	100	20	100 70 40	600	100 300 500	1 1 1	0.62		1.2	500							12
BCX20 (U2)	TO-236 (49)	30*	25	5	100	20	100 70 40	600	100 300 500	1 1 1	0.62		1.2	500							12
BCX70G (AG)	TO-236 (49)	45	45	5	20	32	120 60	220	2 50	5 1	0.55	0.7	1.05	50	4.5	125	10	800	6	(Note 2) (Note 3)	10
BCX70H (AH)	TO-236 (49)	45	45	5	20	32	180 70 20	310	2 50 0.01	5 1 5	0.55	0.7	1.05	50	4.5	125	10	800	6	(Note 2) (Note 3)	10
BCX70J (AJ)	TO-236 (49)	45	45	5	20	32	250 90 40	460	2 50 0.01	5 1 5	0.55	0.7	1.05	50	4.5	125	10	800	6	(Note 2) (Note 3)	10
BCX71G (BG)	TO-236 (49)	45	45	5	20	32	120 60	220	2 50	5 1	0.55	0.7	1.05	50	4.5	125	10	800	6	(Note 2) (Note 3)	68
BCX71J (BJ)	TO-236 (49)	45	45	5	20	32	250 90 40	460	2 50 0.01	5 1 5	0.55	0.7	1.05	50	4.5	125	10	800	6	(Note 2) (Note 3)	68
BCX71K (BK)	**TO-236 (49)**	**45***	**45**	**5**	**20***	**32**	**380 110 100**	**630**	**2 50 0.01**	**5 1 5**	**0.55 0.25**	**0.68 0.6**	**1.05 0.85**	**50 10**	**6**	**125**	**10**	**800**	**6**	**(Note 2) (Note 3)**	**68 (6-59)**
BSR13 (U7)	TO-236 (49)	60	30	5	30	50	35 50 75 100 50 30	300	0.1 1 10 150 150 500	10 10 10 10 1 10	0.4 1.6		1.3 2.6	150 500	8	250	20				19

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Pro Electron Surface Mount Bipolar Devices (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	H_{FE} h_{fe} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	@ I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
BSR14 (U8)	TO-236 (49)	75	40	6	10	60	35		0.1	10	0.3	0.6	1.2	150	8	300	20				19
							50		1	10											
							75		10	10											
							100	300	150	10	1		2	500							
							50		150	1											
							40		500	10											
BSR15 (T7)	TO-236 (49)	60	40	5	20	50	35		0.1	10	0.4		1.3	150	8	200	50	100		(Note 7)	63
							50		1	10											
							75		10	10	1.6		2.6	500							
							100	300	150	10											
							30		500	10											
BSR16 (T8)	TO-236 (49)	60	60	5	10	50	75		0.1	10	0.4		1.3	150	8	200	50	100		(Note 7)	63
							100		1	10											
							100		10	10	1.6		2.6	500							
							100	300	150	10											
							50		500	10											
BSR17A (U92)	**TO-236 (49)**	**60**	**40**	**6**	**50**	**30**	**40**		**0.1**	**1**	**0.2**	**0.65**	**0.85**	**10**	**4**	**300**	**20**	**250**		**(Note 5)**	**23 (6-72)**
							70		**1**	**1**											
							100	**300**	**10**	**1**											
							60		**50**	**1**											
							30		**100**	**1**	**0.3**		**0.95**	**50**							
BSR18A (T92)	**TO-236 (49)**	**40**	**40**	**5**	**50**	**30**	**60**		**0.1**	**1**	**0.25**	**0.65**	**0.85**	**10**	**4.5**	**250**	**10**	**300**		**(Note 5)**	**66 (6-79)**
							80		**1**	**1**											
							100	**300**	**10**	**1**											
							60		**50**	**1**											
							30		**100**	**1**			**0.95**	**50**							
BSS63 (T3)	**TO-236 (49)**	**110**	**100**	**6**	**100**	**90**	**30**		**10**	**1**	**0.25**		**0.9**	**25**		**50**	**25**				**74 (6-84)**
							30		**25**	**1**											
BSS64 (U3)	**TO-236 (49)**	**120**	**80**	**5**	**100**	**90**	**20**		**10**	**1**	**0.15**		**1.2**	**4**	**5**	**60**	**4**				**16 (6-88)**
											0.2			**50**							

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

Pro Electron Surface Mount Bipolar Devices (continued)

Device No. (SOT-23 Mark)	Case Style	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} Min	Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	@ I_C (mA)	$t_{(off)}$ (ns) Max	NF (dB) Max	Test Conditions	Process No.
BSS79C (CF)	TO-236 (49)	60	40	5	100	50	100	300	150	10	0.4			150	6	200	20				19
											1.6			500							
BSV52 (B2)	**TO-236 (49)**	**20**	**12**	**5**	**100**	**10**	**25**		**1**	**1**	**0.3**			**50**	**4**	**400**	**10**	**18**		**(Note 4)**	**21 (6-92)**
							40	**120**	**10**	**1**		**0.7**	**0.85**	**10**							
								25	**50**	**1**											

TEST CONDITIONS

Note 1: I_C = 200 µA, V_{CE} = 5V, f = 1 kHz.

Note 2: I_C = 15 mA, $I_B^1 = I_B^2$ = 1 mA.

Note 3: I_{CE} = 200 µA, V_{CE} = 5V, f = 200 Hz.

Note 4: I_C / I_B = 3.3.

Note 5: I_C = 10 mA, V_{CC} = 3V, $I_B^1 = I_B^2$ = 1 mA.

Note 6: I_C = 100 µA, V_{CE} = 5V, f = 1 kHz.

Note 7: I_C = 150 mA, V_{CC} = 6V, $I_B^1 = I_B^2$ = 15 mA.

NOTE: National preferred device for each process in **bold.** Number shown in parentheses indicates location **(section-page)** of device datasheet.

National Semiconductor™

Discrete POWER & Signal Technologies

JFET Pro Electron Series

Device No.	Case Style	BV_{GSS} BV_{GDO} (V) Min	@ I_G (µA)	I_{GSS} I_{DGD} (nA) Max	@ V_{DG} (V)	V_P (V) Min	V_P (V) Max	@ V_{GS} (V)	I_D (nA)	V_{GS} (V) Min	V_{GS} (V) Max	@ V_{GS} (V)	I_D (µA)	I_{DSS} (mA) Min	I_{DSS} (mA) Max	@ V_{DS} (V)	$R_e\|Y_{fs}\|$ (mmho) Min	$R_e\|Y_{fs}\|$ (mmho) Max	@ Fq. (MHz)	C_{iss} (pF) Max	@ V_{DS} (V)	C_{rss} (pF) Max	@ V_{DS} (V)	V_{GS} (V)	NF (dB) @ $R_G = 1k$ Typ	Freq. (MHz)	Pro. No.	Pkg. No.
BF244A	TO-92	30	1	5	20	0.5	8	15	10	0.4	2.2	15	200	2	6.5	15	3	6.5	0.001	4	20	1.1	20	-1	1.5	100	50	94
BF244B	TO-92	30	1	5	20	0.5	8	15	10	1.6	3.8	15	200	6	15	15	3	6.5	0.001	4	20	1.1	20	-1	1.5	100	50	94
BF244C	TO-92	30	1	5	20	0.5	8	15	10	3.2	7.5	15	200	12	25	15	3	6.5	0.001	4	20	1.1	20	-1	1.5	100	50	94
BF245A	TO-92	30	1	5	20	0.5	8	15	10	0.4	2.2	15	200	2	6.5	15	3	6.5	0.001	4	20	1.1	20	-1			50	97
BF245B	TO-92	30	1	5	20	0.5	8	15	10	1.6	3.8	15	200	6	15	15	3	6.5	0.001	4	20	1.1	20	-1			50	97
BF245C	TO-92	30	1	5	20	0.5	8	15	10	3.2	7.5	15	200	12	25	15	3	6.5	0.001	4	20	1.1	20	-1			50	97
BF256A	TO-92	30	1	5	20					0.5	7.5	15	200	3	7	15	4.5		0.001			0.7	20	-1	7.5	800	50	97
BF256B	TO-92	30	1	5	20					0.5	7.5	15	200	6	13	15	4.5		0.001			0.7	20	-1	7.5	800	50	97
BF256C	TO-92	30	1	5	20					0.5	7.5	15	200	11	18	15	4.5		0.001			0.7	20	-1	7.5	800	50	97
BSR56	TO-236	40	1	1	20	4	10	15	1					50		15						5	10	0			51	49
BSR57	TO-236	40	1	1	20	2	6	15	1					20	100	15						5	10	0			51	49
BSR58	TO-236	40	1	1	20	0.8	4	15	1					8	80	15						5	10	0			51	49

Consumer Series

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max	@ V_{CB} (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max	@ I_C (mA)	NF (dB) Max	Test Conditions	Process No.
CS8050C	TO-92 (92)	40	25	6	100	35	45		5	1	0.5		1.2	800	9	100		50			37
CS8050D	TO-92 (92)	40	25	6	100	35	85	300	100	1	0.5		1.2	800	9	100		50			37
CS8550C	TO-92 (92)	40	25	6	100	35	45		5	1	0.5		1.2	800	15	100		50			77
CS8550D	TO-92 (92)	40	25	6	100	35	85	300	100	1	0.5		1.2	800	15	100		50			77
CS9011I	TO-92 (92)	40	30	5	100	30	132	198	1	5	0.3		0.75	10	3.5	150		1	4	(Note 2)	23
CS9012D	TO-92 (92)	40	25	5	100	25	64	91	50	1	0.6		1.2	300							68
CS9012F	TO-92 (92)	40	25	5	100	25	96	135	50	1	0.6		1.2	300							68
CS9012G	TO-92 (92)	40	25	5	100	25	118	166	50	1	0.6		1.2	300							68
CS9013D	TO-92 (92)	40	25	5	100	25	64	91	50	1	0.6		1.2	300							10
CS9013E	TO-92 (92)	40	25	5	100	25	78	112	50	1	0.6		1.2	300							10
CS9013G	TO-92 (92)	40	25	5	100	25	118	166	50	1	0.6		1.2	300							10
CS9013H	TO-92 (92)	40	25	5	100	25	144	202	50	1	0.6		1.2	300							10
CS9013J	TO-92 (92)	40	25	5	100	25			50	1	0.6		1.2	300							10

Consumer Series (continued)

Device No.	Case Style	V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CBO} (nA) Max @	V_{CB} (V)	h_{FE} Min	h_{FE} Max @	I_C (mA) &	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max &	$V_{BE(SAT)}$ (V) Min	$V_{BE(SAT)}$ (V) Max @	I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	f_T (MHz) Max @	I_C (mA)	NF (dB) Max	Test Conditions	Process No.
CS9014C	TO-92 (92)	50	40	5	50	30	200	600	1	5	0.3		1	10	4.5	100		10	10	(Note 3)	07
CS9015C	TO-92 (92)	50	40	5	50	30	200	600	1	5	0.3		1	10	6	100		10	10	(Note 3)	62
CS9016F	TO-92 (92)	30	20	5	50	20	54	80	1	5	0.3		1	10	1.6	300		1	5	(Note 4)	49
CS9016H	TO-92 (92)	30	20	5	50	20	97	146	1	5	0.3		1	10	1.6	300		1	5	(Note 4)	49
CS9018D	TO-92 (92)	30	15	5	50	20	28	45	1	5	0.3		1	10	1.7	400		2			43
CS9018F	TO-92 (92)	30	15	5	50	20	54	80	1	5	0.3		1	10	1.7	400		2			43
CS9018G	TO-92 (92)	30	15	5	50	20	72	108	1	5	0.3		1	10	1.7	400		2			43
CS9018I	TO-92 (92)	30	15	5	50	20	132	198	1	5	0.3		1	10	1.7	400		2			43
NR431EF	TO-92 (92)	18	15	3	100	15	20	240	1	5	0.3		0.95	10	1.7	350		1		(Note 1)	43
SA733	TO-92 (94)	60	50	50	100	50	90	600	1	6	0.3			100	6	150		10	20		69
2SA1015	TO-92 (94)	50	50	5	100	40	70 25	400	2 150	6 6	0.3			100	7				10		69
2SC945	TO-92 (94)	60	50	5	100	50	90	600	1	6	0.3			100	4	150		10	20		11
2SC1815	TO-92 (94)	60	50	5	100	50	70 25	400	2 150	6 6	0.3			100	4				10		11

TEST CONDITIONS

Note 1: $I_C / I_B = 20$.

Note 2: $I_C = 1.0$ mA, $I_B^1 = I_B^2 = 1$ mA.

Note 3: $I_C = 100$ µA, f = 5.0 kHz.

Note 4: $I_C = 1.0$ mA, f = 100 kHz.

Section 3
Switching Diodes

Section 3 Contents

Switching Diode Datasheets

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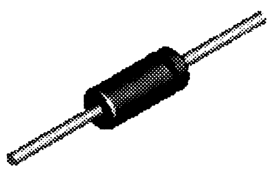
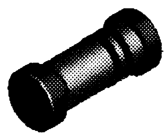
Discrete POWER & Signal Technologies

1N/FDLL 456/A - 1N/FDLL 459/A



DO-35



LL-34

THE PLACEMENT OF THE EXPANSION GAP HAS NO RELATIONSHIP TO THE LOCATION OF THE CATHODE TERMINAL

COLOR BAND MARKING

DEVICE	1ST BAND	2ND BAND
FDLL456	BROWN	WHITE
FDLL456A	BROWN	WHITE
FDLL457	RED	BLACK
FDLL457A	RED	BLACK
FDLL458	RED	BROWN
FDLL458A	RED	BROWN
FDLL459	RED	RED
FDLL459A	RED	RED

High Conductance Low Leakage Diode

Sourced from Process 1M. See MMBD1501/A-1505/A for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter		Value	Units
W_{IV}	Working Inverse Voltage	**456/A**	25	V
		457/A	60	V
		458/A	125	V
		459/A	175	V
I_O	Average Rectified Current		200	mA
I_F	DC Forward Current		500	mA
i_f	Recurrent Peak Forward Current		600	mA
$i_{f(surge)}$	Peak Forward Surge Current			
	Pulse width = 1.0 second		1.0	A
	Pulse width = 1.0 microsecond		4.0	A
T_{stg}	Storage Temperature Range		-65 to +200	°C
T_J	Operating Junction Temperature		175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:

1) These ratings are based on a maximum junction temperature of 200 degrees C.

2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		1N / FDLL 456/A - 459/A	
P_D	Total Device Dissipation	500	mW
	Derate above 25°C	3.33	mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	300	°C/W

High Conductance Low Leakage Diode

(continued)

Electrical Characteristics

TA = 25°C unless otherwise noted

Symbol	Parameter		Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	**456/A**	$I_R = 100\ \mu A$	30		V
		457/A	$I_R = 100\ \mu A$	70		V
		458/A	$I_R = 100\ \mu A$	150		V
		459/A	$I_R = 100\ \mu A$	200		V
I_R	Reverse Current	**456/A**	$V_R = 25\ V$		25	nA
			$V_R = 25\ V$, $T_A = 150°C$		5.0	µA
		457/A	$V_R = 60\ V$		25	nA
			$V_R = 60\ V$, $T_A = 150°C$		5.0	µA
		458/A	$V_R = 125\ V$		25	nA
			$V_R = 125\ V$, $T_A = 150°C$		5.0	µA
		459/A	$V_R = 175\ V$		25	nA
			$V_R = 175\ V$, $T_A = 150°C$		5.0	µA
V_F	Forward Voltage	**456**	$I_F = 40\ mA$		1.0	V
		457	$I_F = 10\ mA$		1.0	V
		458	$I_F = 7.0\ mA$		1.0	V
		459	$I_F = 3.0\ mA$		1.0	V
		456/A-459/A	$I_F = 100\ mA$		1.0	V
C_O	Diode Capacitance		$V_R = 0$, $f = 1.0\ MHz$		6.0	pF

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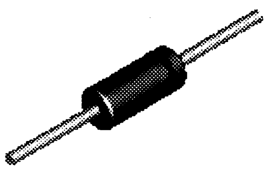
1N/FDLL 914/A/B / 916/A/B / 4148 / 4448



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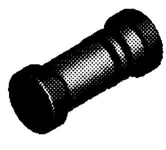


LL-34

THE PLACEMENT OF THE EXPANSION GAP HAS NO RELATIONSHIP TO THE LOCATION OF THE CATHODE TERMINAL

COLOR BAND MARKING

DEVICE	1ST BAND	2ND BAND
FDLL914	BLACK	BROWN
FDLL914A	BLACK	GRAY
FDLL914B	BROWN	BLACK
FDLL916	BLACK	RED
FDLL916A	BLACK	WHITE
FDLL916B	BROWN	BROWN
FDLL4148	BLACK	BROWN
FDLL4448	BROWN	BLACK

High Conductance Fast Diode

Sourced from Process D3.

Absolute Maximum Ratings*   TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	75	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	300	mA
i_f	Recurrent Peak Forward Current	400	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 4.0	 A A
T_{stg}	Storage Temperature Range	-65 to +200	°C
T_J	Operating Junction Temperature	175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics   TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		1N/FDLL 914/A/B / 4148 / 4448	
P_D	Total Device Dissipation Derate above 25°C	500 3.33	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	300	°C/W

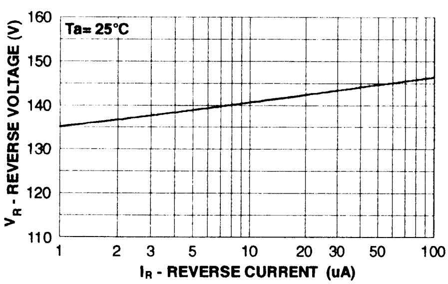
High Conductance Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

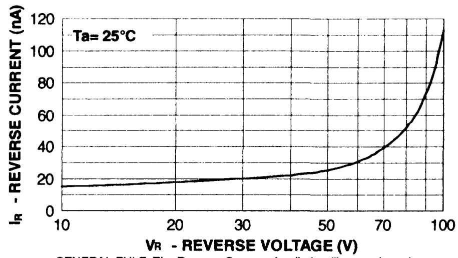
Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 100\ \mu A$	100		V
		$I_R = 5.0\ \mu A$	75		V
I_R	Reverse Current	$V_R = 20\ V$		25	nA
		$V_R = 20\ V$, $T_A = 150°C$		50	µA
		$V_R = 75\ V$		5.0	µA
V_F	Forward Voltage **1N914B / 4448**	$I_F = 5.0\ mA$	620	720	mV
	1N916B	$I_F = 5.0\ mA$	630	730	mV
	1N914 / 916 / 4148	$I_F = 10\ mA$		1.0	V
	1N914A / 916A	$I_F = 20\ mA$		1.0	V
	1N916B	$I_F = 30\ mA$		1.0	V
	1N914B / 4448	$I_F = 100\ mA$		1.0	V
C_O	Diode Capacitance				
	1N916/A/B / 4448	$V_R = 0$, f = 1.0 MHz		2.0	pF
	1N914/A/B / 4148	$V_R = 0$, f = 1.0 MHz		4.0	pF
T_{RR}	Reverse Recovery Time	$I_F = 10\ mA$, $V_R = 6.0\ V$ (60 mA), $I_{rr} = 1.0\ mA$, $R_L = 100\ \Omega$		4.0	nS

Typical Characteristics

REVERSE VOLTAGE vs REVERSE CURRENT
BV - 1.0 to 100 uA

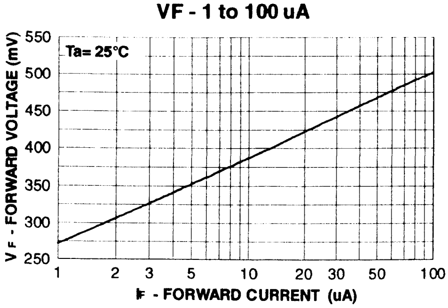


REVERSE CURRENT vs REVERSE VOLTAGE
IR - 10 to 100 V

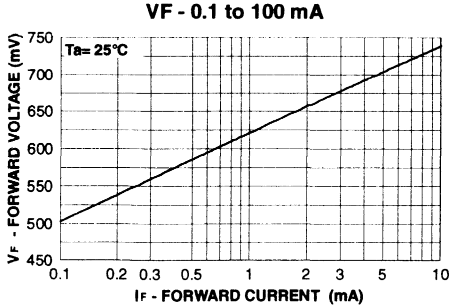


GENERAL RULE: The Reverse Current of a diode will approximately double for every ten (10) Degree C increase in Temperature

FORWARD VOLTAGE vs FORWARD CURRENT
VF - 1 to 100 uA

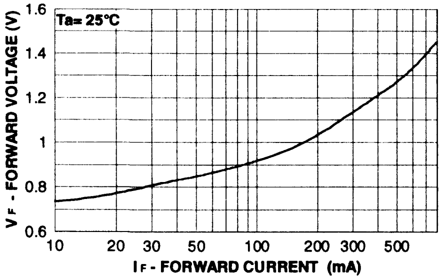


FORWARD VOLTAGE vs FORWARD CURRENT
VF - 0.1 to 100 mA

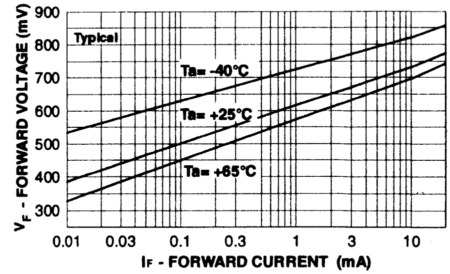


Typical Characteristics (continued)

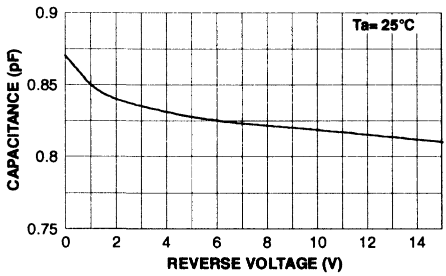
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 10 to 800 mA



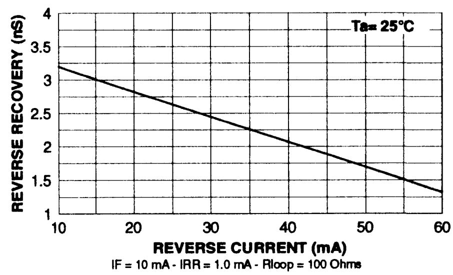
VF - 0.01 - 20 mA (-40 to +65 Deg C) FORWARD VOLTAGE vs AMBIENT TEMPERATURE



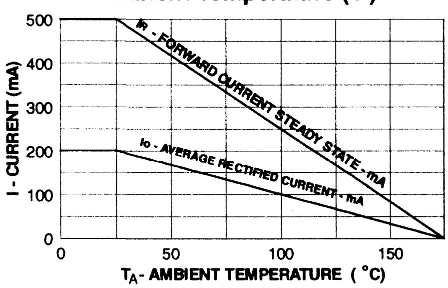
CAPACITANCE vs REVERSE VOLTAGE
VR = 0.0 to 15 V



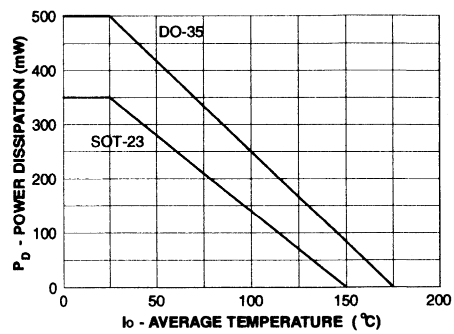
REVERSE RECOVERY TIME vs REVERSE CURRENT



Average Rectified Current (Io) & Forward Current (IF) versus Ambient Temperature (TA)



POWER DERATING CURVE



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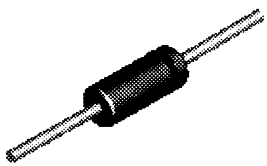
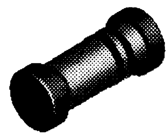
1N4150 / FDLL4150



DO-35



LL-34

THE PLACEMENT OF THE EXPANSION GAP HAS NO RELATIONSHIP TO THE LOCATION OF THE CATHODE TERMINAL

COLOR BAND MARKING		
DEVICE	1ST BAND	2ND BAND
FDLL4150	BLACK	ORANGE

High Conductance Ultra Fast Diode

Sourced from Process 1R. See MMBD1201-1205 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	50	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	400	mA
i_f	Recurrent Peak Forward Current	600	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 4.0	 A A
T_{stg}	Storage Temperature Range	-65 to +200	°C
T_J	Operating Junction Temperature	175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		1N / FDLL 4150	
P_D	Total Device Dissipation Derate above 25°C	500 3.33	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	300	°C/W

High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 5.0\ \mu A$	75		V
I_R	Reverse Current	$V_R = 50\ V$ $V_R = 50\ V,\ T_A = 150°C$		100 100	nA µA
V_F	Forward Voltage	$I_F = 1.0\ mA$ $I_F = 10\ mA$ $I_F = 50\ mA$ $I_F = 100\ mA$ $I_F = 200\ mA$	540 660 760 820 0.87	620 740 860 920 1.0	mV mV mV mV V
C_O	Diode Capacitance	$V_R = 0,\ f = 1.0\ MHz$		2.5	pF
T_{RR}	Reverse Recovery Time	$I_F = I_R = 10\ mA\text{-}200\ mA,\ R_L = 100\Omega$ $I_F = I_R = 200\ mA\text{-}400\ mA,\ R_L = 100\Omega$		4.0 6.0	nS nS
T_{FR}	Forward Recovery Time	$I_F = 200\ mA,\ V_{FR} = 1.0\ V$		10	nS

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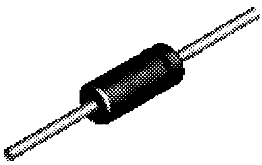
1N4454



DO-35

High Conductance Ultra Fast Diode

Sourced from Process 1R. See MMBD1201-1205 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	50	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	400	mA
i_f	Recurrent Peak Forward Current	600	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 4.0	 A A
T_{stg}	Storage Temperature Range	-65 to +200	°C
T_J	Operating Junction Temperature	175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		1N4454	
P_D	Total Device Dissipation Derate above 25°C	500 3.33	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	300	°C/W

High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	I_R = 5.0 μA	75		V
I_R	Reverse Current	V_R = 50 V		100	nA
		V_R = 50 V, T_A = 150°C		100	μA
V_F	Forward Voltage	I_F = 250 μA	505	575	mV
		I_F = 1.0 mA	550	650	mV
		I_F = 2.0 mA	610	710	mV
		I_F = 10 mA		1.0	V
C_O	Diode Capacitance	V_R = 0, f = 1.0 MHz		4.0	pF
T_{RR}	Reverse Recovery Time	I_F = 10 mA, V_R = 1.0 V, I_{rr} = 1.0 mA, R_L = 100 Ω		4.0	nS

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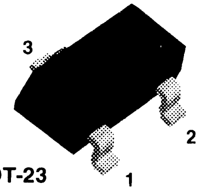
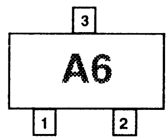
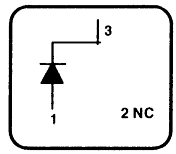
BAS16



SOT-23



CONNECTION DIAGRAM



High Conductance Ultra Fast Diode

Sourced from Process 1P. See BAV99 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	75	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-50 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BAS16	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 5.0\ \mu A$	85		V
I_R	Reverse Current	$V_R = 25\ V$, $T_A = 150°C$ $V_R = 75\ V$ $V_R = 75\ V$, $T_A = 150°C$		30 1.0 50	µA µA µA
V_F	Forward Voltage	$I_F = 1.0\ mA$ $I_F = 10\ mA$ $I_F = 50\ mA$ $I_F = 150\ mA$		715 855 1.0 1.25	mV mV V V
C_O	Diode Capacitance	$V_R = 0$, $f = 1.0\ MHz$		2.0	pF
T_{RR}	Reverse Recovery Time	$I_F = 10\ mA$, $V_R = 6.0\ V$, $I_{RR} = 1.0\ mA$, $R_L = 100\Omega$		6.0	nS

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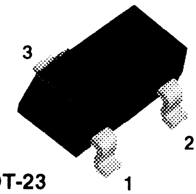
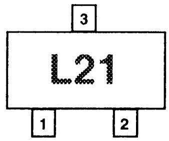
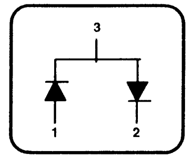
BAS31



SOT-23



CONNECTION DIAGRAM



High Voltage General Purpose Diode

Sourced from Process 1H. See BAV19 / 20 / 21 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	90	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-50 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BAS31	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

High Voltage General Purpose Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	I_R = 1.0 mA	120		V
I_R	Reverse Current	V_R = 90 V V_R = 90 V, T_A = 150°C		100 100	nA µA
V_F	Forward Voltage	I_F = 10 mA I_F = 50 mA I_F = 100 mA I_F = 200 mA I_F = 400 mA		750 840 900 1.0 1.25	mV mV mV V V
C_O	Diode Capacitance	V_R = 0, f = 1.0 MHz		35	pF
T_{RR}	Reverse Recovery Time	I_F = I_R = 30 mA, V_R = 6.0 V, I_{RR} = 3.0 mA, R_L = 100Ω		50	nS

3

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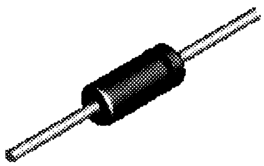
BAV19 / 20 / 21



DO-35

High Voltage General Purpose Diode

Sourced from Process 1J. NSC alternate for BAV19 & BAV20: FDH400.

Absolute Maximum Ratings*

$T_A = 25°C$ unless otherwise noted

Symbol	Parameter		Value	Units
W_{IV}	Working Inverse Voltage	**BAV19**	100	V
		BAV20	150	V
		BAV21	200	V
I_O	Average Rectified Current		200	mA
I_F	DC Forward Current		500	mA
i_f	Recurrent Peak Forward Current		600	mA
$i_{f(surge)}$	Peak Forward Surge Current			
	Pulse width = 1.0 second		1.0	A
	Pulse width = 1.0 microsecond		4.0	A
T_{stg}	Storage Temperature Range		-65 to +200	°C
T_J	Operating Junction Temperature		175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

$T_A = 25°C$ unless otherwise noted

Symbol	Characteristic	Max	Units
		BAV19 / 20 / 21	
P_D	Total Device Dissipation	500	mW
	Derate above 25°C	3.33	mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	300	°C/W

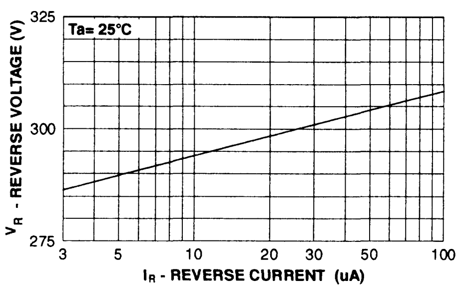
High Voltage General Purpose Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

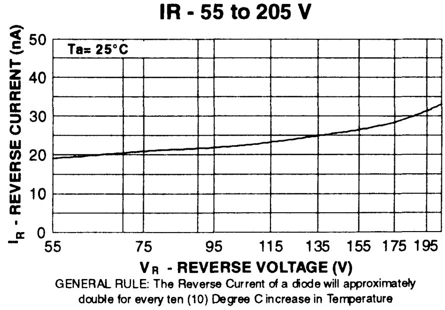
Symbol	Parameter		Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	**BAV19**	$I_R = 100\ \mu A$	120		V
		BAV20	$I_R = 100\ \mu A$	200		V
		BAV21	$I_R = 100\ \mu A$	250		V
I_R	Reverse Current	**BAV19**	$V_R = 100\ V$		100	nA
			$V_R = 100\ V,\ T_A = 150°C$		100	µA
		BAV20	$V_R = 150\ V$		100	nA
			$V_R = 150\ V,\ T_A = 150°C$		100	µA
		BAV21	$V_R = 200\ V$		100	nA
			$V_R = 200\ V,\ T_A = 150°C$		100	µA
V_F	Forward Voltage		$I_F = 100\ mA$		1.0	V
			$I_F = 200\ mA$		1.25	V
C_O	Diode Capacitance		$V_R = 0,\ f = 1.0\ MHz$		5.0	pF
T_{RR}	Reverse Recovery Time		$I_F = I_R = 30\ mA,\ I_{RR} = 3.0\ mA,\ R_L = 100\Omega$		50	nS

Typical Characteristics

REVERSE VOLTAGE vs REVERSE CURRENT
BV - 1.0 to 100 uA

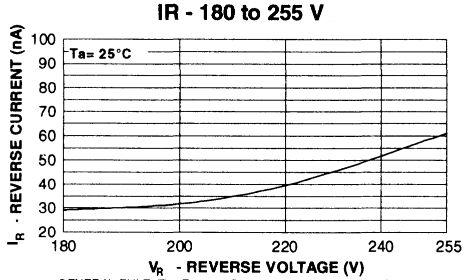


REVERSE CURRENT vs REVERSE VOLTAGE
IR - 55 to 205 V



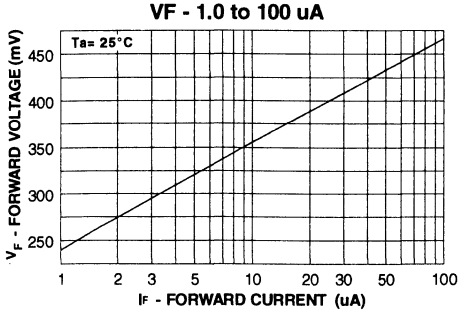
GENERAL RULE: The Reverse Current of a diode will approximately double for every ten (10) Degree C increase in Temperature

REVERSE CURRENT vs REVERSE VOLTAGE
IR - 180 to 255 V



GENERAL RULE: The Reverse Current of a diode will approximately double for every ten Degree C increase in Temperature

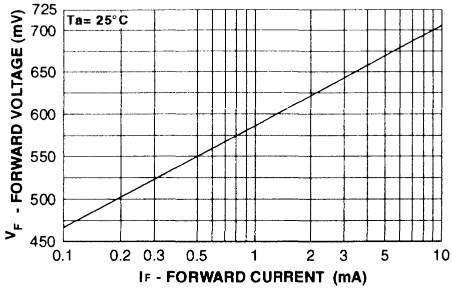
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 1.0 to 100 uA



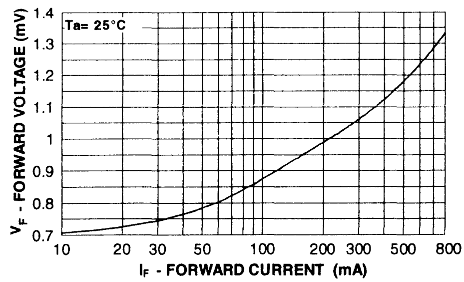
High Voltage General Purpose Diode
(continued)

Typical Characteristics (continued)

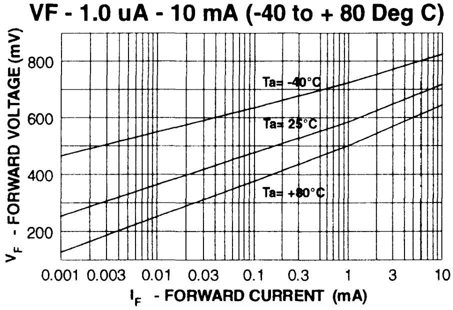
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 0.1 to 10 mA



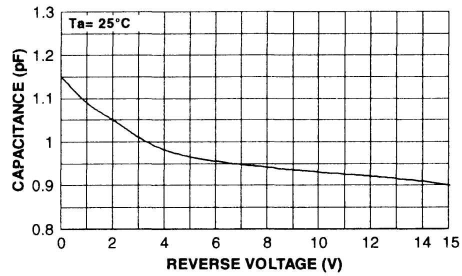
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 10 to 800 mA



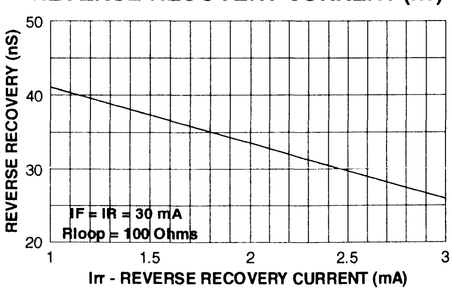
Forward Voltage vs Ambient Temperature
VF - 1.0 uA - 10 mA (-40 to + 80 Deg C)



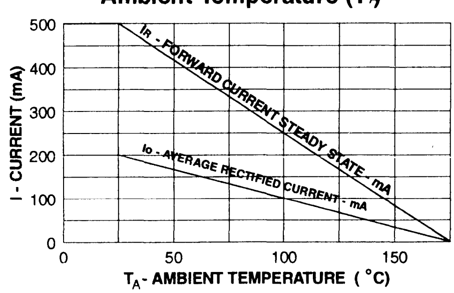
CAPACITANCE vs REVERSE VOLTAGE
VR - 0 to 15 V



REVERSE RECOVERY TIME vs
REVERSE RECOVERY CURRENT (Irr)

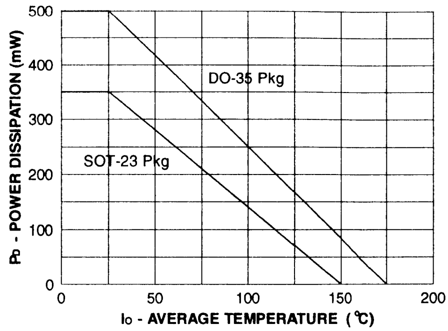


Average Rectified Current (Io) &
Forward Current (IF) versus
Ambient Temperature (TA)



Typical Characteristics (continued)

POWER DERATING CURVE



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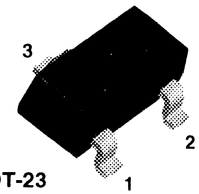
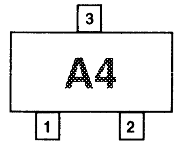
BAV70 / 74

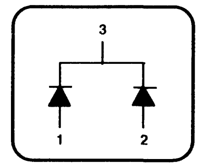


SOT-23



MARKING
BAV70 A4 BAV74 JA

CONNECTION DIAGRAMS



High Conductance Ultra Fast Diode

Sourced from Process 1P. See BAV99 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage **BAV70** **BAV74**	70 50	V V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BAV70/74	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter		Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	**BAV70**	$I_R = 100\ \mu A$	70		V
		BAV74	$I_R = 100\ \mu A$	50		V
I_R	Reverse Current	**BAV70**	$V_R = 25\ V$, $T_A = 150°C$		60	µA
			$V_R = 70\ V$		5.0	µA
			$V_R = 70\ V$, $T_A = 150°C$		100	µA
		BAV74	$V_R = 50\ V$		100	nA
			$V_R = 50\ V$, $T_A = 150°C$		100	µA
V_F	Forward Voltage	**BAV70**	$I_F = 1.0\ mA$		715	mV
			$I_F = 10\ mA$		855	mV
			$I_F = 50\ mA$		1.0	V
			$I_F = 150\ mA$		1.25	V
		BAV74	$I_F = 100\ mA$		1.0	V
C_O	Diode Capacitance	**BAV70**	$V_R = 0$, f = 1.0 MHz		1.5	pF
		BAV74	$V_R = 0$, f = 1.0 MHz		2.0	pF
T_{RR}	Reverse Recovery Time	**BAV70**	$I_F = I_R = 10\ mA$, $I_{RR} = 1.0\ mA$, $R_L = 100\Omega$		6.0	nS
		BAV74	$I_F = I_R = 10\ mA$, $I_{RR} = 1.0\ mA$, $R_L = 100\Omega$		4.0	nS
Q_S	Stored Charge	**BAV70**	$I_F = 10\ mA$		45	pC

3

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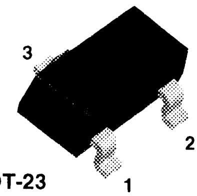
BAV99



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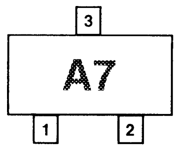
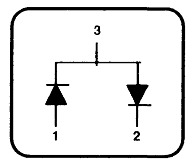


CONNECTION DIAGRAM



High Conductance Ultra Fast Diode

Sourced from Process 1P.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	70	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BAV99	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

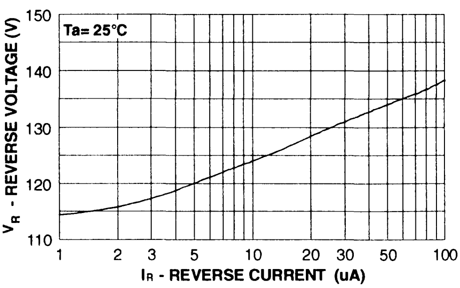
High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

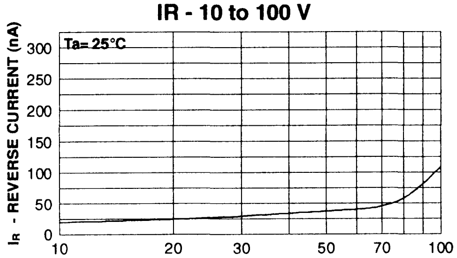
Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 100\ \mu A$	70		V
I_R	Reverse Current	$V_R = 70\ V$ $V_R = 25\ V,\ T_A = 150°C$ $V_R = 70\ V,\ T_A = 150°C$		2.5 30 50	µA µA µA
V_F	Forward Voltage	$I_F = 1.0\ mA$ $I_F = 10\ mA$ $I_F = 50\ mA$ $I_F = 150\ mA$		715 855 1.0 1.25	mV mV V V
C_O	Diode Capacitance	$V_R = 0,\ f = 1.0\ MHz$		1.5	pF
T_{RR}	Reverse Recovery Time	$I_F = I_R = 10\ mA,\ I_{RR} = 1.0\ mA,$ $R_L = 100\Omega$		6.0	nS
V_{FM}	Peak Forward Voltage	$I_F = 10\ mA,\ t_r = 20\ nS$		1.75	V

Typical Characteristics

REVERSE VOLTAGE vs REVERSE CURRENT
BV - 1.0 to 100 uA

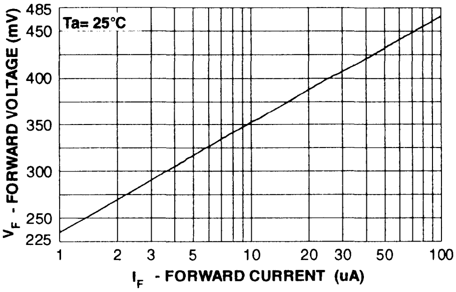


REVERSE CURRENT vs REVERSE VOLTAGE
IR - 10 to 100 V

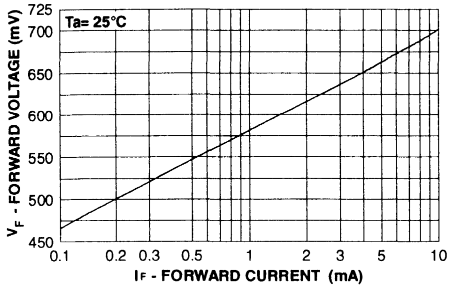


GENERAL RULE: The Reverse Current of a diode will approximately double for every ten (10) Degree C increase in Temperature

FORWARD VOLTAGE vs FORWARD CURRENT
VF - 1.0 to 100 uA



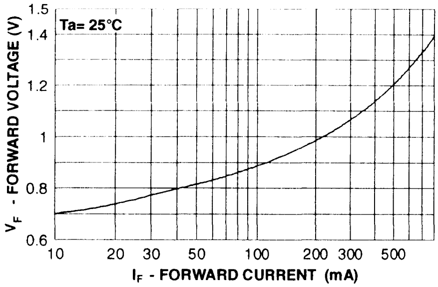
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 0.1 to 10 mA



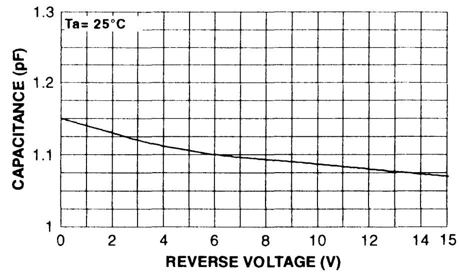
High Conductance Ultra Fast Diode
(continued)

Typical Characteristics (continued)

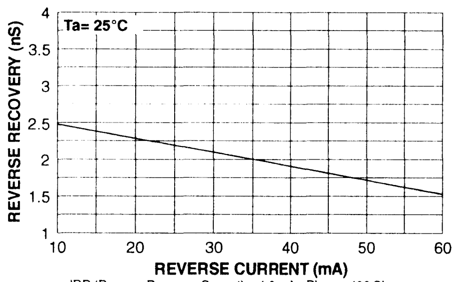
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 10 - 800 mA



CAPACITANCE vs REVERSE VOLTAGE
VR - 0.0 to 15 V

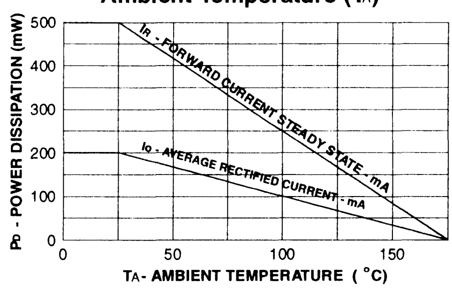


REVERSE RECOVERY TIME vs REVERSE CURRENT
TRR - IR 10 mA vs 60 mA

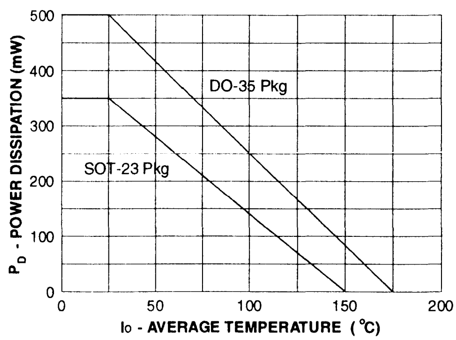


IRR (Reverse Recovery Current) = 1.0 mA - Rloop = 100 Ohms

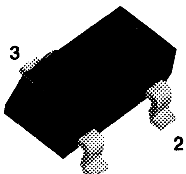
Average Rectified Current (Io) & Forward Current (I_F) versus Ambient Temperature (T_A)



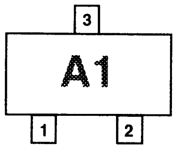
POWER DERATING CURVE



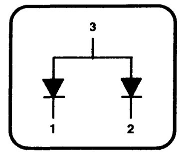
BAW56



SOT-23



CONNECTION DIAGRAMS



High Conductance Ultra Fast Diode

Sourced from Process 1P. See BAV99 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	70	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BAW56	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 5.0\ \mu A$	85		V
I_R	Reverse Current	$V_R = 70$ V		2.5	μA
		$V_R = 25$ V, $T_A = 150°C$		30	μA
		$V_R = 70$ V, $T_A = 150°C$		50	μA
V_F	Forward Voltage	$I_F = 1.0$ mA		715	mV
		$I_F = 10$ mA		855	mV
		$I_F = 50$ mA		1.0	V
		$I_F = 150$ mA		1.25	V
C_O	Diode Capacitance	$V_R = 0$, f = 1.0 MHz		2.0	pF
T_{RR}	Reverse Recovery Time	$I_F = I_R = 10$ mA, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$		6.0	nS
V_{FM}	Peak Forward Voltage	$I_F = 10$ mA, $t_r = 20$ nS		1.75	V

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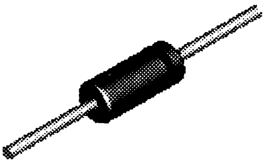
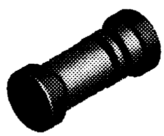
FDH/FDLL 300/A / 333



DO-35



LL-34

THE PLACEMENT OF THE EXPANSION GAP HAS NO RELATIONSHIP TO THE LOCATION OF THE CATHODE TERMINAL

COLOR BAND MARKING

DEVICE	1ST BAND	2ND BAND
FDLL300	BROWN	GREEN
FDLL300A	BROWN	YELLOW
FDLL333	BROWN	BLUE

High Conductance Low Leakage Diode

Sourced from Process 1M. See MMBD1501/A-1505/A for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	125	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	500	mA
i_f	Recurrent Peak Forward Current	600	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 4.0	 A A
T_{stg}	Storage Temperature Range	-65 to +200	°C
T_J	Operating Junction Temperature	175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		FDH/FDLL 300/A / 333	
P_D	Total Device Dissipation Derate above 25°C	500 3.33	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	300	°C/W

High Conductance Low Leakage Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter		Test Conditions	Min	Max	Units
B_V	Breakdown Voltage		I_R = 100 μA	150		V
I_R	Reverse Current	**FDH/FDLL 300/A**	V_R = 125 V		1.0	nA
			V_R = 125 V, T_A = 150°C		3.0	μA
		FDH/FDLL 333	V_R = 125 V		3.0	nA
			V_R = 125 V, T_A = 100°C		500	nA
V_F	Forward Voltage	**FDH/FDLL 300/A**	I_F = 1.0 mA		680	mV
		FDH/FDLL 300	I_F = 5.0 mA		750	mV
		FDH/FDLL 300A	I_F = 5.0 mA		760	mV
		FDH/FDLL 300/A	I_F = 10 mA		800	mV
		FDH/FDLL 300	I_F = 50 mA		880	mV
		FDH/FDLL 300A	I_F = 50 mA		890	mV
		FDH/FDLL 300/A	I_F = 100 mA		920	mV
		FDH/FDLL 300/A	I_F = 200 mA		1.0	V
		FDH/FDLL 333	I_F = 50 mA	800	890	mV
			I_F = 100 mA	830	940	mV
			I_F = 150 mA	860	970	mV
			I_F = 200 mA	0.87	1.05	V
			I_F = 250 mA	0.88	1.08	V
			I_F = 300 mA	0.9	1.15	V
C_O	Diode Capacitance		V_R = 0, f = 1.0 MHz		6.0	pF

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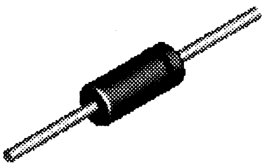
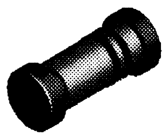
FDH/FDLL 400 / 444



DO-35



LL-34

THE PLACEMENT OF THE EXPANSION GAP HAS NO RELATIONSHIP TO THE LOCATION OF THE CATHODE TERMINAL

COLOR BAND MARKING

DEVICE	1ST BAND	2ND BAND
FDLL400	BROWN	VIOLET
FDLL444	BROWN	GRAY

High Voltage General Purpose Diode

Sourced from Process 1J. See MMBD1401-1405 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage **FDH/FDLL 400**	150	V
	FDH/FDLL 444	100	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	500	mA
i_f	Recurrent Peak Forward Current	600	mA
$i_{f(surge)}$	Peak Forward Surge Current		
	Pulse width = 1.0 second	1.0	A
	Pulse width = 1.0 microsecond	4.0	A
T_{stg}	Storage Temperature Range	-65 to +200	°C
T_J	Operating Junction Temperature	175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		FDH/FDLL 400 / 444	
P_D	Total Device Dissipation	500	mW
	Derate above 25°C	3.33	mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	300	°C/W

High Voltage General Purpose Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter		Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	**FDH/FDLL444**	$I_R = 100\ \mu A$	150		V
		FDH/FDLL400	$I_R = 100\ \mu A$	200		V
I_R	Reverse Current	**FDH/FDLL444**	$V_R = 100$ V		50	nA
			$V_R = 100$ V, $T_A = 150°C$		100	µA
		FDH/FDLL400	$V_R = 150$ V		100	nA
			$V_R = 150$ V, $T_A = 150°C$		100	µA
V_F	Forward Voltage	**FDH/FDLL444**	$I_F = 200$ mA		1.1	V
			$I_F = 300$ mA		1.2	V
		FDH/FDLL400	$I_F = 200$ mA		1.0	V
			$I_F = 300$ mA		1.1	V
C_O	Diode Capacitance	**FDH/FDLL444**	$V_R = 0$, f = 1.0 MHz		2.5	pF
		FDH/FDLL400			2.0	pF
T_{RR}	Reverse Recovery Time					
		FDH/FDLL444	$I_F = I_R = 30$ mA, $I_{rr} = 3.0$ mA, $R_L = 100\ \Omega$		60	nS
		FDH/FDLL400	$I_F = I_R = 30$ mA, $I_{rr} = 3.0$ mA, $R_L = 100\ \Omega$		50	nS

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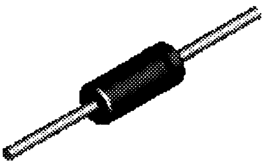
FDH / FDLL 600



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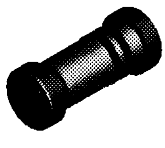


LL-34

THE PLACEMENT OF THE EXPANSION GAP HAS NO RELATIONSHIP TO THE LOCATION OF THE CATHODE TERMINAL

COLOR BAND MARKING		
DEVICE	1ST BAND	2ND BAND
FDLL600	RED	WHITE

High Conductance Ultra Fast Diode

Sourced from Process 1R. See MMBD1201-1205 for characteristics.

Absolute Maximum Ratings*   TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	50	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	400	mA
i_f	Recurrent Peak Forward Current	600	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 4.0	 A A
T_{stg}	Storage Temperature Range	-65 to +200	°C
T_J	Operating Junction Temperature	175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics   TA = 25°C unless otherwise noted

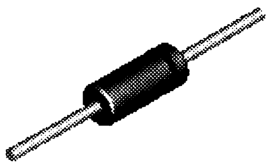
Symbol	Characteristic	Max	Units
		FDH/FDLL 600	
P_D	Total Device Dissipation Derate above 25°C	500 3.33	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	300	°C/W

High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 5.0\ \mu A$	75		V
I_R	Reverse Current	$V_R = 50\ V$ $V_R = 50\ V$, $T_A = 150°C$		100 100	nA µA
V_F	Forward Voltage	$I_F = 1.0\ mA$ $I_F = 10\ mA$ $I_F = 50\ mA$ $I_F = 100\ mA$ $I_F = 200\ mA$		650 790 860 920 1.0	mV mV mV mV V
C_O	Diode Capacitance	$V_R = 0$, $f = 1.0\ MHz$		2.5	pF
T_{RR}	Reverse Recovery Time	$I_F = I_R = 10\ mA$, $I_{rr} = 1.0\ mA$, $R_L = 100\ \Omega$ $I_F = I_R = 200\ mA$, $I_{rr} = 20\ mA$, $R_L = 100\ \Omega$		4.0 6.0	nS nS

FDH3595



DO-35

High Conductance Low Leakage Diode

Sourced from Process 1M. See MMBD1501-1505 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	125	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	500	mA
i_f	Recurrent Peak Forward Current	600	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 4.0	 A A
T_{stg}	Storage Temperature Range	-65 to +175	°C
T_J	Operating Junction Temperature	175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MMBD7000*	
P_D	Total Device Dissipation Derate above 25°C	500 3.33	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	300	°C/W

High Conductance Low Leakage Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 100\ \mu A$	150		V
I_R	Reverse Voltage Leakage Current	$V_R = 125\ V$ $V_R = 30\ V,\ T_A = 125°C$ $V_R = 125\ V,\ T_A = 125°C$ $V_R = 125\ V,\ T_A = 150°C$		1.0 300 500 3.0	nA nA nA µA
V_F	Forward Voltage	$I_F = 1.0\ mA$ $I_F = 5.0\ mA$ $I_F = 10\ mA$ $I_F = 50\ mA$ $I_F = 100\ mA$ $I_F = 200\ mA$	520 600 650 750 790 0.83	680 760 800 890 920 1.0	mV mV mV mV mV V
C_T	Diode Capacitance	$V_R = 0,\ f = 1.0\ MHz$		8.0	pF

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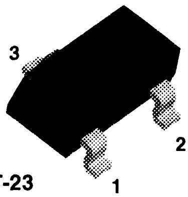
MMBD914



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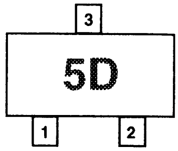
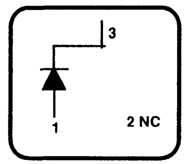


CONNECTION DIAGRAM



High Conductance Ultra Fast Diode

Sourced from Process 1P. See 1N4148 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	75	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MMBD914*	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on glass epoxy PCB 1.6" X 1.6" X 0.06"; mounting pad for the collector lead min. 0.93 in2

High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 100\ \mu A$ $I_R = 5.0\ \mu A$	100 75		V V
I_R	Reverse Current	$V_R = 20\ V$ $V_R = 20\ V,\ T_A = 150°C$ $V_R = 75\ V$		25 50 5.0	nA μA μA
V_F	Forward Voltage	$I_F = 10\ mA$		1.0	V
C_O	Diode Capacitance	$V_R = 0,\ f = 1.0\ MHz$		4.0	pF
T_{RR}	Reverse Recovery Time	$I_F = 10\ mA,\ V_R = 6.0\ V,$ $I_{RR} = 1.0\ mA,\ R_L = 100\Omega$		4.0	nS
V_{FM}	Peak Forward Recovery Voltage	$I_F = 50\ mA$ PEAK SQUARE WAVE PULSE WIDTH = 0.1 μS 5 kHz - 100 kHz REP RATE		2.5	V

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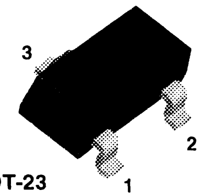
MMBD1201 / 1203 / 1204 / 1205



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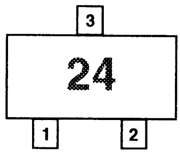
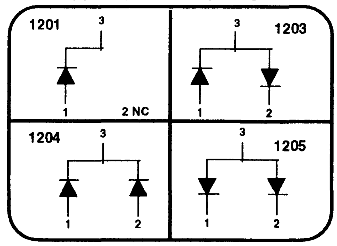


MARKING

MMBD1201 24 MMBD1504A 27
MMBD1203 26 MMBD1505A 28

CONNECTION DIAGRAMS



High Conductance Ultra Fast Diode

Sourced from Process 1P.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	50	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MMBD1201/1203/1204/1205*	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on glass epoxy PCB 1.6" X 1.6" X 0.06"; mounting pad for the collector lead min. 0.93 in2

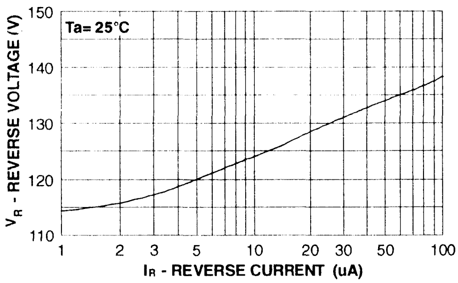
High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

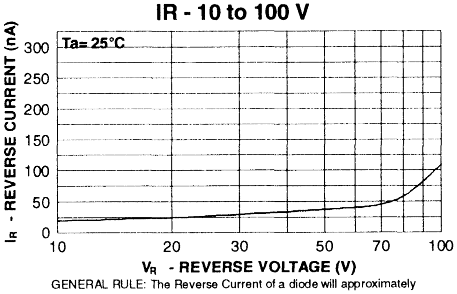
Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 100\ \mu A$	100		V
I_R	Reverse Current	$V_R = 20\ V$ $V_R = 50\ V$ $V_R = 50\ V,\ T_A = 150°C$		25 50 5.0	nA nA µA
V_F	Forward Voltage	$I_F = 1.0\ mA$ $I_F = 10\ mA$ $I_F = 100\ mA$ $I_F = 200\ mA$ $I_F = 300\ mA$	550 660 820 0.87	600 740 920 1.0 1.1	mV mV mV V V
C_T	Diode Capacitance	$V_R = 0,\ f = 1.0\ MHz$		2.0	pF
T_{RR}	Reverse Recovery Time	$I_{RR} = 1.0\ mA,\ I_F = I_R = 10\ mA,$ $R_L = 100\Omega$		4.0	nS

Typical Characteristics

REVERSE VOLTAGE vs REVERSE CURRENT
BV - 1.0 to 100 uA

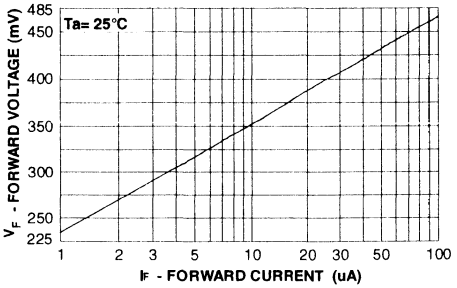


REVERSE CURRENT vs REVERSE VOLTAGE
IR - 10 to 100 V

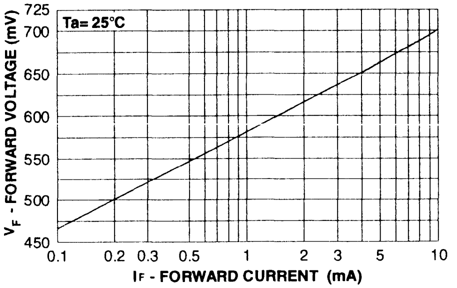


GENERAL RULE: The Reverse Current of a diode will approximately double for every ten (10) Degree C increase in Temperature

FORWARD VOLTAGE vs FORWARD CURRENT
VF - 1.0 to 100 uA

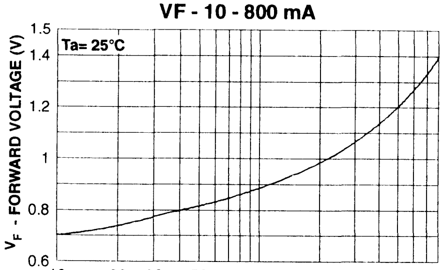


FORWARD VOLTAGE vs FORWARD CURRENT
VF - 0.1 to 10 mA

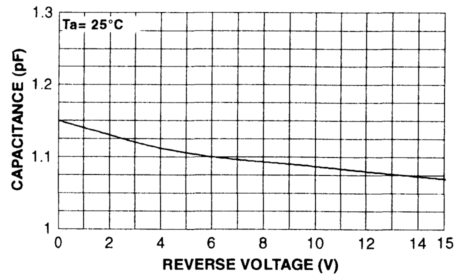


Typical Characteristics (continued)

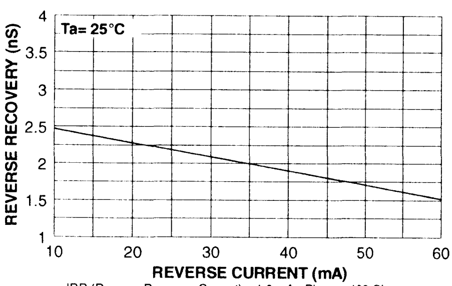
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 10 - 800 mA



CAPACITANCE vs REVERSE VOLTAGE
VR - 0.0 to 15 V

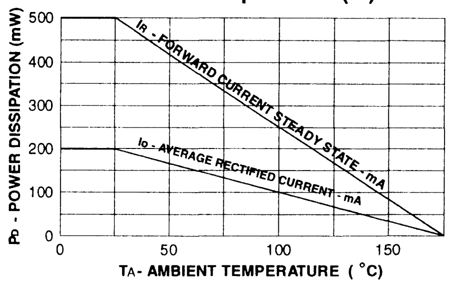


REVERSE RECOVERY TIME vs REVERSE CURRENT
TRR - IR 10 mA vs 60 mA

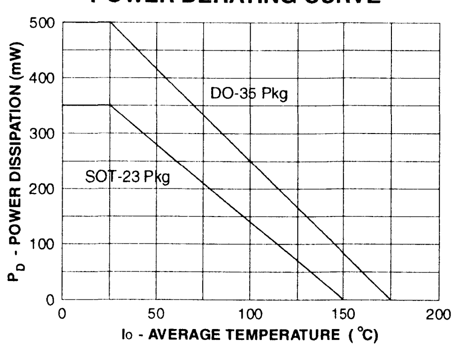


IRR (Reverse Recovery Current) = 1.0 mA - Rloop = 100 Ohms

Average Rectified Current (Io) &
Forward Current (I_F) versus
Ambient Temperature (T_A)



POWER DERATING CURVE



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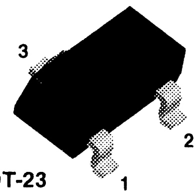
MMBD1401 / 1403 / 1404 / 1405



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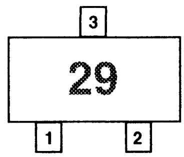
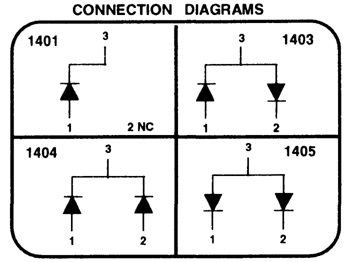


MARKING

MMBD1401	29	MMBD1404	33
MMBD1403	32	MMBD1405	34

CONNECTION DIAGRAMS



High Voltage General Purpose Diode

Sourced from Process 1H.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	175	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MMBD1401/1403/1404/1405*	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on glass epoxy PCB 1.6" X 1.6" X 0.06"; mounting pad for the collector lead min. 0.93 in2

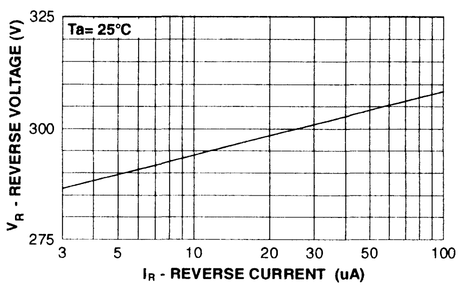
High Voltage General Purpoise Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

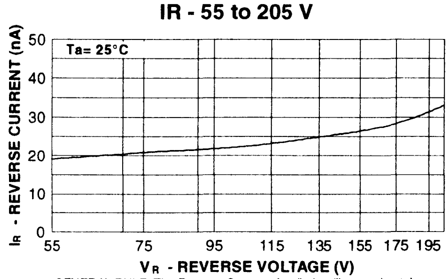
Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 100\ \mu A$	200		V
I_R	Reverse Current	$V_R = 120$ V $V_R = 175$ V		40 100	nA nA
V_F	Forward Voltage	$I_F = 10$ mA $I_F = 50$ mA $I_F = 200$ mA $I_F = 300$ mA	 760 	800 920 1.0 1.1	mV mV V V
C_O	Diode Capacitance	$V_R = 0$, f = 1.0 MHz		2.0	pF
T_{RR}	Reverse Recovery Time	$I_F = I_R = 30$ mA, $I_{RR} = 1.0$ mA, $R_L = 100\Omega$		50	nS

Typical Characteristics

REVERSE VOLTAGE vs REVERSE CURRENT
BV - 1.0 to 100 uA

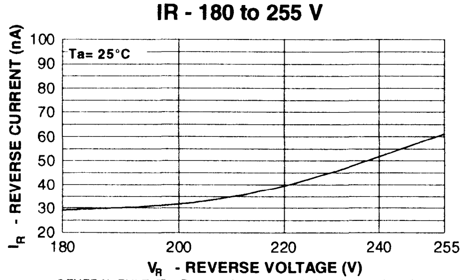


REVERSE CURRENT vs REVERSE VOLTAGE
IR - 55 to 205 V



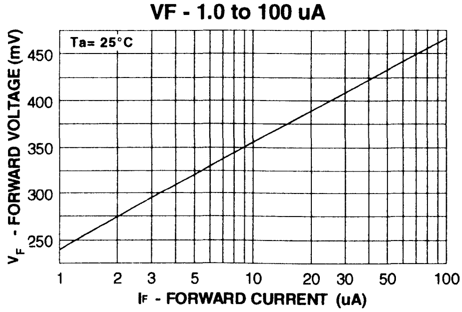
GENERAL RULE: The Reverse Current of a diode will approximately double for every ten (10) Degree C increase in Temperature

REVERSE CURRENT vs REVERSE VOLTAGE
IR - 180 to 255 V



GENERAL RULE: The Reverse Current of a diode will approximately double for every ten Degree C increase in Temperature

FORWARD VOLTAGE vs FORWARD CURRENT
VF - 1.0 to 100 uA

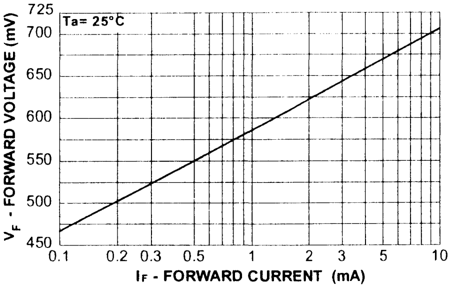


3

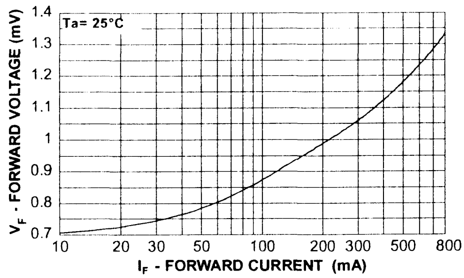
High Voltage General Purpose Diode
(continued)

Typical Characteristics (continued)

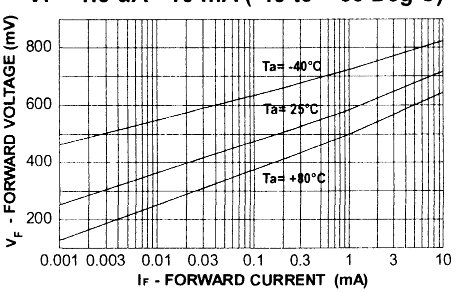
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 0.1 to 10 mA



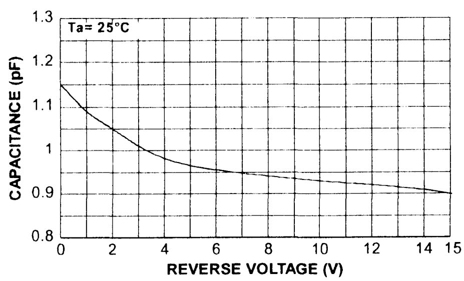
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 10 to 800 mA



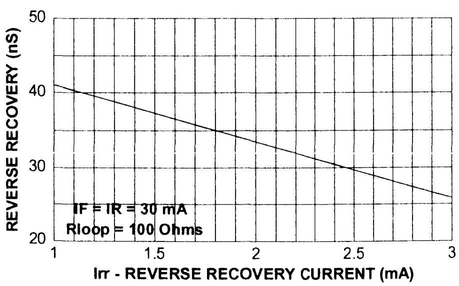
Forward Voltage vs Ambient Temperature
VF - 1.0 uA - 10 mA (-40 to + 80 Deg C)



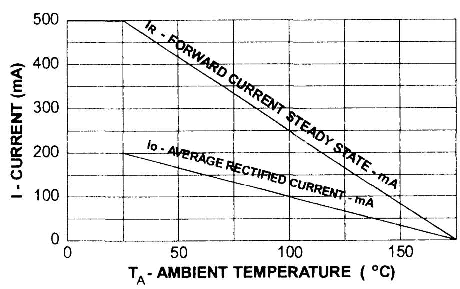
CAPACITANCE vs REVERSE VOLTAGE
VR - 0 to 15 V



REVERSE RECOVERY TIME vs
REVERSE RECOVERY CURRENT (Irr)

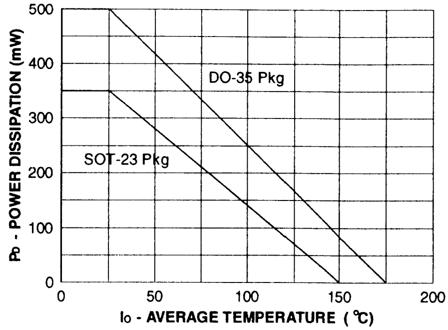


Average Rectified Current (Io) &
Forward Current (I_F) versus
Ambient Temperature (T_A)



Typical Characteristics (continued)

POWER DERATING CURVE



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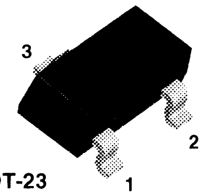
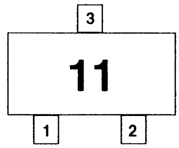
MMBD1501/A / 1503/A / 1504/A / 1505/A



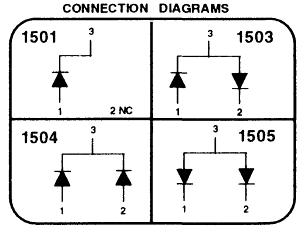
SOT-23



MARKING

MMBD1501	11	MMBD1501A	A11
MMBD1503	13	MMBD1503A	A13
MMBD1504	14	MMBD1504A	A14
MMBD1505	15	MMBD1505A	A15

CONNECTION DIAGRAMS



High Conductance Low Leakage Diode

Sourced from Process 1L.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	180	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MMBD1501/A/ 1503-1505/A*	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on glass epoxy PCB 1.6" X 1.6" X 0.06"; mounting pad for the collector lead min. 0.93 in2

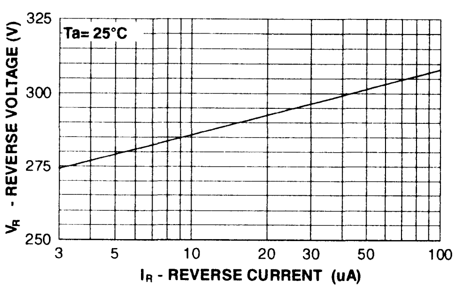
High Conductance Low Leakage Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

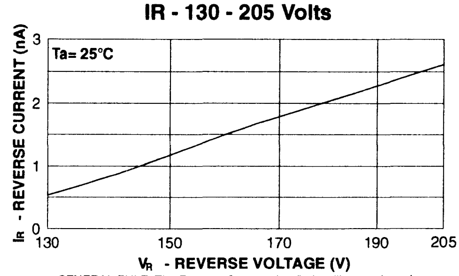
Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	I_R = 5.0 µA	200		V
I_R	Reverse Current	V_R = 125 V V_R = 125 V, T_A = 150°C V_R = 180 V V_R = 180 V, T_A = 150°C		1.0 3.0 10 5.0	nA µA nA µA
V_F	Forward Voltage	I_F = 1.0 mA I_F = 10 mA I_F = 50 mA I_F = 100 mA I_F = 200 mA I_F = 300 mA	620 720 800 830 0.87 0.9	720 830 890 930 1.1 1.15	mV mV mV mV V V
C_O	Diode Capacitance	V_R = 0, f = 1.0 MHz		4.0	pF

Typical Characteristics

REVERSE VOLTAGE vs REVERSE CURRENT
BV - 3.0 to 100 uA

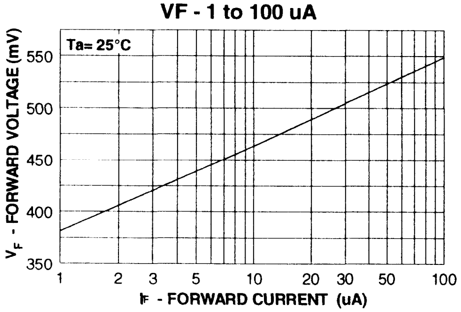


REVERSE CURRENT vs REVERSE VOLTAGE
IR - 130 - 205 Volts

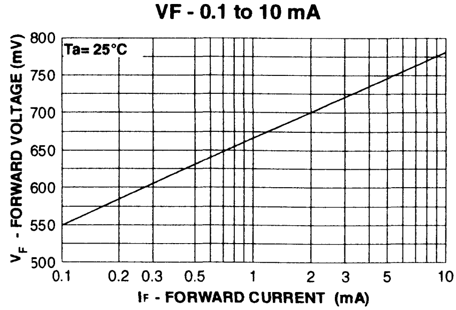


GENERAL RULE: The Reverse Current of a diode will approximately double for every ten (10) Degree C increase in Temperature

FORWARD VOLTAGE vs FORWARD CURRENT
VF - 1 to 100 uA



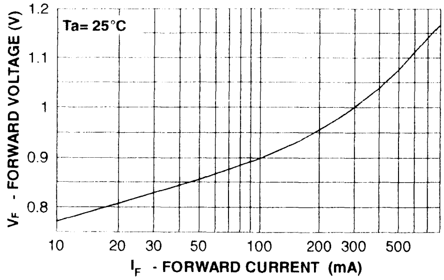
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 0.1 to 10 mA



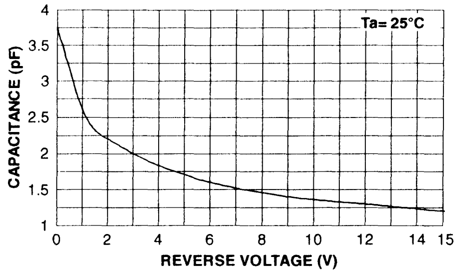
High Conductance Low Leakage Diode
(continued)

Typical Characteristics (continued)

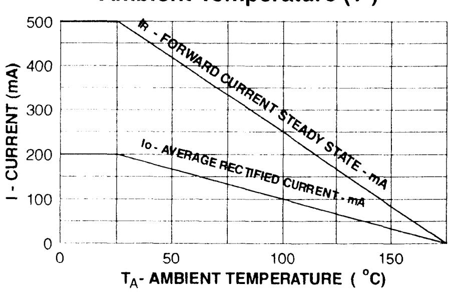
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 10 to 800 mA



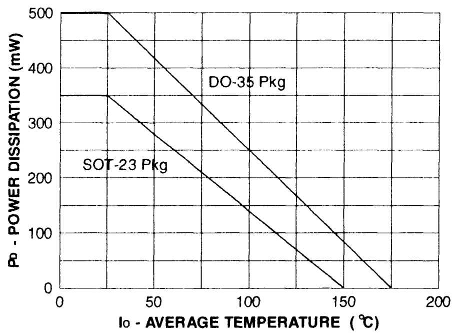
CAPACITANCE vs REVERSE VOLTAGE
VR - 0 to 15 V



Average Rectified Current (Io) & Forward Current (IF) versus Ambient Temperature (TA)



POWER DERATING CURVE



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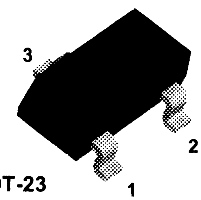
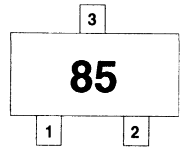
MMBD1701/A / 1703/A / 1704/A / 1705/A



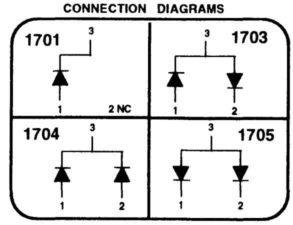
SOT-23



MARKING

MMBD1701	85	MMBD1701A	85A
MMBD1703	87	MMBD1703A	87A
MMBD1704	88	MMBD1704A	88A
MMBD1705	89	MMBD1705A	89A

CONNECTION DIAGRAMS



High Conductance Low Leakage Diode

Sourced from Process 1T.

Absolute Maximum Ratings*
TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	20	V
I_O	Average Rectified Current	50	mA
I_F	DC Forward Current	150	mA
i_f	Recurrent Peak Forward Current	150	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second	250	mA
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

Thermal Characteristics
TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MMBD1701/A /1703/A-1705/A*	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on glass epoxy PCB 1.6" X 1.6" X 0.06"; mounting pad for the collector lead min. 0.93 in2

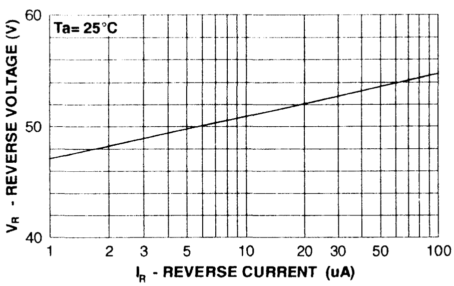
High Conductance Low Leakage Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

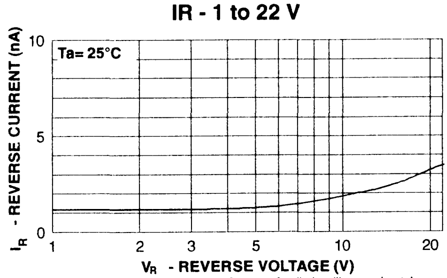
Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 5.0\ \mu A$	30		V
I_R	Reverse Current	$V_R = 20\ V$		50	nA
V_F	Forward Voltage	$I_F = 10\ \mu A$	420	500	mV
		$I_F = 100\ \mu A$	520	610	mV
		$I_F = 1.0\ mA$	640	740	mV
		$I_F = 10\ mA$	760	880	mV
		$I_F = 20\ mA$	810	950	mV
		$I_F = 50\ mA$	0.89	1.1	V
C_O	Diode Capacitance	$V_R = 0$, f = 1.0 MHz		1.0	pF
T_{RR}	Reverse Recovery Time				
	MMBD1701-1705	$I_F = I_R = 10\ mA\ I_{RR} = 1.0\ mA$, $R_L = 100\Omega$		700	pS
	MMBD1701A-1705A	$I_F = I_R = 10\ mA\ I_{RR} = 1.0\ mA$, $R_L = 100\Omega$		1.0	nS

Typical Characteristics

REVERSE VOLTAGE vs REVERSE CURRENT
BV - 1.0 to 100 uA

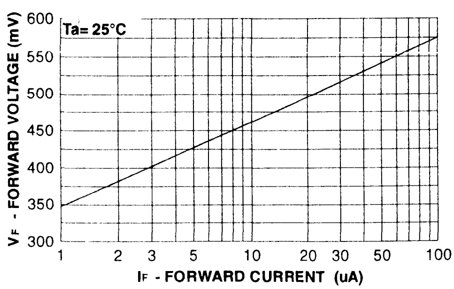


REVERSE CURRENT vs REVERSE VOLTAGE
IR - 1 to 22 V

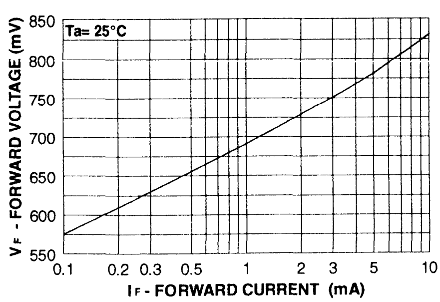


GENERAL RULE: The Reverse Current of a diode will approximately double for every ten (10) Degree C increase in Temperature

FORWARD VOLTAGE vs FORWARD CURRENT
VF - 1.0 to 100 uA

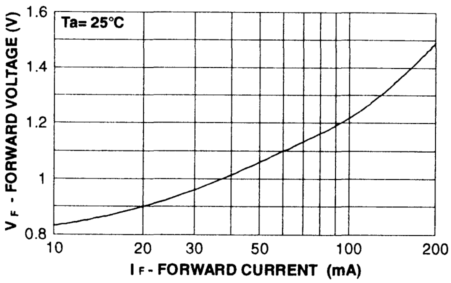


FORWARD VOLTAGE vs FORWARD CURRENT
VF - 0.1 to 10 mA

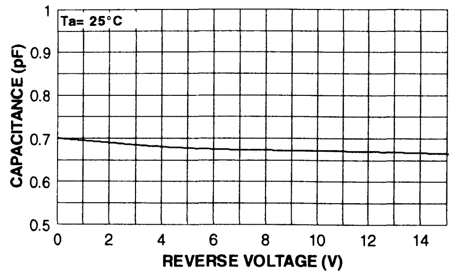


Typical Characteristics (continued)

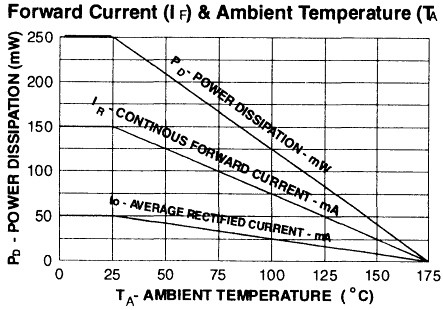
FORWARD VOLTAGE vs FORWARD CURRENT
VF - 10 - 200 mA



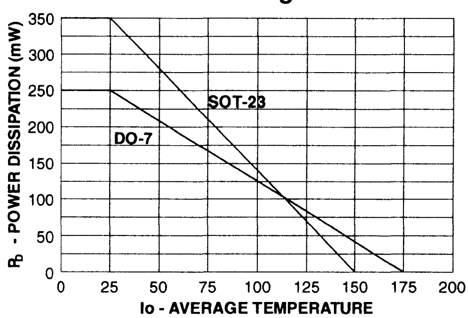
CAPACITANCE vs REVERSE CURRENT
VR - 0 to 15 V



Power Dissipation, Average Rectified Current (Io), Forward Current (I F) & Ambient Temperature (TA)



Power Derating Curve



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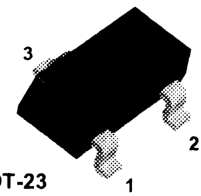
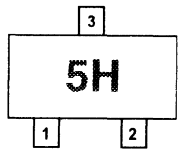
MMBD4148 / SE / CC / CA



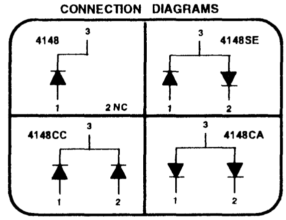
SOT-23



MARKING

MMBD4148	5H	MMBD4148CA	D6
MMBD4148CC	D5	MMBD4148SE	D4

CONNECTION DIAGRAMS



High Conductance Ultra Fast Diode

Sourced from Process 1P. See MMBD1201-1205 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	75	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current Pulse width = 1.0 second Pulse width = 1.0 microsecond	 1.0 2.0	 A A
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MMBD4148/SE/CC/CA*	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on glass epoxy PCB 1.6" X 1.6" X 0.06"; mounting pad for the collector lead min. 0.93 in2

High Conductance Low Leakage Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	$I_R = 100\ \mu A$ $I_R = 5.0\ \mu A$	100 75		V V
I_R	Reverse Current	$V_R = 20\ V$ $V_R = 20\ V$, $T_A = 150°C$ $V_R = 75\ V$		25 50 5.0	nA µA µA
V_F	Forward Voltage	$I_F = 10\ mA$		1.0	V
C_O	Diode Capacitance	$V_R = 0$, $f = 1.0\ MHz$		4.0	pF
T_{RR}	Reverse Recovery Time	$I_F = 10\ mA$, $V_R = 6.0\ V$, $I_{RR} = 1.0\ mA$, $R_L = 100\Omega$		4.0	nS

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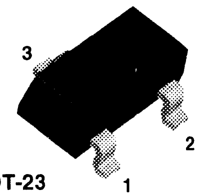
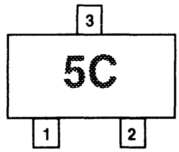
Discrete POWER & Signal Technologies

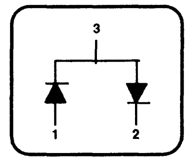
MMBD7000



SOT-23



CONNECTION DIAGRAM



High Conductance Ultra Fast Diode

Sourced from Process 1P. See MMBD1201-1205 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
W_{IV}	Working Inverse Voltage	70	V
I_O	Average Rectified Current	200	mA
I_F	DC Forward Current	600	mA
i_f	Recurrent Peak Forward Current	700	mA
$i_{f(surge)}$	Peak Forward Surge Current		
	Pulse width = 1.0 second	1.0	A
	Pulse width = 1.0 microsecond	2.0	A
T_{stg}	Storage Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature	150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MMBD7000*	
P_D	Total Device Dissipation	350	mW
	Derate above 25°C	2.8	mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on glass epoxy PCB 1.6" X 1.6" X 0.06"; mounting pad for the collector lead min. 0.93 in2

High Conductance Ultra Fast Diode
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
B_V	Breakdown Voltage	I_R = 100 μA	100		V
I_R	Reverse Current	V_R = 100 V V_R = 50 V V_R = 50 V, T_A = 125°C		500 300 100	nA nA μA
V_F	Forward Voltage	I_F = 1.0 mA I_F = 10 mA I_F = 50 mA I_F = 150 mA	550 670 0.75	700 820 1.1 1.25	mV mV V V
C_O	Diode Capacitance	V_R = 0, f = 1.0 MHz		1.5	pF
T_{RR}	Reverse Recovery Time	I_F = 10 mA, I_{RR} = 1.0 mA, R_L = 100Ω		4.0	nS

Section 4
Zener Diodes

Section 4 Contents

Zener Diode Datasheets

National Semiconductor™

1N746A - 1N759A Series Half Watt Zeners

Absolute Maximum Ratings*

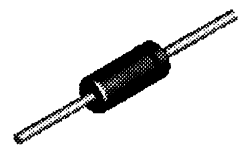
TA = 25°C unless otherwise noted

Parameter	Value	Units
Storage Temperature Range	-65 to +200	°C
Maximum Junction Operating Temperature	+ 175	°C
Lead Temperature (1/16" from case for 10 seconds)	+ 230	°C
Total Device Dissipation Derate above 25°C	500 3.33	mW mW/°C

*These ratings are limiting values above which the serviceability of the diode may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Tolerance: A = 5%



DO-35

Electrical Characteristics

TA = 25°C unless otherwise noted

Device	V_Z (V)	Z_Z (Ω)	@	I_{ZT} (mA)	I_{R1} (μA)	@	V_R (V)	I_{R2} (μA)	@	V_R T_A=150°C (V)	T_C (%/°C)	I_{ZM}* (mA)
1N746A	3.3	28		20	10		1.0	30		1.0	- 0.070	110
1N747A	3.6	24		20	10		1.0	30		1.0	- 0.065	100
1N748A	3.9	23		20	10		1.0	30		1.0	- 0.060	95
1N749A	4.3	22		20	2.0		1.0	30		1.0	+/- 0.055	85
1N750A	4.7	19		20	2.0		1.0	30		1.0	+/- 0.030	75
1N751A	5.1	17		20	1.0		1.0	20		1.0	+/- 0.030	70
1N752A	5.6	11		20	1.0		1.0	20		1.0	+ 0.038	65
1N753A	6.2	7.0		20	0.1		1.0	20		1.0	+ 0.045	60
1N754A	6.8	5.0		20	0.1		1.0	20		1.0	+ 0.050	55
1N755A	7.5	6.0		20	0.1		1.0	20		1.0	+ 0.058	50
1N756A	8.2	8.0		20	0.1		1.0	20		1.0	+ 0.062	45
1N757A	9.1	10		20	0.1		1.0	20		1.0	+ 0.068	40
1N758A	10	17		20	0.1		1.0	20		1.0	+ 0.075	35
1N759A	12	30		20	0.1		1.0	20		1.0	+ 0.077	38

*IZM (Maximum Zener Current Rating) Values shown are based on the JEDEC rating of 400 milliwatts. Where the actual zener voltage (VZ) is known at the operating point, the maximum zener current may be increased and is limited by the derating curve.

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1N957B - 1N973B Series Half Watt Zeners

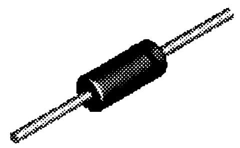
Absolute Maximum Ratings*
TA = 25°C unless otherwise noted

Parameter	Value	Units
Storage Temperature Range	-65 to +200	°C
Maximum Junction Operating Temperature	+ 175	°C
Lead Temperature (1/16" from case for 10 seconds)	+ 230	°C
Total Device Dissipation Derate above 25°C	500 3.33	mW mW/°C

*These ratings are limiting values above which the serviceability of the diode may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Tolerance: B = 5%



DO-35

Electrical Characteristics
TA = 25°C unless otherwise noted

Device	V_Z (V)	Z_Z (Ω)	@ I_{ZT} (mA)	Z_{ZK} (Ω)	@ I_{ZK} (mA)	I_R (μA)	@ V_R (V)	T_C (%/°C)	I_{ZM}* (mA)
1N957B	6.8	4.5	18.5	700	1.0	150	5.2	0.05	47
1N958B	7.5	5.5	16.5	700	0.5	75	5.7	0.058	42
1N959B	8.2	6.5	15	700	0.5	50	6.2	0.062	38
1N960B	9.1	7.5	14	700	0.5	25	6.9	0.068	35
1N961B	10	8.5	12.5	700	0.25	10	7.6	0.072	32
1N962B	11	9.5	11.5	700	0.25	5	8.4	0.073	28
1N963B	12	11.5	10.5	700	0.25	5	9.1	0.076	26
1N964B	13	13	9.5	700	0.25	5	9.9	0.079	24
1N965B	15	16	8.5	700	0.25	5	11.4	0.082	21
1N966B	16	17	7.8	700	0.25	5	12.2	0.083	19
1N967B	18	21	7.0	750	0.25	5	13.7	0.085	17
1N968B	20	25	6.2	750	0.25	5	15.2	0.086	15
1N969B	22	29	5.6	750	0.25	5	16.7	0.087	14
1N970B	24	33	5.2	750	0.25	5	18.2	0.088	13
1N971B	27	41	4.6	750	0.25	5	20.6	0.090	11
1N972B	30	49	4.2	1,000	0.25	5	22.8	0.091	10
1N973B	33	58	3.8	1,000	0.25	5	25.1	0.092	9.2

*IZM (Maximum Zener Current Rating) Values shown are based on the JEDEC rating of 400 milliwatts. Where the actual zener voltage (VZ) is known at the operating point, the maximum zener current may be increased and is limited by the derating curve.

National Semiconductor™

Discrete POWER & Signal Technologies

1N4728A - 1N4752A Series One Watt Zeners

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Parameter	Value	Units
Storage Temperature Range	-65 to +200	°C
Maximum Junction Operating Temperature	+ 200	°C
Lead Temperature (1/16" from case for 10 seconds)	+ 230	°C
Total Device Dissipation Derate above 25°C	1.0 6.67	W mW/°C
Surge Power**	10	W

*These ratings are limiting values above which the serviceability of the diode may be impaired.

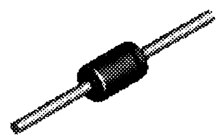
**Non-recurrent square wave PW= 8.3 ms, TA= 55 degrees C.

NOTES:

1) These ratings are based on a maximum junction temperature of 200 degrees C.

2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Tolerance: A = 5%



DO-41

Electrical Characteristics

TA = 25°C unless otherwise noted

Device	V_Z (V)	Z_Z (Ω) @	I_{ZT} (mA)	Z_{ZK} (Ω) @	I_{ZK} (mA)	V_R (V) @	I_R (µA)	I_{SURGE} (mA)	I_{ZM} (mA)
1N4728A	3.3	10	76	400	1.0	1.0	100	1,380	276
1N4729A	3.6	10	69	400	1.0	1.0	100	1,260	252
1N4730A	3.9	9.0	64	400	1.0	1.0	50	1,190	234
1N4731A	4.3	9.0	58	400	1.0	1.0	10	1,070	217
1N4732A	4.7	8.0	53	500	1.0	1.0	10	970	193
1N4733A	5.1	7.0	49	550	1.0	1.0	10	890	178
1N4734A	5.6	5.0	45	600	1.0	2.0	10	810	162
1N4735A	6.2	2.0	41	700	1.0	3.0	10	730	146
1N4736A	6.8	3.5	37	700	1.0	4.0	10	660	133
1N4737A	7.5	4.0	34	700	0.5	5.0	10	605	121
1N4738A	8.2	4.5	31	700	0.5	6.0	10	550	110
1N4739A	9.1	5.0	28	700	0.5	7.0	10	500	100
1N4740A	10	7.0	25	700	0.25	7.6	10	454	91
1N4741A	11	8.0	23	700	0.25	8.4	5.0	414	83
1N4742A	12	9.0	21	700	0.25	9.1	5.0	380	76
1N4743A	13	10	19	700	0.25	9.9	5.0	344	69
1N4744A	15	14	17	700	0.25	11.4	5.0	304	61
1N4745A	16	16	15.5	700	0.25	12.2	5.0	285	57
1N4746A	18	20	14	750	0.25	13.7	5.0	250	50
1N4747A	20	22	12.5	750	0.25	15.2	5.0	225	45
1N4748A	22	23	11.5	750	0.25	16.7	5.0	205	41
1N4749A	24	25	10.5	750	0.25	18.2	5.0	190	38
1N4750A	27	35	9.5	750	0.25	20.6	5.0	170	34
1N4751A	30	40	8.5	1,000	0.25	22.8	5.0	150	30
1N4752A	33	45	7.5	1,000	0.25	25.1	5.0	135	27

V_F Foward Voltage = 1.2 V Maximum @ I_F = 200 mA for all 1N4700 series

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1N5226B - 1N5257B Series Half Watt Zeners

Absolute Maximum Ratings*

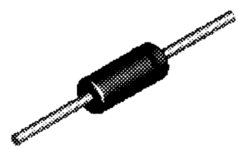
TA = 25°C unless otherwise noted

Parameter	Value	Units
Storage Temperature Range	-65 to +200	°C
Maximum Junction Operating Temperature	+ 200	°C
Lead Temperature (1/16" from case for 10 seconds)	+ 230	°C
Total Device Dissipation Derate above 25°C	500 4.0	mW mW/°C
Surge Power**	10	W

*These ratings are limiting values above which the serviceability of the diode may be impaired.
**Non-recurrent square wave PW= 8.3 ms, TA= 55 degrees C.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Tolerance: B = 5%



DO-35

Electrical Characteristics

TA = 25°C unless otherwise noted

Device	V_Z (V)	Z_Z (Ω)	@	I_{ZT} (mA)	Z_{ZK} (Ω)	@	I_{ZK} (mA)	V_R (V)	@	I_R (μA)	T_C (%/°C)
1N5226B	3.3	28		20	1,600		0.25	1.0		25	- 0.07
1N5227B	3.6	24		20	1,700		0.25	1.0		15	- 0.065
1N5228B	3.9	23		20	1,900		0.25	1.0		10	- 0.06
1N5229B	4.3	22		20	2,000		0.25	1.0		5.0	+/- 0.055
1N5230B	4.7	19		20	1,900		0.25	2.0		5.0	+/- 0.03
1N5231B	5.1	17		20	1,600		0.25	2.0		5.0	+/- 0.03
1N5232B	5.6	11		20	1,600		0.25	3.0		5.0	0.038
1N5233B	6.0	7.0		20	1,600		0.25	3.5		5.0	0.038
1N5234B	6.2	7.0		20	1,000		0.25	4.0		5.0	0.045
1N5235B	6.8	5.0		20	750		0.25	5.0		3.0	0.05
1N5236B	7.5	6.0		20	500		0.25	6.0		3.0	0.058
1N5237B	8.2	8.0		20	500		0.25	6.5		3.0	0.062
1N5238B	8.7	8.0		20	600		0.25	6.5		3.0	0.065
1N5239B	9.1	10		20	600		0.25	7.0		3.0	0.068
1N5240B	10	17		20	600		0.25	8.0		3.0	0.075
1N5241B	11	22		20	600		0.25	8.4		2.0	0.076
1N5242B	12	30		20	600		0.25	9.1		1.0	0.077

V_F Foward Voltage = 1.1 V Maximum @ I_F = 200 mA for all 1N5200 series

NOTE: National preferred devices in **BOLD**

Series Zener
(continued)

Electrical Characteristics (continued) TA = 25°C unless otherwise noted

Device	V_Z (V)	Z_Z (Ω)	@	I_{ZT} (mA)	Z_{ZK} (Ω)	@	I_{ZK} (mA)	V_R (V)	@	I_R (nA)	T_C (%/°C)
1N5243B	13	13		9.5	600		0.25	9.9		500	0.079
1N5244B	14	15		9.0	600		0.25	10		100	0.082
1N5245B	15	16		8.5	600		0.25	11		100	0.082
1N5246B	16	17		7.8	600		0.25	12		100	0.083
1N5247B	17	19		7.4	600		0.25	13		100	0.084
1N5248B	18	21		7.0	600		0.25	14		100	0.085
1N5249B	19	23		6.6	600		0.25	14		100	0.086
1N5250B	20	25		6.2	600		0.25	15		100	0.086
1N5251B	22	29		5.6	600		0.25	17		100	0.087
1N5252B	24	33		5.2	600		0.25	18		100	0.088
1N5253B	25	35		5.0	600		0.25	19		100	0.089
1N5254B	27	41		4.6	600		0.25	21		100	0.090
1N5255B	28	44		4.5	600		0.25	21		100	0.091
1N5256B	30	49		4.2	600		0.25	23		100	0.091
1N5257B	33	58		3.8	700		0.25	25		100	0.092

V_F Foward Voltage = 1.1 V Maximum @ I_F = 200 mA for all 1N5200 series

NOTE: National preferred devices in **BOLD**

4

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Discrete POWER & Signal Technologies

BZX55C 3V3 - 33 Series Half Watt Zeners

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

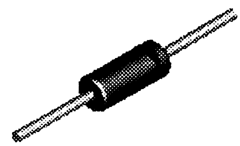
Parameter	Value	Units
Storage Temperature Range	-65 to +200	°C
Maximum Junction Operating Temperature	+ 200	°C
Lead Temperature (1/16" from case for 10 seconds)	+ 230	°C
Total Device Dissipation Derate above 25°C	500 4.0	mW mW/°C
Surge Power**	30	W

*These ratings are limiting values above which the serviceability of the diode may be impaired.

**Non-recurrent square wave PW= 8.3 ms, TA= 50 degrees C.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Tolerance: C = 5%



DO-35

Electrical Characteristics

TA = 25°C unless otherwise noted

Device	V_Z (V) MIN	V_Z (V) MAX	Z_Z (Ω)	@ I_{ZT} (mA)	Z_{ZK} (Ω)	@ I_{ZT} (mA)	V_R (V)	@ I_R (μA)	@ I_R (μA) T_A= 150°C	T_C (%/°C)	I_{ZM} (mA)
BZX55C 3V3	3.1	3.5	85	5.0	600	1.0	1.0	2.0	40	- 0.060	115
BZX55C 3V6	3.4	3.8	85	5.0	600	1.0	1.0	2.0	40	- 0.055	105
BZX55C 3V9	3.7	4.1	85	5.0	600	1.0	1.0	2.0	40	- 0.050	95
BZX55C 4V3	4.0	4.6	75	5.0	600	1.0	1.0	1.0	20	- 0.040	90
BZX55C 4V7	4.4	5.0	60	5.0	600	1.0	1.0	0.5	10	- 0.020	85
BZX55C 5V1	4.8	5.4	35	5.0	550	1.0	1.0	0.1	2.0	+0.010	80
BZX55C 5V6	5.2	6.0	25	5.0	450	1.0	1.0	0.1	2.0	+0.025	70
BZX55C 6V2	5.8	6.6	10	5.0	200	1.0	2.0	0.1	2.0	+0.032	64
BZX55C 6V8	6.4	7.2	8.0	5.0	150	1.0	3.0	0.1	2.0	+0.040	58
BZX55C 7V5	7.0	7.9	7.0	5.0	50	1.0	5.0	0.1	2.0	+0.045	53
BZX55C 8V2	7.7	8.7	7.0	5.0	50	1.0	6.2	0.1	2.0	+0.048	47
BZX55C 9V1	8.5	9.6	10	5.0	50	1.0	6.8	0.1	2.0	+0.050	43
BZX55C 10	9.4	10.6	15	5.0	70	1.0	7.5	0.1	2.0	+0.055	40
BZX55C 11	10.4	11.6	20	5.0	70	1.0	8.2	0.1	2.0	+0.060	36
BZX55C 12	11.4	12.7	20	5.0	90	1.0	9.1	0.1	2.0	+0.065	32
BZX55C 13	12.4	14.1	26	5.0	110	1.0	10	0.1	2.0	0.070	29
BZX55C 15	13.8	15.6	30	5.0	110	1.0	11	0.1	2.0	0.070	27
BZX55C 16	15.3	17.1	40	5.0	170	1.0	12	0.1	2.0	0.075	24
BZX55C 18	16.8	19.1	50	5.0	170	1.0	13	0.1	2.0	0.075	21
BZX55C 20	18.8	21.1	55	5.0	220	1.0	15	0.1	2.0	0.080	20
BZX55C 22	20.8	23.3	55	5.0	220	1.0	16	0.1	2.0	0.080	18
BZX55C 24	22.8	25.6	80	5.0	220	1.0	18	0.1	2.0	0.080	16
BZX55C 27	25.1	28.9	80	5.0	220	1.0	20	0.1	2.0	0.085	14
BZX55C 30	28.0	32.0	80	5.0	220	1.0	22	0.1	2.0	0.085	13
BZX55C 33	31.0	35.0	80	5.0	220	1.0	24	0.1	2.0	0.085	12

V_F Foward Voltage = 1.0 V Maximum @ I_F = 100 mA for all BZX 55 series

BZX79C 3V3 - 33 Series Half Watt Zeners

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Parameter	Value	Units
Storage Temperature Range	-65 to +200	°C
Maximum Junction Operating Temperature	+ 200	°C
Lead Temperature (1/16" from case for 10 seconds)	+ 230	°C
Total Device Dissipation Derate above 25°C	500 4.0	mW mW/°C
Surge Power**	30	W

*These ratings are limiting values above which the serviceability of the diode may be impaired.

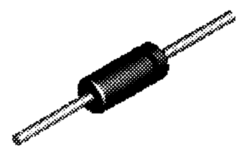
**Non-recurrent square wave PW= 8.3 ms, TA= 50 degrees C.

NOTES:

1) These ratings are based on a maximum junction temperature of 200 degrees C.

2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Tolerance: C = 5%



DO-35

Electrical Characteristics

TA = 25°C unless otherwise noted

Device	V_Z* (V) MIN	V_Z* (V) MAX	Z_Z (Ω)	@ I_{ZT} (mA)	Z_{ZK} (Ω)	@ I_{ZT} (mA)	V_R (V)	@ I_R (µA)	T_C (mV/°C) MIN	T_C (mV/°C) MAX
BZX79C 3V3	3.1	3.5	95	5.0	600	1.0	1.0	25	- 3.5	0.0
BZX79C 3V6	3.4	3.8	90	5.0	600	1.0	1.0	15	- 3.5	0.0
BZX79C 3V9	3.7	4.1	90	5.0	600	1.0	1.0	10	- 3.5	+ 0.3
BZX79C 4V3	4.0	4.6	90	5.0	600	1.0	1.0	5.0	- 3.5	+ 1.0
BZX79C 4V7	4.4	5.0	80	5.0	500	1.0	2.0	3.0	- 3.5	+ 0.2
BZX79C 5V1	4.8	5.4	60	5.0	480	1.0	2.0	2.0	- 2.7	+ 1.2
BZX79C 5V6	5.2	6.0	40	5.0	400	1.0	2.0	1.0	- 2.0	+ 2.5
BZX79C 6V2	5.8	6.6	10	5.0	150	1.0	4.0	3.0	+ 0.4	+ 3.7
BZX79C 6V8	6.4	7.2	15	5.0	80	1.0	4.0	2.0	+ 1.2	+ 4.5
BZX79C 7V5	7.0	7.9	15	5.0	80	1.0	5.0	1.0	+ 2.5	+ 5.3
BZX79C 8V2	7.7	8.7	15	5.0	80	1.0	5.0	0.7	+ 3.2	+ 6.2
BZX79C 9V1	8.5	9.6	15	5.0	100	1.0	6.0	0.5	+ 3.8	+ 7.0
BZX79C 10	9.4	10.6	20	5.0	150	1.0	7.0	0.2	+ 4.5	+ 8.0
BZX79C 11	10.4	11.6	20	5.0	150	1.0	8.0	0.1	+ 5.4	+ 9.0
BZX79C 12	11.4	12.7	25	5.0	150	1.0	8.0	0.1	+ 6.0	+ 10
BZX79C 13	12.4	14.1	30	5.0	170	1.0	8.0	0.10	- 7.0	+ 11
BZX79C 15	13.8	15.6	30	5.0	200	1.0	10.5	0.05	- 9.2	+ 13
BZX79C 16	15.3	17.1	40	5.0	200	1.0	11.2	0.05	+ 10.4	+ 14
BZX79C 18	16.8	19.1	45	5.0	225	1.0	12.6	0.05	+ 12.4	+ 16
BZX79C 20	18.8	21.2	55	5.0	225	1.0	14	0.05	+ 14.4	+ 18
BZX79C 22	20.8	23.3	55	5.0	250	1.0	15.4	0.05	+ 16.4	+ 20
BZX79C 24	22.8	25.6	70	5.0	250	1.0	16.8	0.05	+ 18.4	+ 22
BZX79C 27	25.1	28.9	80	2.0	300	0.5	18.9	0.05	+ 21.4	+ 25.3
BZX79C 30	28	32	80	2.0	300	0.5	21	0.05	+ 24.4	+ 29.4
BZX79C 33	31	35	80	2.0	325	0.5	23.1	0.05	+ 27.4	+ 33.4

V_F Foward Voltage = 1.5 V Maximum @ I_F = 100 mA for all BZX 79 series

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

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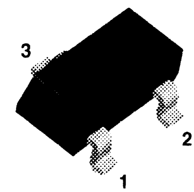
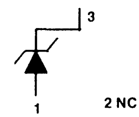
BZX84C 4V7 - BZX84C 33 Series Zeners

Tolerance: C = 5%



SOT-23

CONNECTION DIAGRAM



Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Parameter	Value	Units
Storage Temperature Range	-55 to +150	°C
Maximum Junction Operating Temperature	+ 150	°C
Total Device Dissipation Derate above 25°C	350 1.8	mW mW/°C
Repetitive Peak Forward Current (I_{FRM})	250	mA
Repetitive Peak Working Current (I_{ZRM})	250	mA

*These ratings are limiting values above which the serviceability of the diode may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Electrical Characteristics

TA = 25°C unless otherwise noted

Device	Mark	I_{ZT} = 5.0 mA			I_{ZT} = 1.0 mA			I_{ZT} = 20 mA		
		V_Z (V) MIN	V_Z (V) MAX	Z_Z (Ω)	V_Z (V) MIN	V_Z (V) MAX	Z_Z (Ω)	V_Z (V) MIN	V_Z (V) MAX	Z_Z (Ω)
BZX84C 4V7	Z1	4.4	5.0	80	3.7	4.7	500	4.5	5.4	15
BZX84C 5V1	Z2	4.8	5.4	60	4.2	5.3	480	5.0	5.9	15
BZX84C 5V6	Z3	5.2	6.0	40	4.8	6.0	400	5.2	6.3	10
BZX84C 6V2	Z4	5.8	6.6	10	5.6	6.6	150	5.8	6.8	6
BZX84C 6V8	Z5	6.4	7.2	15	6.3	7.2	80	6.4	7.4	6
BZX84C 7V5	Z6	7.0	7.9	15	6.9	7.9	80	7.0	8.0	6
BZX84C 8V2	Z7	7.7	8.7	15	7.6	8.7	80	7.7	8.8	6
BZX84C 9V1	Z8	8.5	9.6	15	8.4	9.6	100	8.5	9.7	8
BZX84C 10	Z9	9.4	10.6	20	9.3	10.6	150	9.4	10.7	10
BZX84C 11	Y1	10.4	11.6	20	10.2	11.6	150	10.4	11.8	10
BZX84C 12	Y2	11.4	12.7	25	11.2	12.7	150	11.4	12.9	10
BZX84C 13	Y3	12.4	14.1	30	12.3	14.0	170	12.5	14.2	15
BZX84C 15	Y4	13.8	15.6	30	13.7	15.5	200	13.9	15.7	20
BZX84C 16	Y5	15.3	17.1	40	15.2	17	200	15.4	17.2	20
BZX84C 18	Y6	16.8	19.1	45	16.7	19	225	16.9	19.2	20
BZX84C 20	Y7	18.8	21.2	55	18.7	21.1	225	18.9	21.4	20
BZX84C 22	Y8	20.8	23.3	55	20.7	23.2	250	20.9	23.4	25
BZX84C 24	Y9	22.8	25.6	70	22.7	25.5	250	22.9	25.7	25

NOTE: National preferred devices in **BOLD**

BZX84C Series Zeners
(continued)

Electrical Characteristics (continued)

T_A = 25°C unless otherwise noted

Device	Mark	I_{ZT} = 2.0 mA V_Z (V) MIN	I_{ZT} = 2.0 mA V_Z (V) MAX	I_{ZT} = 2.0 mA Z_Z (Ω)	I_{ZT} = 100 µA* V_Z (V) MIN	I_{ZT} = 100 µA* V_Z (V) MAX	I_{ZT} = 100 µA* Z_Z (Ω)	I_{ZT} = 10 mA V_Z (V) MIN	I_{ZT} = 10 mA V_Z (V) MAX	I_{ZT} = 10 mA Z_Z (Ω)
BZX84C 27	Y10	25.1	28.9	80	25	28.9	300	25.2	29.3	45
BZX84C 30	Y11	28	32	80	27.8	32	300	28.1	32.4	50
BZX84C 33	Y12	31	35	80	30.8	35	325	31.1	35.4	55

V_F Foward Voltage = 0.9 V Maximum @ I_F = 10 mA for all BZX 84 series

*Capacitance @ VR = 0.0 volts; Frequency = 1.0 megahertz.

Device	V_R (V)	I_R (µA)	CAP* (pF)	D_{VZ} / D_t @ 5.0 mA (mV/k) MIN	D_{VZ} / D_t @ 5.0 mA (mV/k) MAX
BZX84C 4V7	2.0	3	260	- 3.5	+ 0.2
BZX84C 5V1	2.0	2	225	- 2.7	+ 1.2
BZX84C 5V6	2.0	1	200	- 2.0	+ 2.5
BZX84C 6V2	4.0	3	185	+ 0.4	+ 3.7
BZX84C 6V8	4.0	2	155	+ 1.2	+ 4.5
BZX84C 7V5	5.0	1	140	+ 2.5	+ 5.3
BZX84C 8V2	5.0	0.7	135	+ 3.2	+ 6.2
BZX84C 9V1	6.0	0.5	130	+ 3.8	+ 7.0
BZX84C 10	7.0	0.2	130	+ 4.5	+ 8.0
BZX84C 11	8.0	0.1	130	+ 5.4	+ 9.0
BZX84C 12	8.0	0.1	130	+ 6.0	+ 10
BZX84C 13	8.0	0.1	120	+ 7.0	+ 11
BZX84C 15	10.5	0.05	110	+ 9.2	+ 13
BZX84C 16	11.2	0.05	105	+ 10.4	+ 14
BZX84C 18	12.6	0.05	100	+ 12.4	+ 16
BZX84C 20	14	0.05	85	+ 14.4	+ 18
BZX84C 22	15.4	0.05	85	+ 16.4	+ 20
BZX84C 24	16.8	0.05	80	+ 18.4	+ 22

Device	V_R (V)	I_R (µA)	CAP* (pF)	D_{VZ} / D_t @ 2.0 mA (mV/k) MIN	D_{VZ} / D_t @ 2.0 mA (mV/k) MAX
BZX84C 27	18.9	0.05	70	21.4	25.3
BZX84C 30	21	0.05	70	24.4	29.4
BZX84C 33	23.1	0.05	70	27.4	33.4

4

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BZX85C 3V3 - 33 Series 1.3 Watt Zeners

Absolute Maximum Ratings*

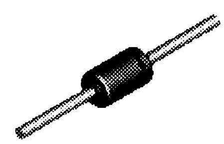
TA = 25°C unless otherwise noted

Parameter	Value	Units
Storage Temperature Range	-65 to +200	°C
Maximum Junction Operating Temperature	+ 200	°C
Lead Temperature (1/16" from case for 10 seconds)	+ 230	°C
Total Device Dissipation Derate above 25°C	1.3 10.4	W mW/°C

*These ratings are limiting values above which the serviceability of the diode may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Tolerance: C = 5%



DO-41

Electrical Characteristics

TA = 25°C unless otherwise noted

Device	V_Z (V)	Z_Z (Ω) @	I_{ZT} (mA)	Z_{ZK} (Ω) @	I_{ZK} (mA)	V_R (V) @	I_R (μA)	I_{SURGE} (mA)	I_{ZM} (mA)
BZX85C 3V3	3.3	20	80	400	1.0	1.0	60	1,380	276
BZX85C 3V6	3.6	15	60	500	1.0	1.0	30	1,260	252
BZX85C 3V9	3.9	15	60	500	1.0	1.0	5.0	1,190	234
BZX85C 4V3	4.3	13	50	500	1.0	1.0	3.0	1,070	217
BZX85C 4V7	4.7	13	45	600	1.0	1.5	3.0	970	193
BZX85C 5V1	5.1	10	45	500	1.0	2.0	1.0	890	178
BZX85C 5V6	5.6	7.0	45	400	1.0	2.0	1.0	810	162
BZX85C 6V2	6.2	4.0	35	300	1.0	3.0	1.0	730	146
BZX85C 6V8	6.8	3.5	35	300	1.0	4.0	1.0	660	133
BZX85C 7V5	7.5	3.0	35	200	1.0	4.5	1.0	605	121
BZX85C 8V2	8.2	5.0	25	200	0.5	5.0	1.0	550	110
BZX85C 9V1	9.1	5.0	25	200	0.5	6.5	1.0	500	100
BZX85C 10	10	7.0	25	200	0.5	7.0	0.5	454	91
BZX85C 11	11	8.0	20	300	0.5	7.7	0.5	414	83
BZX85C 12	12	9.0	20	350	0.5	8.4	0.5	380	76
BZX85C 13	13	10	20	400	0.5	9.1	0.5	344	69
BZX85C 15	15	15	15	500	0.5	10.5	0.5	304	61
BZX85C 16	16	15	15	500	0.5	11	0.5	285	57
BZX85C 18	18	20	15	500	0.5	12.5	0.5	250	50
BZX85C 20	20	24	10	600	0.5	14	0.5	225	45
BZX85C 22	22	25	10	600	0.5	15.5	0.5	205	41
BZX85C 24	24	25	10	600	0.5	17	0.5	190	38
BZX85C 27	27	30	8.0	750	0.25	19	0.5	170	34
BZX85C 30	30	30	8.0	1,000	0.25	21	0.5	150	30
BZX85C 33	33	35	8.0	1,200	0.25	23	0.5	135	27

V_F Foward Voltage = 1.2 V Maximum @ I_F = 200 mA for all BZX85 series

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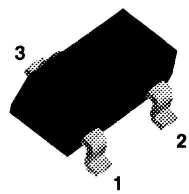
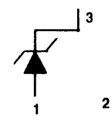
MMBZ5226B - MMBZ5257B Series Zeners

Tolerance: B = 5%



SOT-23

CONNECTION DIAGRAM



Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Parameter	Value	Units
Storage Temperature Range	-55 to +150	°C
Maximum Junction Operating Temperature	+ 150	°C
Total Device Dissipation Derate above 25°C	350 1.8	mW mW/°C

*These ratings are limiting values above which the serviceability of the diode may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Electrical Characteristics

TA = 25°C unless otherwise noted

Device	Mark	V_Z (V)	Z_Z (Ω)	@	I_{ZT} (mA)	Z_{ZK} (Ω)	@	I_{ZK} (mA)	V_R (V)	@	I_R (µA)
MMBZ 5226B	8A	3.3	28		20	1,600		0.25	1.0		25
MMBZ 5227B	8B	3.6	24		20	1,700		0.25	1.0		15
MMBZ 5228B	8C	3.9	23		20	1,900		0.25	1.0		10
MMBZ 5229B	8D	4.3	22		20	1,000		0.25	1.0		5.0
MMBZ 5230B	8E	4.7	19		20	1,900		0.25	2.0		5.0
MMBZ 5231B	8F	5.1	17		20	1,600		0.25	2.0		5.0
MMBZ 5232B	8G	5.6	11		20	1,600		0.25	3.0		5.0
MMBZ 5233B	8H	6.0	7.0		20	1,600		0.25	3.5		5.0
MMBZ 5234B	8J	6.2	7.0		20	1,000		0.25	4.0		5.0
MMBZ 5235B	8K	6.8	5.0		20	750		0.25	5.0		3.0
MMBZ 5236B	8L	7.5	6.0		20	500		0.25	6.0		3.0
MMBZ 5237B	8M	8.2	8.0		20	500		0.25	6.5		3.0
MMBZ 5238B	8N	8.7	8.0		20	600		0.25	6.5		3.0
MMBZ 5239B	8P	9.1	10		20	600		0.25	7.0		3.0
MMBZ 5240B	8Q	10	17		20	600		0.25	8.0		3.0
MMBZ 5241B	8R	11	22		20	600		0.25	8.4		2.0
MMBZ 5242B	8S	12	30		20	600		0.25	9.1		1.0

V_F Foward Voltage = 0.9 V Maximum @ I_F = 10 mA for all MMBZ 5200 series

NOTE: National preferred devices in **BOLD**

4

MMBZ Series Zeners
(continued)

Electrical Characteristics (continued) TA = 25°C unless otherwise noted

Device	Mark	V_Z (V)	Z_Z (Ω)	I_{ZT} (mA)	Z_{ZK} (Ω)	I_{ZK} (mA)	V_R (V)	I_R (nA)
MMBZ 5243B	8T	13	13	9.5	600	0.25	9.9	500
MMBZ 5244B	8U	14	15	9.0	600	0.25	10	100
MMBZ 5245B	8V	15	16	8.5	600	0.25	11	100
MMBZ 5246B	8W	16	17	7.8	600	0.25	12	100
MMBZ 5247B	8X	17	19	7.4	600	0.25	13	100
MMBZ 5248B	8Y	18	21	7.0	600	0.25	14	100
MMBZ 5249B	8Z	19	23	6.6	600	0.25	14	100
MMBZ 5250B	81A	20	25	6.2	600	0.25	15	100
MMBZ 5251B	81B	22	29	5.6	600	0.25	17	100
MMBZ 5252B	81C	24	33	5.2	600	0.25	18	100
MMBZ 5253B	81D	25	35	5.0	600	0.25	19	100
MMBZ 5254B	81E	27	41	4.6	600	0.25	21	100
MMBZ 5255B	81F	28	44	4.5	600	0.25	21	100
MMBZ 5256B	81G	30	49	4.2	600	0.25	23	100
MMBZ 5257B	81H	33	58	3.8	700	0.25	25	100

V_F Foward Voltage = 0.9 V Maximum @ I_F = 10 mA for all MMBZ 5200 series

NOTE: National preferred devices in **BOLD**

Section 5
Bipolar Transistors

Section 5 Contents

Bipolar Transistor Datasheets

Section 5 Contents (continued)

Bipolar Transistor Datasheets (continued)

National
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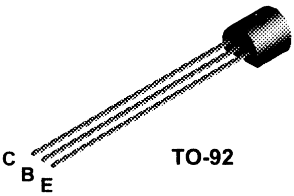
Discrete POWER & Signal Technologies

PN100 PN100A MMBT100 MMBT100A



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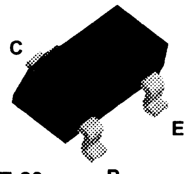


SOT-23
Mark: NA / NA1

NPN General Purpose Amplifier

This device is designed for general purpose amplifier applications at collector currents to 300 mA. Sourced from Process 10.

Absolute Maximum Ratings*   TA=25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	75	V
V_{CBO}	Collector-Base Voltage	45	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	500	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics   TA= 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		PN100A	*MMBT100A	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

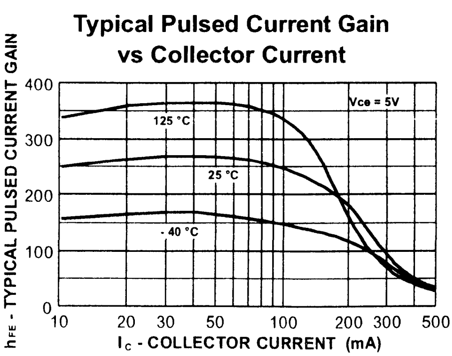
NPN General Purpose Amplifier
(continued)

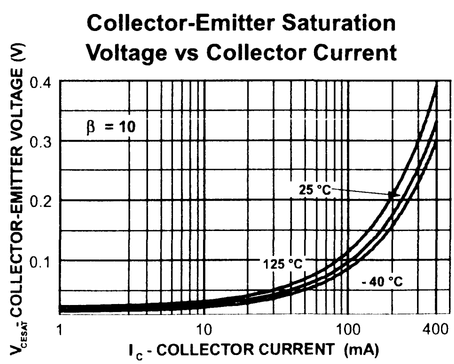
Electrical Characteristics
TA= 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Max	Units
OFF CHARACTERISTICS						
BV_{CBO}	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_B = 0$		75		V
BV_{CEO}	Collector-Emitter Breakdown Voltage*	$I_C = 1$ mA, $I_E = 0$		45		V
BV_{EBO}	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$		6.0		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 60$ V			50	nA
I_{CES}	Collector Cutoff Current	$V_{CE} = 40$ V			50	nA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = 4$ V			50	nA
ON CHARACTERISTICS						
h_{FE}	DC Current Gain	$I_C = 100\ \mu A$, $V_{CE} = 1.0$ V	**100**	80		
			100A	240		
		$I_C = 10$ mA, $V_{CE} = 1.0$ V	**100**	100	450	
			100A	300	600	
		$I_C = 100$ mA, $V_{CE} = 1.0$ V*		100		
		$I_C = 150$ mA, $V_{CE} = 5.0$ V*	**100**	100	350	
			100A	100		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA			0.2	V
		$I_C = 200$ mA, $I_B = 20$ mA*			0.4	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA			0.85	V
		$I_C = 200$ mA, $I_B = 20$ mA*			1.0	V
SMALL SIGNAL CHARACTERISTICS						
f_T	Current Gain - Bandwidth Product	$V_{CE} = 20$ V, $I_C = 20$ mA		250		MHz
C_{obo}	Output Capacitance	$V_{CB} = 5.0$ V, f = 1.0 MHz			4.5	pF
NF	Noise Figure	$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V,	**100**		5.0	dB
		$R_G = 2.0\ k\Omega$, f = 1.0 kHz	**100A**		4.0	dB

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

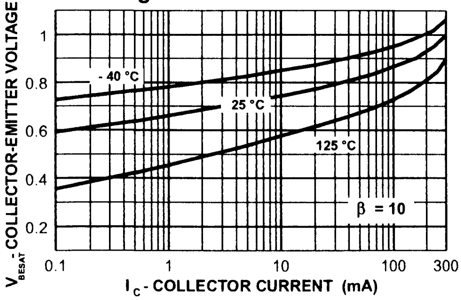
DC Typical Characteristics



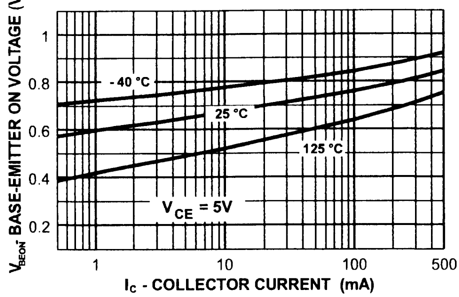


DC Typical Characteristics (continued)

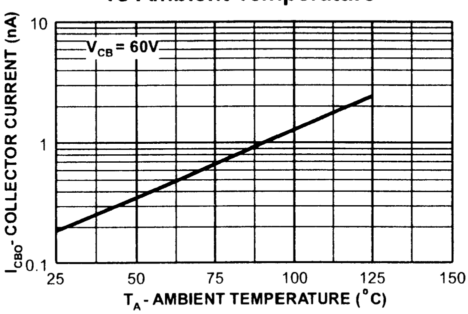
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

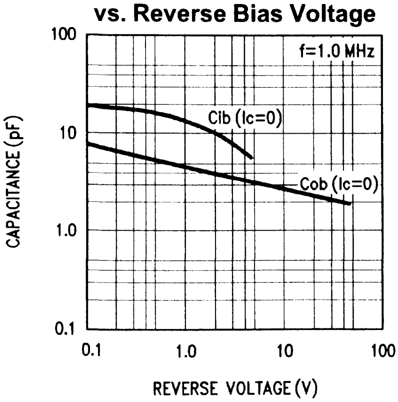


Collector-Cutoff Current vs Ambient Temperature

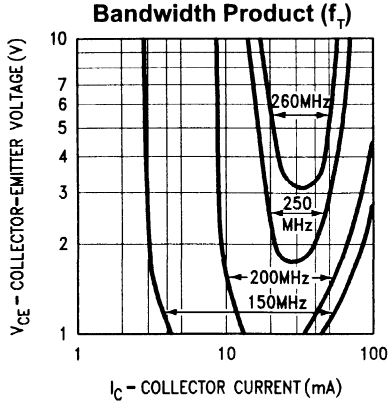


AC Typical Characteristics

Input / Output Capacitance vs. Reverse Bias Voltage



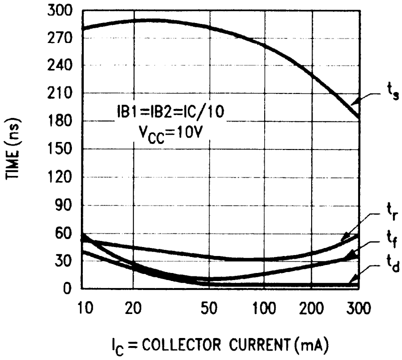
Contours of Constant Gain Bandwidth Product (f_T)



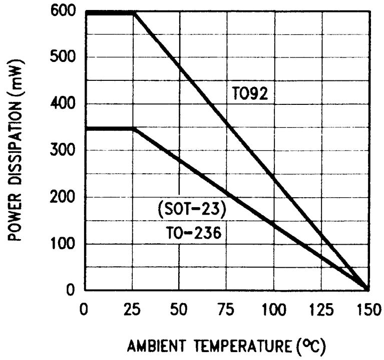
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

Switching Times vs. Collector Current



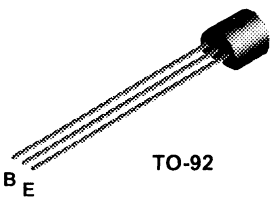
Total Power Dissipation vs. Ambient Temperature



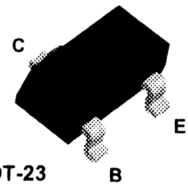
National Semiconductor™

PN200
PN200A

MMBT200
MMBT200A



TO-92



SOT-23
Mark: N2 / N2A

PNP General Purpose Amplifier

This device is designed for general purpose amplifier applications at collector currents to 300 mA. Sourced from Process 68.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	60	V
V_{CBO}	Collector-Base Voltage	45	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	500	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		PN200A	*MMBT200A	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

PNP General Purpose Amplifier
(continued)

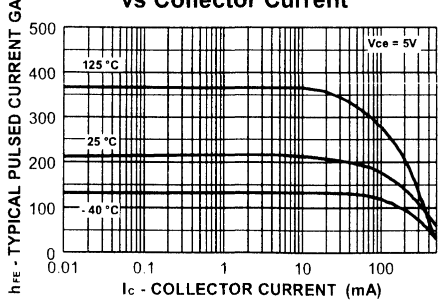
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Max	Units
OFF CHARACTERISTICS						
BV_{CBO}	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_B = 0$		60		V
BV_{CEO}	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_E = 0$		45		V
BV_{EBO}	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$		6.0		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 50$ V, $I_E = 0$			50	nA
I_{CES}	Collector Cutoff Current	$V_{CE} = 40$ V, $I_E = 10$			50	nA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = 4.0$ V, $I_C = 0$			50	nA
ON CHARACTERISTICS						
h_{FE}	DC Current Gain	$I_C = 100\ \mu A$, $V_{CE} = 1.0$ V	**200**	80		
			200A	240		
		$I_C = 10$ mA, $V_{CE} = 1.0$ V	**200**	100	450	
			200A	300	600	
		$I_C = 100$ mA, $V_{CE} = 1.0$ V*	**200A**	100		
		$I_C = 150$ mA, $V_{CE} = 5.0$ V*	**200**	100	350	
			200A	100		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA			0.2	V
		$I_C = 200$ mA, $I_B = 20$ mA*			0.4	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA			0.85	V
		$I_C = 200$ mA, $I_B = 20$ mA*			1.0	V
SMALL SIGNAL CHARACTERISTICS						
f_T	Current Gain - Bandwidth Product	$V_{CE} = 20$ V, $I_C = 20$ mA		250		MHz
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, f = 1.0 MHz			6.0	pF
NF	Noise Figure	$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V,	**200**		5.0	dB
		$R_G = 2.0\ k\Omega$, f = 1.0 kHz	**200A**		4.0	dB

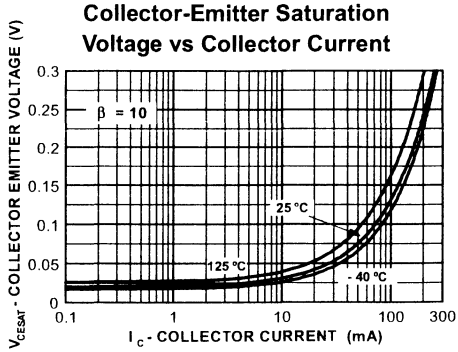
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

DC Typical Characteristics

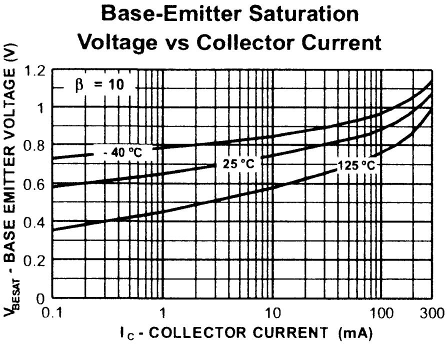
Typical Pulsed Current Gain vs Collector Current

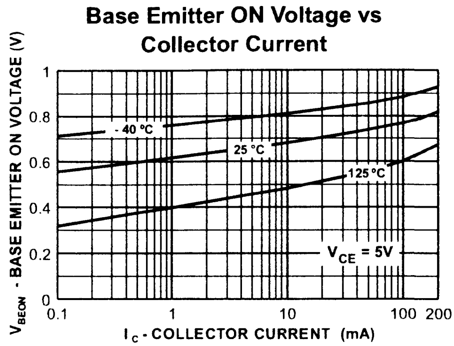


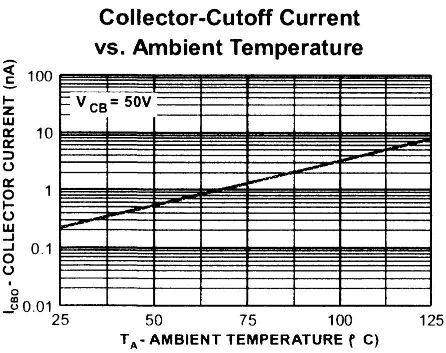
Collector-Emitter Saturation Voltage vs Collector Current

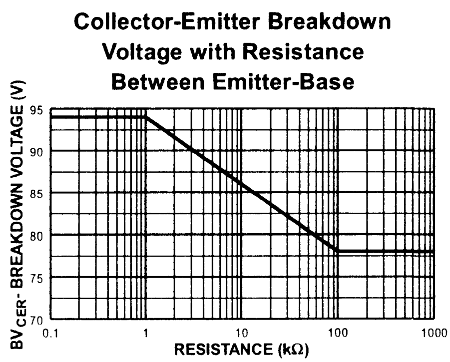


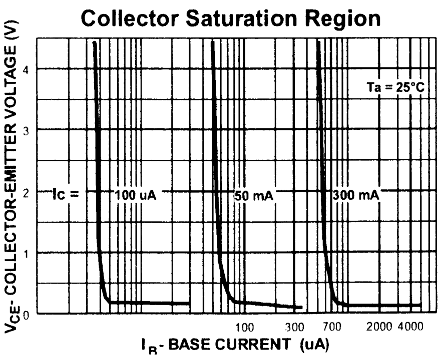
DC Typical Characteristics (continued)











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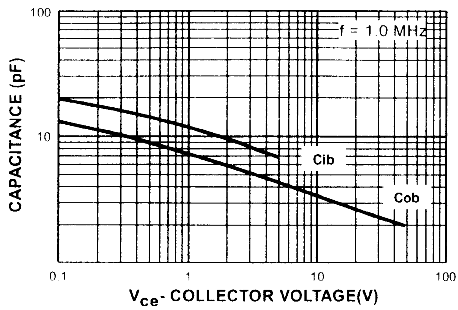
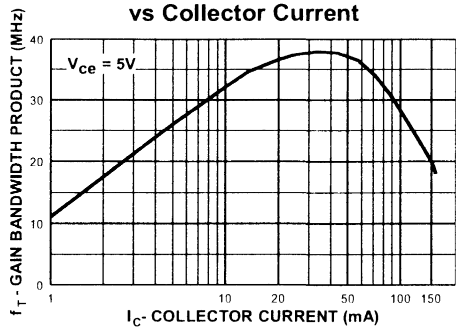
PNP General Purpose Amplifier
(continued)

AC Typical Characteristics

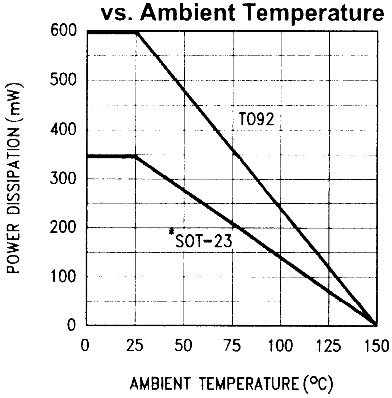
Input and Output Capacitance vs Reverse Voltage



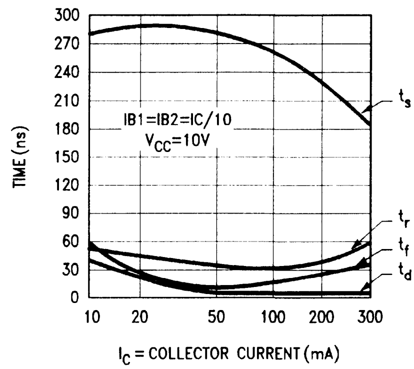
Gain Bandwidth Product vs Collector Current



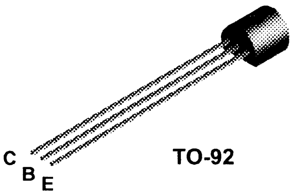
Maximum Power Dissipation vs. Ambient Temperature



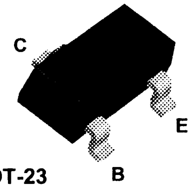
Switching Times vs. Collector Current



PN918 MMBT918



TO-92



SOT-23
Mark: 3B

NPN RF Transistor

This device is designed for use as RF amplifiers, oscillators and multipliers with collector currents in the 1.0 mA to 30 mA range. Sourced from Process 43.

Absolute Maximum Ratings* TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	15	V
V_{CBO}	Collector-Base Voltage	30	V
V_{EBO}	Emitter-Base Voltage	3.0	V
I_C	Collector Current - Continuous	50	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		PN918	*MMBT918	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN RF Transistor
(continued)

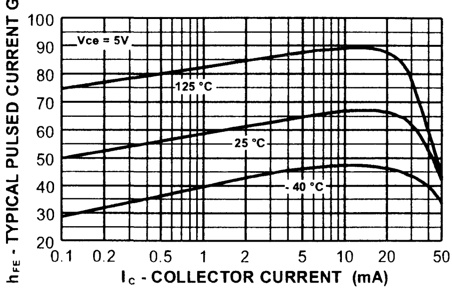
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{CEO(sus)}$	Collector-Emitter Sustaining Voltage*	I_C = 3.0 mA, I_B = 0	15		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 1.0 μA, I_E = 0	30		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	3.0		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 15 V, I_E = 0 V_{CB} = 15 V, T_A = 150°C		0.01 1.0	μA μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 3.0 mA, V_{CE} = 1.0 V	20		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA		0.4	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA		1.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 4.0 mA, V_{CE} = 10 V, f = 100 MHz	600		MHz
C_{obo}	Output Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz V_{CB} = 0, I_E = 0, f = 1.0 MHz		1.7 3.0	pF pF
C_{ibo}	Input Capacitance	V_{BE} = 0.5 V, I_C = 0, f = 1.0 MHz		2.0	pF
NF	Noise Figure	I_C = 1.0 mA, V_{CE} = 6.0 V, R_G = 400Ω, f = 60 MHz		6.0	dB
FUNCTIONAL TEST					
G_{pe}	Amplifier Power Gain	V_{CB} = 12 V, I_C = 6.0 mA, f = 200 MHz	15		dB
P_O	Power Output	V_{CB} = 15 V, I_C = 8.0 mA, f = 500 MHz	30		mW
η	Collector Efficiency	V_{CB} = 15 V, I_C = 8.0 mA, f = 500 MHz	25		%

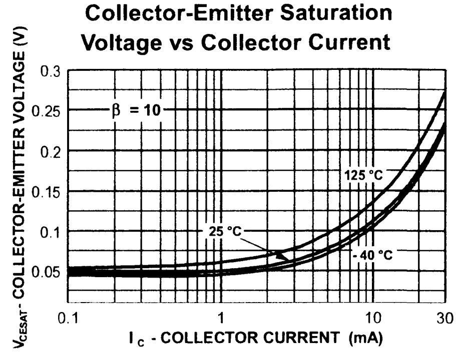
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

DC Typical Characteristics

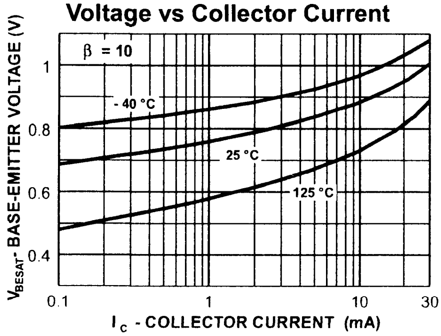
Typical Pulsed Current Gain vs Collector Current



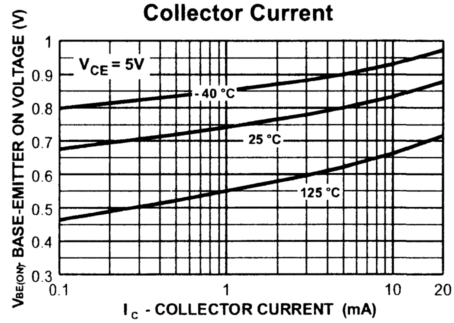
Collector-Emitter Saturation Voltage vs Collector Current



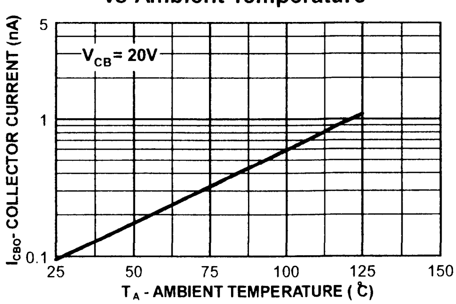
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current



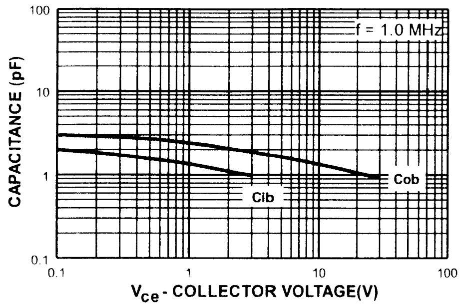
Collector-Cutoff Current vs Ambient Temperature



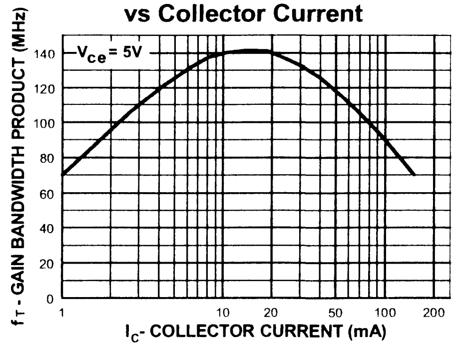
NPN RF Transistor
(continued)

AC Typical Characteristics

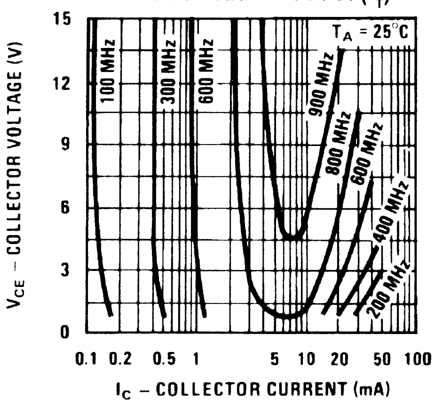
Input and Output Capacitance vs Reverse Voltage



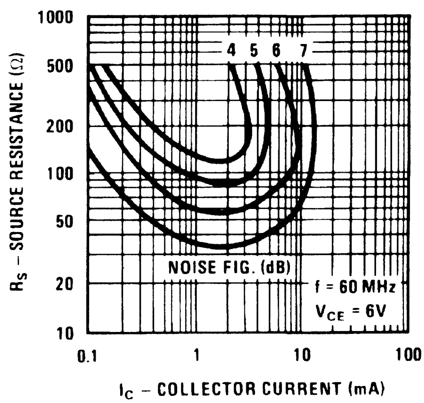
Gain Bandwidth Product vs Collector Current



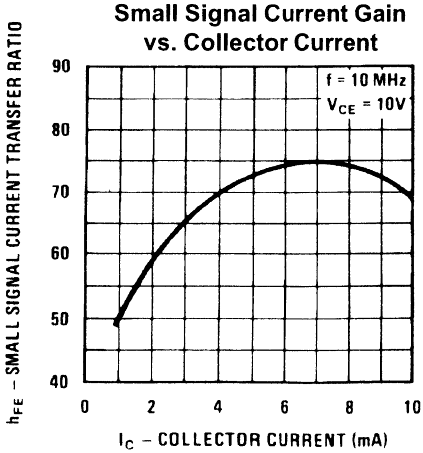
Contours of Constant Gain Bandwidth Product (f_T)



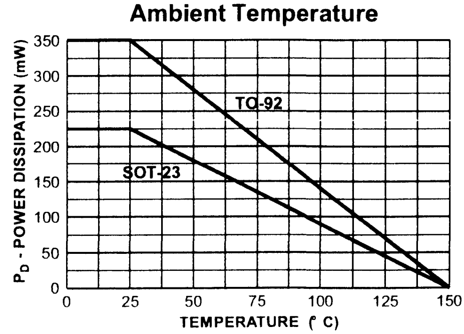
Contours of Constant Noise Figure



Small Signal Current Gain vs. Collector Current

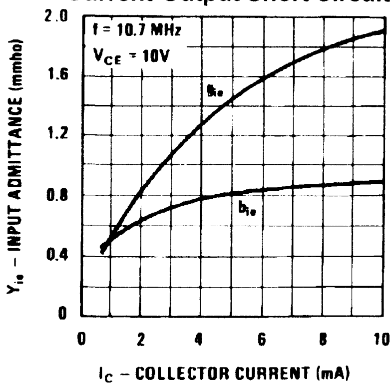


Power Dissipation vs Ambient Temperature

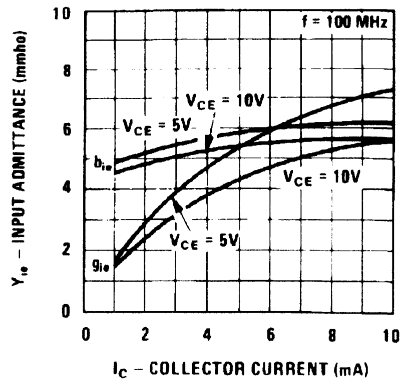


Common Emitter Y Parameters vs. Frequency

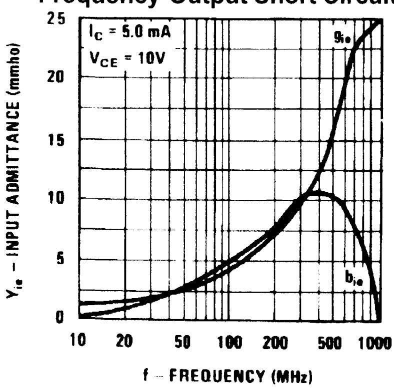
Input Admittance vs. Collector Current-Output Short Circuit



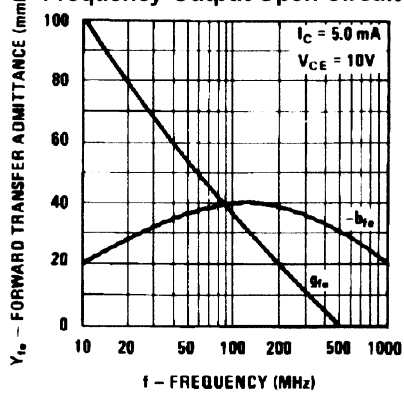
Input Admittance vs. Collector Current-Output Short Circuit



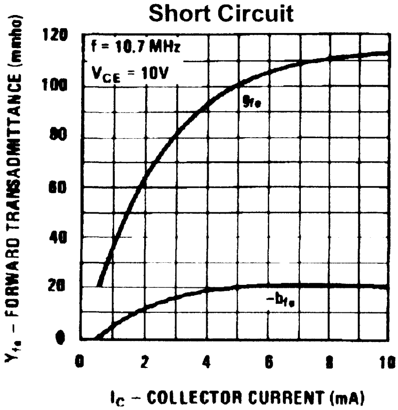
Input Admittance vs. Frequency-Output Short Circuit



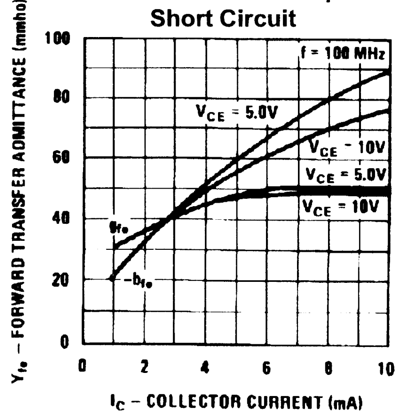
Forward Transfer Admittance vs. Frequency-Output Open Circuit



Forward Transfer Admittance vs. Collector Current-Output Short Circuit



Forward Transfer Admittance vs. Collector Current-Output Short Circuit



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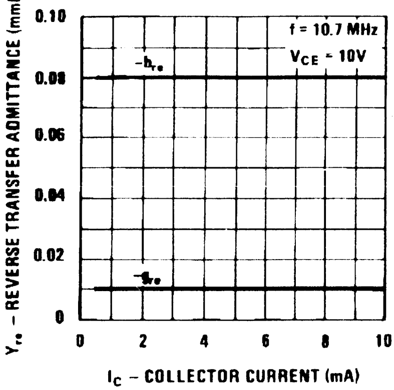
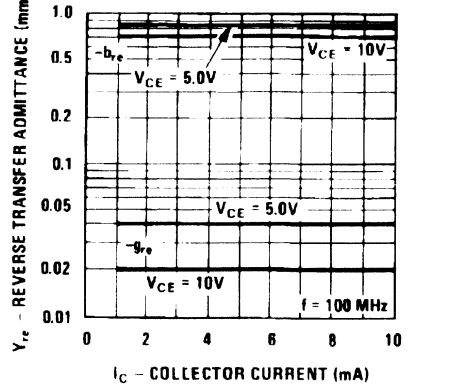
NPN RF Transistor
(continued)

Common Emitter Y Parameters vs. Frequency (continued)

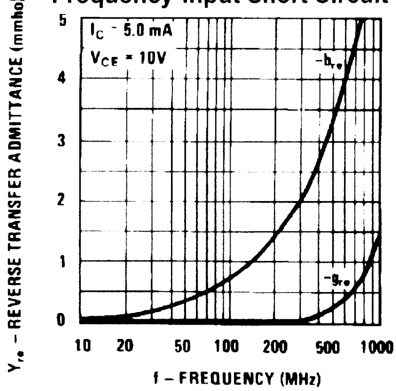
Reverse Transfer Admittance vs. Collector Current-Input Short Circuit



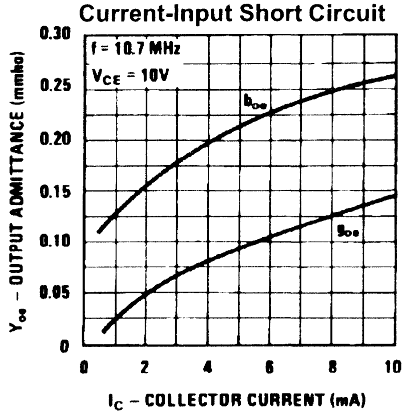
Reverse Transfer Admittance vs. Collector Current-Input Short Circuit



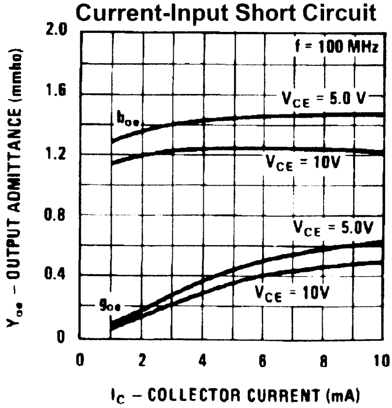
Reverse Transfer Admittance vs. Frequency-Input Short Circuit



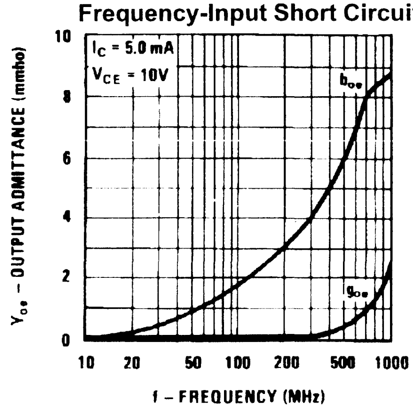
Output Admittance vs. Collector Current-Input Short Circuit



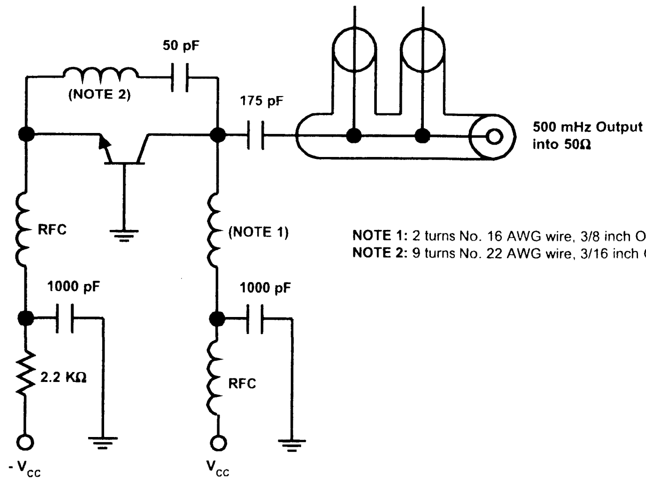
Output Admittance vs. Collector Current-Input Short Circuit



Output Admittance vs. Frequency-Input Short Circuit



Test Circuit



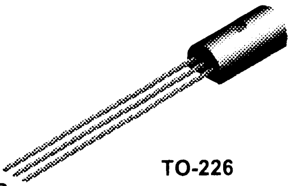
NOTE 1: 2 turns No. 16 AWG wire, 3/8 inch OD, 1 1/4 inch long
NOTE 2: 9 turns No. 22 AWG wire, 3/16 inch OD, 1/2 inch long

FIGURE 1: 500 MHz Oscillator Circuit

National Semiconductor™

Discrete POWER & Signal Technologies

TN2219A



C B E

TO-226

NPN General Purpose Amplifier

This device is for use as a medium power amplifier and switch requiring collector currents up to 500 mA. Sourced from Process 19. See PN2222A for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	75	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	1.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:

1) These ratings are based on a maximum junction temperature of 150 degrees C.

2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		TN2219A	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 10$ mA, $I_B = 0$	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10$ µA, $I_E = 0$	75		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10$ µA, $I_C = 0$	6.0		V
I_{CEX}	Collector Cutoff Current	$V_{CE} = 60$ V, $V_{EB(OFF)} = 3.0$ V		10	nA
I_{CBO}	Collector Cutoff Current	$V_{CB} = 60$ V, $I_E = 0$ $V_{CB} = 60$ V, $I_E = 0$, $T_A = 150°C$		10 10	nA µA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = 3.0$ V, $I_C = 0$		10	nA
I_{BL}	Base Cutoff Current	$V_{CE} = 60$ V, $V_{EB(OFF)} = 3.0$		20	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 0.1$ mA, $V_{CE} = 10$ 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 $I_C = 150$ mA, $V_{CE} = 1.0$ V $I_C = 500$ mA, $V_{CE} = 10$ V	35 50 75 100 50 40	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage*	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA		0.3 1.0	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage*	$I_C = 150$ mA, $I_B = 1.0$ mA $I_C = 500$ mA, $I_B = 5.0$ mA	0.6	1.2 2.0	V V
SMALL SIGNAL CHARACTERISTICS					
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 100 kHz		8.0	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5$ V, $I_C = 0$, f = 100 kHz		25	pF
h_{fe}	Small-Signal Current Gain	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz $I_C = 10$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	50 75	300 375	
$rb'C_C$	Collector Base Time Constant	$I_E = 20$ mA, $V_{CB} = 20$ V, f = 31.8 MHz		150	pS
NF	Noise Figure	$I_C = 100$ µA, $V_{CE} = 10$ V, $R_S = 1.0$ kΩ, f = 1.0 kHz, $B_W = 1.0$ Hz		4.0	dB
$Re(h_{ie})$	Real Part of Common-Emitter High Frequency Input Impedance	$I_C = 20$ mA, $V_{CE} = 20$ V, f = 300 MHz		60	Ω
SWITCHING CHARACTERISTICS					
t_d	Delay Time	$V_{CC} = 30$ V, $V_{BE(OFF)} = 0.5$ V,		10	ns
t_r	Rise Time	$I_C = 150$ mA, $I_{B1} = 15$ mA		25	ns
t_s	Storage Time	$V_{CC} = 30$ V, $I_C = 150$ mA,		225	ns
t_f	Fall Time	$I_{B1} = I_{B2} = 15$ mA		60	ns

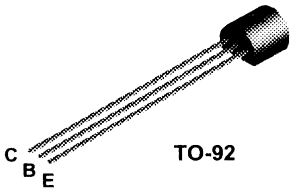
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%

5

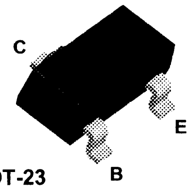
National Semiconductor™

Discrete POWER & Signal Technologies

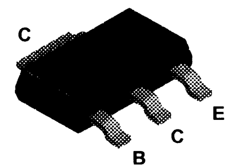
PN2222A MMBT2222A PZT2222A



TO-92

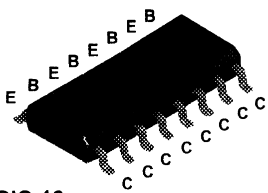


SOT-23
Mark: 1P

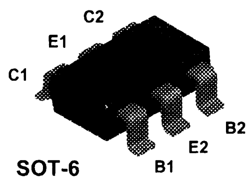


SOT-223

MMPQ2222 NMT2222



SOIC-16



SOT-6
Mark: .1B

NPN General Purpose Amplifier

This device is for use as a medium power amplifier and switch requiring collector currents up to 500 mA. Sourced from Process 19.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	75	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	1.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 10 mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 µA, I_E = 0	75		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 µA, I_C = 0	6.0		V
I_{CEX}	Collector Cutoff Current	V_{CE} = 60 V, $V_{EB(OFF)}$ = 3.0 V		10	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = 60 V, I_E = 0 V_{CB} = 60 V, I_E = 0, T_A = 150°C		0.01 10	µA µA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 3.0 V, I_C = 0		10	nA
I_{BL}	Base Cutoff Current	V_{CE} = 60 V, $V_{EB(OFF)}$ = 3.0 V		20	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 0.1 mA, V_{CE} = 10 V I_C = 1.0 mA, V_{CE} = 10 V I_C = 10 mA, V_{CE} = 10 V I_C = 10 mA, V_{CE} = 10 V, T_A = -55°C I_C = 150 mA, V_{CE} = 10 V* I_C = 150 mA, V_{CE} = 1.0 V* I_C = 500 mA, V_{CE} = 10 V*	35 50 75 35 100 50 40	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage*	I_C = 150 mA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA		0.3 1.0	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage*	I_C = 150 mA, I_B = 1.0 mA I_C = 500 mA, I_B = 5.0 mA	0.6	1.2 2.0	V V
SMALL SIGNAL CHARACTERISTICS (except MMPQ2222 and NMT2222)					
f_T	Current Gain - Bandwidth Product	I_C = 20 mA, V_{CE} = 20 V, f = 100 MHz	300		MHz
C_{obo}	Output Capacitance	V_{CB} = 10 V, I_E = 0, f = 100 kHz		8.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5 V, I_C = 0, f = 100 kHz		25	pF
$rb'C_C$	Collector Base Time Constant	I_C = 20 mA, V_{CB} = 20 V, f = 31.8 MHz		150	pS
NF	Noise Figure	I_C = 100 µA, V_{CE} = 10 V, R_S = 1.0 kΩ, f = 1.0 kHz		4.0	dB
$Re(h_{ie})$	Real Part of Common-Emitter High Frequency Input Impedance	I_C = 20 mA, V_{CE} = 20 V, f = 300 MHz		60	Ω
SWITCHING CHARACTERISTICS (except MMPQ2222 and NMT2222)					
t_d	Delay Time	V_{CC} = 30 V, $V_{BE(OFF)}$ = 0.5 V,		10	ns
t_r	Rise Time	I_C = 150 mA, I_{B1} = 15 mA		25	ns
t_s	Storage Time	V_{CC} = 30 V, I_C = 150 mA,		225	ns
t_f	Fall Time	I_{B1} = I_{B2} = 15 mA		60	ns

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

Spice Model

NPN (Is=14.34f Xti=3 Eg=1.11 Vaf=74.03 Bf=255.9 Ne=1.307 Ise=14.34f Ikf=.2847 Xtb=1.5 Br=6.092 Nc=2 Isc=0 Ikr=0 Rc=1 Cjc=7.306p Mjc=.3416 Vjc=.75 Fc=.5 Cje=22.01p Mje=.377 Vje=.75 Tr=46.91n Tf=411.1p Itf=.6 Vtf=1.7 Xtf=3 Rb=10)

NPN General Purpose Amplifier

(continued)

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		PN2222A	*PZT2222A	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	125	°C/W

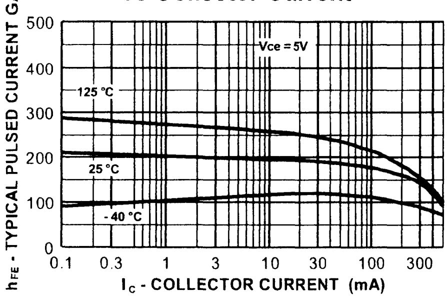
Symbol	Characteristic	Max		Units
		**MMBT2222A	MMPQ2222	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient Effective 4 Die Each Die	357	 125 240	°C/W °C/W °C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

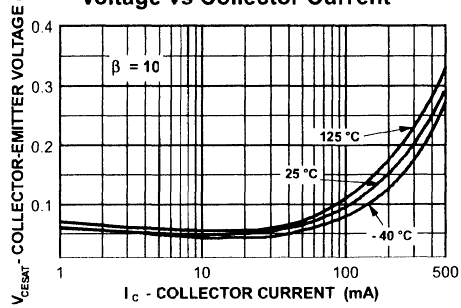
**Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

DC Typical Characteristics

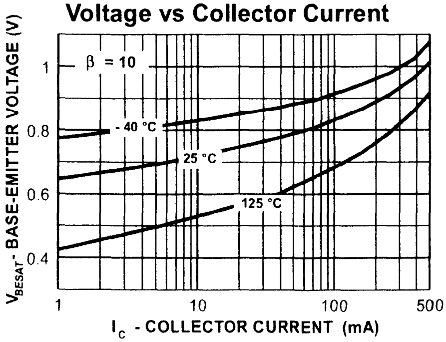
Typical Pulsed Current Gain vs Collector Current



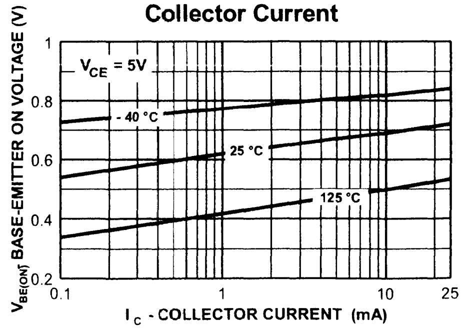
Collector-Emitter Saturation Voltage vs Collector Current



Base-Emitter Saturation Voltage vs Collector Current

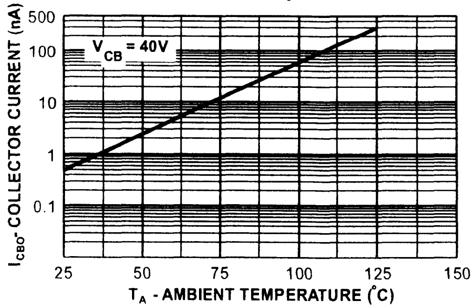


Base-Emitter ON Voltage vs Collector Current



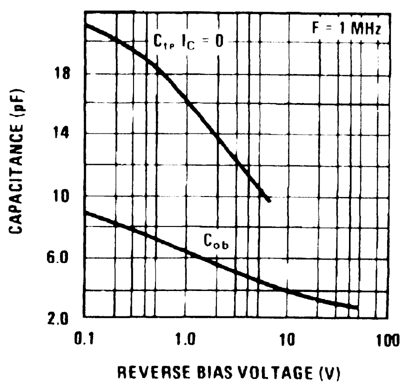
DC Typical Characteristics (continued)

Collector-Cutoff Current vs Ambient Temperature

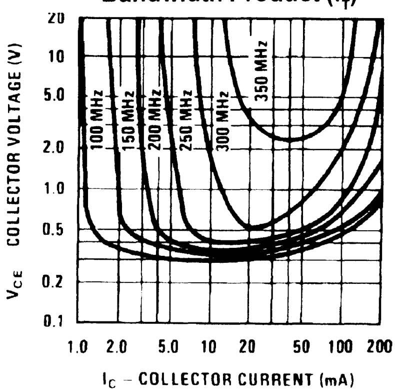


AC Typical Characteristics

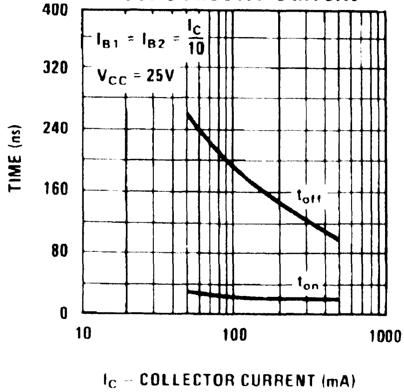
Emitter Transition and Output Capacitance vs. Reverse Bias Voltage



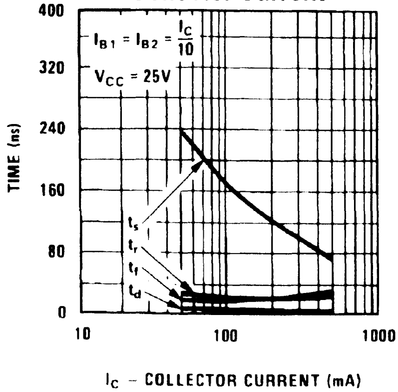
Contours of Constant Gain Bandwidth Product (f_T)



Turn On / Turn Off Times vs. Collector Current

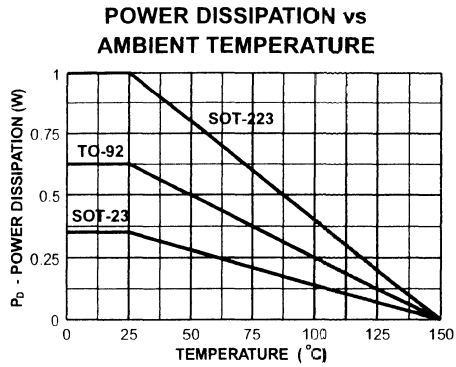


Switching Times vs. Collector Current

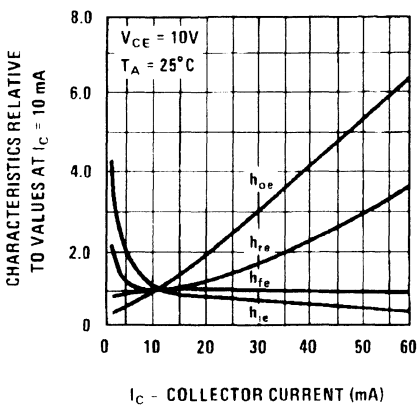


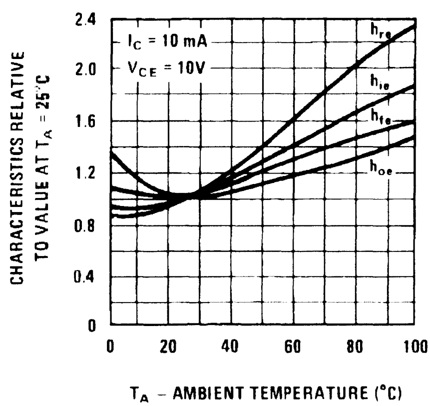
NPN General Purpose Amplifier
(continued)

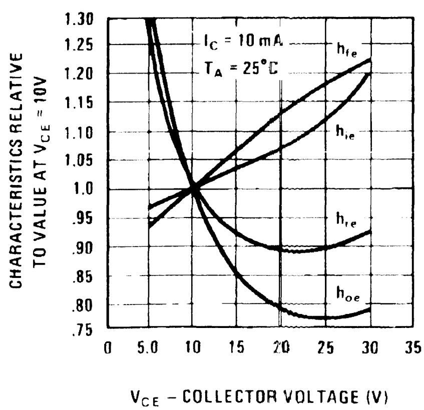
AC Typical Characteristics (continued)



Typical Common Emitter Characteristics (f = 1.0 kHz)







Test Circuits

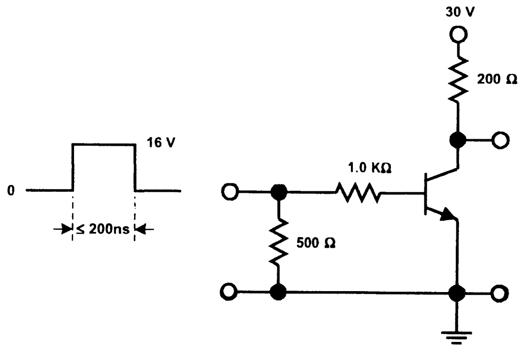


FIGURE 1: Saturated Turn-On Switching Time

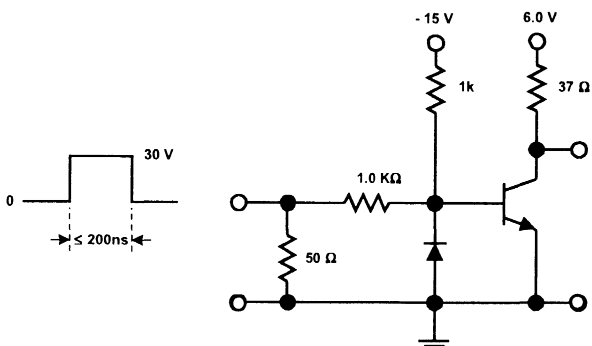


FIGURE 2: Saturated Turn-Off Switching Time

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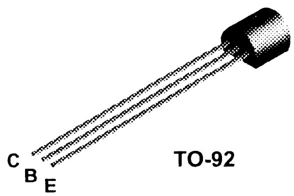
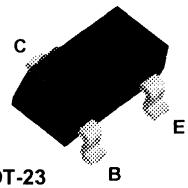
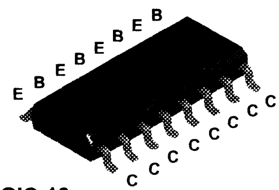
PN2369A MMBT2369A MMPQ2369



TO-92



SOT-23
Mark: 1S



SOIC-16

NPN Switching Transistor

This device is designed for high speed saturation switching at collector currents of 10 mA to 100 mA. Sourced from Process 21.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	15	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	4.5	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		PN2369A	MMBT2369A*	MMPQ2369	
P_D	Total Device Dissipation	350	225	1,000	mW
	Derate above 25°C	2.8	1.8	8.0	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556		°C/W
	Effective 4 Die			125	°C/W
	Each Die			240	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN Switching Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 10 mA, I_B = 0	15		V
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	I_C = 10 μA, V_{BE} = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_E = 0	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	4.5		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 20 V, I_E = 0 V_{CB} = 20 V, I_E = 0, T_A = 125°C		0.4 30	μA μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain*	I_C = 10 mA, V_{CE} = 1.0 V I_C = 10 mA,V_{CE} = 0.35 V,T_A = -55°C I_C = 100 mA, V_{CE} = 2.0 V	40 20 20	120	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage*	I_C = 10 mA, I_B = 1.0 mA I_C = 10 mA, I_B = 1.0 mA,T_A = 125°C I_C = 30 mA, I_B = 3.0 mA I_C = 100 mA, I_B = 10 mA		0.2 0.3 0.25 0.5	V V V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA I_C = 10 mA, I_B = 1.0 mA,T_A = -55°C I_C = 10 mA, I_B = 1.0 mA,T_A = 125°C I_C = 30 mA, I_B = 3.0 mA I_C = 100 mA, I_B = 10 mA	0.7 0.59 	0.85 1.02 1.15 1.6	V V V V V
SMALL SIGNAL CHARACTERISTICS					
C_{obo}	Output Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 1.0 MHz		4.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz		5.0	pF
h_{fe}	Small-Signal Current Gain	I_C = 10 mA, V_{CE} = 10 V, R_G = 2.0 kΩ, f = 100 MHz	5.0		
SWITCHING CHARACTERISTICS (except MMPQ2369)					
t_s	Storage Time	I_{B1} = I_{B2} = I_C = 10 mA		13	ns
t_{on}	Turn-On Time	V_{CC} = 3.0 V, I_C = 10 mA, I_{B1} = 3.0 mA		12	ns
t_{off}	Turn-Off Time	V_{CC} = 3.0 V, I_C = 10 mA, I_{B1} = 3.0 mA, I_{B2} = 1.5 mA		18	ns

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

Spice Model

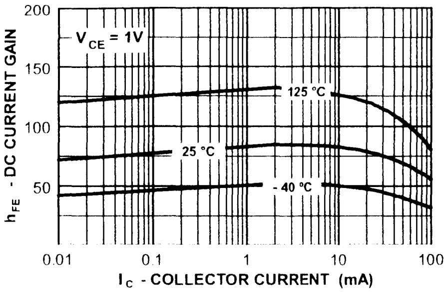
NPN (Is=44.14f Xti=3 Eg=1.11 Vaf=100 Bf=78.32 Ne=1.389 Ise=91.95f Ikf=.3498 Xtb=1.5 Br=12.69m Nc=2 Isc=0 Ikr=0 Rc=.6 Cjc=2.83p Mjc=86.19m Vjc=.75 Fc=.5 Cje=4.5p Mje=.2418 Vje=.75 Tr=1.073u Tf=227.6p Itf=.3 Vtf=4 Xtf=4 Rb=10)

NPN Switching Transistor

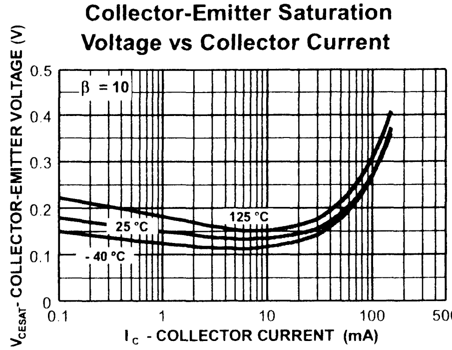
(continued)

DC Typical Characteristics

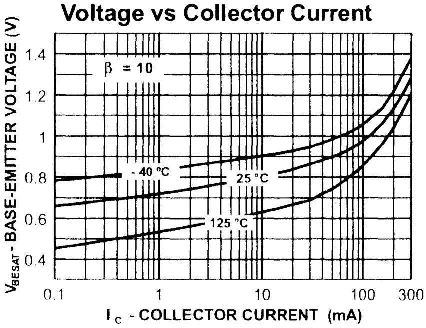
DC Current Gain vs Collector Current



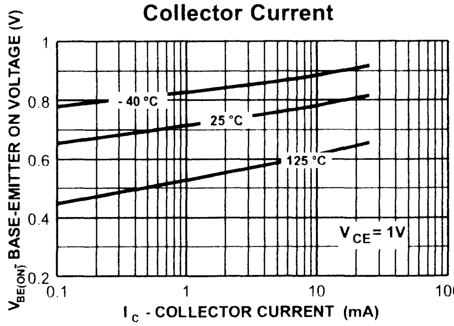
Collector-Emitter Saturation Voltage vs Collector Current



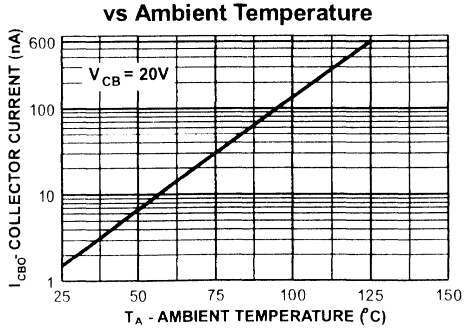
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

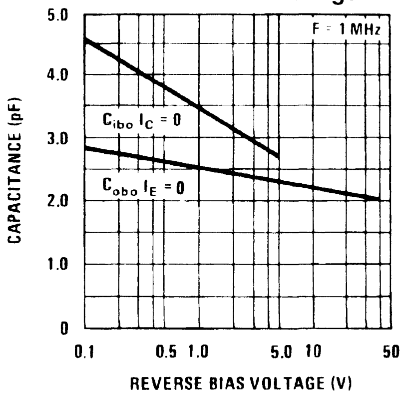


Collector-Cutoff Current vs Ambient Temperature

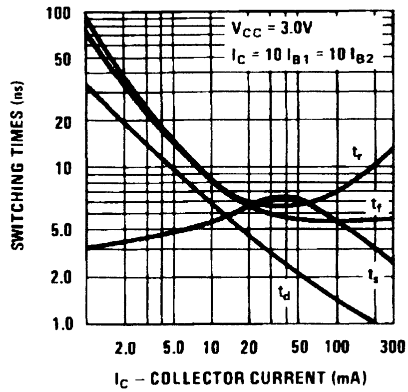


AC Typical Characteristics

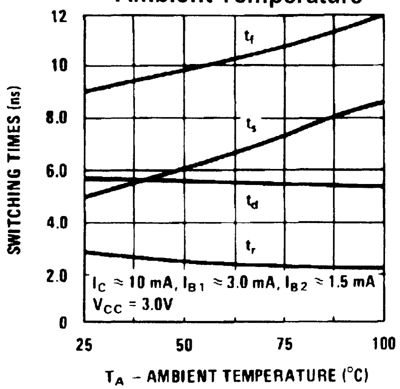
Output Capacitances vs. Reverse Bias Voltage



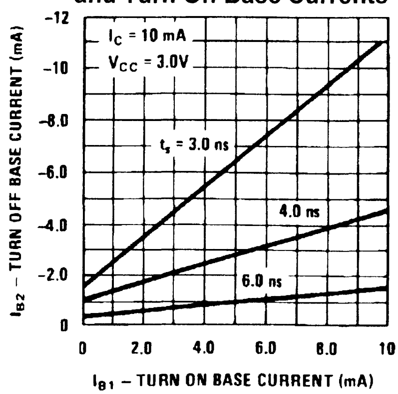
Switching Times vs. Collector Current



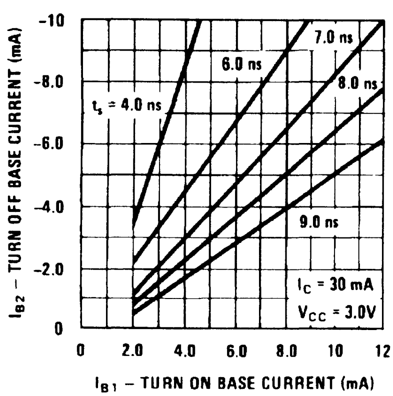
Switching Times vs. Ambient Temperature



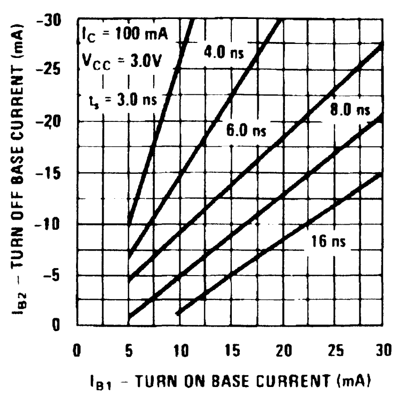
Storage Time vs. Turn On and Turn Off Base Currents



Storage Time vs. Turn On and Turn Off Base Currents



Storage Time vs. Turn On and Turn Off Base Currents

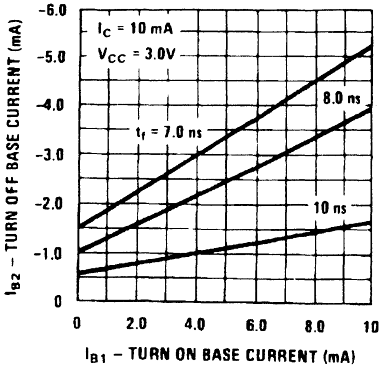


NPN Switching Transistor

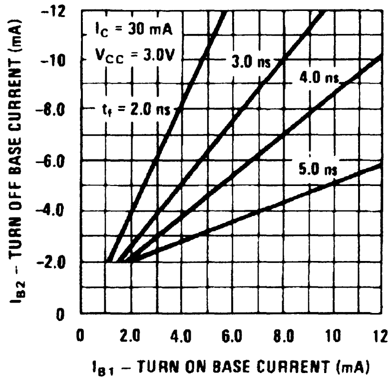
(continued)

AC Typical Characteristics (continued)

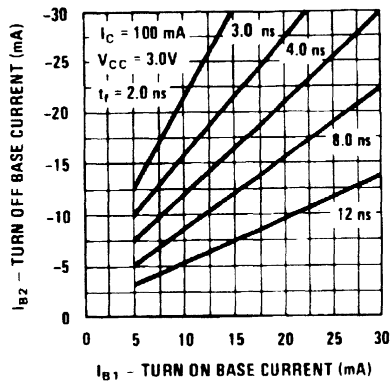
Fall Time vs. Turn On and Turn Off Base Currents



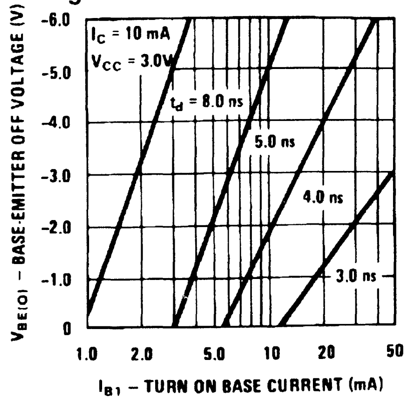
Fall Time vs. Turn On and Turn Off Base Currents



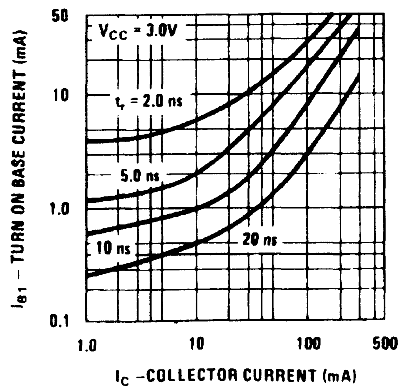
Fall Time vs. Turn On and Turn Off Base Currents



Delay Time vs. Base-Emitter OFF Voltage and Turn On Base Current

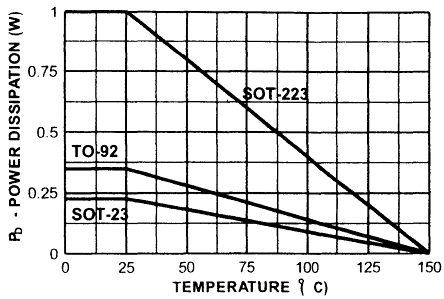


Rise Time vs. Turn On Base Current and Collector Current



AC Typical Characteristics (continued)

POWER DISSIPATION vs AMBIENT TEMPERATURE



Test Circuits

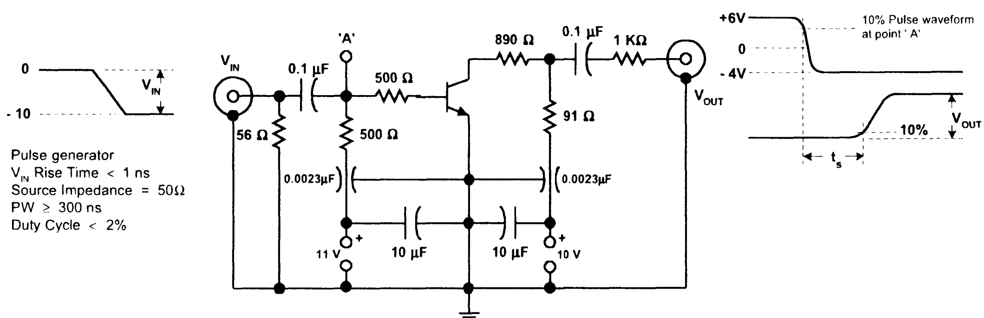


FIGURE 1: Charge Storage Time Measurement Circuit

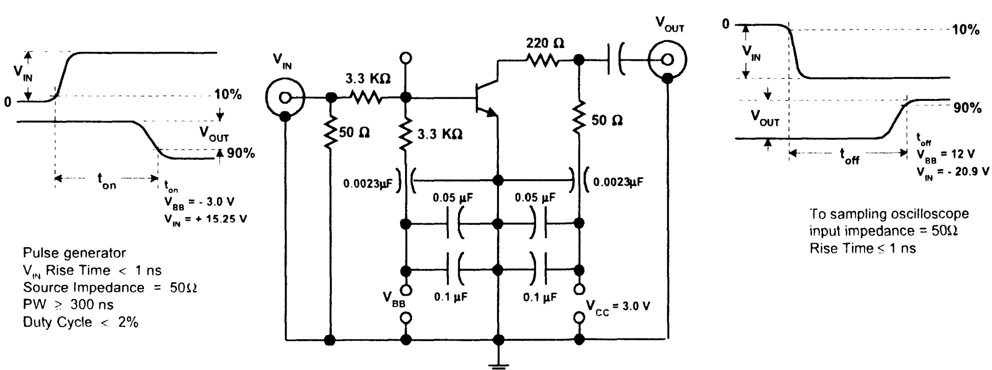


FIGURE 2: t_{ON}, t_{OFF} Measurement Circuit

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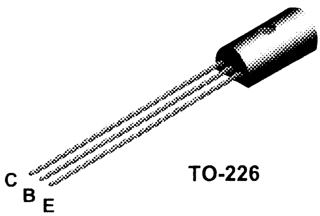
TN2905A



TO-226

PNP General Purpose Amplifier

This device is designed for use as a general purpose amplifier and switch requiring collector currents to 500 mA. Sourced from Process 63. See PN2907A for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	60	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	800	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		TN2905A	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W

PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 10 mA, I_B = 0	60		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_E = 0	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	5.0		V
I_B	Base Cutoff Current	V_{CE} = 30 V, V_{BE} = 0.5 V		50	nA
I_{CEX}	Collector Cutoff Current	V_{CE} = 30 V, V_{BE} = 0.5 V		50	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = 50 V, I_E = 0 V_{CB} = 50 V, I_E = 0, T_A = 150°C		0.01 10	μA μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 0.1 mA, 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*	75 100 100 100 50	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage*	I_C = 150 mA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA		0.4 1.6	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 150 mA, I_B = 15 mA* I_C = 500 mA, I_B = 50 mA		1.3 2.6	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 50 mA, V_{CE} = 20 V, f = 100 MHz	200		MHz
C_{obo}	Output Capacitance	V_{CB} = 10 V, I_E = 0, f = 100 kHz		8.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 2.0 V, I_C = 0, f = 100 kHz		30	pF
SWITCHING CHARACTERISTICS					
t_{on}	Turn-on Time	V_{CC} = 30 V, I_C = 150 mA, I_{B1} = 15 mA		45	ns
t_d	Delay Time			10	ns
t_r	Rise Time			40	ns
t_{off}	Turn-off Time	V_{CC} = 6.0 V, I_C = 150 mA I_{B1} = I_{B2} = 15 mA		100	ns
t_s	Storage Time			80	ns
t_f	Fall Time			30	ns

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

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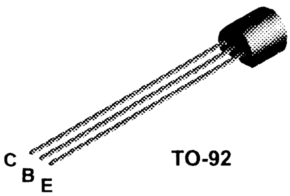
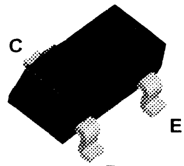
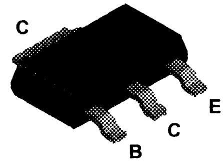
PN2907A MMBT2907A PZT2907A



TO-92

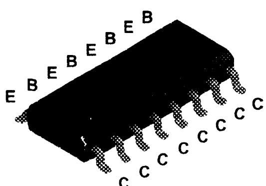


SOT-23
Mark: 2F

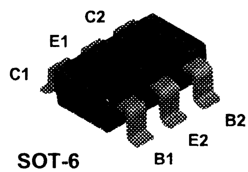


SOT-223

MMPQ2907 NMT2907



SOIC-16



SOT-6
Mark: .2B

PNP General Purpose Amplifier

This device is designed for use as a general purpose amplifier and switch requiring collector currents to 500 mA. Sourced from Process 63.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	60	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	800	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Electrical Characteristics

TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 10 mA, I_B = 0	60		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 µA, I_E = 0	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 µA, I_C = 0	5.0		V
I_B	Base Cutoff Current	V_{CB} = 30 V, V_{EB} = 0.5 V		50	nA
I_{CEX}	Collector Cutoff Current	V_{CE} = 30 V, V_{BE} = 0.5 V		50	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = 50 V, I_E = 0 V_{CB} = 50 V, I_E = 0, T_A = 150°C		0.02 20	µA µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 0.1 mA, 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*	75 100 100 100 50	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage*	I_C = 150 mA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA		0.4 1.6	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 150 mA, I_B = 15 mA* I_C = 500 mA, I_B = 50 mA		1.3 2.6	V V
SMALL SIGNAL CHARACTERISTICS (except MMPQ2907 and NMT2907)					
f_T	Current Gain - Bandwidth Product	I_C = 50 mA, V_{CE} = 20 V, f = 100 MHz	200		MHz
C_{obo}	Output Capacitance	V_{CB} = 10 V, I_E = 0, f = 100 kHz		8.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 2.0 V, I_C = 0, f = 100 kHz		30	pF
SWITCHING CHARACTERISTICS (except MMPQ2907 and NMT2907)					
t_{on}	Turn-on Time	V_{CC} = 30 V, I_C = 150 mA,		45	ns
t_d	Delay Time	I_{B1} = 15 mA		10	ns
t_r	Rise Time			40	ns
t_{off}	Turn-off Time	V_{CC} = 6.0 V, I_C = 150 mA		100	ns
t_s	Storage Time	I_{B1} = I_{B2} = 15 mA		80	ns
t_f	Fall Time			30	ns

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

Spice Model

PNP (Is=650.6E-18 Xti=3 Eg=1.11 Vaf=115.7 Bf=231.7 Ne=1.829 Ise=54.81f Ikf=1.079 Xtb=1.5 Br=3.563 Nc=2 Isc=0 Ikr=0 Rc=.715 Cjc=14.76p Mjc=.5383 Vjc=.75 Fc=.5 Cje=19.82p Mje=.3357 Vje=.75 Tr=111.3n Tf=603.7p Itf=.65 Vtf=5 Xtf=1.7 Rb=10)

PNP General Purpose Amplifier
(continued)

Thermal Characteristics
TA = 25°C unless otherwise noted

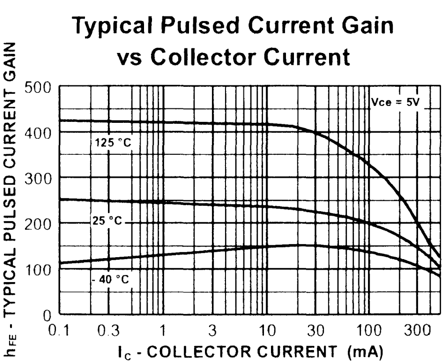
Symbol	Characteristic	Max		Units
		PN2907A	*PZT2907A	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	125	°C/W

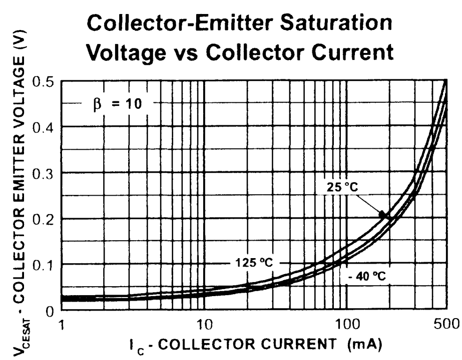
Symbol	Characteristic	Max		Units
		**MMBT2907A	MMPQ2907	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient Effective 4 Die Each Die	357	 125 240	°C/W °C/W °C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

**Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

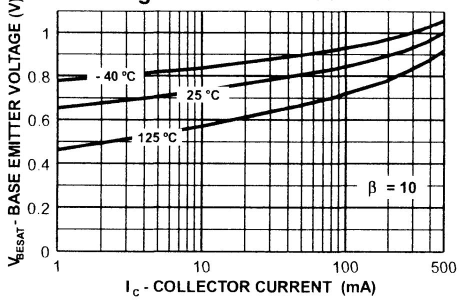
DC Typical Characteristics



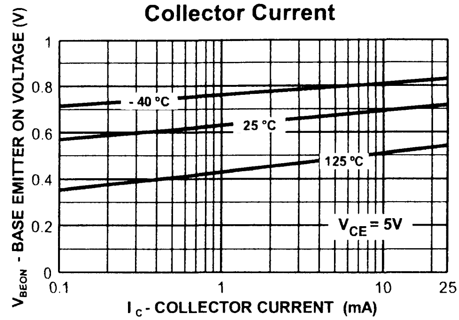


DC Typical Characteristics (continued)

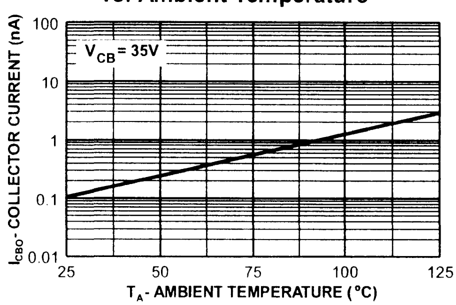
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

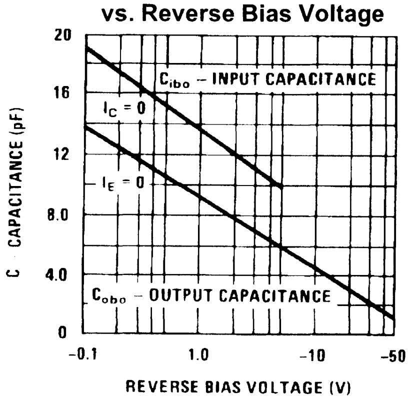


Collector-Cutoff Current vs. Ambient Temperature

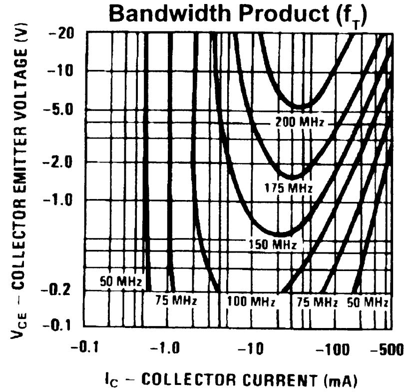


AC Typical Characteristics

Input / Output Capacitance vs. Reverse Bias Voltage



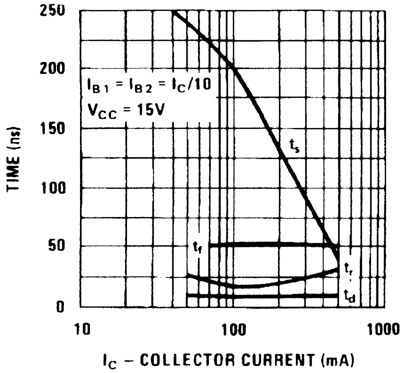
Contours of Constant Gain Bandwidth Product (f_T)



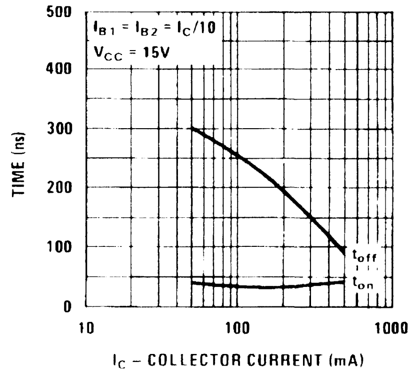
PNP General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

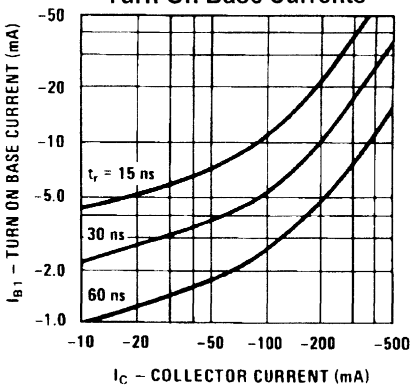
Switching Times vs. Collector Current



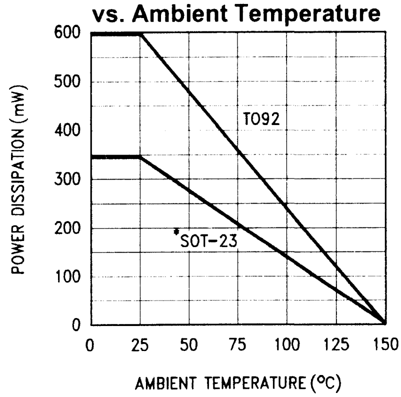
Turn On / Turn Off Time vs. Collector Current



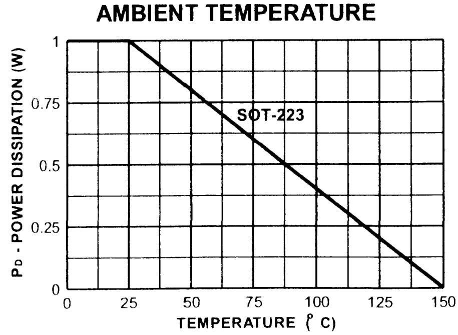
Rise Time vs. Collector and Turn On Base Currents



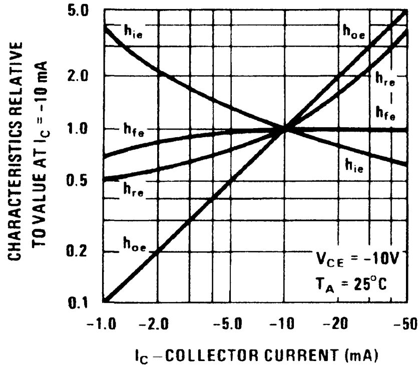
Maximum Power Dissipation vs. Ambient Temperature

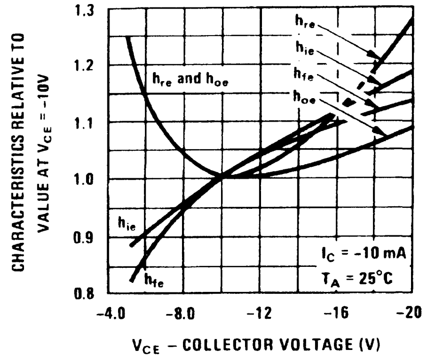


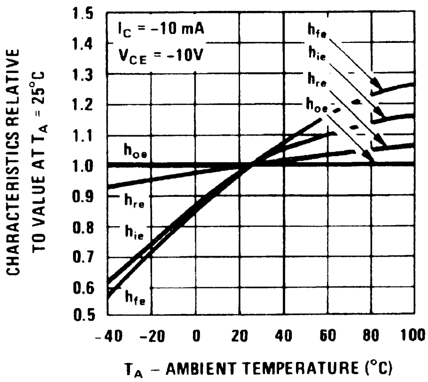
POWER DISSIPATION vs AMBIENT TEMPERATURE



Typical Common Emitter Characteristics







PNP General Purpose Amplifier
(continued)

Test Circuits

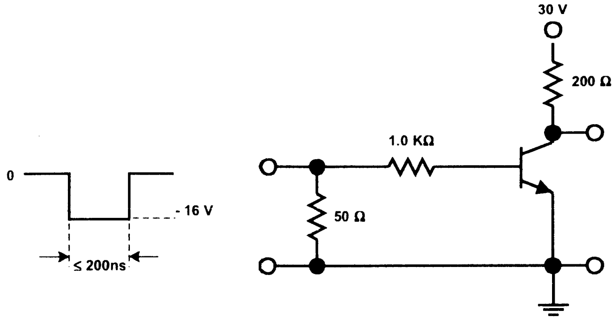


FIGURE 1: Saturated Turn-On Switching Time Test Circuit

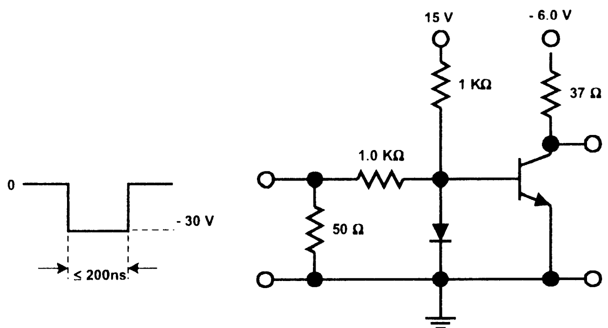
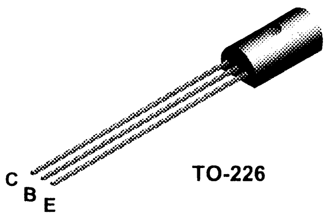


FIGURE 2: Saturated Turn-Off Switching Time Test Circuit

TN3019A



TO-226

NPN General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 500 mA and collector voltages up to 80 V. Sourced from Process 12.

Absolute Maximum Ratings* TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	80	V
V_{CBO}	Collector-Base Voltage	140	V
V_{EBO}	Emitter-Base Voltage	7.0	V
I_C	Collector Current - Continuous	1.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		TN3019A	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W

NPN General Purpose Amplifier
(continued)

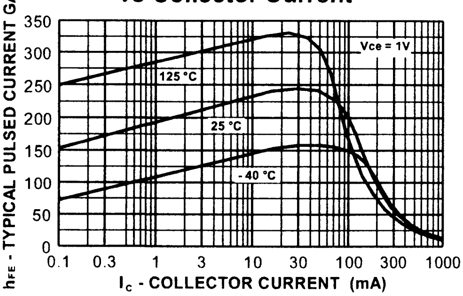
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 30 mA, I_B = 0	80		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	140		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	7.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 90 V, I_E = 0 V_{CB} = 90 V, I_E = 0, T_A = 150°C		0.01 10	μA μA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 5.0 V, I_C = 0		0.01	μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 0.1 mA, V_{CE} = 10 V I_C = 10 mA, V_{CE} = 10 V I_C = 150 mA, V_{CE} = 10 V I_C=150 mA, V_{CE}=10 V, T_A= -55°C I_C = 500 mA, V_{CE} = 10 V* I_C = 1.0 A, V_{CE} = 10 V*	50 90 100 40 50 15	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 150 mA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA		0.2 0.5	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA		1.1	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 50 mA, V_{CE} = 10 V, f = 20 MHz	100		MHz
C_{obo}	Output Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		12	pF
C_{ibo}	Input Capacitance	V_{BE} = 0.5 V, I_C = 0, f = 1.0 MHz		60	pF
h_{fe}	Small-Signal Current Gain	I_C = 1.0 mA, V_{CE} = 5.0 V, f = 1.0 MHz	80	400	
$rb'C_C$	Collector Base Time Constant	I_E = 10 mA, V_{CB} = 10 V, f = 4.0 MHz		400	pS
NF	Noise Figure	I_C = 100 mA, V_{CE} = 10 V, R_S = 1.0 kΩ, f = 1.0 kHz		4.0	dB

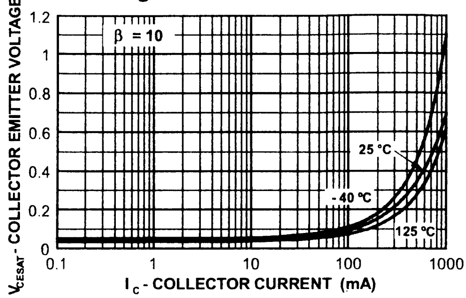
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

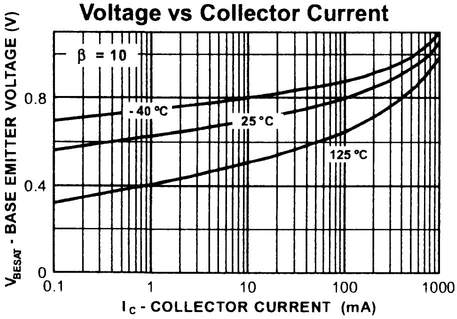
Typical Pulsed Current Gain vs Collector Current



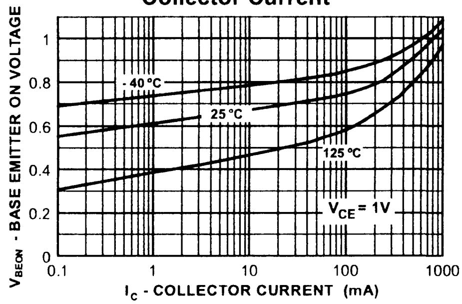
Collector-Emitter Saturation Voltage vs Collector Current



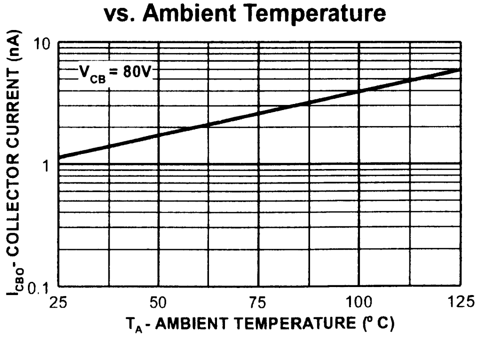
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current



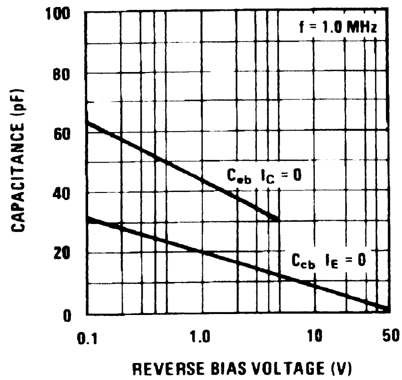
Collector-Cutoff Current vs. Ambient Temperature



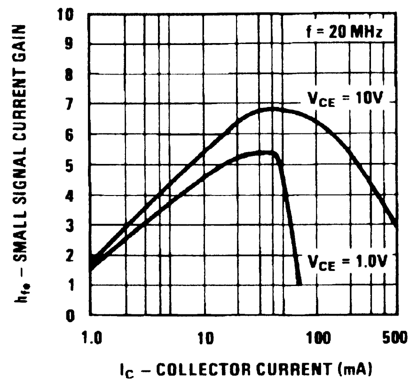
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics

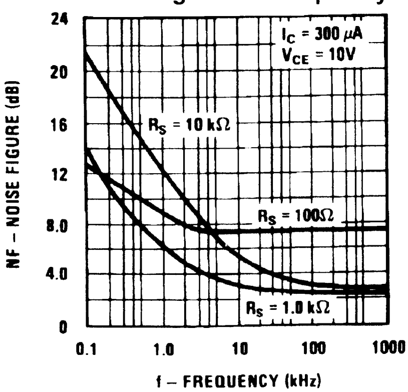
Collector-Base / Emitter-Base Capacitance vs. Reverse Bias Voltage



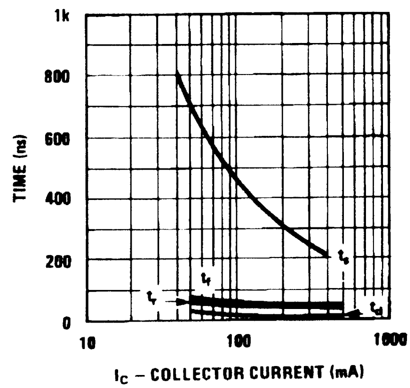
Small Signal Current Gain at 20 MHz



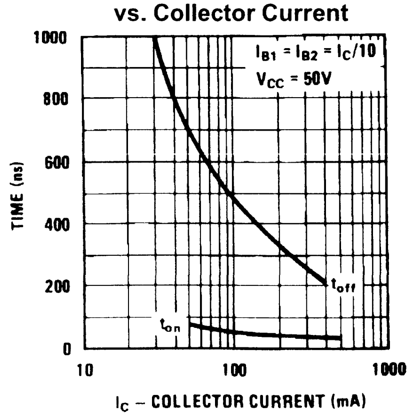
Noise Figure vs. Frequency



Switching Times vs. Collector Current

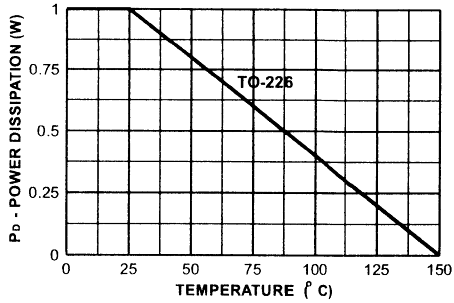


Turn-On / Turn Off Times vs. Collector Current

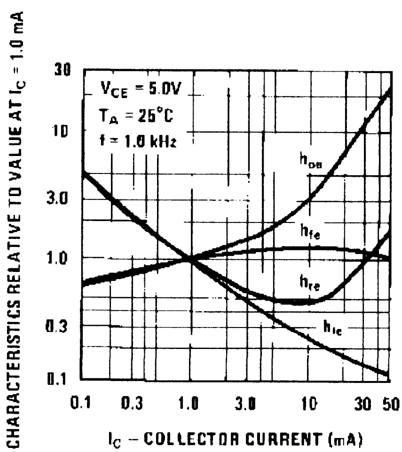


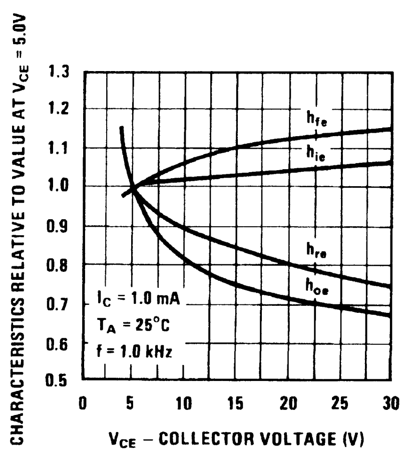
AC Typical Characteristics (continued)

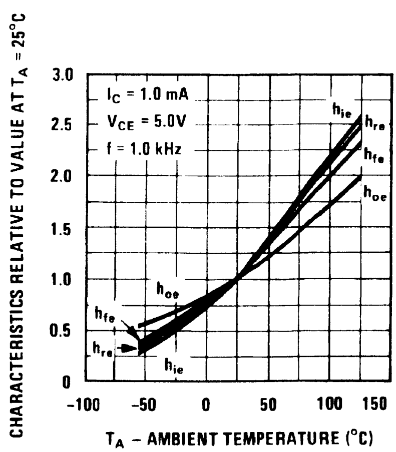
POWER DISSIPATION vs AMBIENT TEMPERATURE



Typical Common Emitter Characteristics







NPN General Purpose Amplifier
(continued)

Test Circuit

I_C	R_b	R_L
150 mA	314 Ω	330 Ω
200 mA	157 Ω	167 Ω
500 mA	94 Ω	100 Ω

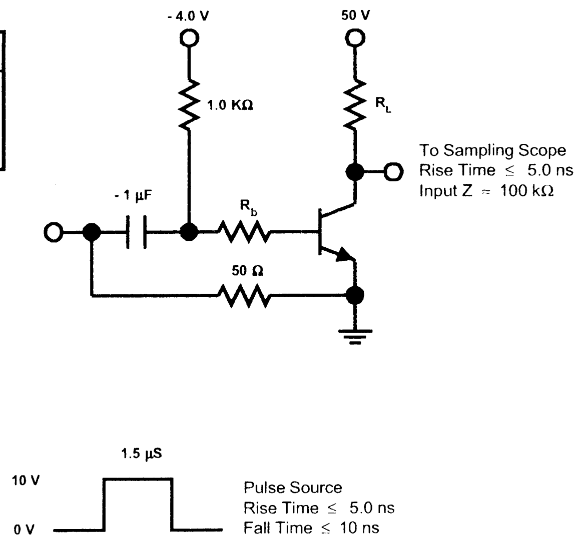
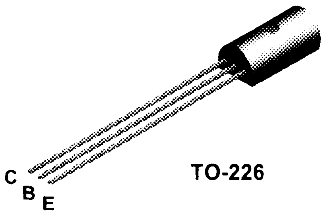


FIGURE 1: t_{ON}, t_{OFF} Test Circuit

TN3440A



TO-226

NPN General Purpose Amplifier

This device is designed for use in horizontal driver, class A off-line amplifier and off-line switching applications. Sourced from Process 36.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	250	V
V_{CBO}	Collector-Base Voltage	300	V
V_{EBO}	Emitter-Base Voltage	7.0	V
I_C	Collector Current - Continuous	100	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		TN3440A	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W

NPN General Purpose Amplifier
(continued)

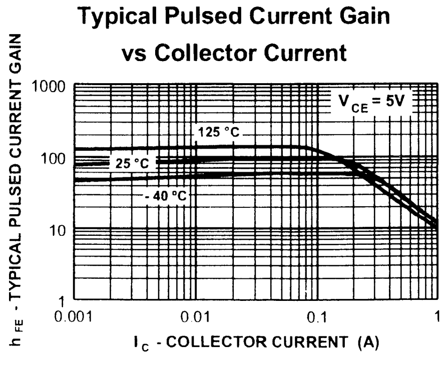
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{CEO(sus)}$	Collector-Emitter Sustaining Voltage*	$I_C = 50$ mA, $I_B = 0$	250		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100$ µA, $I_E = 0$	300		V
I_{CEO}	Collector-Cutoff Current	$V_{CE} = 200$ V, $I_B = 0$		50	µA
I_{CEX}	Collector-Cutoff Current	$V_{CE} = 300$ V, $V_{BE} = 1.5$ V		500	µA
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 250$ V, $I_E = 0$		20	µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 5.0$ V, $I_C = 0$		20	µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 2.0$ mA, $V_{CE} = 10$ V $I_C = 20$ mA, $V_{CE} = 10$ V	30 40	 160	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 50$ mA, $I_B = 4.0$ mA		0.5	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 50$ mA, $I_B = 4.0$ mA		1.3	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 10$ V, $f = 5.0$ MHz	15		MHz
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, $I_E = 0$, $f = 1.0$ MHz		10	pF
C_{ibo}	Input Capacitance	$V_{BE} = 5.0$ V, $I_C = 0$, $f = 1.0$ MHz		95	pF
h_{fe}	Small-Signal Current Gain	$I_C = 5.0$ mA, $V_{CE} = 10$ V, $f = 1.0$ kHz	25		

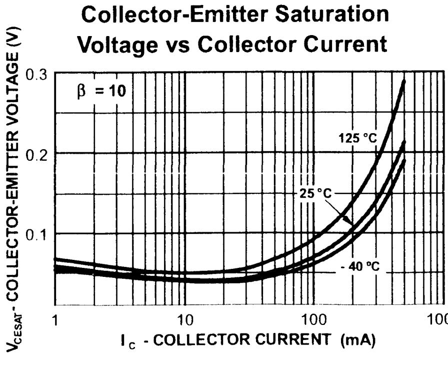
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

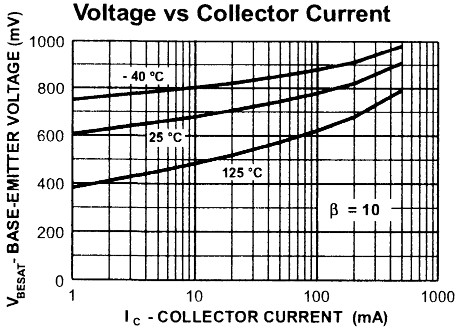


Collector-Emitter Saturation Voltage vs Collector Current

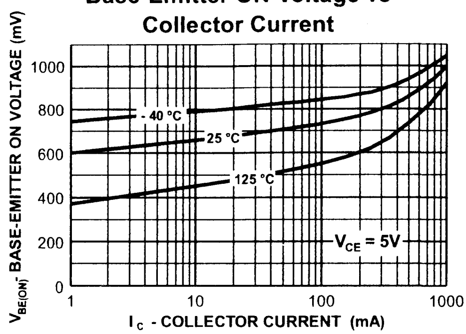


DC Typical Characteristics (continued)

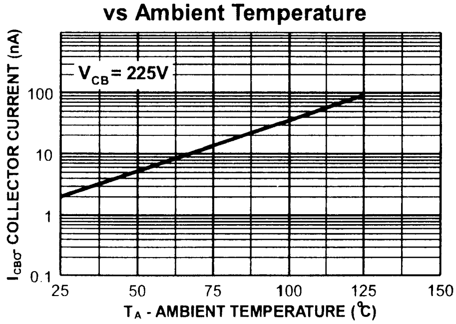
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

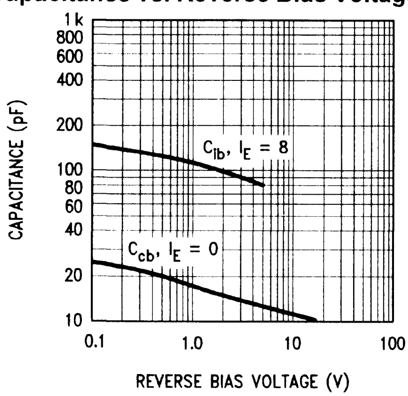


Collector-Cutoff Current vs Ambient Temperature

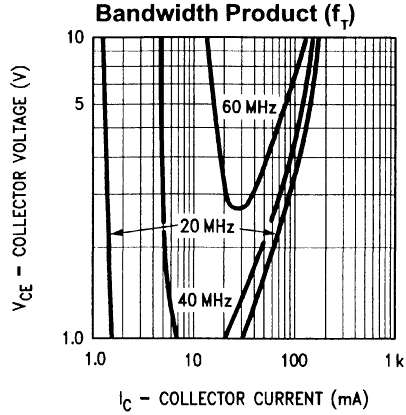


AC Typical Characteristics

Collector-Base / Emitter-Base Capacitance vs. Reverse Bias Voltage



Contours of Constant Gain Bandwidth Product (f_T)



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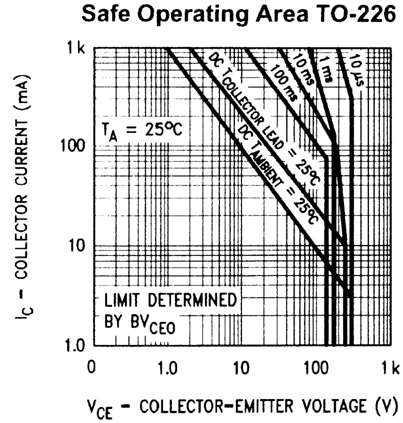
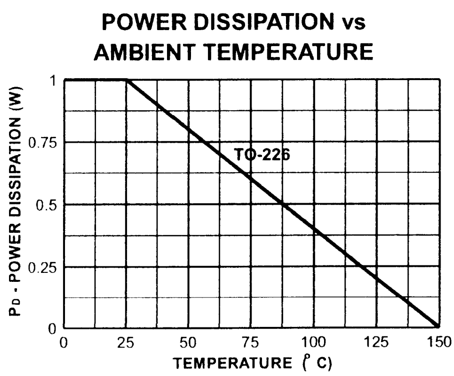
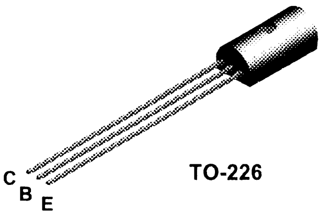
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

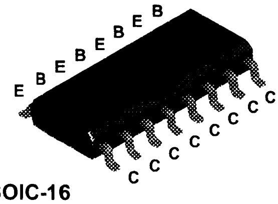




TN3467A MMPQ3467



TO-226



SOIC-16

PNP Switching Transistor

This device is designed for high speed saturated switching applications at currents to 800 mA. Sourced from Process 70.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		TN3467A	MMPQ3467	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	50		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient Effective 4 Die Each Die	125	 125 240	°C/W °C/W °C/W

PNP Switching Transistor
(continued)

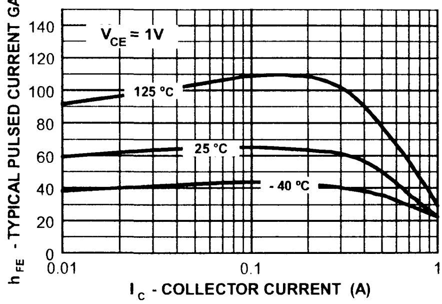
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 10$ mA, $I_B = 0$	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_E = 0$	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$	5.0		V
I_{BEV}	Base-Cutoff Current	$V_{CE} = 30$ V, $V_{BE} = 3.0$ V		120	nA
I_{CEX}	Collector-Cutoff Current	$V_{CE} = 30$ V, $V_{BE} = 3.0$ V		100	nA
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 30$ V, $I_E = 0$ $V_{CB} = 30$ V, $I_E = 0$, $T_A = 150°C$		0.01 15	µA µA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 150$ mA, $V_{CE} = 1.0$ V $I_C = 500$ mA, $V_{CE} = 1.0$ V $I_C = 1.0$ A, $V_{CE} = 5.0$ V	40 40 40	 120 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA $I_C = 1.0$ A, $I_B = 100$ mA		0.3 0.5 1.0	V V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA $I_C = 1.0$ A, $I_B = 100$ mA	 0.8	1.0 1.2 1.6	V V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain-Bandwidth Product	$I_C = 50$ mA, $V_{CE} = 10$ V, f = 100 MHz	175		MHz
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 KHz		25	pF
C_{ibo}	Input Capacitance	$V_{BE} = 0.5$ V, $I_C = 0$, f = 1.0 KHz		100	pF
SWITCHING CHARACTERISTICS (except for MMPQ3467)					
t_d	Delay Time	$V_{CC} = 30$ V, $V_{BE} = 2.0$ V,		10	ns
t_r	Rise Time	$I_C = 500$ mA, $I_{B1} = 50$ mA		30	ns
t_s	Storage Time	$V_{CC} = 30$ V, $I_C = 500$ mA,		60	ns
t_f	Fall Time	$I_{B1} = I_{B2} = 50$ mA		30	ns

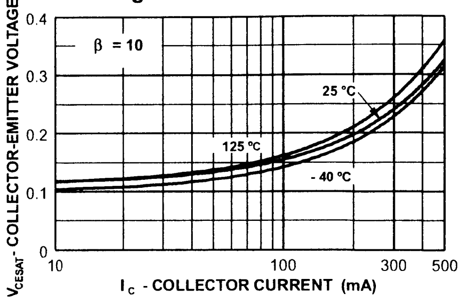
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

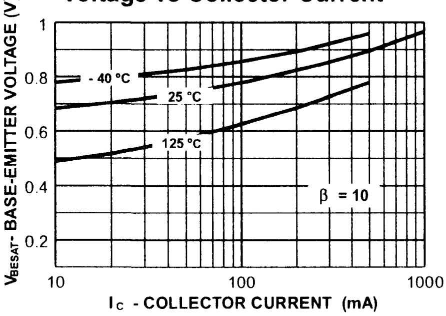
Typical Pulsed Current Gain vs Collector Current



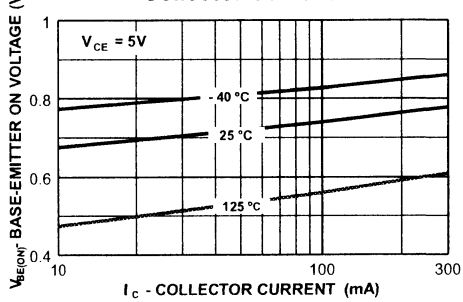
Collector-Emitter Saturation Voltage vs Collector Current



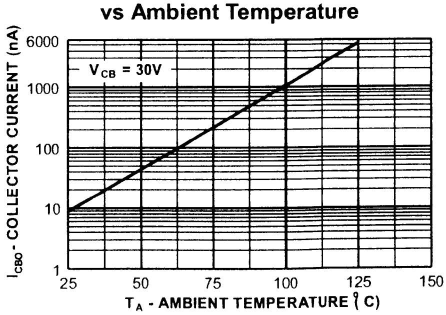
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current



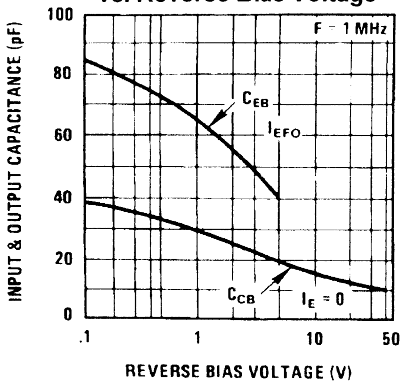
Collector-Cutoff Current vs Ambient Temperature



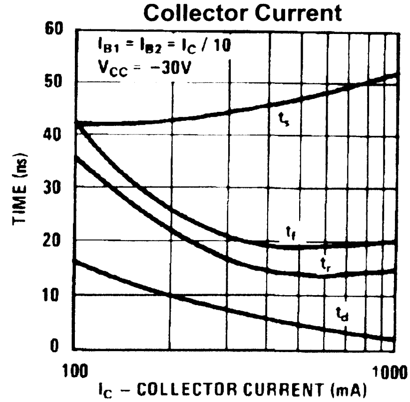
PNP Switching Transistor
(continued)

AC Typical Characteristics

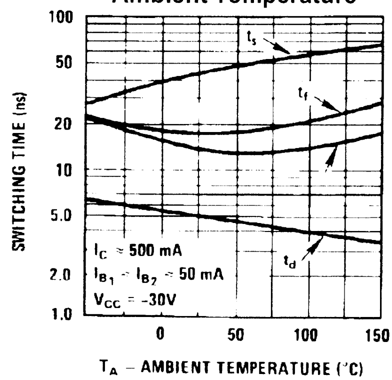
Input / Output Capacitance vs. Reverse Bias Voltage



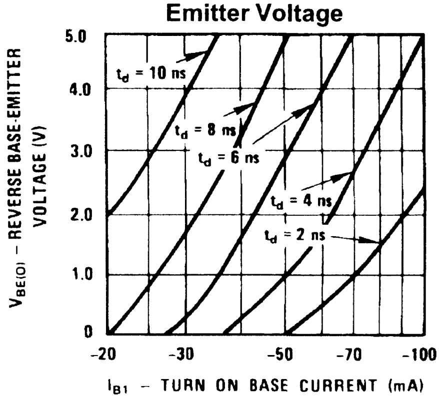
Switching Times vs. Collector Current



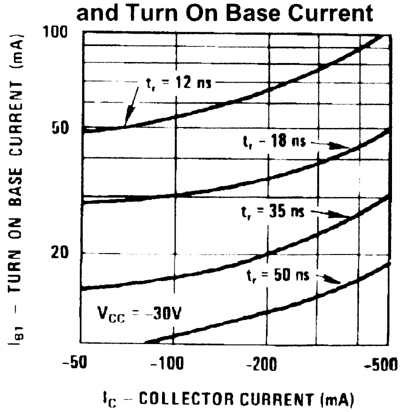
Switching Times vs. Ambient Temperature



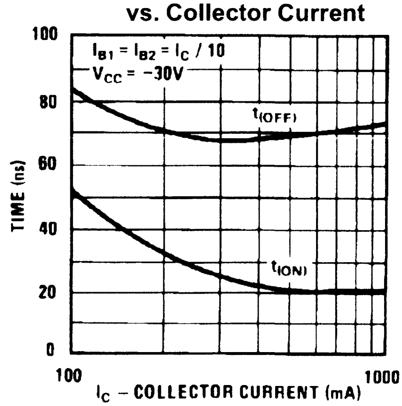
Delay Time vs. Turn On Base Current and Reverse Bias Emitter Voltage



Rise Time vs. Collector Current and Turn On Base Current

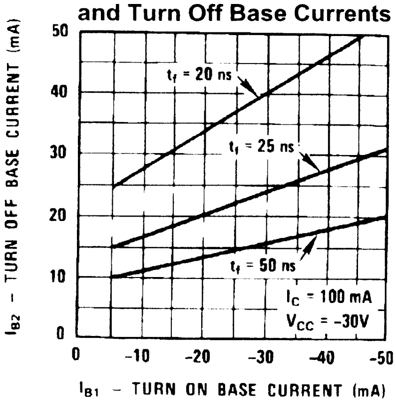


Turn On / Turn Off Times vs. Collector Current

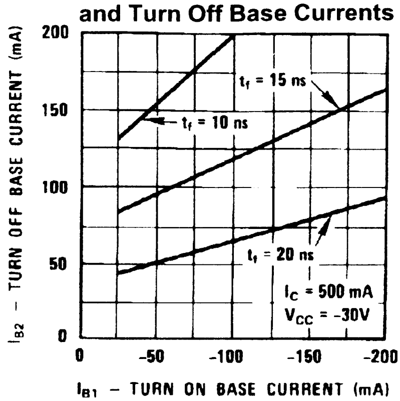


AC Typical Characteristics (continued)

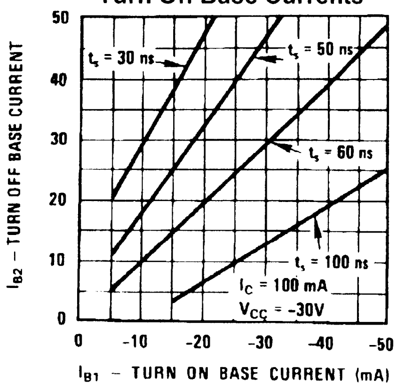
Fall Time vs. Turn On and Turn Off Base Currents



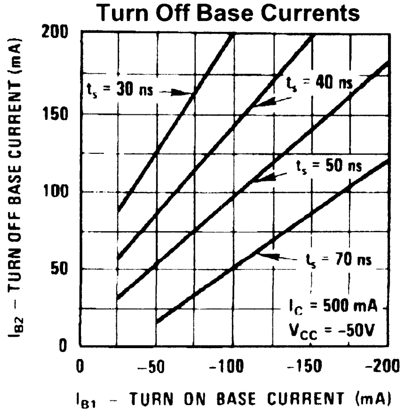
Fall Time vs. Turn On and Turn Off Base Currents



Storage Time vs. Turn On and Turn Off Base Currents



Storage Time vs. Turn On and Turn Off Base Currents



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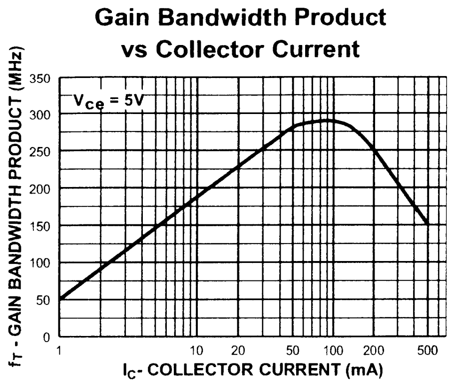
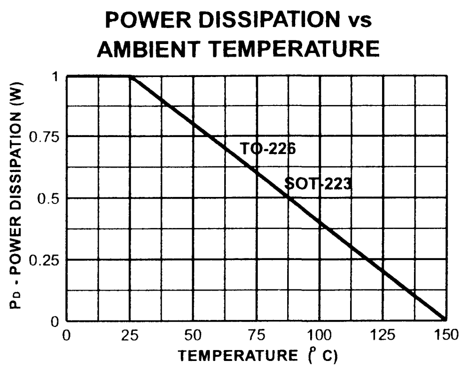
PNP Switching Transistor
(continued)

AC Typical Characteristics (continued)





Test Circuits

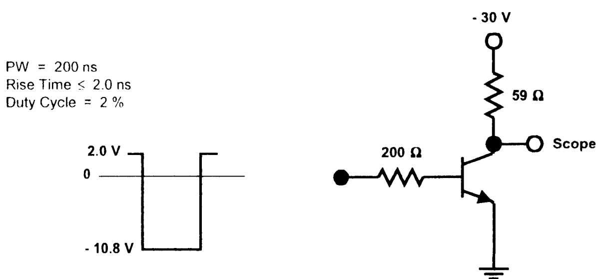


FIGURE 1: t_{ON} Equivalent Test Circuit

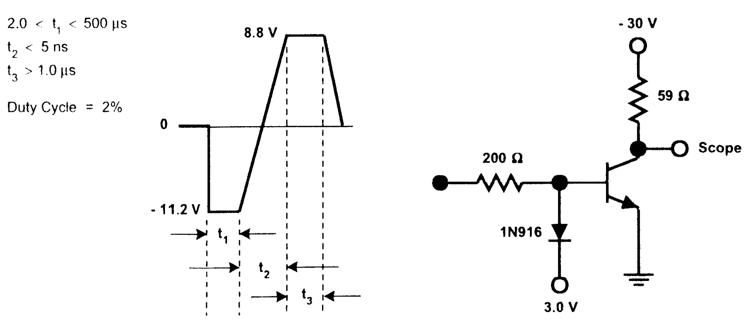
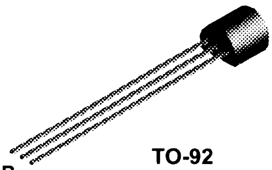


FIGURE 2: t_{OFF} Equivalent Test Circuit

National Semiconductor™

Discrete POWER & Signal Technologies

PN3563



NPN RF Amplifier

This device is designed for use as RF amplifiers, oscillators and multipliers with collector currents in the 1.0 mA to 30 mA range. Sourced from Process 43. See PN918 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	15	V
V_{CBO}	Collector-Base Voltage	30	V
V_{EBO}	Emitter-Base Voltage	2.0	V
I_C	Collector Current - Continuous	50	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		PN3563	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

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NPN RF Amplifier
(continued)

Electrical Characteristics
TA= 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{CEO(sus)}$	Collector-Emitter Sustaining Voltage*	$I_C = 3.0$ mA, $I_B = 0$	15		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu$A, $I_E = 0$	30		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu$A, $I_C = 0$	2.0		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 15$ V, $I_E = 0$ $V_{CB} = 15$ V, $T_A = 150°$C		0.05 5.0	µA nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 8.0$ mA, $V_{CE} = 10$ V	20	200	
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 8.0$ mA, $V_{CE} = 10$ V, f = 100 MHz	600	1500	MHz
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz $V_{CB} = 0$, $I_E = 0$, f = 1.0 MHz		1.7 3.0	pF pF
C_{ibo}	Input Capacitance	$V_{BE} = 0.5$ V, $I_C = 0$, f = 140 MHz		2.0	pF
h_{fe}	Small-Signal Current Gain	$I_C = 8.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	20	250	
$rb'C_C$	Collector Base Time Constant	$I_C = 8.0$ mA, $V_{CE} = 10$ V, f = 79.8 MHz	8.0	25	pS
FUNCTIONAL TEST					
G_{pe}	Amplifier Power Gain	$I_C = 8.0$ mA, $V_{CB} = 10$ V, f = 200 MHz	14	26	dB

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

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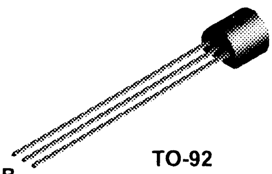
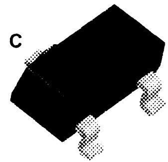
PN3640 MMBT3640





PNP Switching Transistor

This device is designed for very high speed saturate switching at collector currents to 100 mA. Sourced from Process 65. See PN4258 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	12	V
V_{CBO}	Collector-Base Voltage	12	V
V_{EBO}	Emitter-Base Voltage	4.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		PN3640	*MMBT3640	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

PNP Switching Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 10 mA, I_B = 0	12		V
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	I_C = 100 μA, V_{BE} = 0	12		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	12		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	4.0		V
I_{CES}	Collector Cutoff Current	V_{CE} = 6.0 V, V_{BE} = 0 V_{CE} = 6.0 V, V_{BE} = 0, T_A = 65°C		0.01 1.0	μA μA
I_B	Base Current	V_{CE} = 6.0 V, V_{BE} = 0		10	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 10 mA, V_{CE} = 0.3 V I_C = 50 mA, V_{CE} = 1.0 V	30 20	120	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 0.5 mA I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA I_C= 10 mA, I_B= 1.0 mA, T_A =65°C		0.3 0.2 0.6 0.25	V V V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10 mA, I_B = 0.5 mA I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA	0.75 0.8	0.95 1.0 1.5	V V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz	500		MHz
C_{obo}	Output Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 1.0 MHz		3.5	pF
C_{ibo}	Input Capacitance	V_{BE} = 0.5 V, I_C = 0, f = 1.0 MHz		3.5	pF
SWITCHING CHARACTERISTICS					
t_d	Delay Time	V_{CC} = 6.0 V, $V_{BE(off)}$ = 1.9 V, I_C = 50 mA, I_{B1} = 5.0 mA		10	ns
t_r	Rise Time			20	ns
t_s	Storage Time	V_{CC} = 6.0 V, I_C = 50 mA, I_{B1} = I_{B2} = 5.0 mA		20	ns
t_f	Fall Time			12	ns
t_{on}	Turn-On Time	V_{CC} = 6.0 V, $V_{BE(off)}$ = 1.9 V, I_C = 50 mA, I_{B1} = 5.0 mA		25	ns
		V_{CC} = 1.5 V, I_C = 10 mA, I_{B1} = I_{B2} = 0.5 mA		60	ns
t_{off}	Turn-Off Time	V_{CC} = 6.0 V, $V_{BE(off)}$ = 1.9 V, I_C = 50 mA, I_{B1} = 5.0 mA		35	ns
		V_{CC} = 1.5 V, I_C = 10 mA, I_{B1} = I_{B2} = 0.5 mA		75	ns

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

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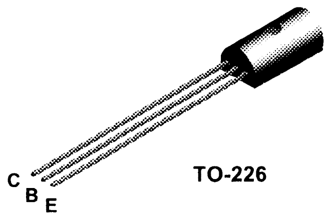
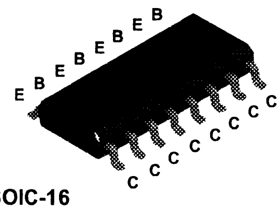
TN3725A MMPQ3725



TO-226



SOIC-16

NPN Switching Transistor

This device is designed for high speed core driver applications up to collector currents of 1.0 A. Sourced from Process 25.

Absolute Maximum Ratings
TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics
TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		TN3725A	MMPQ3725	
P_D	Total Device Dissipation	1.0	1.0	W
	Derate above 25°C	8.0	8.0	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	50		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	125		°C/W
	Effective 4 Die		125	°C/W
	Each Die		240	°C/W

NPN Switching Transistor
(continued)

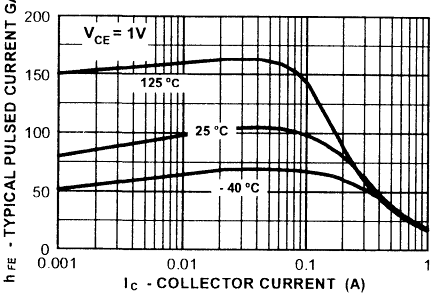
Electrical Characteristics
TA= 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 10 mA, I_B = 0	40		V
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	I_C = 10 μA, V_{BE} = 0	60		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_{CE} = 0	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	6.0		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 60 V, I_E = 0 V_{CB} = 60 V, I_E = 0, T_A = 100°C		1.7 120	μA μA
I_{CES}	Collector Cutoff Current	V_{CE} = 80 V, V_{EB} = 0		10	μA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 10 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V I_C =100mA, V_{CE} =1.0V, T_A = -55°C I_C = 300 mA, V_{CE} = 1.0 V I_C = 500 mA, V_{CE} = 1.0 V I_C =500mA, V_{CE} =1.0V, T_A = -55°C I_C = 800 mA, V_{CE} = 2.0 V I_C = 1.0 A, V_{CE} = 5.0 V	30 60 30 40 35 20 20 25	 150	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA I_C = 100 mA, I_B = 10 mA I_C = 300 mA, I_B = 30 mA I_C = 500 mA, I_B = 50 mA I_C = 800 mA, I_B = 80 mA I_C = 1.0 A, I_B = 100 mA		0.25 0.26 0.4 0.52 0.8 0.95	V V V V V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA I_C = 100 mA, I_B = 10 mA I_C = 300 mA, I_B = 30 mA I_C = 500 mA, I_B = 50 mA I_C = 800 mA, I_B = 80 mA I_C = 1.0 A, I_B = 100 mA		0.76 0.86 1.1 1.2 1.5 1.7	V V V V V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 50 mA, V_{CE} = 10 V, f = 100 MHz	300		MHz
C_{obo}	Output Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		10	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz		55	pF
SWITCHING CHARACTERISTICS (except MMPQ3725)					
t_{on}	Turn-on Time	V_{CC} = 30 V, $V_{BE(off)}$ = 3.8 V, I_C = 500 mA, I_{B1} = 50 mA		35	ns
t_d	Delay Time			10	ns
t_r	Rise Time			30	ns
t_{off}	Turn-off Time	V_{CC} = 30 V, I_C = 500 mA I_{B1} = I_{B2} = 50 mA		60	ns
t_s	Storage Time			50	ns
t_f	Fall Time			30	ns

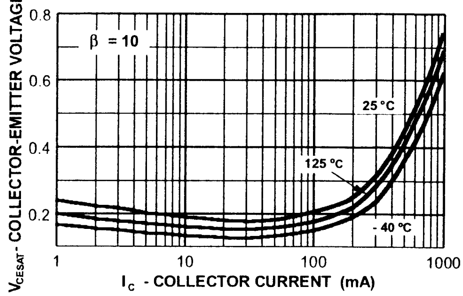
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

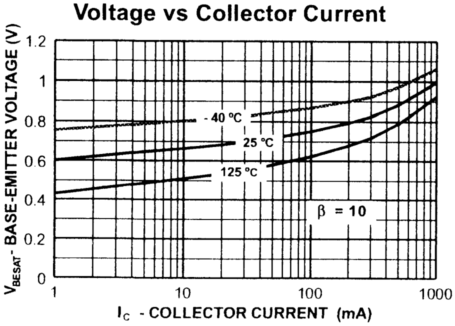
Typical Pulsed Current Gain vs Collector Current



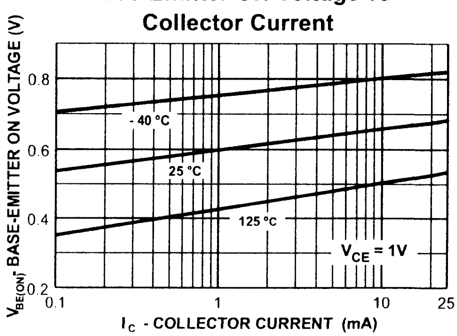
Collector-Emitter Saturation Voltage vs Collector Current



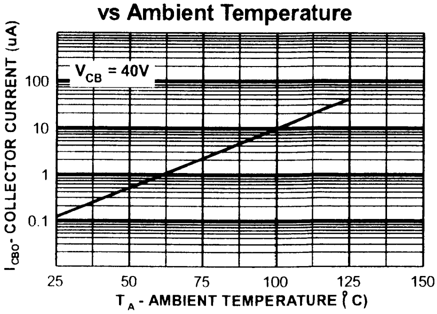
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current



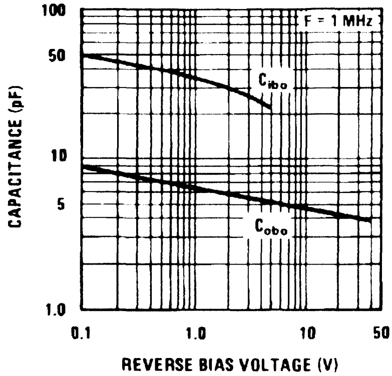
Collector-Cutoff Current vs Ambient Temperature



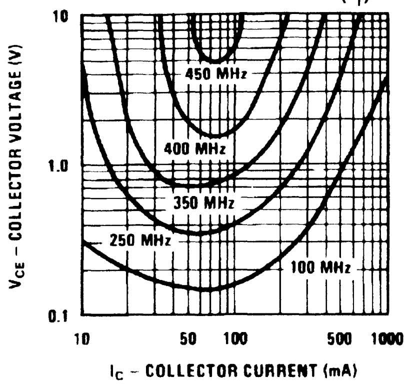
NPN Switching Transistor
(continued)

AC Typical Characteristics

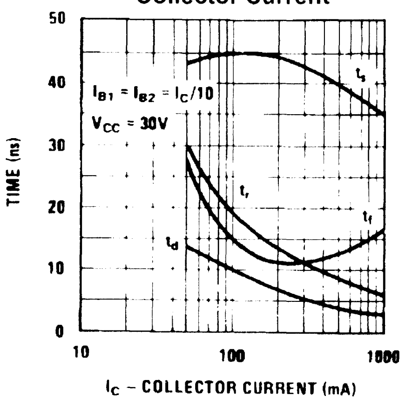
Input/Output Capacitance vs. Reverse Bias



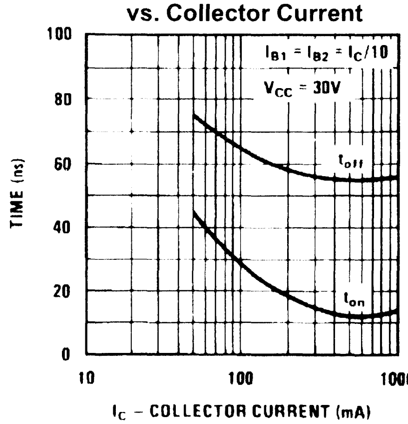
Contours of Constant Bandwidth Product (f_T)



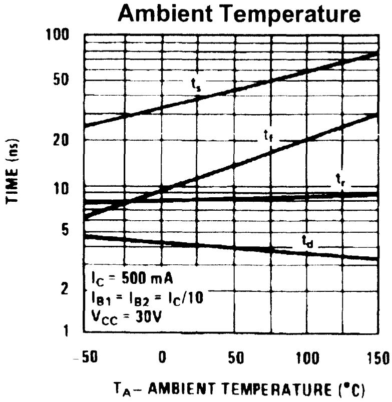
Switching Time vs. Collector Current



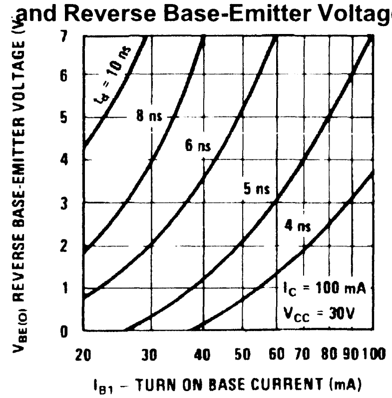
Turn On / Turn Off Times vs. Collector Current



Switching Times vs. Ambient Temperature

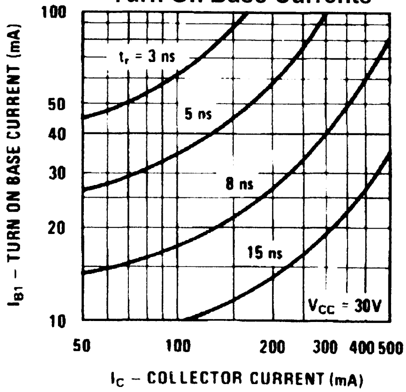


Delay Time vs. Turn On Base Current and Reverse Base-Emitter Voltage

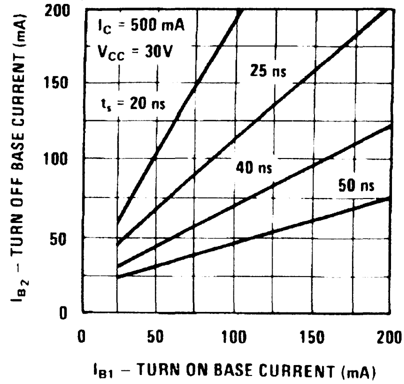


AC Typical Characteristics (continued)

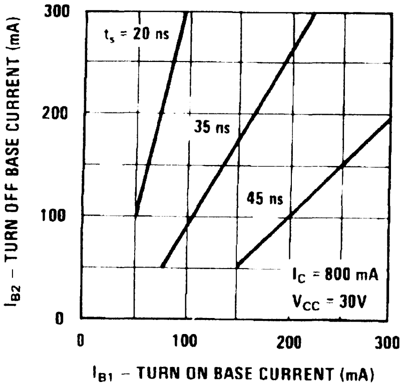
Rise Time vs. Collector and Turn On Base Currents



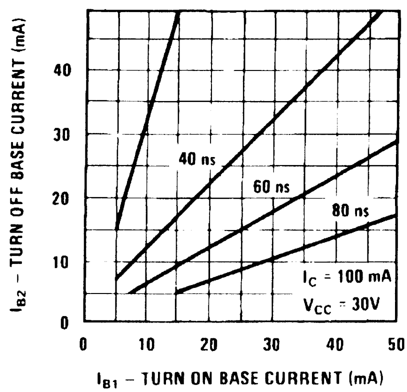
Storage Time vs. Turn On and Turn Off Base Currents



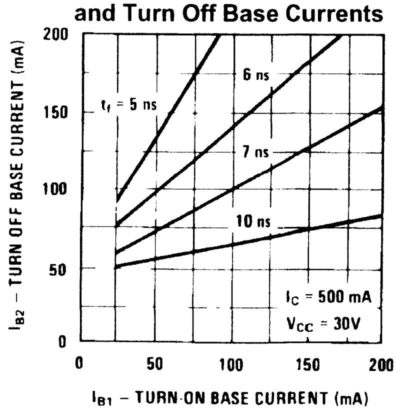
Storage Time vs. Turn On and Turn Off Base Currents



Storage Time vs. Turn On and Turn Off Base Currents



Fall Time vs. Turn On and Turn Off Base Currents

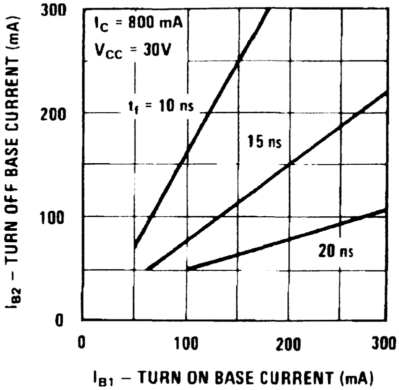


5

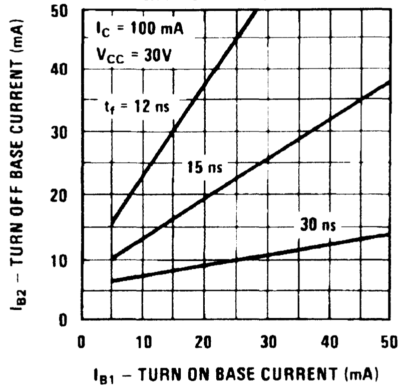
NPN Switching Transistor
(continued)

AC Typical Characteristics (continued)

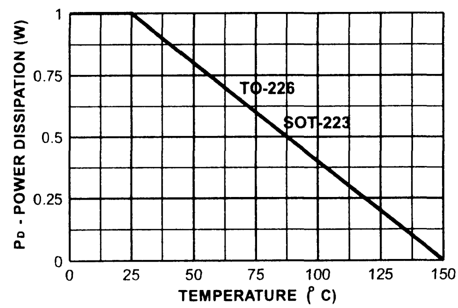
Fall Time vs. Turn On and Turn Off Base Currents



Fall Time vs. Turn On and Turn Off Base Currents



POWER DISSIPATION vs AMBIENT TEMPERATURE



Test Circuit

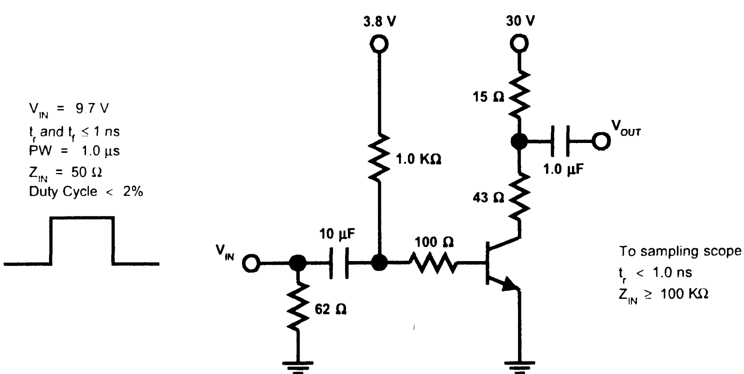


FIGURE 1: Switching Time Test Circuit
(I_C = 500 mA, I_{B1} = 50 mA, I_{B2} = 50 mA)

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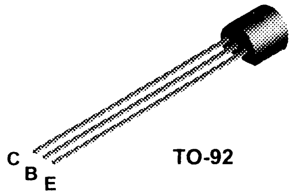
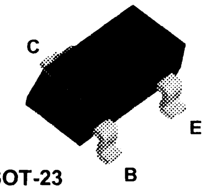
2N3904



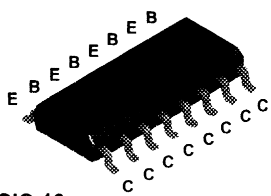
TO-92

MMBT3904



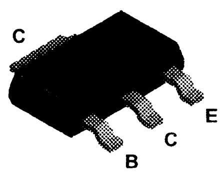
SOT-23
Mark: 1A

MMPQ3904



SOIC-16

PZT3904



SOT-223

NPN General Purpose Amplifier

This device is designed as a general purpose amplifier and switch. The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier. Sourced from Process 23.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 1.0 mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_E = 0	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	6.0		V
I_{BL}	Base Cutoff Current	V_{CE} = 30 V, V_{EB} = 0		50	nA
I_{CEX}	Collector Cutoff Current	V_{CE} = 30 V, V_{EB} = 0		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 0.1 mA, V_{CE} = 1.0 V I_C = 1.0 mA, V_{CE} = 1.0 V I_C = 10 mA, V_{CE} = 1.0 V I_C = 50 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V	40 70 100 60 30	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA		0.2 0.3	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz	300		MHz
C_{obo}	Output Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 1.0 MHz		4.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz		8.0	pF
NF	Noise Figure (except MMPQ3904)	I_C = 100 μA, V_{CE} = 5.0 V, R_S =1.0kΩ, f=10 Hz to 15.7 kHz		5.0	dB
SWITCHING CHARACTERISTICS (except MMPQ3904)					
t_d	Delay Time	V_{CC} = 3.0 V, V_{BE} = 0.5 V,		35	ns
t_r	Rise Time	I_C = 10 mA, I_{B1} = 1.0 mA		35	ns
t_s	Storage Time	V_{CC} = 3.0 V, I_C = 10mA		200	ns
t_f	Fall Time	I_{B1} = I_{B2} = 1.0 mA		50	ns

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

Spice Model

NPN (Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259 Ise=6.734 Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1 Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75 Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)

NPN General Purpose Amplifier
(continued)

Thermal Characteristics
TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N3904	*PZT3904	
P_D	Total Device Dissipation	625	1,000	mW
	Derate above 25°C	5.0	8.0	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	125	°C/W

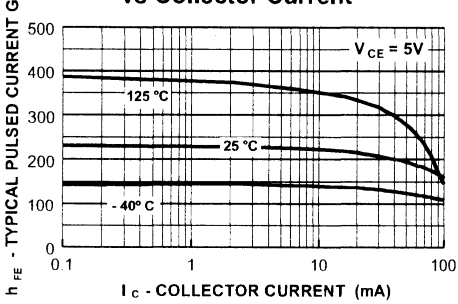
Symbol	Characteristic	Max		Units
		**MMBT3904	MMPQ3904	
P_D	Total Device Dissipation	350	1,000	mW
	Derate above 25°C	2.8	8.0	mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357		°C/W
	Effective 4 Die		125	°C/W
	Each Die		240	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

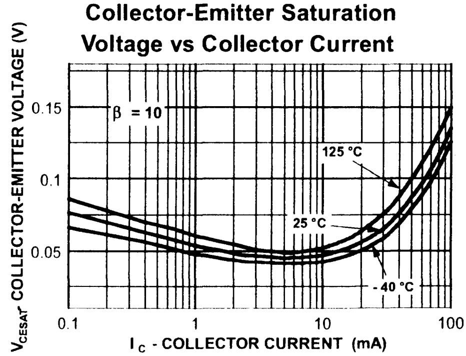
**Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

DC Typical Characteristics

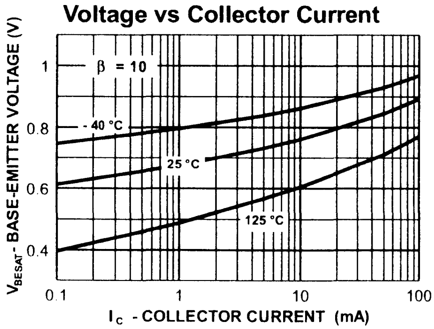
Typical Pulsed Current Gain vs Collector Current



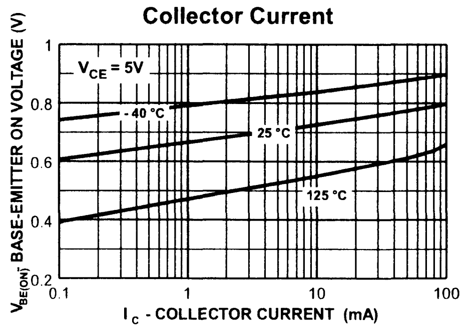
Collector-Emitter Saturation Voltage vs Collector Current



Base-Emitter Saturation Voltage vs Collector Current

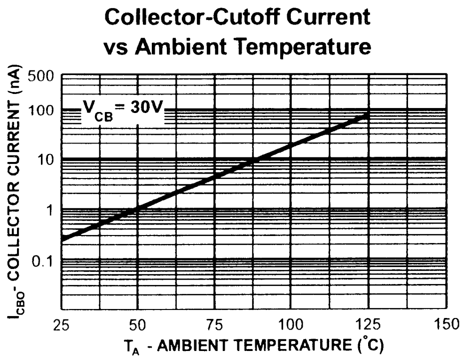


Base-Emitter ON Voltage vs Collector Current

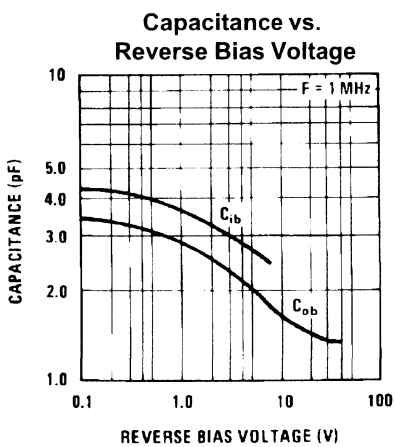


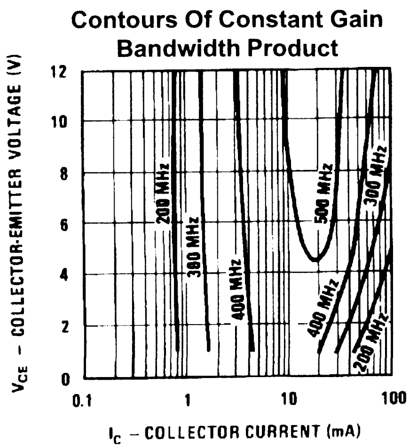
NPN General Purpose Amplifier
(continued)

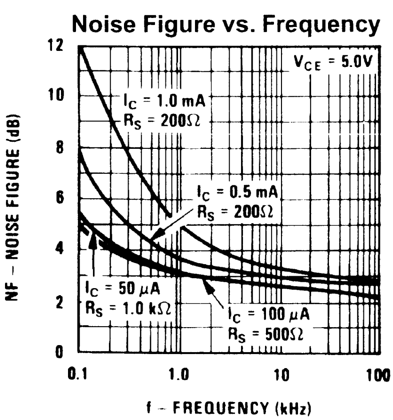
DC Typical Characteristics (continued)

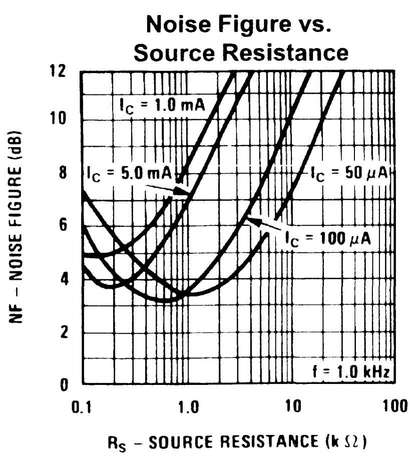


AC Typical Characteristics



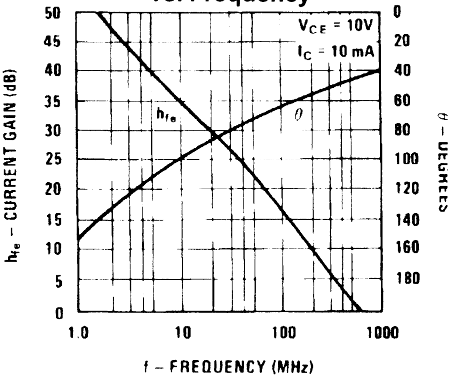




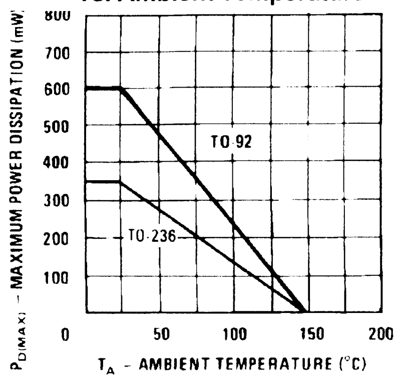


AC Typical Characteristics (continued)

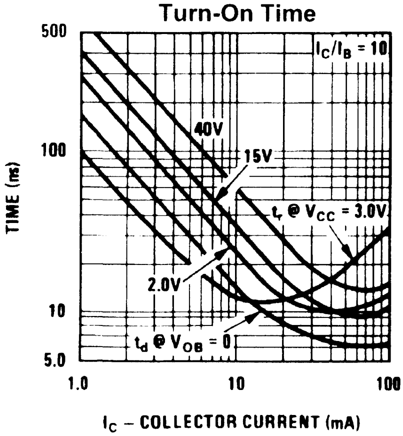
Current Gain and Phase Angle vs. Frequency



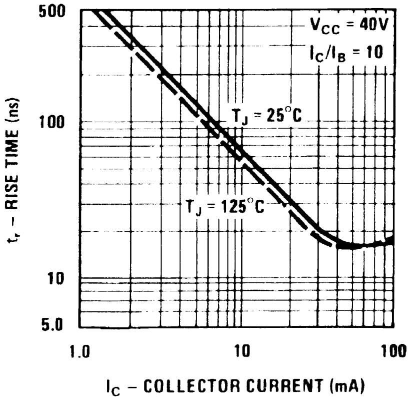
Maximum Power Dissipation vs. Ambient Temperature



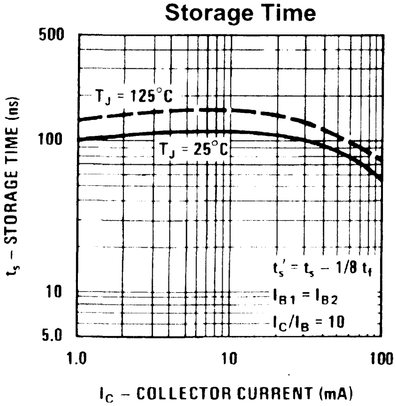
Turn-On Time



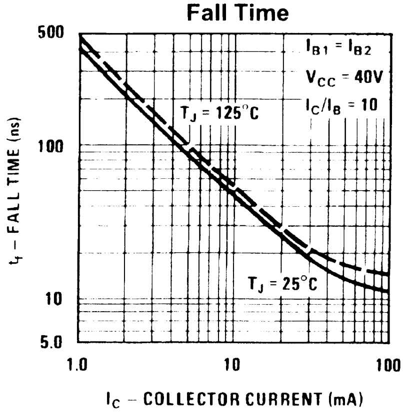
Rise Time



Storage Time



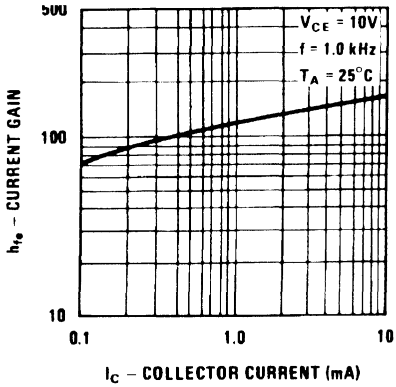
Fall Time



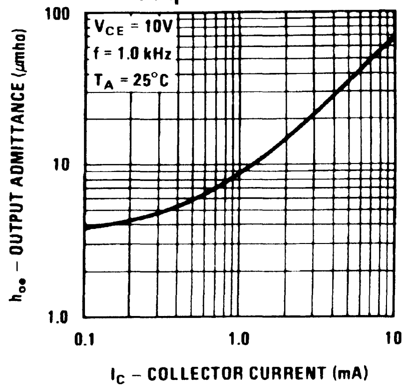
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

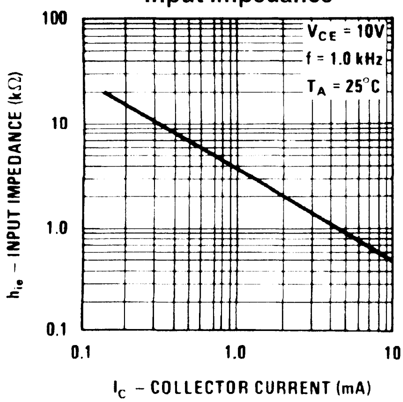
Current Gain



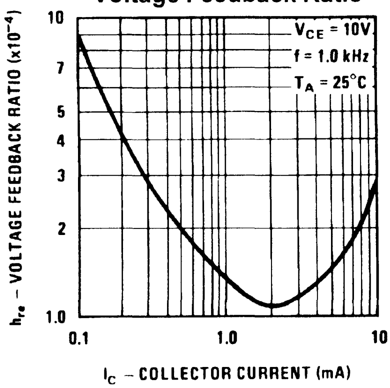
Output Admittance



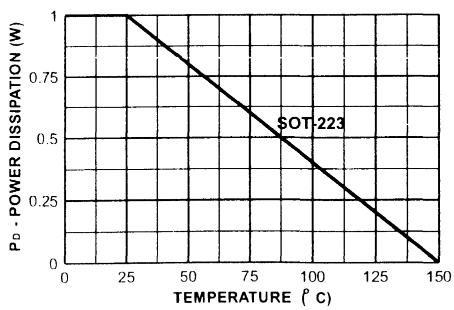
Input Impedance



Voltage Feedback Ratio



POWER DISSIPATION vs AMBIENT TEMPERATURE



Test Circuits

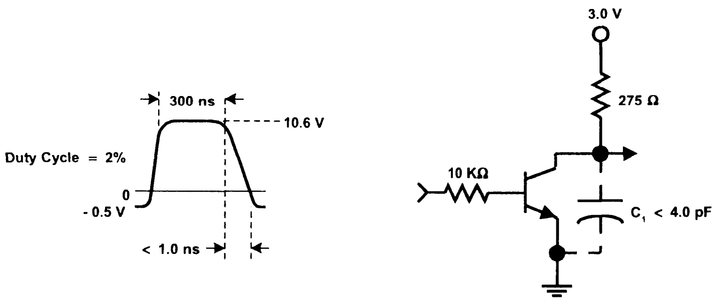


FIGURE 1: Delay and Rise Time Equivalent Test Circuit

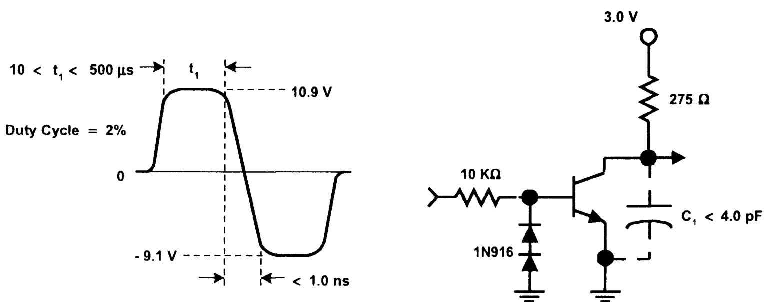
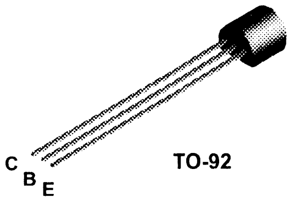


FIGURE 2: Storage and Fall Time Equivalent Test Circuit

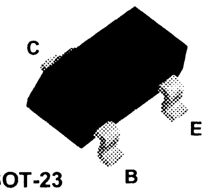
National Semiconductor™

Discrete POWER & Signal Technologies

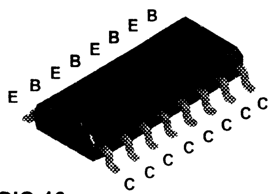
2N3906 MMBT3906 MMPQ3906 PZT3906



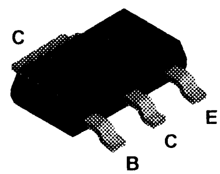
TO-92



SOT-23
Mark: 2A



SOIC-16



SOT-223

PNP General Purpose Amplifier

This device is designed for general purpose amplifier and switching applications at collector currents of 10 μA to 100 mA. Sourced from Process 66.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_B = 0$	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10$ μA, $I_E = 0$	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10$ μA, $I_C = 0$	5.0		V
I_{BL}	Base Cutoff Current	$V_{CE} = 30$ V, $V_{BE} = 3.0$ V		50	nA
I_{CEX}	Collector Cutoff Current	$V_{CE} = 30$ V, $V_{BE} = 3.0$ V		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain *	$I_C = 0.1$ mA, $V_{CE} = 1.0$ V $I_C = 1.0$ mA, $V_{CE} = 1.0$ V $I_C = 10$ mA, $V_{CE} = 1.0$ V $I_C = 50$ mA, $V_{CE} = 1.0$ V $I_C = 100$ mA, $V_{CE} = 1.0$ V	60 80 100 60 30	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA		0.25 0.4	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 20$ V, f = 100 MHz	250		MHz
C_{obo}	Output Capacitance	$V_{CB} = 5.0$ V, $I_E = 0$, f = 100 kHz		4.5	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5$ V, $I_C = 0$, f = 100 kHz		10.0	pF
NF	Noise Figure (except MMPQ3906)	$I_C = 100$ μA, $V_{CE} = 5.0$ V, $R_S = 1.0$kΩ, f=10 Hz to 15.7 kHz		4.0	dB
SWITCHING CHARACTERISTICS (except MMPQ3906)					
t_d	Delay Time	$V_{CC} = 3.0$ V, $V_{BE} = 0.5$ V,		35	ns
t_r	Rise Time	$I_C = 10$ mA, $I_{B1} = 1.0$ mA		35	ns
t_s	Storage Time	$V_{CC} = 3.0$ V, $I_C = 10$mA		225	ns
t_f	Fall Time	$I_{B1} = I_{B2} = 1.0$ mA		75	ns

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

Spice Model

PNP (Is=1.41f Xti=3 Eg=1.11 Vaf=18.7 Bf=180.7 Ne=1.5 Ise=0 Ikf=80m Xtb=1.5 Br=4.977 Nc=2 Isc=0 Ikr=0 Rc=2.5 Cjc=9.728p Mjc=.5776 Vjc=.75 Fc=.5 Cje=8.063p Mje=.3677 Vje=.75 Tr=33.42n Tf=179.3p Itf=.4 Vtf=4 Xtf=6 Rb=10)

PNP General Purpose Amplifier
(continued)

Thermal Characteristics
TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N3906	*PZT3906	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	125	°C/W

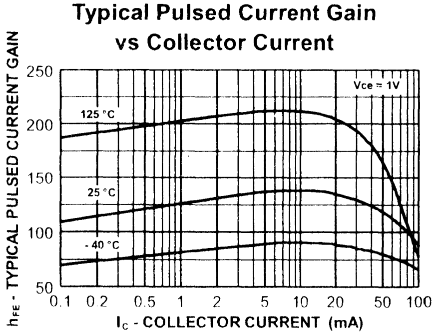
Symbol	Characteristic	Max		Units
		**MMBT3906	MMPQ3906	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient Effective 4 Die Each Die	357	 125 240	°C/W °C/W °C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm[2].

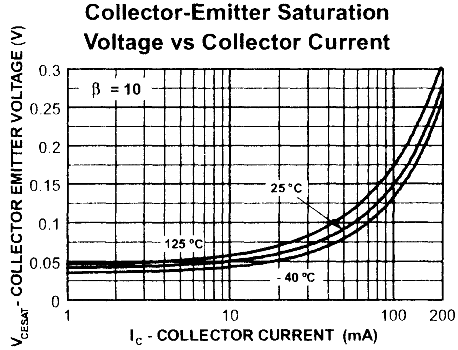
**Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

DC Typical Characteristics

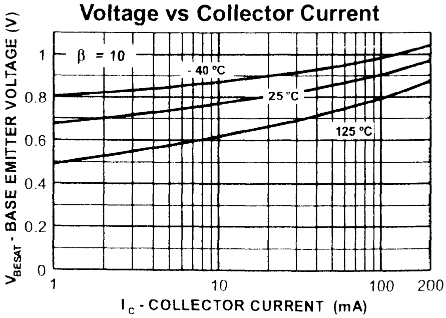
Typical Pulsed Current Gain vs Collector Current



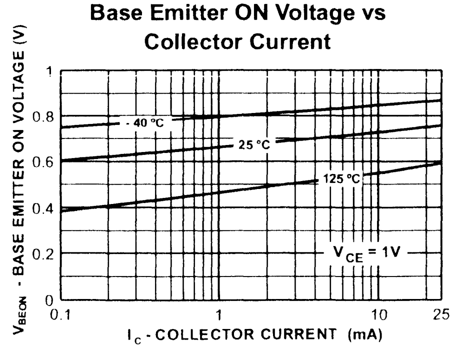
Collector-Emitter Saturation Voltage vs Collector Current



Base-Emitter Saturation Voltage vs Collector Current



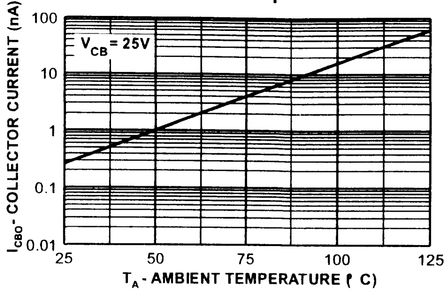
Base Emitter ON Voltage vs Collector Current



2N3906 / MMBT3906 / MMPQ3906 / PZT3906

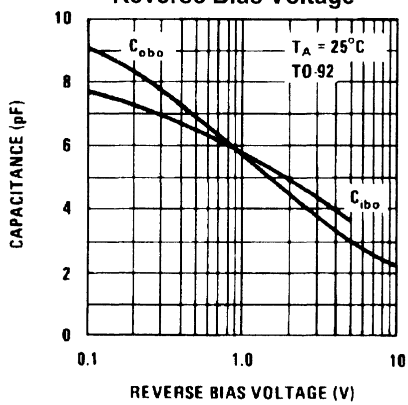
DC Typical Characteristics (continued)

Collector-Cutoff Current vs. Ambient Temperature

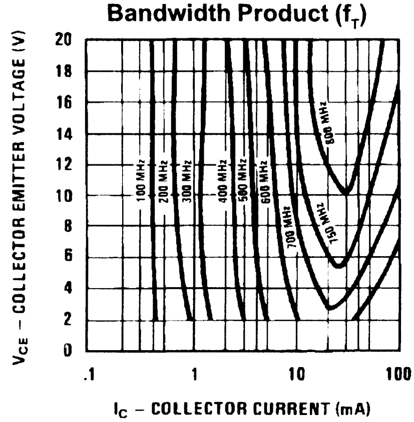


AC Typical Characteristics

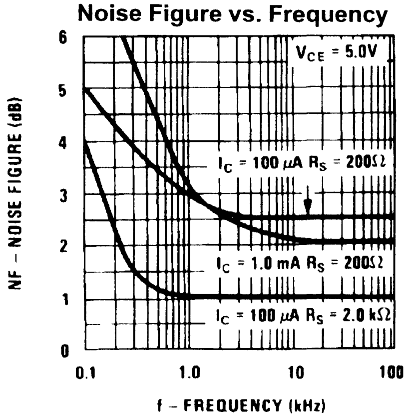
Common-Base Open Circuit Input / Output Capacitance vs. Reverse Bias Voltage



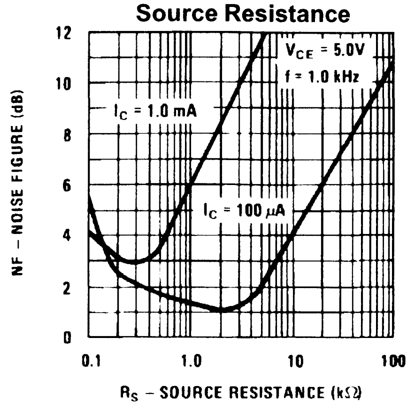
Contours of Constant Gain Bandwidth Product (f_T)



Noise Figure vs. Frequency



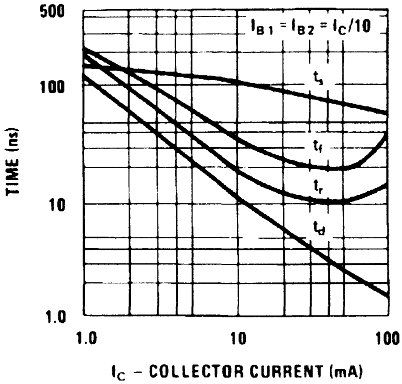
Noise Figure vs. Source Resistance



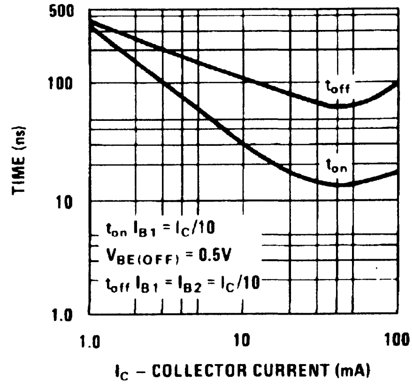
PNP General Purpose Amplifier
(continued)

AC Typical Characteristics

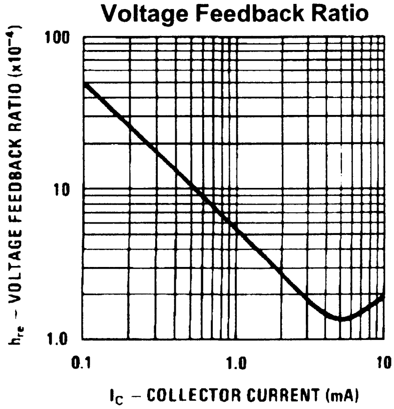
Switching Times vs. Collector Current



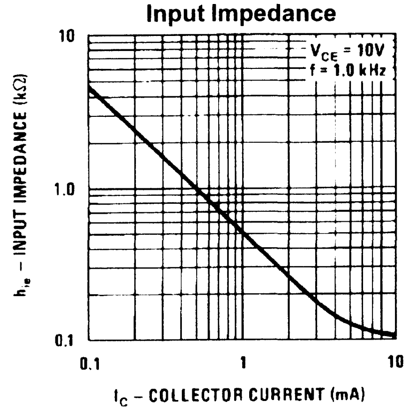
Turn On / Turn Off Times vs. Collector Current



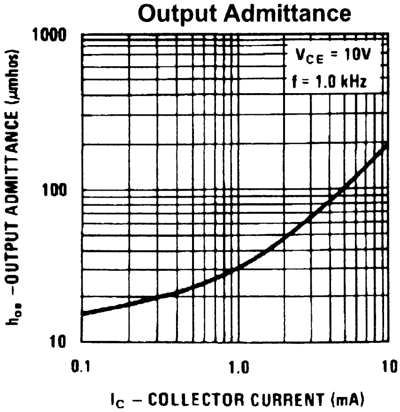
Voltage Feedback Ratio



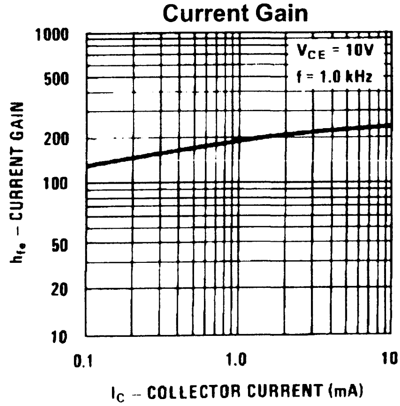
Input Impedance



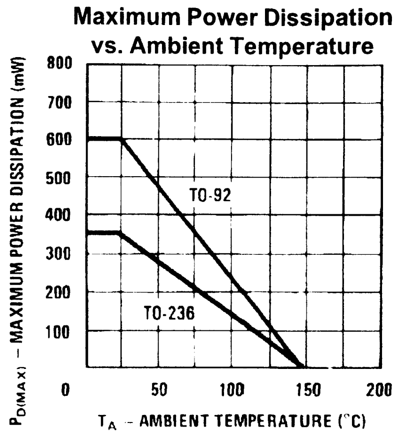
Output Admittance

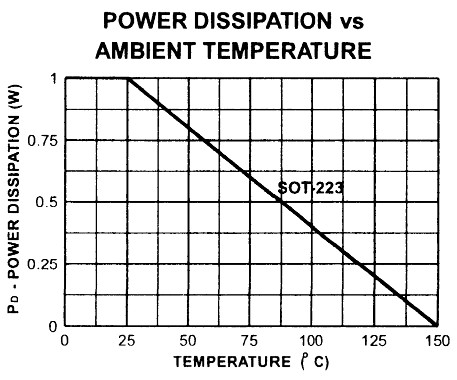


Current Gain



AC Typical Characteristics (continued)

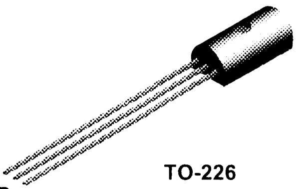




National Semiconductor

Discrete POWER & Signal Technologies

TN4033A



C B E

TO-226

PNP General Purpose Amplifier

This device is designed for general purpose amplifier and switching applications at currents to 500 mA and collector voltages up to 70V. Sourced from Process 67.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	80	V
V_{CBO}	Collector-Base Voltage	80	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		TN4033A	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W

PNP General Purpose Amplifier
(continued)

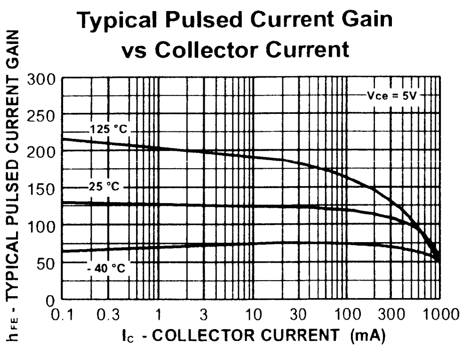
Electrical Characteristics
TA = 25°C unless otherwise noted

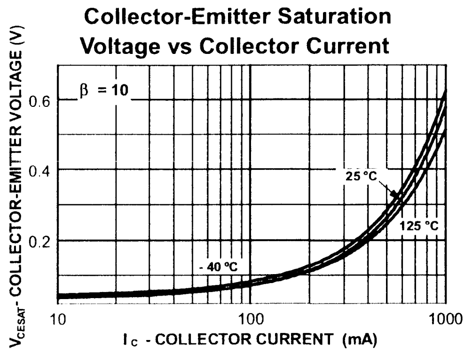
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage*	$I_C = 10$ mA, $I_B = 0$	80		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_E = 0$	80		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 60$ V, $I_E = 0$ $V_{CB} = 60$ V, $I_E = 0$, $T_A = 150°C$		50 50	nA µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 5.0$ V, $I_C = 0$		10	µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V I_C=100mA, V_{CE}=5.0V,T_A = -55°C $I_C = 100$ mA, $V_{CE} = 5.0$ V $I_C = 500$ mA, $V_{CE} = 5.0$ V $I_C = 1.0$ A, $V_{CE} = 5.0$ V	75 40 100 70 25	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA		0.15 0.5	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA		0.9	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 500$ mA, $V_{CE} = 0.5$ V		1.1	V
SMALL SIGNAL CHARACTERISTICS					
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		20	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5$ V, $I_C = 0$, f = 1.0 MHz		110	pF
h_{fe}	Small-Signal Current Gain	$I_C = 50$ mA, $V_{CE} = 10$ V, f = 100 MHz	1.0	4.0	
SWITCHING CHARACTERISTICS					
t_s	Storage Time	$I_C = 500$ mA, $I_{B1} = I_{B2} = 50$ mA		350	ns
t_{on}	Turn-On Time	$I_C = 500$ mA, $I_{B1} = 50$ mA		100	ns
t_f	Fall Time	$I_C = 500$ mA, $I_{B1} = I_{B2} = 50$ mA		50	ns

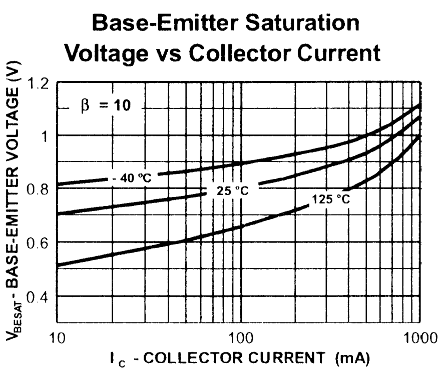
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%

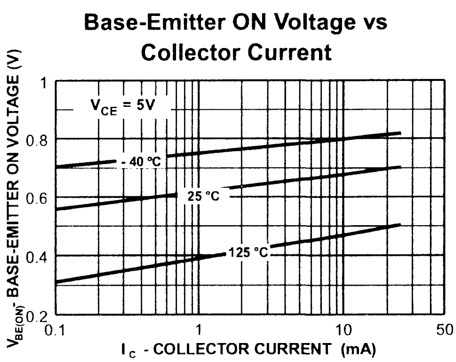
PNP General Purpose Amplifier
(continued)

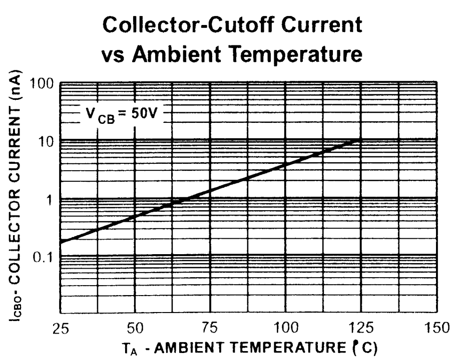
DC Typical Characteristics





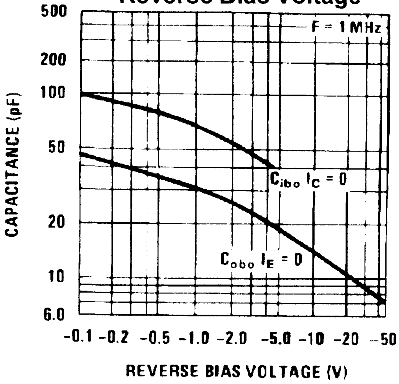




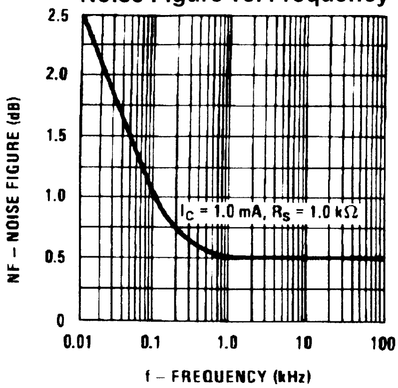


AC Typical Characteristics

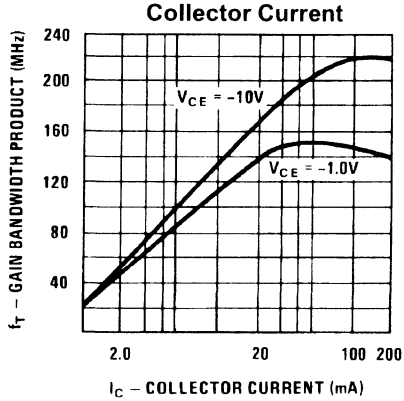
Common-Base Open Circuit Input / Output Capacitance vs. Reverse Bias Voltage



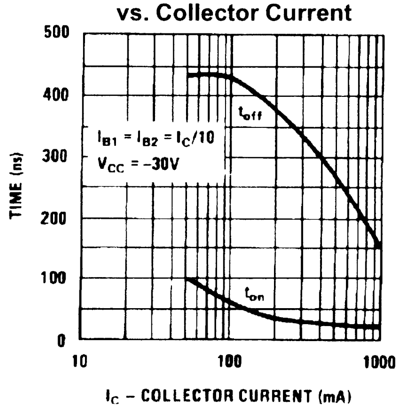
Noise Figure vs. Frequency



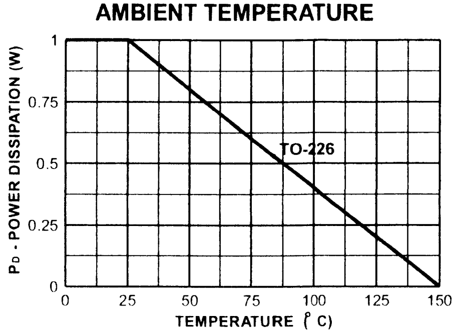
Switching Times vs. Collector Current



Turn On / Turn Off Times vs. Collector Current



POWER DISSIPATION vs AMBIENT TEMPERATURE



National Semiconductor

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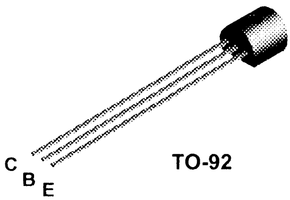
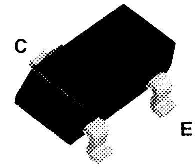
2N4124 MMBT4124



TO-92



SOT-23
Mark: ZC

NPN General Purpose Amplifier

This device is designed as a general purpose amplifier and switch. The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier. Sourced from Process 23. See 2N3904 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	25	V
V_{CBO}	Collector-Base Voltage	30	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N4124	*MMBT4124	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 1.0 mA, I_B = 0	25		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_E = 0	30		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_C = 10 μA, I_C = 0	5.0		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 20 V, I_E = 0		50	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 3.0 V, I_C = 0		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 2.0 mA, V_{CE} = 1.0 V I_C = 50 mA, V_{CE} = 1.0 V	120 60	360	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 50 mA, I_B = 5.0 mA		0.3	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 50 mA, I_B = 5.0 mA		0.95	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz	300		MHz
C_{obo}	Output Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 100 kHz		4.0	pF
C_{ibo}	Input Capacitance	V_{BE} = 0.5 V, I_C = 0, f = 1.0 kHz		8.0	pF
C_{cb}	Collector-Base Capcitance	V_{CB} = 5.0 V, I_E = 0, f = 100 kHz		4.0	pF
h_{fe}	Small-Signal Current Gain	V_{CE} = 10 V, I_C = 2.0 mA, f = 1.0 kHz	120	480	
NF	Noise Figure	I_C = 100 μA, V_{CE} = 5.0 V, R_S =1.0kΩ, f=10 Hz to 15.7 kHz		5.0	dB

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

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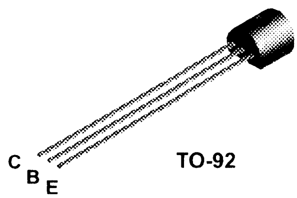
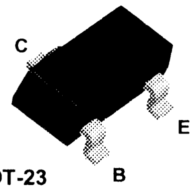
Discrete POWER & Signal Technologies

2N4126 MMBT4126





SOT-23
Mark: ZF

PNP General Purpose Amplifier

This device is designed for general purpose amplifier and switching applications at collector currents to 10 µA as a switch and to 100 mA as an amplifier. Sourced from Process 66. See 2N3906 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	25	V
V_{CBO}	Collector-Base Voltage	25	V
V_{EBO}	Emitter-Base Voltage	4.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA= 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N4126	*MMBT4126	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

PNP General Purpose Amplifier
(continued)

Electrical Characteristics

TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 1.0$ mA, $I_B = 0$	25		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10$ μA, $I_E = 0$	25		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_C = 10$ μA, $I_C = 0$	4.0		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 20$ V, $I_E = 0$		50	nA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = 3.0$ V, $I_C = 0$		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 2.0$ mA, $V_{CE} = 1.0$ V $I_C = 50$ mA, $V_{CE} = 1.0$ V	120 60	360	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 50$ mA, $I_B = 5.0$ mA		0.4	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 50$ mA, $I_B = 5.0$ mA		0.95	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 20$ V, f = 100 MHz	250		MHz
C_{ibo}	Input Capacitance	$V_{EB} = 0.5$ V, $I_C = 0$, f = 1.0 MHz		10	pF
C_{cb}	Collector-Base Capcitance	$V_{CB} = 5.0$ V, $I_E = 0$, f = 100 kHz		4.5	pF
h_{fe}	Small-Signal Current Gain	$I_C = 2.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	120	480	
NF	Noise Figure	$I_C = 100$ μA, $V_{CE} = 5.0$ V, R_S=1.0 kΩ, f=10 Hz to 15.7 kHz		4.0	dB

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

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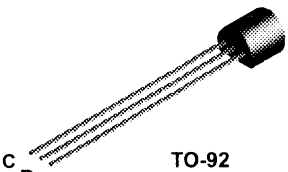
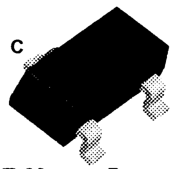
PN4258 MMBT4258





PNP Switching Transistor

This device is designed for very high speed saturate switching at collector currents to 100 mA. Sourced from Process 65.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	12	V
V_{CBO}	Collector-Base Voltage	12	V
V_{EBO}	Emitter-Base Voltage	4.5	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		PN4258	*MMBT4258	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

Electrical Characteristics

TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage*	$I_C = 100\ \mu A$, $V_{BE} = 0$	12		V
$V_{CEO(sus)}$	Collector-Emitter Sustaining Voltage*	$I_C = 3.0$ mA, $I_B = 0$	12		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu A$, $I_E = 0$	12		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 100\ \mu A$, $I_C = 0$	4.5		V
I_{CES}	Collector Cutoff Current	$V_{CE} = 6.0$ V, $V_{BE} = 0$ $V_{CE} = 6.0$ V, $V_{BE} = 0$, $T_A = 65°C$		0.01 5.0	µA µA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 1.0$ mA, $V_{CE} = 0.5$ V $I_C = 10$ mA, $V_{CE} = 3.0$ V $I_C = 50$ mA, $V_{CE} = 1.0$ V	15 30 30	 120 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA		0.15 0.5	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA	0.75	0.95 1.5	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 5.0$ V, f = 100 MHz $I_C = 10$ mA, $V_{CE} = 10$ V, f = 100 MHz	700 700		MHz MHz
C_{ibo}	Input Capacitance	$V_{BE} = 0.5$ V, $I_C = 0$, f = 1.0 MHz		3.5	pF
C_{cb}	Collector-Base Capacitance	$V_{CB} = 5.0$ V, $I_E = 0$, f = 1.0 MHz		3.0	pF
SWITCHING CHARACTERISTICS					
t_{on}	Turn-On Time	$V_{CC} = 1.5$ V, $V_{BE(off)} = 0$ V, $I_C = 10$ mA, $I_{B1} = 1.0$ mA		15	ns
t_d	Delay Time			10	ns
t_r	Rise Time			15	ns
t_{off}	Turn-Off Time	$V_{CC} = 1.5$ V, $I_C = 10$mA $I_{B1} = I_{B2} = 1.0$ mA		20	ns
t_s	Storage Time			20	ns
t_f	Fall Time			10	ns
t_s	Storage Time	$I_C = 10$ mA, $I_{B1} = I_{B2} = 10$ mA		20	ns

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

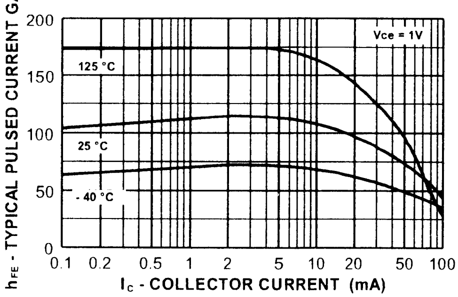
Spice Model

PNP (Is=545.6E-18 Xti=3 Eg=1.11 Vaf=100 Bf=61.42 Ne=1.5 Ise=0 Ikf=50m Xtb=1.5 Br=1.426 Nc=2 Isc=0 Ikr=0 Rc=3.75 Cjc=2.77p Mjc=.1416 Vjc=.75 Fc=.5 Cje=2.65p Mje=.3083 Vje=.75 Tr=4.109n Tf=118.5p Itf=.5 Vtf=3 Xtf=6 Rb=10)

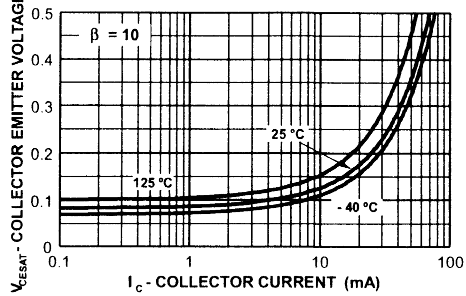
PNP Switching Transistor
(continued)

DC Typical Characteristics

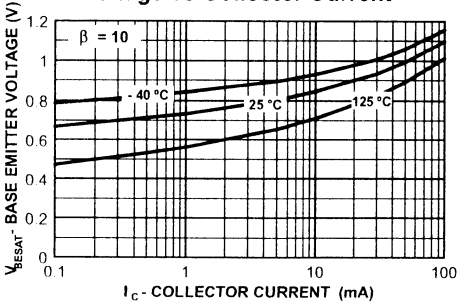
Typical Pulsed Current Gain vs Collector Current



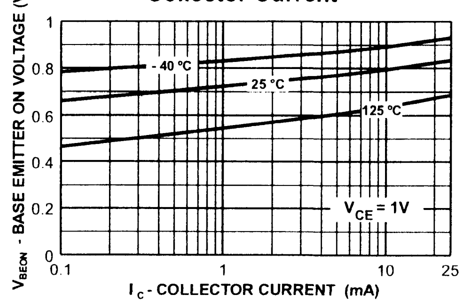
Collector-Emitter Saturation Voltage vs Collector Current



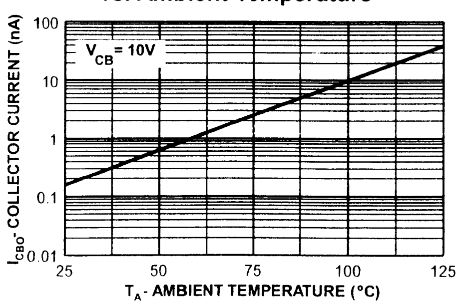
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

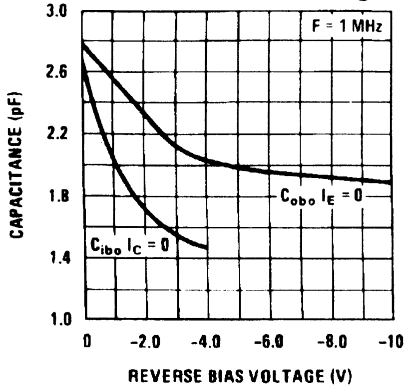


Collector-Cutoff Current vs. Ambient Temperature

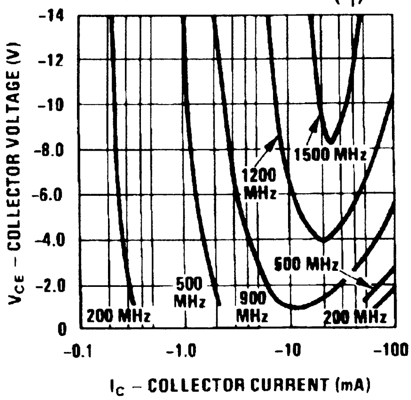


AC Typical Characteristics

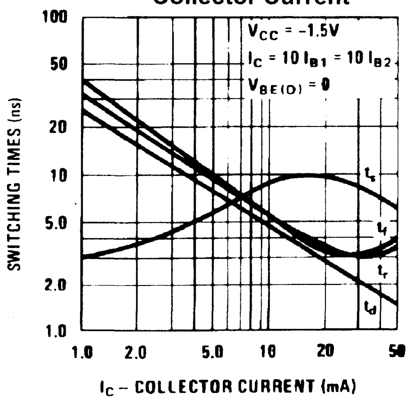
Input / Output Capacitance vs. Reverse Bias Voltage



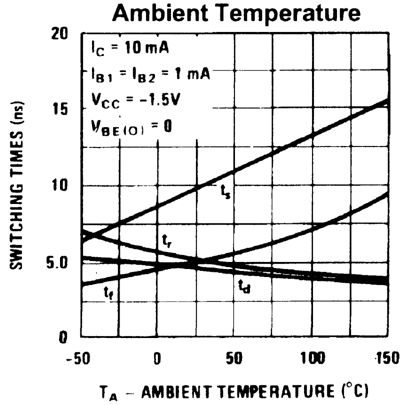
Contours of Constant Gain Bandwidth Product (f_T)



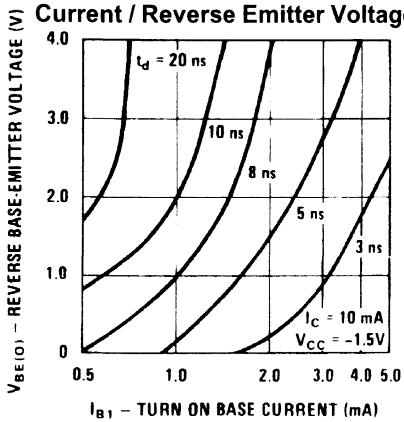
Switching Times vs. Collector Current



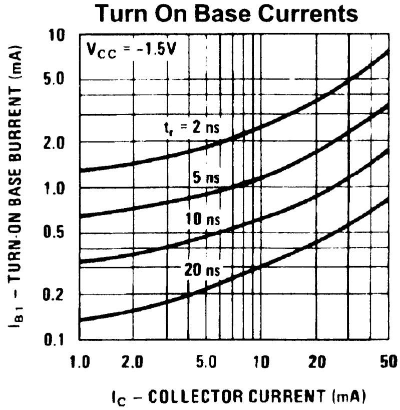
Switching Times vs. Ambient Temperature



Delay Time vs. Turn On Base Current / Reverse Emitter Voltage



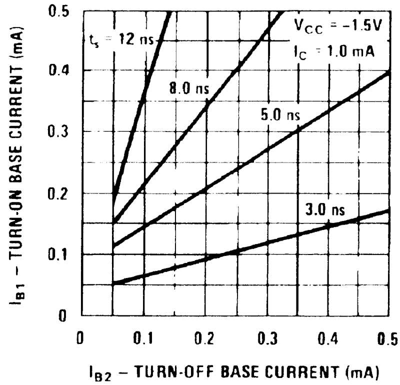
Rise Time vs. Collector and Turn On Base Currents



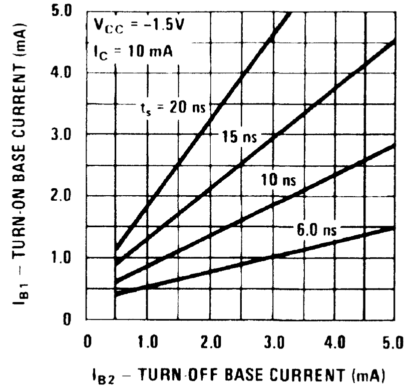
PNP Switching Transistor
(continued)

AC Typical Characteristics (continued)

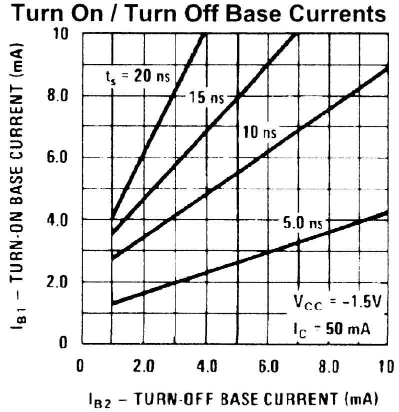
Storage Time vs. Turn On / Turn Off Base Currents



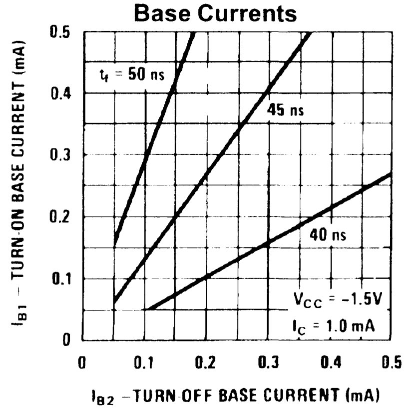
Storage Time vs. Turn On / Turn Off Base Currents



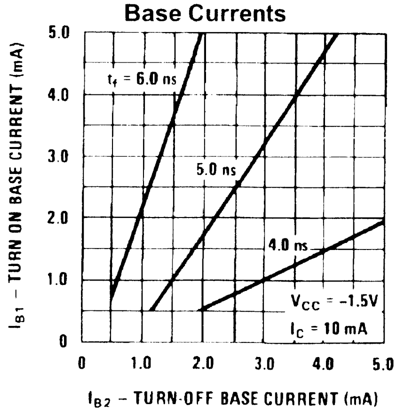
Storage Time vs. Turn On / Turn Off Base Currents



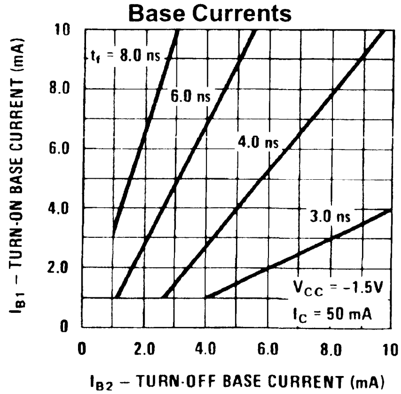
Fall Time vs. Turn On / Turn Off Base Currents



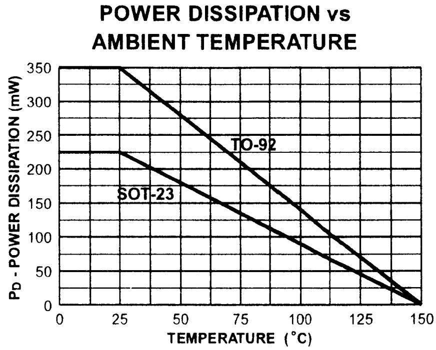
Fall Time vs. Turn On / Turn Off Base Currents



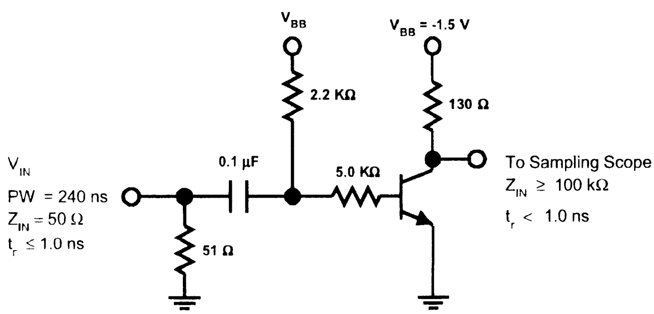
Fall Time vs. Turn On / Turn Off Base Currents



AC Typical Characteristics (continued)



Test Circuit



t_{ON}	t_{OFF}
V_{BB} = ground	V_{BB} = - 8.0 V
V_{IN} = - 5.8 V	V_{IN} = 9.8 V

I_C = 10 mA, I_{B1} = 1.0 mA, I_{B2} = 1.0 mA

FIGURE 1: t_{ON}, t_{OFF} Test Circuit

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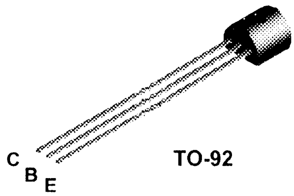
PN4356



TO-92

PNP General Purpose Amplifier

This device is designed for use as general purpose amplifiers and switches requiring collector currents to 500 mA. Sourced from Process 63. See PN2907A for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CES}	Collector-Emitter Voltage	80	V
V_{CBO}	Collector-Base Voltage	80	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	800	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		PN4356	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	°C/W

PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 10$ mA, $I_B = 0$	80		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu$A, $I_E = 0$	80		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu$A, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 50$ V, $I_E = 0$ $V_{CB} = 50$ V, $I_E = 0$, $T_A = 75$ °C		50 5.0	nA µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 4.0$ V, $I_C = 0$		100	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$V_{CE} = 10$ V, $I_C = 100\ \mu$A $V_{CE} = 10$ V, $I_C = 1.0$ mA $V_{CE} = 10$ V, $I_C = 10$ mA $V_{CE} = 10$ V, $I_C = 100$ mA $V_{CE} = 10$ V, $I_C = 500$ mA	25 40 50 40 30	 250 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA		0.15 0.5	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA		0.9 1.1	V V
SMALL SIGNAL CHARACTERISTICS					
C_{ob}	Output Capacitance	$V_{CB} = 10$ V, f = 1.0 MHz		30	pF
C_{ib}	Input Capacitance	$V_{BE} = 0.5$ V, f = 1.0 MHz		110	pF
h_{fe}	Small-Signal Current Gain	$I_C = 50$ mA, $V_{CE} = 10$ V, f = 100 MHz	1.0	5.0	
NF	Noise Figure	$V_{CE} = 10$ V, $I_C = 100\ \mu$A, $R_S = 1.0$ kΩ, f = 1.0 kHz, $B_W = 1.0$ Hz		3.0	dB
SWITCHING CHARACTERISTICS					
t_{on}	Turn-On Time	$V_{CC} = 30$ V, $I_C = 500$ mA,		100	ns
t_{off}	Turn-Off Time	$I_{B1} = I_{B2} = 50$ mA		400	ns

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

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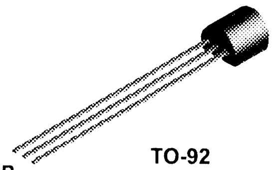
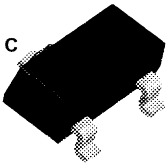
2N4401 MMBT4401



C B E TO-92



C E B SOT-23 Mark: 2X

NPN General Pupose Amplifier

This device is designed for use as a medium power amplifier and switch requiring collector currents up to 500 mA. Sourced from Process 19. See PN2222A for characteristics.

Absolute Maximum Ratings* TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	1.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N4401	*MMBT4401	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_B = 0$	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 0.1$ mA, $I_E = 0$	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 0.1$ mA, $I_C = 0$	6.0		V
I_{BL}	Base Cutoff Current	$V_{CE} = 35$ V, $V_{EB} = 0.4$ V		0.1	µA
I_{CEX}	Collector Cutoff Current	$V_{CE} = 35$ V, $V_{EB} = 0.4$ V		0.1	µA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 0.1$ mA, $V_{CE} = 1.0$ V $I_C = 1.0$ mA, $V_{CE} = 1.0$ V $I_C = 10$ mA, $V_{CE} = 1.0$ V $I_C = 150$ mA, $V_{CE} = 1.0$ V $I_C = 500$ mA, $V_{CE} = 2.0$ V	20 40 80 100 40	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA		0.4 0.75	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA	0.75	0.95 1.2	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 20$ mA, $V_{CE} = 10$ V, f = 100 MHz	250		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 5.0$ V, $I_E = 0$, f = 140 kHz		6.5	pF
C_{eb}	Emitter-Base Capacitance	$V_{BE} = 0.5$ V, $I_C = 0$, f = 140 kHz		30	pF
h_{ie}	Input Impedance	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	1.0	15	kΩ
h_{re}	Voltage Feedback Ratio	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	0.1	8.0	$\times 10^{-4}$
h_{fe}	Small-Signal Current Gain	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	40	500	
h_{oe}	Output Admittance	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	1.0	30	µmhos
SWITCHING CHARACTERISTICS					
t_d	Delay Time	$V_{CC} = 30$ V, $V_{EB} = 0.2$ V,		15	ns
t_r	Rise Time	$I_C = 150$ mA, $I_{B1} = 15$ mA		20	ns
t_s	Storage Time	$V_{CC} = 30$ V, $I_C = 150$ mA		225	ns
t_f	Fall Time	$I_{B1} = I_{B2} = 15$ mA		30	ns

*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle $\leq 2.0\%$

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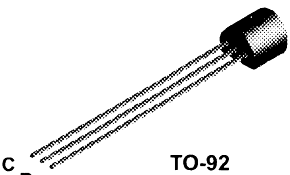
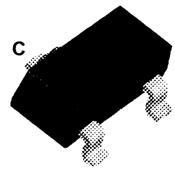
2N5086 2N5087 MMBT5086 MMBT5087



TO-92



SOT-23
Mark: 2P / 2Q

PNP General Purpose Amplifier

This device is designed for low level, high gain, low noise general purpose amplifier applications at collector currents to 50 mA. Sourced from Process 62.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	50	V
V_{CBO}	Collector-Base Voltage	50	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	100	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA= 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N5086 2N5086	*MMBT5086 *MMBT5087	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

Electrical Characteristics

TA= 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_B = 0$	50		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu A$, $I_E = 0$	50		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 10$ V, $I_E = 0$ $V_{CB} = 35$ V, $I_E = 0$		10 50	nA nA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = 3.0$ V, $I_C = 0$		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V **2N5086** **2N5087** $I_C = 1.0$ mA, $V_{CE} = 5.0$ V **2N5086** **2N5087** $I_C = 10$ mA, $V_{CE} = 5.0$ V **2N5086** **2N5087**	150 250 150 250 150 250	500 800	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA		0.3	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V		0.85	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 500\ \mu A$, $V_{CE} = 5.0$ V, f = 20 MHz	40		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 5.0$ V, $I_E = 0$, f = 100 kHz		4.0	pF
h_{fe}	Small-Signal Current Gain	$I_C = 1.0$ mA, $V_{CE} = 5.0$, **2N5086** f = 1.0 kHz **2N5087**	150 250	600 900	
NF	Noise Figure	$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V, **2N5086** $R_S = 3.0\ k\Omega$, f = 1.0 kHz **2N5087** $I_C = 20\ \mu A$, $V_{CE} = 5.0$ V, **2N5086** $R_S = 10\ k\Omega$, **2N5087** f = 10 Hz to 15.7 kHz		3.0 2.0 3.0 2.0	dB dB dB dB

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

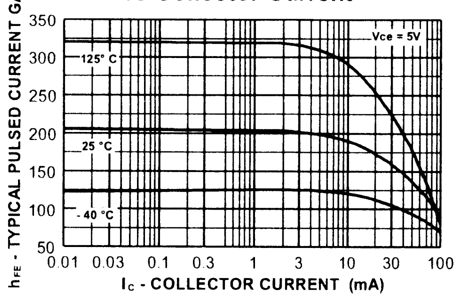
Spice Model

PNP (Is=6.734f Xti=3 Eg=1.11 Vaf=45.7 Bf=254.1 Ne=1.741 Ise=6.734f Ikf=.1962 Xtb=1.5 Br=2.683 Nc=2 Isc=0 Ikr=0 Rc=1.67 Cjc=6.2p Mjc=.301 Vjc=.75 Fc=.5 Cje=7.5p Mje=.2861 Vje=.75 Tr=10.1n Tf=467.8p Itf=.17 Vtf=5 Xtf=8 Rb=10)

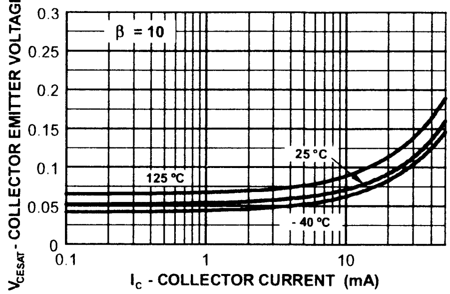
PNP General Purpose Amplifier
(continued)

DC Typical Characteristics

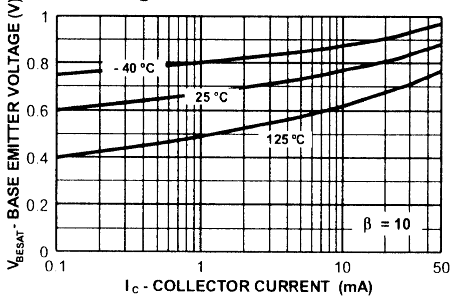
Typical Pulsed Current Gain vs Collector Current



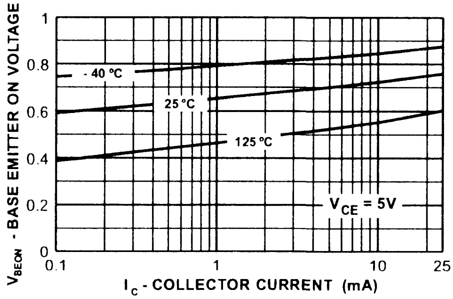
Collector-Emitter Saturation Voltage vs Collector Current



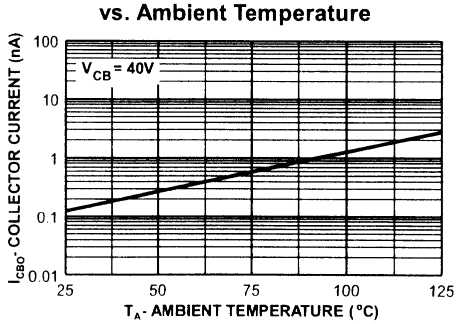
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

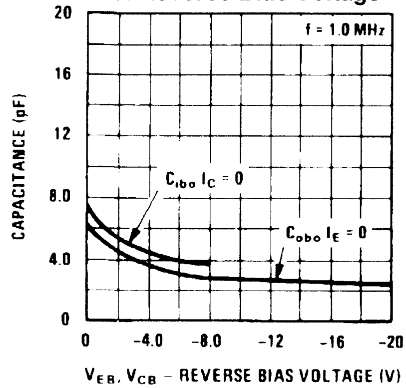


Collector-Cutoff Current vs. Ambient Temperature

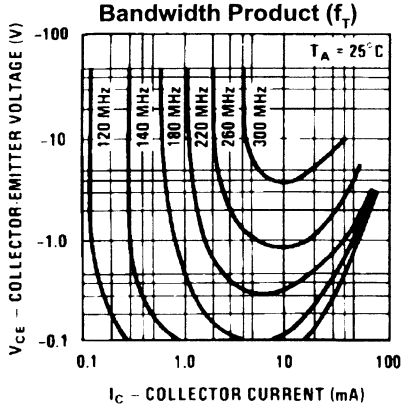


AC Typical Characteristics

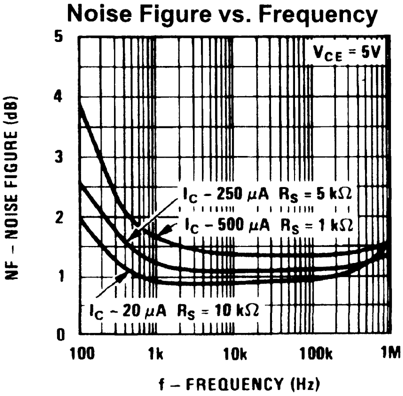
Input / Output Capacitance vs. Reverse Bias Voltage



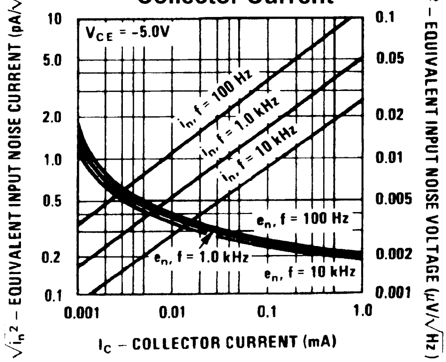
Contours of Constant Gain Bandwidth Product (f_T)



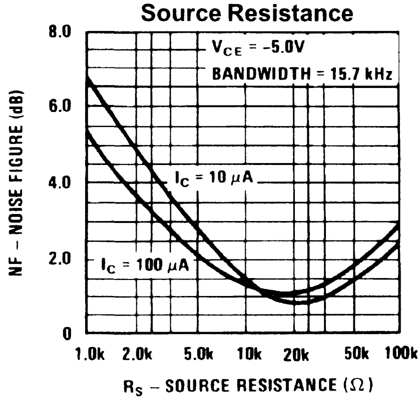
Noise Figure vs. Frequency



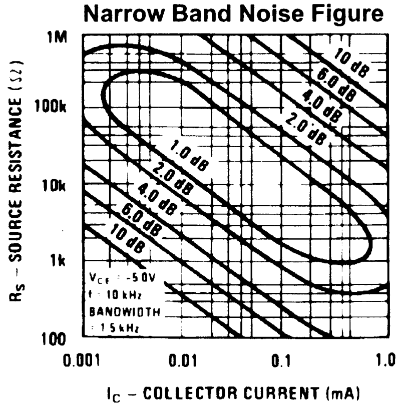
Equivalent Input Noise Voltage and Noise Current vs. Collector Current



Wideband Noise Figure vs. Source Resistance



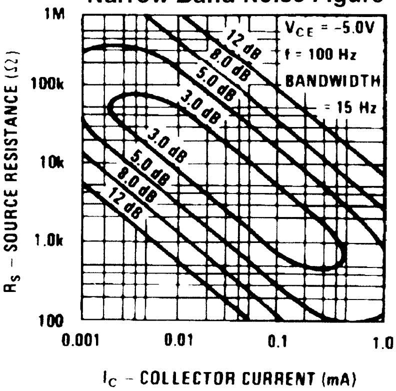
Contours of Constant Narrow Band Noise Figure



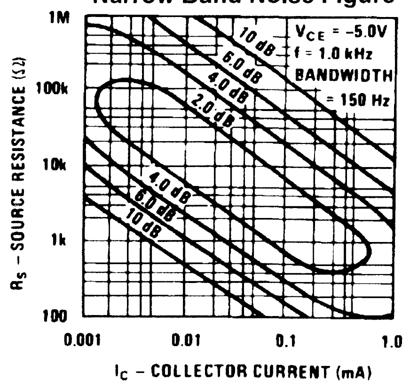
PNP General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

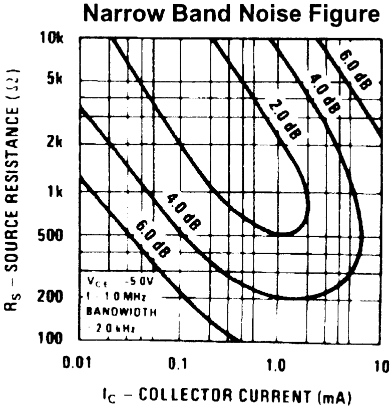
Contours of Constant Narrow Band Noise Figure



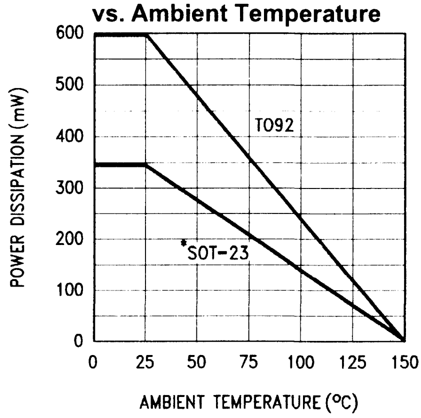
Contours of Constant Narrow Band Noise Figure



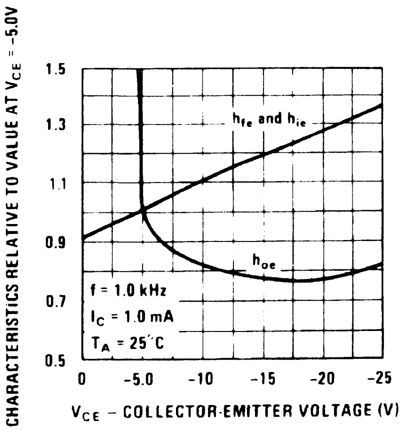
Contours of Constant Narrow Band Noise Figure

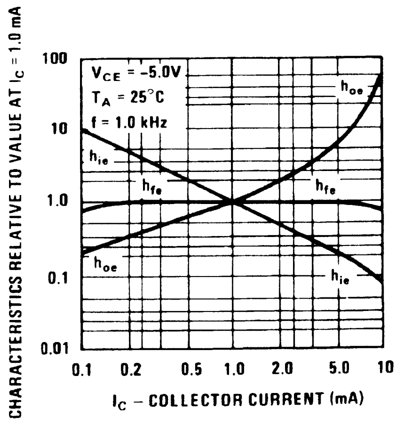


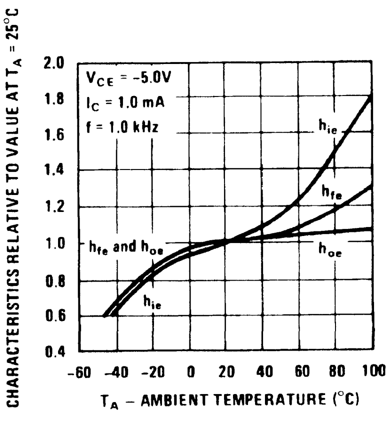
Maximum Power Dissipation vs. Ambient Temperature



Typical Common Emitter Characteristics (f = 1.0 kHz)







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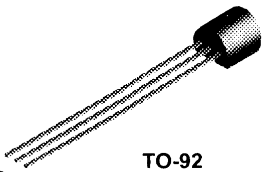
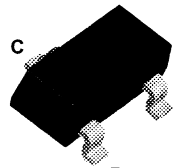
2N5088 2N5089

MMBT5088 MMBT5089



C B E TO-92



C E B SOT-23

Mark: 1Q / 1R

NPN General Purpose Amplifier

This device is designed for low noise, high gain, general purpose amplifier applications at collector currents from 1μA to 50 mA. Sourced from Process 07.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter		Value	Units
V_{CEO}	Collector-Emitter Voltage	**2N5088**	30	V
		2N5089	25	V
V_{CBO}	Collector-Base Voltage	**2N5088**	35	V
		2N5089	30	V
V_{EBO}	Emitter-Base Voltage		4.5	V
I_C	Collector Current - Continuous		100	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range		-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N5088 2N5089	***MMBT5088 *MMBT5089**	
P_D	Total Device Dissipation	625	350	mW
	Derate above 25°C	5.0	2.8	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN General Purpose Amplifier
(continued)

Electrical Characteristics

TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 1.0 mA, I_B = 0	**2N5088**	30		V
			2N5089	25		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	**2N5088**	35		V
			2N5089	30		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 20 V, I_E = 0	**2N5088**		50	nA
		V_{CB} = 15 V, I_E = 0	**2N5089**		50	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 3.0 V, I_C = 0			50	nA
		V_{EB} = 4.5 V, I_C = 0			100	nA
ON CHARACTERISTICS						
h_{FE}	DC Current Gain	I_C = 100 μA, V_{CE} = 5.0 V	**2N5088**	300	900	
			2N5089	400	1200	
		I_C = 1.0 mA, V_{CE} = 5.0 V	**2N5088**	350		
			2N5089	450		
		I_C = 10 mA, V_{CE} = 5.0 V*	**2N5088**	300		
			2N5089	400		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA			0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 10 mA, V_{CE} = 5.0 V			0.8	V
SMALL SIGNAL CHARACTERISTICS						
f_T	Current Gain - Bandwidth Product	I_C = 500 μA, V_{CE} = 5.0 mA, f = 20 MHz		50		MHz
C_{cb}	Collector-Base Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 100 kHz			4.0	pF
C_{eb}	Emitter-Base Capacitance	V_{BE} = 0.5 V, I_C = 0, f = 100 kHz			10	pF
h_{fe}	Small-Signal Current Gain	I_C = 1.0 mA, V_{CE} = 5.0 V,	**2N5088**	350	1400	
		f = 1.0 kHz	**2N5089**	450	1800	
NF	Noise Figure	I_C = 100 μA, V_{CE} = 5.0 V,	**2N5088**		3.0	dB
		R_S = 10 kΩ,	**2N5089**		2.0	dB
		f = 10 Hz to 15.7 kHz				

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

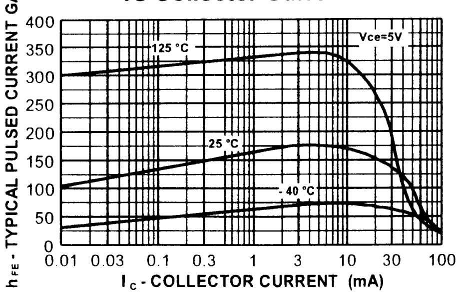
Spice Model

NPN (Is=5.911f Xti=3 Eg=1.11 Vaf=62.37 Bf=1.122K Ne=1.394 Ise=5.911f Ikf=14.92m Xtb=1.5 Br=1.271 Nc=2 Isc=0 Ikr=0 Rc=1.61 Cjc=4.017p Mjc=.3174 Vjc=.75 Fc=.5 Cje=4.973p Mje=.4146 Vje=.75 Tr=4.673n Tf=821.7p Itf=.35 Vtf=4 Xtf=7 Rb=10)

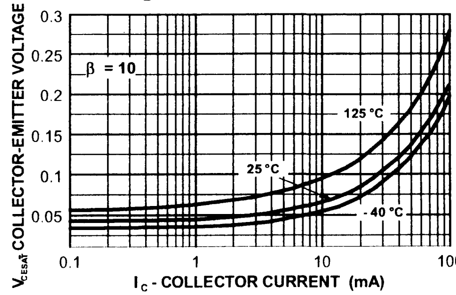
NPN General Purpose Amplifier
(continued)

DC Typical Characteristics

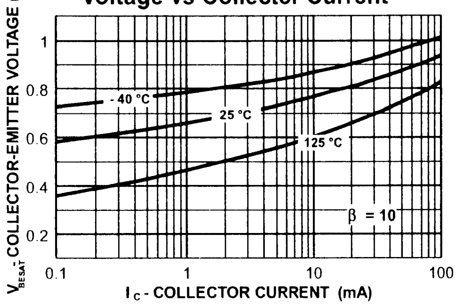
Typical Pulsed Current Gain vs Collector Current



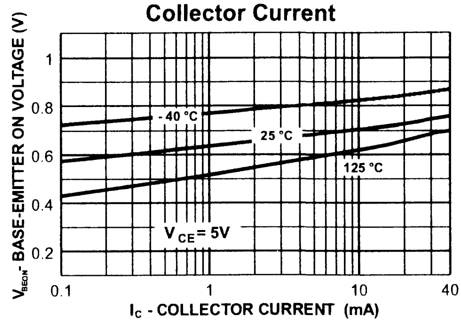
Collector-Emitter Saturation Voltage vs Collector Current



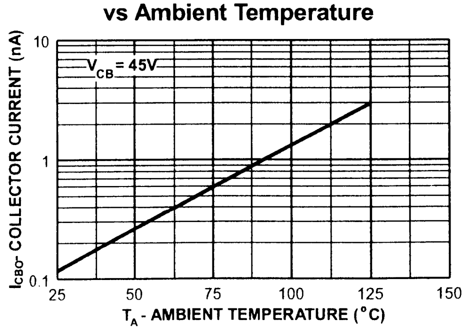
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

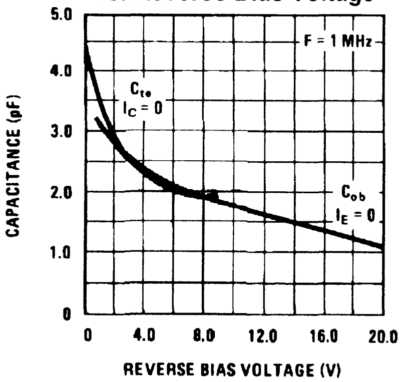


Collector-Cutoff Current vs Ambient Temperature

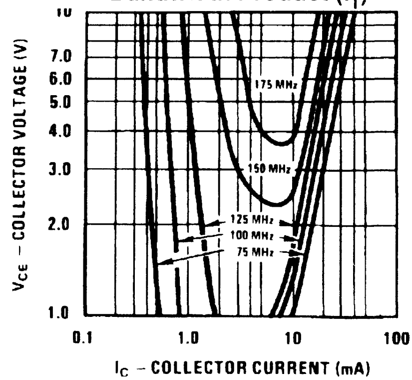


AC Typical Characteristics

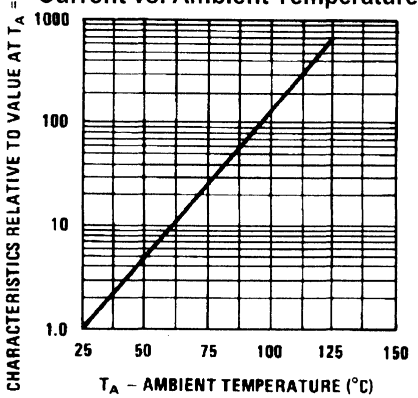
Input / Output Capacitance vs. Reverse Bias Voltage



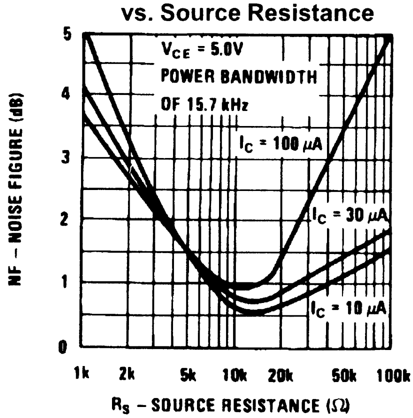
Contours of Constant Gain Bandwidth Product (f_T)



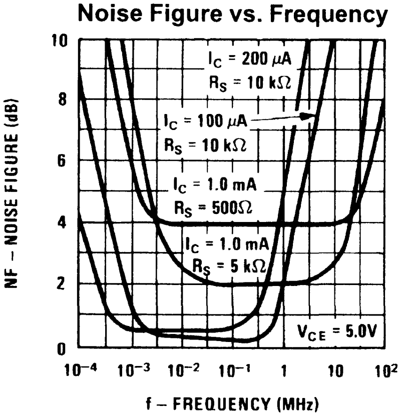
Normalized Collector Cutoff Current vs. Ambient Temperature



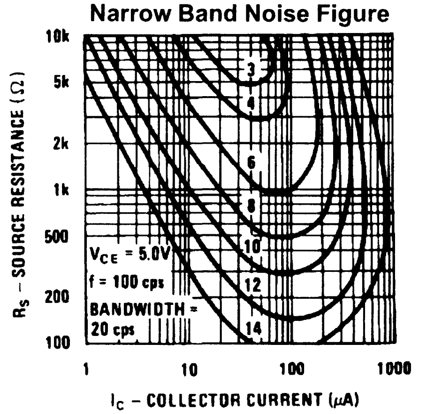
Wideband Noise Figure vs. Source Resistance



Noise Figure vs. Frequency



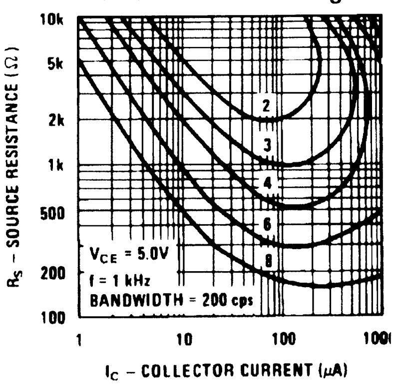
Contours of Constant Narrow Band Noise Figure



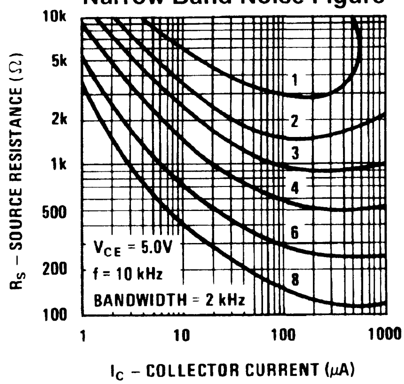
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

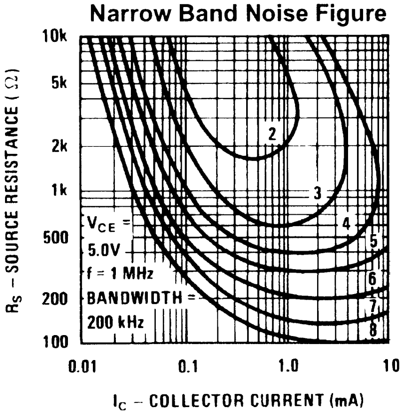
Contours of Constant Narrow Band Noise Figure



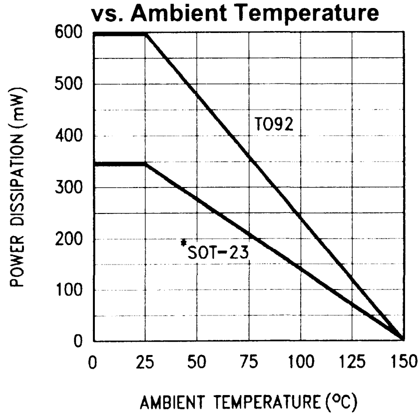
Contours of Constant Narrow Band Noise Figure



Contours of Constant Narrow Band Noise Figure

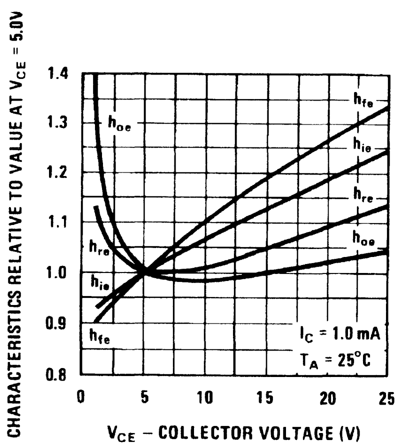


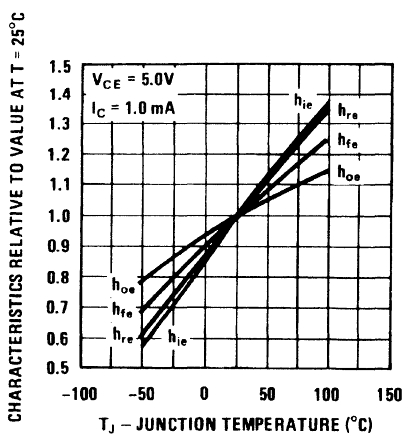
Maximum Power Dissipation vs. Ambient Temperature

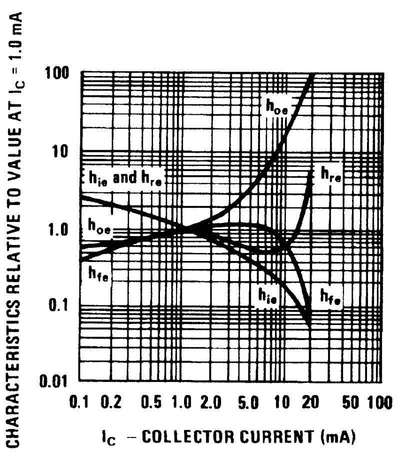


NPN General Purpose Amplifier
(continued)

Typical Common Emitter Characteristics (f = 1.0 kHz)







5

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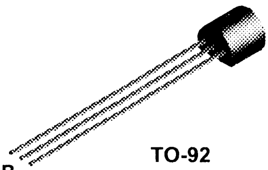
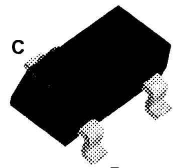
MPS5179 MMBT5179



TO-92



SOT-23
Mark: 3C

NPN RF Transistor

This device is designed for use in low noise UHF/VHF amplifiers with collector currents in the 100 μA to 30 mA range in common emitter or common base mode of operation, and in low frequency drift, high ouput UHF oscillators. Sourced from Process 40.

Absolute Maximum Ratings*
TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	12	V
V_{CBO}	Collector-Base Voltage	20	V
V_{EBO}	Emitter-Base Voltage	2.5	V
I_C	Collector Current - Continuous	50	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics
TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		MPS5179	*MMBT5179	
P_D	Total Device Dissipation	350	225	mW
	Derate above 25°C	2.8	1.8	mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN RF Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{CEO(sus)}$	Collector-Emitter Sustaining Voltage*	I_C = 3.0 mA, I_B = 0	12		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 1.0 μA, I_E = 0	20		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	2.5		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 15 V, I_E = 0 V_{CB} = 15 V, T_A = 150°C		0.02 1.0	μA μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 3.0 mA, V_{CE} = 1.0 V	25	250	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA		0.4	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA		1.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 5.0 mA, V_{CE} = 6.0 V, f = 100 MHz	900	2000	MHz
C_{cb}	Collector-Base Capacitance	V_{CB} = 10 V, I_E = 0, f = 0.1 to 1.0 MHz		1.0	pF
h_{fe}	Small-Signal Current Gain	I_C = 2.0 mA, V_{CE} = 6.0 V, f = 1.0 kHz	25	300	
$rb'C_C$	Collector Base Time Constant	I_C = 2.0 mA, V_{CB} = 6.0 V, f = 31.9 MHz	3.0	14	ps
NF	Noise Figure	I_C = 1.5 mA, V_{CE} = 6.0 V, R_S = 50Ω, f = 200 MHz		5.0	dB
FUNCTIONAL TEST					
G_{pe}	Amplifier Power Gain	V_{CE} = 6.0 V, I_C = 5.0 mA, f = 200 MHz	15		dB
P_O	Power Output	V_{CB} = 10 V, I_E = 12 mA, f ≥ 500 MHz	20		mW

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

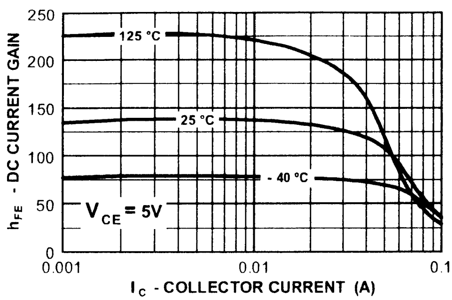
Spice Model

NPN (Is=69.28E-18 Xti=3 Eg=1.11 Vaf=100 Bf=282.1 Ne=1.177 Ise=69.28E-18 Ikf=22.03m Xtb=1.5 Br=1.176 Nc=2 Isc=0 Ikr=0 Rc=4 Cjc=1.042p Mjc=.2468 Vjc=.75 Fc=.5 Cje=1.52p Mje=.3223 Vje=.75 Tr=1.588n Tf=135.6p Itf=.27 Vtf=10 Xtf=30 Rb=10)

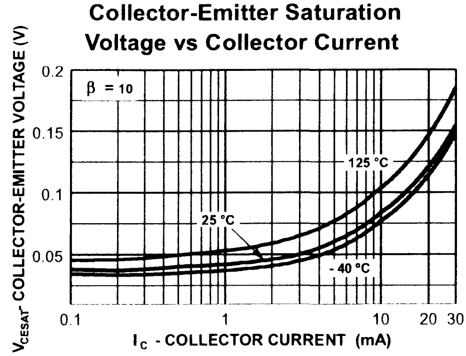
NPN RF Transistor
(continued)

DC Typical Characteristics

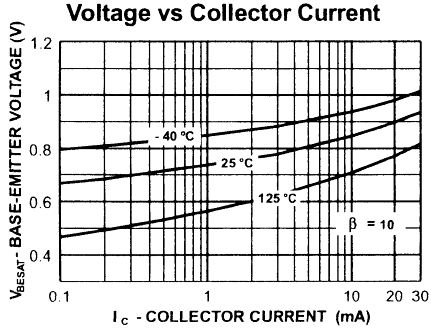
DC Current Gain vs Collector Current



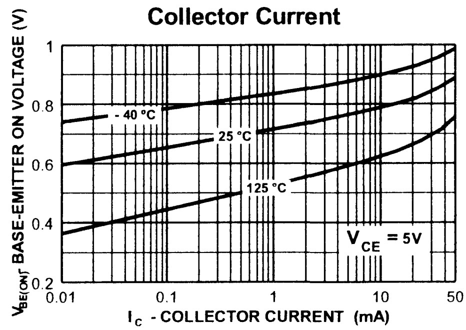
Collector-Emitter Saturation Voltage vs Collector Current



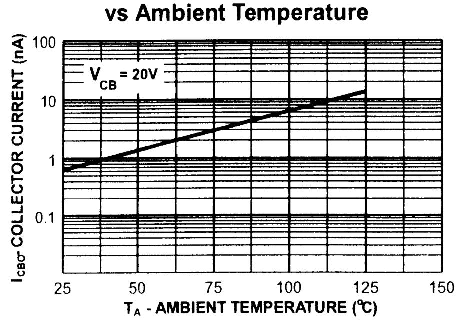
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

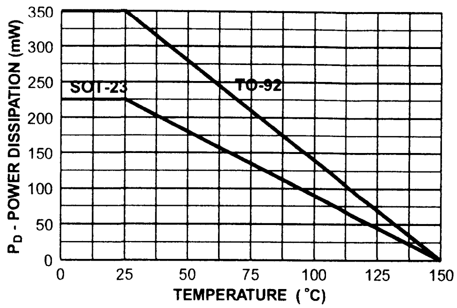


Collector-Cutoff Current vs Ambient Temperature

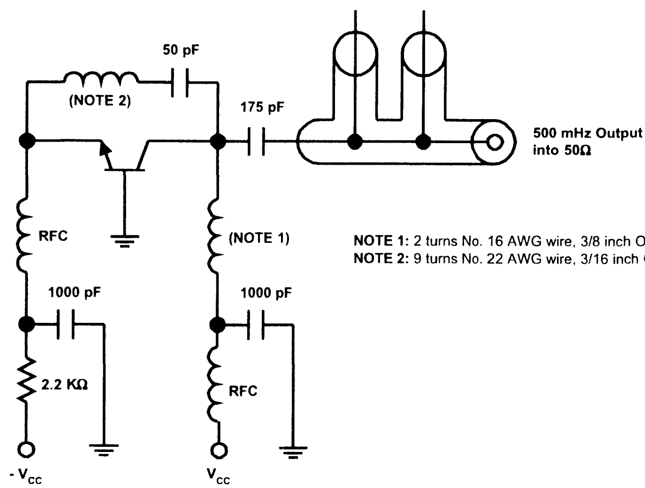


AC Typical Characteristics

POWER DISSIPATION vs
AMBIENT TEMPERATURE



Test Circuit



NOTE 1: 2 turns No. 16 AWG wire, 3/8 inch OD, 1 1/4 inch long
NOTE 2: 9 turns No. 22 AWG wire, 3/16 inch OD, 1/2 inch long

FIGURE 1: 500 MHz Oscillator Circuit

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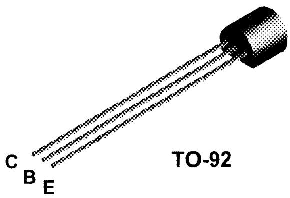
2N5210



NPN General Purpose Amplifier

This device is designed for low noise, high gain, general purpose amplifier applications at collector currents from 1µA to 50 mA. Sourced from Process 07. See 2N5088 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	50	V
V_{CBO}	Collector-Base Voltage	50	V
V_{EBO}	Emitter-Base Voltage	4.5	V
I_C	Collector Current - Continuous	100	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		2N5210	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	°C/W

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 1.0$ mA, $I_B = 0$	50		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 0.1$ mA, $I_E = 0$	50		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 35$ V, $I_E = 0$		50	nA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = 3.0$ V, $I_C = 0$		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 100\ \mu$A, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V*	200 250 250	600	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA		0.7	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V		0.85	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 500\ \mu$A, $V_{CE} = 5.0$ V, f= 20 MHz	30		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 5.0$ V, $I_E = 0$, f = 100 kHz		4.0	pF
h_{fe}	Small-Signal Current Gain	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V, f = 1.0 kHz	250	900	
NF	Noise Figure	$I_C = 20\ \mu$A, $V_{CE} = 5.0$ V, $R_S = 22\ k\Omega$, f = 10 Hz to 15.7 kHz $I_C = 20\ \mu$A, $V_{CE} = 5.0$ V, $R_S = 10\ k\Omega$, f = 1.0 kHz		2.0 3.0	dB dB

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

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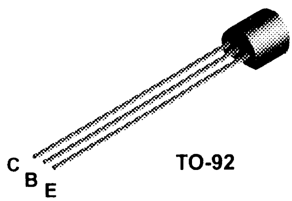
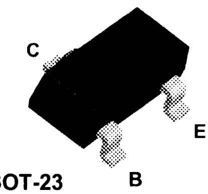
2N5401 MMBT5401



TO-92



SOT-23
Mark: 2L

PNP General Purpose Amplifier

This device is designed as a general purpose amplifier and switch for applications requiring high voltages. Sourced from Process 74.

Absolute Maximum Ratings* TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	150	V
V_{CBO}	Collector-Base Voltage	160	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N5401	*MMBT5401	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_B = 0$	150		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu$A, $I_E = 0$	160		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu$A, $I_C = 0$	5.0		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 120$ V, $I_E = 0$ $V_{CB} = 120$ V, $I_E = 0$, $T_A = 100°C$		50 50	nA µA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = 3.0$ V, $I_C = 0$		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V $I_C = 50$ mA, $V_{CE} = 5.0$ V	50 60 50	 240 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA		0.2 0.5	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA		1.0 1.0	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 10$ V, f = 100 MHz	100	300	MHz
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		6.0	pF
NF	Noise Figure	$I_C = 250\ \mu$A, $V_{CE} = 5.0$ V, $R_S = 1.0$ kΩ, f = 10 Hz to 15.7 kHz		8.0	dB

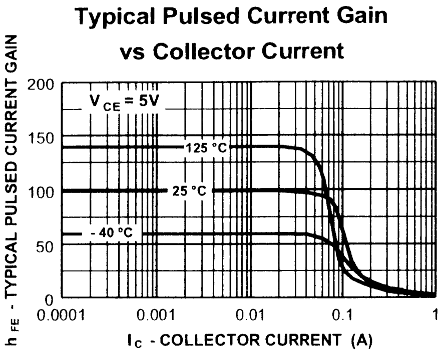
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%

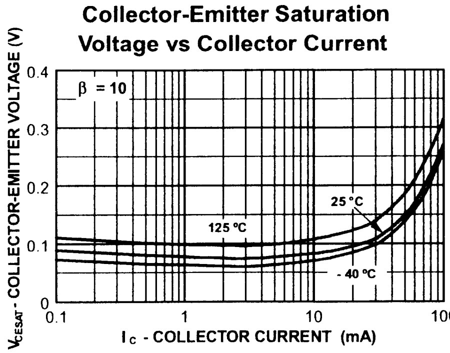
Spice Model

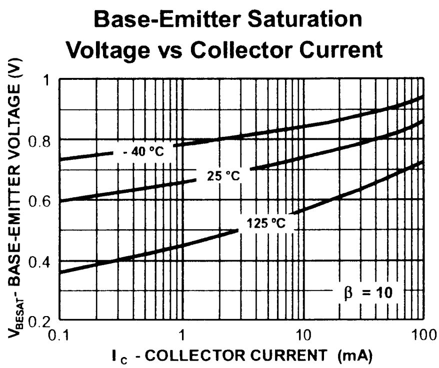
PNP (Is=21.48f Xti=3 Eg=1.11 Vaf=100 Bf=132.1 Ne=1.375 Ise=21.48f Ikf=.1848 Xtb=1.5 Br=3.661 Nc=2 Isc=0 Ikr=0 Rc=1.6 Cjc=17.63p Mjc=.5312 Vjc=.75 Fc=.5 Cje=73.39p Mje=.3777 Vje=.75 Tr=1.476n Tf=641.9p Itf=0 Vtf=0 Xtf=0 Rb=10)

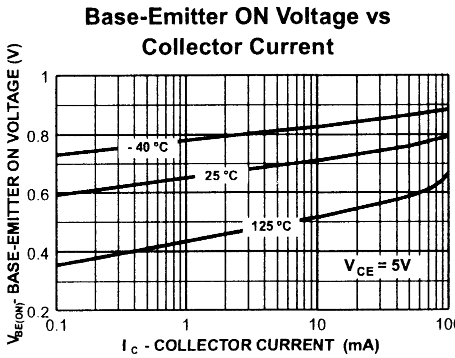
PNP General Purpose Amplifer
(continued)

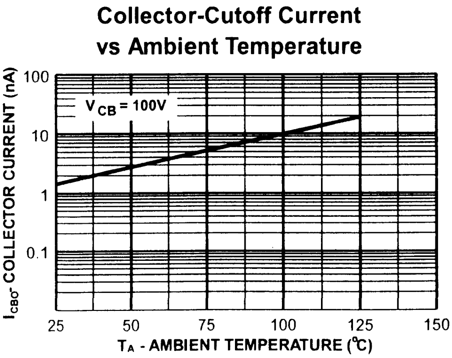
DC Typical Characteristics





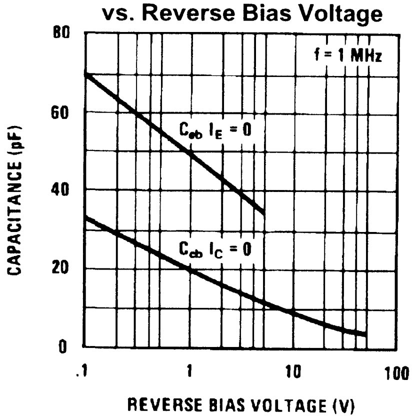




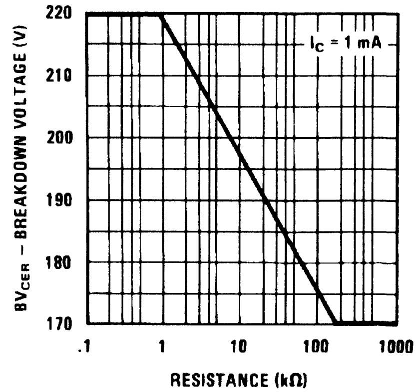


AC Typical Characteristics

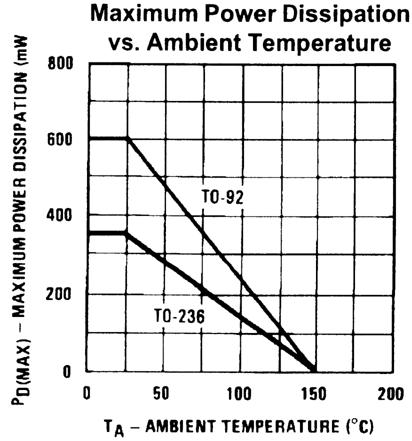
Input / Output Capacitance vs. Reverse Bias Voltage



Collector-Emitter Breakdown Voltage with Resistance Between Base-Emitter



Maximum Power Dissipation vs. Ambient Temperature



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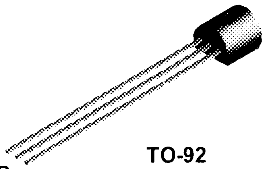
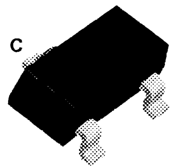
2N5551 MMBT5551


C B E

TO-92


C E B

SOT-23

Mark: 3S

NPN General Purpose Amplifier

This device is designed for general purpose high voltage amplifiers and gas discharge display driving. Sourced from Process 16.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	160	V
V_{CBO}	Collector-Base Voltage	180	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N5551	*MMBT5551	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage*	$I_C = 1.0$ mA, $I_B = 0$	160		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100$ μA, $I_E = 0$	180		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10$ μA, $I_C = 0$	6.0		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 120$ V, $I_E = 0$, $V_{CB} = 120$ V, $I_E = 0$, $T_A = 100°C$		50 50	nA μA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = 4.0$ V, $I_C = 0$		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V $I_C = 50$ mA, $V_{CE} = 5.0$ V	80 80 30	 250 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA		0.15 0.20	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA		1.0 1.0	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 10$ V, f = 100 MHz	100	300	MHz
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		6.0	pF
C_{ibo}	Input Capacitance	$V_{BE} = 0.5$ V, $I_C = 0$, f = 1.0 MHz		20	pF
h_{fe}	Small-Signal Current Gain	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	50	250	
NF	Noise Figure	$I_C = 250$ μA, $V_{CE} = 5.0$ V, R_S=1.0 kΩ, f=10 Hz to 15.7 kHz		8.0	dB

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

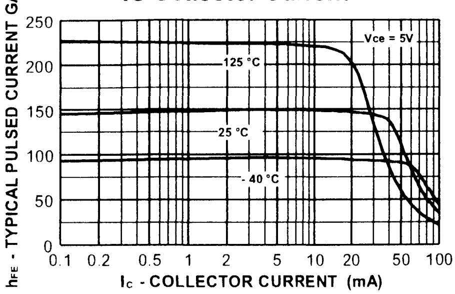
Spice Model

NPN (Is=2.511f Xti=3 Eg=1.11 Vaf=100 Bf=242.6 Ne=1.249 Ise=2.511f Ikf=.3458 Xtb=1.5 Br=3.197 Nc=2 Isc=0 Ikr=0 Rc=1 Cjc=4.883p Mjc=.3047 Vjc=.75 Fc=.5 Cje=18.79p Mje=.3416 Vje=.75 Tr=1.202n Tf=560p Itf=50m Vtf=5 Xtf=8 Rb=10)

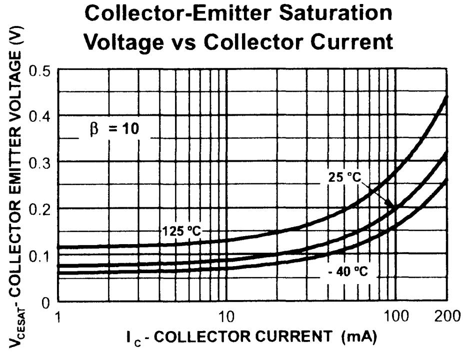
NPN General Purpose Amplifier
(continued)

DC Typical Characteristics

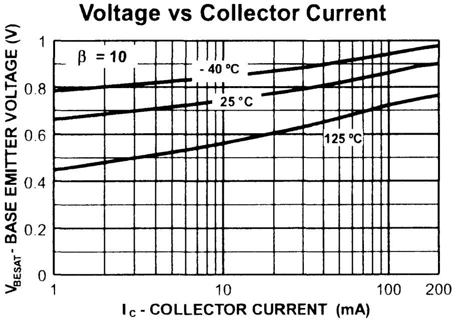
Typical Pulsed Current Gain vs Collector Current



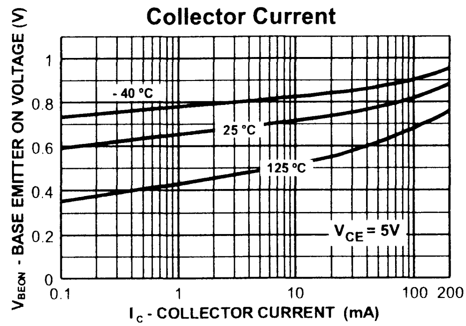
Collector-Emitter Saturation Voltage vs Collector Current



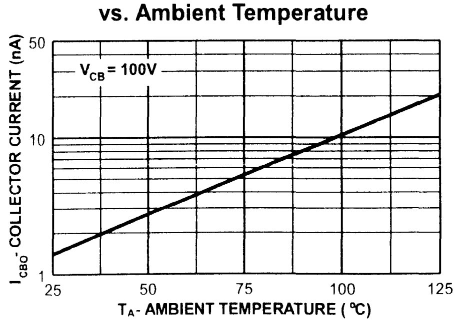
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

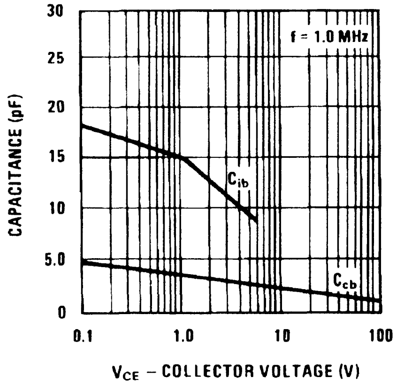


Collector-Cutoff Current vs. Ambient Temperature

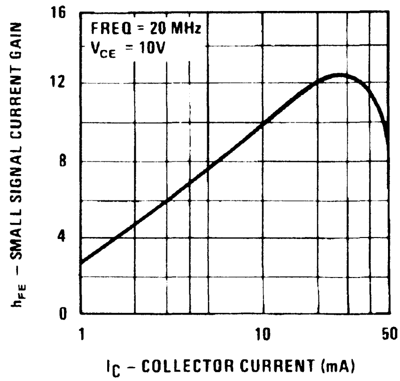


AC Typical Characteristics

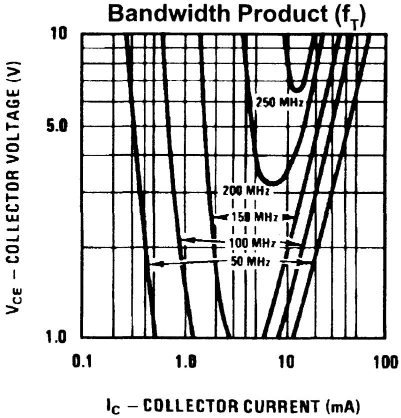
Input / Output Capacitance vs. Reverse Bias Voltage



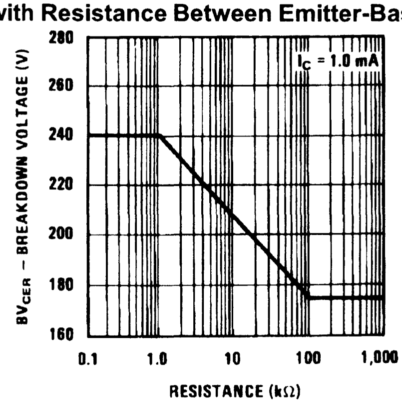
Small Signal Current Gain vs. Collector Current



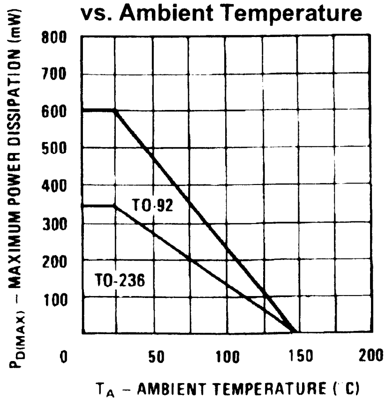
Contours of Constant Gain Bandwidth Product (f_T)



Collector-Emitter Breakdown Voltage with Resistance Between Emitter-Base



Maximum Power Dissipation vs. Ambient Temperature



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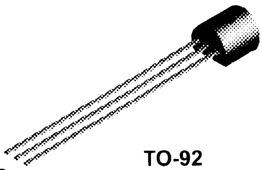
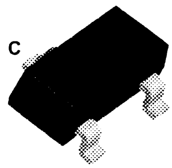
2N5771 MMBT5771



C B E TO-92



C E B SOT-23 Mark: 3R

PNP Switching Transistor

This device is designed for very high speed saturate switching at collector currents to 100 mA. Sourced from Process 65. See PN4258 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	15	V
V_{CBO}	Collector-Base Voltage	15	V
V_{EBO}	Emitter-Base Voltage	4.5	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N5771	*MMBT5771	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

PNP Switching Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 3.0 mA, I_B = 0	15		V
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	I_C = 100 μA, V_{BE} = 0	15		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	15		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	4.5		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 8.0 V, I_E = 0		10	nA
I_{CES}	Collector Cutoff Current	V_{CE} = 8.0 V, V_{BE} = 0 V_{CE} = 8.0 V, V_{BE} = 0, T_A= 125°C		10 5.0	nA μA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 4.5 V, I_C = 0		1.0	μA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 1.0 mA, V_{CE} = 0.5 V I_C = 10 mA, V_{CE} = 0.3 V I_C = 10mA, V_{CE} = 0.3V, T_A = -55°C I_C = 50 mA, V_{CE} = 1.0 V	35 50 20 40	 120 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 1.0 mA, I_B = 0.1 mA I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA		0.15 0.18 0.6	V V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 1.0 mA, I_B = 0.1 mA I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA	 0.75 	0.8 0.95 1.5	V V V
SMALL SIGNAL CHARACTERISTICS					
C_{cb}	Collector-Base Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 140 kHz		3.0	pF
C_{eb}	Emitter-Base Capacitance	V_{BE} = 0.5 V, I_C = 0, f = 140 kHz		3.5	pF
h_{fe}	Small-Signal Current Gain	I_C = 10 mA, V_{CE} = 10 V, f = 100 MHz	8.5		MHz
SWITCHING CHARACTERISTICS					
t_s	Storage Time	I_C = 10 mA, V_{CC} = 1.5 V, I_{B1} = I_{B2} = 1.0 mA		20	ns
t_{on}	Turn-On Time	I_C = 10 mA, V_{CC} = 1.5 V, I_B = 1.0 mA		15	ns
t_{off}	Turn-Off Time	I_C = 10 mA, V_{CC} = 1.5 V, I_{B1} = I_{B2} = 1.0 mA		20	ns

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

5

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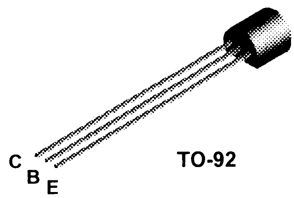
2N6427 MMBT6427



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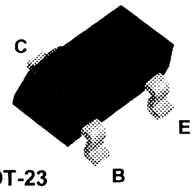

SOT-23
Mark: 1V

NPN Darlington Transistor

This device is designed for applications requiring extremely high current gain at collector currents to 1.0 A. Sourced from Process 05. See MPSA14 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	12	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N6427	*MMBT6427	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN Darlington Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 10 mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	12		V
I_{CEO}	Collector Cutoff Current	V_{CE} = 25 V, I_B = 0		1.0	μA
I_{CBO}	Collector Cutoff Current	V_{CB} = 30 V, I_E = 0		50	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 10 V, I_C = 0		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain*	I_C = 10 mA, V_{CE} = 5.0 V I_C = 100 mA, V_{CE} = 5.0 V I_C = 500 mA, V_{CE} = 5.0 V	10,000 20,000 14,000	100,000 200,000 140,000	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 50 mA, I_B = 0.5 mA I_C = 500 mA, I_B = 0.5 mA		1.2 1.5	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 500 mA, I_B = 0.5 mA		2.0	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 50 mA, V_{CE} = 5.0 mA		1.75	V
SMALL SIGNAL CHARACTERISTICS					
C_{obo}	Output Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		7.0	pF
C_{ibo}	Input Capcitance	V_{BE} = 1.0 V, I_C = 0, f = 1.0 MHz		15	pF

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

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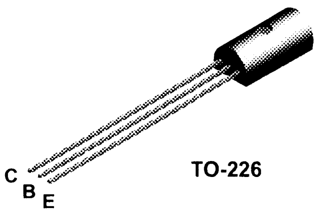
TN6714A NZT6714



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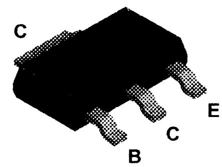


SOT-223

NPN General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 1.5 A. Sourced from Process 37.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	30	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	2.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		TN6714A	*NZT6714	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	50		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	125	125	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

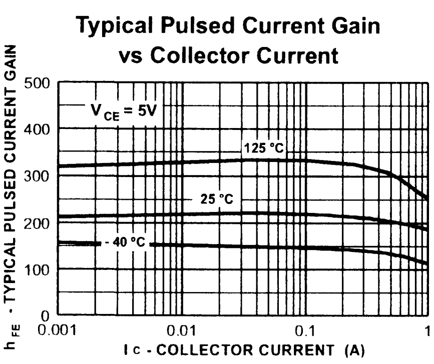
NPN General Purpose Amplifier
(continued)

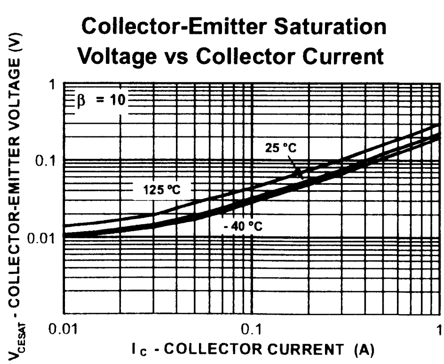
Electrical Characteristics
TA= 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 10 mA, I_B = 0	30		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 µA, I_E = 0	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 µA, I_C = 0	5.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 40 V, I_E = 0		0.1	µA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 5.0 V, I_C = 0		0.1	µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 10 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V I_C = 1.0 A, V_{CE} = 1.0 V	55 60 50	 250	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 1.0 A, I_B = 100 mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 1.0 A, V_{CE} = 1.0 V		1.2	V
SMALL SIGNAL CHARACTERISTICS					
h_{fe}	Small-Signal Current Gain	I_C = 50 mA, V_{CE} = 10 V, f = 20 MHz	2.5	25	
C_{cb}	Collector-Base Capacitance	V_{CB} = 10 mA, I_E = 0, f = 1.0 MHz		30	pF

*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

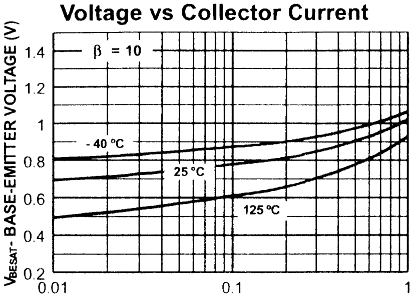




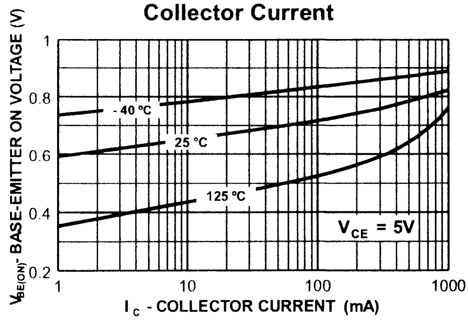
NPN General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

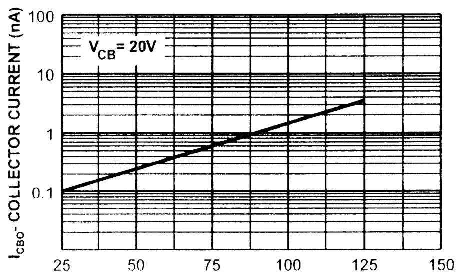
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

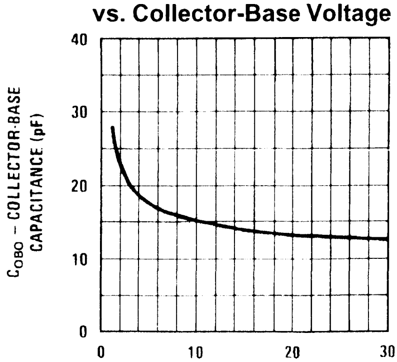


Collector-Cutoff Current vs Ambient Temperature

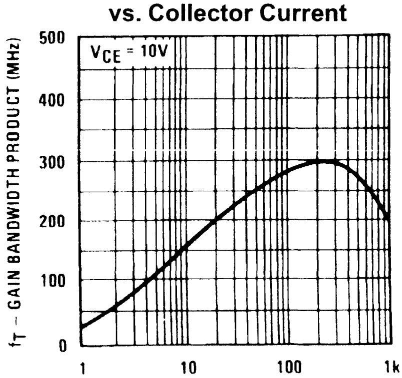


AC Typical Characteristics

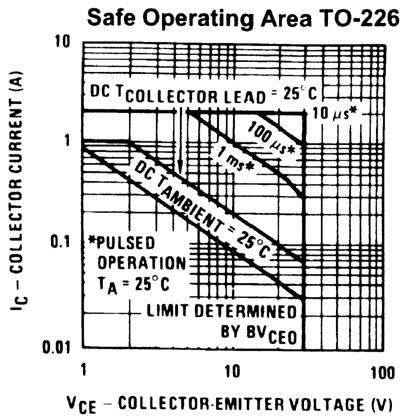
Collector-Base Capacitance vs. Collector-Base Voltage

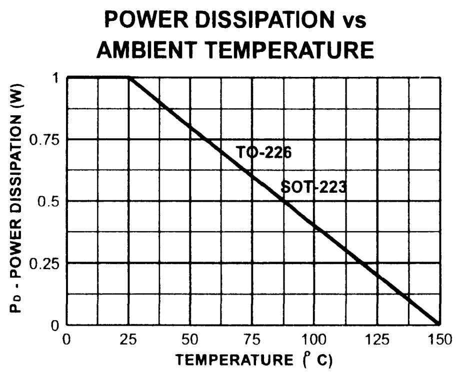


Gain Bandwidth Product vs. Collector Current



AC Typical Characteristics (continued)





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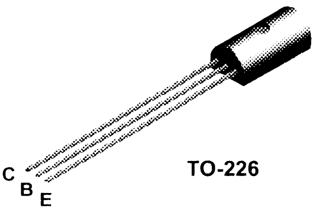
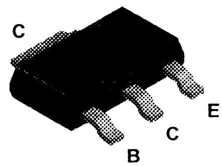
TN6715A NZT6715



TO-226



SOT-223

NPN General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 1.2 A. Sourced from Process 38.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	50	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.5	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		TN6715A	*NZT6715	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	50		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	125	125	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

NPN General Purpose Amplifier
(continued)

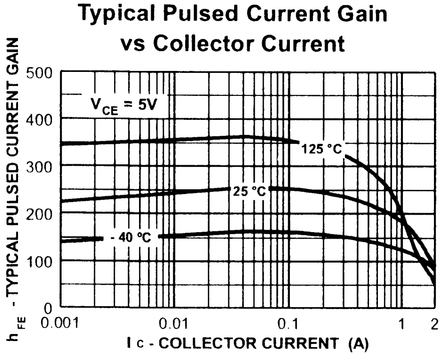
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 10 mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	50		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	5.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 50 V, I_E = 0		0.1	μA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 5.0 V, I_C = 0		0.1	μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 10 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V I_C = 1.0 A, V_{CE} = 1.0 V	55 60 50	 250	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 1.0 A, I_B = 100 mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 1.0 A, V_{CE} = 1.0 V		1.2	V
SMALL SIGNAL CHARACTERISTICS					
h_{fe}	Small-Signal Current Gain	I_C = 50 mA, V_{CE} = 10 V, f = 20 MHz	2.5	20	
C_{cb}	Collector-Base Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		30	pF

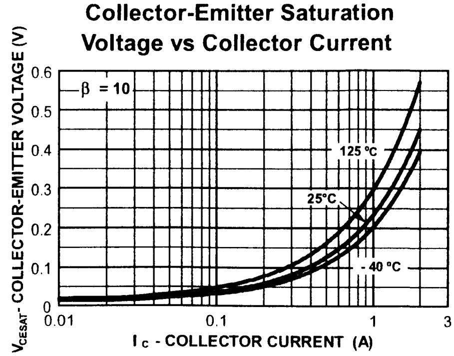
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



Collector-Emitter Saturation Voltage vs Collector Current



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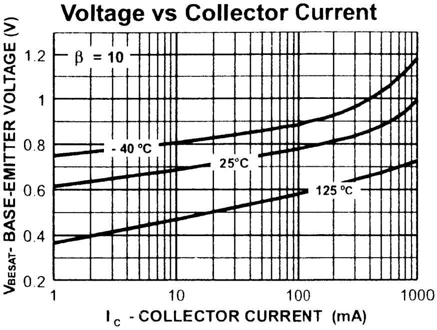
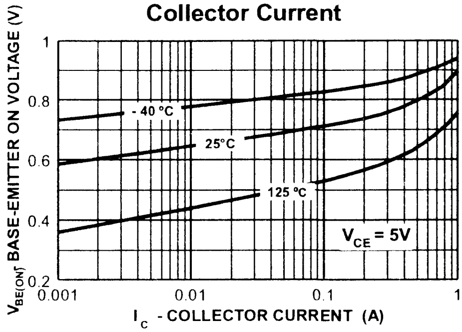
NPN General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

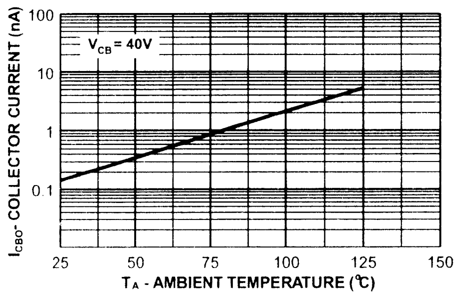
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

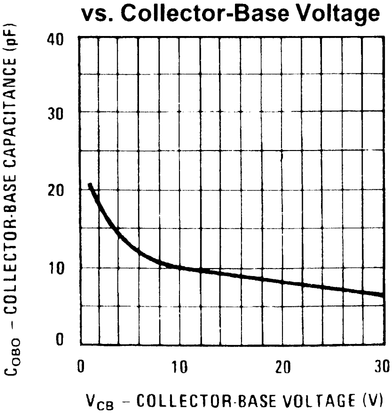


Collector-Cutoff Current vs Ambient Temperature

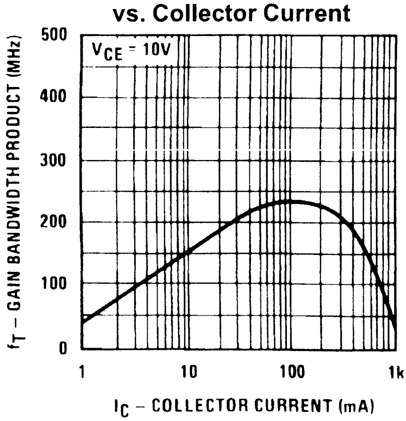


AC Typical Characteristics

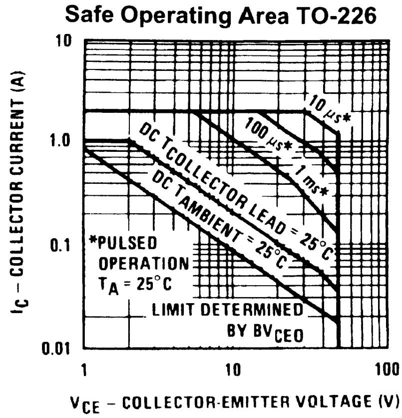
Collector-Base Capacitance vs. Collector-Base Voltage

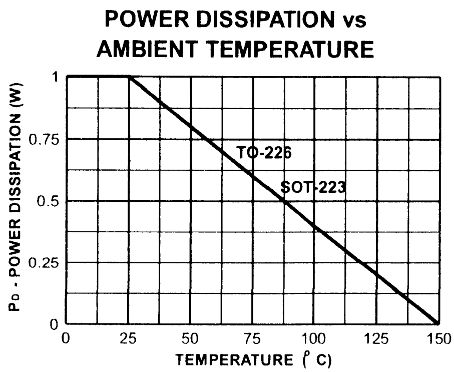


Gain Bandwidth Product vs. Collector Current



AC Typical Characteristics (continued)





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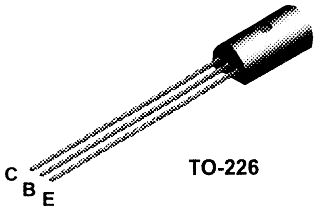
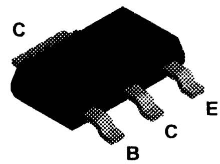
TN6717A NZT6717



TO-226



SOT-223

NPN General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 1.0 A. Sourced from Process 39.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	80	V
V_{CBO}	Collector-Base Voltage	80	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		TN6717A	*NZT6717	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	50		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	125	125	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

NPN General Purpose Amplifier
(continued)

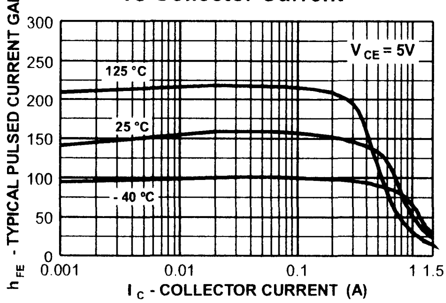
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_B = 0$	80		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100$ µA, $I_E = 0$	80		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 100$ µA, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 60$ V, $I_E = 0$		0.1	µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 5.0$ V, $I_C = 0$		0.1	µA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 50$ mA, $V_{CE} = 1.0$ V $I_C = 250$ mA, $V_{CE} = 1.0$ V	80 50	 250	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 250$ mA, $I_B = 100$ mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 250$ mA, $V_{CE} = 1.0$ V		1.2	V
SMALL SIGNAL CHARACTERISTICS					
h_{fe}	Small-Signal Current Gain	$I_C = 200$ mA, $V_{CE} = 5.0$ V, f = 20 MHz	2.5	25	
C_{cb}	Collector-Base Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		30	pF

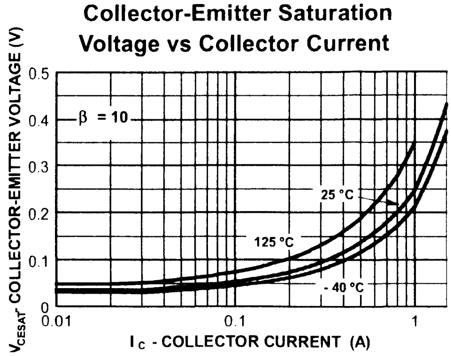
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



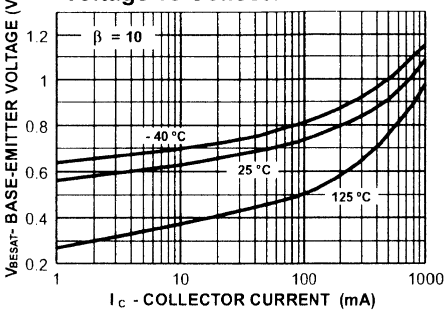
Collector-Emitter Saturation Voltage vs Collector Current



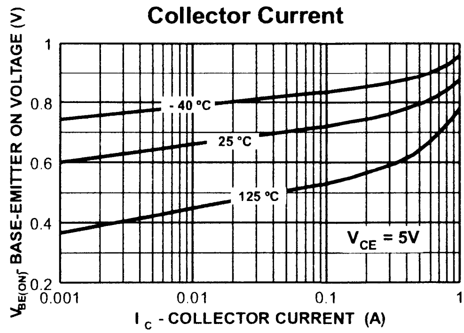
NPN General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

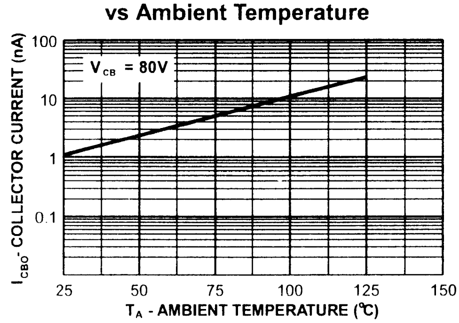
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

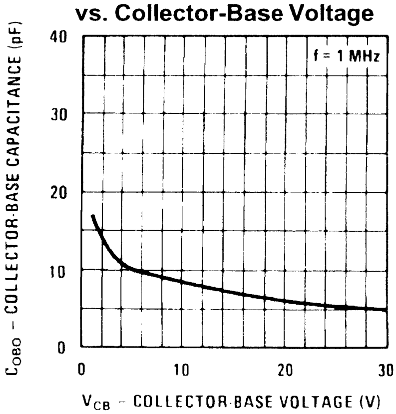


Collector-Cutoff Current vs Ambient Temperature

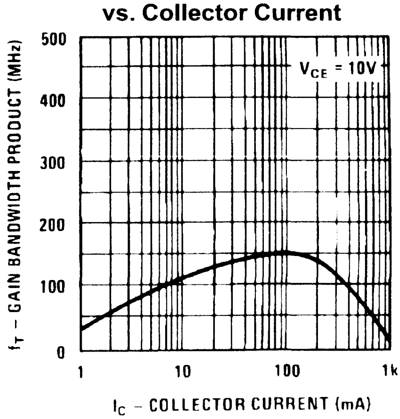


AC Typical Characteristics

Collector-Base Capacitance vs. Collector-Base Voltage

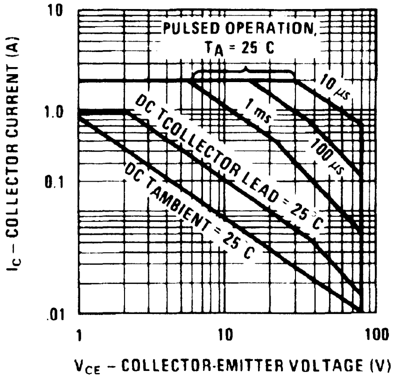


Gain Bandwidth Product vs. Collector Current

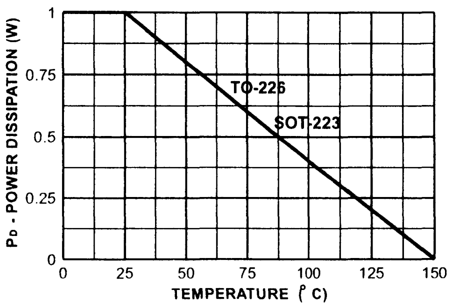


AC Typical Characteristics (continued)

Safe Operating Area TO-226



POWER DISSIPATION vs
AMBIENT TEMPERATURE



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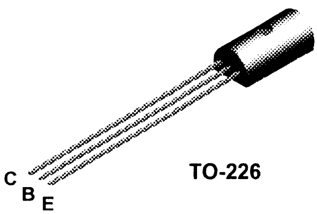
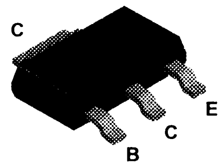
TN6726A NZT6726



TO-226



SOT-223

PNP General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 1.0 A. Sourced from Process 77.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	30	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.5	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		TN6726A	*NZT6726	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	50		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	125	125	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

Electrical Characteristics

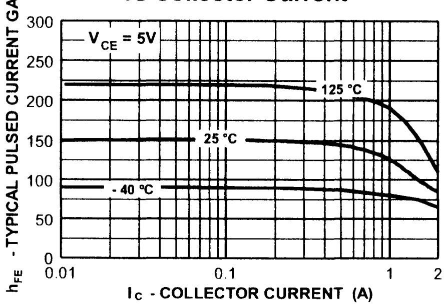
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 10 mA, I_B = 0	30		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	5.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 40 V, I_E = 0		0.1	μA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 5.0 V, I_C = 0		0.1	μA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 100 mA, V_{CE} = 1.0 V I_C = 1.0 A, V_{CE} = 1.0 V	60 50	 250	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 1.0 A, I_B = 100 mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 1.0 A, V_{CE} = 1.0 V		1.2	V
SMALL SIGNAL CHARACTERISTICS					
h_{fe}	Small-Signal Current Gain	I_C = 50 mA, V_{CE} = 10 V, f = 20 MHz	2.5	25	
C_{cb}	Collector-Base Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		30	pF

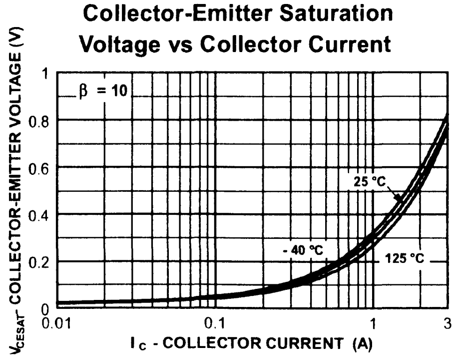
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



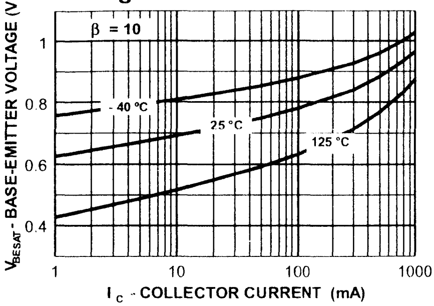
Collector-Emitter Saturation Voltage vs Collector Current



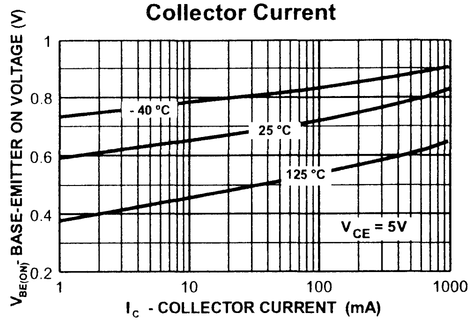
PNP General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

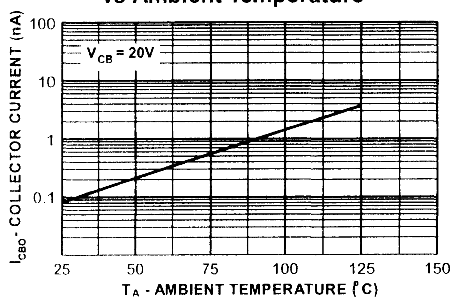
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

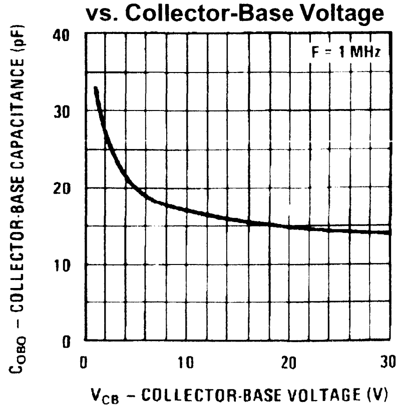


Collector-Cutoff Current vs Ambient Temperature

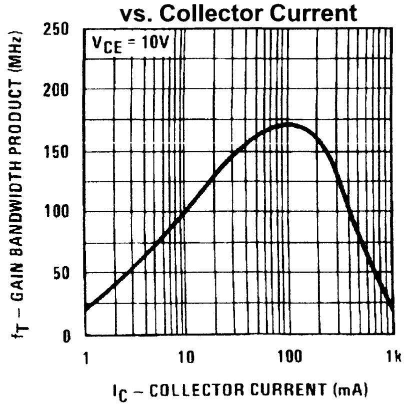


AC Typical Characteristics

Collector-Base Capacitance vs. Collector-Base Voltage

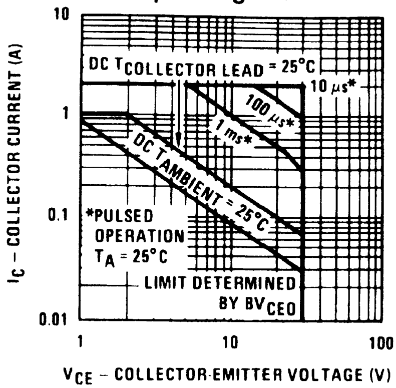


Gain Bandwidth Product vs. Collector Current

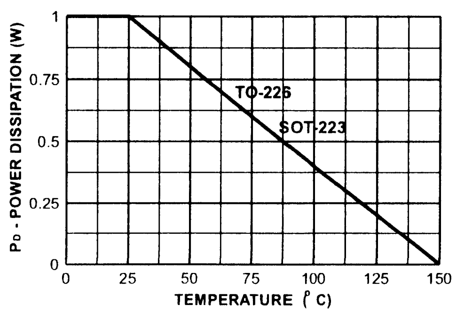


AC Typical Characteristics (continued)

Safe Operating Area TO-226



POWER DISSIPATION vs AMBIENT TEMPERATURE



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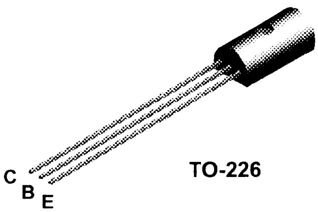
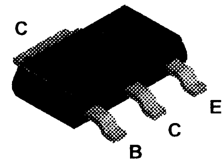
TN6728A NZT6728



TO-226



SOT-223

PNP General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 1.0 A. Sourced from Process 78.

Absolute Maximum Ratings* TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	60	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		TN6728A	*NZT6728	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	50		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	125	125	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

PNP General Purpose Amplifier
(continued)

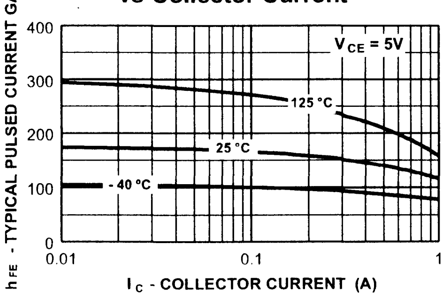
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	60		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu A$, $I_E = 0$	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 1.0$ mA, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 40$ V, $I_E = 0$		0.1	μA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 5.0$ V, $I_C = 0$		0.1	μA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 50$ mA, $V_{CE} = 1.0$ V $I_C = 250$ mA, $V_{CE} = 1.0$ V $I_C = 500$ mA, $V_{CE} = 1.0$ V	80 50 20	 250	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 250$ mA, $I_B = 10$ mA $I_C = 250$ mA, $I_B = 25$ mA		0.5 0.35	V V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 250$ mA, $V_{CE} = 1.0$ V		1.2	V
SMALL SIGNAL CHARACTERISTICS					
h_{fe}	Small-Signal Current Gain	$V_{CE} = 5.0$ V, $I_C = 200$ mA, f = 20 MHz	2.5	25	
C_{cb}	Collector-Base Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		30	pF

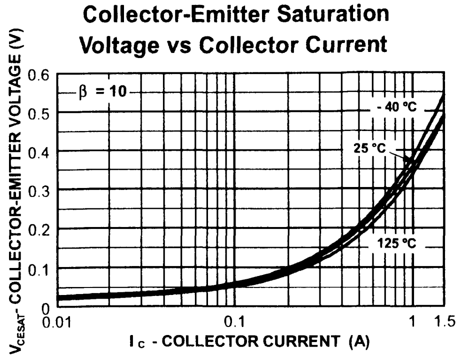
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



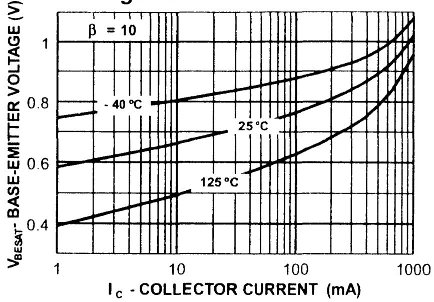
Collector-Emitter Saturation Voltage vs Collector Current



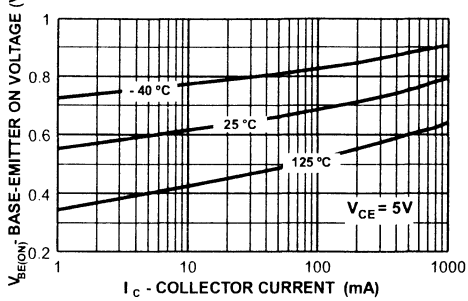
PNP General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

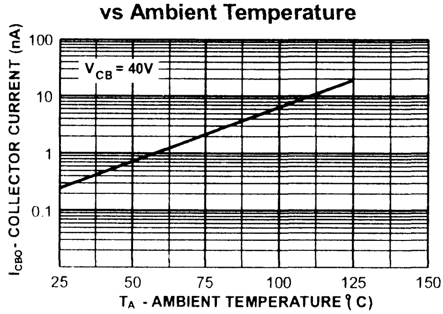
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

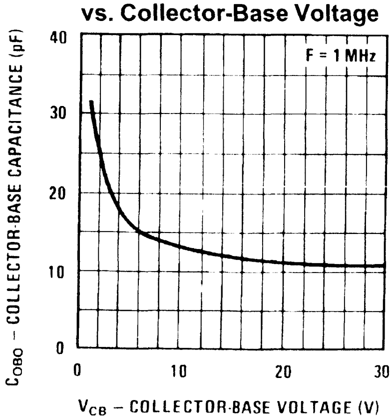


Collector-Cutoff Current vs Ambient Temperature

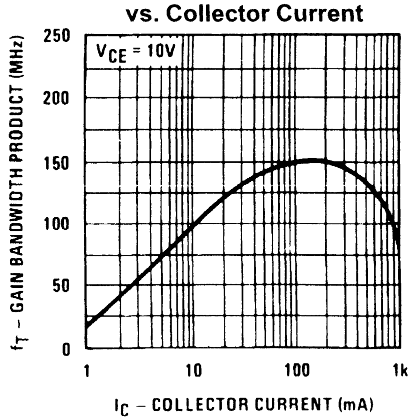


AC Typical Characteristics

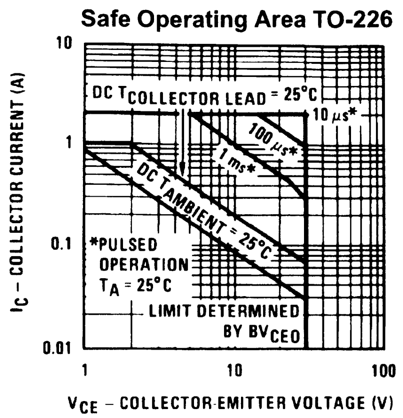
Collector-Base Capacitance vs. Collector-Base Voltage

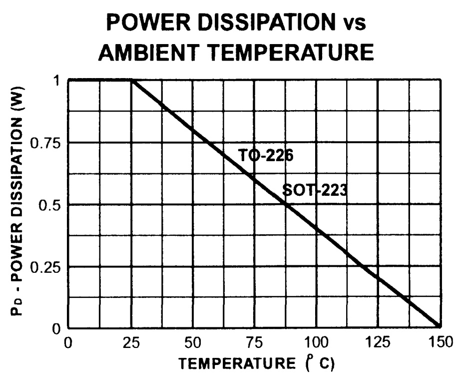


Gain Bandwidth Product vs. Collector Current



AC Typical Characteristics (continued)





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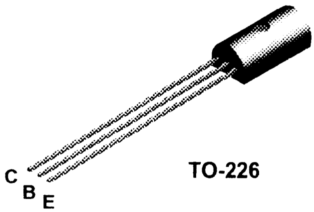
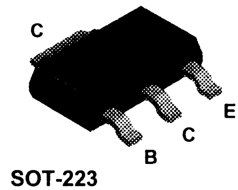
TN6729A NZT6729





PNP General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 800 mA. Sourced from Process 79.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	80	V
V_{CBO}	Collector-Base Voltage	80	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		TN6729A	*NZT6729	
P_D	Total Device Dissipation Derate above 25°C	1.0 8.0	1.0 8.0	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	50		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	125	125	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

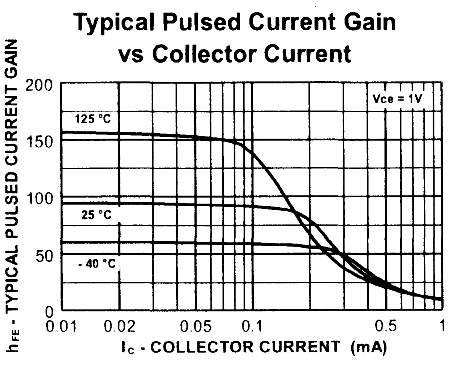
PNP General Purpose Amplifier
(continued)

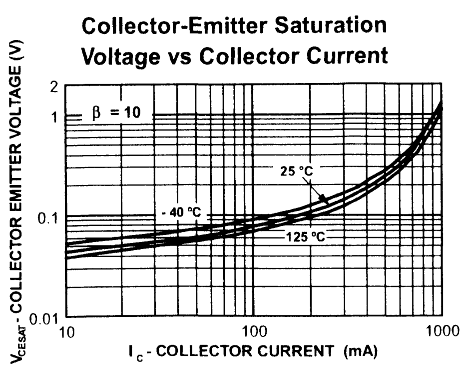
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 1.0 mA, I_B = 0	80		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	80		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 1.0 mA, I_C = 0	5.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 60 V, I_E = 0		0.1	μA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 5.0 V, I_C = 0		10	μA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 50 mA, V_{CE} = 1.0 V I_C = 250 mA, V_{CE} = 1.0 V I_C = 500 mA, V_{CE} = 1.0 V	80 50 20	 250 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 250 mA, I_B = 10 mA I_C = 250 mA, I_B = 25 mA		0.5 0.35	V V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 250 mA, V_{CE} = 1.0 V		1.2	V
SMALL SIGNAL CHARACTERISTICS					
h_{fe}	Small-Signal Current Gain	I_C = 200 mA, V_{CE} = 5.0 V, f = 20 MHz	2.5	25	
C_{cb}	Collector-Base Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		30	pF

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

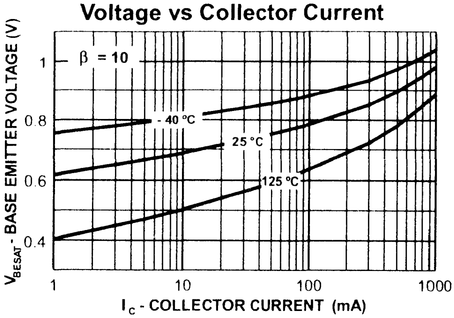




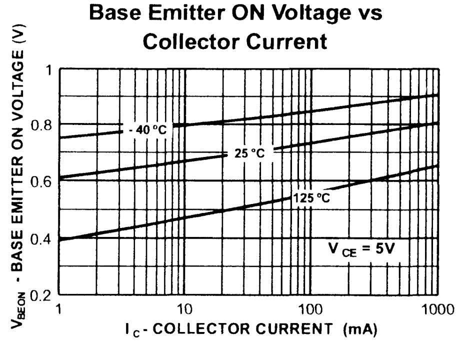
PNP General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

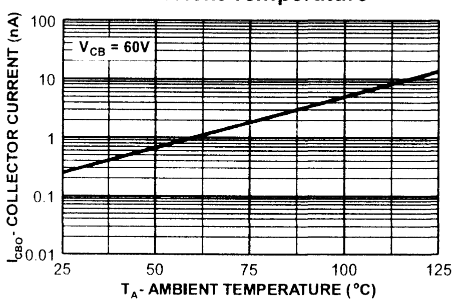
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

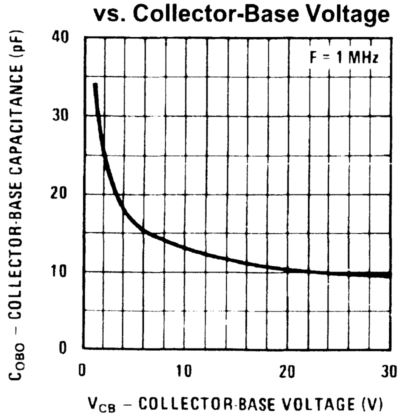


Collector-Cutoff Current vs. Ambient Temperature

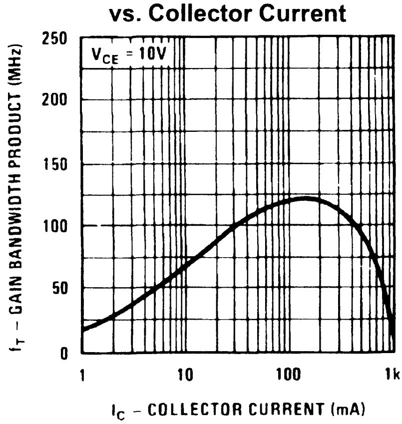


AC Typical Characteristics

Collector-Base Capacitance vs. Collector-Base Voltage

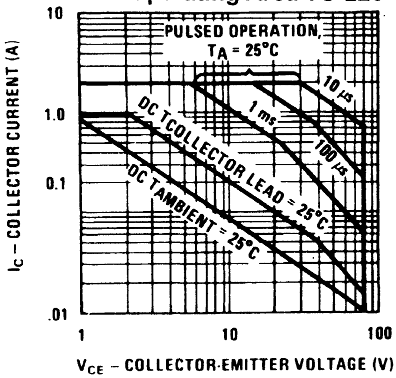


Gain Bandwidth Product vs. Collector Current

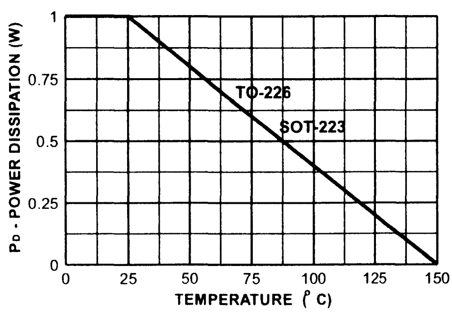


AC Typical Characteristics

Safe Operating Area TO-226



POWER DISSIPATION vs AMBIENT TEMPERATURE



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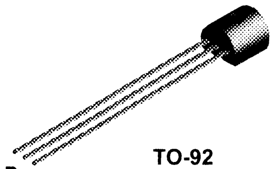
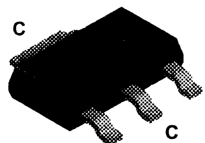
2N7052
2N7053

NZT7053





NPN Darlington Transistor

This device is designed for applications requiring extremely high gain at collector currents to 1.0 A and high breakdown voltage. Sourced from Process 06.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	100	V
V_{CBO}	Collector-Base Voltage	100	V
V_{EBO}	Emitter-Base Voltage	12	V
I_C	Collector Current - Continuous	1.5	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N7053	*NZT7053	
P_D	Total Device Dissipation	625	1,000	mW
	Derate above 25°C	5.0	8.0	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	125	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

NPN Darlington Transistor
(continued)

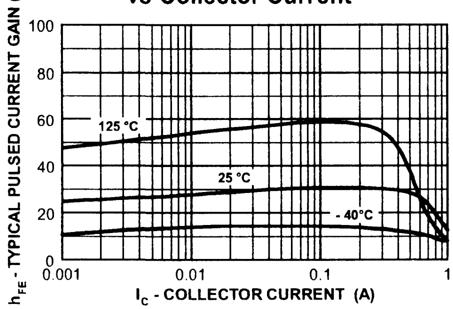
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_B = 0$	100		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu$A, $I_E = 0$	100		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 1.0$ mA, $I_C = 0$	12		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 80$ V, $I_E = 0$		0.1	µA
I_{CES}	Collector-Cutoff Current	$V_{CE} = 80$ V, $I_E = 0$		0.2	µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 7.0$ V, $I_C = 0$		0.1	µA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 100$ mA, $V_{CE} = 5.0$ V $I_C = 1.0$ A, $V_{CE} = 5.0$ V	10,000 1,000	 20,000	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 100$ mA, $I_B = 0.1$ mA		1.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 100$ mA, $V_{BE} = 5.0$ V		2.0	V
SMALL SIGNAL CHARACTERISTICS					
F_T	Transition Frequency	$I_C = 100$ mA, $V_{CE} = 5.0$ V,	200		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 10$ V, f = 1.0 MHz **2N7052** **2N7053**		10 8.0	pF

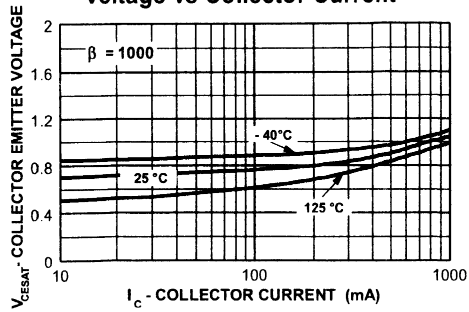
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



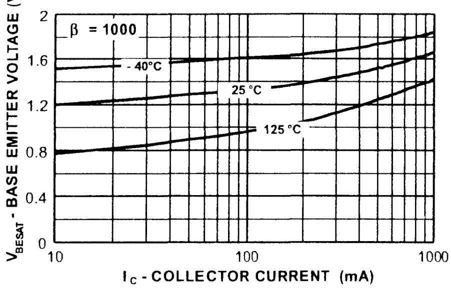
Collector-Emitter Saturation Voltage vs Collector Current



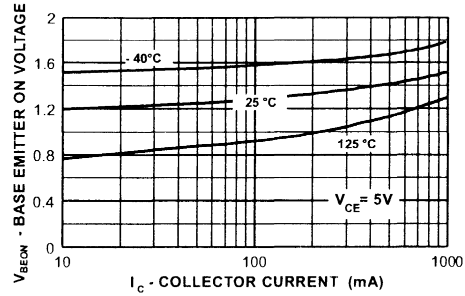
NPN Darlington Transistor
(continued)

DC Typical Characteristics (continued)

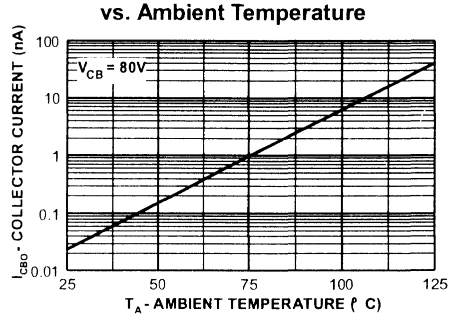
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

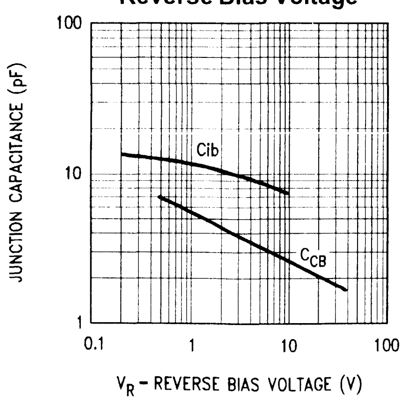


Collector-Cutoff Current vs. Ambient Temperature

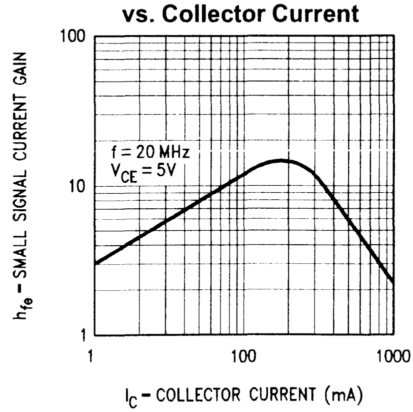


AC Typical Characteristics

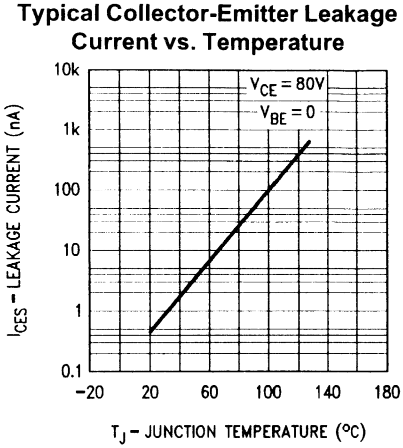
Junction Capacitance vs. Reverse Bias Voltage

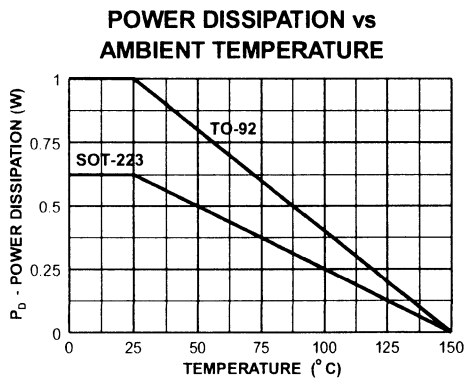


Small Signal Current Gain vs. Collector Current



AC Typical Characteristics (continued)





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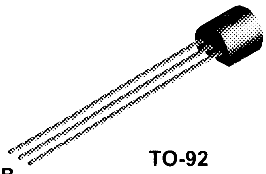
MPS8050



NPN General Purpose Amplifier

This device is designed for general purpose audio amplifier applications at collector currents to 500 mA. Sourced from Process 30.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	25	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	1.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MPS8050	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	°C/W

NPN General Purpose Amplifier
(continued)

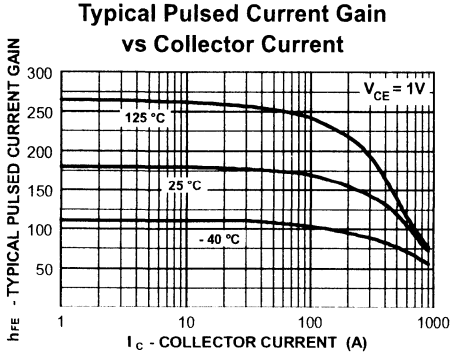
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage*	I_C = 30 mA, I_B = 0	25		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	6.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 35 V, I_E = 0		0.1	μA
I_{CES}	Collector-Cutoff Current	V_{CE} = 20 V, I_E = 0		75	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 5.0 mA, V_{CE} = 1.0 I_C = 100 mA, V_{CE} = 1.0 I_C = 800 mA, V_{CE} = 1.0	45 80 40	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 800 mA, I_B = 80 mA		0.5	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 800 mA, I_B = 80 mA		1.2	V

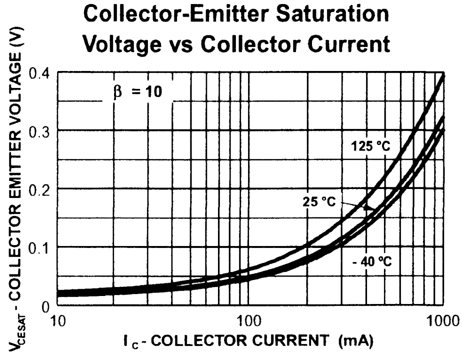
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

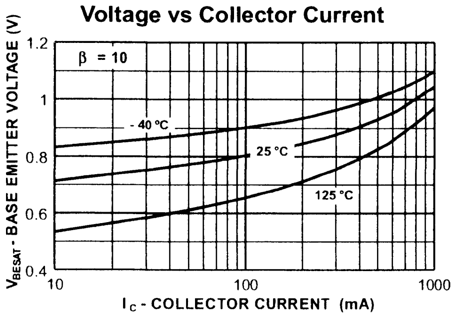
Typical Pulsed Current Gain vs Collector Current



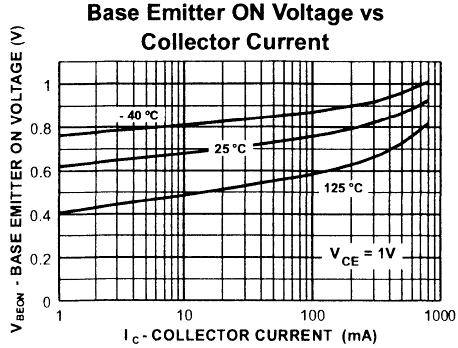
Collector-Emitter Saturation Voltage vs Collector Current



Base-Emitter Saturation Voltage vs Collector Current



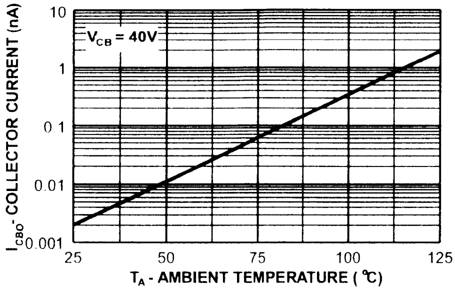
Base Emitter ON Voltage vs Collector Current



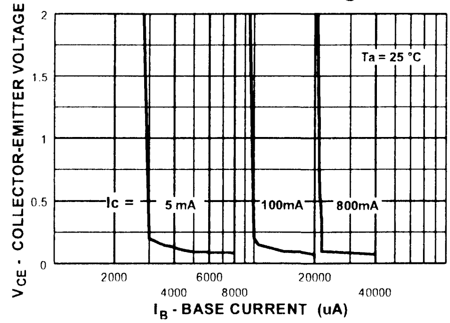
NPN General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

Collector-Cutoff Current vs. Ambient Temperature

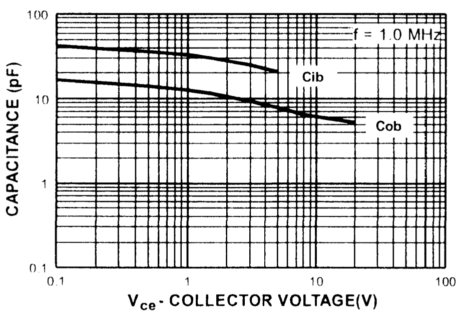


Collector Saturation Region

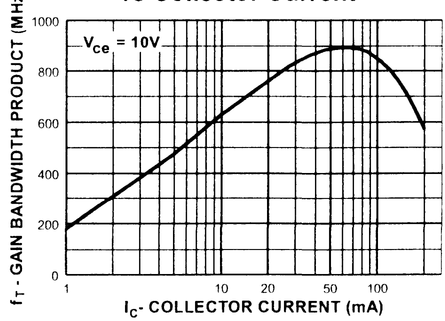


AC Typical Characteristics

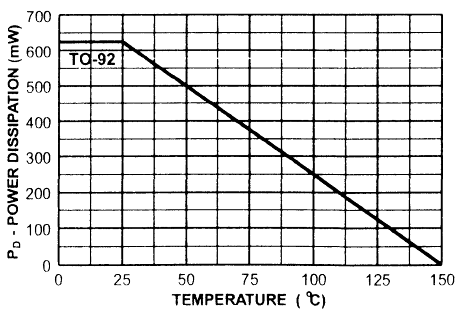
Input and Output Capacitance vs Reverse Voltage



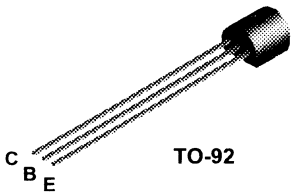
Gain Bandwidth Product vs Collector Current



POWER DISSIPATION vs AMBIENT TEMPERATURE



MPS8550



TO-92

PNP General Purpose Amplifier

This device is designed for general purpose audio amplifier applications at collector currents to 500 mA. Sourced from Process 60.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	25	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	800	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		MPS8550	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	°C/W

PNP General Purpose Amplifier
(continued)

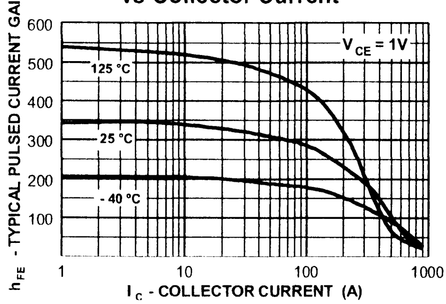
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage*	I_C = 30 mA, I_B = 0	25		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	6.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 35 V, I_E = 0		0.1	μA
I_{CES}	Colector-Cutoff Current	V_{CE} = 20 V, I_E = 0		75	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 5.0 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V I_C = 800 mA, V_{CE} = 1.0 V	45 85 40	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 800 mA, I_B = 80 mA		0.5	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 800 mA, I_B = 80 mA		1.2	V

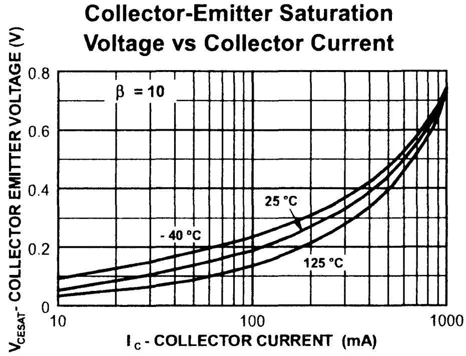
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%

DC Typical Characteristics

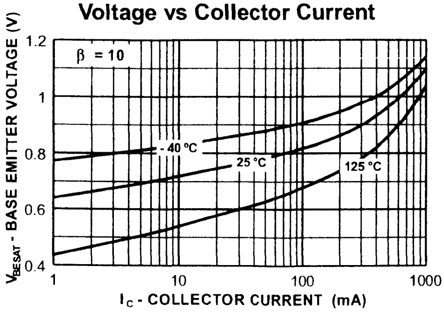
Typical Pulsed Current Gain vs Collector Current



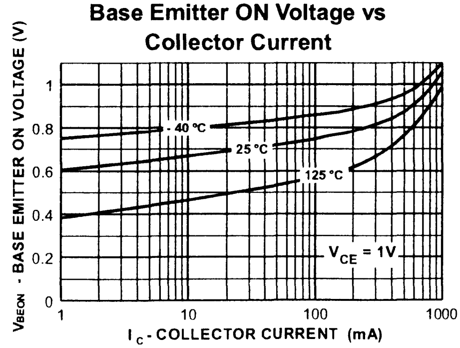
Collector-Emitter Saturation Voltage vs Collector Current



Base-Emitter Saturation Voltage vs Collector Current

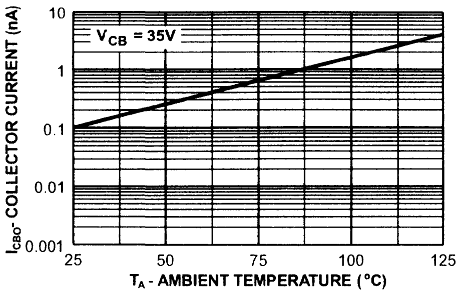


Base Emitter ON Voltage vs Collector Current

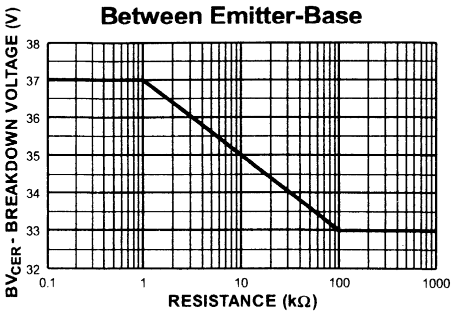


DC Typical Characteristics (continued)

Collector-Cutoff Current vs. Ambient Temperature

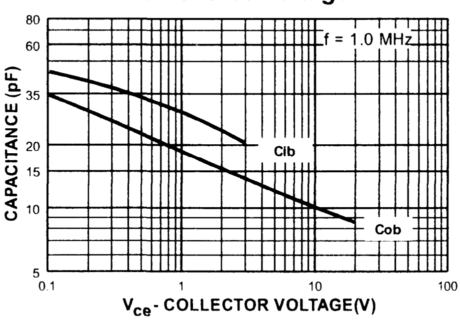


Collector-Emitter Breakdown Voltage with Resistance Between Emitter-Base

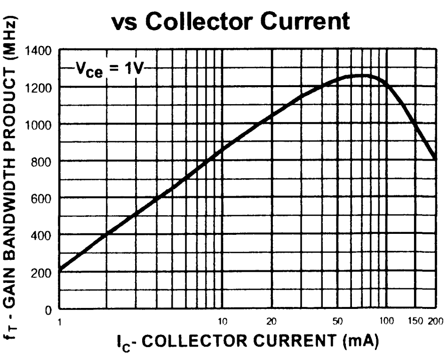


AC Typical Characteristics

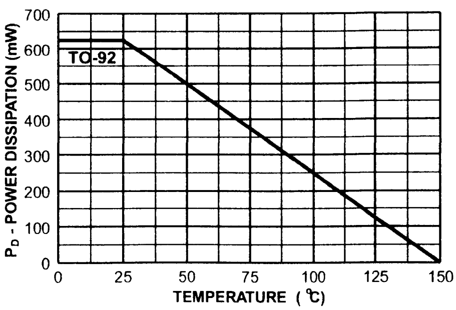
Input and Output Capacitance vs Reverse Voltage



Gain Bandwidth Product vs Collector Current



POWER DISSIPATION vs AMBIENT TEMPERATURE



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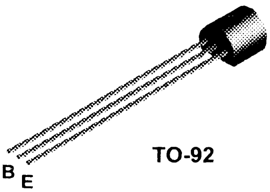
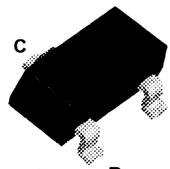
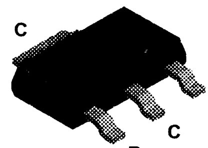
MPSA06 MMBTA06 PZTA06



TO-92



SOT-23
Mark: 1G



SOT-223

NPN General Purpose Amplifier

This device is designed for general purpose amplifier applications at collector currents to 300 mA. Sourced from Process 33.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	80	V
V_{CBO}	Collector-Base Voltage	80	V
V_{EBO}	Emitter-Base Voltage	4.0	V
I_C	Collector Current - Continuous	500	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		MPSA06	*MMBTA06	**PZTA06	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

**Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

NPN General Purpose Amplifier
(continued)

Electrical Characteristics

TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage*	I_C = 1.0 mA, I_B = 0	80		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	4.0		V
I_{CEO}	Collector-Cutoff Current	V_{CE} = 60 V, I_B = 0		0.1	μA
I_{CBO}	Collector-Cutoff Current	V_{CB} = 80 V, I_E = 0		0.1	μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 10 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V	100 100		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 100 mA, I_B = 10 mA		0.25	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 100 mA, V_{CE} = 1.0 V		1.2	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 2.0 V, f = 100 MHz	100		MHz

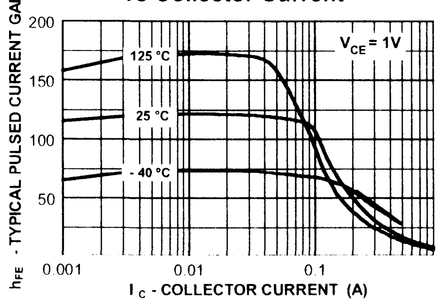
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

Spice Model

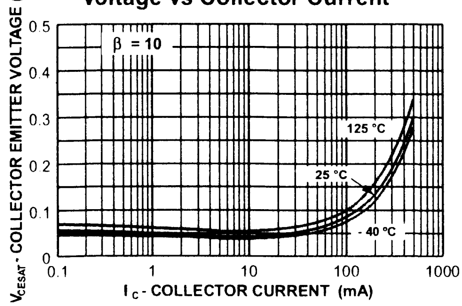
NPN (Is=8.324f Xti=3 Eg=1.11 Vaf=100 Bf=12.16K Ne=1.368 Ise=73.27f Ikf=.1096 Xtb=1.5 Br=11.1 Nc=2 Isc=0 Ikr=0 Rc=.25 Cjc=18.36p Mjc=.3843 Vjc=.75 Fc=.5 Cje=55.61p Mje=.3834 Vje=.75 Tr=72.15n Tf=516.1p Itf=.5 Vtf=4 Xtf=6 Rb=10)

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



Collector-Emitter Saturation Voltage vs Collector Current

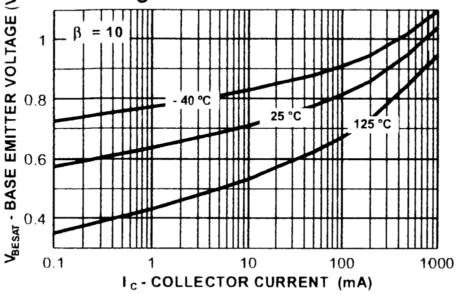


5

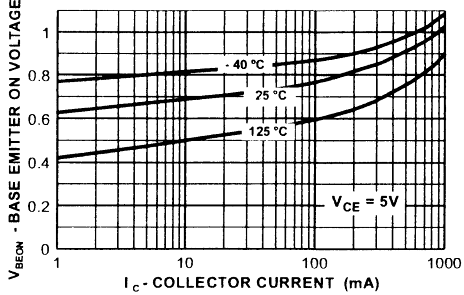
NPN General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

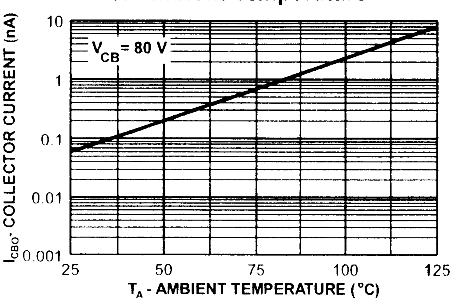
Base-Emitter Saturation Voltage vs Collector Current



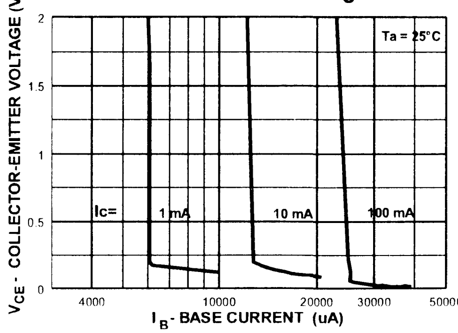
Base Emitter ON Voltage vs Collector Current



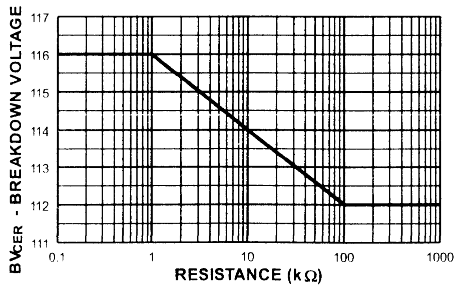
Collector-Cutoff Current vs. Ambient Temperature



Collector Saturation Region

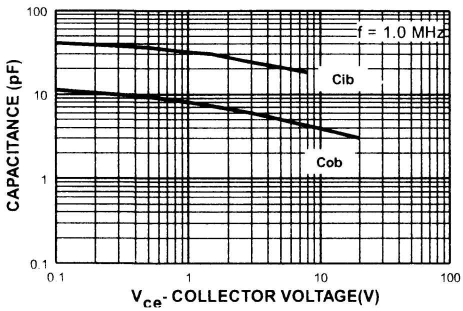


Collector-Emitter Breakdown Voltage with Resistance Between Emitter-Base

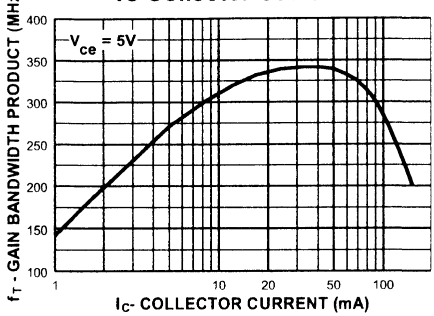


AC Typical Characteristics

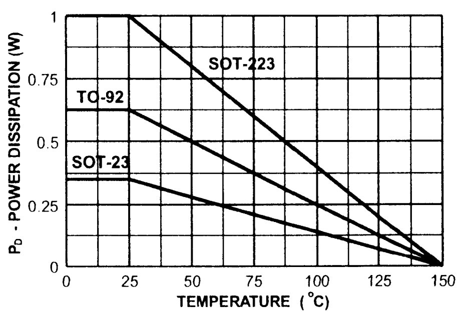
Input and Output Capacitance vs Reverse Voltage



Gain Bandwidth Product vs Collector Current



POWER DISSIPATION vs AMBIENT TEMPERATURE



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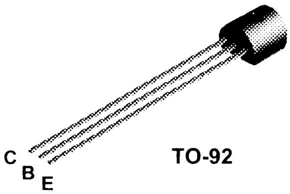
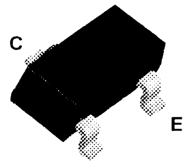
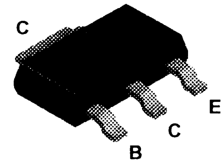
MPSA14 MMBTA14 PZTA14



TO-92



SOT-23
Mark: 1N



SOT-223

NPN Darlington Transistor

This device is designed for applications requiring extremely high current gain at collector currents to 1.0 A. Sourced from Process 05.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CES}	Collector-Emitter Voltage	30	V
V_{CBO}	Collector-Base Voltage	30	V
V_{EBO}	Emitter-Base Voltage	10	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		MPSA14	*MMBTA14	**PZTA14	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

**Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

NPN Darlington Transistor
(continued)

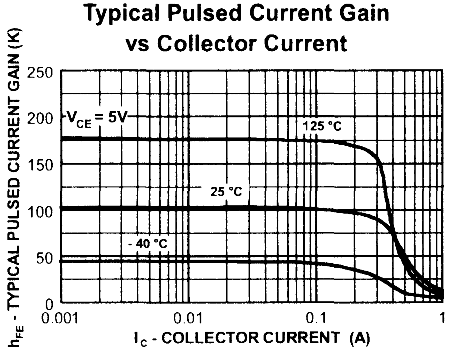
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	I_C = 100 µA, I_B = 0	30		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 30 V, I_E = 0		100	nA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 10 V, I_C = 0		100	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 10 mA, V_{CE} = 5.0 V I_C = 100 mA, V_{CE} = 5.0 V	10,000 20,000		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 100 mA, I_B = 0.1 mA		1.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 100 mA, V_{CE} = 5.0 V		2.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 10 V, f = 100 MHz	125		MHz

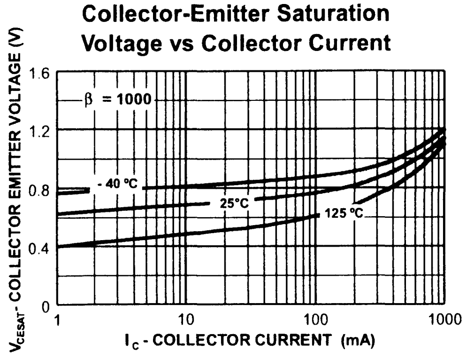
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

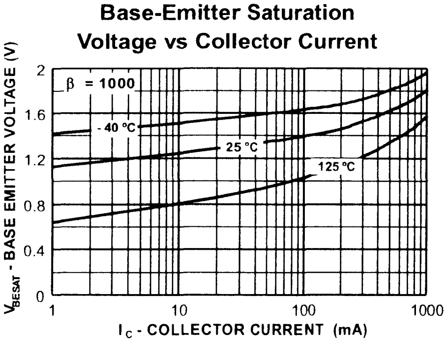


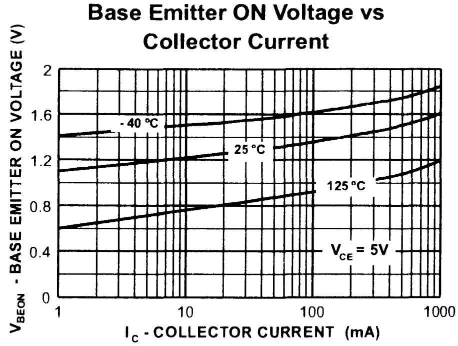
Collector-Emitter Saturation Voltage vs Collector Current

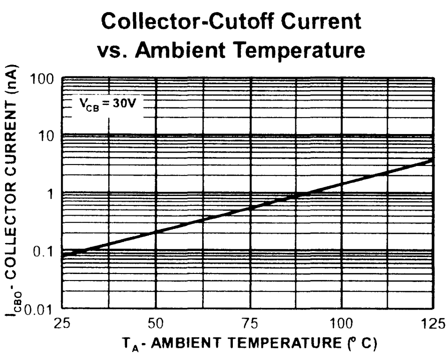


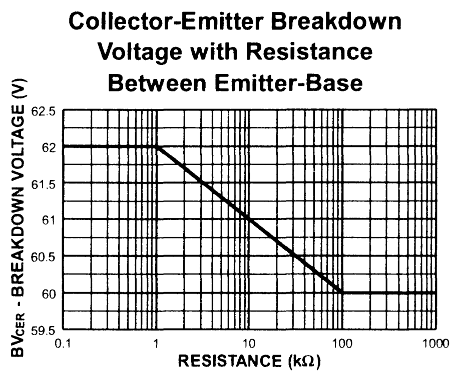
NPN Darlington Transistor
(continued)

DC Typical Characteristics (continued)

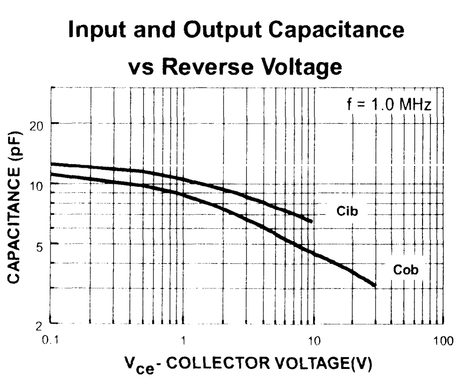


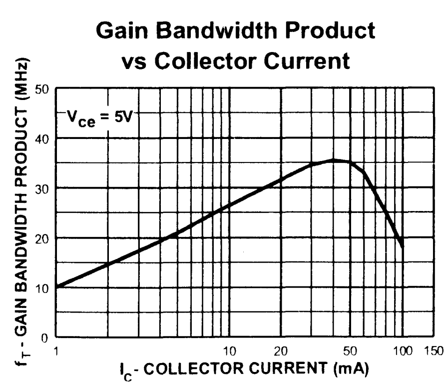




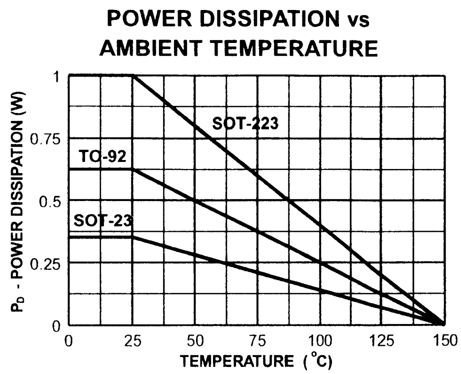


AC Typical Characteristics





AC Typical Characteristics (continued)



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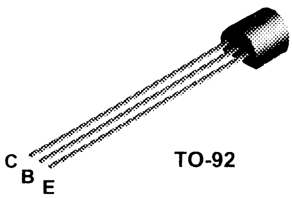
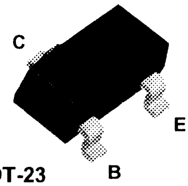
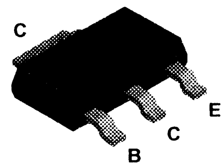
MPSA28 MMBTA28 PZTA28



TO-92



SOT-23
Mark: 3SS



SOT-223

NPN Darlington Transistor

This device is designed for applications requiring extremely high current gain at collector currents to 500 mA. Sourced from Process 03.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CES}	Collector-Emitter Voltage	80	V
V_{CBO}	Collector-Base Voltage	80	V
V_{EBO}	Emitter-Base Voltage	12	V
I_C	Collector Current - Continuous	800	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		MPSA28	*MMBTA28	**PZTA28	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

**Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

NPN Darlington Transistor
(continued)

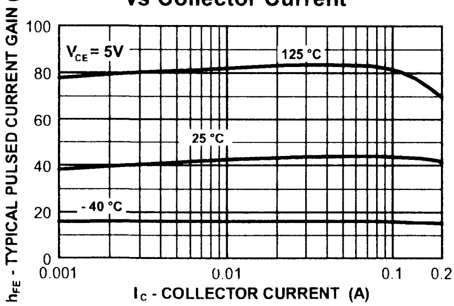
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	I_C = 100 μA, V_{BE} = 0	80		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	80		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	12		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 60 V, I_E = 0		100	nA
I_{CES}	Collector Cutoff Current	V_{CE} = 60 V, V_{BE} = 0		500	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 10 V, I_C = 0		100	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 10 mA, V_{CE} = 5.0 V I_C = 100 mA, V_{CE} = 5.0 V	10,000 10,000		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 0.01 mA I_C = 100 mA, I_B = 0.1 mA		1.2 1.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 100 mA, V_{CE} = 5.0 V		2.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 5.0, f = 100 MHz	125		MHz
C_{obo}	Output Capacitance	V_{CB} = 1.0 V, I_E = 0, f = 1.0 MHz		8.0	pF

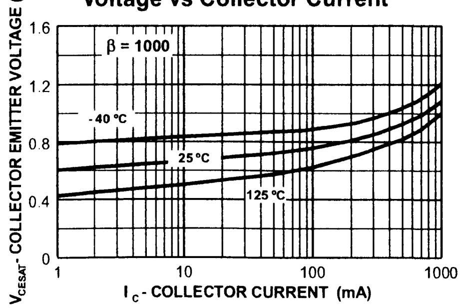
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



Collector-Emitter Saturation Voltage vs Collector Current



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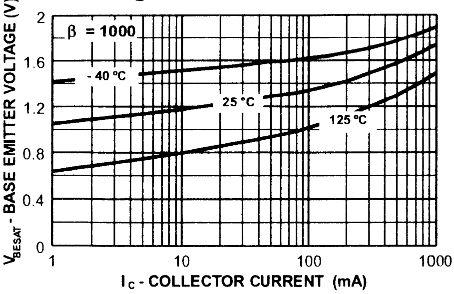
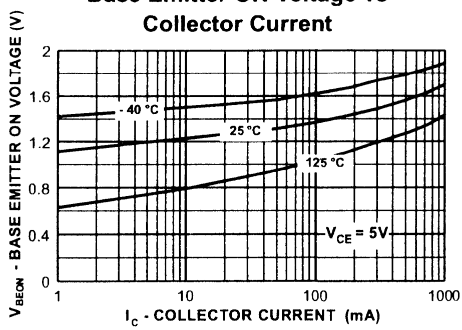
NPN Darlington Transistor
(continued)

DC Typical Characteristics (continued)

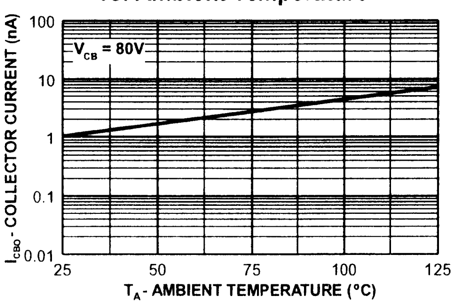
Base-Emitter Saturation Voltage vs Collector Current



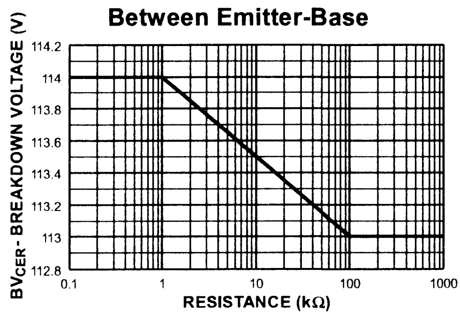
Base Emitter ON Voltage vs Collector Current



Collector-Cutoff Current vs. Ambient Temperature

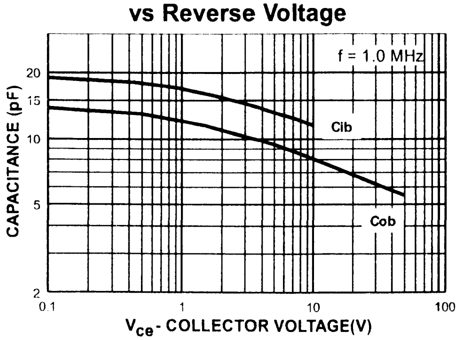


Collector-Emitter Breakdown Voltage with Resistance Between Emitter-Base

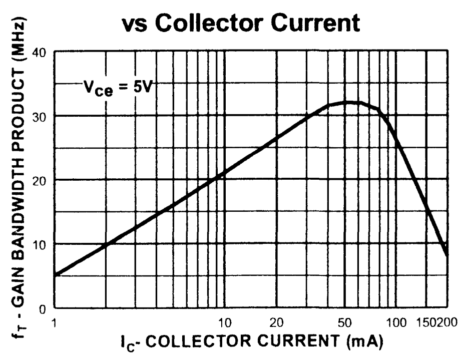


AC Typical Characteristics

Input and Output Capacitance vs Reverse Voltage

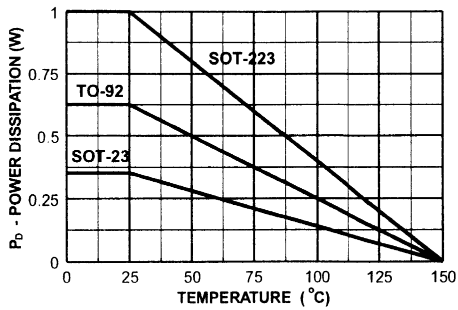


Gain Bandwidth Product vs Collector Current



AC Typical Characteristics (continued)

POWER DISSIPATION vs AMBIENT TEMPERATURE



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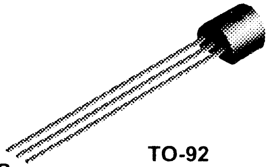
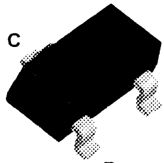
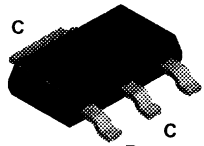
MPSA42 MMBTA42 PZTA42







NPN High Voltage Amplifier

This device is designed for application as a video output to drive color CRT and other high voltage applications. Sourced from Process 48.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CES}	Collector-Emitter Voltage	300	V
V_{CBO}	Collector-Base Voltage	300	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		MPSA42	*MMBTA42	**PZTA42	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

**Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

NPN High Voltage Amplifier
(continued)

Electrical Characteristics

TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 1.0 mA, I_B = 0	300		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	300		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	6.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 200 V, I_E = 0		0.1	μA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 6.0 V, I_C = 0		0.1	μA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 1.0 mA, V_{CE} = 10 V I_C = 10 mA, V_{CE} = 10 V I_C = 30 mA, V_{CE} = 10 V	25 40 40		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 20 mA, I_B = 2.0 mA		0.5	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 20 mA, I_B = 2.0 mA		0.9	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz	50		MHz
C_{cb}	Collector-Base Capacitance	V_{CB} = 20 V, I_E = 0, f = 1.0 MHz		3.0	pF

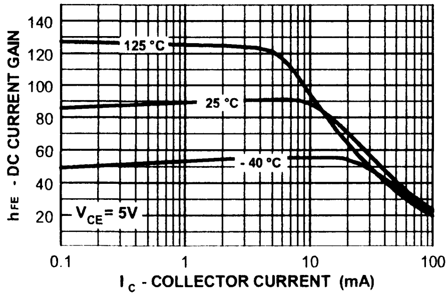
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

Spice Model

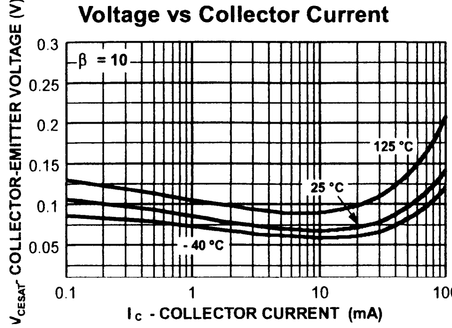
NPN (Is=34.9f Xti=3 Eg=1.11 Vaf=100 Bf=2.65K Ne=1.708 Ise=16.32p Ikf=23.79m Xtb=1.5 Br=9.769 Nc=2 Isc=0 Ikr=0 Rc=7 Cjc=14.23p Mjc=.5489 Vjc=.75 Fc=.5 Cje=49.62p Mje=.4136 Vje=.75 Tr=934.3p Tf=1.69n Itf=5 Vtf=20 Xtf=150 Rb=10)

DC Typical Characteristics

DC Current Gain vs Collector Current



Collector-Emitter Saturation Voltage vs Collector Current



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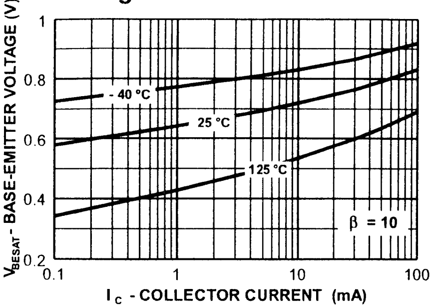
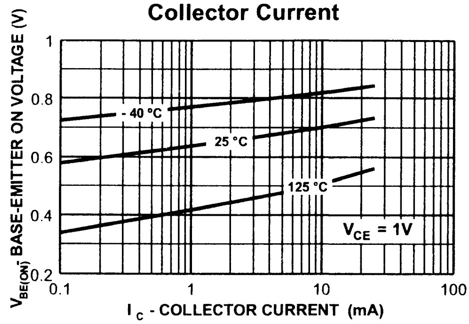
NPN High Voltage Amplifier
(continued)

DC Typical Characteristics (continued)

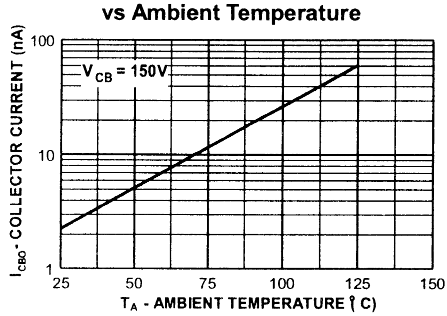
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

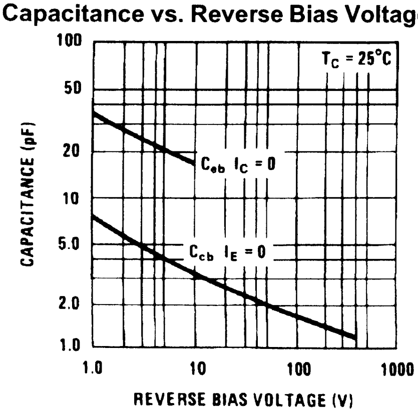


Collector-Cutoff Current vs Ambient Temperature

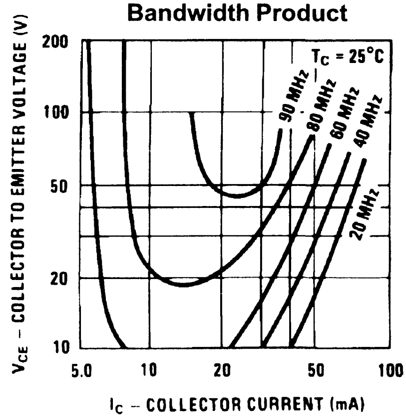


AC Typical Characteristics

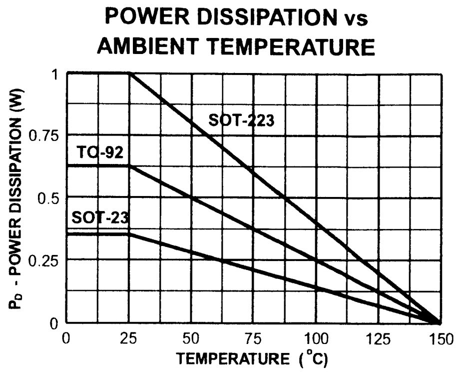
Collector-Base / Emitter-Base Capacitance vs. Reverse Bias Voltage



Contours of Constant Gain Bandwidth Product



AC Typical Characteristics (continued)



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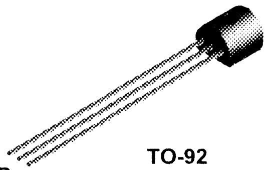
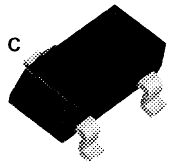
MPSA43 MMBTA43



C B E

TO-92



C E B

SOT-23

Mark: 1E

NPN High Voltage Amplifier

This device is designed for application as a video output to drive color CRT and other high voltage applications. Sourced from Process 48. See MPSA42 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CES}	Collector-Emitter Voltage	200	V
V_{CBO}	Collector-Base Voltage	200	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		MPSA43	*MMBTA43	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN High Voltage Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_B = 0$	200		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100$ μA, $I_E = 0$	200		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 100$ μA, $I_C = 0$	6.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 160$ V, $I_E = 0$		0.1	μA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 4.0$ V, $I_C = 0$		0.1	μA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 1.0$ mA, $V_{CE} = 10$ V $I_C = 10$ mA, $V_{CE} = 10$ V $I_C = 30$ mA, $V_{CE} = 10$ V	25 40 50	 200	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 20$ mA, $I_B = 2.0$ mA		0.4	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 20$ mA, $I_B = 2.0$ mA		0.9	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 20$ V, f = 100 MHz	50		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 20$ V, $I_E = 0$, f = 1.0 MHz		4.0	pF

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

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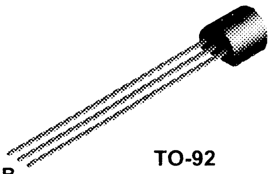
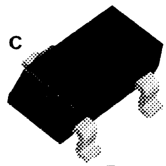
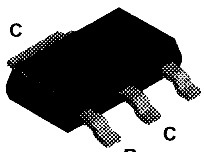
MPSA56 MMBTA56 PZTA56







PNP General Purpose Amplifier

This device is designed for general purpose amplifier applications at collector currents to 300 mA. Sourced from Process 73.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CES}	Collector-Emitter Voltage	80	V
V_{CBO}	Collector-Base Voltage	80	V
V_{EBO}	Emitter-Base Voltage	4.0	V
I_C	Collector Current - Continuous	500	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		MPSA56	*MMBTA56	**PZTA56	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

**Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 1.0 mA, I_B = 0	80		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	80		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 100 μA, I_C = 0	4.0		V
I_{CEO}	Collector-Cutoff Current	V_{CE} = 60 V, I_B = 0		0.1	μA
I_{CBO}	Collector-Cutoff Current	V_{CB} = 80 V, I_E = 0		0.1	μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 10 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V	100 100		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 100 mA, I_B = 10 mA		0.25	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 100 mA, V_{CE} = 1.0 V		1.2	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 100 mA, V_{CE} = 1.0 V, f = 100 MHz	50		MHz

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

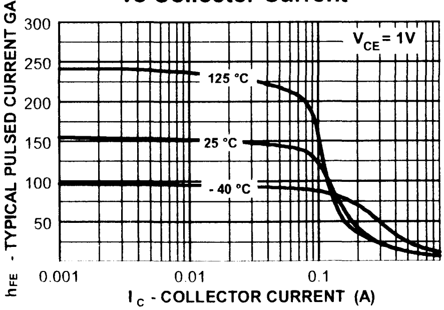
Spice Model

PNP (Is=12.27p Xti=3 Eg=1.11 Vaf=100 Bf=91.63 Ne=1.531 Ise=12.27p Ikf=1.009 Xtb=1.5 Br=1.287 Nc=2 Isc=0 Ikr=0 Rc=.6 Cjc=48.28p Mjc=.5615 Vjc=.75 Fc=.5 Cje=106.7p Mje=.5168 Vje=.75 Tr=496.3n Tf=865.8p Itf=.2 Vtf=2 Xtf=.8 Rb=10)

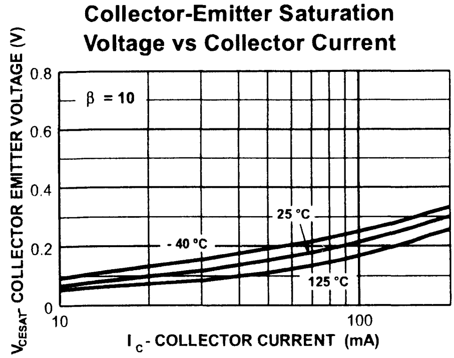
5

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



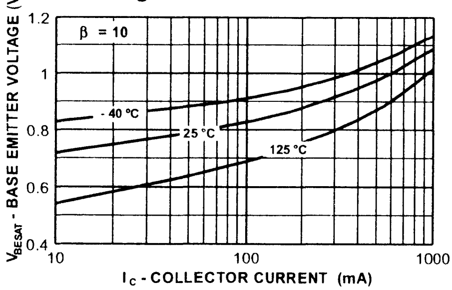
Collector-Emitter Saturation Voltage vs Collector Current



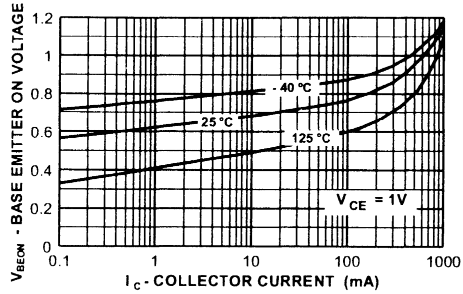
PNP General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

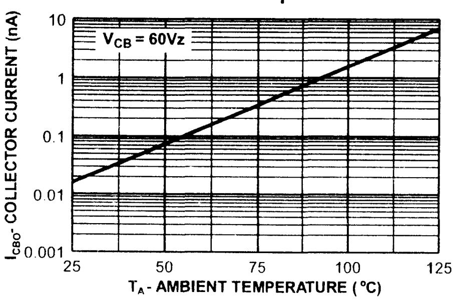
Base-Emitter Saturation Voltage vs Collector Current



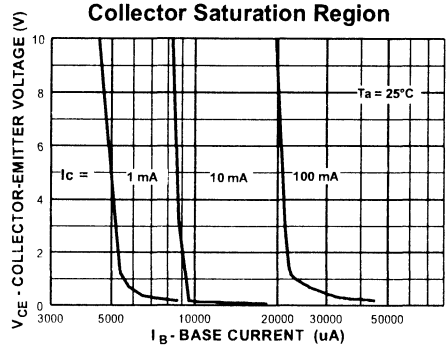
Base Emitter ON Voltage vs Collector Current



Collector-Cutoff Current vs. Ambient Temperature

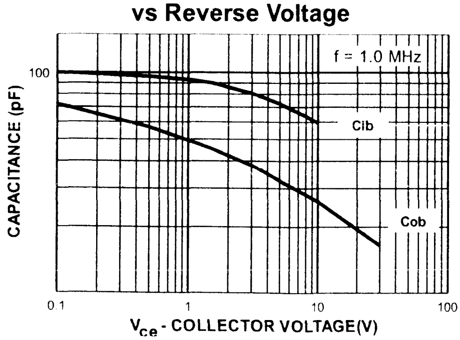


Collector Saturation Region

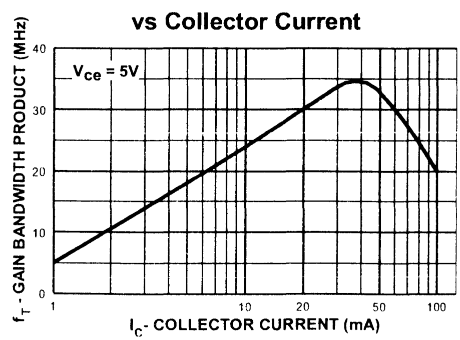


AC Typical Characteristics

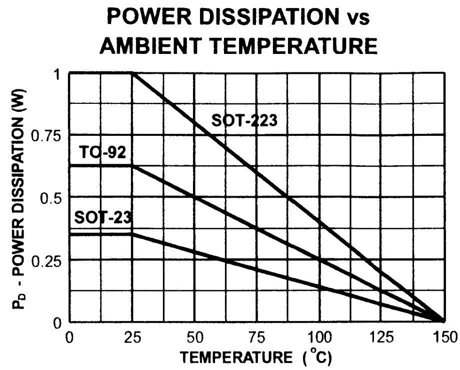
Input and Output Capacitance vs Reverse Voltage



Gain Bandwidth Product vs Collector Current



AC Typical Characteristics (continued)



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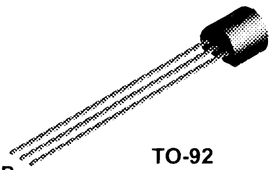
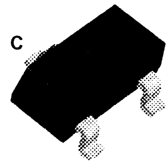
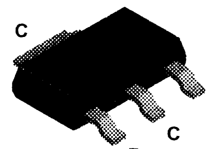
MPSA64 MMBTA64 PZTA64



TO-92



SOT-23
Mark: 2V



SOT-223

PNP Darlington Transistor

This device is designed for applications requiring extremely high current gain at currents to 800 mA. Sourced from Process 61.

Absolute Maximum Ratings* TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CES}	Collector-Emitter Voltage	30	V
V_{CBO}	Collector-Base Voltage	30	V
V_{EBO}	Emitter-Base Voltage	10	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics TA = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		MPSA64	*MMBTA64	**PZTA64	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

**Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

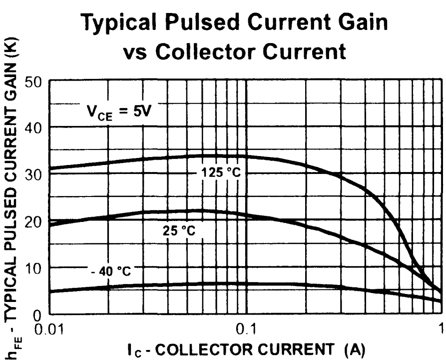
PNP Darlington Transistor
(continued)

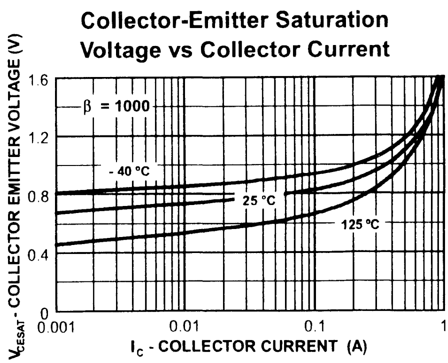
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	I_C = 100 μA, I_B = 0	30		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 30 V, I_E = 0		100	nA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 10 V, I_C = 0		100	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 10 mA, V_{CE} = 5.0 V I_C = 100 mA, V_{CE} = 5.0 V	10,000 20,000		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 100 mA, I_B = 0.1 mA		1.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 100 mA, V_{CE} = 5.0 V		2.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz	125		MHz

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

DC Typical Characteristics



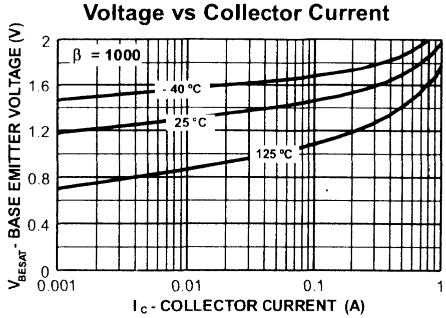


PNP Darlington Transistor

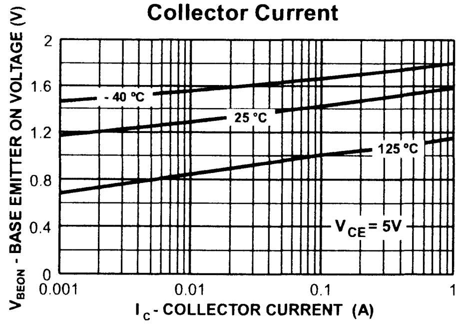
(continued)

DC Typical Characteristics (continued)

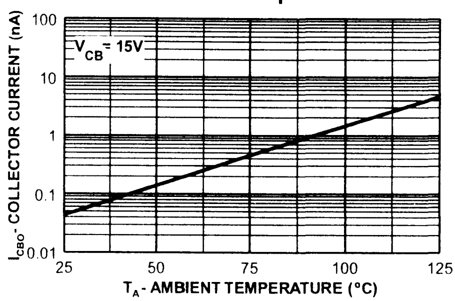
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

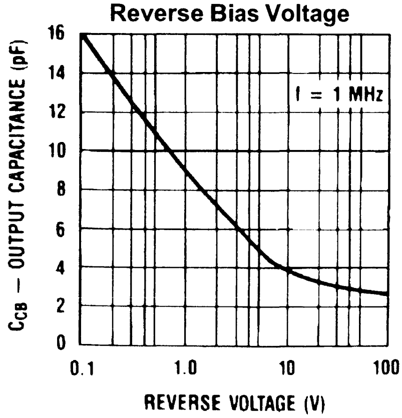


Collector-Cutoff Current vs. Ambient Temperature

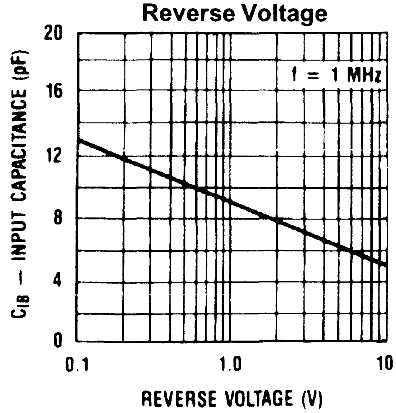


AC Typical Characteristics

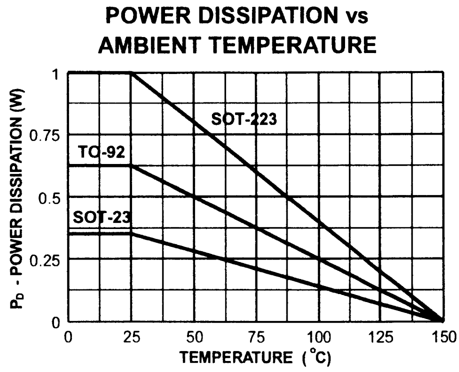
Output Capacitance vs. Reverse Bias Voltage



Input Capacitance vs. Reverse Voltage



AC Typical Characteristics



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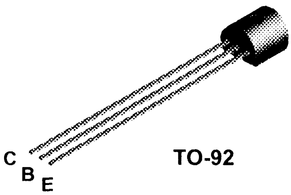
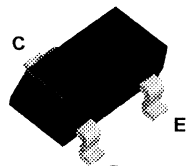
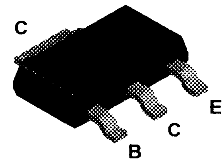
MPSA92 MMBTA92 PZTA92



TO-92



SOT-23
Mark: 2D



SOT-223

PNP High Voltage Amplifier

This device is designed for high voltage driver applications.
Sourced from Process 76.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	300	V
V_{CBO}	Collector-Base Voltage	300	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	100	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		MPSA92	*MMBTA92	**PZTA92	
P_D	Total Device Dissipation	625	350	1,000	mW
	Derate above 25°C	5.0	2.8	8.0	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

**Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

PNP High Voltage Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_B = 0$	300		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu A$, $I_E = 0$	300		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 100\ \mu A$, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 200$ V, $I_E = 0$		0.25	µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 3.0$ V, $I_C = 0$		0.1	µA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 1.0$ mA, $V_{CE} = 10$ V $I_C = 10$ mA, $V_{CE} = 10$ V $I_C = 30$ mA, $V_{CE} = 10$ V	25 40 25		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 20$ mA, $I_B = 2.0$ mA		0.5	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 20$ mA, $I_B = 2.0$ mA		0.9	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 20$ V, f = 100 MHz	50		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 20$ V, $I_E = 0$, f = 1.0 MHz		6.0	pF

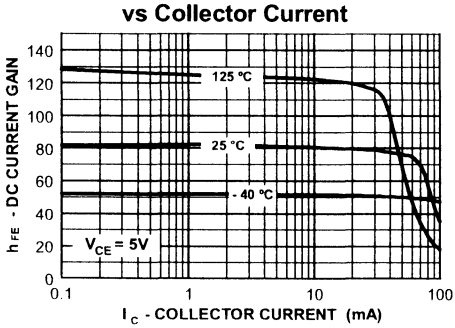
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%

Spice Model

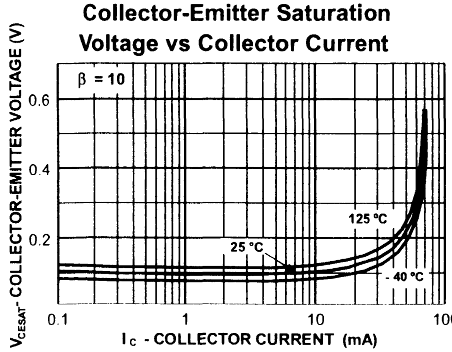
PNP (Is=218.9f Xti=3 Eg=1.11 Vaf=100 Bf=99 Ne=1.307 Ise=218.9f Ikf=.2016 Xtb=1.5 Br=24.67 Nc=2 Isc=0 Ikr=0 Rc=7 Cjc=19.88p Mjc=.4876 Vjc=.75 Fc=.5 Cje=81.49p Mje=.3493 Vje=.75 Tr=516.9p Tf=1.395n Itf=1.5 Vtf=22 Xtf=270 Rb=10)

DC Typical Characteristics

DC Current Gain vs Collector Current



Collector-Emitter Saturation Voltage vs Collector Current

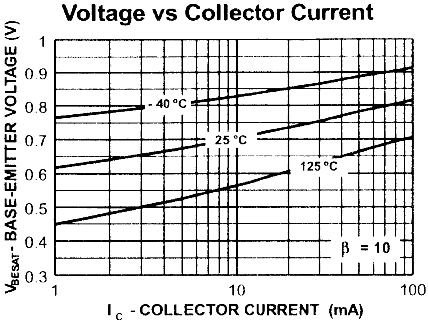


5

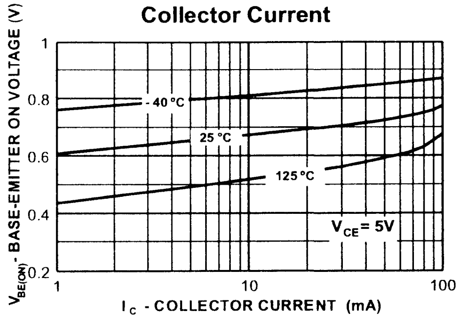
PNP High Voltage Amplifier
(continued)

DC Typical Characteristics (continued)

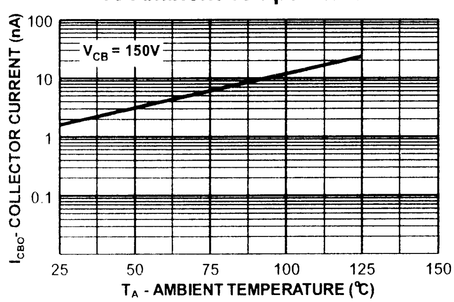
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

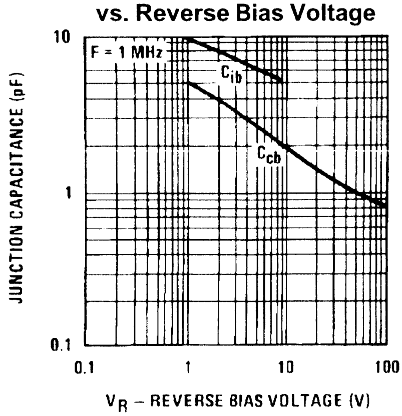


Collector-Cutoff Current vs Ambient Temperature

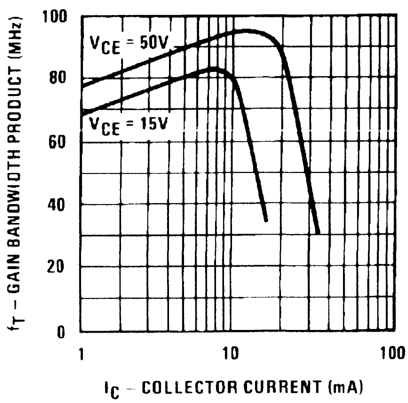


AC Typical Characteristics

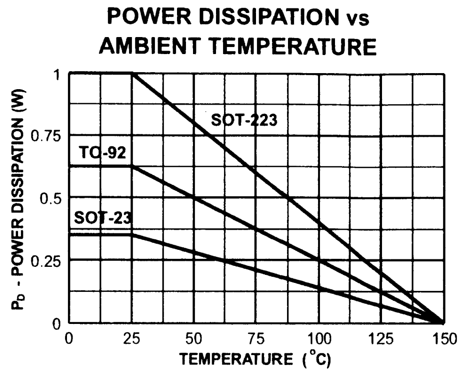
Junction Capacitance vs. Reverse Bias Voltage



Gain Bandwidth Product vs. Collector Current



AC Typical Characteristics (continued)



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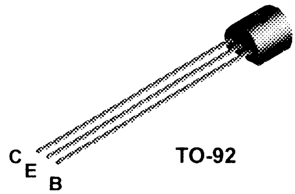
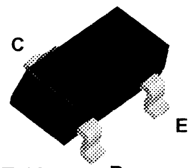
MPSH10 MMBTH10





NPN RF Transistor

This device is designed for use in low noise UHF/VHF amplifiers, with collector currents in the 100 μA to 20 mA range in common emitter or common base mode of operations, and in low frequency drift, high output UHF oscillators. Sourced from Process 42.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	25	V
V_{CBO}	Collector-Base Voltage	30	V
V_{EBO}	Emitter-Base Voltage	3.0	V
I_C	Collector Current - Continuous	50	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		MPSH10	*MMBTH10	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN RF Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage*	$I_C = 1.0$ mA, $I_B = 0$	25		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu A$, $I_E = 0$	30		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$	3.0		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 25$ V, $I_E = 0$		100	nA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = 2.0$ V, $I_C = 0$		100	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 4.0$ mA, $V_{CE} = 10$ V	60		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 4.0$ mA, $I_B = 0.4$ mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 4.0$ mA, $V_{CE} = 10$ V		0.95	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 4.0$ mA, $V_{CE} = 10$ V, f = 100 MHz	650		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		0.7	pF
C_{rb}	Common-Base Feedback Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz	0.35	0.65	pF
$rb'C_c$	Collector Base Time Constant	$I_C = 4.0$ mA, $V_{CB} = 10$ V, f = 31.8 MHz		9.0	pS

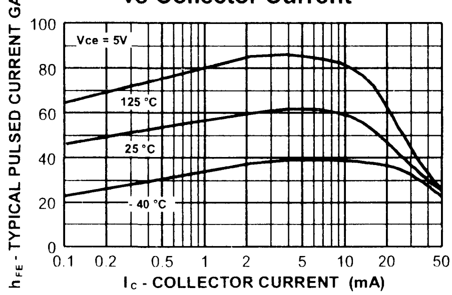
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

Spice Model

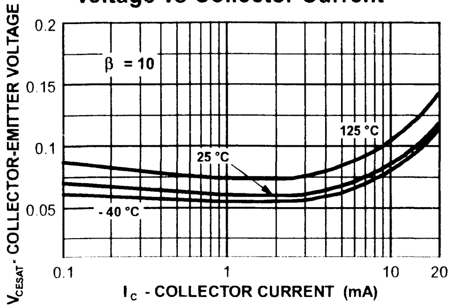
NPN (Is=69.28E-18 Xti=3 Eg=1.11 Vaf=100 Bf=308.6 Ne=1.197 Ise=69.28E-18 Ikf=22.83m Xtb=1.5 Br=1.11 Nc=2 Isc=0 Ikr=0 Rc=4 Cjc=1.042p Mjc=.2468 Vjc=.75 Fc=.5 Cje=1.52p Mje=.3223 Vje=.75 Tr=1.558n Tf=135.8p Itf=.27 Vtf=10 Xtf=30 Rb=10)

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



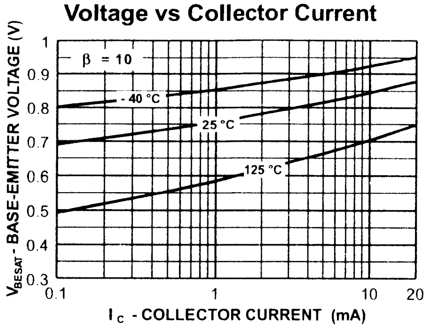
Collector-Emitter Saturation Voltage vs Collector Current



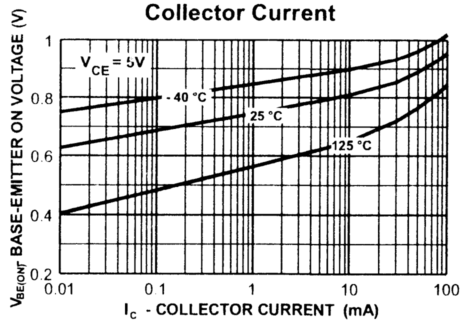
NPN RF Transistor
(continued)

DC Typical Characteristics (continued)

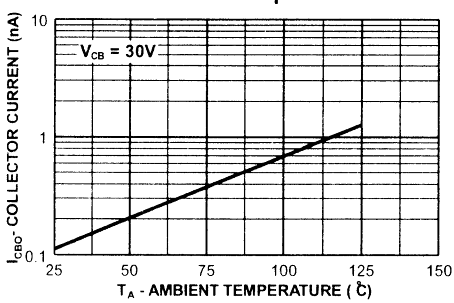
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

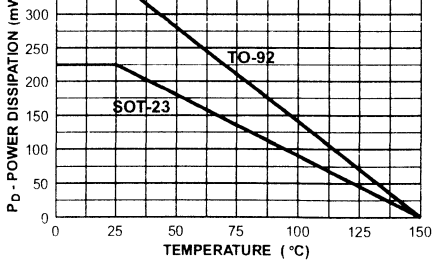


Collector-Cutoff Current vs Ambient Temperature



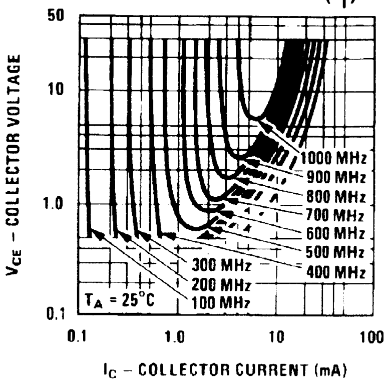
AC Typical Characteristics

POWER DISSIPATION vs AMBIENT TEMPERATURE



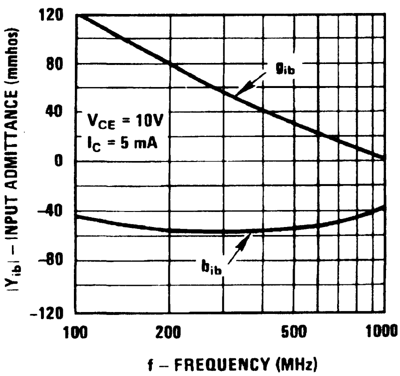
AC Typical Characteristics (continued)

Contours of Constant Gain Bandwidth Product (f_T)

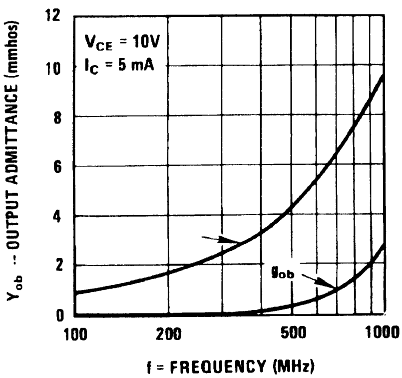


Common Base Y Parameters vs. Frequency

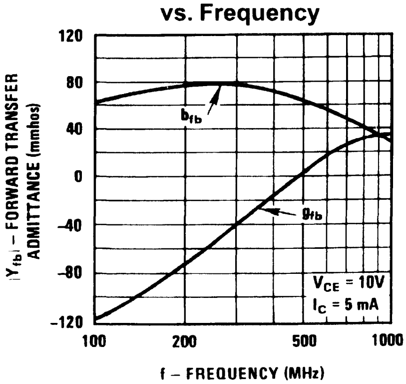
Input Admittance vs. Frequency



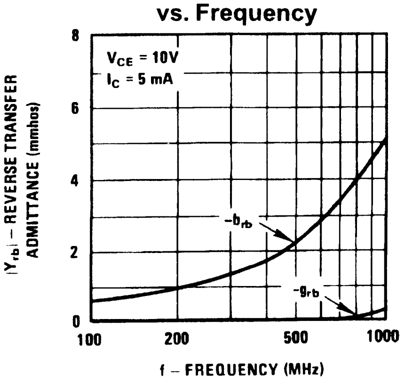
Output Admittance vs. Frequency



Forward Transfer Admittance vs. Frequency



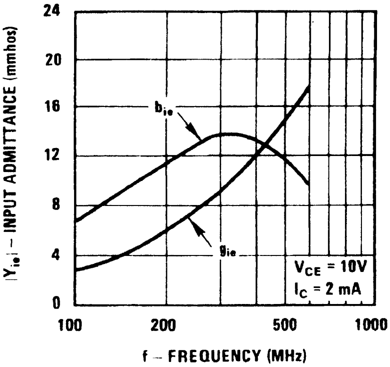
Reverse Transfer Admittance vs. Frequency



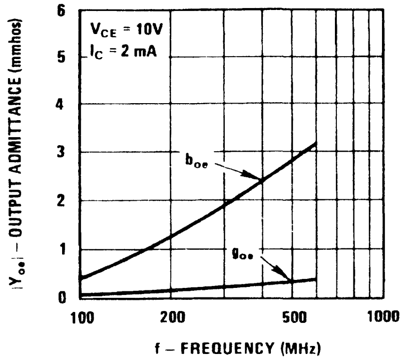
NPN RF Transistor
(continued)

Common Emitter Y Parameters vs. Frequency

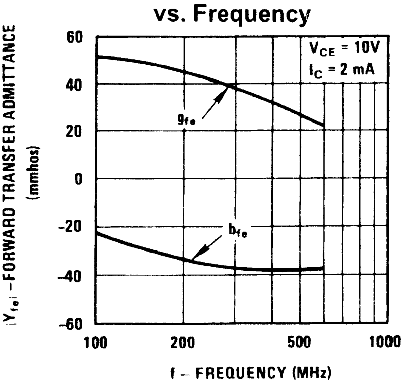
Input Admittance vs. Frequency



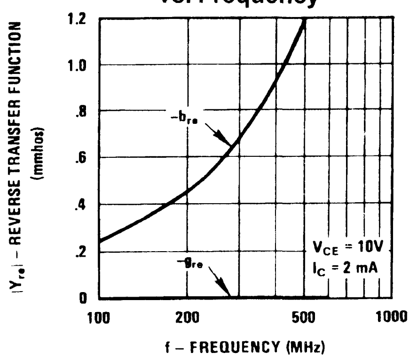
Output Admittance vs. Frequency



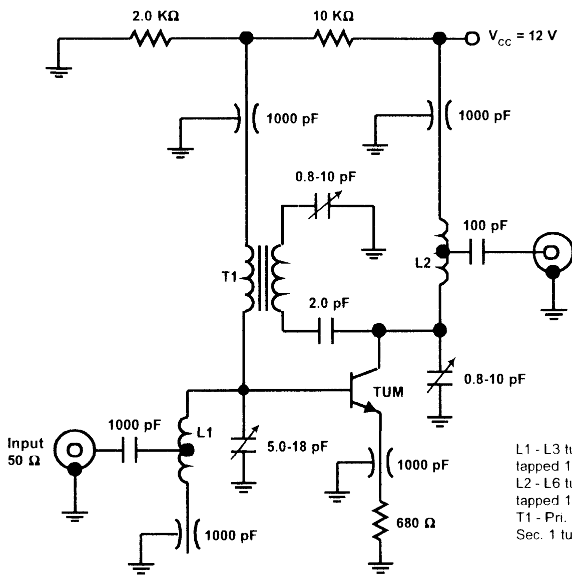
Forward Transfer Admittance vs. Frequency



Reverse Transfer Admittance vs. Frequency

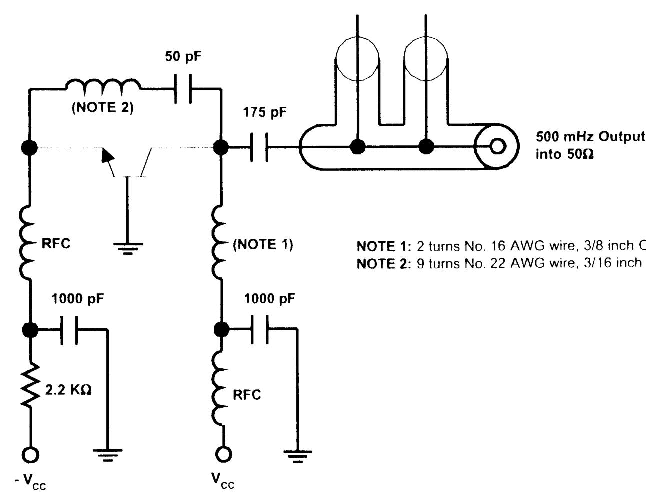


Test Circuits



L1 - L3 turns No. 16 wire, 1/2 inch L x 1/4 inch ID tapped 1 1/2 turns from cold side
L2 - L6 turns No. 14 wire, 1 inch L x 1/4 inch ID tapped 1 1/2 turns from cold side
T1 - Pri. 1 turn No. 16 wire
Sec. 1 turn No. 18 wire

FIGURE 1: Neutralized 200 MHz pF and NF Circuit



NOTE 1: 2 turns No. 16 AWG wire, 3/8 inch OD, 1 1/4 inch long
NOTE 2: 9 turns No. 22 AWG wire, 3/16 inch OD, 1/2 inch long

FIGURE 2: 500 MHz Oscillator Circuit

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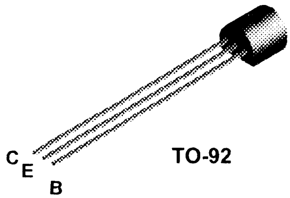
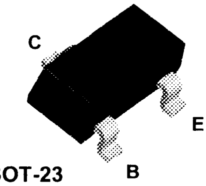
MPSH11 MMBTH11





NPN RF Transistor

This device is designed for common-emitter low noise amplifier and mixer applications with collector currents in the 100 μA to 10 mA range to 300 MHz, and low frequency drift common-base VHF oscillator applications with high output levels for driving FET mixers. Sourced from Process 47.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	25	V
V_{CBO}	Collector-Base Voltage	30	V
V_{EBO}	Emitter-Base Voltage	3.0	V
I_C	Collector Current - Continuous	50	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		MPSH11	*MMBTH11	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN RF Transistor
(continued)

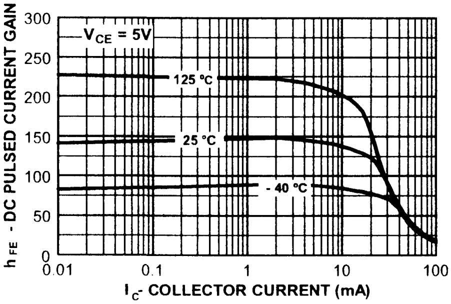
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage*	I_C = 1.0 mA, I_B = 0	25		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	30		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	3.0		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 25 V, I_E = 0		100	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 2.0 V, I_C = 0		100	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 4.0 mA, V_{CE} = 10 V	60		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 4.0 mA, I_B = 0.4 mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 4.0 mA, V_{CE} = 10 V		0.95	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 4.0 mA, V_{CE} = 10 V, f = 100 MHz	650		MHz
C_{cb}	Collector-Base Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		0.7	pF
C_{rb}	Common-Base Feedback Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz	0.6	0.9	pF
$rb'C_c$	Collector Base Time Constant	I_C = 4.0 mA, V_{CB} = 10 V, f = 31.8 MHz		9.0	pS

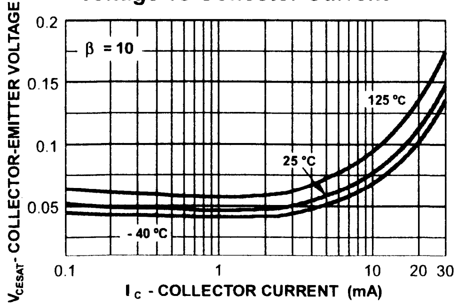
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

DC Typical Characteristics

DC Current Gain vs Collector Current



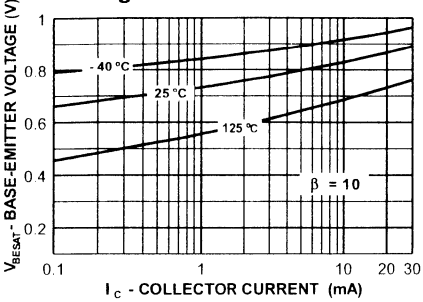
Collector-Emitter Saturation Voltage vs Collector Current



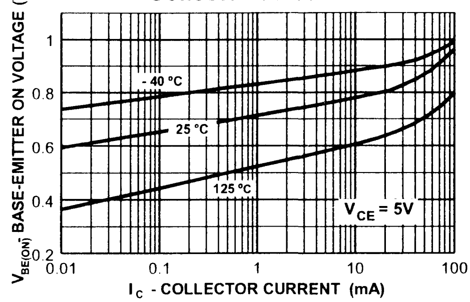
NPN RF Transistor
(continued)

DC Typical Characteristics (continued)

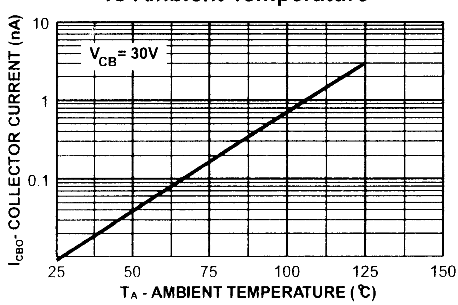
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

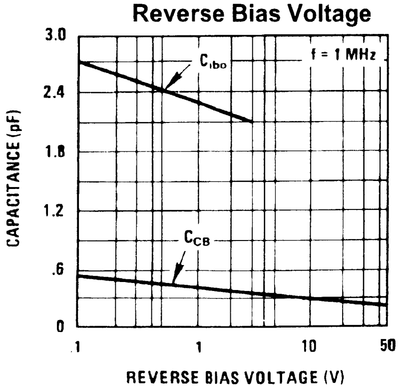


Collector-Cutoff Current vs Ambient Temperature

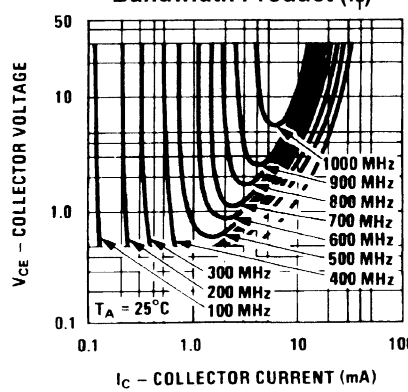


AC Typical Characteristics

Capacitance vs. Reverse Bias Voltage

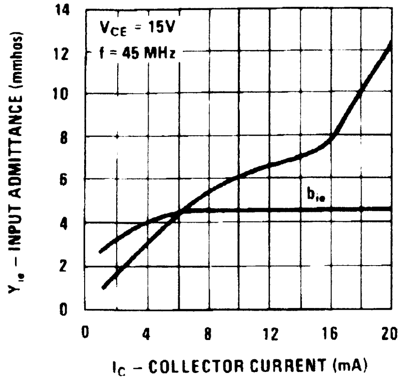


Contours of Constant Gain Bandwidth Product (f_T)

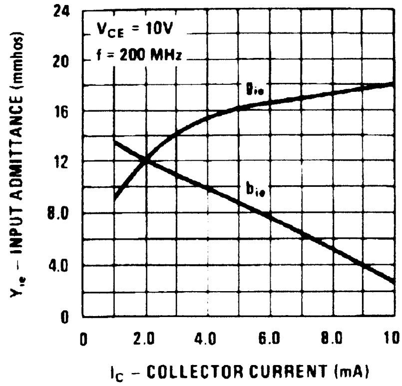


Common Emitter Y Parameters

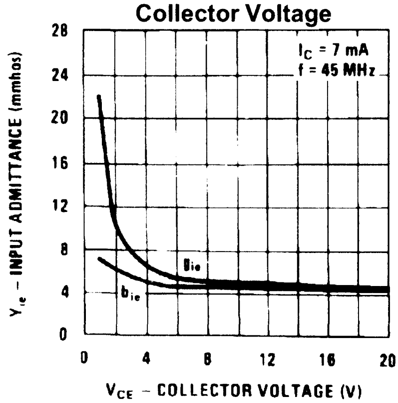
Input Admittance vs. Collector Current



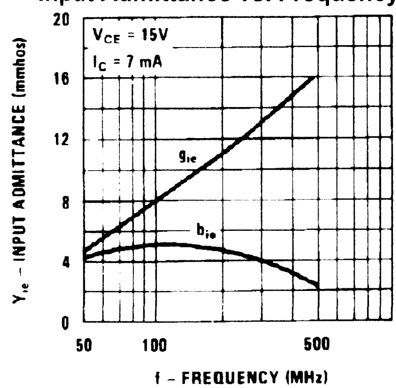
Input Admittance vs. Collector Current



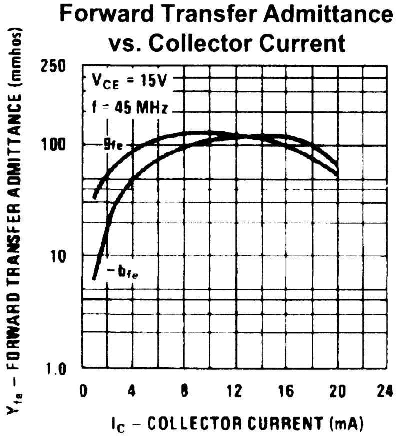
Input Admittance vs. Collector Voltage



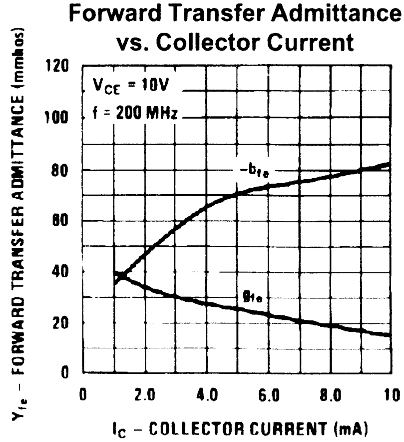
Input Admittance vs. Frequency



Forward Transfer Admittance vs. Collector Current



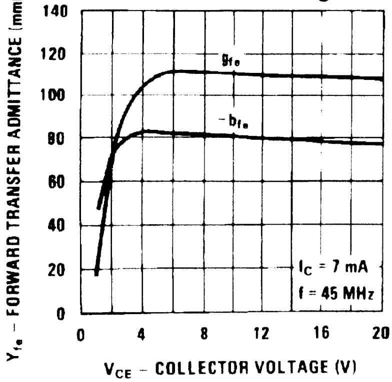
Forward Transfer Admittance vs. Collector Current



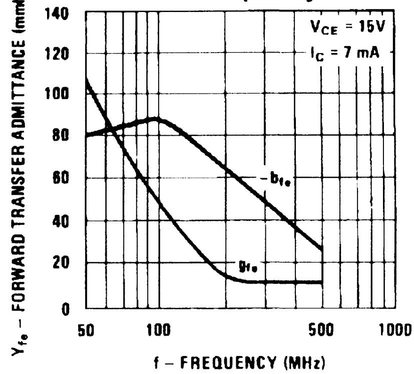
NPN RF Transistor
(continued)

Common Emitter Y Parameters (continued)

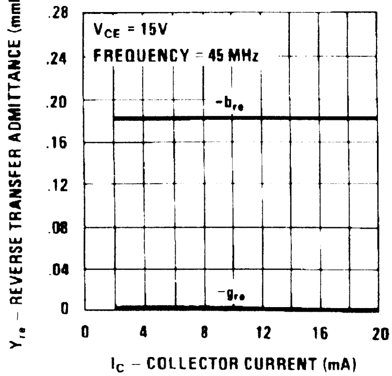
Forward Transfer Admittance vs. Collector Voltage



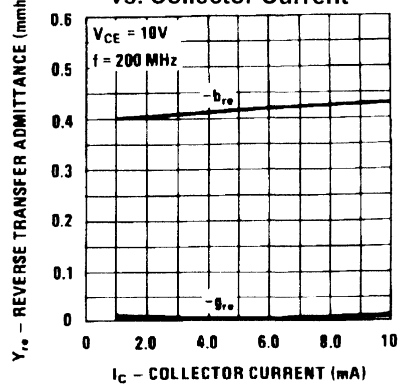
Forward Transfer Admittance vs. Frequency



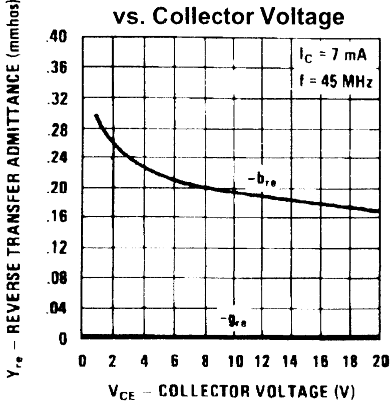
Reverse Transfer Admittance vs. Collector Current



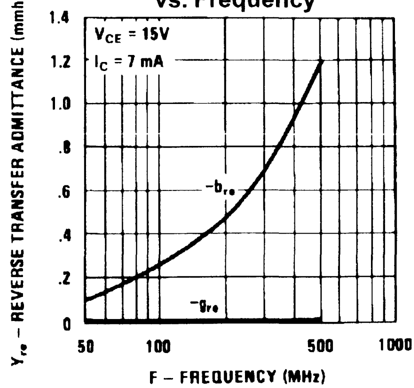
Reverse Transfer Admittance vs. Collector Current



Reverse Transfer Admittance vs. Collector Voltage

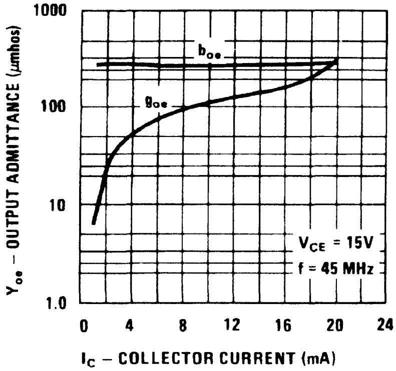


Reverse Transfer Admittance vs. Frequency

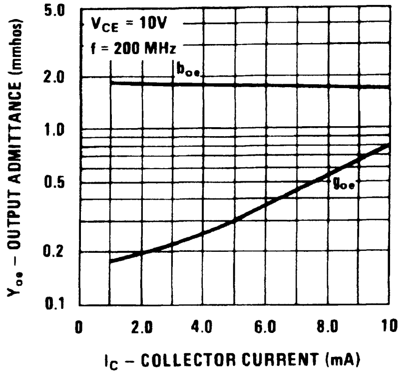


Common Emitter Y Parameters (continued)

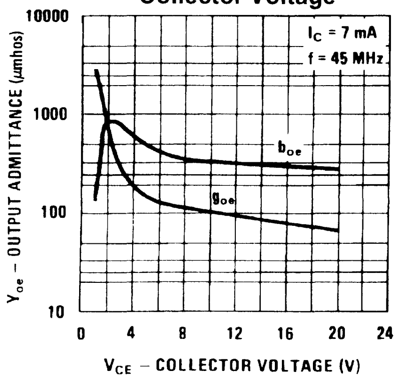
Output Admittance vs. Collector Current



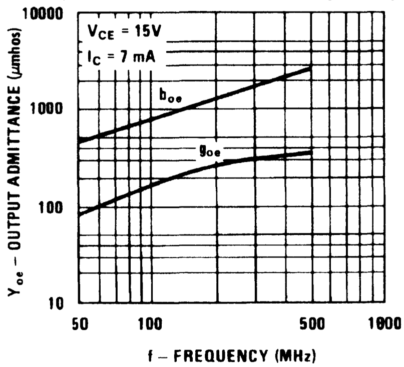
Output Admittance vs. Collector Current



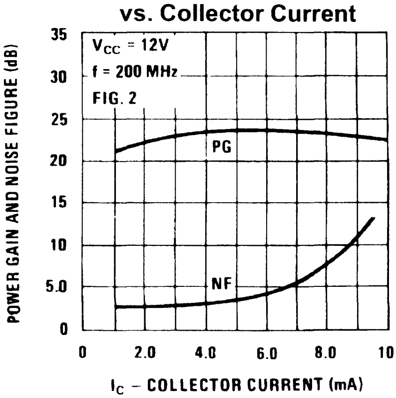
Output Admittance vs. Collector Voltage



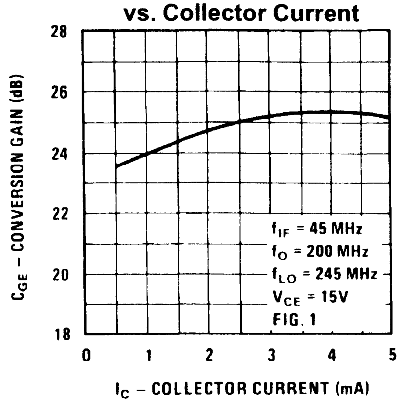
Output Admittance vs. Frequency



Power Gain and Noise Figure vs. Collector Current

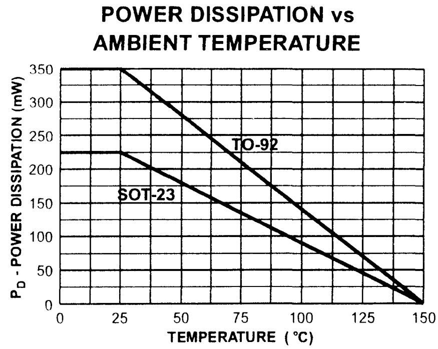


Conversion Gain vs. Collector Current



NPN RF Transistor
(continued)

AC Typical Characteristics



Test Circuits

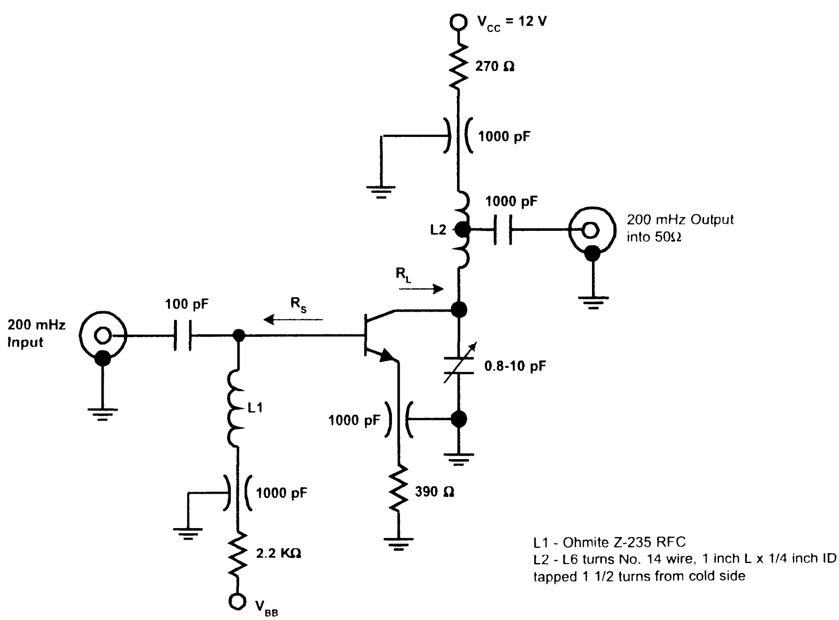


FIGURE 1: Unneutralized 200 MHz PG NF Test Circuit

Test Circuits (continued)

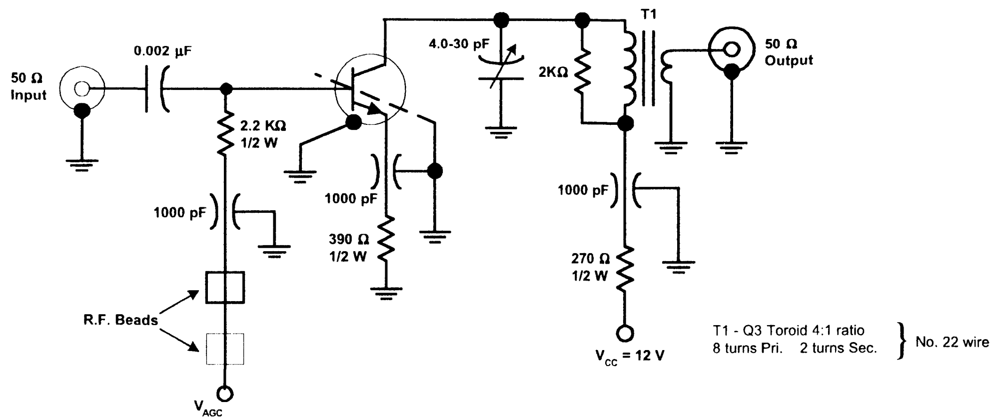


FIGURE 2: 45 MHz Power Gain Circuit

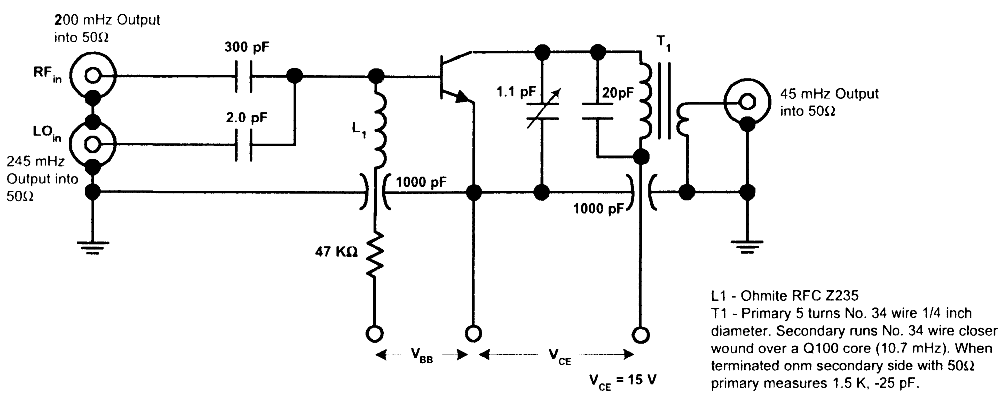
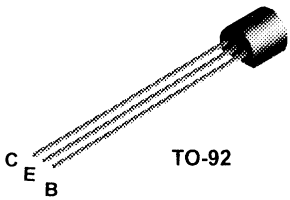


FIGURE 3: 200 MHz Conversion Gain Test Circuit

National Semiconductor

Discrete POWER & Signal Technologies

MPSH20 MMBTH20



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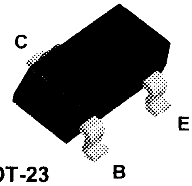


SOT-23
Mark: 3L

NPN RF Transistor

This device is designed for general RF amplifier and mixer applications to 250 MHz with collector currents in the 1.0 mA to 30 mA range. Sourced from Process 49.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	30	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	4.0	V
I_C	Collector Current - Continuous	50	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		MPSH20	*MMBTH20	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN RF Transistor
(continued)

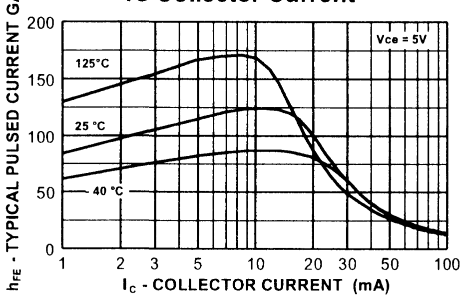
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage	I_C = 1.0 mA, I_B = 0	30		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 µA, I_E = 0	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 µA, I_C = 0	4.0		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 15 V, I_E = 0		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 4.0 mA, V_{CE} = 10 V	25		
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 4.0 mA, V_{CE} = 10 V, f = 100 MHz	400		MHz
C_{cb}	Collector-Base Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		0.65	pF
	Conversion Gain (213 MHz to 45 MHz)	I_C = 4.0 mA, V_{CB} = 10 V, Oscillator injection = 200 mV	18		dB

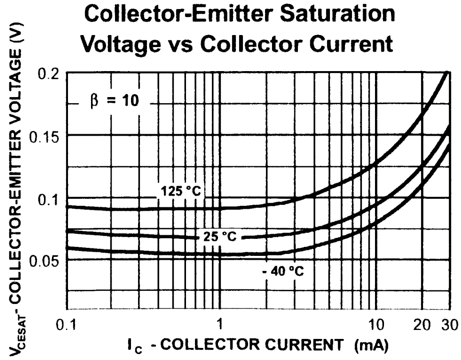
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

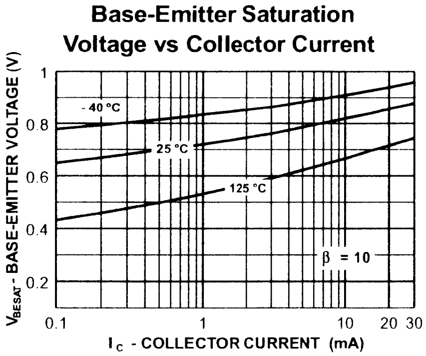


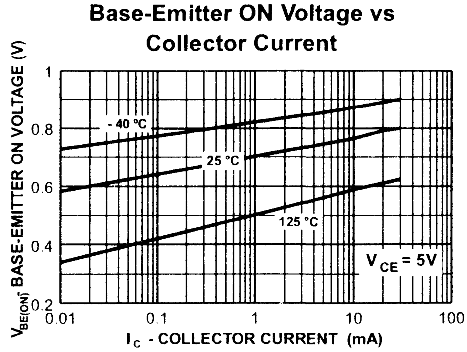
Collector-Emitter Saturation Voltage vs Collector Current

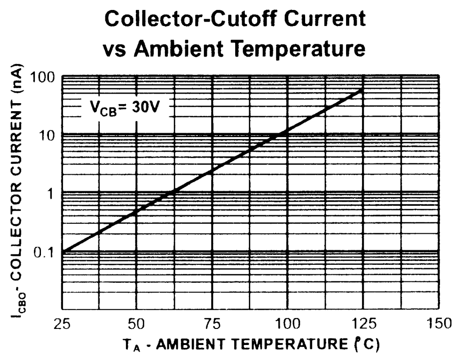


NPN RF Transistor
(continued)

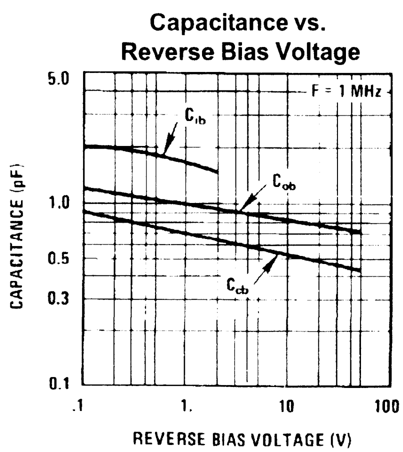
DC Typical Characteristics (continued)

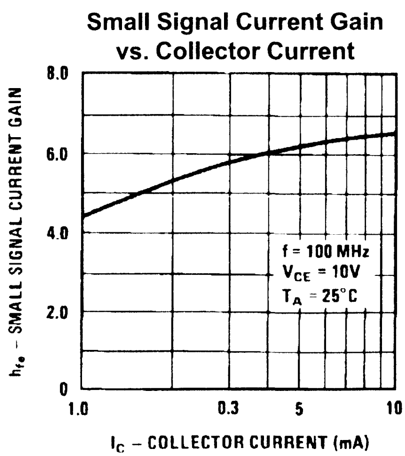




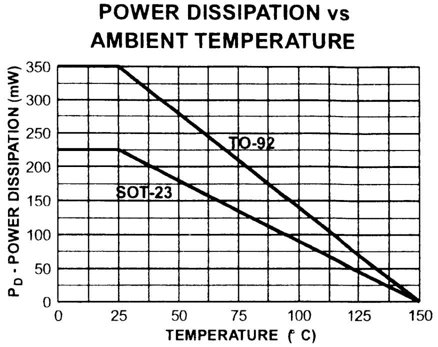


AC Typical Characteristics

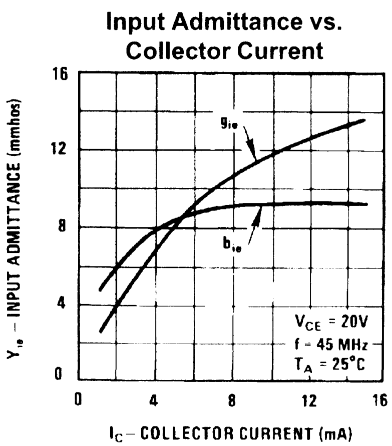


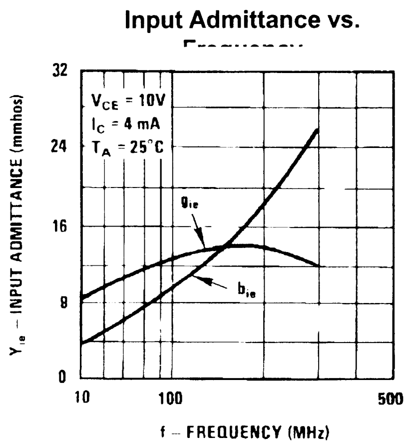


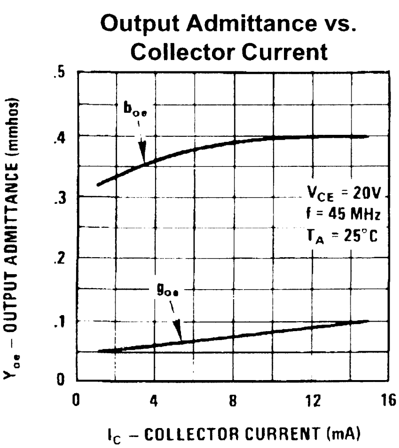
AC Typical Characteristics (continued)

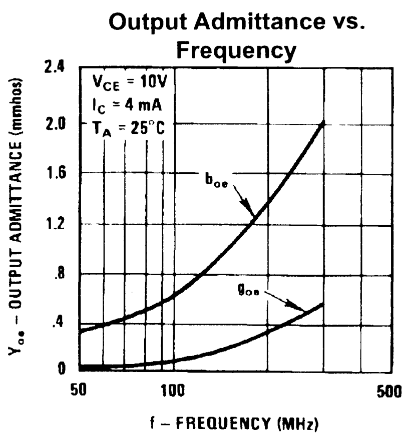


Common Emitter Y Parameters





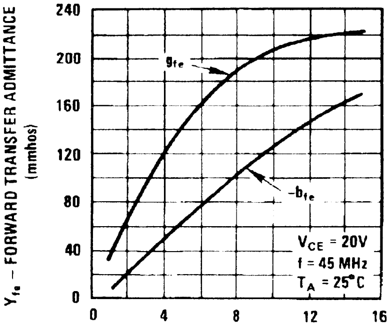




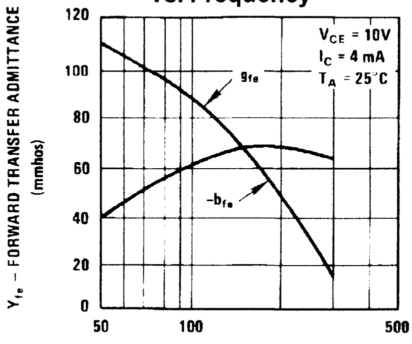
NPN RF Transistor
(continued)

Common Emitter Y Parameters (continued)

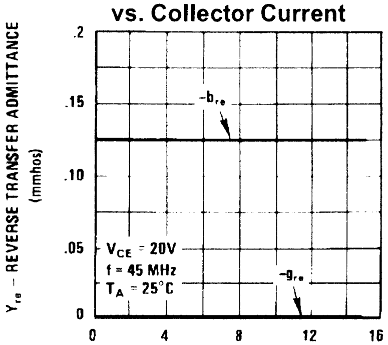
Forward Transfer Admittance vs. Collector Current



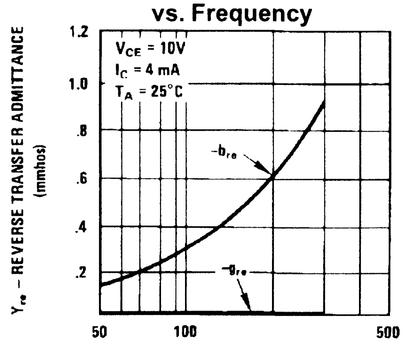
Forward Transfer Admittance vs. Frequency



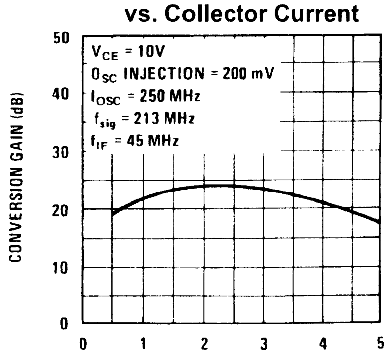
Reverse Transfer Admittance vs. Collector Current



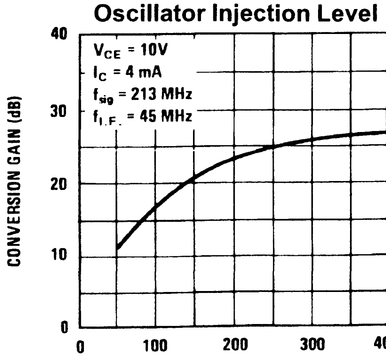
Reverse Transfer Admittance vs. Frequency



Conversion Gain vs. Collector Current



Conversion Gain vs. Oscillator Injection Level



Test Circuits

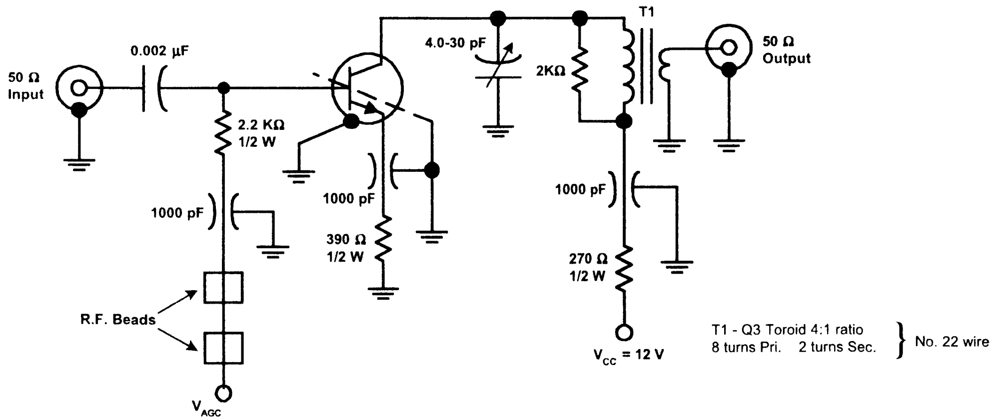


FIGURE 1: 45 MHz Power Gain Circuit

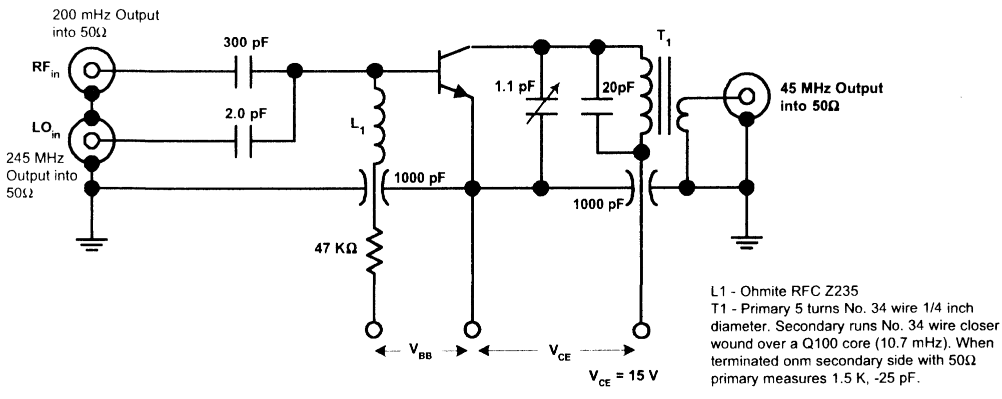
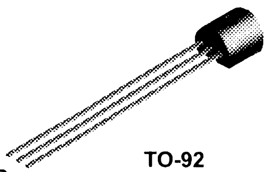


FIGURE 2: 200 MHz Conversion Gain Test Circuit

National Semiconductor™

Discrete POWER & Signal Technologies

MPSH24 MMBTH24



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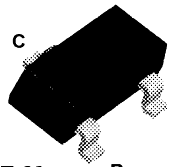

SOT-23
Mark: 3A

NPN RF Transistor

This device is designed for common-emitter low noise amplifier and mixer applications with collector currents in the 100 μA to 20 mA range to 300 MHz, and low frequency drift common-base VHF oscillator applications with high output levels for driving FET mixers. Sourced from Process 47. See MPSH11 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	30	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	4.0	V
I_C	Collector Current - Continuous	50	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		MPSH24	*MMBTH24	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN RF Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage*	$I_C = 1.0$ mA, $I_B = 0$	30		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100$ μA, $I_E = 0$	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10$ μA, $I_C = 0$	4.0		V
I_{CBO}	Collector Cutoff Current	$V_{CB} = 15$ V, $I_E = 0$		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 8.0$ mA, $V_{CE} = 10$ V	30		
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 8.0$ mA, $V_{CE} = 10$ V, f = 100 MHz	400		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		0.36	pF

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

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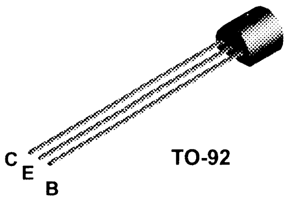
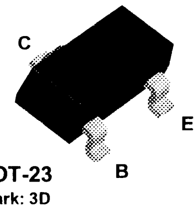
MPSH81 MMBTH81





PNP RF Transistor

This device is designed for general RF amplifier and mixer applications to 250 mHz with collector currents in the 1.0 mA to 30 mA range. Sourced from Process 75.

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	20	V
V_{CBO}	Collector-Base Voltage	20	V
V_{EBO}	Emitter-Base Voltage	3.0	V
I_C	Collector Current - Continuous	50	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

T_A = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		MPSH81	*MMBTH81	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

PNP RF Transistor
(continued)

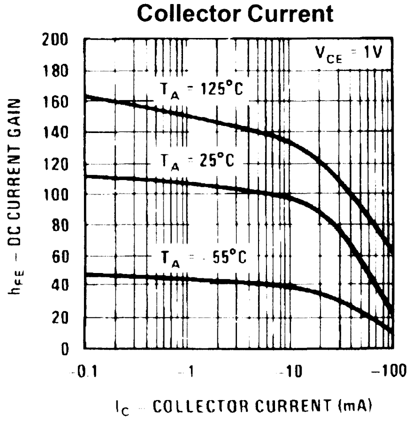
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 1.0 mA, I_B = 0	20		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_E = 0	20		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	3.0		V
I_{CBO}	Collector Cutoff Current	V_{CB} = 10 V, I_E = 0		100	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 2.0 V, I_C = 0		100	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 5.0 mA, V_{CE} = 10 V	60		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 5.0 mA, I_B = 0.5 mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 5.0 mA, V_{CE} = 10 V		0.9	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 5.0 mA, V_{CE} = 10 V, f = 100 MHz	600		MHz
C_{cb}	Collector-Base Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		0.85	pF
C_{ce}	Collector Emitter Capcitance	V_{CB} = 10 V, I_B = 0, f = 1.0 MHz		0.65	pF

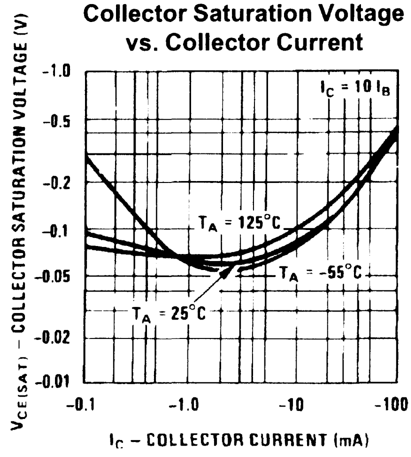
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

DC Typical Characteristics

DC Current Gain vs. Collector Current



Collector Saturation Voltage vs. Collector Current



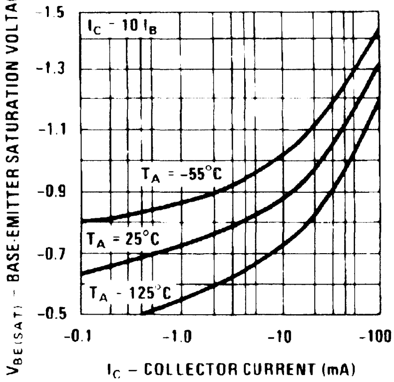
5

PNP RF Transistor

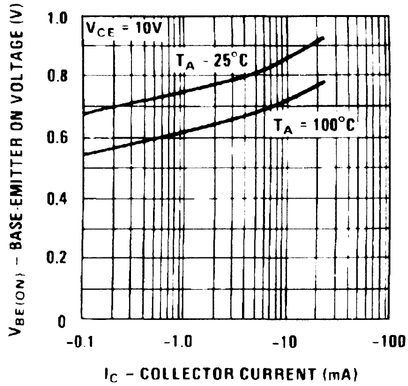
(continued)

DC Typical Characteristics (continued)

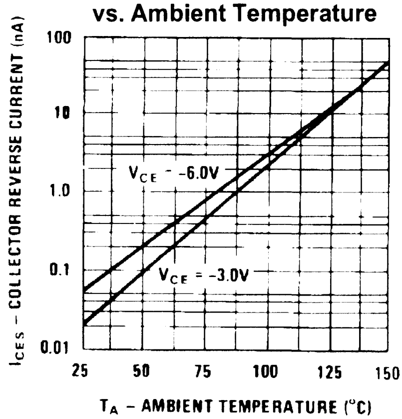
Base-Emitter Saturation Voltage vs. Collector Current



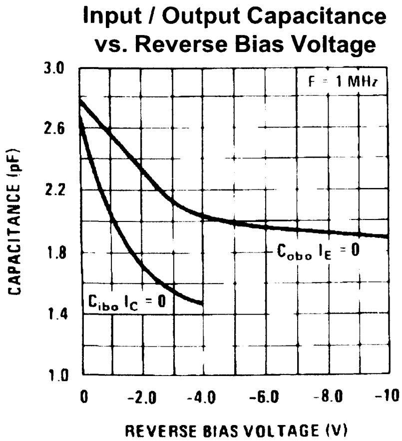
Base-Emitter ON Voltage vs. Collector Current

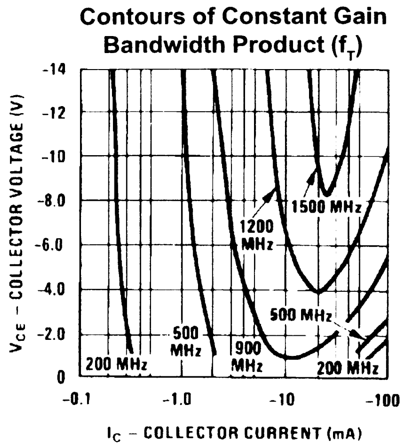


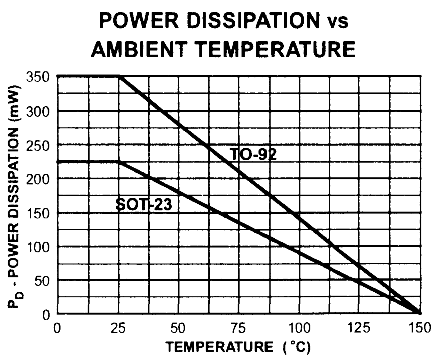
Collector Reverse Current vs. Ambient Temperature



AC Typical Characteristics







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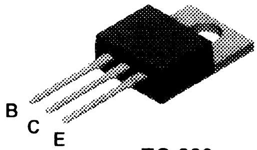
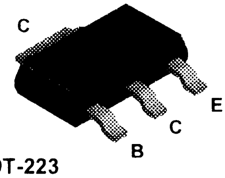
D44H8 NZT44H8



TO-220



SOT-223

NPN Power Amplifier

This device is designed for power amplifier, regulator and switching circuits where speed is important. Sourced from Process 4Q.

Absolute Maximum Ratings*
TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	60	V
I_C	Collector Current - Continuous	8.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics
TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		D44H8	*NZT44H8	
P_D	Total Device Dissipation Derate above 25°C	60 480	1.5 12	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	2.1		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	62.5	83.3	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

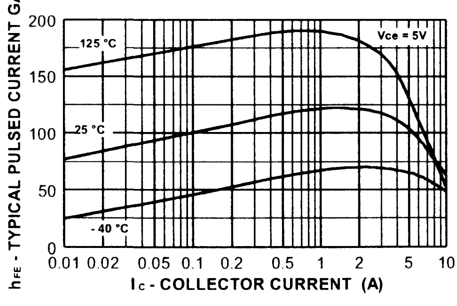
NPN Power Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

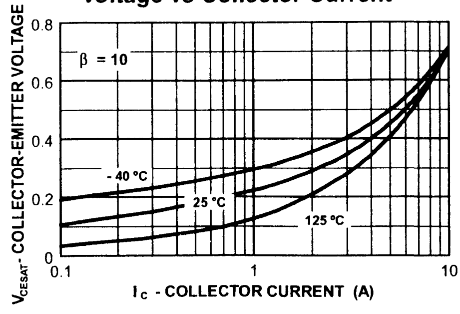
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	I_C = 100 mA, I_B = 0	60		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 60 V, I_E = 0		10	μA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 5.0 V, I_C = 0		100	μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 2.0 A, V_{CE} = 1.0 V I_C = 4.0 A, V_{CE} = 1.0 V	60 40		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 8.0 A, I_B = 0.4 A		1.0	V
$V_{BE(sat)}$	Base-Emitter On Voltage	I_C = 8.0 A, I_B = 0.8 A		1.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 10 mA, V_{CE} = 2.0 V	0.52	0.65	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 500 mA, V_{CE} = 10 V,	50		MHz

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



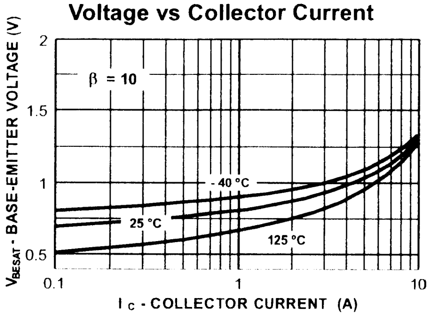
Collector-Emitter Saturation Voltage vs Collector Current



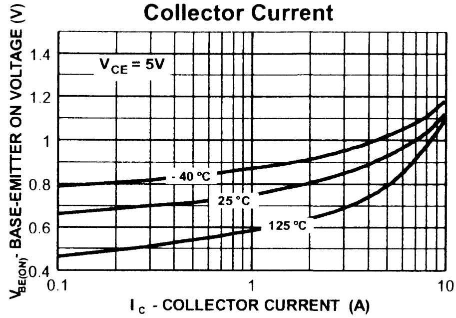
NPN Power Amplifier
(continued)

DC Typical Characteristics (continued)

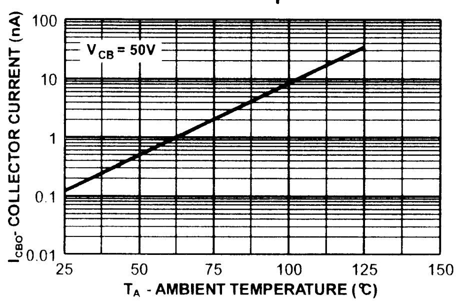
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

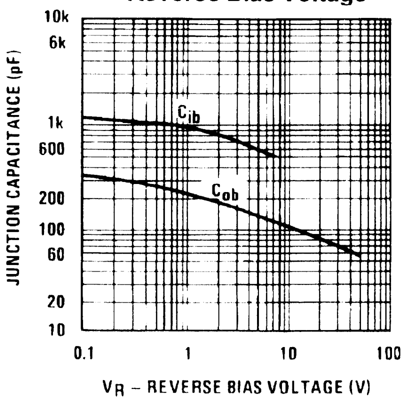


Collector-Cutoff Current vs Ambient Temperature

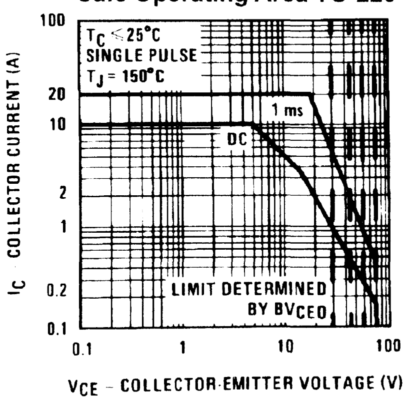


AC Typical Characteristics

Junction Capacitance vs. Reverse Bias Voltage

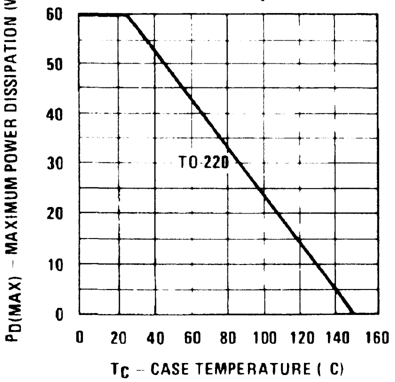


Safe Operating Area TO-220

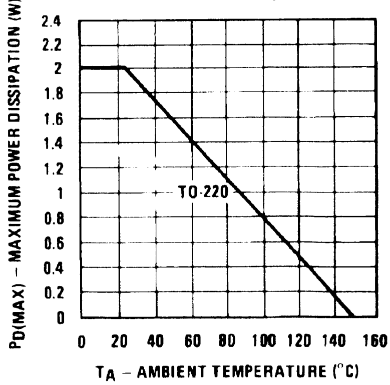


AC Typical Characteristics (continued)

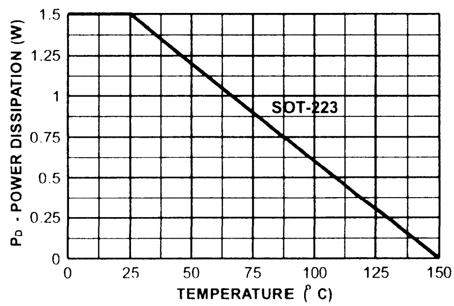
Maximum Power Dissipation vs. Case Temperature



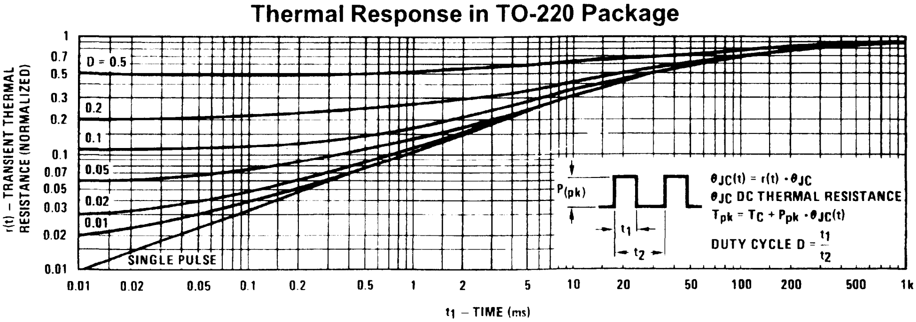
Maximum Power Dissipation vs. Ambient Temperature



POWER DISSIPATION vs AMBIENT TEMPERATURE



Thermal Response in TO-220 Package



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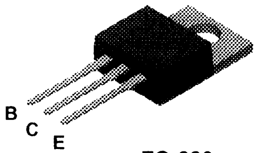
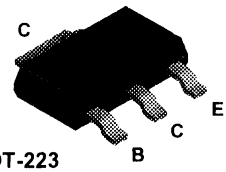
D45H8 NZT45H8



TO-220



SOT-223

PNP Power Amplifier

This device is designed for power amplifier, regulator and switching circuits where speed is important. Sourced from Process 5Q.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	60	V
I_C	Collector Current - Continuous	8.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		D45H8	*NZT45H8	
P_D	Total Device Dissipation Derate above 25°C	60 480	1.5 12	W mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	2.1		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	62.5	83.3	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

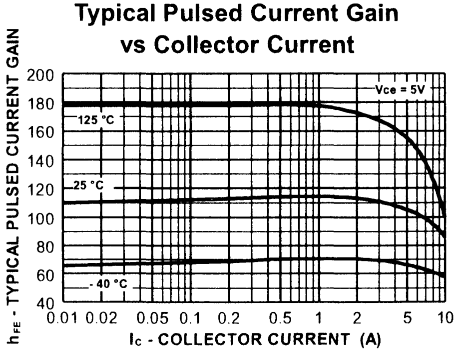
PNP Power Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

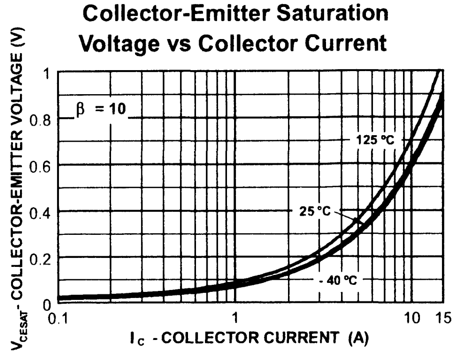
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 100 mA, I_B = 0	60		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 60 V, I_E = 0		10	µA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 5.0 V, I_C = 0		100	µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 2.0 A, V_{CE} = 1.0 V I_C = 4.0 A, V_{CE} = 1.0 V	60 40		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 8.0 A, I_B = 0.4 A		1.0	V
$V_{BE(sat)}$	Base-Emitter On Voltage	I_C = 8.0 A, I_B = 0.8 A		1.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 10 mA, V_{CE} = 2.0 V	0.54	0.65	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 500 mA, V_{CE} = 10 V,	40		MHz

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



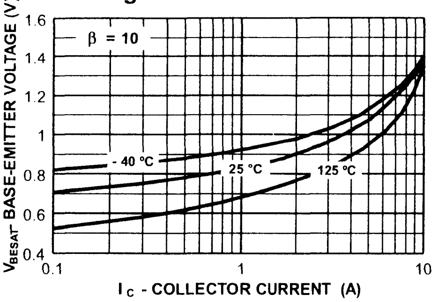
Collector-Emitter Saturation Voltage vs Collector Current



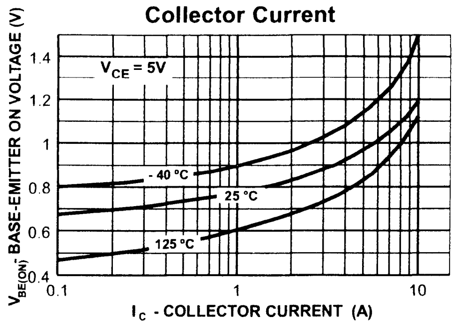
PNP Power Amplifier
(continued)

DC Typical Characteristics (continued)

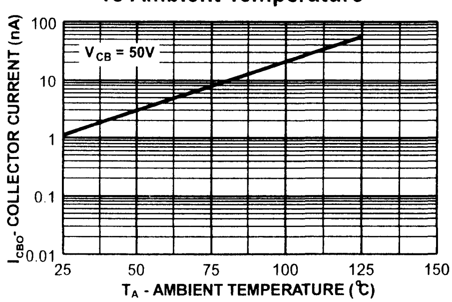
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

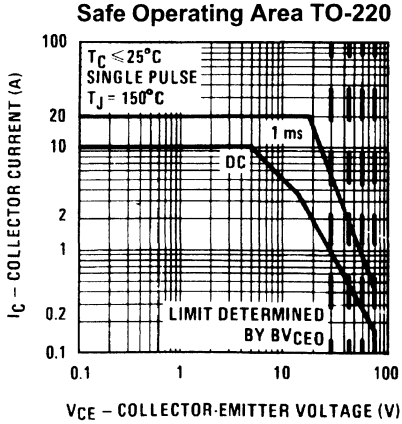


Collector-Cutoff Current vs Ambient Temperature

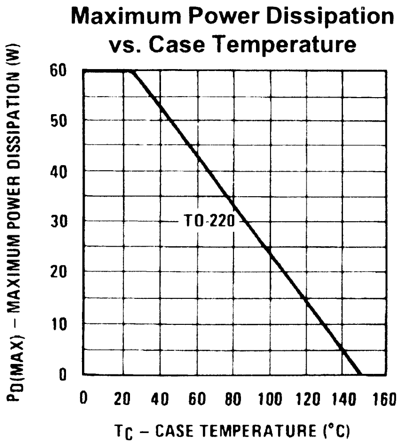


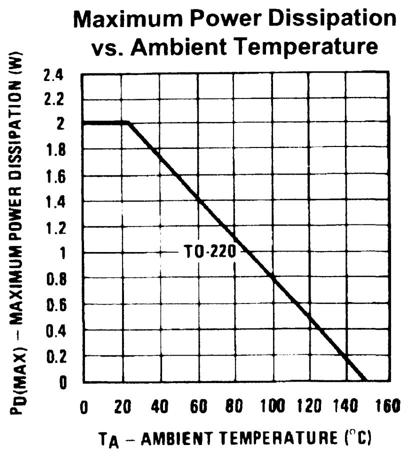
AC Typical Characteristics

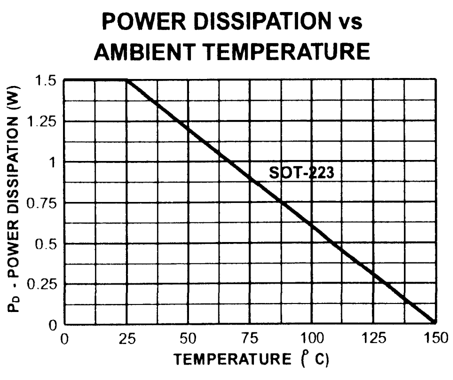
Safe Operating Area TO-220

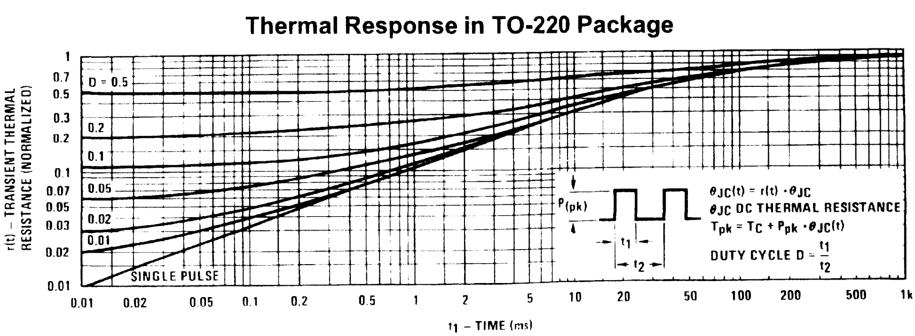


AC Typical Characteristics (continued)









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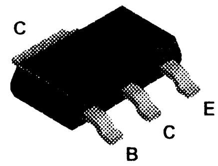
NZT651



SOT-223

NPN Current Driver Transistor

This device is designed for power amplifier, regulator and switching circuits where speed is important. Sourced from Process 4P.

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	60	V
V_{CBO}	Collector-Base Voltage	80	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	4.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

T_A = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*NZT651	
P_D	Total Device Dissipation Derate above 25°C	1.2 9.7	W mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	103	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

NPN Current Driver Transistor
(continued)

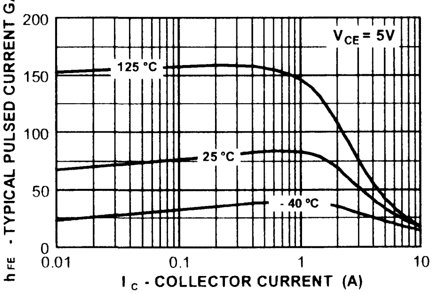
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage	$I_C = 10$ mA, $I_B = 0$	60		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu A$, $I_E = 0$	80		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 100\ \mu A$, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 80$ V, $I_E = 0$		100	nA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 4.0$ V, $I_C = 0$		0.1	µA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 50$ mA, $V_{CE} = 2.0$ V $I_C = 500$ mA, $V_{CE} = 2.0$ V $I_C = 1.0$ A, $V_{CE} = 2.0$ V $I_C = 2.0$ A, $V_{CE} = 2.0$ V	75 75 75 40		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 1.0$ A, $I_B = 100$ mA $I_C = 2.0$ A, $I_B = 200$ mA		0.3 0.5	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 1.0$ A, $I_B = 100$ mA		1.2	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 1.0$ A, $V_{CE} = 2.0$ V		1.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 50$ mA, $V_{CE} = 5.0$ V, f = 100 MHz	75		MHz

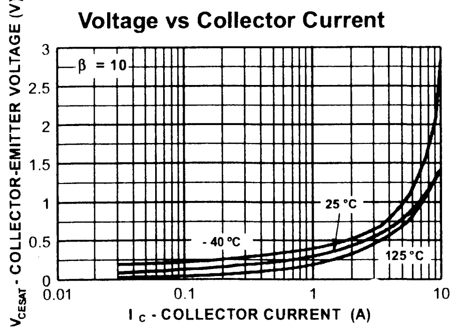
*Pulse Test: Pulse Width < 300 µs, Duty Cycle ≤ 2.0%

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



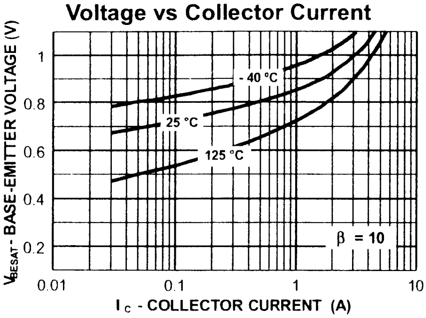
Collector-Emitter Saturation Voltage vs Collector Current



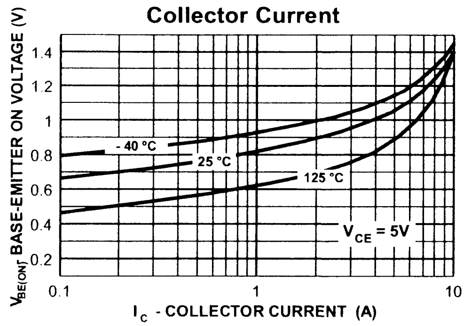
NPN Current Driver Transistor
(continued)

DC Typical Characteristics (continued)

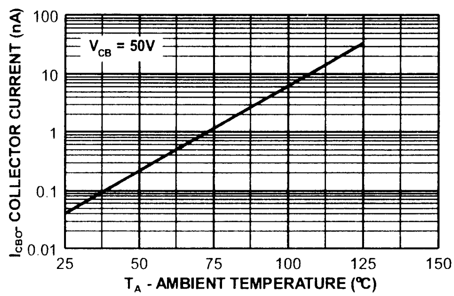
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

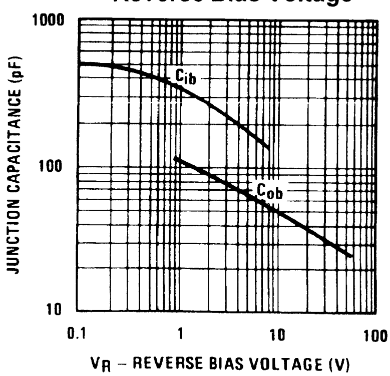


Collector-Cutoff Current vs Ambient Temperature



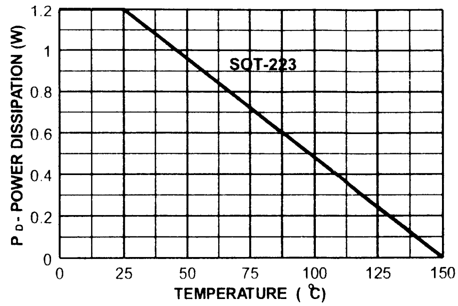
AC Typical Characteristics

Junction Capacitance vs. Reverse Bias Voltage



AC Typical Characteristics (continued)

POWER DISSIPATION vs AMBIENT TEMPERATURE



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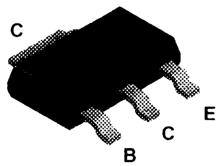
NZT751



SOT-223

PNP Current Driver Transistor

This device is designed for power amplifier, regulator and switching circuits where speed is important. Sourced from Process 5P.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	60	V
V_{CBO}	Collector-Base Voltage	80	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	4.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*NZT751	
P_D	Total Device Dissipation	1.2	mW
	Derate above 25°C	9.7	mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	103	°C/W

*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

PNP Current Driver Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Sustaining Voltage	I_C = 10 mA, I_B = 0	60		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100 µA, I_E = 0	80		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 µA, I_C = 0	5.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 80 V, I_E = 0		100	nA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 4.0 V, I_C = 0		0.1	µA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 50 mA, V_{CE} = 2.0 V I_C = 500 mA, V_{CE} = 2.0 V I_C = 1.0 A, V_{CE} = 2.0 V I_C = 2.0 A, V_{CE} = 2.0 V	75 75 75 40		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 1.0 A, I_B = 100 mA I_C = 2.0 A, I_B = 200 mA		0.3 0.5	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 1.0 A, I_B = 100 mA		1.2	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 1.0 A, V_{CE} = 2.0 V		1.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 50 mA, V_{CE} = 5.0 V, f = 100 MHz	75		MHz

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

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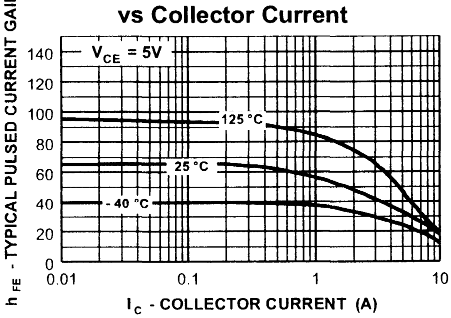
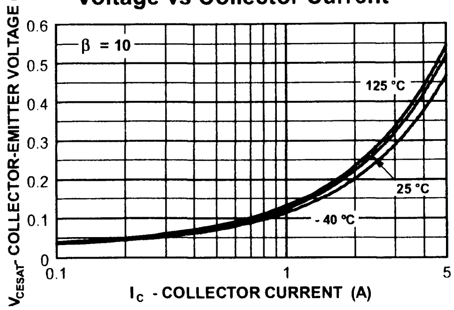
DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



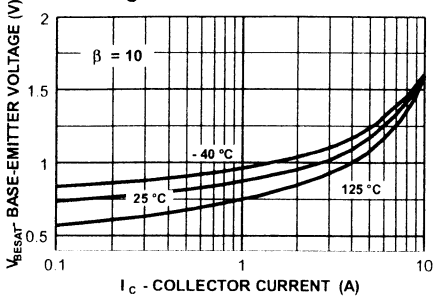
Collector-Emitter Saturation Voltage vs Collector Current



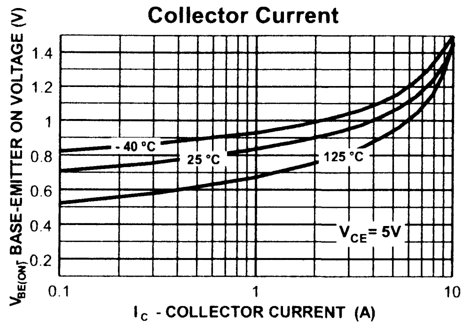
PNP Current Driver Transistor
(continued)

DC Typical Characteristics (continued)

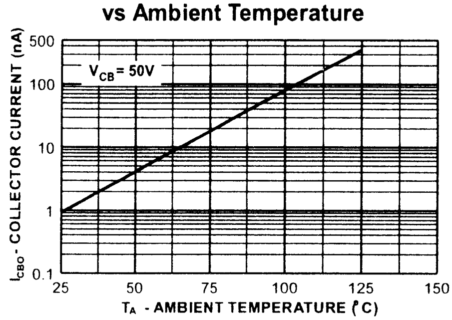
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

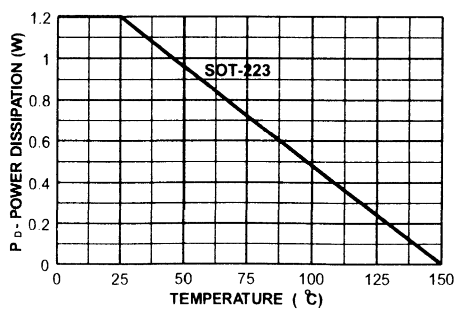


Collector-Cutoff Current vs Ambient Temperature



AC Typical Characteristics

POWER DISSIPATION vs AMBIENT TEMPERATURE



Section 6

Pro-Electron Transistors

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Section 6 Contents

Pro-Electron Transistor Datasheets

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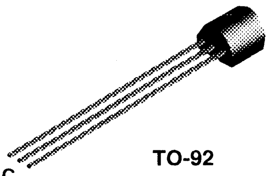
BC368



B C E TO-92

NPN General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 1.5 A. Sourced from Process 37.

Absolute Maximum Ratings* TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	20	V
V_{CES}	Collector-Base Voltage	25	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	2.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

Thermal Characteristics TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BC368	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	°C/W

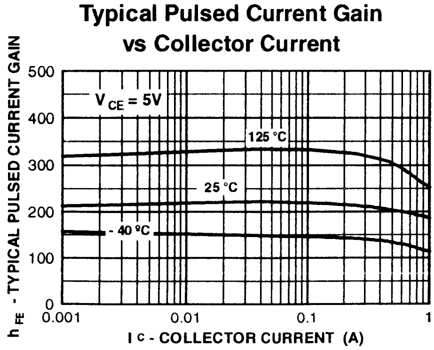
NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

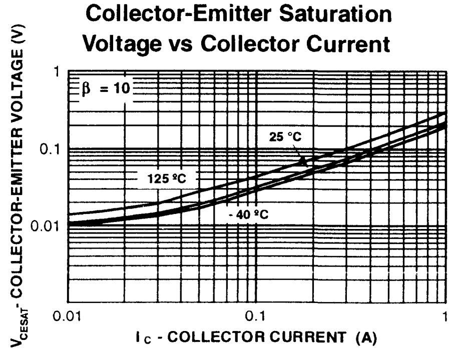
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 10 mA, I_B = 0	20		V
$V_{(BR)CES}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	25		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	5.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 25 V, I_E = 0 V_{CB} = 25 V, I_E = 0, T_A = 150°C		10 1.0	μA mA
I_{EBO}	Emitter-Cutoff Current	V_{EB} = 5.0 V, I_C = 0		10	μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 5.0 mA, V_{CE} = 10 V I_C = 0.5 A, V_{CE} = 1.0 V I_C = 1.0 A, V_{CE} = 1.0 V	50 85 60	 375 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 1.0 A, I_B = 100 mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 1.0 A, V_{CE} = 1.0 V		1.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 5.0 V, f = 35 MHz	45		MHz

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

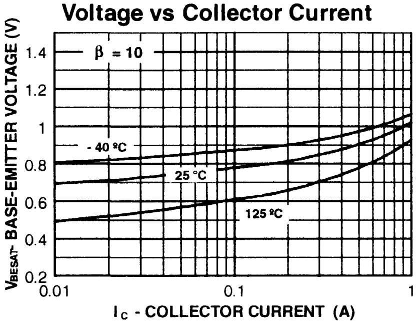


Collector-Emitter Saturation Voltage vs Collector Current

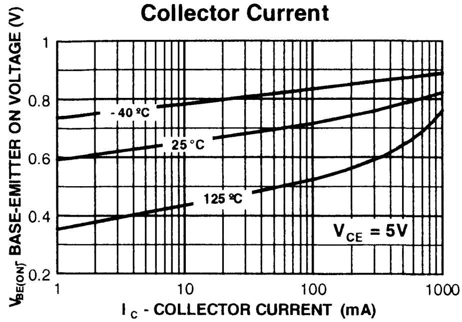


DC Typical Characteristics (continued)

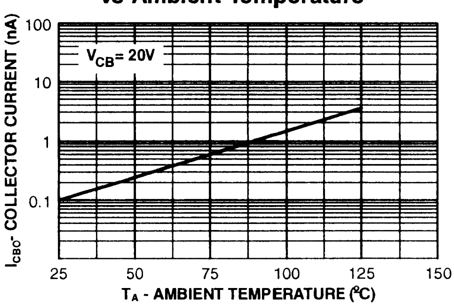
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

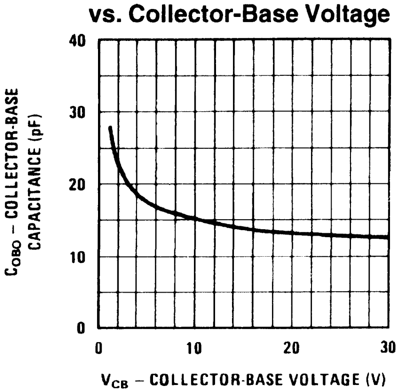


Collector-Cutoff Current vs Ambient Temperature

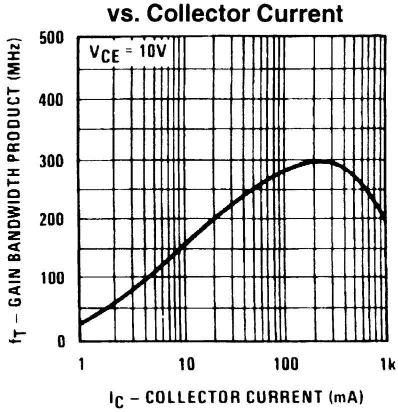


AC Typical Characteristics

Collector-Base Capacitance vs. Collector-Base Voltage



Gain Bandwidth Product vs. Collector Current



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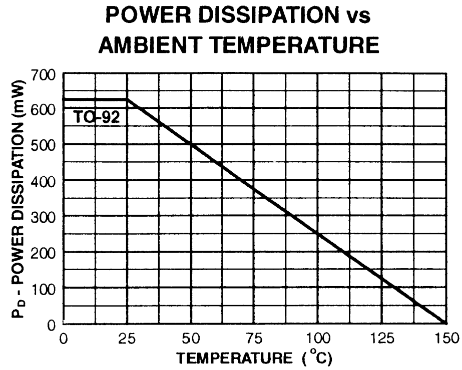
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)



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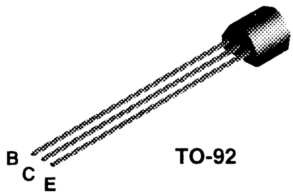
BC369



TO-92

PNP General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 1.2 A. Sourced from Process 77.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	20	V
V_{CES}	Collector-Base Voltage	25	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.5	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BC369	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	°C/W

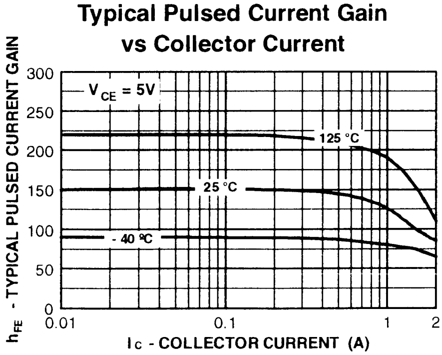
PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

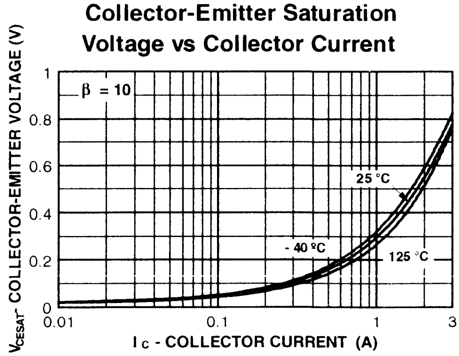
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	20		V
$V_{(BR)CES}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu A$, $I_E = 0$	25		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 25$ V, $I_E = 0$ $V_{CB} = 25$ V, $I_E = 0$, $T_A = 150°C$		10 1.0	μA mA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 5.0$ V, $I_C = 0$		10	μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 5.0$ mA, $V_{CE} = 10$ V $I_C = 0.5$ A, $V_{CE} = 1.0$ V $I_C = 1.0$ A, $V_{CE} = 1.0$ V	50 85 60	 375 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 1.0$ A, $I_B = 100$ mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 1.0$ A, $V_{CE} = 1.0$ V		1.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 5.0$ V, f = 35 MHz	45		MHz

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

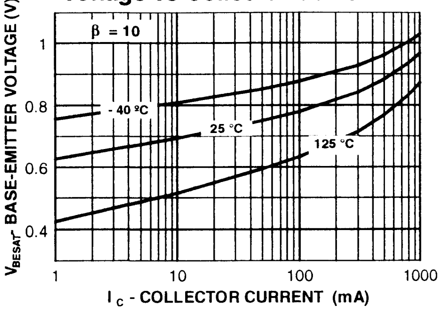


Collector-Emitter Saturation Voltage vs Collector Current

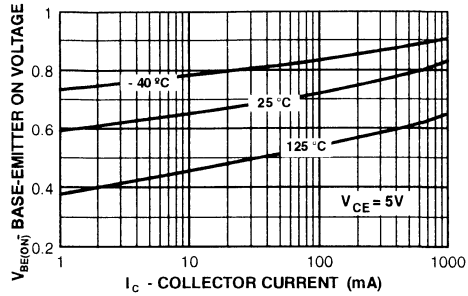


DC Typical Characteristics (continued)

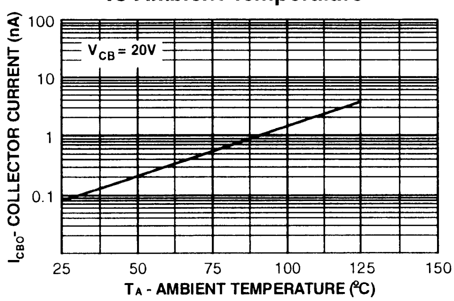
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

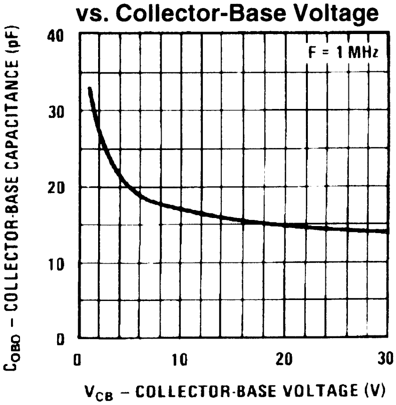


Collector-Cutoff Current vs Ambient Temperature

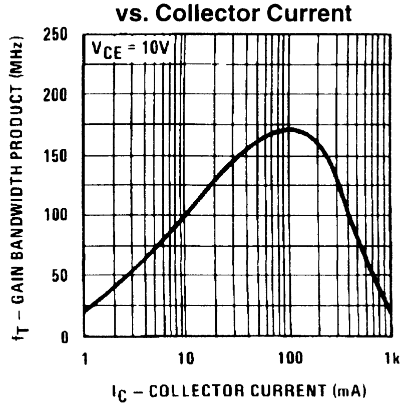


AC Typical Characteristics

Collector-Base Capacitance vs. Collector-Base Voltage

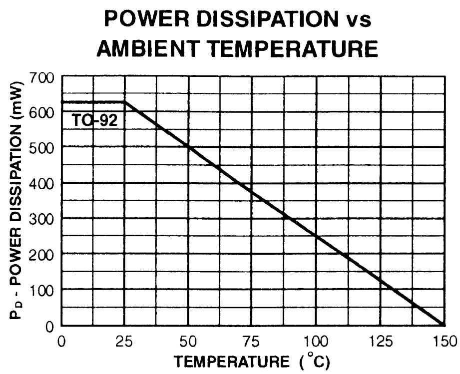


Gain Bandwidth Product vs. Collector Current



PNP General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)



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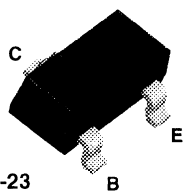
BC807-16
BC807-25
BC807-40



SOT-23
Mark: 5A. / 5B. / 5C.

PNP General Purpose Amplifier

This device is designed for general purpose amplifier and switching applications at currents to 1.0 A. Sourced from Process 78.

Absolute Maximum Ratings*
TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	45	V
V_{CES}	Collector-Base Voltage	50	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics
TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BC807-16 / -25 / -40	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

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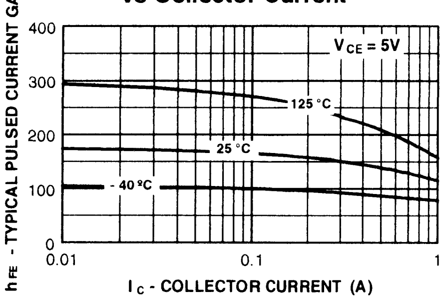
PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

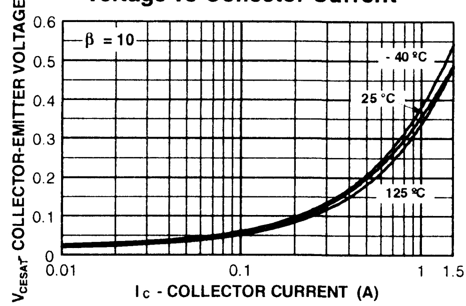
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 10 mA, I_B = 0	45		V
$V_{(BR)CES}$	Collector-Base Breakdown Voltage	I_C = 100 μA, I_E = 0	50		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	5.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 20 V V_{CB} = 20 V, T_A = 150°C		100 5.0	nA μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 100 mA, V_{CE} = 1.0 V **- 16** **- 25** **- 40** I_C = 500 mA, V_{CE} = 1.0 V	100 160 250 40	250 400 600	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 500 mA, I_B = 50 mA		0.7	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 500 mA, V_{CE} = 1.0 V		1.2	V

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

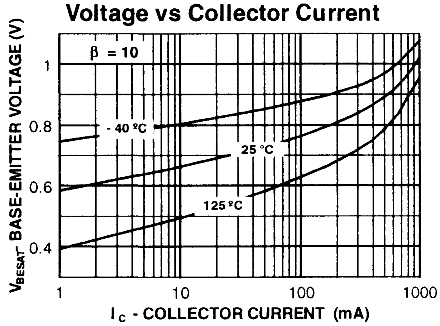


Collector-Emitter Saturation Voltage vs Collector Current

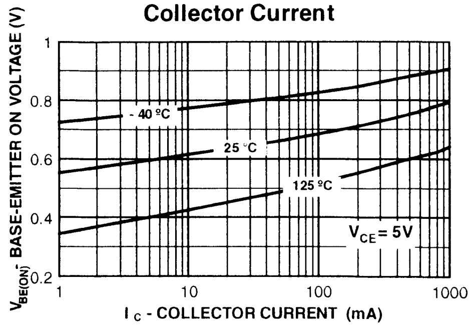


DC Typical Characteristics (continued)

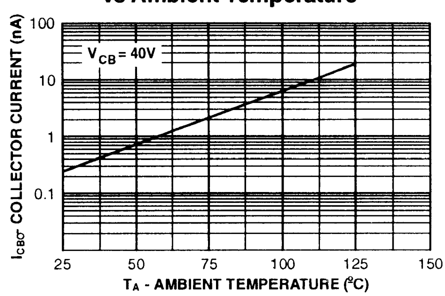
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

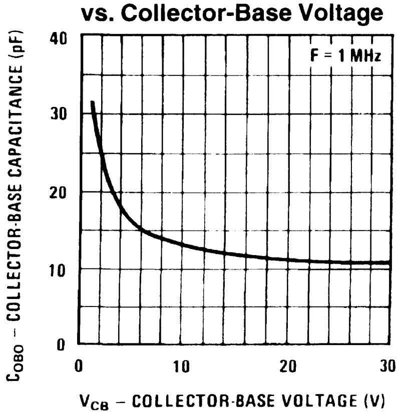


Collector-Cutoff Current vs Ambient Temperature

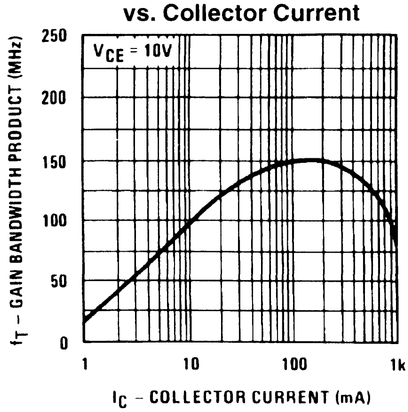


AC Typical Characteristics

Collector-Base Capacitance vs. Collector-Base Voltage



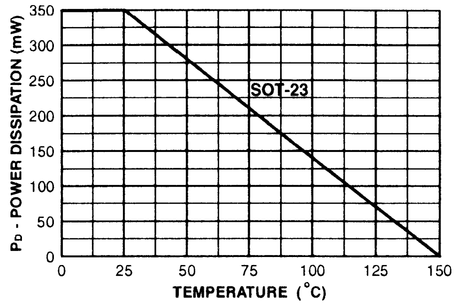
Gain Bandwidth Product vs. Collector Current



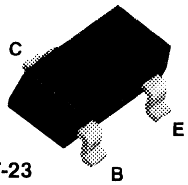
PNP General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

POWER DISSIPATION vs AMBIENT TEMPERATURE



BC817-25
BC817-40



SOT-23
Mark: 6B. / 6C.

NPN General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 1.2 A. Sourced from Process 38.

Absolute Maximum Ratings*   TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	45	V
V_{CES}	Collector-Base Voltage	50	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.5	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics   TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BC817-25 / BC817-40	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

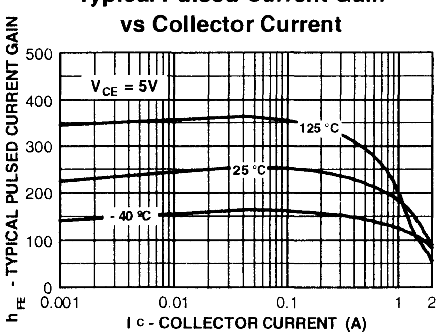
NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

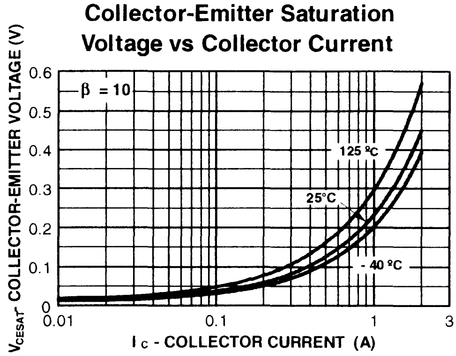
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	45		V
$V_{(BR)CES}$	Collector-Base Breakdown Voltage	$I_C = 100$ µA, $I_E = 0$	50		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10$ µA, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 20$ V $V_{CB} = 20$ V, $T_A = 150°C$		100 5.0	nA µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 100$ mA, $V_{CE} = 1.0$ V **- 25** **- 40** $I_C = 500$ mA, $V_{CE} = 1.0$ V	160 250 40	400 600	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 500$ mA, $I_B = 50$ mA		0.7	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 500$ mA, $V_{CE} = 1.0$ V		1.2	V

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

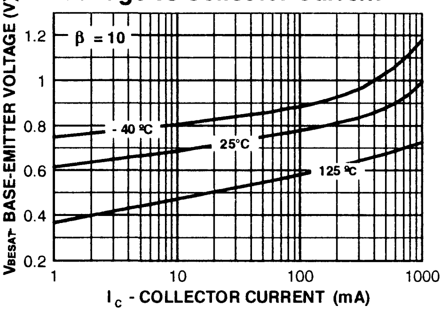


Collector-Emitter Saturation Voltage vs Collector Current

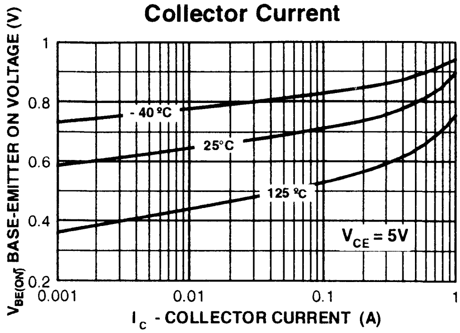


DC Typical Characteristics (continued)

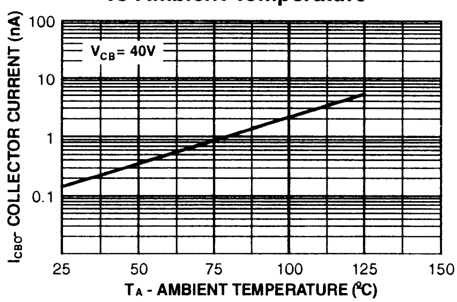
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

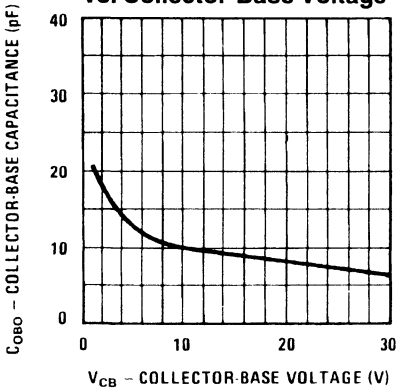


Collector-Cutoff Current vs Ambient Temperature

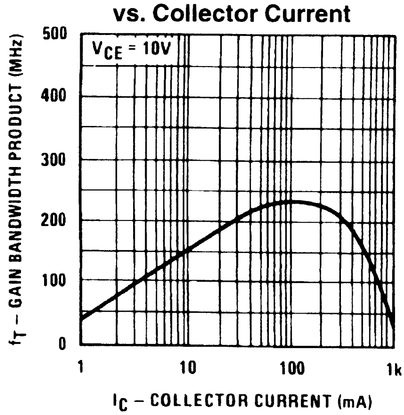


AC Typical Characteristics

Collector-Base Capacitance vs. Collector-Base Voltage



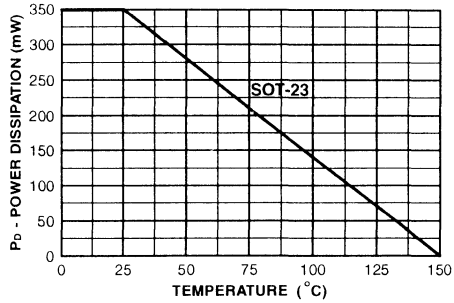
Gain Bandwidth Product vs. Collector Current



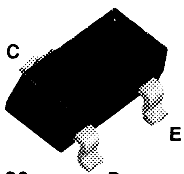
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

POWER DISSIPATION vs AMBIENT TEMPERATURE



BC818-25
BC818-40



SOT-23
Mark: 6F. / 6G.

NPN General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switches requiring collector currents to 1.2 A. Sourced from Process 38. See BC817 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	25	V
V_{CES}	Collector-Base Voltage	30	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.5	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BC818-25 / BC818-40	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

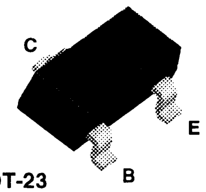
NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

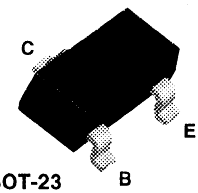
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	25		V
$V_{(BR)CES}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu A$, $I_E = 0$	30		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 20$ V $V_{CB} = 20$ V, $T_A = 150°C$		100 5.0	nA µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 100$ mA, $V_{CE} = 1.0$ V **- 25** **- 40** $I_C = 500$ mA, $V_{CE} = 1.0$ V	160 250 40	400 600	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 500$ mA, $I_B = 50$ mA		0.7	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 500$ mA, $V_{CE} = 1.0$ V		1.2	V

BC846A
BC846B

BC847A
BC847B
BC847C



SOT-23
Mark: 1A. / 1B.



SOT-23
Mark: 1E. / 1F. / 1G.

NPN General Purpose Amplifier

This device is designed for low noise, high gain, general purpose amplifier applications at collector currents from 1.0 µA to 50 mA. Sourced from Process 07.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter		Value	Units
V_{CEO}	Collector-Emitter Voltage	**BC846 series**	65	V
		BC847 series	45	V
V_{CES}	Collector-Base Voltage	**BC846 series**	80	V
		BC847 series	50	V
V_{EBO}	Emitter-Base Voltage		6.0	V
I_C	Collector Current - Continuous		100	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range		-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		***BC846 / BC847**	
P_D	Total Device Dissipation	325	mW
	Derate above 25°C	2.8	mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

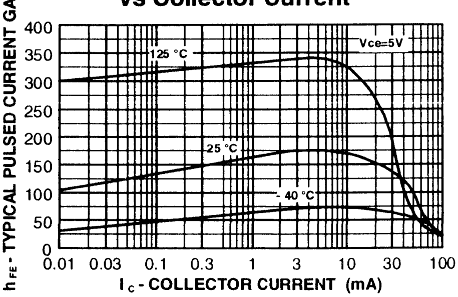
NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

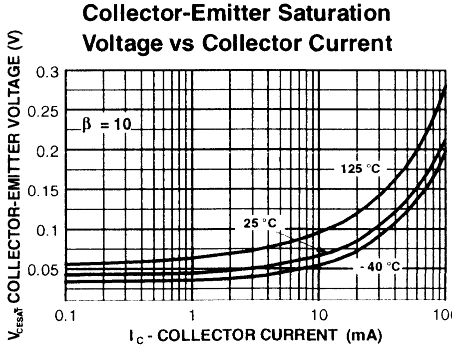
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 10 mA, I_B = 0 **BC846** **BC847**	65 45		V
$V_{(BR)CES}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_E = 0 **BC846** **BC847**	80 50		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	6.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 30 V V_{CB} = 30 V, T_A = 150°C		15 5.0	nA μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 2.0 mA, V_{CE} = 5.0 V **BC846A / 847A** **BC846B / 847B** **BC847C**	 110 200 420	 220 450 800	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 0.5 mA I_C = 100 mA, I_B = 5.0 mA		0.25 0.6	V V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 2.0 mA, V_{CE} = 5.0 V I_C = 10 mA, V_{CE} = 5.0 V	0.58	0.70 0.77	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 5.0, f = 100 MHz	100		MHz
C_{obo}	Output Capacitance	V_{CB} = 10 V, f = 1.0 MHz		4.5	pF
NF	Noise Figure	I_C = 0.2 mA, V_{CE} = 5.0, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz		10	dB

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

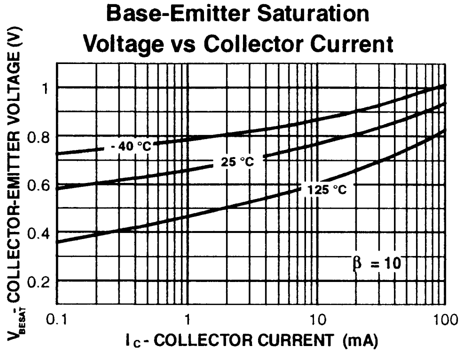


Collector-Emitter Saturation Voltage vs Collector Current

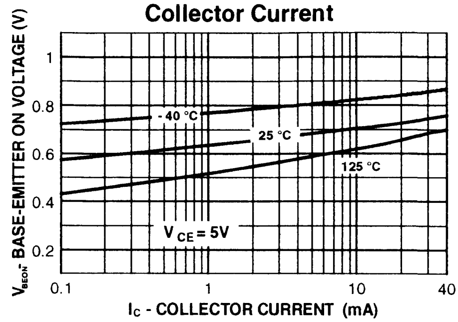


DC Typical Characteristics (continued)

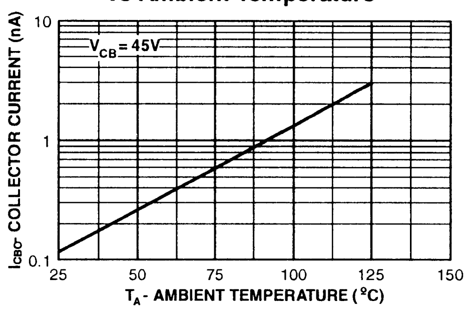
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

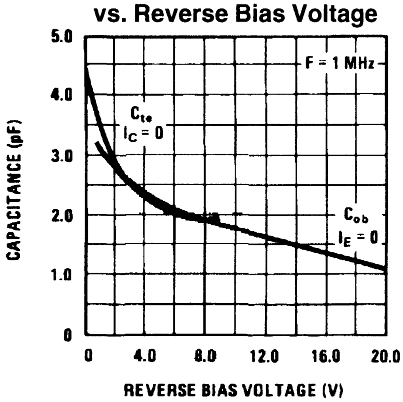


Collector-Cutoff Current vs Ambient Temperature

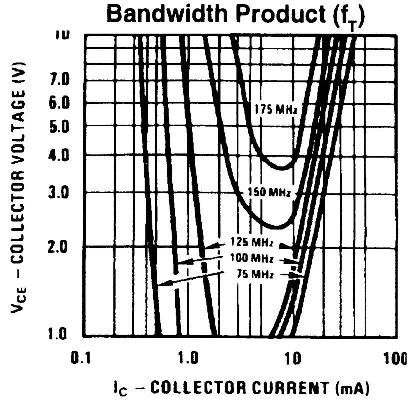


AC Typical Characteristics

Input / Output Capacitance vs. Reverse Bias Voltage



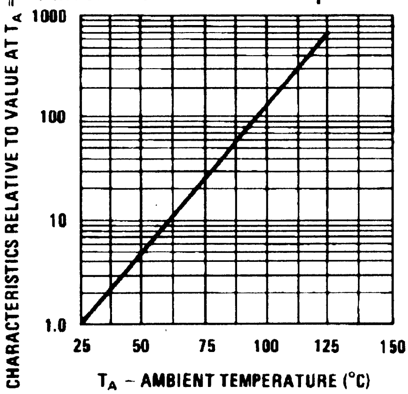
Contours of Constant Gain Bandwidth Product (f_T)



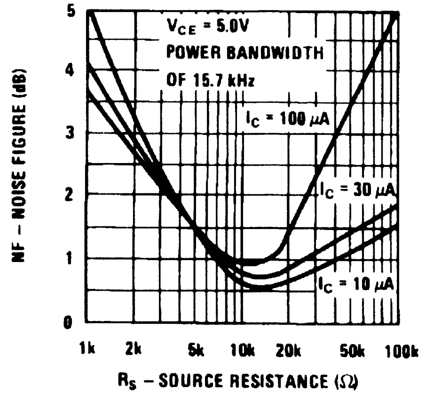
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

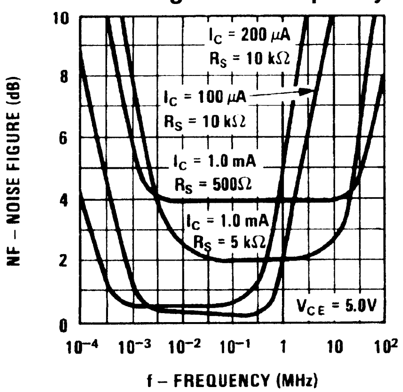
Normalized Collector Cutoff Current vs. Ambient Temperature



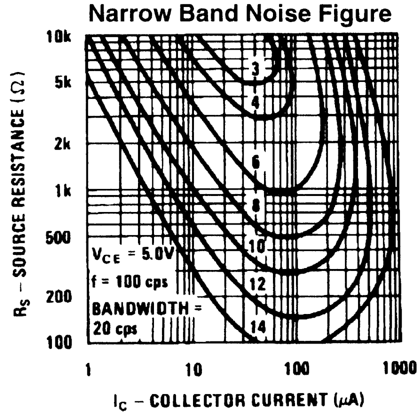
Wideband Noise Figure vs. Source Resistance



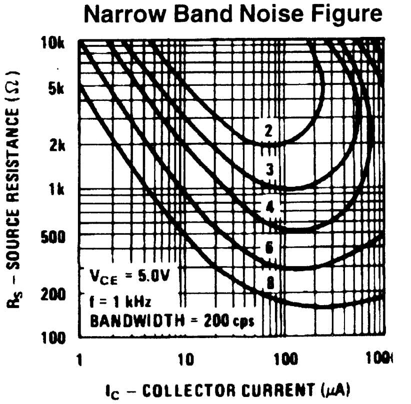
Noise Figure vs. Frequency



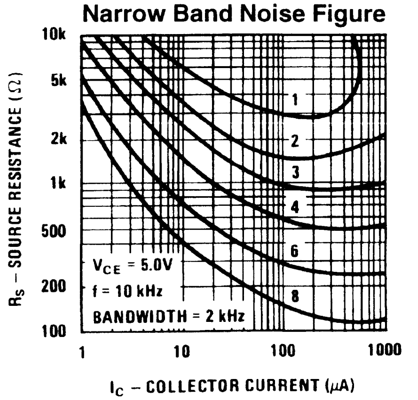
Contours of Constant Narrow Band Noise Figure



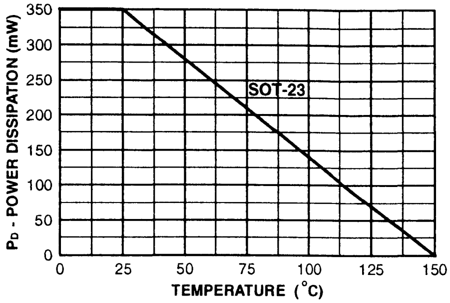
Contours of Constant Narrow Band Noise Figure



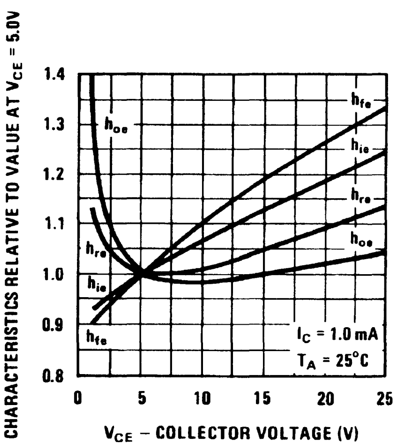
Contours of Constant Narrow Band Noise Figure

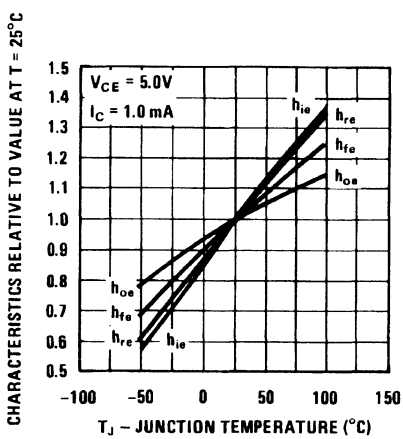


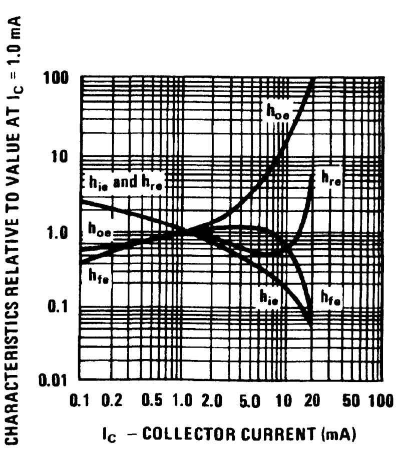
AC Typical Characteristics (continued)



Typical Common Emitter Characteristics (f = 1.0 kHz)







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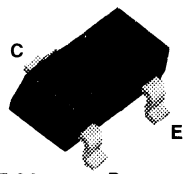
BC857A
BC857B
BC857C



SOT-23
Mark: 3E / 3F / 3G.

PNP General Purpose Amplifier

This device is designed for general purpose amplifier applications at collector currents to 300 mA. Sourced from Process 68.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	45	V
V_{CBO}	Collector-Base Voltage	50	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	500	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BC857A / B / C	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

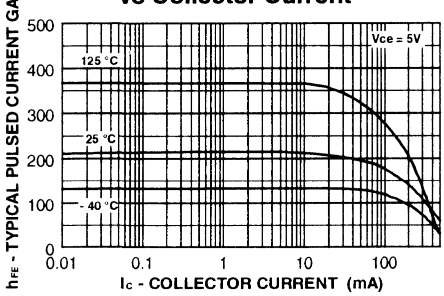
PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

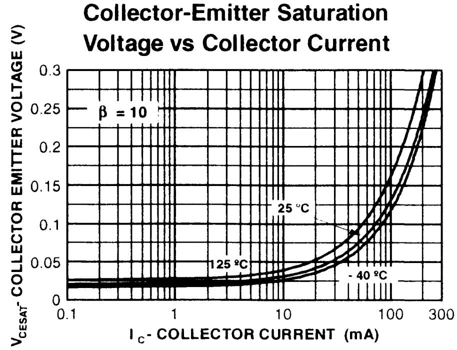
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	45		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10$ μA, $I_E = 0$	50		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 1.0$ μA, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 30$ V $V_{CB} = 30$ V, $T_A = 150$°C		15 4.0	nA μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 2.0$ mA, $V_{CE} = 5.0$ V **BC857A** **BC857B** **BC857C**	 125 220 420	 250 475 800	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 0.5$ mA $I_C = 100$ mA, $I_B = 5.0$ mA		0.3 0.65	V V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 2.0$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V	0.6	0.75 0.82	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 5.0$, f = 100 mHz	100		MHz
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, f = 1.0 MHz		4.5	pF
NF	Noise Figure	$I_C = 0.2$ mA, $V_{CE} = 5.0$, $R_S = 2.0$ kΩ, f = 1.0 kHz, BW = 200 Hz		10	dB

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



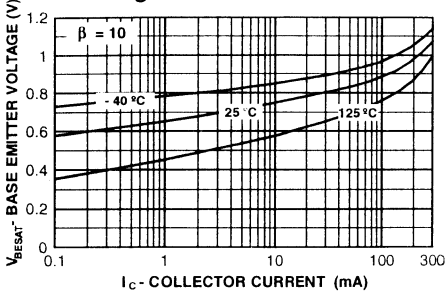
Collector-Emitter Saturation Voltage vs Collector Current



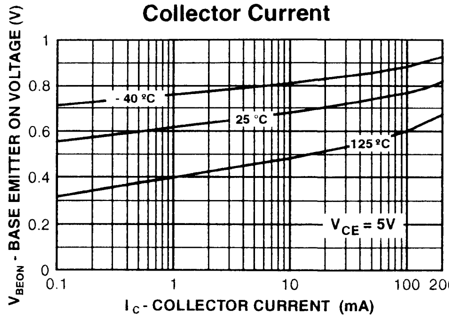
PNP General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

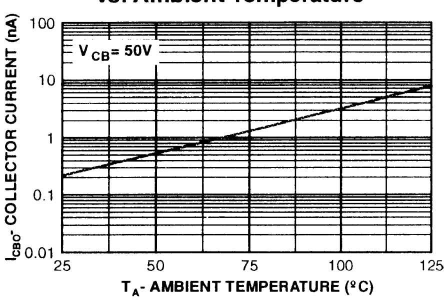
Base-Emitter Saturation Voltage vs Collector Current



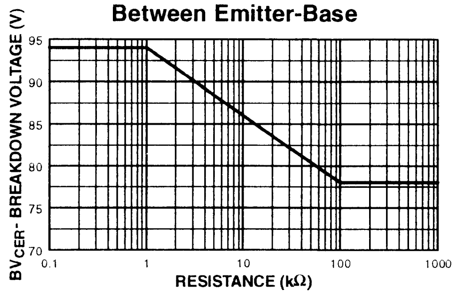
Base Emitter ON Voltage vs Collector Current



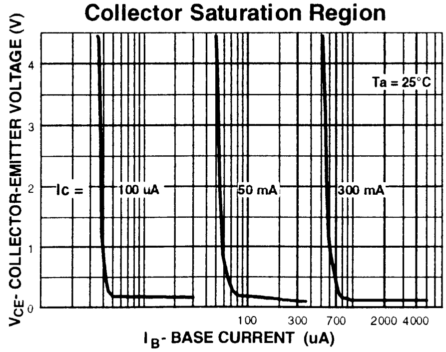
Collector-Cutoff Current vs. Ambient Temperature



Collector-Emitter Breakdown Voltage with Resistance Between Emitter-Base

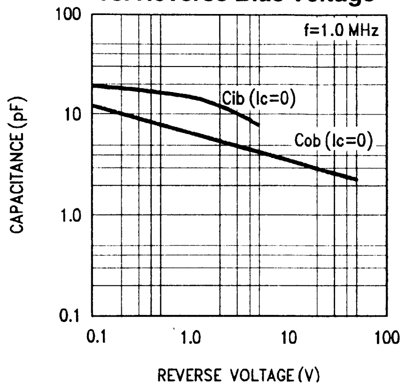


Collector Saturation Region

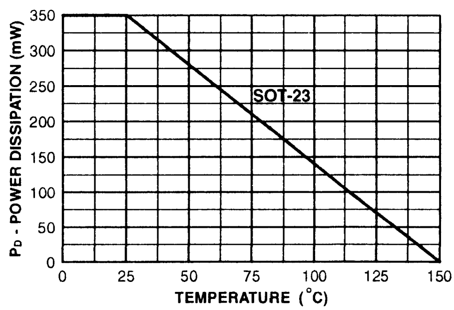


AC Typical Characteristics

Input / Output Capacitance vs. Reverse Bias Voltage



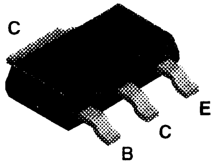
POWER DISSIPATION vs AMBIENT TEMPERATURE



National Semiconductor

Discrete POWER & Signal Technologies

BCP52



SOT-223

PNP General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switching circuits requiring collector currents to 1.0 A. Sourced from Process 78.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	60	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BCP52	
P_D	Total Device Dissipation Derate above 25°C	1.5 12	W mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	83.3	°C/W

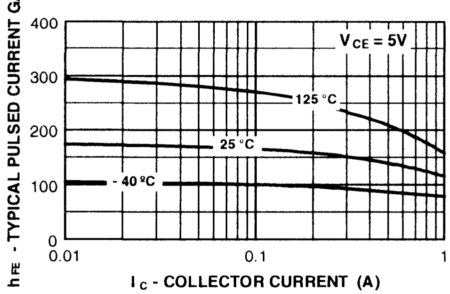
PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

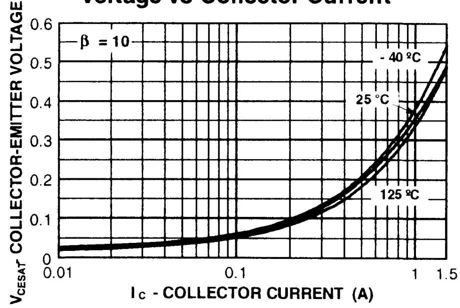
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	60		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100$ μA, $I_E = 0$	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10$ μA, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 30$ V, $I_E = 0$ $V_{CB} = 30$ V, $I_E = 0$, $T_A = 125$°C		100 10	nA μA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 5.0$ V, $I_C = 0$		10	μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 5.0$ mA, $V_{CE} = 2.0$ V $I_C = 150$ mA, $V_{CE} = 2.0$ V $I_C = 500$ mA, $V_{CE} = 2.0$ V	25 40 25	 250 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 500$ mA, $I_B = 50$ mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 500$ mA, $V_{CE} = 2.0$ V		1.0	V

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



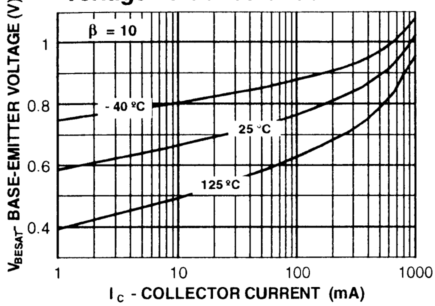
Collector-Emitter Saturation Voltage vs Collector Current



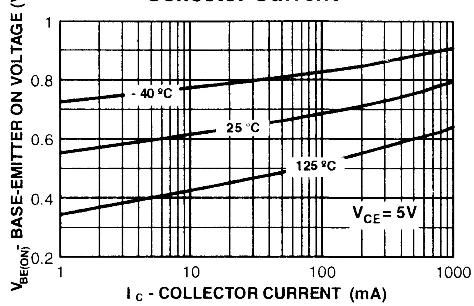
PNP General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

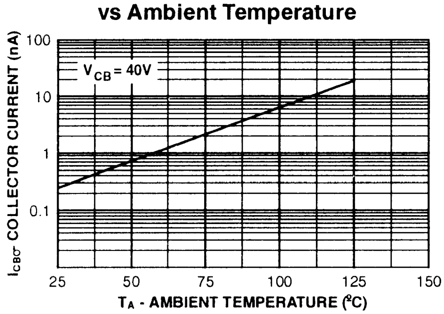
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

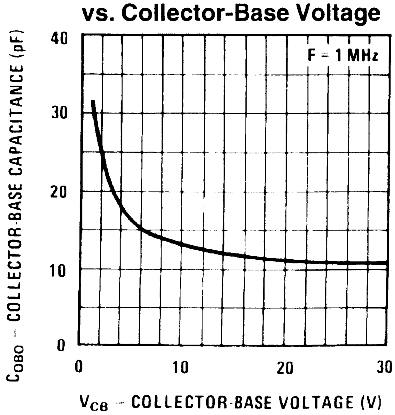


Collector-Cutoff Current vs Ambient Temperature

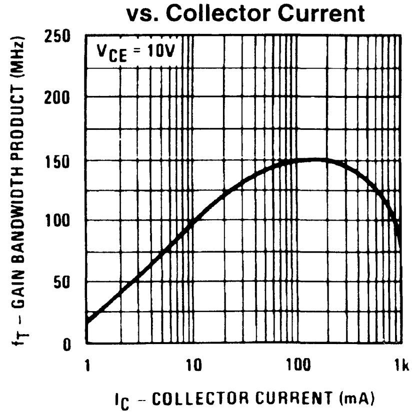


AC Typical Characteristics

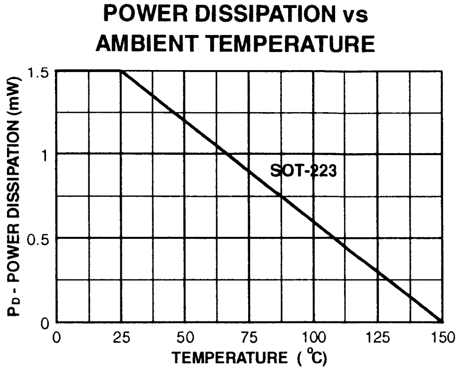
Collector-Base Capacitance vs. Collector-Base Voltage



Gain Bandwidth Product vs. Collector Current



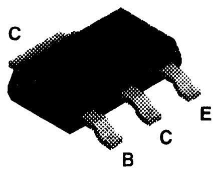
AC Typical Characteristics (continued)



National Semiconductor™

Discrete POWER & Signal Technologies

BCP54



SOT-223

NPN General Purpose Amplifier

This device is designed for general purpose medium power amplifiers and switching circuits requiring collector currents to 1.2 A. Sourced from Process 38.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	45	V
V_{CBO}	Collector-Base Voltage	45	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.5	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BCP54	
P_D	Total Device Dissipation Derate above 25°C	1.5 12	W mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	83.3	°C/W

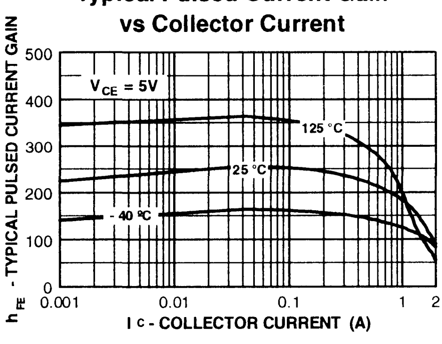
NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

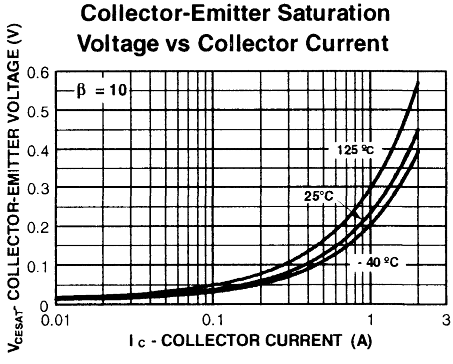
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	45		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu$A, $I_E = 0$	45		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu$A, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 30$ V, $I_E = 0$ $V_{CB} = 30$ V, $I_E = 0$, $T_A = 125°C$		100 10	nA µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 5.0$ V, $I_C = 0$		10	µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 5.0$ mA, $V_{CE} = 2.0$ V $I_C = 150$ mA, $V_{CE} = 2.0$ V $I_C = 500$ mA, $V_{CE} = 2.0$ V	25 40 25	 250 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 500$ mA, $I_B = 50$ mA		0.5	V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 500$ mA, $V_{CE} = 2.0$ V		1.0	V

DC Typical Characteristics

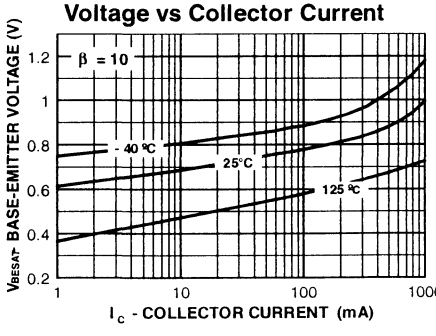
Typical Pulsed Current Gain vs Collector Current



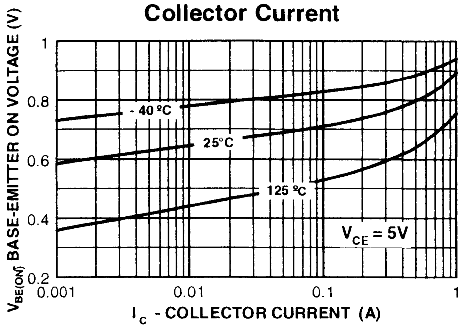
Collector-Emitter Saturation Voltage vs Collector Current



Base-Emitter Saturation Voltage vs Collector Current



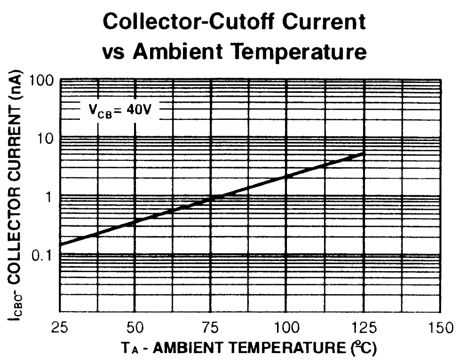
Base-Emitter ON Voltage vs Collector Current



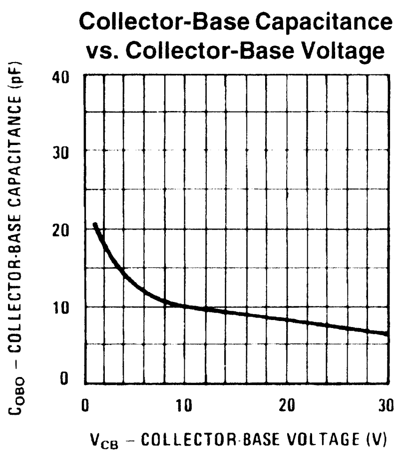
6

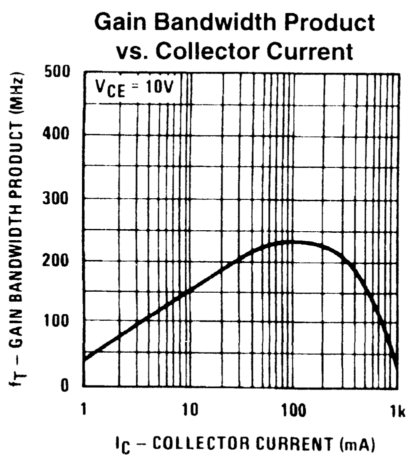
NPN General Purpose Amplifier
(continued)

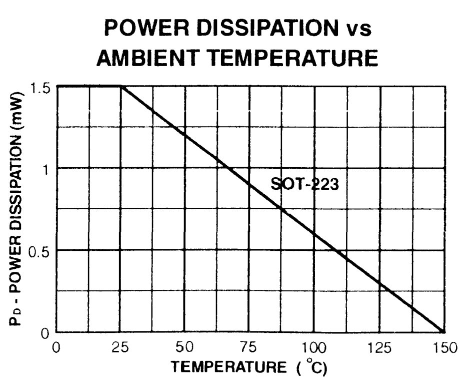
DC Typical Characteristics (continued)



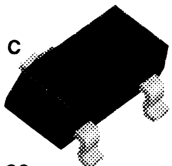
AC Typical Characteristics







BCV26



SOT-23
Mark: FD

PNP Darlington Transistor

This device is designed for applications requiring extremely high current gain at currents to 800 mA. Sourced from Process 61.

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	30	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	10	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

T_A = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BCV26	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

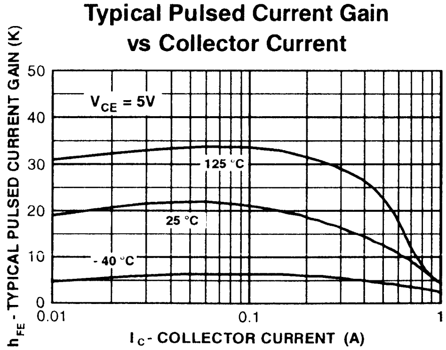
PNP Darlington Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

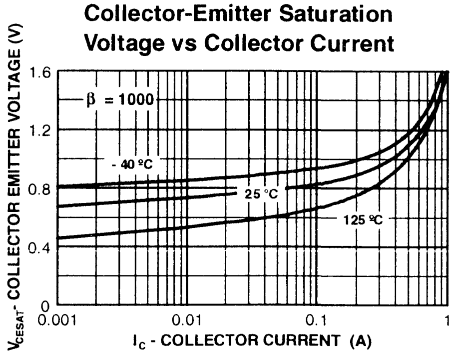
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	30			V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_E = 0$	40			V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 100$ nA, $I_C = 0$	10			V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 30$ V, $I_E = 0$			0.1	µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 10$ V, $I_C = 0$			0.1	µA
ON CHARACTERISTICS						
h_{FE}	DC Current Gain	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V $I_C = 100$ mA, $V_{CE} = 5.0$ V	4,000 10,000 20,000			
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 100$ mA, $I_B = 0.1$ mA			1.0	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 100$ mA, $I_B = 0.1$ mA			1.5	V
SMALL SIGNAL CHARACTERISTICS						
f_T	Current Gain - Bandwidth Product	$I_C = 30$ mA, $V_{CE} = 5.0$ V, f = 100 MHz		220		MHz
C_C	Collector Capacitance	$V_{CB} = 30$ V, $I_E = 0$, f = 1.0 MHz		3.5		pF

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

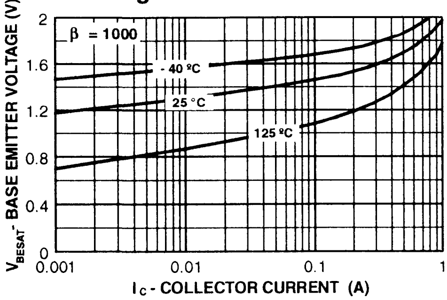


Collector-Emitter Saturation Voltage vs Collector Current

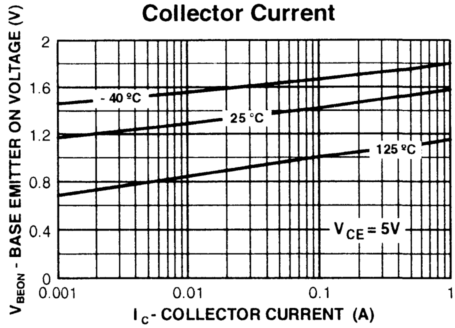


DC Typical Characteristics (continued)

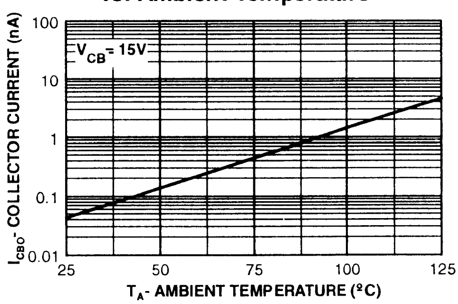
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

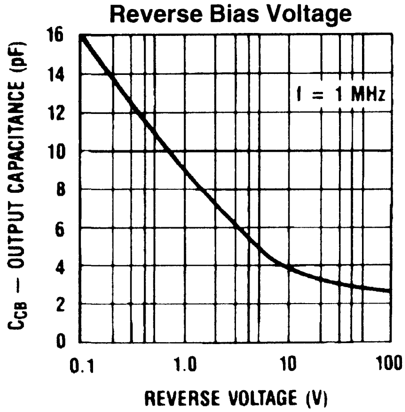


Collector-Cutoff Current vs. Ambient Temperature

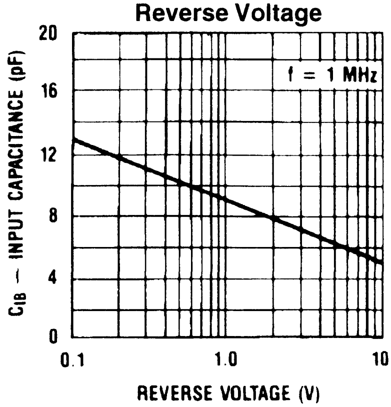


AC Typical Characteristics

Output Capacitance vs. Reverse Bias Voltage



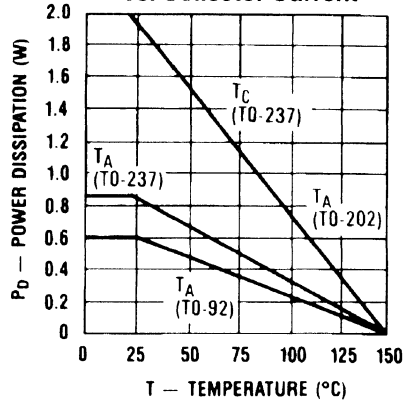
Input Capacitance vs. Reverse Voltage



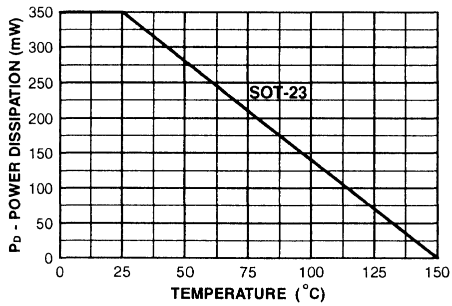
PNP Darlington Transistor
(continued)

AC Typical Characteristics (continued)

Small Signal Current Gain
vs. Collector Current



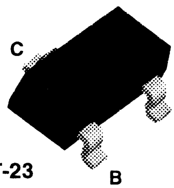
POWER DISSIPATION vs
AMBIENT TEMPERATURE



National Semiconductor

Discrete POWER & Signal Technologies

BCV27



SOT-23
Mark: FF

NPN Darlington Transistor

This device is designed for applications requiring extremely high current gain at collector currents to 1.0 A. Sourced from Process 05.

Absolute Maximum Ratings*
TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	30	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	10	V
I_C	Collector Current - Continuous	1.2	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

Thermal Characteristics
TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BCV27	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

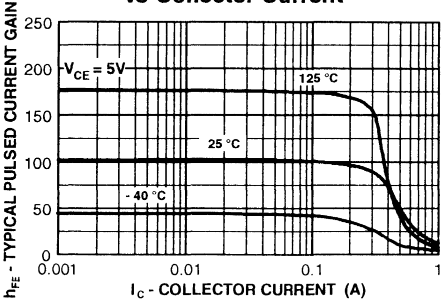
NPN Darlington Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

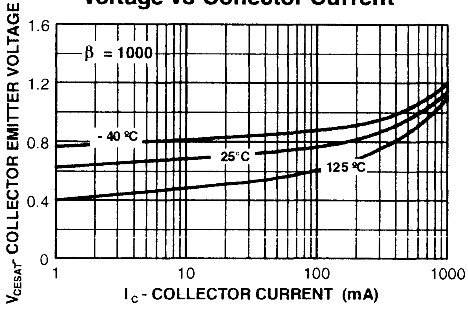
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	30			V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu$A, $I_E = 0$	40			V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 100$ nA, $I_C = 0$	10			V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 30$ V, $I_E = 0$			0.1	µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 10$ V, $I_C = 0$			0.1	µA
ON CHARACTERISTICS						
h_{FE}	DC Current Gain	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V $I_C = 100$ mA, $V_{CE} = 5.0$ V	4,000 10,000 20,000			
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 100$ mA, $I_B = 0.1$ mA			1.0	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 100$ mA, $I_B = 0.1$ mA			1.5	V
SMALL SIGNAL CHARACTERISTICS						
f_T	Current Gain - Bandwidth Product	$I_C = 30$ mA, $V_{CE} = 5.0$ V, f = 100 MHz		220		MHz
C_C	Collector Capacitance	$V_{CB} = 30$ V, $I_E = 0$, f = 1.0 MHz		3.5		pF

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

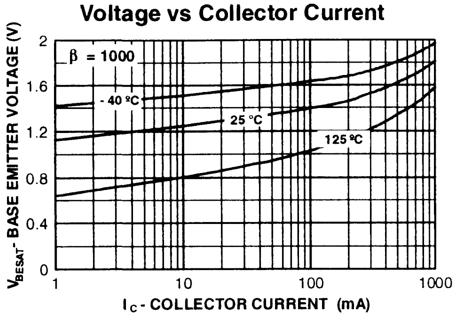


Collector-Emitter Saturation Voltage vs Collector Current

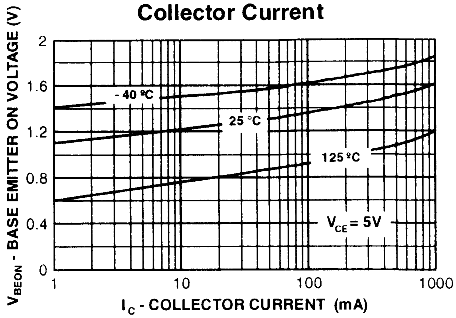


DC Typical Characteristics (continued)

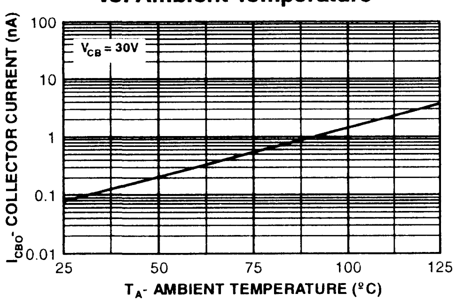
Base-Emitter Saturation Voltage vs Collector Current



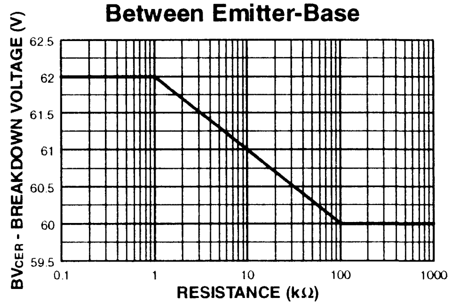
Base Emitter ON Voltage vs Collector Current



Collector-Cutoff Current vs. Ambient Temperature

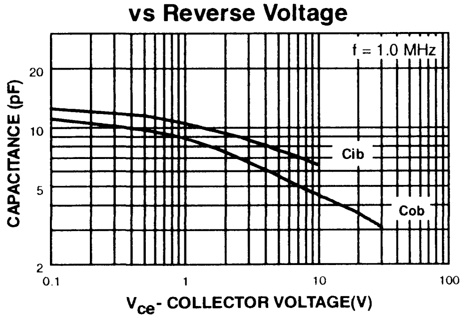


Collector-Emitter Breakdown Voltage with Resistance Between Emitter-Base

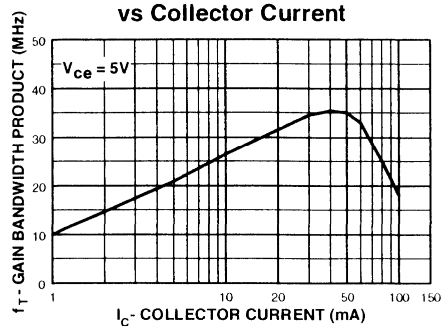


AC Typical Characteristics

Input and Output Capacitance vs Reverse Voltage



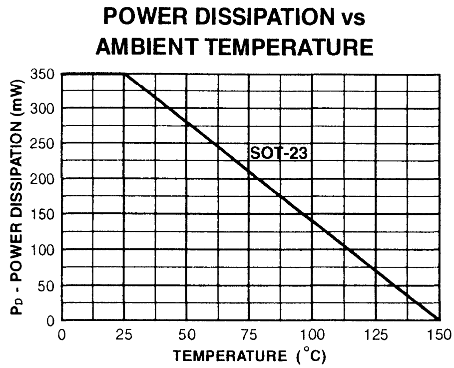
Gain Bandwidth Product vs Collector Current



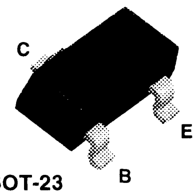
6

NPN Darlington Transistor
(continued)

AC Typical Characteristics (continued)



BCW31
BCW32
BCW33



SOT-23
Mark: D1 / D2 / D3

NPN General Purpose Amplifier

This device is designed for general purpose amplifier applications at collector currents to 300 mA. Sourced from Process 10. See BCW71 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	32	V
V_{CBO}	Collector-Base Voltage	32	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	500	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BCW31 / 32 / 33	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

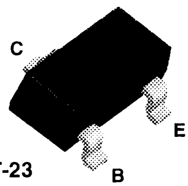
NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 2.0 mA, I_B = 0	32		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_B = 0	32		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	5.0		V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 32 V, I_E = 0 V_{CB} = 32 V, I_E = 0, T_A = 100°C		100 10	nA μA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 2.0 mA, V_{CE} = 5.0 V **BCW31** **BCW32** **BCW33**	 110 200 420	 220 450 800	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 0.5 mA		0.25	V
$V_{BE(on)}$	Base-Emitter On Voltage	I_C = 2.0 mA, V_{CE} = 5.0 V	0.55	0.7	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 2.0 mA, V_{CE} = 5.0, f = 35 MHz	200		MHz
C_{obo}	Output Capacitance	V_{CB} = 10 V, I_E = 0, f = 1.0 MHz		4.0	pF
NF	Noise Figure	I_C = 0.2 mA, V_{CE} = 5.0, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz		10	dB

National Semiconductor™

BCW65C



SOT-23
Mark: ED

NPN General Purpose Amplifier

This device is designed for general purpose amplifier applications at collector currents to 500 mA. Sourced from Process 19.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	32	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	1.0	A
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BCW65C	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

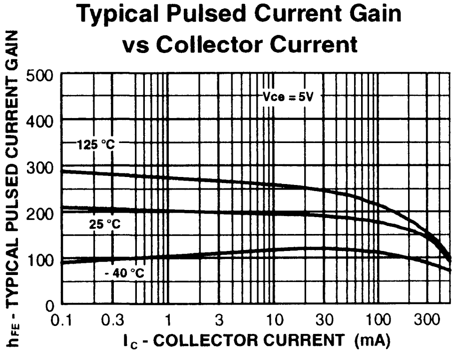
NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

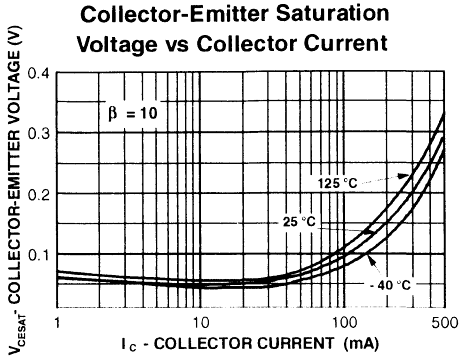
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	32		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_E = 0$	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$	5.0		V
I_{CES}	Collector-Cutoff Current	$V_{CB} = 32$ V, $I_E = 0$ $V_{CB} = 32$ V, $I_E = 0$, $T_A = 150°C$		20 20	nA µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 4.0$ V, $I_C = 0$		20	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 100\ \mu A$, $V_{CE} = 10$ V $I_C = 10$ mA, $V_{CE} = 1.0$ V $I_C = 100$ mA, $V_{CE} = 1.0$ V $I_C = 500$ mA, $V_{CE} = 2.0$ V	80 180 250 50	 630 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 100$ mA, $I_B = 10$ mA $I_C = 500$ mA, $_B = 50$ mA		0.3 0.7	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 500$ mA, $I_B = 50$ mA		2.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 20$ mA, $V_{CE} = 10$ V, f = 100 MHz	100		MHz
C_{obo}	Output Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		12	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5$ V, $I_C = 0$, f = 1.0 MHz		80	pF
NF	Noise Figure	$I_C = 0.2$ mA, $V_{CE} = 5.0$, $R_S = 1.0\ k\Omega$, f = 1.0 kHz, BW = 200 Hz		10	dB
SWITCHING CHARACTERISTICS					
$t_{(on)}$	Turn-On Time	$I_{B1} = I_{B2} = 15$ mA		100	ns
$t_{(off)}$	Turn-Off Time	$I_C = 150$ mA, $R_L = 150\ \Omega$		400	ns

DC Typical Characteristics

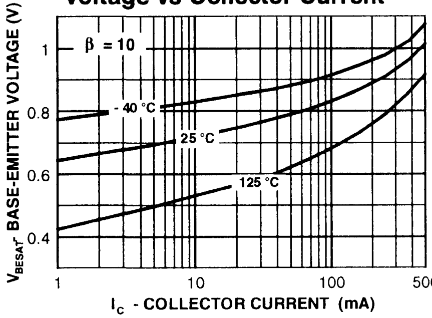
Typical Pulsed Current Gain vs Collector Current



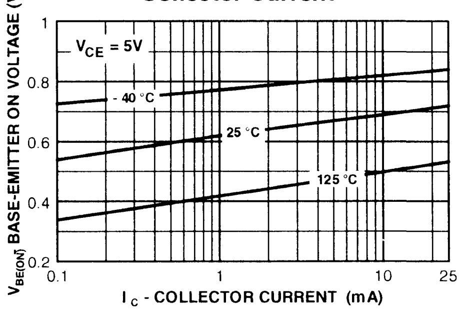
Collector-Emitter Saturation Voltage vs Collector Current



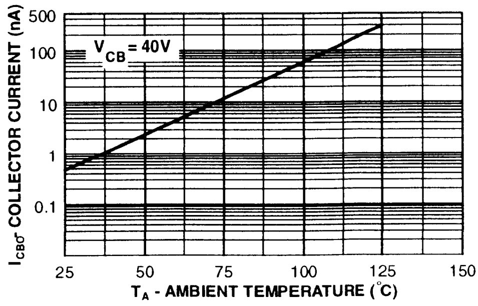
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current



Collector-Cutoff Current vs Ambient Temperature



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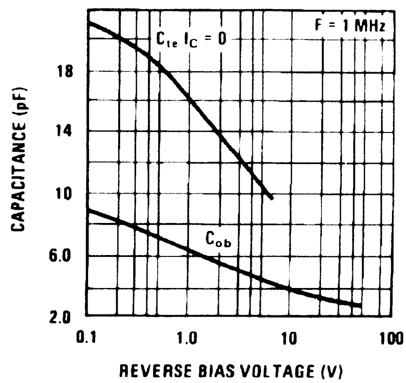
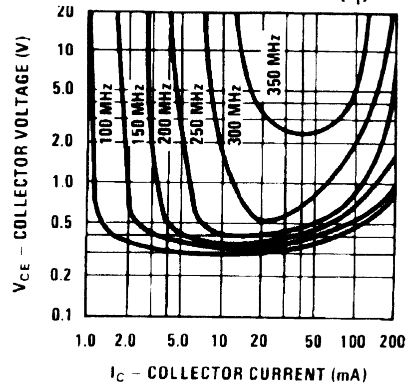
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics

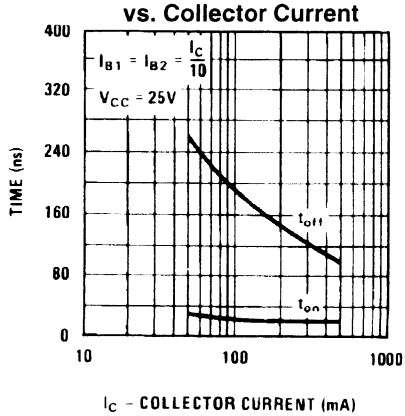
Emitter Transition and Output Capacitance vs. Reverse Bias Voltage



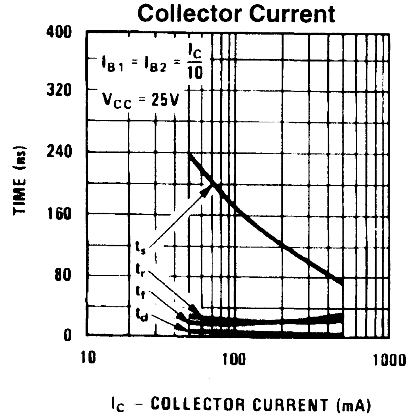
Contours of Constant Gain Bandwidth Product (f_T)



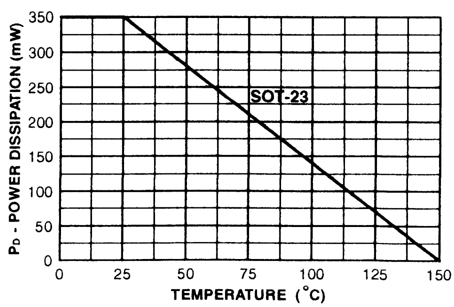
Turn On / Turn Off Times vs. Collector Current



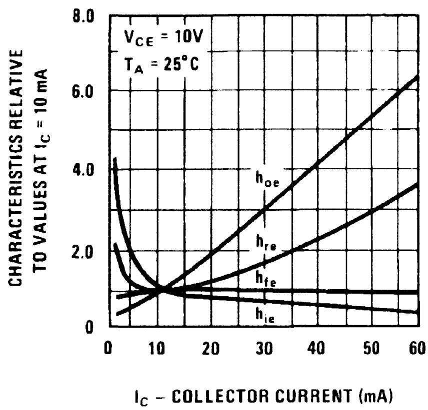
Switching Times vs. Collector Current

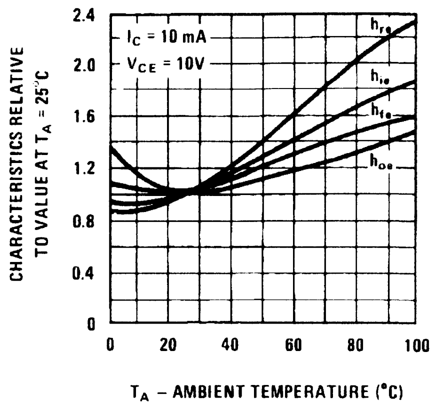


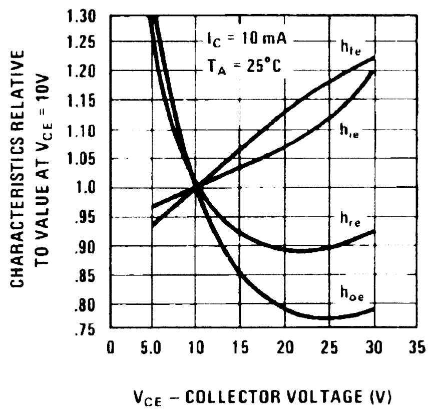
POWER DISSIPATION vs AMBIENT TEMPERATURE



Typical Common Emitter Characteristics (f = 1.0 kHz)







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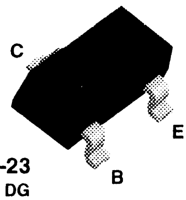
BCW68G



SOT-23
Mark: DG

PNP General Purpose Amplifier

This device is designed for general purpose amplifier and switching applications at currents to 500 mA. Sourced from Process 63.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	45	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	800	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BCW68C	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

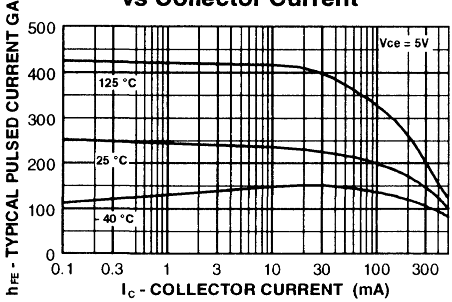
PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

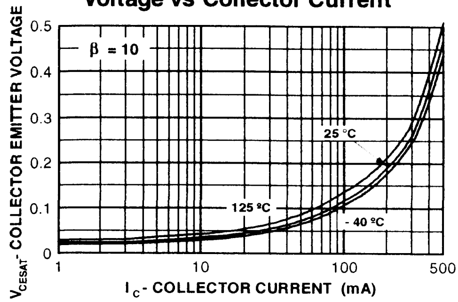
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$		45	V
$V_{(BR)CES}$	Collector-Base Breakdown Voltage	$I_C = 10$ µA		60	V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100$ µA, $I_E = 0$		60	V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10$ µA, $I_C = 0$		5.0	V
I_{CES}	Collector-Cutoff Current	$V_{CE} = 45$ V $V_{CE} = 45$ V, $T_A = 150$ °C		20 10	nA µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 4.0$ V		20	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 10$ mA, $V_{CE} = 1.0$ V $I_C = 100$ mA, $V_{CE} = 1.0$ V $I_C = 300$ mA, $V_{CE} = 1.0$ V	120 160 60	 400 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 300$ mA, $I_B = 30$ mA		1.5	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 500$ mA, $I_B = 50$ mA		2.0	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 20$ mA, $V_{CE} = 10$ V, f = 100 MHz	100		MHz
C_{obo}	Ouput Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		18	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5$ V, $I_E = 0$, f = 1.0 MHz		105	pF
NF	Noise Figure	$I_C = 0.2$ mA V, $V_{CE} = 5.0$ V, $R_S = 1.0$ kΩ, f = 1.0 kHz, $B_W = 200$ Hz		10	dB

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



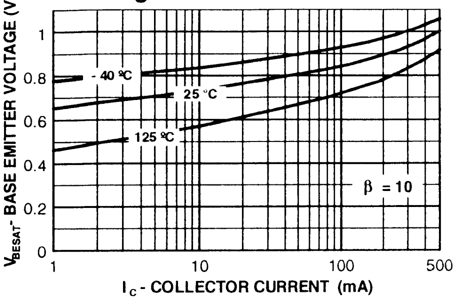
Collector-Emitter Saturation Voltage vs Collector Current



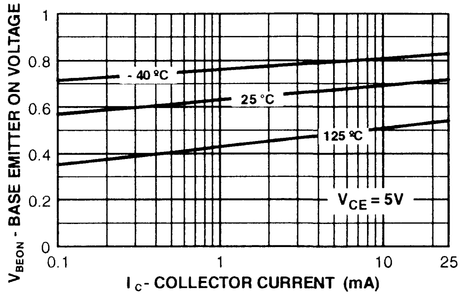
PNP General Purpose Amplifier
(continued)

DC Typical Characteristics (continued)

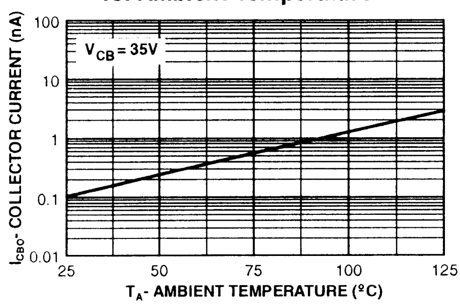
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

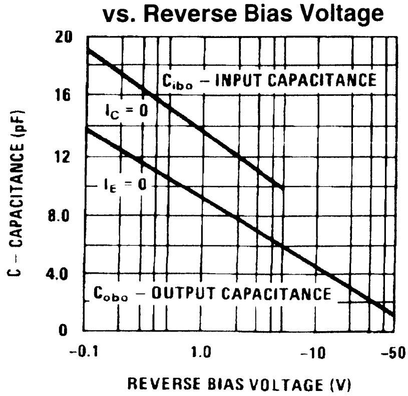


Collector-Cutoff Current vs. Ambient Temperature

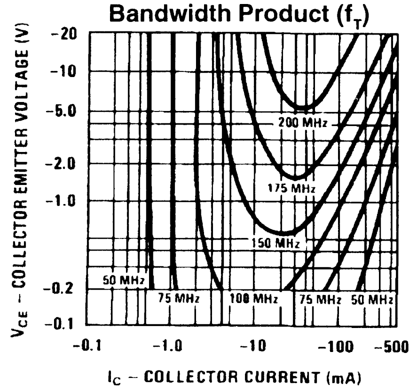


AC Typical Characteristics

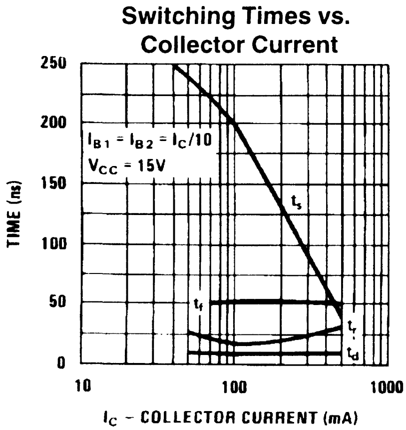
Input / Output Capacitance vs. Reverse Bias Voltage

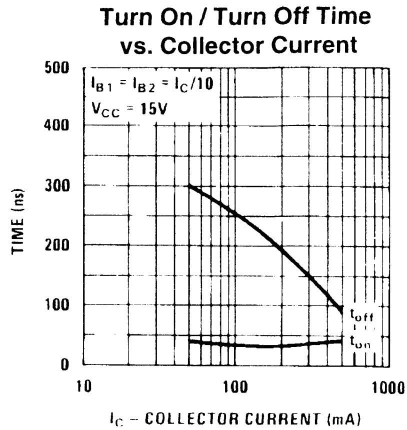


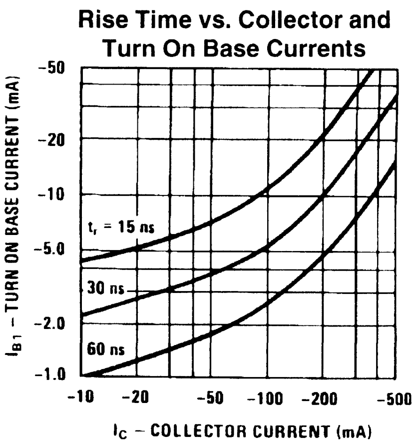
Contours of Constant Gain Bandwidth Product (f_T)

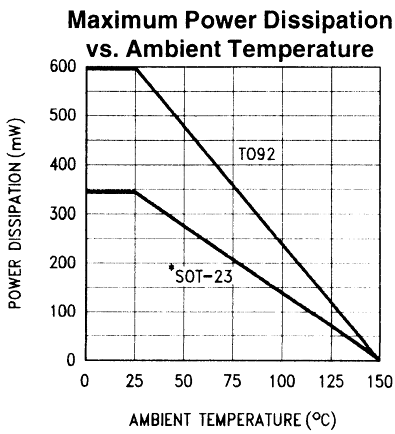


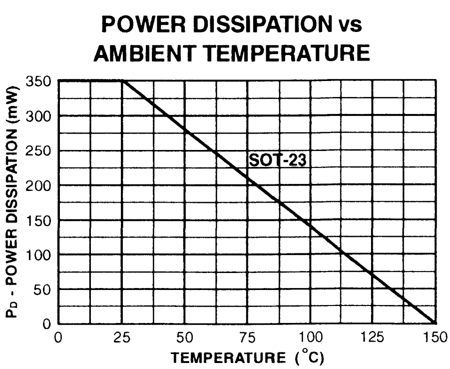
AC Typical Characteristics (continued)





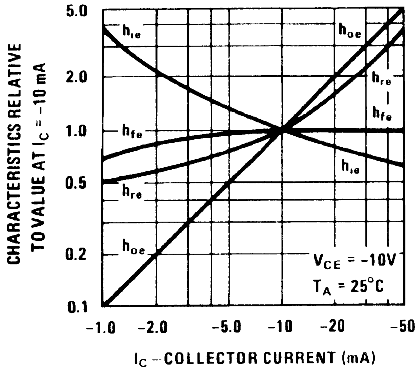


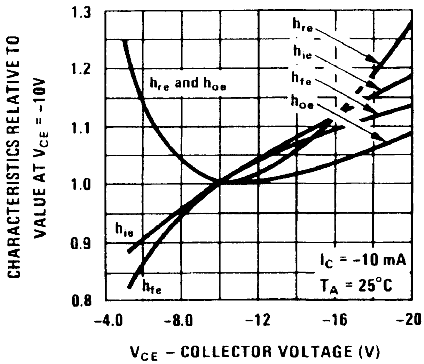


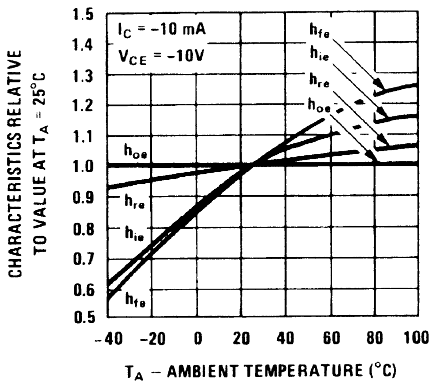


PNP General Purpose Amplifier
(continued)

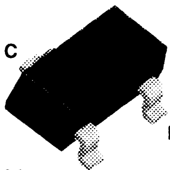
Typical Common Emitter Characteristics







BCW71



SOT-23
Mark: K1

NPN General Purpose Amplifier

This device is designed for general purpose amplifier applications at collector currents to 300 mA. Sourced from Process 10.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	45	V
V_{CBO}	Collector-Base Voltage	50	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	500	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BCW71	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

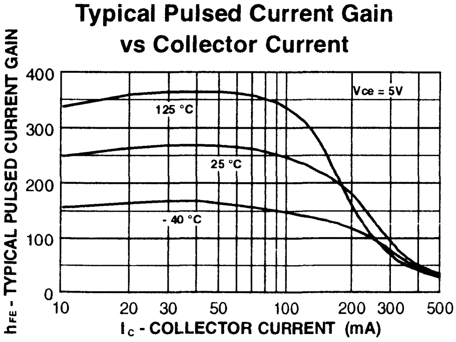
NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

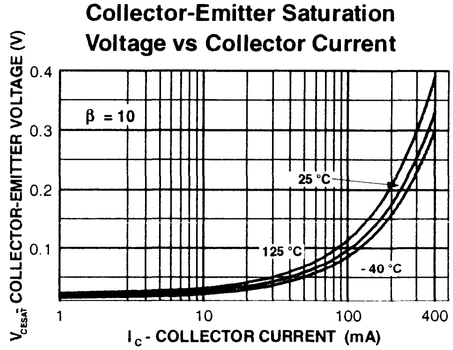
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 1.0$ mA, $I_B = 0$	45			V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu$A, $I_E = 0$	50			V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu$A, $I_C = 0$	5.0			V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 20$ V, $I_E = 0$ $V_{CB} = 20$ V, $I_E = 0$, $T_A = 100°C$			100 10	nA µA
ON CHARACTERISTICS						
h_{FE}	DC Current Gain	$I_C = 2.0$ mA, $V_{CE} = 5.0$ V	110		220	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 0.5$ mA			0.25	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 50$ mA, $I_B = 2.5$ mA		0.85		V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 2.0$ mA, $V_{CE} = 5.0$ V	0.6		0.75	V
SMALL SIGNAL CHARACTERISTICS						
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 5.0$ V, f = 35 MHz		300		MHz
C_{obo}	Output Capacitance	$V_{CE} = 10$ V, $I_E = 0$, f = 1.0 MHz			4.0	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5$ V, $I_C = 0$, f = 1.0 MHz		9.0		pF
NF	Noise Figure	$I_C = 0.2$ mA, $V_{CE} = 5.0$, $R_S = 2.0$ kΩ, f = 1.0 kHz, BW = 200 Hz			10	dB

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

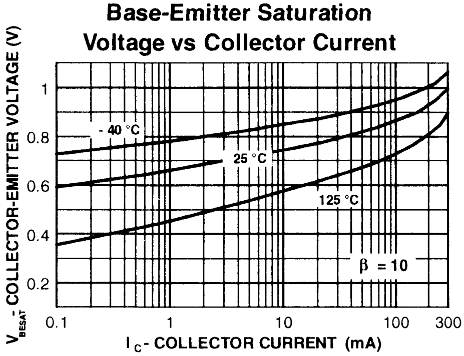


Collector-Emitter Saturation Voltage vs Collector Current

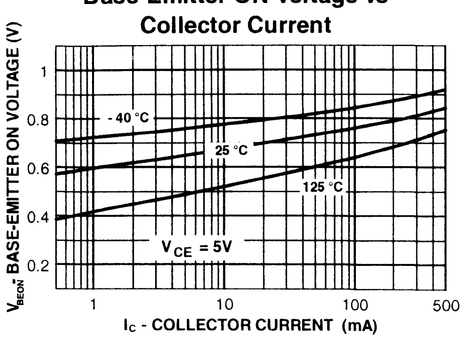


DC Typical Characteristics (continued)

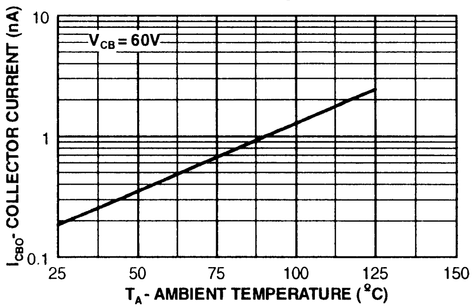
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

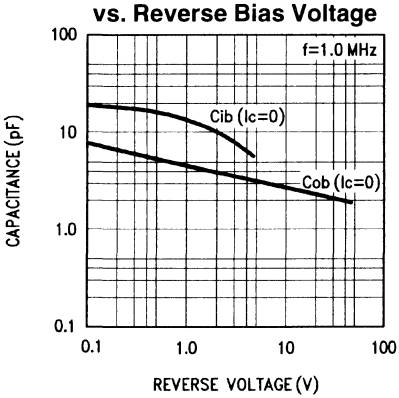


Collector-Cutoff Current vs Ambient Temperature

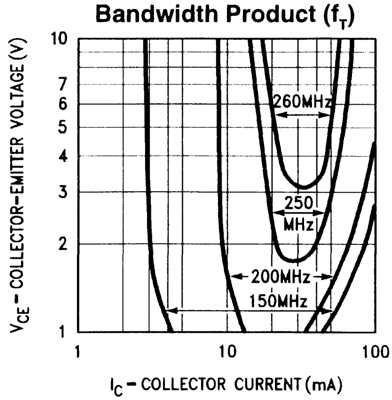


AC Typical Characteristics (continued)

Input / Output Capacitance vs. Reverse Bias Voltage



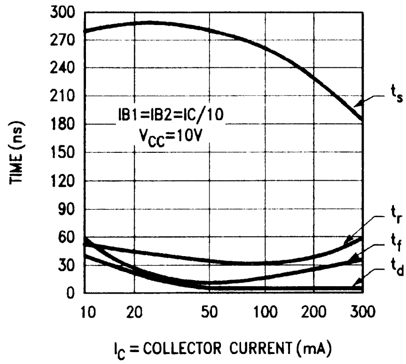
Contours of Constant Gain Bandwidth Product (f_T)



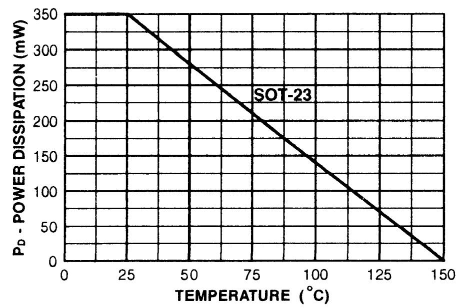
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

Switching Times vs. Collector Current



POWER DISSIPATION vs AMBIENT TEMPERATURE



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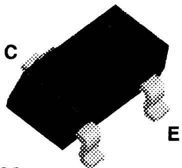


SOT-23
Mark: BK

PNP General Purpose Amplifier

This device is designed for applications requiring extremely high current gain at collector currents to 300 mA. Sourced from Process 68.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	45	V
V_{CES}	Collector-Base Voltage	45	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	500	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BCX71K	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

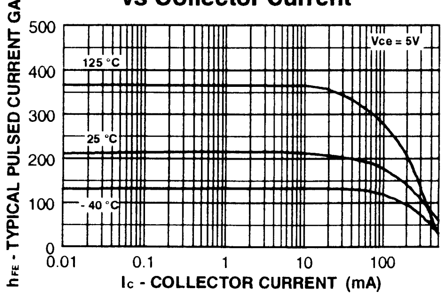
PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

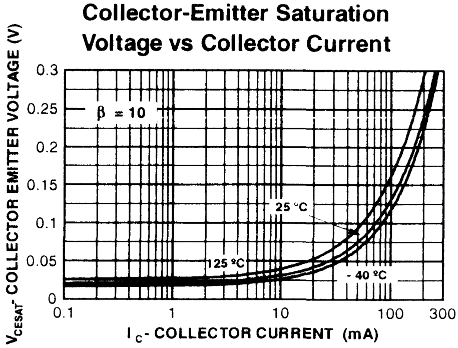
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 1.0$ mA, $I_B = 0$	45		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu$A, $I_C = 0$	5.0		V
I_{CES}	Collector-Cutoff Current	$V_{CB} = 45$ V, $I_E = 0$ $V_{CB} = 45$ V, $I_E = 0$, $T_A = 100°$C		20 20	nA µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 10\ \mu$A, $V_{CE} = 5.0$ V $I_C = 2.0$ mA, $V_{CE} = 5.0$ V $I_C = 50$ mA, $V_{CE} = 1.0$ V	100 380 110	 630	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 0.25$ mA $I_C = 50$ mA, $I_B = 1.25$ mA	0.06 0.12	0.25 0.55	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 0.25$ mA $I_C = 50$ mA, $I_B = 1.25$ mA	0.6 0.68	0.85 1.05	V V
$V_{BE(on)}$	Base-Emitter On Voltage	$I_C = 2.0$ mA, $V_{CE} = 5.0$ V	0.6	0.75	V
SMALL SIGNAL CHARACTERISTICS					
C_{obo}	Output Capacitance	$V_{CE} = 10$ V, $I_C = 0$, f = 1.0 MHz		6.0	pF
NF	Noise Figure	$I_C = 0.2$ mA, $V_{CE} = 5.0$ V, $R_S = 2.0$ kΩ, f = 1.0 kHz, BW = 200 Hz		6.0	dB
SWITCHING CHARACTERISTICS					
$t_{(on)}$	Turn-On Time	$I_C = 10$ mA, $I_{B1} = 1.0$ mA		150	ns
$t_{(off)}$	Turn-Off Time	$I_{B2} = 1.0$ mA, $V_{BB} = 3.6$ V, R1 = R2 = 5.0 kΩ, $R_L = 990$ Ω		800	ns

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current

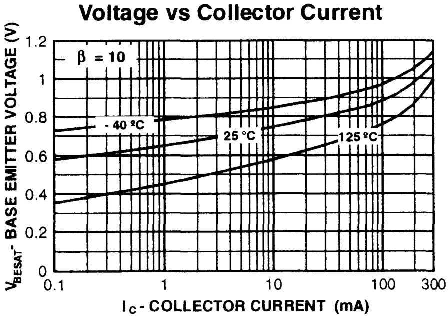


Collector-Emitter Saturation Voltage vs Collector Current

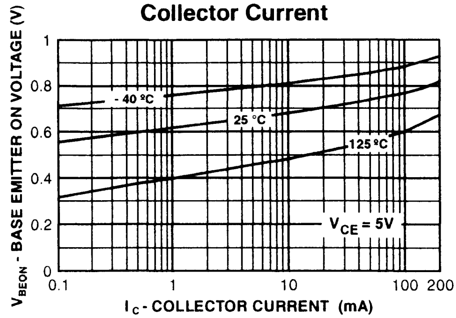


DC Typical Characteristics (continued)

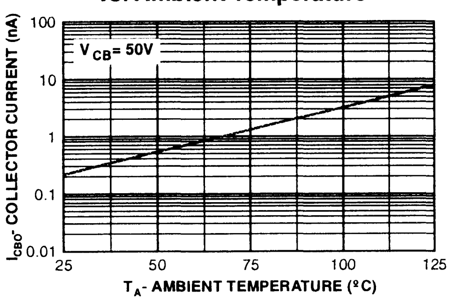
Base-Emitter Saturation Voltage vs Collector Current



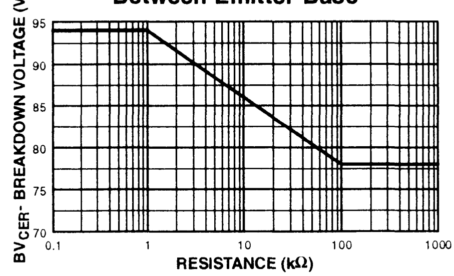
Base Emitter ON Voltage vs Collector Current



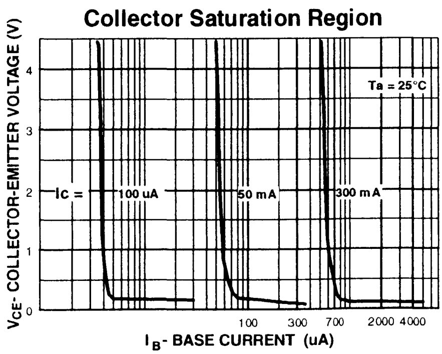
Collector-Cutoff Current vs. Ambient Temperature



Collector-Emitter Breakdown Voltage with Resistance Between Emitter-Base



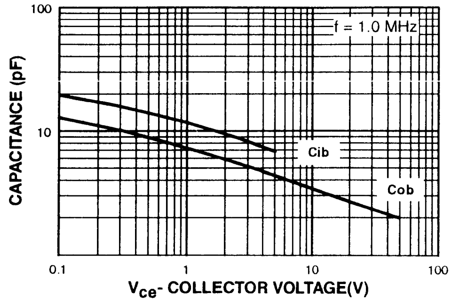
Collector Saturation Region



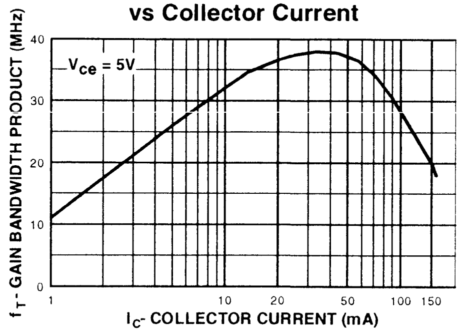
PNP General Purpose Amplifier
(continued)

AC Typical Characteristics

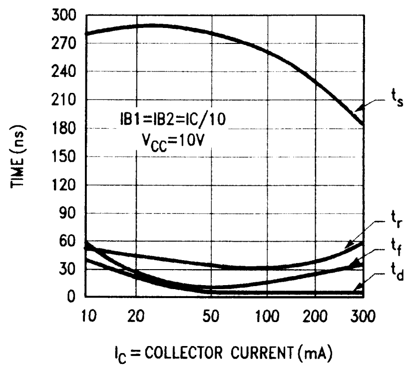
Input and Ouput Capacitance vs Reverse Voltage



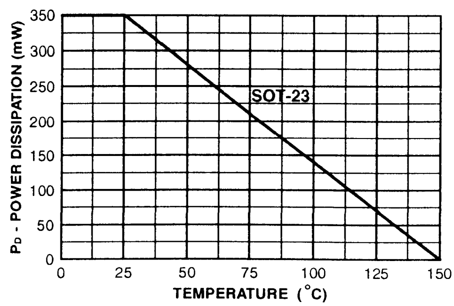
Gain Bandwidth Product vs Collector Current



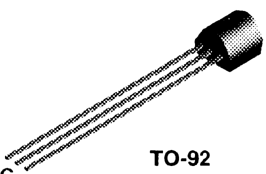
Switching Times vs. Collector Current



POWER DISSIPATION vs AMBIENT TEMPERATURE



BF244A
BF244B
BF244C



S G D TO-92

N-Channel JFET RF Amplifier

This device is designed for RF amplifier and mixer and applications operating up to 450 MHz, and for analog switching requiring low capacitance. Sourced from Process 50.

Absolute Maximum Ratings* TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	30	V
V_{GS}	Gate-Source Voltage	30	V
I_D	Drain Current	50	mA
I_{GF}	Forward Gate Current	10	mA
T_{stg}	Storage Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		BF244A / BF244B / BF244C	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

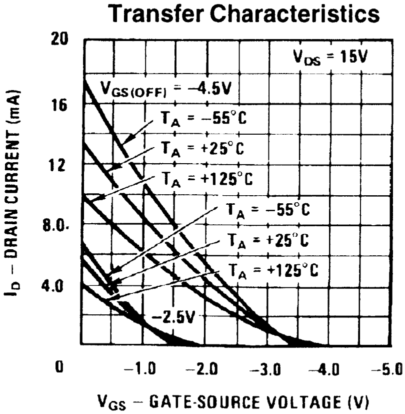
N-Channel JFET RF Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

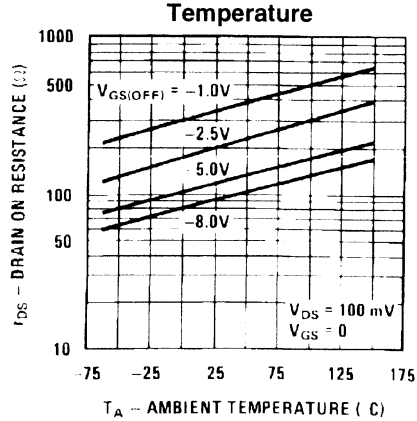
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30			V
I_{GSS}	Gate Reverse Current	$V_{GS} = 20\ V$, $V_{DS} = 0$			5.0	nA
$V_{GSS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 15\ V$, $I_D = 10\ nA$	- 0.5		- 8.0	V
V_{GS}	Gate-Source Voltage	$V_{DS} = 15\ V$, $I_D = 200\ \mu A$ **BF244A**	0.4		2.2	V
		BF244B	1.6		3.8	V
		BF244C	3.2		7.5	V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current	$V_{DS} = 15\ V$, $V_{GS} = 0$ **BF244A**	2.0		6.5	mA
		BF244B	6.0		15	mA
		BF244C	12		25	mA
SMALL SIGNAL CHARACTERISTICS						
y_{fs}	Forward Transfer Admittance	$V_{DS} = 15$, $V_{GS} = 0$, f = 1.0 kHz	3.0		6.5	mmhos
		$V_{DS} = 15$, $V_{GS} = 0$, f = 200 MHz		5.6		mmhos
y_{os}	Output Admittance	$V_{DS} = 15$, $V_{GS} = 0$, f = 1.0 kHz		40		µmhos
y_{rs}	Reverse Transfer Admittance	$V_{DS} = 15$, $V_{GS} = 0$, f = 200 MHz		1.0		µmhos
C_{iss}	Input Capacitance	$V_{DS} = 20$, $V_{GS} = 1V$		3.0		pF
C_{rss}	Reverse Transfer Capacitance	$V_{DS} = 20$, $V_{GS} = 1V$, f = 1.0 MHz		0.7		pF
C_{oss}	Output Capacitance	$V_{DS} = 20$, $V_{GS} = 1V$, f = 1.0 MHz		0.9		pF
NF	Noise Figure	$V_{DS} = 15\ V$, $V_{GS} = 0$, $R_G = 1.0\ k\Omega$, f = 100 MHz		1.5		dB
$F(Y_{fs})$	Cut-Off Frequency	$V_{DS} = 15\ V$, $V_{GS} = 0$		700		MHz

Typical Characteristics

Transfer Characteristics



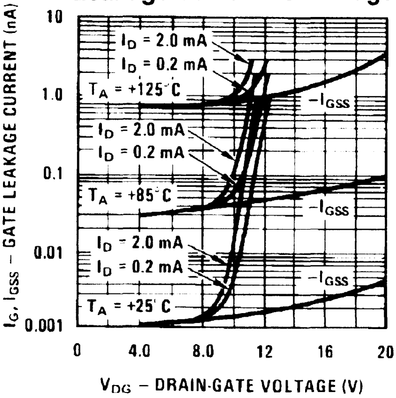
Channel Resistance vs. Temperature



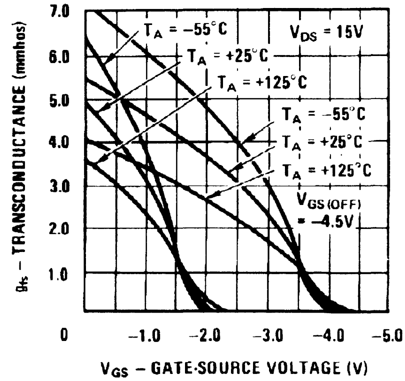
N-Channel JFET RF Amplifier
(continued)

Typical Characteristics (continued)

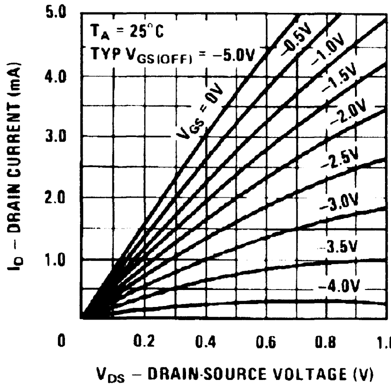
Leakage Current vs. Voltage



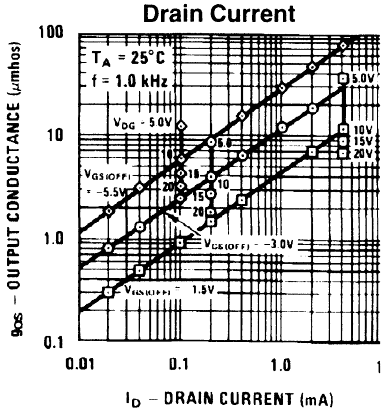
Transconductance Characteristics



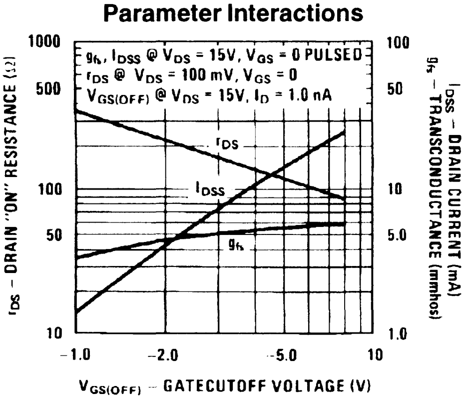
Common-Drain Source



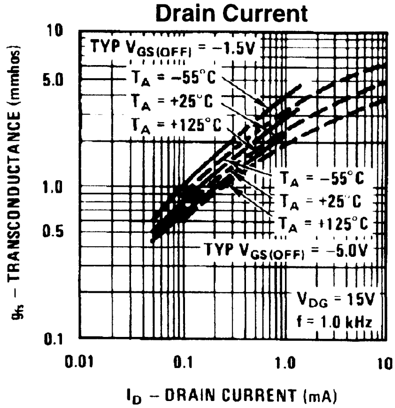
Output Conductance vs. Drain Current



Parameter Interactions



Transconductance vs. Drain Current

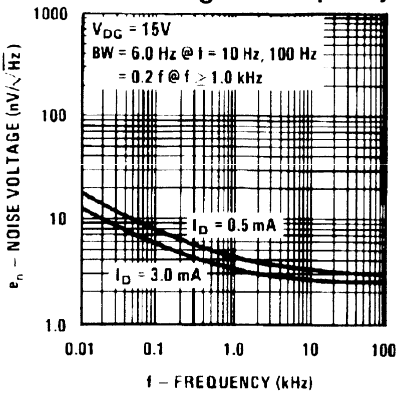


N-Channel JFET RF Amplifier

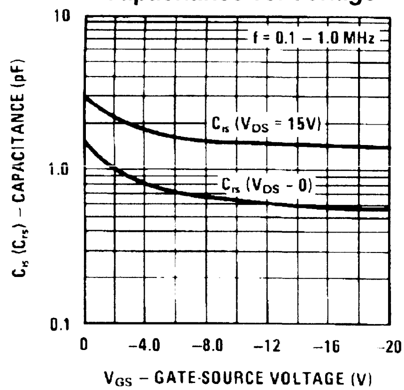
(continued)

Typical Characteristics (continued)

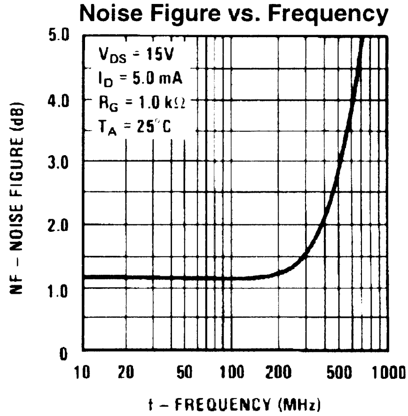
Noise Voltage vs. Frequency



Capacitance vs. Voltage

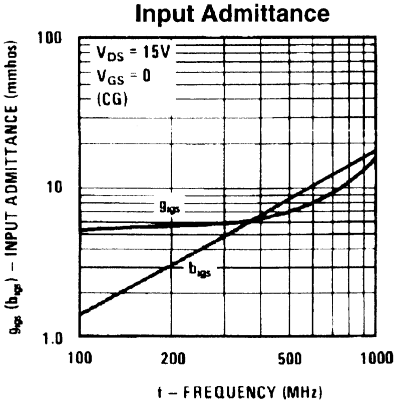


Noise Figure vs. Frequency

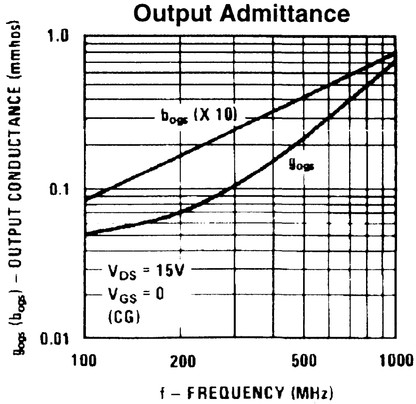


Common Gate Characteristics

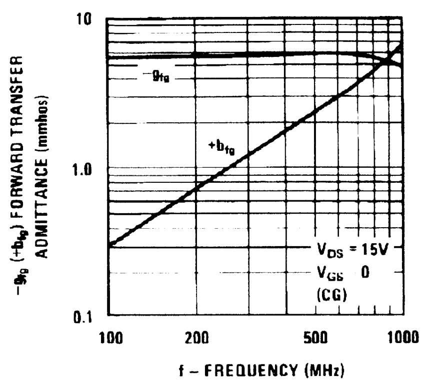
Input Admittance

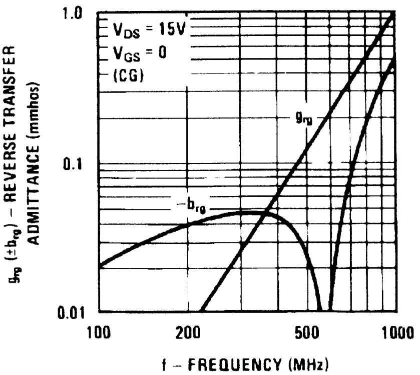


Output Admittance

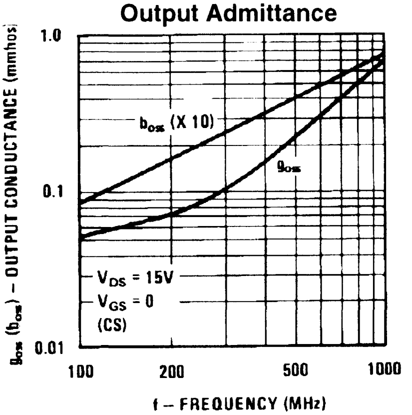


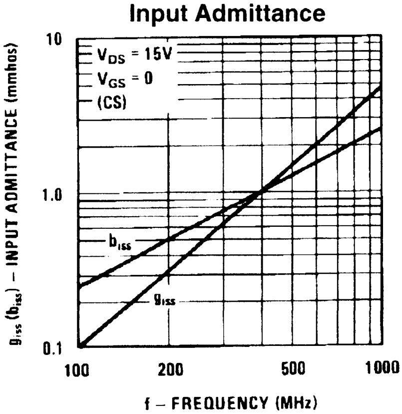
Common Gate Characteristics (continued)

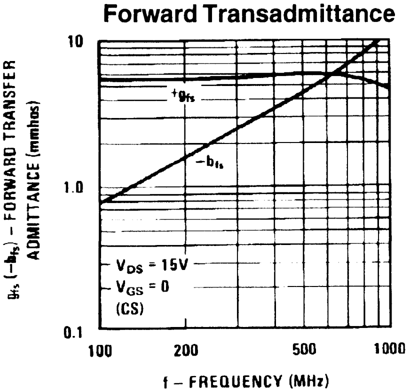


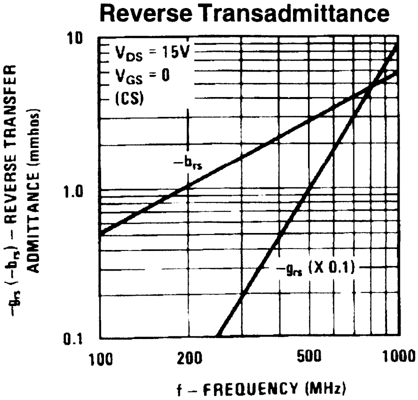


Common Source Characteristics









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Technologies

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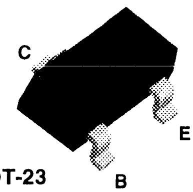


SOT-23
Mark: U8

NPN General Purpose Amplifier

This device is for use as a medium power amplifier and switch requiring collector currents up to 500 mA. Sourced from Process 19. See BCW65C for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	75	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	800	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BSR14	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10\ \mu A$, $I_B = 0$		75	V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_E = 0$		40	V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$		6.0	V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 60$ V $V_{CB} = 60$ V, $T_A = 150°C$		10 10	nA µA
I_{CEX}	Collector-Cutoff Current	$V_{CE} = 60$ V, $V_{EB} = 3.0$ V		10	nA
I_{BEX}	Reverse Base Current	$V_{CE} = 60$ V, $V_{EB} = 3.0$ V		20	nA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 3.0$ V, $I_C = 0$		15	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 0.1$ mA, $V_{CE} = 10$ 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 $I_C = 150$ mA, $V_{CE} = 1.0$ V $I_C = 500$ mA, $V_{CE} = 10$ V	35 50 75 100 50 40	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA		0.3 1.0	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA	0.6	1.2 2.0	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 20$ mA, $V_{CE} = 20$, f = 100 mHz	300		MHz
C_{CB}	Collector-Base Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		8.0	pF
h_{ie}	Input Impedance	V_{CE}= 10 V,I_C= 1.0 mA,f=1.0 kHz	2.0	8.0	kΩ
h_{fe}	Small-Signal Current Gain	V_{CE}= 10 V,I_C= 1.0 mA,f=1.0 kHz	50	300	
h_{oe}	Output Admittance	V_{CE}= 10 V,I_C= 1.0 mA,f=1.0 kHz	5	35	µS
SWITCHING CHARACTERISTICS					
t_d	Delay Time	$V_{CC} = 30$ V, $V_{BE(OFF)} = 0.5$ V,		10	ns
t_r	Rise Time	$I_C = 150$ mA, $I_{B1} = 15$ mA		25	ns
t_s	Storage Time	$V_{CC} = 30$ V, $I_C = 150$ mA,		225	ns
t_f	Fall Time	$I_{B1} = I_{B2} = 15$ mA		60	ns

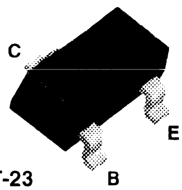
Spice Model

NPN (Is=14.34f Xti=3 Eg=1.11 Vaf=74.03 Bf=255.9 Ne=1.307 Ise=14.34f Ikf=.2847 Xtb=1.5 Br=6.092 Nc=2 Isc=0 Ikr=0 Rc=1 Cjc=7.306p Mjc=.3416 Vjc=.75 Fc=.5 Cje=22.01p Mje=.377 Vje=.75 Tr=46.91n Tf=411.1p Itf=.6 Vtf=1.7 Xtf=3 Rb=10)

National Semiconductor

Discrete POWER & Signal Technologies

BSR15



SOT-23
Mark: T7

PNP General Purpose Amplifier

This device is designed for use as general purpose amplifier and switches requiring collector currents to 500 mA. Sourced from Process 63. See BCW68G for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	800	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BSR15	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 100\ \mu A$, $I_B = 0$	60		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_E = 0$	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 50$ V $V_{CB} = 50$ V, $T_A = 150°C$		20 20	nA µA
I_{CEX}	Collector-Cutoff Current	$V_{CE} = 30$ V, $V_{EB} = 0.5$ V		50	nA
I_{BEX}	Reverse Base Current	$V_{CE} = 30$ V, $V_{EB} = 3.0$ V		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 0.1$ mA, $V_{CE} = 10$ 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	35 50 75 100 30	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA		0.4 1.6	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA		1.3 2.6	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 50$ mA, $V_{CE} = 20$, f = 100 MHz, $T_A = 25°C$	200		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		8.0	pF
C_{eb}	Emitter-Base Capacitance	$V_{EB} = 2.0$ V, $I_E = 0$, f = 1.0 MHz		30	pF
SWITCHING CHARACTERISTICS					
t_{on}	Turn-on Time	$V_{CC} = 30$ V, $I_C = 150$ mA,		45	ns
t_d	Delay Time	$I_{B1} = 15$ mA		10	ns
t_r	Rise Time			40	ns
t_{off}	Turn-off Time	$V_{CC} = 6.0$ V, $I_C = 150$ mA		100	ns
t_s	Storage Time	$I_{B1} = I_{B2} = 15$ mA		80	ns
t_f	Fall Time			30	ns

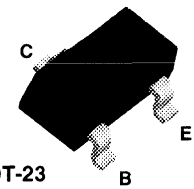
Spice Model

PNP (Is=650.6E-18 Xti=3 Eg=1.11 Vaf=115.7 Bf=231.7 Ne=1.829 Ise=54.81f Ikf=1.079 Xtb=1.5 Br=3.563 Nc=2 Isc=0 Ikr=0 Rc=.715 Cjc=14.76p Mjc=.5383 Vjc=.75 Fc=.5 Cje=19.82p Mje=.3357 Vje=.75 Tr=111.3n Tf=603.7p Itf=.65 Vtf=5 Xtf=1.7 Rb=10)

National Semiconductor™

Discrete POWER & Signal Technologies

BSR17A



SOT-23
Mark: U92

NPN General Purpose Amplifier

This device is designed as a general purpose amplifier and switch. The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier. Sourced from Process 23.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BSR17A	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 10 µA, I_B = 0		60	V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 1.0 mA, I_E = 0		40	V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 µA, I_C = 0		6.0	V
I_{CBO}	Collector-Cutoff Current	V_{CB} = 30 V, T_A = 150°C		5.0	µA
I_{CEX}	Collector-Cutoff Current	V_{CE} = 30 V, V_{EB} = 3.0 V		50	nA
I_{BEX}	Reverse Base Current	V_{CE} = 30 V, V_{EB} = 3.0 V		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	I_C = 0.1 mA, V_{CE} = 1.0 V I_C = 1.0 mA, V_{CE} = 1.0 V I_C = 10 mA, V_{CE} = 1.0 V I_C = 50 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V	40 70 100 60 30	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage*	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA		0.2 0.3	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage*	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Transition Frequency	I_C = 20 mA, V_{CE} = 20 V, f = 100 MHz	300		MHz
C_{cb}	Collector-Base Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 1.0 MHz		4.0	pF
C_{eb}	Emitter-Base Capacitance	V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz		8.0	pF
h_{ie}	Input Impedance	V_{CE}= 10 V,I_C= 1.0 mA,f=1.0 kHz	1.0	10	kΩ
h_{fe}	Small-Signal Current Gain	V_{CE}= 10 V,I_C= 1.0 mA,f=1.0 kHz	100	400	
h_{oe}	Output Admittance	V_{CE}= 10 V,I_C= 1.0 mA,f=1.0 kHz	1.0	40	µS
SWITCHING CHARACTERISTICS					
t_d	Delay Time	I_C = 10 mA, I_{B1} = 1.0 mA, V_{EB} = 0.5 V		35	ns
t_r	Rise Time			35	ns
t_s	Storage Time	I_C = 10 mA, I_{Bon} = I_{Boff} = 1.0 mA		200	ns
t_f	Fall Time			50	ns

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

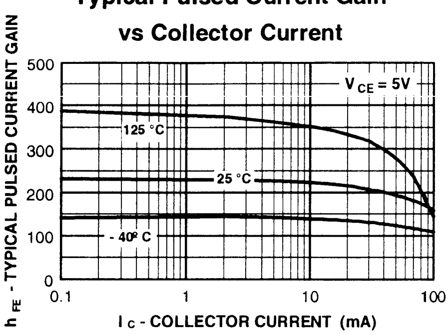
Spice Model

NPN (Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259 Ise=6.734 Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1 Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75 Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)

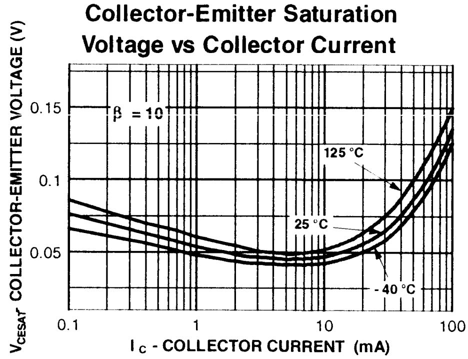
NPN General Purpose Amplifier
(continued)

DC Typical Characteristics

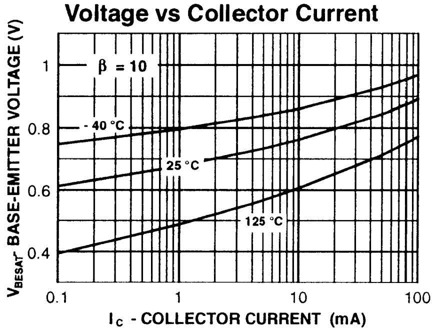
Typical Pulsed Current Gain vs Collector Current



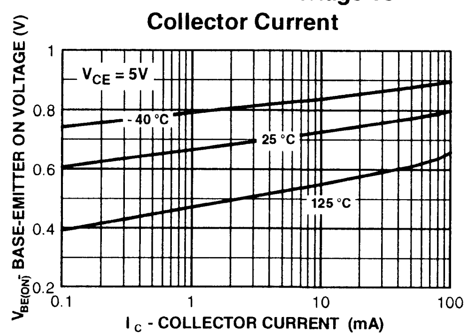
Collector-Emitter Saturation Voltage vs Collector Current



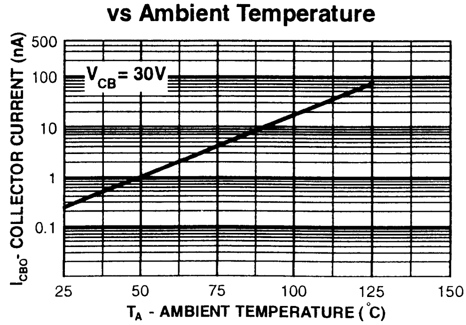
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

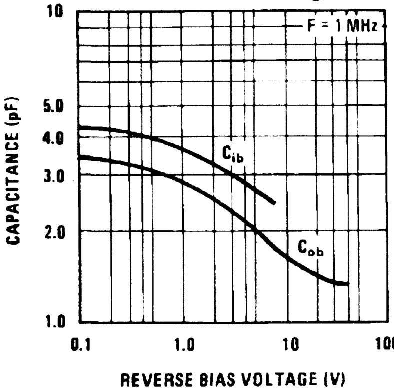


Collector-Cutoff Current vs Ambient Temperature

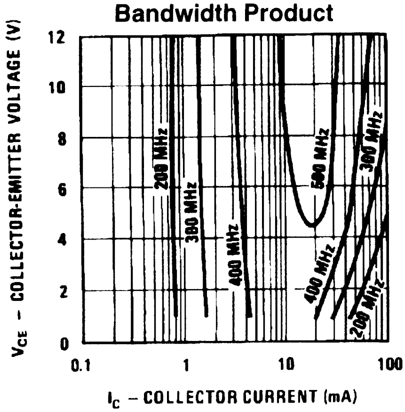


AC Typical Characteristics

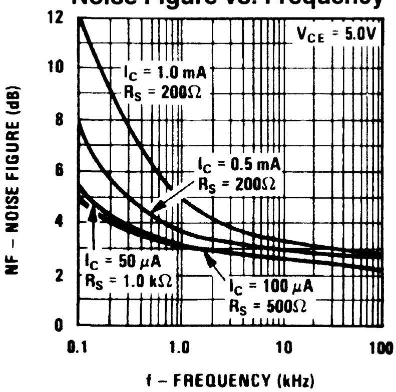
Capacitance vs. Reverse Bias Voltage



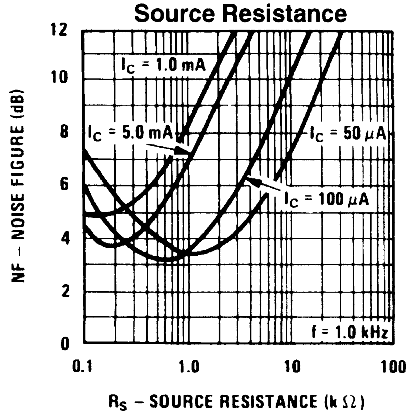
Contours Of Constant Gain Bandwidth Product



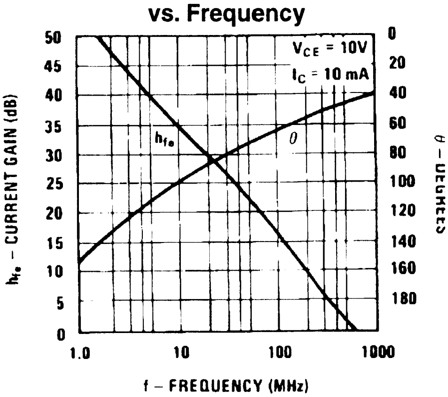
Noise Figure vs. Frequency



Noise Figure vs. Source Resistance



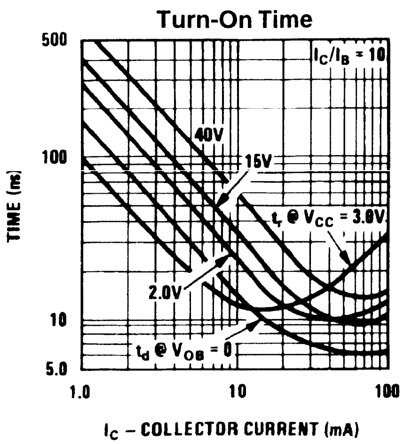
Current Gain and Phase Angle vs. Frequency

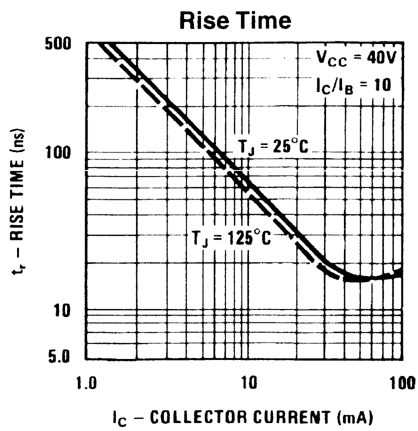


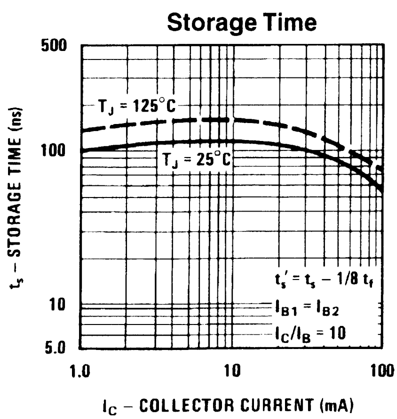
6

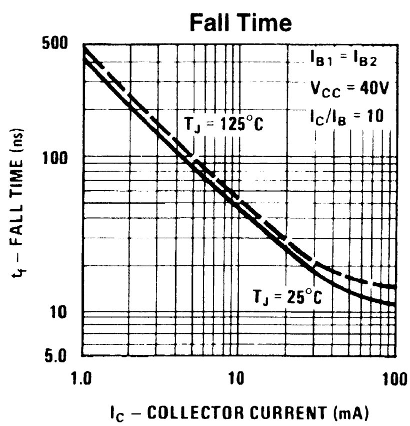
NPN General Purpose Amplifier
(continued)

AC Typical Characteristics (continued)

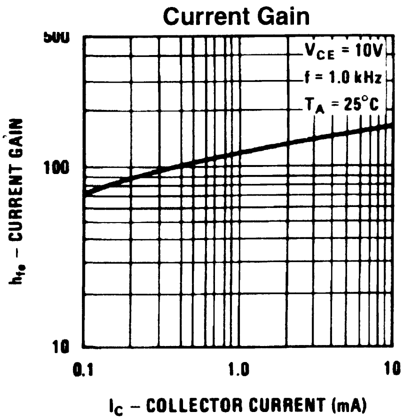


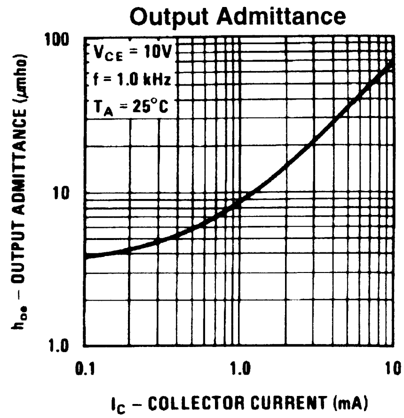


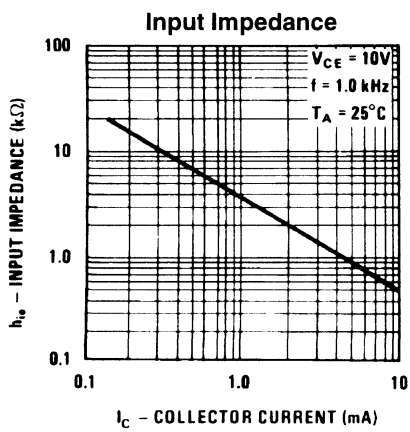


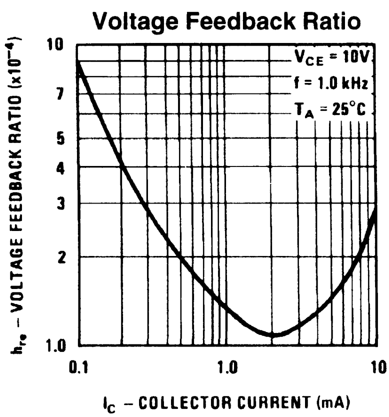


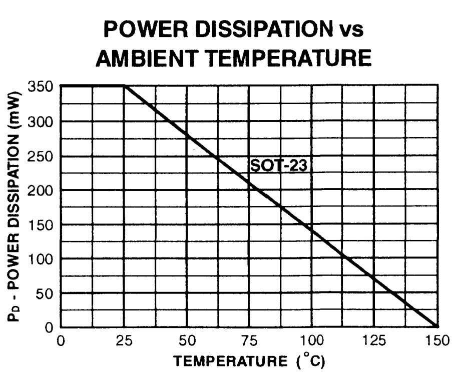
AC Typical Characteristics (continued)











NPN General Purpose Amplifier
(continued)

Test Circuits

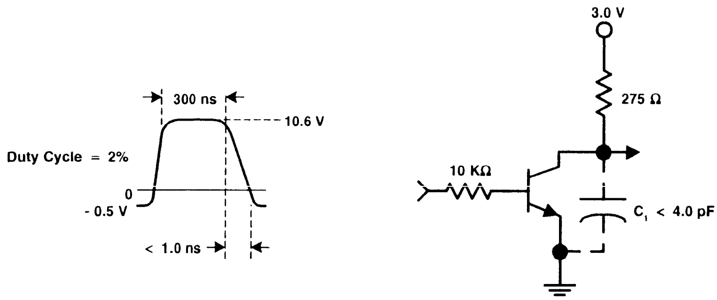


FIGURE 1: Delay and Rise Time Equivalent Test Circuit

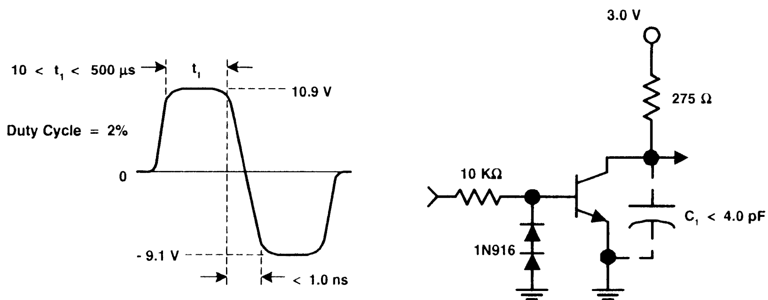
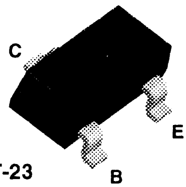


FIGURE 2: Storage and Fall Time Equivalent Test Circuit

BSR18A



SOT-23
Mark: T92

PNP General Purpose Amplifier

This device is designed as a general purpose amplifier and switching applications at collector currents of 10 µA to 100 mA. Sourced from Process 66.

Absolute Maximum Ratings* TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BSR18A	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10\ \mu A$, $I_B = 0$		40	V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 1.0$ mA, $I_E = 0$		40	V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\ \mu A$, $I_C = 0$		5.0	V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 30$ V		50	nA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 3.0$ V, $I_C = 0$		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 0.1$ mA, $V_{CE} = 1.0$ V $I_C = 1.0$ mA, $V_{CE} = 1.0$ V $I_C = 10$ mA, $V_{CE} = 1.0$ V $I_C = 50$ mA, $V_{CE} = 1.0$ V $I_C = 100$ mA, $V_{CE} = 1.0$ V	60 80 100 60 30	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA		0.25 0.4	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Transition Frequency	$I_C = 10$ mA, $V_{CE} = 20$, f = 100 MHz	250		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 5.0$ V, $I_E = 0$, f = 100 kHz		4.5	pF
C_{eb}	Emitter-Base Capacitance	$V_{EB} = 0.5$ V, $I_C = 0$, f = 100 kHz		10	pF
h_{ie}	Input Impedance	V_{CE}= 10 V,I_C= 1.0 mA,f=1.0 kHz	2.0	12	kΩ
h_{fe}	Small-Signal Current Gain	V_{CE}= 10 V,I_C= 1.0 mA,f=1.0 kHz	100	400	
h_{oe}	Output Admittance	V_{CE}= 10 V,I_C= 1.0 mA,f=1.0 kHz	3.0	60	μS
SWITCHING CHARACTERISTICS					
t_d	Delay Time	$I_C = 10$ mA, $I_{B1} = 1.0$ mA,		35	ns
t_r	Rise Time	$V_{EB} = 0.5$ V		35	ns
t_s	Storage Time	$I_C = 10$ mA, $I_{Bon} = I_{Boff} = 1.0$ mA		275	ns
t_f	Fall Time			75	ns

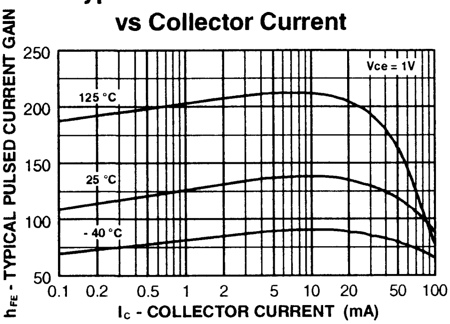
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 0.01%

Spice Model

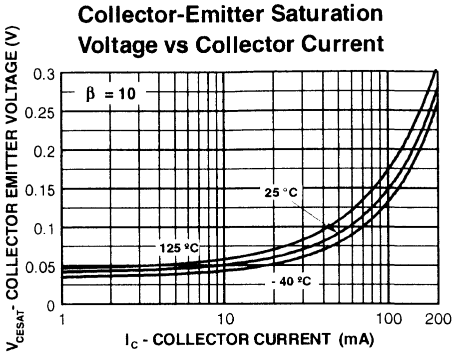
PNP (Is=1.41f Xti=3 Eg=1.11 Vaf=18.7 Bf=180.7 Ne=1.5 Ise=0 Ikf=80m Xtb=1.5 Br=4.977 Nc=2 Isc=0 Ikr=0 Rc=2.5 Cjc=9.728p Mjc=.5776 Vjc=.75 Fc=.5 Cje=8.063p Mje=.3677 Vje=.75 Tr=33.42n Tf=179.3p Itf=.4 Vtf=4 Xtf=6 Rb=10)

DC Typical Characteristics

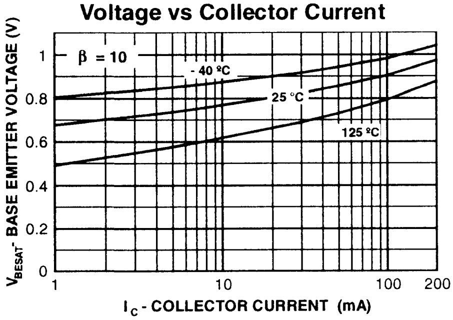
Typical Pulsed Current Gain vs Collector Current



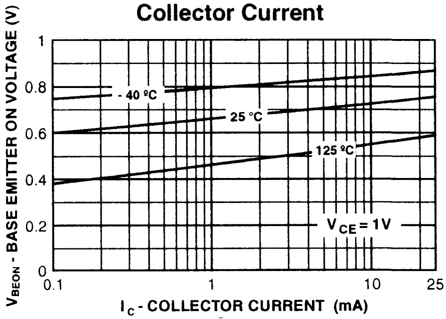
Collector-Emitter Saturation Voltage vs Collector Current



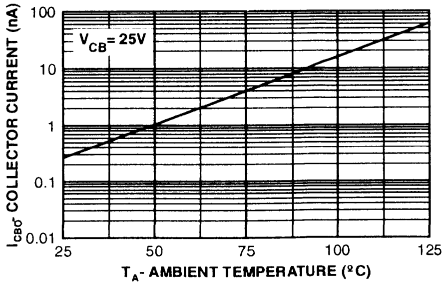
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current



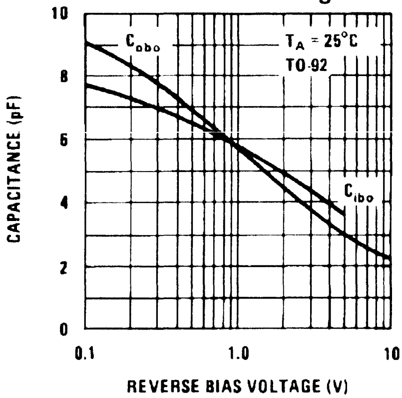
Collector-Cutoff Current vs. Ambient Temperature



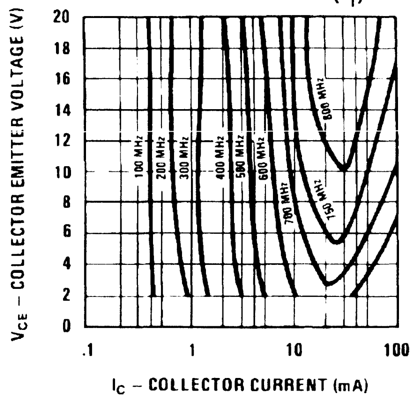
PNP General Purpose Amplifier
(continued)

AC Typical Characteristics

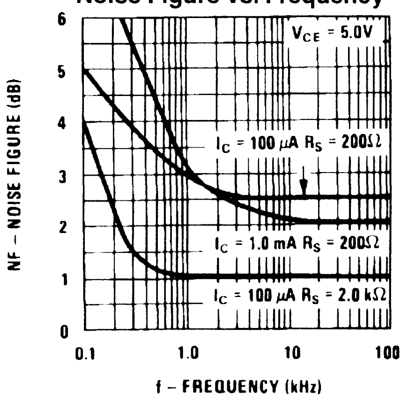
Common-Base Open Circuit Input / Output Capacitance vs. Reverse Bias Voltage



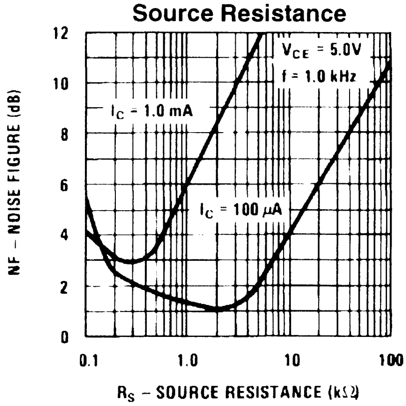
Contours of Constant Gain Bandwidth Product (f_T)



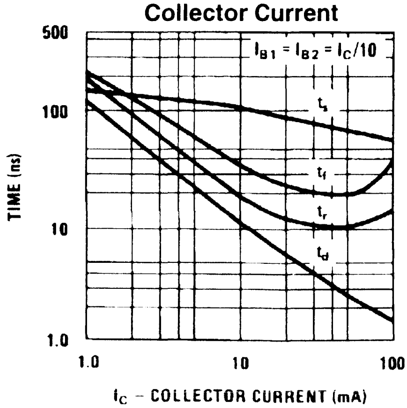
Noise Figure vs. Frequency



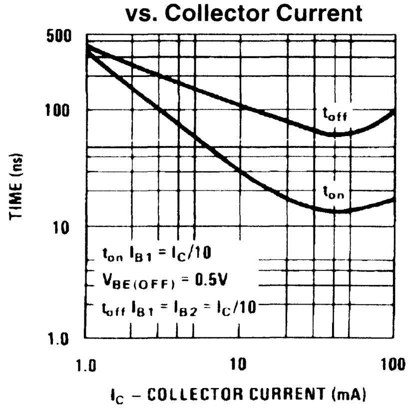
Noise Figure vs. Source Resistance



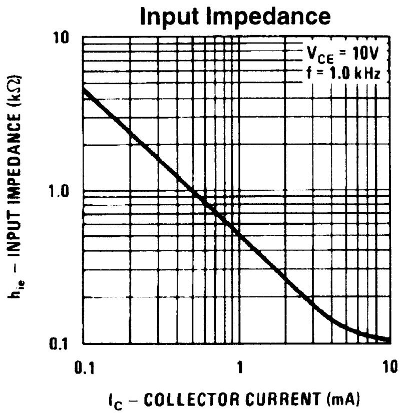
Switching Times vs. Collector Current

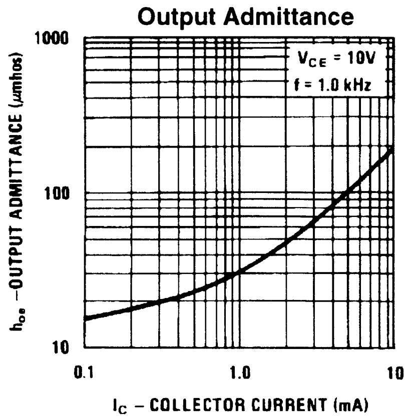


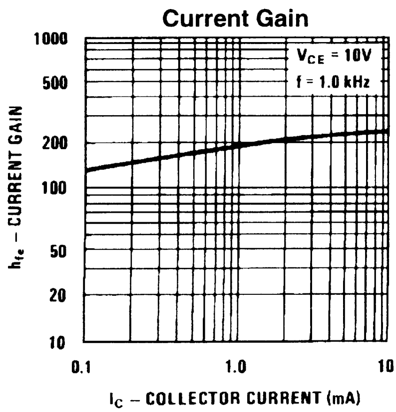
Turn On / Turn Off Times vs. Collector Current

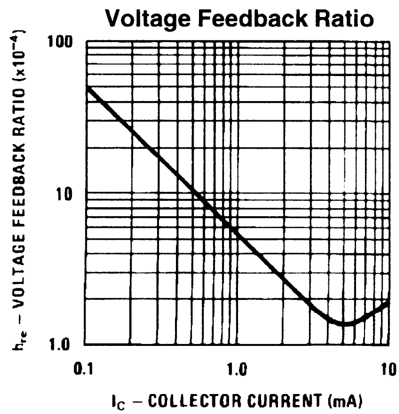


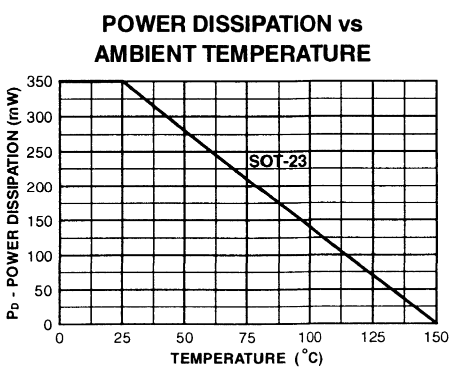
AC Typical Characteristics (continued)









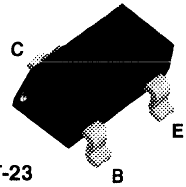


6

National Semiconductor

Discrete POWER & Signal Technologies

BSS63



SOT-23
Mark: T3

PNP General Pupose Amplifier

This device is designed for general purpose amplifier and switch applications requiring high voltages. Sourced from Process 74.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	100	V
V_{CBO}	Collector-Base Voltage	110	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BSS63	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

PNP General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

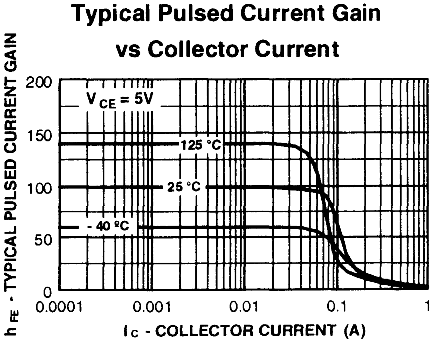
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 100\ \mu A$, $I_B = 0$	100		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_E = 0$	110		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 1.0\ \mu A$, $I_C = 0$	6.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 90\ V$, $I_E = 0$ $V_{CB} = 90\ V$, $I_E = 0$, $T_A = 150°C$		100 50	nA µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 6.0\ V$, $I_C = 0$		200	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 10\ mA$, $V_{CE} = 1.0\ V$ $I_C = 25\ mA$, $V_{CE} = 1.0\ V$	30 30		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 25\ mA$, $I_B = 2.5\ mA$		0.25	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 25\ mA$, $I_B = 2.5\ mA$		0.9	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 25\ mA$, $V_{CE} = 5.0$, $f = 35\ MHz$	50		MHz

Spice Model

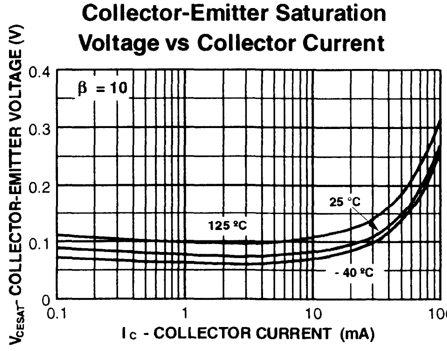
PNP (Is=21.48f Xti=3 Eg=1.11 Vaf=100 Bf=132.1 Ne=1.375 Ise=21.48f Ikf=.1848 Xtb=1.5 Br=3.661 Nc=2 Isc=0 Ikr=0 Rc=1.6 Cjc=17.63p Mjc=.5312 Vjc=.75 Fc=.5 Cje=73.39p Mje=.3777 Vje=.75 Tr=1.476n Tf=641.9p Itf=0 Vtf=0 Xtf=0 Rb=10)

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



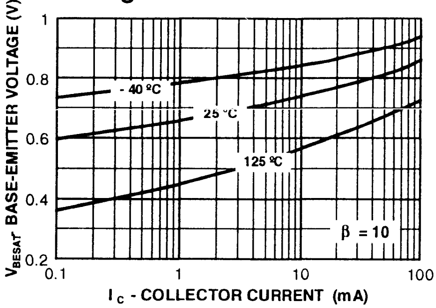
Collector-Emitter Saturation Voltage vs Collector Current



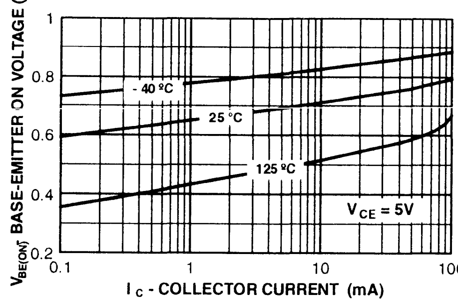
PNP General Purpose Amplifer
(continued)

DC Typical Characteristics (continued)

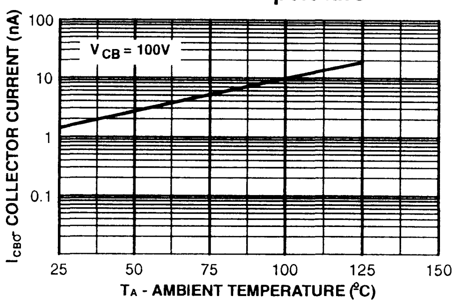
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current

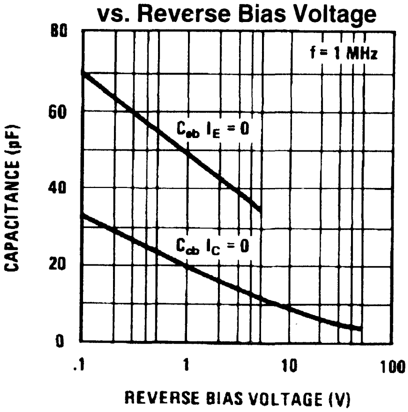


Collector-Cutoff Current vs Ambient Temperature

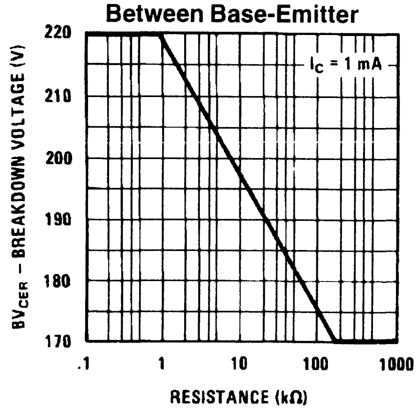


AC Typical Characteristics

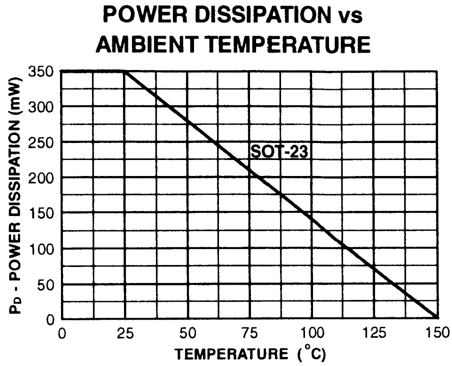
Input / Output Capacitance vs. Reverse Bias Voltage



Collector-Emitter Breakdown Voltage with Resistance Between Base-Emitter



AC Typical Characteristics (continued)



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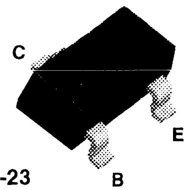
BSS64



SOT-23
Mark: U3

NPN General Pupose Amplifier

This device is designed for general purpose high voltage amplifiers and gas discharge display driving. Sourced from Process 16.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	80	V
V_{CBO}	Collector-Base Voltage	120	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BSS64	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

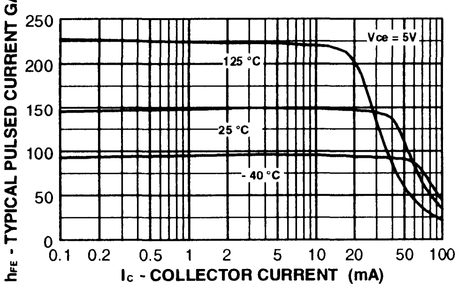
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 4.0$ mA, $I_B = 0$	80		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 100\ \mu A$, $I_E = 0$	120		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 100\ \mu A$, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 90$ V, $I_E = 0$ $V_{CB} = 90$ V, $I_E = 0$, $T_A = 150°C$		0.1 50	µA µA
I_{EBO}	Emitter-Cutoff Current	$V_{EB} = 5.0$ V, $I_C = 0$		200	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 10$ mA, $V_{CE} = 1.0$ V	20		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 4.0$ mA, $I_B = 400\ \mu A$ $I_C = 50$ mA, $I_B = 15$ mA		0.15 0.2	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 4.0$ mA, $I_B = 400\ \mu A$		1.2	V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 4.0$ mA, $V_{CE} = 10$, f = 35 MHz	60		MHz
C_{ob}	Output Capacitance	$V_{CB} = 10$ V, f = 1.0 MHz		5.0	pF

Spice Model

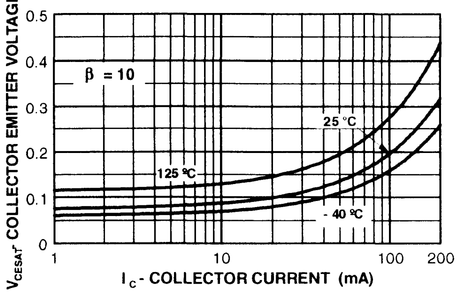
NPN (Is=2.511f Xti=3 Eg=1.11 Vaf=100 Bf=242.6 Ne=1.249 Ise=2.511f Ikf=.3458 Xtb=1.5 Br=3.197 Nc=2 Isc=0 Ikr=0 Rc=1 Cjc=4.883p Mjc=.3047 Vjc=.75 Fc=.5 Cje=18.79p Mje=.3416 Vje=.75 Tr=1.202n Tf=560p Itf=50m Vtf=5 Xtf=8 Rb=10)

DC Typical Characteristics

Typical Pulsed Current Gain vs Collector Current



Collector-Emitter Saturation Voltage vs Collector Current

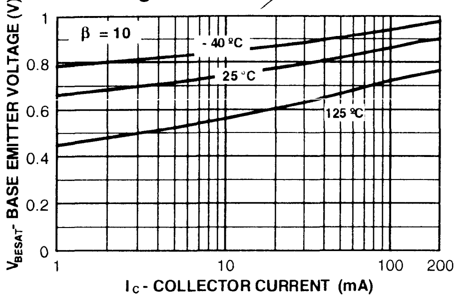


NPN General Purpose Amplifer

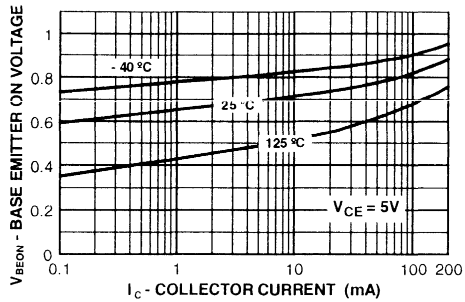
(continued)

DC Typical Characteristics (continued)

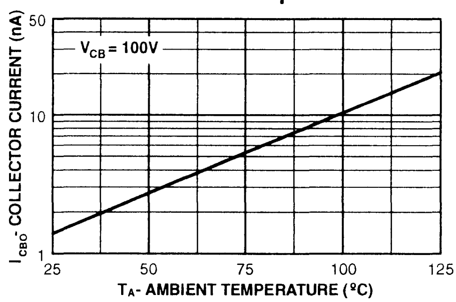
Base-Emitter Saturation Voltage vs Collector Current



Base Emitter ON Voltage vs Collector Current

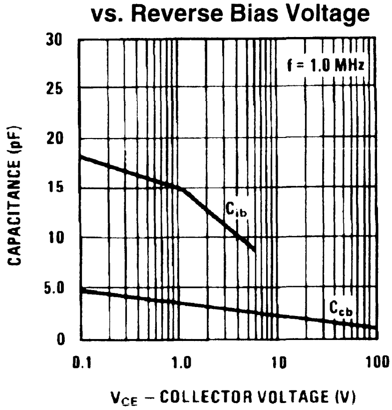


Collector-Cutoff Current vs. Ambient Temperature

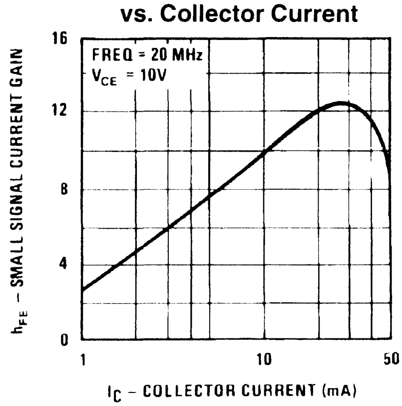


AC Typical Characteristics

Input / Output Capacitance vs. Reverse Bias Voltage

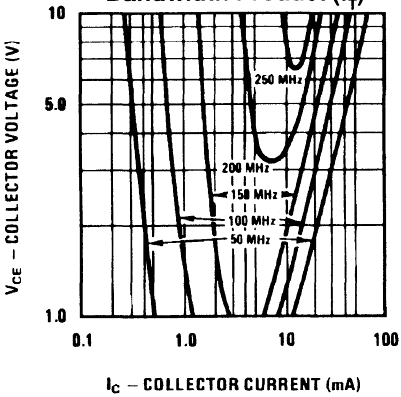


Small Signal Current Gain vs. Collector Current

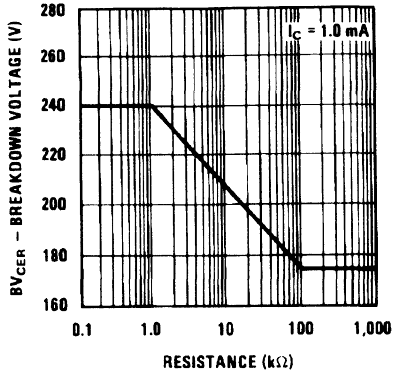


AC Typical Characteristics (continued)

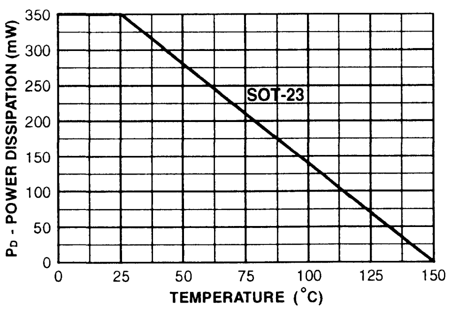
Contours of Constant Gain Bandwidth Product (f_T)



Collector-Emitter Breakdown Voltage with Resistance Between Emitter-Base



POWER DISSIPATION vs AMBIENT TEMPERATURE



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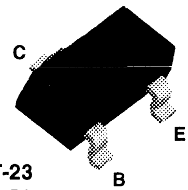
BSV52



SOT-23
Mark: B2

NPN Switching Transistor

This device is designed for high speed saturation switching at collector currents of 10 mA to 100 mA. Sourced from Process 21.

Absolute Maximum Ratings*   TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	12	V
V_{CES}	Collector-Base Voltage	20	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics   TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		*BSV52	
P_D	Total Device Dissipation Derate above 25°C	225 1.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	556	°C/W

*Device mounted on FR-4 PCB 40 mm X 40 mm X 1.5 mm.

NPN Switching Transistor
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

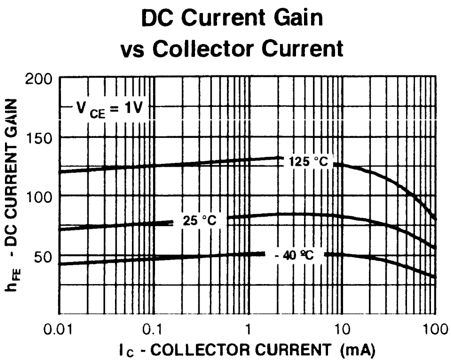
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 10$ mA, $I_B = 0$	12		V
$V_{(BR)CES}$	Collector-Base Breakdown Voltage	$I_C = 10\ \mu A$, $I_E = 0$	20		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 100\ \mu A$, $I_C = 0$	5.0		V
I_{CBO}	Collector-Cutoff Current	$V_{CB} = 10$ V, $I_E = 0$ $V_{CB} = 10$ V, $I_E = 0$, $T_A = 125°C$		100 5.0	nA µA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain	$I_C = 1.0$ mA, $V_{CE} = 1.0$ V $I_C = 10$ mA, $V_{CE} = 1.0$ V $I_C = 50$ mA, $V_{CE} = 1.0$ V	25 40 25	 120 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 0.3$ mA $I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA		0.3 0.25 0.4	V V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA	0.7	0.85 1.2	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Transition Frequency	$I_C = 10$ mA, $V_{CE} = 10$ V, f = 100 MHz	400		MHz
C_{cb}	Collector-Base Capacitance	$I_E = 0$, $V_{CB} = 5.0$ V, f = 1.0 MHz		4.0	pF
C_{eb}	Emitter-Base Capacitance	$I_C = 0$, $V_{EB} = 1.0$ V, f = 1.0 MHz		4.5	pF
SWITCHING CHARACTERISTICS					
t_s	Storage Time	$I_{B1} = I_{B2} = I_C = 10$ mA		13	ns
t_{on}	Turn-On Time	$V_{CC} = 3.0$ V, $I_C = 10$ mA, $I_{B1} = 3.0$ mA		12	ns
t_{off}	Turn-Off Time	$V_{CC} = 3.0$ V, $I_C = 10$ mA, $I_{B1} = 3.0$ mA, $I_{B2} = 1.5$ mA		18	ns

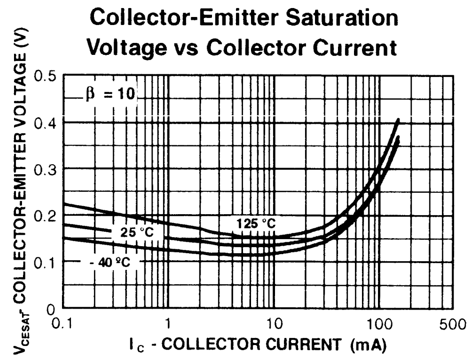
Spice Model

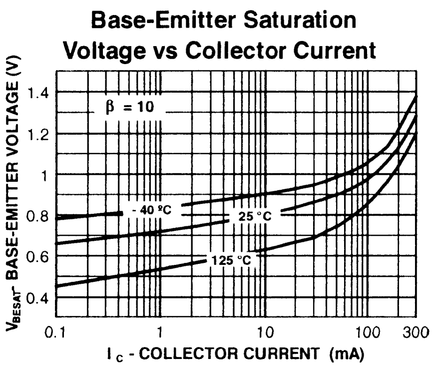
NPN (Is=44.14f Xti=3 Eg=1.11 Vaf=100 Bf=78.32 Ne=1.389 Ise=91.95f Ikf=.3498 Xtb=1.5 Br=12.69m Nc=2 Isc=0 Ikr=0 Rc=.6 Cjc=2.83p Mjc=86.19m Vjc=.75 Fc=.5 Cje=4.5p Mje=.2418 Vje=.75 Tr=1.073u Tf=227.6p Itf=.3 Vtf=4 Xtf=4 Rb=10)

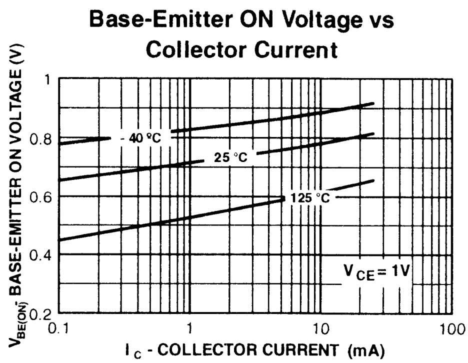
NPN Switching Transistor
(continued)

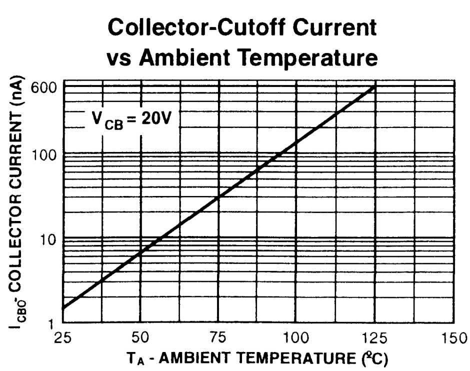
DC Typical Characteristics





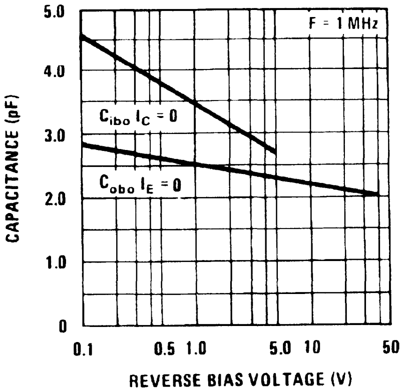




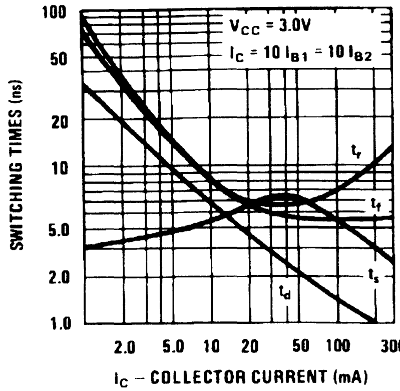


AC Typical Characteristics

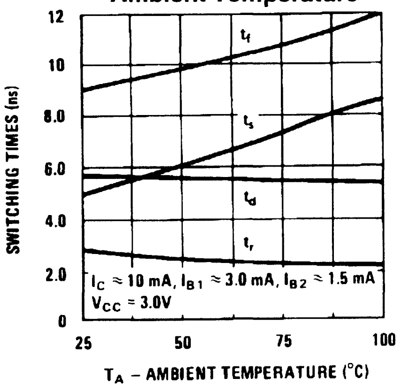
Output Capacitances vs. Reverse Bias Voltage



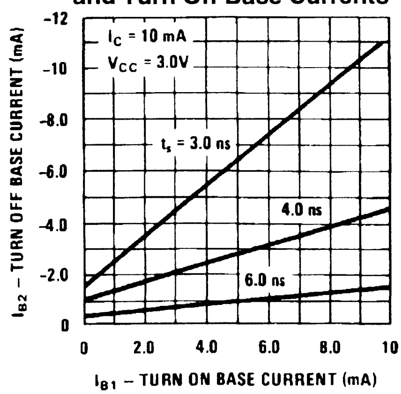
Switching Times vs. Collector Current



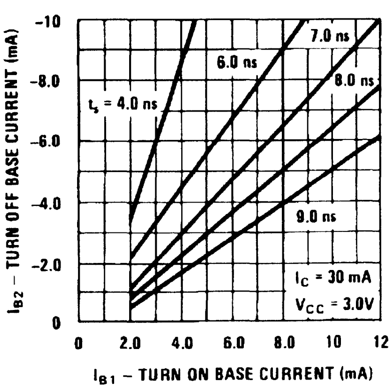
Switching Times vs. Ambient Temperature



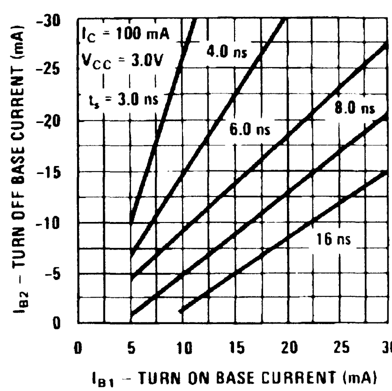
Storage Time vs. Turn On and Turn Off Base Currents



Storage Time vs. Turn On and Turn Off Base Currents



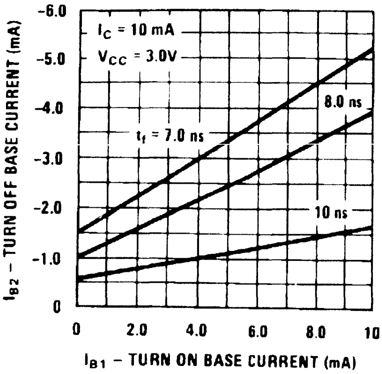
Storage Time vs. Turn On and Turn Off Base Currents



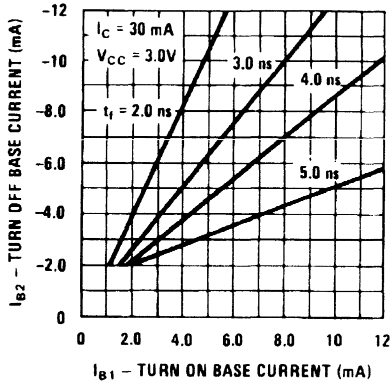
NPN Switching Transistor
(continued)

AC Typical Characteristics (continued)

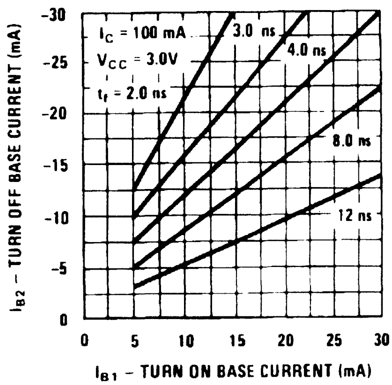
Fall Time vs. Turn On and Turn Off Base Currents



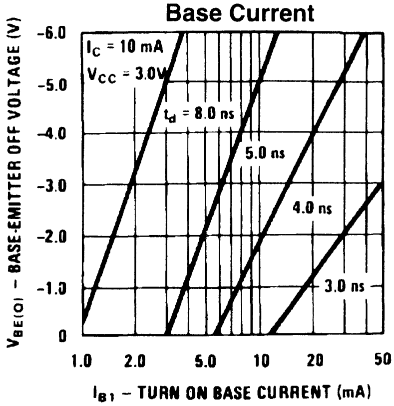
Fall Time vs. Turn On and Turn Off Base Currents



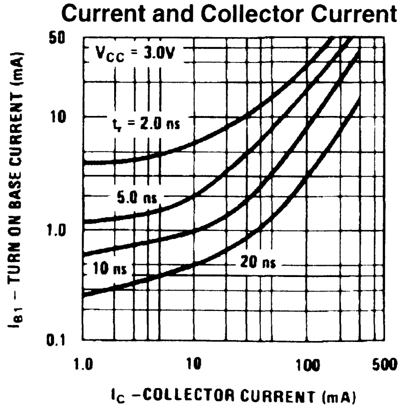
Fall Time vs. Turn On and Turn Off Base Currents



Delay Time vs. Base-Emitter OFF Voltage and Turn On Base Current

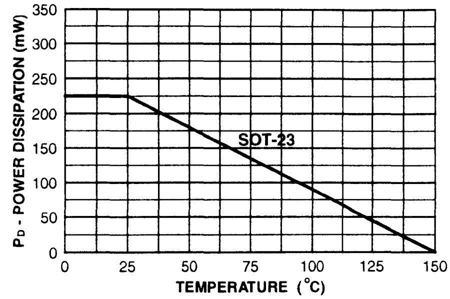


Rise Time vs. Turn On Base Current and Collector Current



AC Typical Characteristics (continued)

POWER DISSIPATION vs AMBIENT TEMPERATURE



Test Circuits

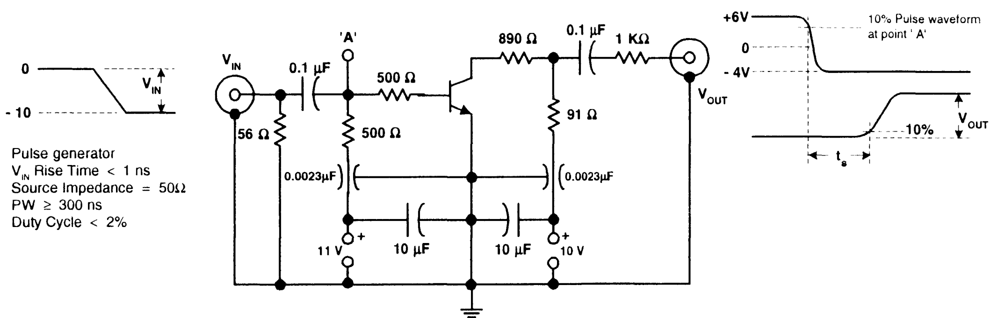


FIGURE 1: Charge Storage Time Measurement Circuit

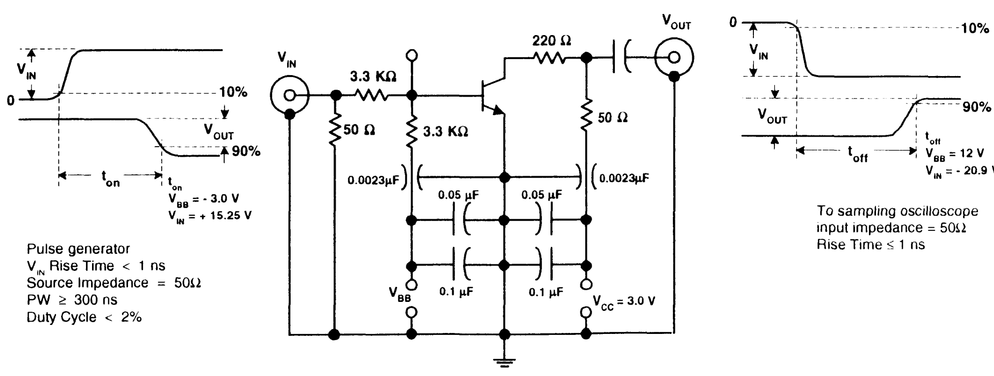


FIGURE 2: t_{ON}, t_{OFF} Measurement Circuit

Section 7
JFET Transistors

Section 7 Contents

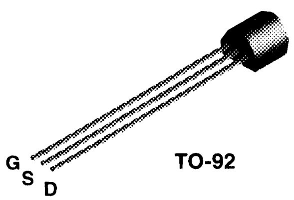
JFET Datasheets

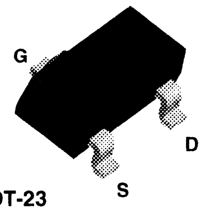
National Semiconductor™

Discrete POWER & Signal Technologies

J105
J106
J107

NDSJ105





N-Channel Switch

This device is designed for analog or digital switching applications where very low On Resistance is mandatory. Sourced from Process 59.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	25	V
V_{GS}	Gate-Source Voltage	- 25	V
I_{GF}	Forward Gate Current	10	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		J105 / J106 / J107	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

7

N-Channel Switch
(continued)

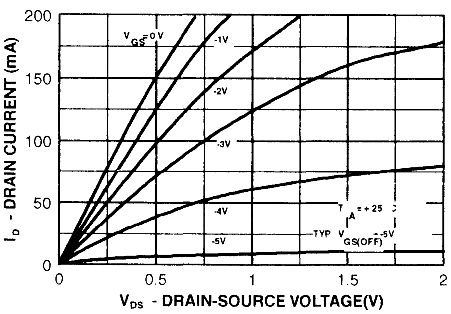
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	I_G = - 10 μA, V_{DS} = 0		- 25		V
I_{GSS}	Gate Reverse Current	V_{GS} = - 15 V, V_{DS} = 0			- 3.0	nA
		V_{GS} = - 15 V, V_{DS} = 0, T_A = 100°C			- 200	nA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	V_{DS} = 15 V, I_D = 10 nA	**J105**	- 4.5	- 10	V
			J106	- 2.0	- 6.0	V
			J107	- 0.5	- 4.5	V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	V_{DS} = 15 V, I_{GS} = 0	**J105**	500		mA
			J106	200		mA
			J107	100		mA
$r_{DS(on)}$	Drain-Source On Resistance	V_{DS} ≤ 0.1 V, V_{GS} = 0	**J105**		3.0	Ω
			J106		6.0	Ω
			J107		8.0	Ω
SMALL SIGNAL CHARACTERISTICS						
$C_{dg(on)}$ $C_{sg(on)}$	Drain Gate & Source Gate On Capacitance	V_{DS} = 0, V_{GS} = 10 V, f = 1.0 MHz			160	pF
$C_{dg(off)}$	Drain-Gate Off Capacitance	V_{DS} = 0, V_{GS} = 10 V, f = 1.0 MHz			35	pF
$C_{sg(off)}$	Source-Gate Off Capacitance	V_{DS} = 0, V_{GS} = 10 V, f = 1.0 MHz			35	pF

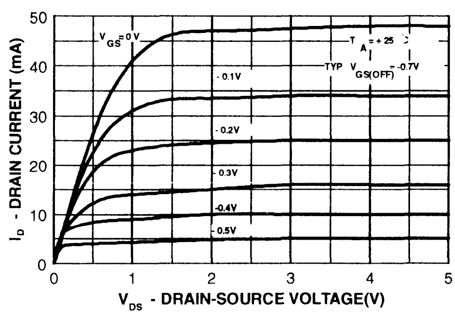
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

Typical Characteristics

Common Drain-Source Characteristics

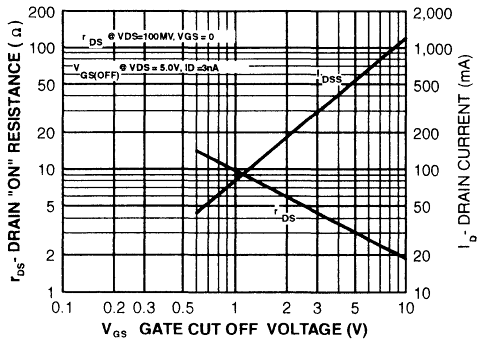


Common Drain-Source Characteristics

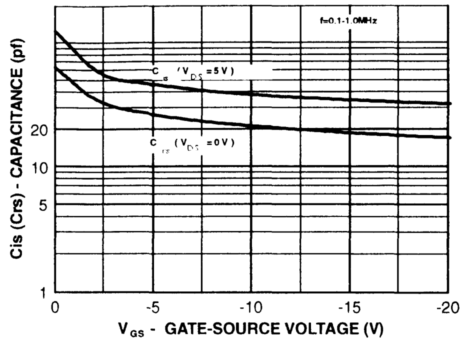


Typical Characteristics (continued)

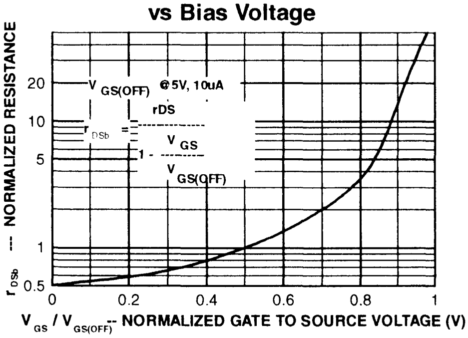
Parameter Interactions



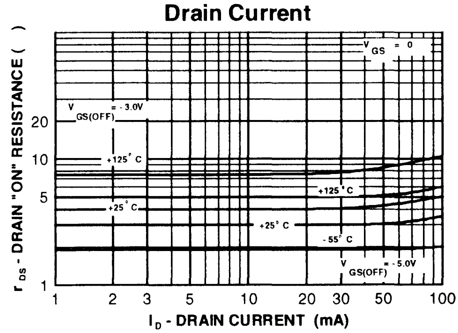
Capacitance vs Voltage



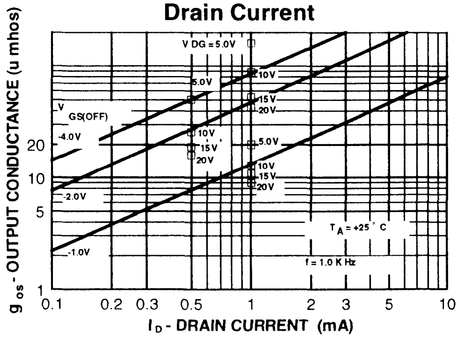
Normalized Drain Resistance vs Bias Voltage



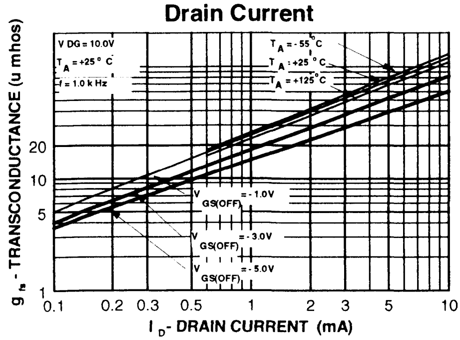
On Resistance vs Drain Current



Output Conductance vs Drain Current



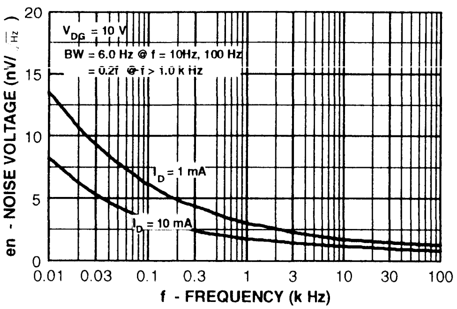
Transconductance vs Drain Current



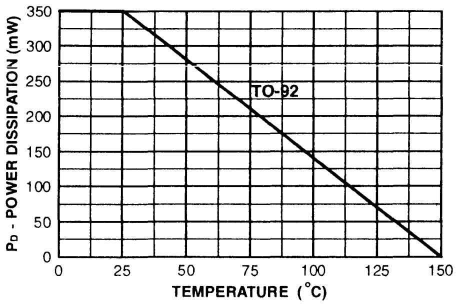
N-Channel Switch
(continued)

Typical Characteristics (continued)

Noise Voltage vs Frequency



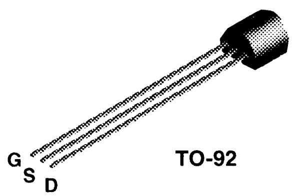
POWER DISSIPATION vs AMBIENT TEMPERATURE



National
Semiconductor™

Discrete POWER & Signal
Technologies

J108
J109
J110



TO-92

N-Channel Switch

This device is designed for analog or digital switching applications where very low on resistance is mandatory. Sourced from Process 58.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	25	V
V_{GS}	Gate-Source Voltage	- 25	V
I_{GF}	Forward Gate Current	10	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		J108 / J109 / J110	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	°C/W

N-Channel Switch
(continued)

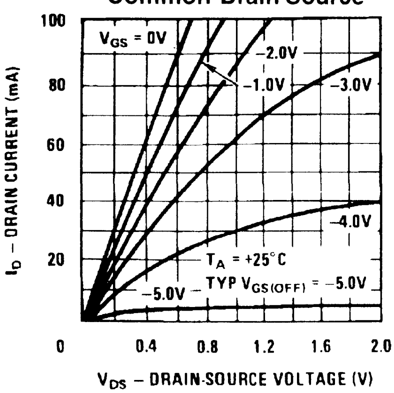
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	I_G = - 10 μA, V_{DS} = 0		- 25		V
I_{GSS}	Gate Reverse Current	V_{GS} = - 15 V, V_{DS} = 0			- 3.0	nA
		V_{GS} = - 15 V, V_{DS} = 0, T_A = 100°C			- 200	nA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	V_{DS} = 15 V, I_D = 10 nA	**J108**	- 3.0	- 10	V
			J109	- 2.0	- 6.0	V
			J110	- 0.5	- 4.0	V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	V_{DS} = 15 V, I_{GS} = 0	**J108**	80		mA
			J109	40		mA
			J110	10		mA
$r_{DS(on)}$	Drain-Source On Resistance	V_{DS} ≤ 0.1 V, V_{GS} = 0	**J108**		8.0	Ω
			J109		12	Ω
			J110		18	Ω
SMALL SIGNAL CHARACTERISTICS						
$C_{dg(on)}$ $C_{sg(off)}$	Drain Gate & Source Gate On Capacitance	V_{DS} = 0, V_{GS} = 0, f = 1.0 MHz			85	pF
$C_{dg(off)}$	Drain-Gate Off Capacitance	V_{DS} = 0, V_{GS} = - 10 V, f = 1.0 MHz			15	pF
$C_{sg(off)}$	Source-Gate Off Capacitance	V_{DS} = 0, V_{GS} = - 10 V, f = 1.0 MHz			15	pF

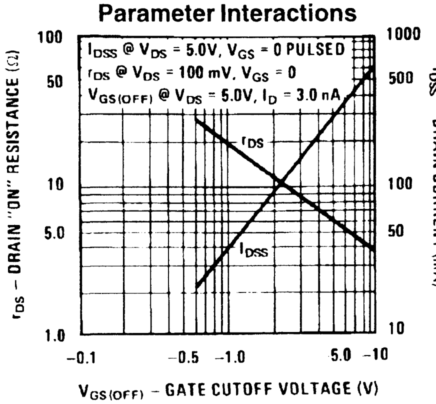
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

Typical Characteristics

Common-Drain Source

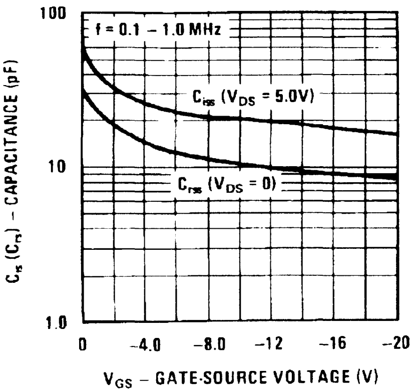


Parameter Interactions

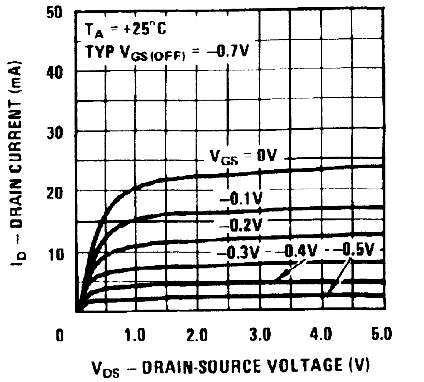


Typical Characteristics (continued)

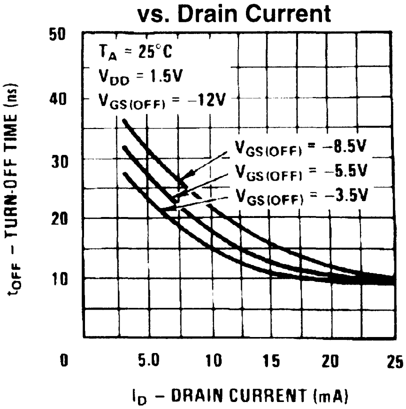
Common Drain-Source



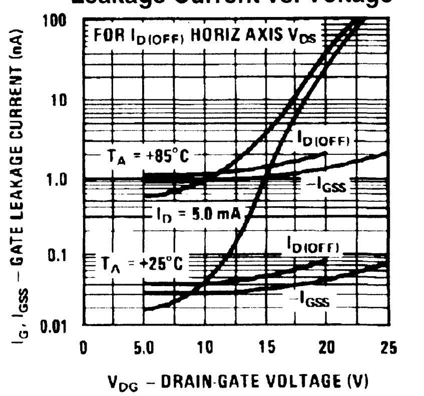
Common Drain-Source



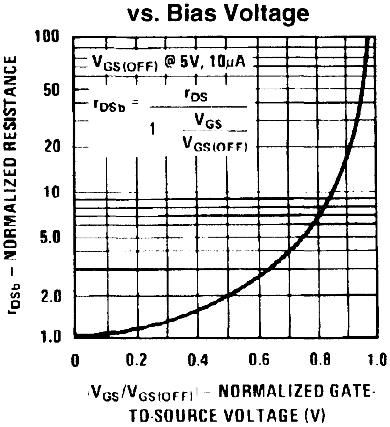
Switching Turn-On Time vs. Drain Current



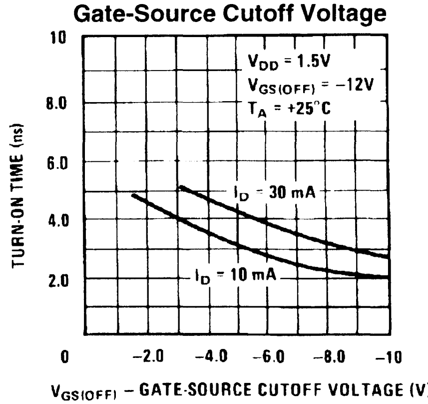
Leakage Current vs. Voltage



Normalized Drain Resistance vs. Bias Voltage



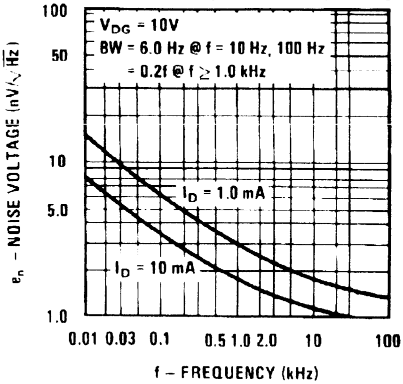
Switching Turn-On Time vs. Gate-Source Cutoff Voltage



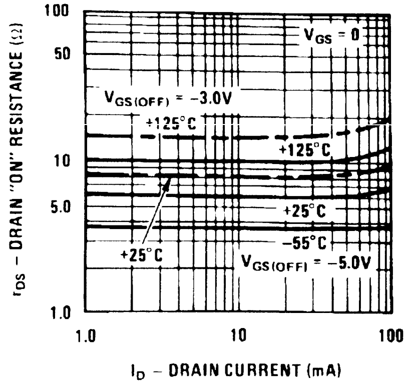
N-Channel Switch
(continued)

Typical Characteristics (continued)

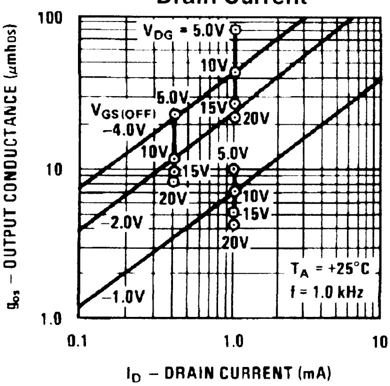
Noise Voltage vs. Frequency



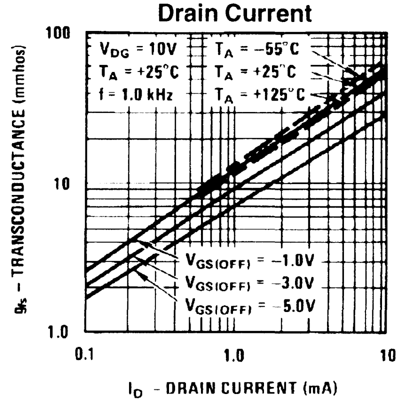
On Resistance vs. Drain Current



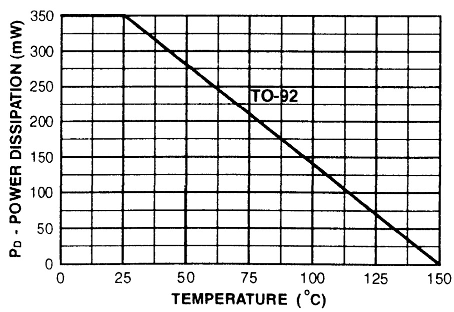
Output Conductance vs. Drain Current



Transconductance vs. Drain Current



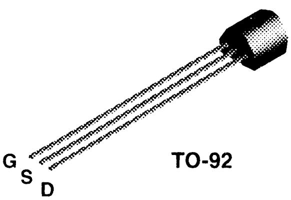
POWER DISSIPATION vs AMBIENT TEMPERATURE



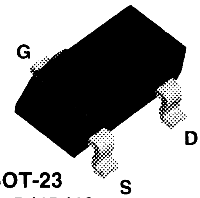
National Semiconductor

Discrete POWER & Signal Technologies

J111 J112 J113 MMBFJ111 MMBFJ112 MMBFJ113



TO-92



SOT-23
Mark: 6P / 6R / 6S

N-Channel Switch

This device is designed for low level analog switching, sample and hold circuits and chopper stabalized amplifiers. Sourced from Process 51.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	35	V
V_{GS}	Gate-Source Voltage	- 35	V
I_{GF}	Forward Gate Current	50	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		J111- J113	*MMBFJ111	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

N-Channel Switch
(continued)

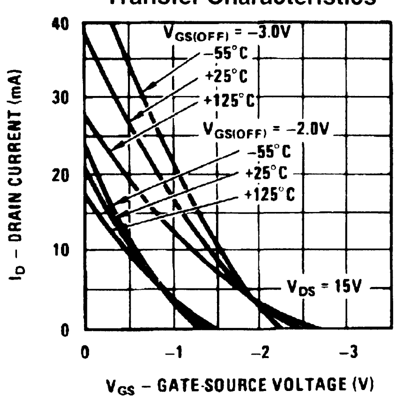
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	I_G = - 1.0 µA, V_{DS} = 0		- 35		V
I_{GSS}	Gate Reverse Current	V_{GS} = - 15 V, V_{DS} = 0			- 1.0	nA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	V_{DS} = 5.0 V, I_D = 1.0 µA	**J111**	- 3.0	- 10	V
			J112	- 1.0	- 5.0	V
			J113	- 0.5	- 3.0	V
$I_{D(off)}$	Gate-Source Cutoff Voltage	V_{DS} = 5.0 V, V_{GS} = - 10 V			1.0	nA
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	V_{DS} = 15 V, I_{GS} = 0	**J111**	20		mA
			J112	5.0		mA
			J113	2.0		mA
$r_{DS(on)}$	Drain-Source On Resistance	V_{DS} ≤ 0.1 V, V_{GS} = 0	**J111**		30	Ω
			J112		50	Ω
			J113		100	Ω
SMALL-SIGNAL CHARACTERISTICS						
$C_{dg(on)}$ $C_{sg(on)}$	Drain Gate & Source Gate On Capacitance	V_{DS} = 0, V_{GS} = 0, f = 1.0 MHz			28	pF
$C_{dg(off)}$	Drain-Gate Off Capacitance	V_{DS} = 0, V_{GS} = - 10 V, f = 1.0 MHz			5.0	pF
$C_{sg(off)}$	Source-Gate Off Capacitance	V_{DS} = 0, V_{GS} = - 10 V, f = 1.0 MHz			5.0	pF

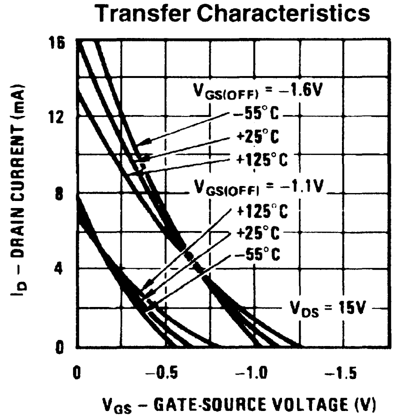
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 3.0%

Typical Characteristics

Transfer Characteristics

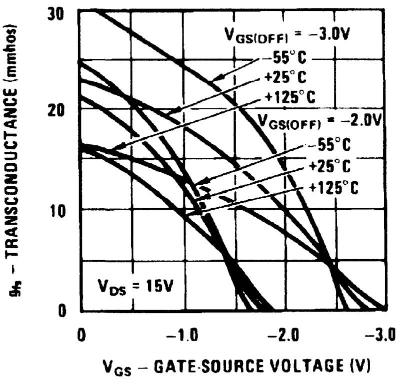


Transfer Characteristics

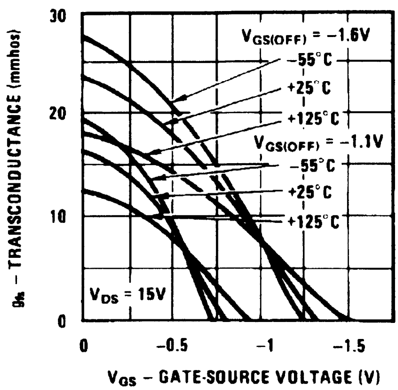


Typical Characteristics (continued)

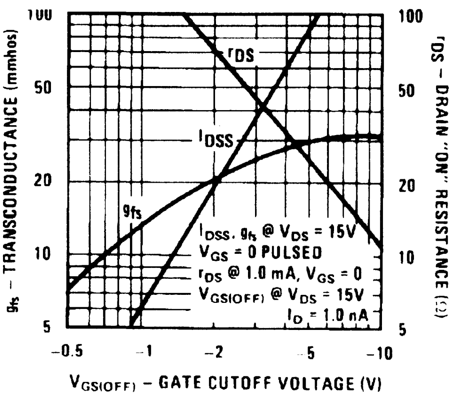
Transfer Characteristics



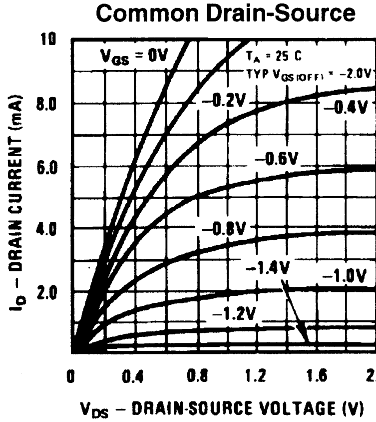
Transfer Characteristics



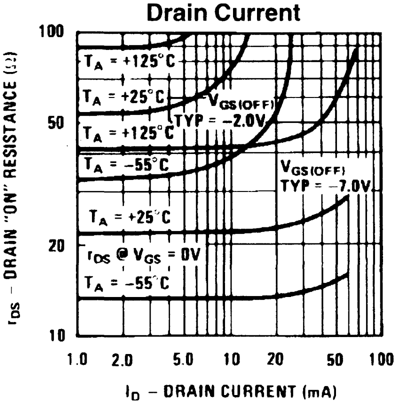
Parameter Interactions



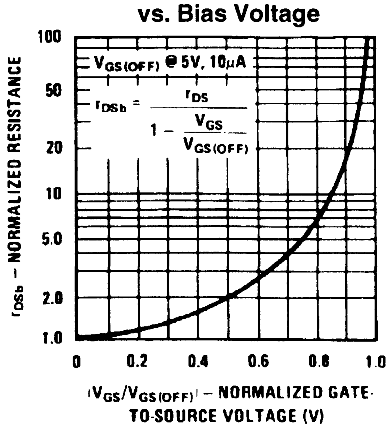
Common Drain-Source



Resistance vs. Drain Current



Normalized Drain Resistance vs. Bias Voltage

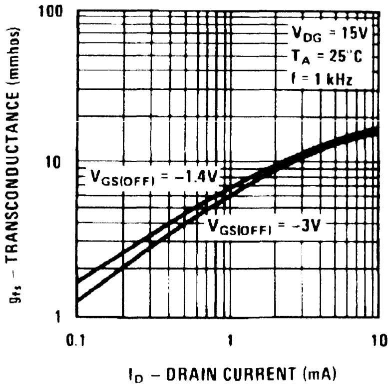


N-Channel Switch

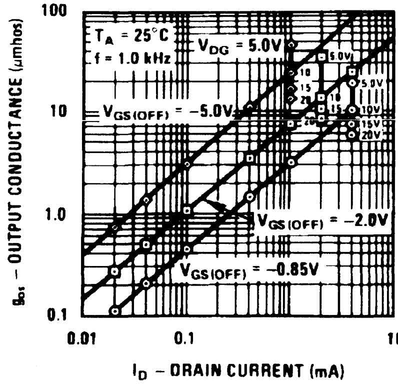
(continued)

Typical Characteristics (continued)

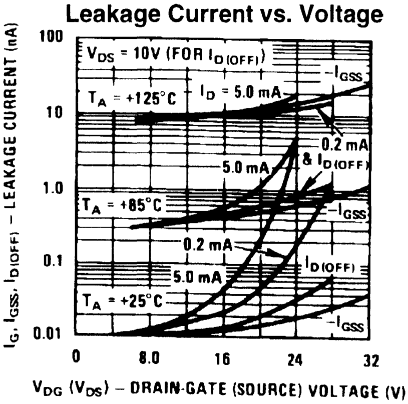
Transconductance vs. Drain Current



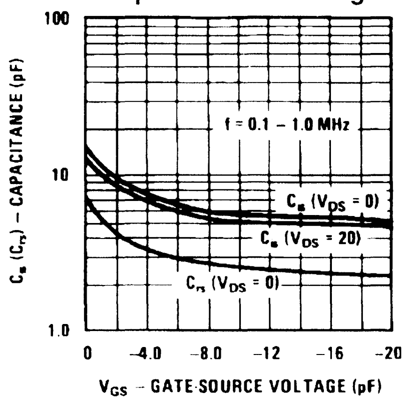
Output Conductance vs. Drain Current



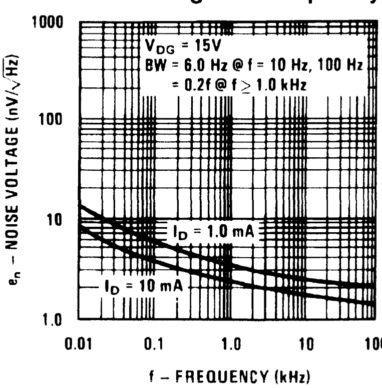
Leakage Current vs. Voltage



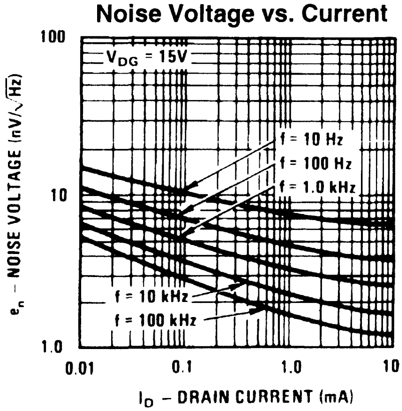
Capacitance vs. Voltage



Noise Voltage vs. Frequency

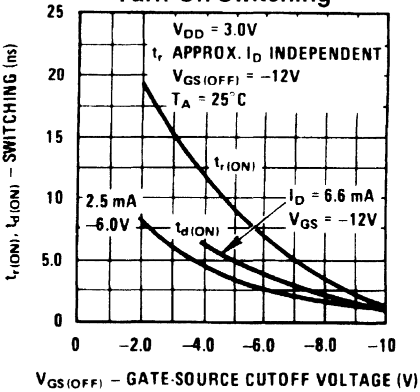


Noise Voltage vs. Current

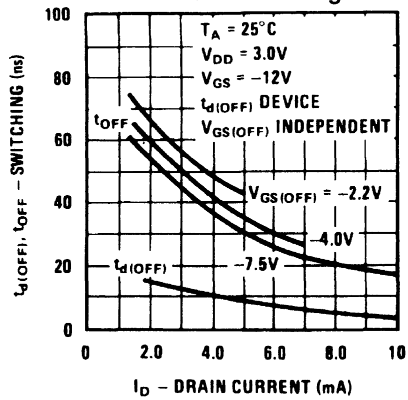


Typical Characteristics (continued)

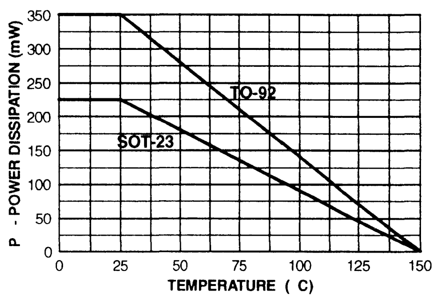
Turn-On Switching



Turn-Off Switching



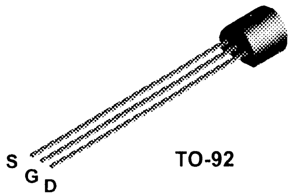
POWER DISSIPATION vs AMBIENT TEMPERATURE



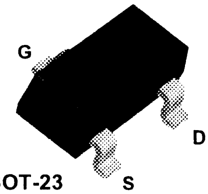
National Semiconductor™

Discrete POWER & Signal Technologies

J174 J175 J176 J177 MMBFJ175 MMBFJ176 MMBFJ177



TO-92



SOT-23
Mark: 6W / 6X / 6Y

P-Channel Switch

This device is designed for low level analog switching sample and hold circuits and chopper stabalized amplifiers. Sourced from Process 88.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	- 30	V
V_{GS}	Gate-Source Voltage	30	V
I_{GF}	Forward Gate Current	50	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		J174 - J177	*MMBFJ175	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

P-Channel Switch
(continued)

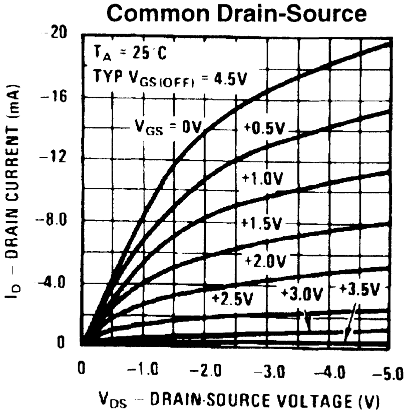
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Max	Units
OFF CHARACTERISTICS						
$B_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 1.0\ \mu A$, $V_{DS} = 0$		30		V
I_{GSS}	Gate Reverse Current	$V_{GS} = 20\ V$, $V_{DS} = 0$			1.0	nA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = -15\ V$, $I_D = -10\ nA$	**J174**	5.0	10	V
			J175	3.0	6.0	V
			J176	1.0	4.0	V
			J177	0.8	2.5	V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = -15\ V$, $I_{GS} = 0$	**J174**	- 20	- 100	mA
			J175	- 7.0	- 60	mA
			J176	- 2.0	- 25	mA
			J177	- 1.5	- 20	mA
$r_{DS(on)}$	Drain-Source On Resistance	$V_{DS} \le 0.1\ V$, $V_{GS} = 0$	**J174**		85	Ω
			J175		125	Ω
			J176		250	Ω
			J177		300	Ω

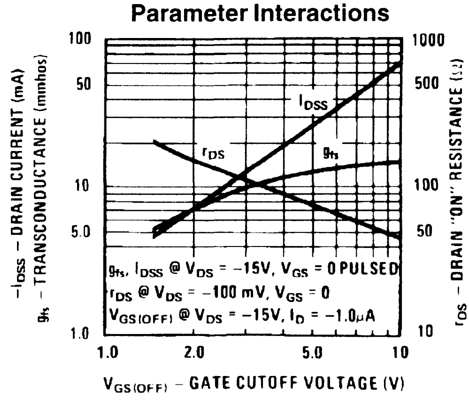
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

Typical Characteristics

Common Drain-Source



Parameter Interactions



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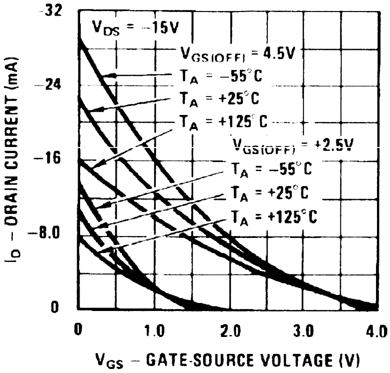
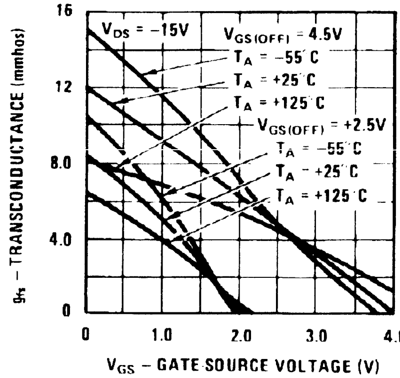
P-Channel Switch
(continued)

Typical Characteristics (continued)

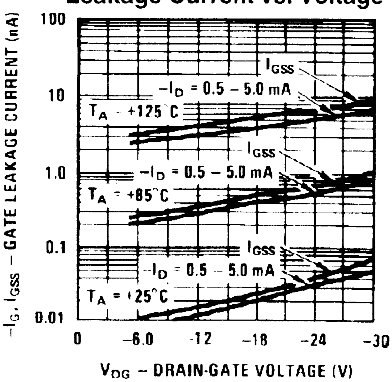
Transfer Characteristics



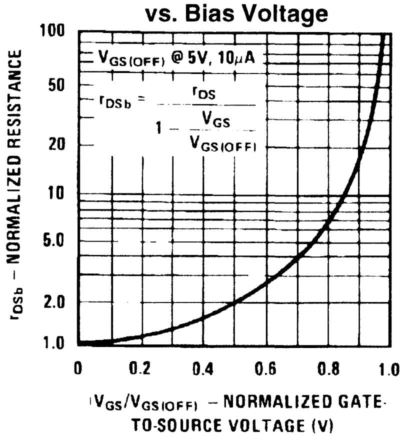
Transfer Characteristics



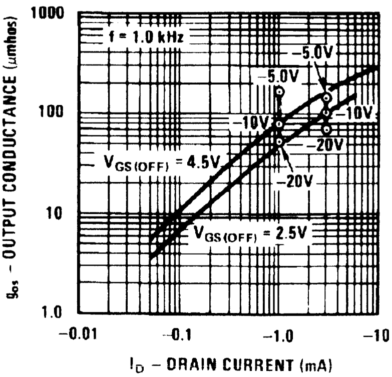
Leakage Current vs. Voltage



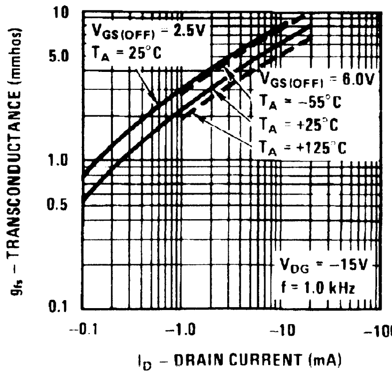
Normalized Drain Resistance vs. Bias Voltage



Output Conductance vs. Drain Current

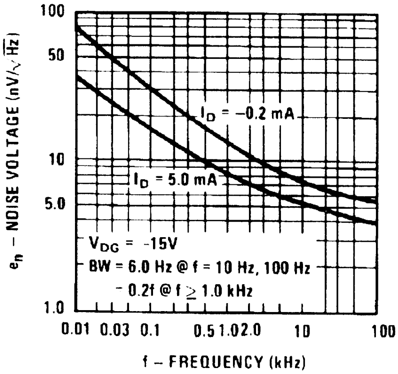


Transconductance vs. Drain Current

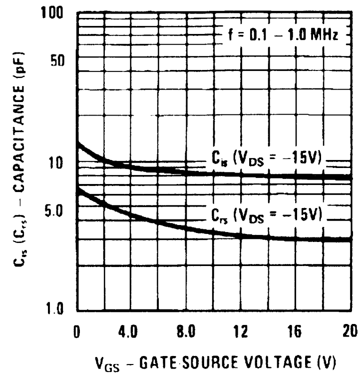


Typical Characteristics (continued)

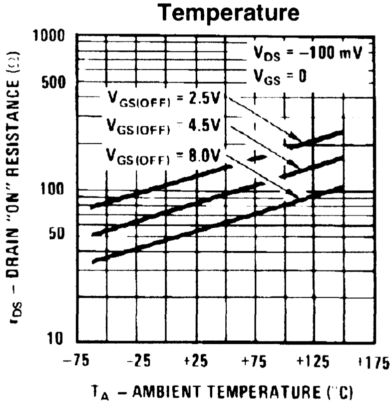
Noise Voltage vs. Frequency



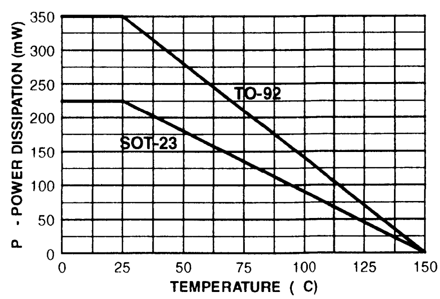
Capacitance vs. Voltage



Channel Resistance vs. Temperature



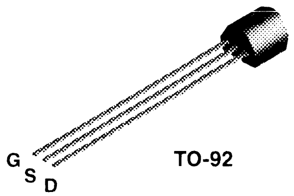
POWER DISSIPATION vs AMBIENT TEMPERATURE



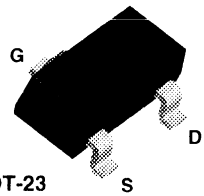
National Semiconductor

Discrete POWER & Signal Technologies

J201 J202 MMBFJ201 MMBFJ202



TO-92



SOT-23

Mark: 62P / 62Q

N-Channel General Purpose Amplifier

This device is designed primarily for low level audio and general purpose applications with high impedance signal sources. Sourced from Process 52.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	40	V
V_{GS}	Gate-Source Voltage	- 40	V
I_{GF}	Forward Gate Current	50	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		J201 / J202	*MMBFJ201	
P_D	Total Device Dissipation	625	350	mW
	Derate above 25°C	5.0	2.8	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

N-Channel General Purpose Amplifier
(continued)

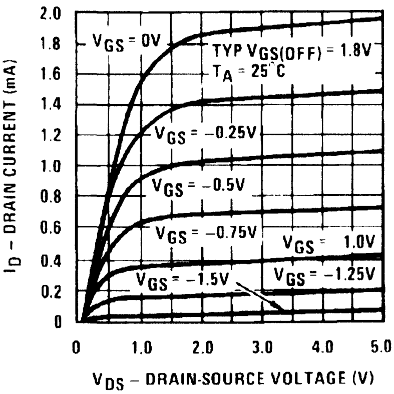
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	I_G = - 1.0 μA, V_{DS} = 0		- 40		V
I_{GSS}	Gate Reverse Current	V_{GS} = - 20 V, V_{DS} = 0			-100	pA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	V_{DS} = 20 V, I_D = 10 nA	**J201**	- 0.3	- 1.5	V
			J202	- 0.8	- 4.0	V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	V_{DS} = 20 V, I_{GS} = 0	**J201**	0.2	1.0	mA
			J202	0.9	4.5	mA
SMALL SIGNAL CHARACTERISTICS						
y_{fs}	Forward Transfer Admittance	V_{DS} = 20, f = 1.0 kHz	**J201**	500		μmhos
			J202	1000		μmhos

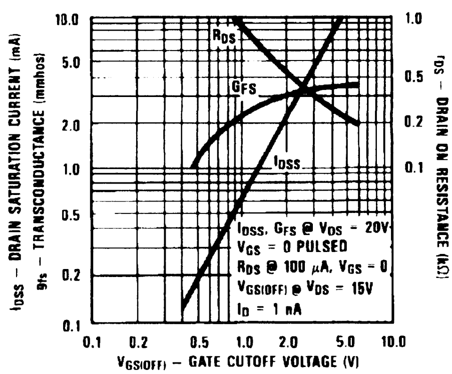
*Pulse Test: Pulse Width ≤ 300 μS

Typical Characteristics

Common Drain-Source



Parameter Interactions

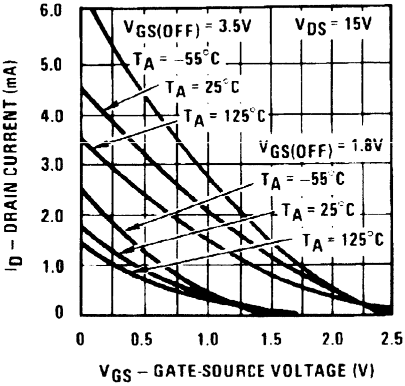


7

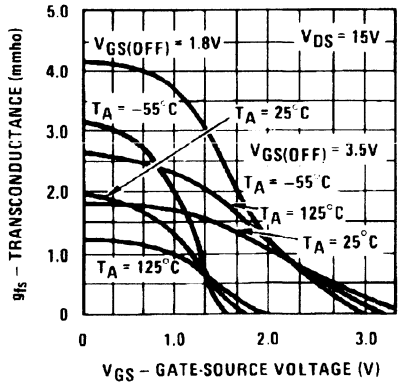
N-Channel General Purpose Amplifier
(continued)

Typical Characteristics (continued)

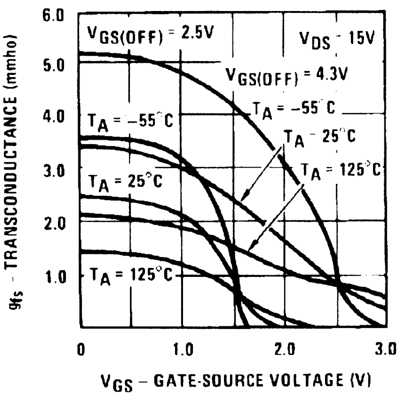
Transfer Charactersitics



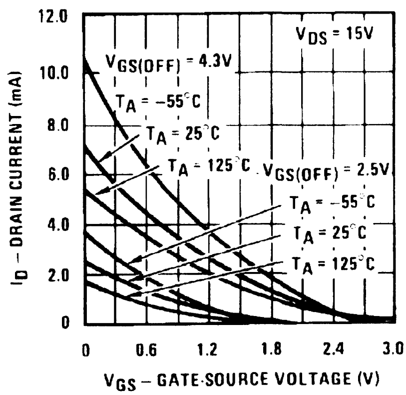
Transfer Characteristics



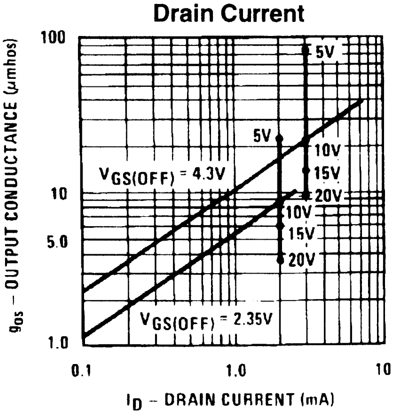
Transfer Characteristics



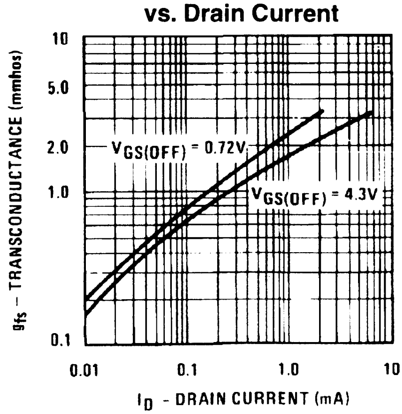
Transfer Characteristics



Output Conductance vs. Drain Current

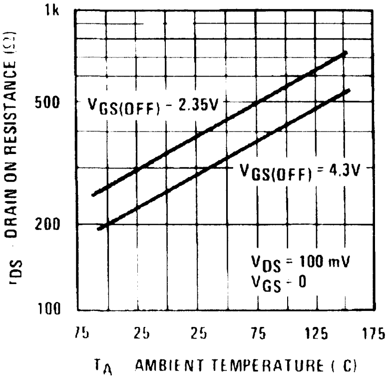


Transconductance vs. Drain Current

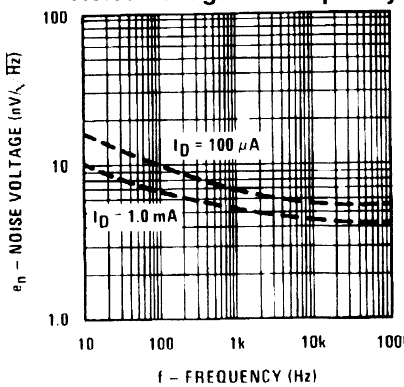


Typical Characteristics (continued)

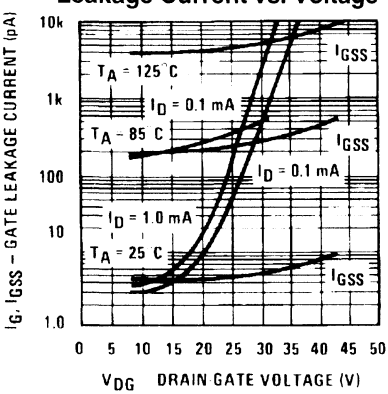
Channel Resistance vs. Temperature



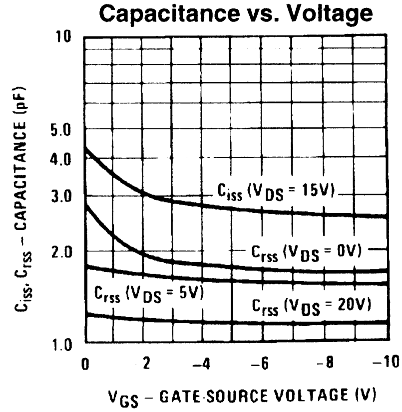
Noise Voltage vs. Frequency



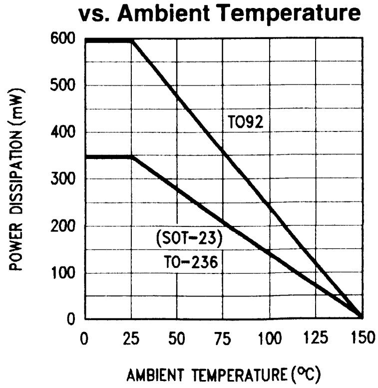
Leakage Current vs. Voltage



Capacitance vs. Voltage



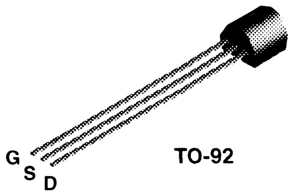
Total Power Dissipation vs. Ambient Temperature



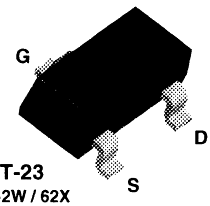
National Semiconductor

Discrete POWER & Signal Technologies

J211 J212 MMBFJ211 MMBFJ212



TO-92



SOT-23
Mark: 62W / 62X

N-Channel General Purpose Amplifier

This device is designed for VHF/UHF mixer/amplifier and applications where Process 50 is not adequate. Sufficient gain and low noise, common gate configuration at 450 MHz, for sensitive receivers. Sourced from Process 90.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	25	V
V_{GS}	Gate-Source Voltage	- 25	V
I_{GF}	Forward Gate Current	10	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		J211 / J212	*MMBFJ211	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

N-Channel General Purpose Amplifier
(continued)

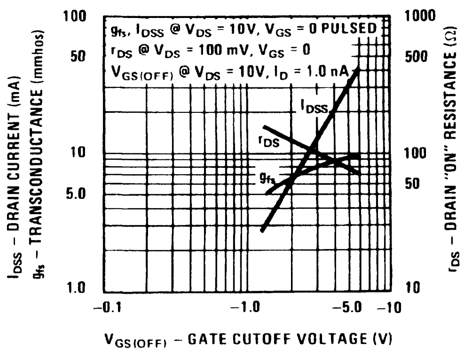
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	- 25		V
I_{GSS}	Gate Reverse Current	$V_{GS} = 15\ V$, $V_{DS} = 0$		- 100	pA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 15\ V$, $I_D = 1.0\ nA$ **J211** **J212**	- 2.5 - 4.0	- 4.5 - 6.0	V V
ON CHARACTERISTICS					
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = 15\ V$, $V_{GS} = 0$ **J211** **J212**	7.0 15	20 40	mA mA
SMALL SIGNAL CHARACTERISTICS					
g_{fs}	Common Source Forward Transconductance	$V_{DS} = 15\ V$, $V_{GS} = 0$, f = 1.0 kHz **J211** **J212**	 6000 7000	 12,000 12,000	 µmhos µmhos
g_{oss}	Common Source Output Conductance	$V_{DS} = 15\ V$, $V_{GS} = 0$, f = 1.0 kH		200	µmhos µmhos

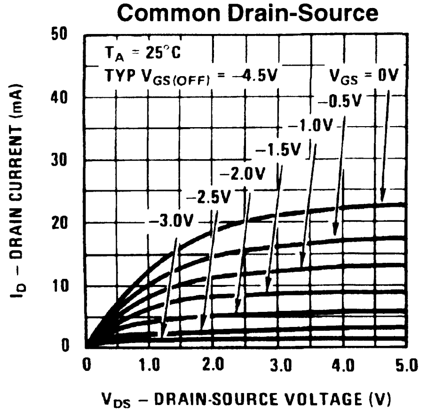
*Pulse Test: Pulse Width ≤ 300 µS

Typical Characteristics

Parameter Interactions



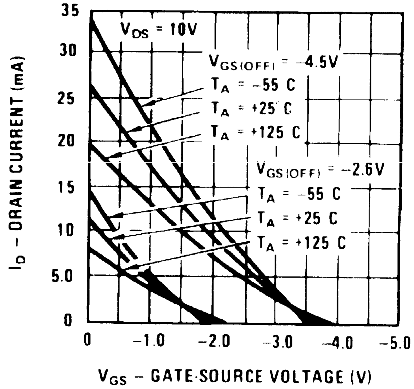
Common Drain-Source



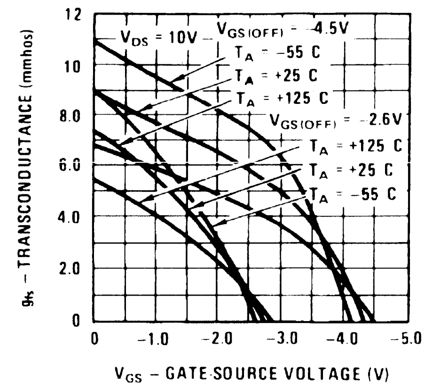
N-Channel General Purpose Amplifier
(continued)

Typical Characteristics (continued)

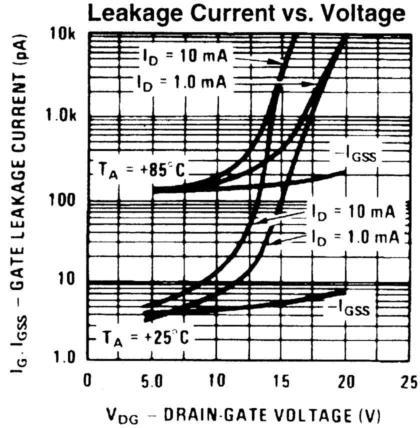
Transfer Characteristics



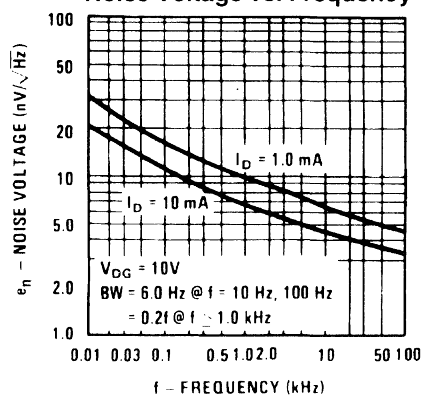
Transfer Characteristics



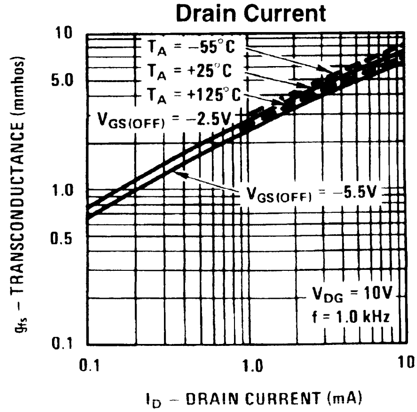
Leakage Current vs. Voltage



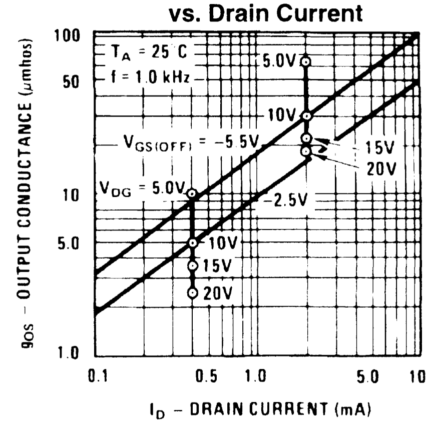
Noise Voltage vs. Frequency



Transconductance vs. Drain Current

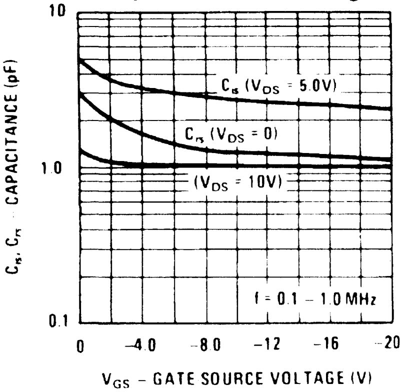


Output Conductance vs. Drain Current

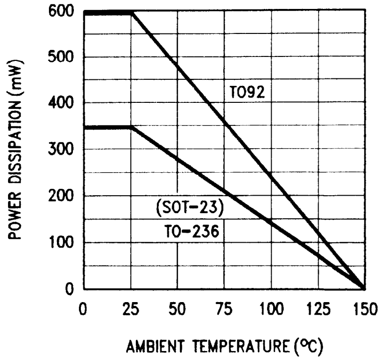


Typical Characteristics (continued)

Capacitance vs. Voltage

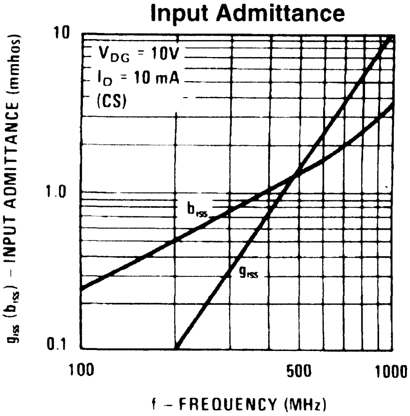


Total Power Dissipation vs. Ambient Temperature

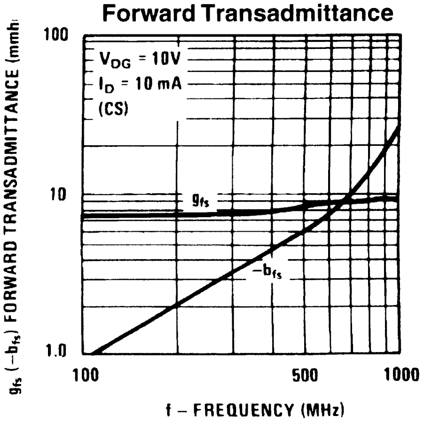


Common Source Characteristics

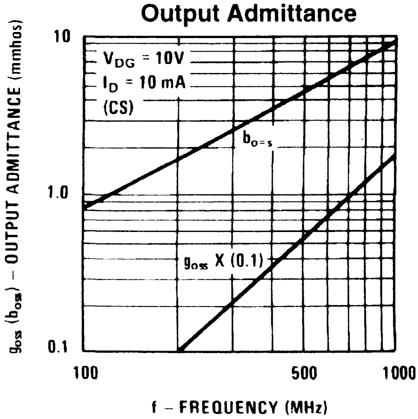
Input Admittance



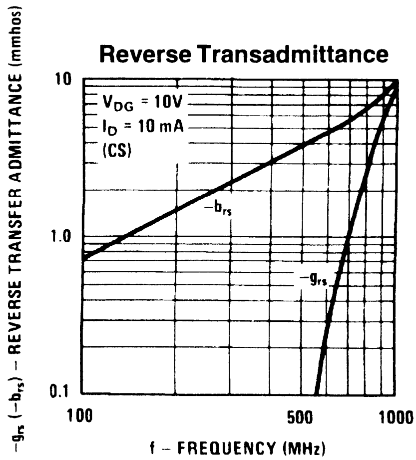
Forward Transadmittance



Output Admittance

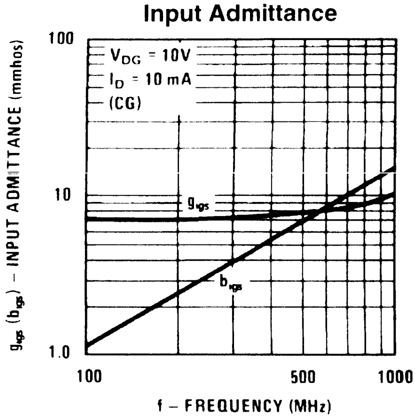


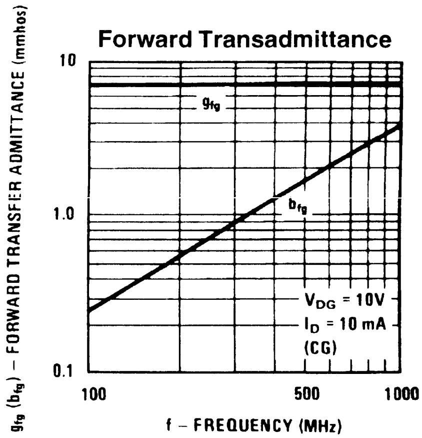
Reverse Transadmittance

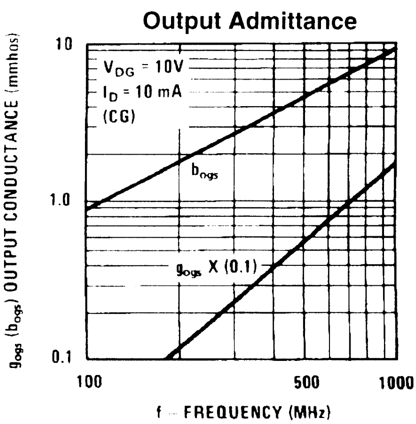


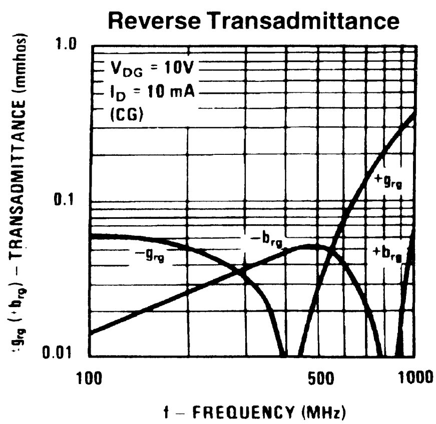
N-Channel General Purpose Amplifier
(continued)

Common Gate Characteristics





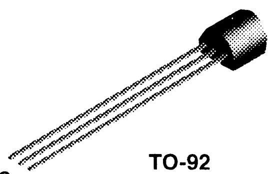




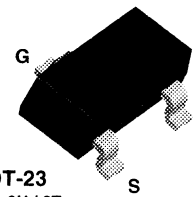
National Semiconductor

J309
J310

MMBFJ309
MMBFJ310



TO-92



SOT-23
Mark: 6U / 6T

N-Channel RF Amplifier

This device is designed for VHF/UHF amplifier, oscillator and mixer applications. As a common gate amplifier, 16 dB at 100 MHz and 12 dB at 450 MHz can be realized. Sourced from Process 92.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DS}	Drain-Source Voltage	25	V
V_{GS}	Gate-Source Voltage	- 25	V
I_{GF}	Forward Gate Current	10	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

7

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		J309 / J310	*MMBFJ309	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

N-Channel RF Amplifier
(continued)

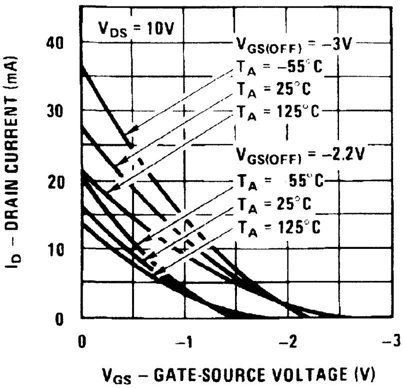
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	I_G = - 1.0 μA, V_{DS} = 0	- 25			V
I_{GSS}	Gate Reverse Current	V_{GS} = - 15 V, V_{DS} = 0 V_{GS} = - 15 V, V_{DS} = 0, T_A = 125°C			- 1.0 - 1.0	nA μA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	V_{DS} = 10 V, I_D = 1.0 nA **J309** **J310**	- 1.0 - 2.0		- 4.0 - 6.5	V V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	V_{DS} = 10 V, V_{GS} = 0 **J309** **J310**	12 24		30 60	mA mA
$V_{GS(f)}$	Gate-Source Forward Voltage	V_{DS} = 0, I_G = 1.0 mA			1.0	V
SMALL SIGNAL CHARACTERISTICS						
$Re(y_{is})$	Common-Source Input Conductance	V_{DS} = 10, I_D = 10 mA, f = 100 MHz **J309** **J310**		 0.7 0.5		 mmhos mmhos
$Re(y_{os})$	Common-Source Output Conductance	V_{DS} = 10, I_D = 10 mA, f = 100 MHz		0.25		mmhos
G_{pg}	Common-Gate Power Gain	V_{DS} = 10, I_D = 10 mA, f = 100 MHz		16		dB
$Re(y_{fs})$	Common-Source Forward Transconductance	V_{DS} = 10, I_D = 10 mA, f = 100 MHz		12		mmhos
$Re(y_{ig})$	Common-Gate Input Conductance	V_{DS} = 10, I_D = 10 mA, f = 100 MHz		12		mmhos
g_{fs}	Common-Source Forward Transconductance	V_{DS} = 10, I_D = 10 mA, f = 1.0 kHz **J309** **J310**	 10,000 8000		 20,000 18,000	 μmhos μmhos
g_{os}	Common-Source Output Conductance	V_{DS} = 10, I_D = 10 mA, f = 1.0 kHz			150	μmhos
g_{fg}	Common-Gate Forward Conductance	V_{DS} = 10, I_D = 10 mA, f = 1.0 kHz **J309** **J310**		 13,000 12,000		 μmhos μmhos
g_{og}	Common-Gate Output Conductance	V_{DS} = 10, I_D = 10 mA, f = 1.0 kHz **J309** **J310**		 100 150		 μmhos μmhos
C_{dg}	Drain-Gate Capacitance	V_{DS} = 0, V_{GS} = - 10, f = 1.0 MHz		2.0	2.5	pF
C_{sg}	Source-Gate Capacitance	V_{DS} = 0, V_{GS} = - 10, f = 1.0 MHz		4.1	5.0	pF
NF	Noise Figure	V_{DS} = 10 V, I_D = 10 mA, f = 450 MHz		3.0		dB
e_n	Equivalent Short-Circuit Input Noise Voltage	V_{DS} = 10 V, I_D = 10 mA, f = 100 Hz		6.0		$nV/\sqrt{Hz}$

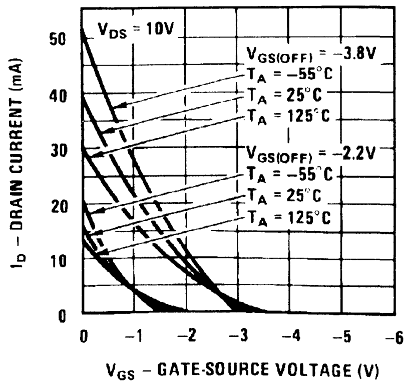
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

Typical Characteristics

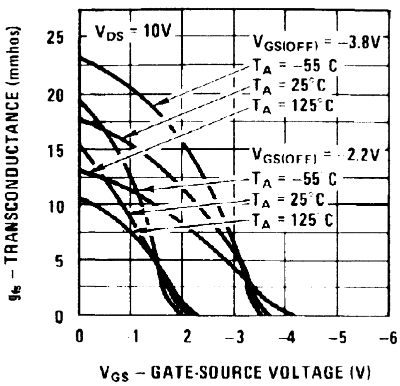
Transfer Characteristics



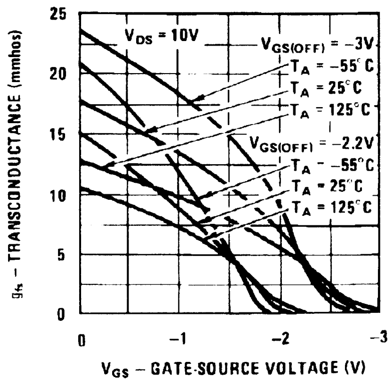
Transfer Characteristics



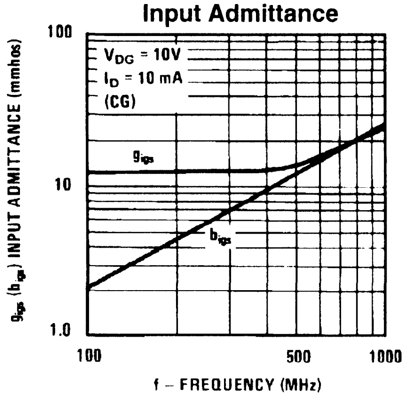
Transfer Characteristics



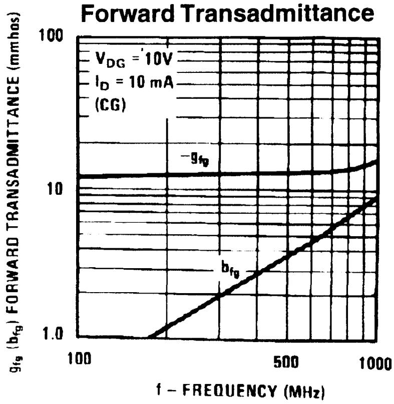
Transfer Characteristics



Input Admittance



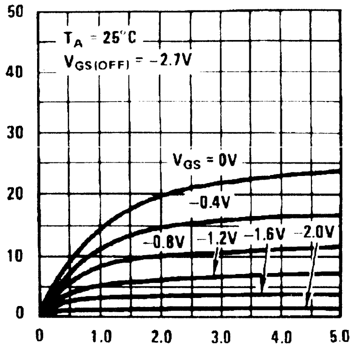
Forward Transadmittance



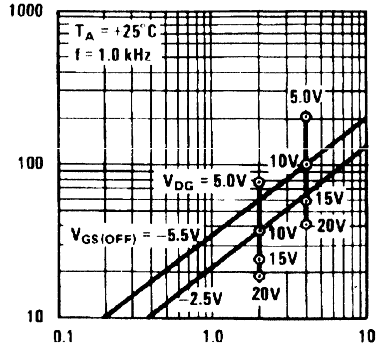
N-Channel RF Amplifier
(continued)

Typical Characteristics (continued)

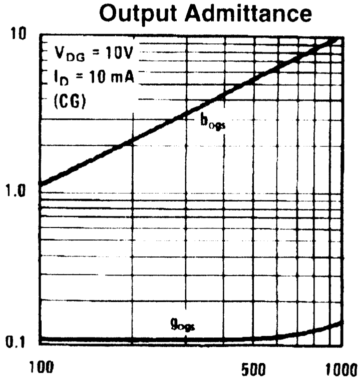
Common Drain-Source



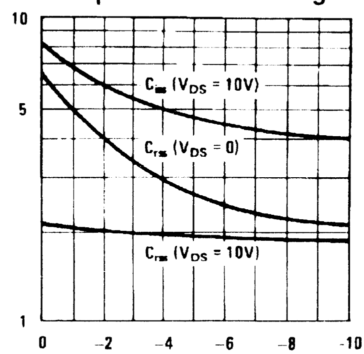
Output Conductance vs. Drain Current



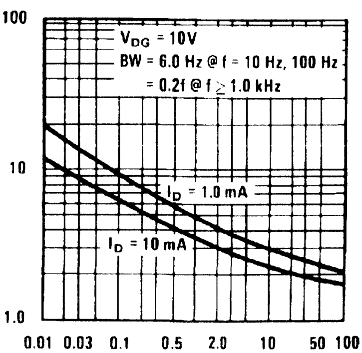
Output Admittance



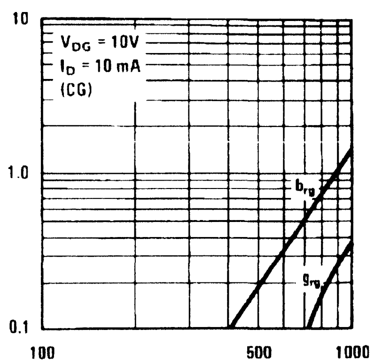
Capacitance vs. Voltage



Noise Voltage vs. Frequency

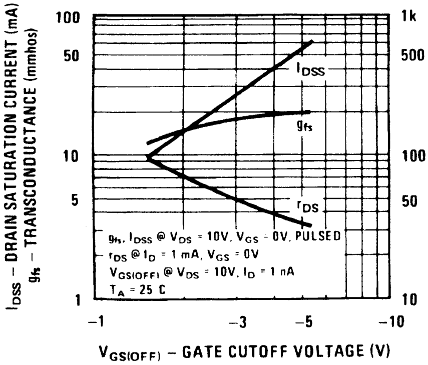


Reverse Transadmittance

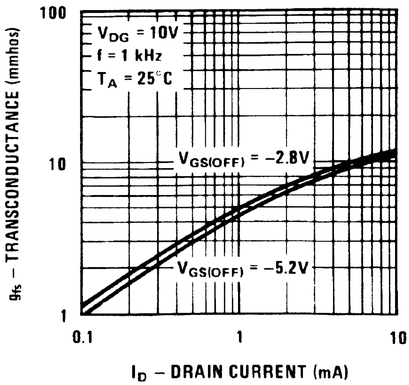


Typical Characteristics (continued)

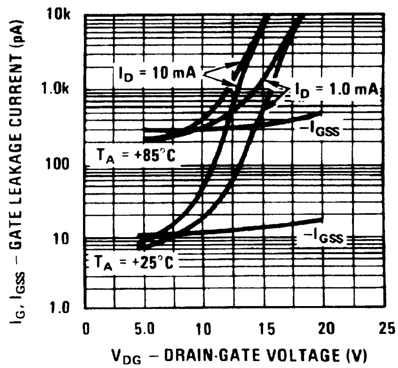
Parameter Interactions



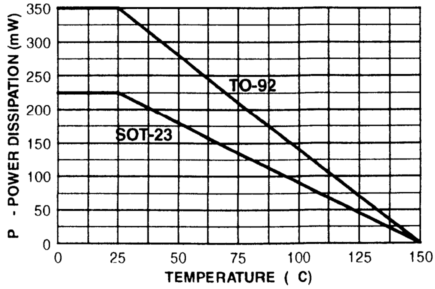
Transconductance vs. Drain Current



Leakage Current vs. Voltage



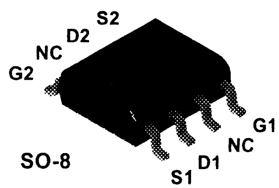
POWER DISSIPATION vs AMBIENT TEMPERATURE



National Semiconductor™

Discrete POWER & Signal Technologies

NPDS402
NPDS403
NPDS404
NPDS406



N-Channel General Purpose Dual Amplifier

Sourced from Process 98.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	50	V
V_{GS}	Gate-Source Voltage	50	V
I_{GF}	Forward Gate Current	10	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

General Purpose Dual Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

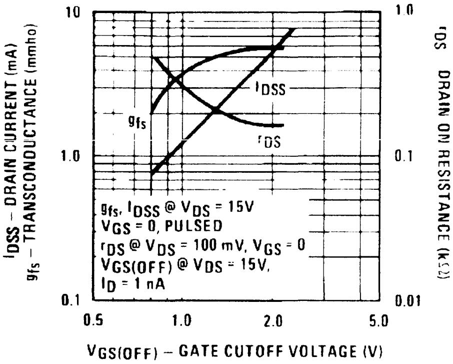
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	- 50		V
I_{GSS}	Gate Reverse Current	$V_{GS} = 30\ V$, $V_{DS} = 0$		25	pA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 15\ V$, $I_D = 1.0\ nA$	- 0.5	- 2.5	V
V_{GS}	Gate-Source Voltage	$V_{DG} = 15\ V$, $I_D = 200\ \mu A$		- 2.3	V
V_{G1-G2}	Voltage Gate 1-Gate 2	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	+/- 50		V
ON CHARACTERISTICS					
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = 10\ V$, $V_{GS} = 0$	0.5	10	mA
SMALL SIGNAL CHARACTERISTICS					
g_{fs}	Common Source Forward Transconductance	$V_{DS} = 10\ V$, $V_{GS} = 0$, $f = 1.0\ kHz$ $V_{DS} = 15\ V$, $I_D = 200 \mu A$, $f = 1.0\ kHz$	2000 1000	7000 2000	µmhos µmhos
g_{oss}	Common Source Output Conductance	$V_{DS} = 10\ V$, $V_{GS} = 0$, $f = 1.0\ kHz$		20	µmhos
g_{os}	Common Source Output Conductance	$V_{DS} = 15\ V$, $I_D = 200 \mu A$, $f = 1.0\ kHz$		2.0	µmhos
C_{iss}	Input Capacitance	$V_{DG} = 15\ V$, $I_D = 200\ \mu A$, $f = 1.0\ MHz$		8.0	pF
C_{rss}	Reverse Transfer Capacitance	$V_{DG} = 15\ V$, $I_D = 200\ \mu A$, $f = 1.0\ MHz$		3.0	pF
CMMR	Common Mode Rejection	$V_{DG} = 10$ to $20\ V$, $I_D = 200\ \mu A$	95		dB
$V_{GS1} - V_{GS2}$	Differential Match	$V_{DG} = 10\ V$, $I_D = 200\ \mu A$, **NPDS402** **NPDS403** **NPDS404** **NPDS406**		 10 10 15 40	 mV mV mV mV
$\Delta V_{GS1} - V_{GS2}$	Differential Drift	$V_{DG} = 10\ V$, $I_D = 200\ \mu A$, $T_A = -55$ to $25\ °C$ **NPDS402** **NPDS403** **NPDS404** **NPDS406** $V_{DG} = 10\ V$, $I_D = 200\ \mu A$ $T_A = 25$ to $125\ °C$ **NPDS402** **NPDS403** **NPDS404** **NPDS406**		 10 25 25 80 10 25 25 80	 µV/°C µV/°C µV/°C µV/°C µV/°C µV/°C µV/°C µV/°C

*Pulse Test: Pulse Width ≤ 300 ms, Duty Cycle ≤ 2%

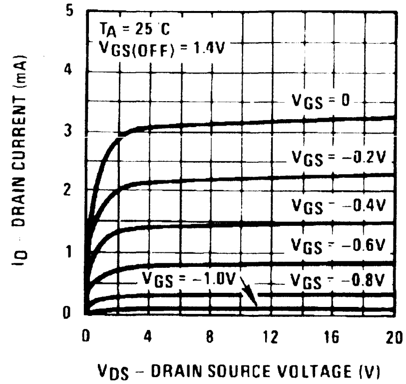
General Purpose Dual Amplifier
(continued)

Typical Characteristics (continued)

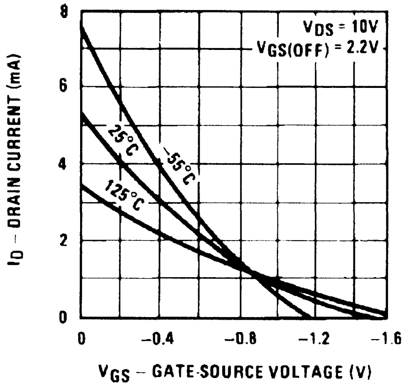
Parameter Interactions



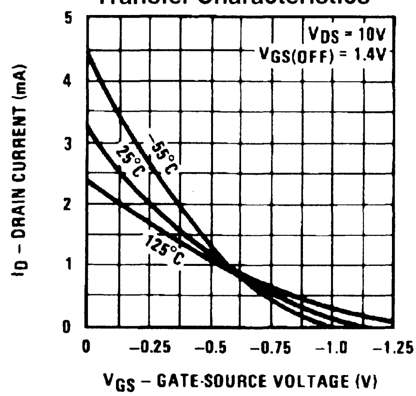
Common Drain-Source



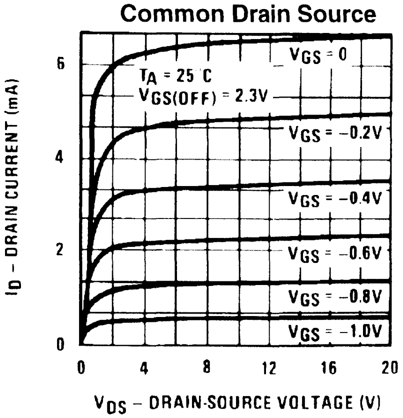
Transfer Characteristics



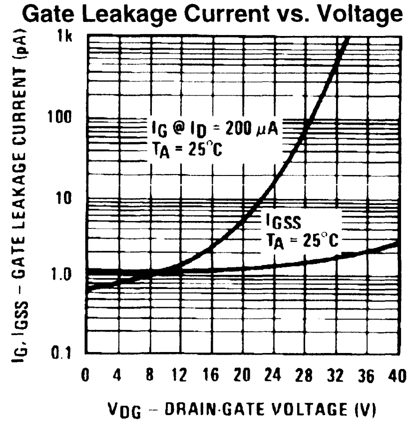
Transfer Characteristics



Common Drain Source

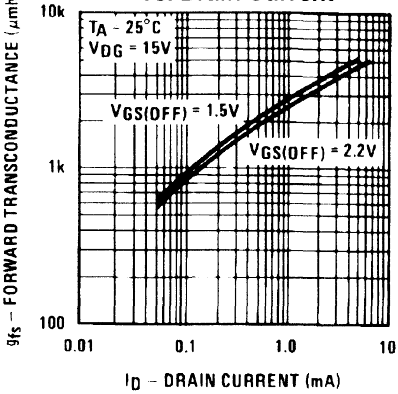


Gate Leakage Current vs. Voltage

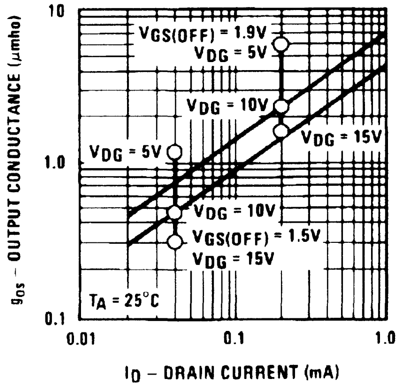


Typical Characteristics (continued)

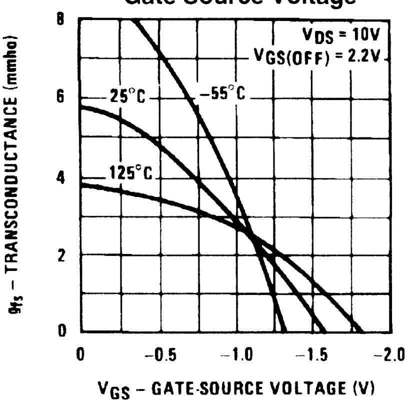
Forward Transconductance vs. Drain Current



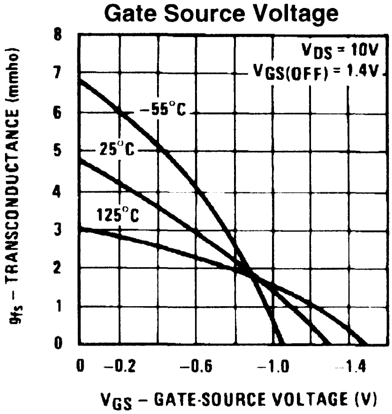
Output Conductance vs. Drain Current



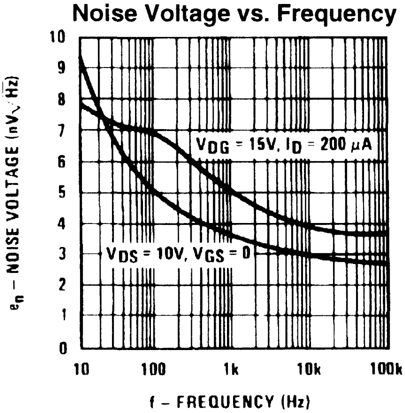
Transconductance vs. Gate Source Voltage



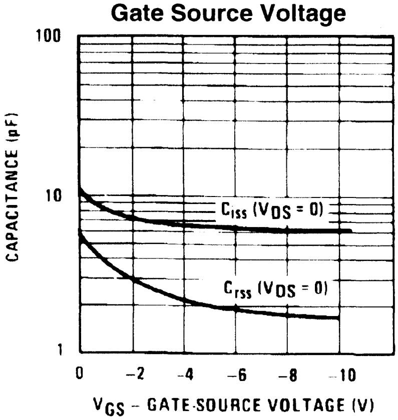
Transconductance vs. Gate Source Voltage



Noise Voltage vs. Frequency



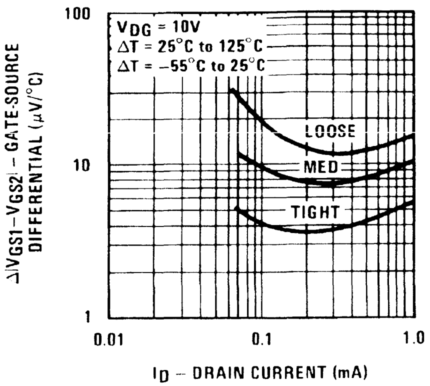
Capacitance vs. Gate Source Voltage



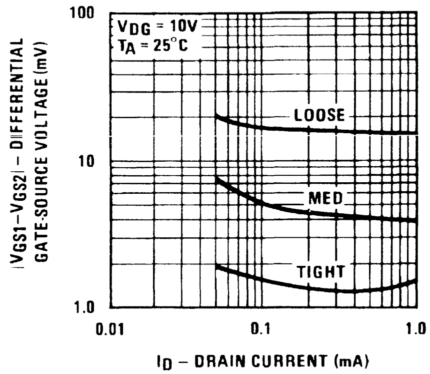
General Purpose Dual Amplifier
(continued)

Typical Characteristics (continued)

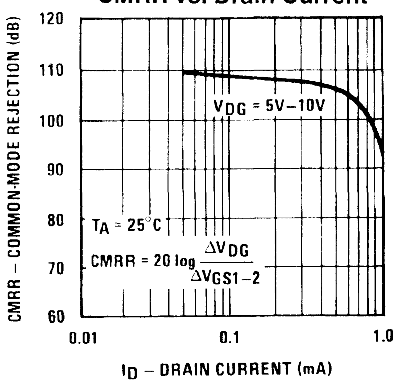
Differential Drift



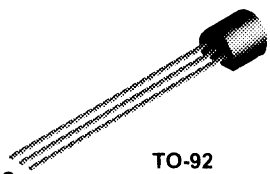
Differential Offset



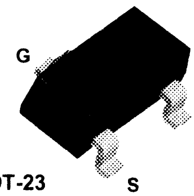
CMRR vs. Drain Current



PN4117 PN4118 PN4119 MMBF4117 MMBF4118 MMBF4119



G S D TO-92



G D SOT-23 S
Mark: 61A / 61C / 61E

N-Channel Switch

This device is designed for low current DC and audio applications. These devices provide excellent performance as input stages for sub-picoamp instrumentation or any high impedance signal sources. Sourced from Process 53.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	40	V
V_{GS}	Gate-Source Voltage	- 40	V
I_{GF}	Forward Gate Current	50	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		PN4117	*MMBF4117	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

N-Channel Switch
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

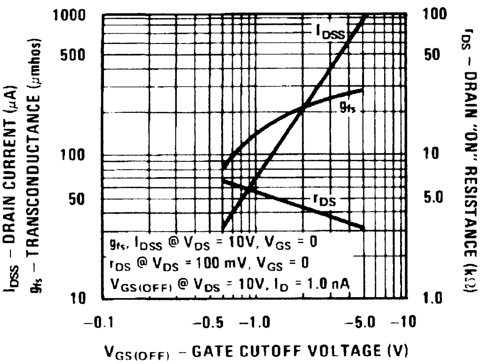
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	- 40		V
I_{GSS}	Gate Reverse Current	$V_{GS} = 20\ V$, $V_{DS} = 0$ $V_{GS} = 20\ V$, $V_{DS} = 0$, $T_A = 150°C$		- 10 - 25	pA nA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 10\ V$, $I_D = 1.0\ nA$ **PN4117** **PN4118** **PN4119**	- 0.6 - 1.0 - 2.0	- 1.8 - 3.0 - 6.0	V V V
ON CHARACTERISTICS					
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = 10\ V$, $V_{GS} = 0$ **PN4117** **PN4118** **PN4119**	30 80 200	90 240 600	µA µA µA
SMALL-SIGNAL CHARACTERISTICS					
g_{fs}	Common-Source Forward Transconductance	$V_{DS} = 10\ V$ $V_{GS} = 0$, f= 1.0 kHz **PN4117** **PN4118** **PN4119**	 70 80 100	 210 250 330	 µmhos µmhos µmhos
g_{oss}	Common-Source Output Conductance	$V_{DS} = 10\ V$ $V_{GS} = 0$, f= 1.0 kHz **PN4117** **PN4118** **PN4119**		 3.0 5.0 10	 µmhos µmhos µmhos
$Re_{(yfs)}$	Common-Source Forwad Transconductance	$V_{DS} = 10\ V$, $V_{GS} = 0$, f= 30 MHz **PN4117** **PN4118** **PN4119**	 60 70 90		 µmhos µmhos µmhos
C_{iss}	Input Capacitance	$V_{DS} = 10\ V$, $V_{GS} = 0$, f= 1.0 kHz		3.0	pF
C_{rss}	Reverse Transfer Capacitance	$V_{DS} = 10\ V$, $V_{GS} = 0$, f= 1.0 MHz,		1.5	pF

*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%

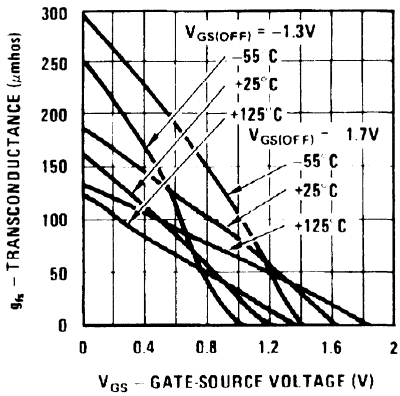
N-Channel Switch
(continued)

Typical Characteristics

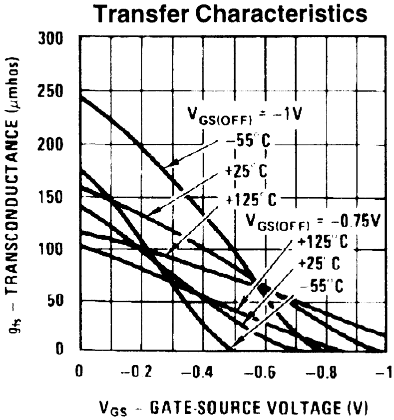
Parameter Interactions



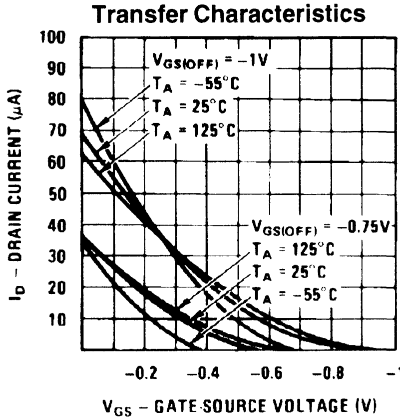
Transfer Characteristics



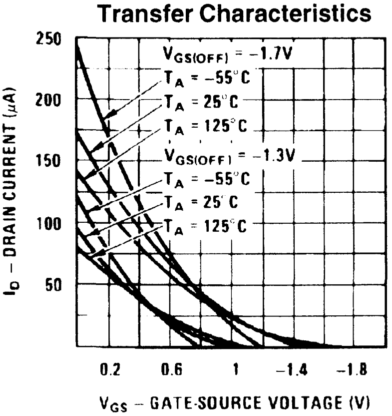
Transfer Characteristics



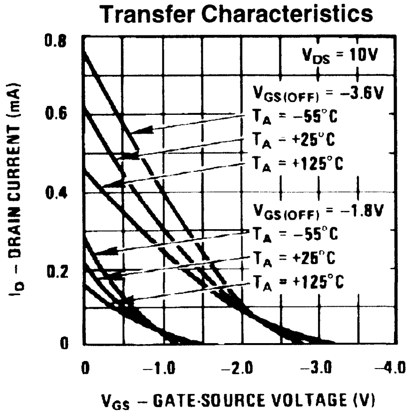
Transfer Characteristics



Transfer Characteristics



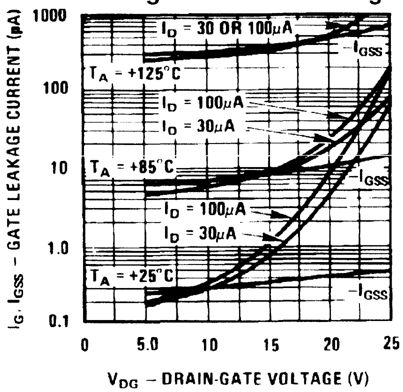
Transfer Characteristics



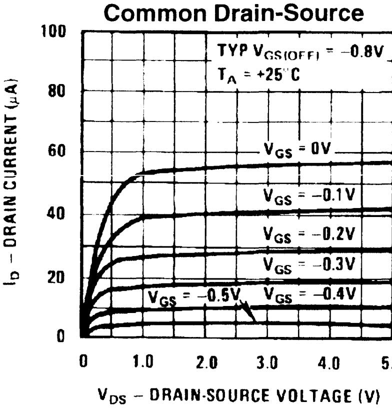
N-Channel Switch
(continued)

Typical Characteristics (continued)

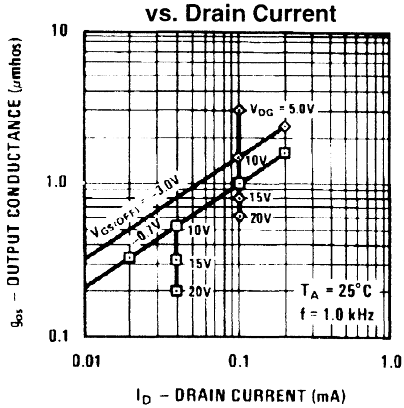
Leakage Current vs. Voltage



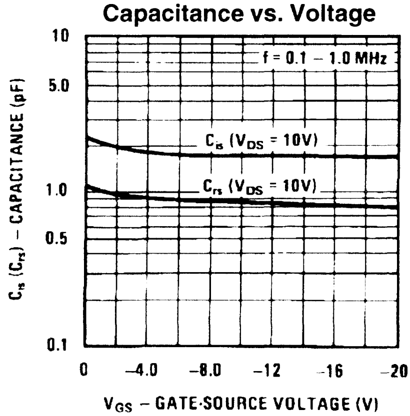
Common Drain-Source



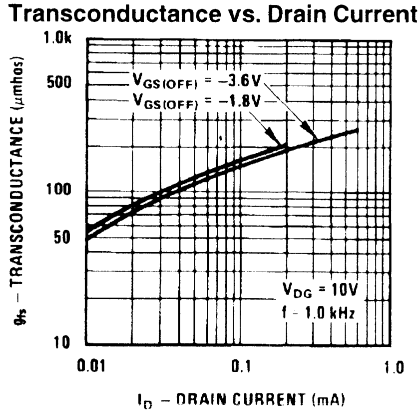
Output Conductance vs. Drain Current



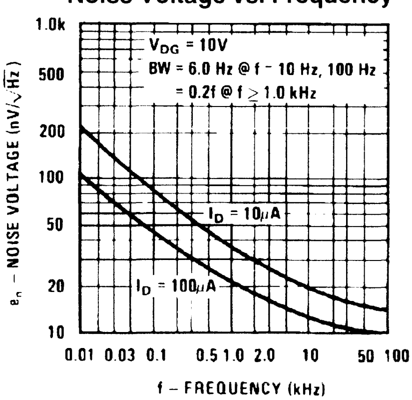
Capacitance vs. Voltage



Transconductance vs. Drain Current



Noise Voltage vs. Frequency



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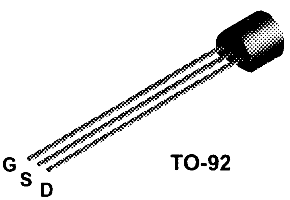
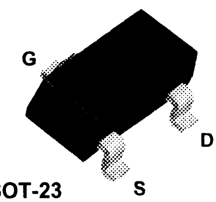
PN4391 PN4392 PN4393

MMBF4391 MMBF4392 MMBF4393



TO-92



SOT-23

Mark: 6J / 6K / 6G

N-Channel Switch

This device is designed for low level analog switching, sample and hold circuits and chopper stabalized amplifiers. Sourced from Process 51. See J111 for characteristics.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	30	V
V_{GS}	Gate-Source Voltage	- 30	V
I_{GF}	Forward Gate Current	50	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		PN4391	*MMBF4391	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

N-Channel Switch
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	I_G = 1.0 µA, V_{DS} = 0		- 30		V
I_{GSS}	Gate Reverse Current	V_{GS} = 15 V, V_{DS} = 0			- 1.0	nA
		V_{GS} = 15 V, V_{DS} = 0, T_A = 150°C			- 0.2	µA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	V_{DS} = 20 V, I_D = 1.0 nA	**PN4391**	- 4.0	- 10	V
			PN4392	- 2.0	- 5.0	V
			PN4393	- 0.5	- 3.0	V
$V_{GS(f)}$	Gate-Source Forward Voltage	I_G = 1.0 mA, V_{DS} = 0			1.0	V
$I_{D(off)}$	Drain Cutoff Leakage Current	V_{DS} = 20 V, V_{GS} = 12 V	**PN4391**		0.1	nA
		V_{DS} = 20 V, V_{GS} = 7.0 V	**PN4392**		0.1	nA
		V_{DS} = 20 V, V_{GS} = 5.0 V	**PN4393**		0.1	nA
		V_{DS} = 20 V, V_{GS} = 12 V, T_A = 150°C	**PN4391**		0.2	µA
		V_{DS} = 20 V, V_{GS} = 7.0 V, T_A = 150°C	**PN4392**		0.2	µA
		V_{DS} = 20 V, V_{GS} = 5.0 V, T_A = 150°C	**PN4393**		0.2	µA
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	V_{DS} = 20 V, V_{GS} = 0	**PN4391**	50	150	mA
			PN4392	25	75	mA
			PN4393	5.0	30	mA
$V_{DS(on)}$	Drain-Source On Voltage	I_D = 12 mA, V_{GS} = 0	**PN4391**		0.4	V
		I_D = 6.0 mA, V_{GS} = 0	**PN4392**		0.4	V
		I_D = 3.0 mA, V_{GS} = 0	**PN4393**		0.4	V
$r_{DS(on)}$	Drain-Source On Resistance	I_D = 1.0 mA, V_{GS} = 0	**PN4391**		30	Ω
			PN4392		60	Ω
			PN4393		100	Ω
SMALL-SIGNAL CHARACTERISTICS						
$r_{ds(on)}$	Drain-Source On Resistance	V_{DS} = V_{GS} = 0, f= 1.0 kHz	**PN4391**		30	Ω
			PN4392		60	Ω
			PN4393		100	Ω
C_{iss}	Input Capacitance	V_{DS} = 20, V_{GS} = 0, f = 1.0 MHz			14	pF
C_{rss}	Reverse Transfer Capacitance	V_{GS} = 12 V, f = 1.0 MHz	**PN4391**		3.5	pF
		V_{GS} = 7.0 V, f = 1.0 MHz	**PN4392**		3.5	pF
		V_{GS} = 5.0 V, f = 1.0 MHz	**PN4393**		3.5	pF
SWITCHING CHARACTERISTICS						
t_r	Rise Time	$I_{D(on)}$ = 12 mA	**PN4391**		5.0	ns
		$I_{D(on)}$ = 6.0 mA	**PN4392**		5.0	ns
		$I_{D(on)}$ = 3.0 mA	**PN4393**		5.0	ns
t_f	Fall Time	$V_{GS(off)}$ = 12 mA	**PN4391**		15	ns
		$V_{GS(off)}$ = 6.0 mA	**PN4392**		20	ns
		$V_{GS(off)}$ = 3.0 mA	**PN4393**		30	ns
t_{on}	Turn-On Time	$I_{D(on)}$ = 12 mA	**PN4391**		15	ns
		$I_{D(on)}$ = 6.0 mA	**PN4392**		15	ns
		$I_{D(on)}$ = 3.0 mA	**PN4393**		15	ns
t_{off}	Turn-Off Time	$V_{GS(off)}$ = 12 mA	**PN4391**		20	ns
		$V_{GS(off)}$ = 6.0 mA	**PN4392**		35	ns
		$V_{GS(off)}$ = 3.0 mA	**PN4393**		50	ns

*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%

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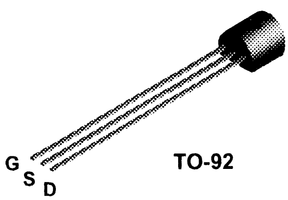
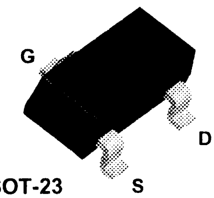
2N5457 MMBF5457
2N5458 MMBF5458
2N5459 MMBF5459



TO-92



SOT-23

Mark: 6D / 61S / 6L

N-Channel General Purpose Amplifier

This device is a low level audio amplifier and switching transistors, and can be used for analog switching applications. Sourced from Process 55.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	25	V
V_{GS}	Gate-Source Voltage	- 25	V
I_{GF}	Forward Gate Current	10	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N5457	*MMBF5457	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

N-Channel General Purpose Amplifier
(continued)

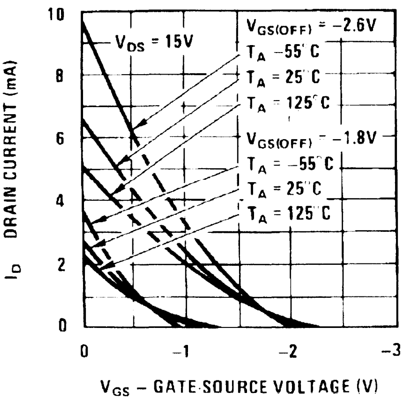
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 10\ \mu A$, $V_{DS} = 0$	- 25			V
I_{GSS}	Gate Reverse Current	$V_{GS} = -15\ V$, $V_{DS} = 0$			- 1.0	nA
		$V_{GS} = -15\ V$, $V_{DS} = 0$, $T_A = 100°C$			- 200	nA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 15\ V$, $I_D = 10\ nA$ **2N5457**	- 0.5		- 6.0	V
		2N5458	- 1.0		- 7.0	V
		2N5459	- 2.0		- 8.0	V
V_{GS}	Gate-Source Voltage	$V_{DS} = 15\ V$, $I_D = 100\ \mu A$ **2N5457**		- 2.5		V
		$V_{DS} = 15\ V$, $I_D = 200\ \mu A$ **2N5458**		- 3.5		V
		$V_{DS} = 15\ V$, $I_D = 400\ \mu A$ **2N5459**		- 4.5		V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = 15\ V$, $V_{GS} = 0$ **2N5457**	1.0	3.0	5.0	mA
		2N5458	2.0	6.0	9.0	mA
		2N5459	4.0	9.0	16	mA
SMALL SIGNAL CHARACTERISTICS						
g_{fs}	Forward Transfer Conductance*	$V_{DS} = 15\ V$, $V_{GS} = 0$, $f = 1.0\ kHz$				
		2N5457	1000		5000	μmhos
		2N5458	1500		5500	μmhos
		2N5459	2000		6000	μmhos
g_{os}	Output Conductance*	$V_{DS} = 15\ V$, $V_{GS} = 0$, $f = 1.0\ kHz$		10	50	μmhos
C_{iss}	Input Capacitance	$V_{DS} = 15\ V$, $V_{GS} = 0$, $f = 1.0\ MHz$		4.5	7.0	pF
C_{rss}	Reverse Transfer Capacitance	$V_{DS} = 15\ V$, $V_{GS} = 0$, $f = 1.0\ MHz$		1.5	3.0	pF
NF	Noise Figure	$V_{DS} = 15\ V$, $V_{GS} = 0$, $f = 1.0\ kHz$, $R_G = 1.0$ megohm, $BW = 1.0\ Hz$			3.0	dB

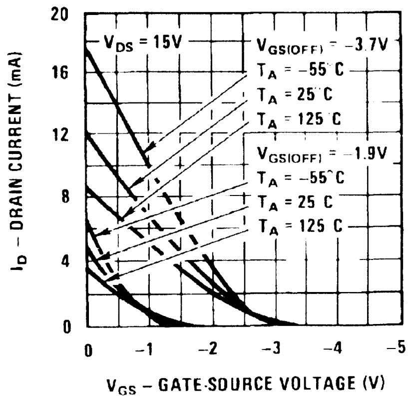
*Pulse Test: Pulse Width < 300 ms, Duty Cycle ≤ 2%

Typical Characteristics

Transfer Characteristics



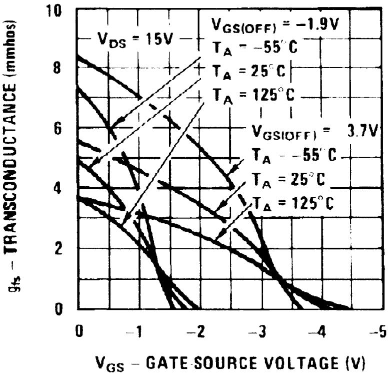
Transfer Characteristics



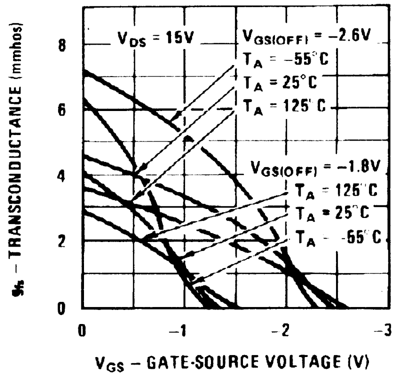
N-Channel General Purpose Amplifier
(continued)

Typical Characteristics (continued)

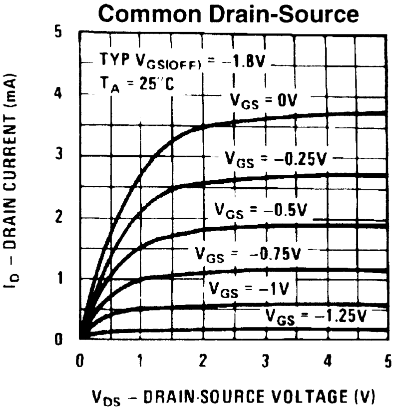
Transfer Characteristics



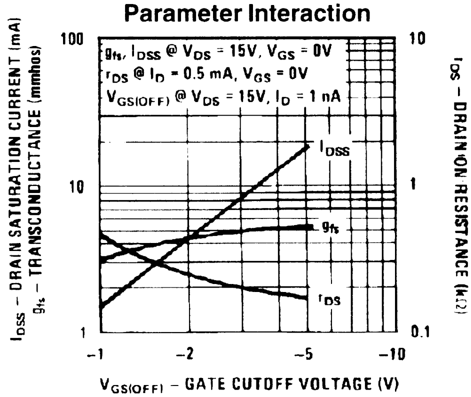
Transfer Characteristics



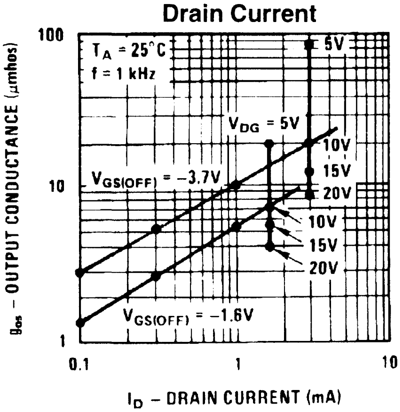
Common Drain-Source



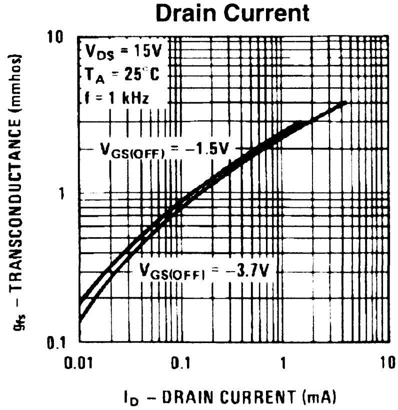
Parameter Interaction



Output Conductance vs. Drain Current



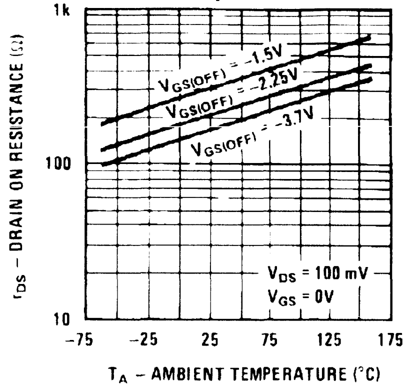
Transconductance vs. Drain Current



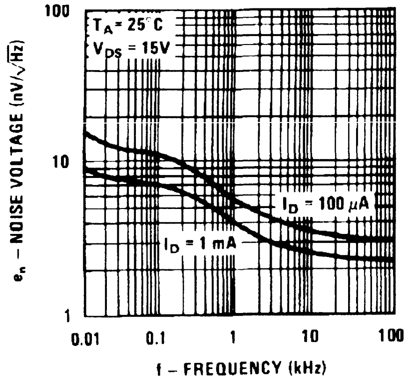
N-Channel General Purpose Amplifier
(continued)

Typical Characteristics (continued)

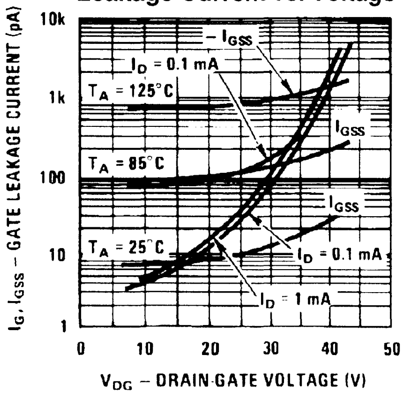
Channel Resistance vs. Temperature



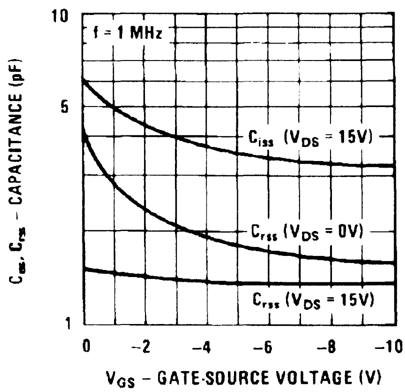
Noise Voltage vs. Frequency



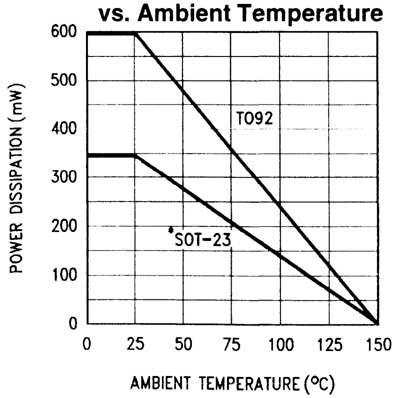
Leakage Current vs. Voltage



Capacitance vs. Voltage

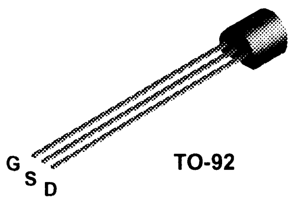


Maximum Power Dissipation vs. Ambient Temperature

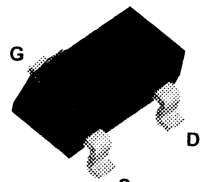


National Semiconductor™

2N5460 2N5461 2N5462 MMBF5460 MMBF5461



TO-92



SOT-23
Mark: 6E / 61U

P-Channel General Purpose Amplifier

This device is designed primarily for low level audio and general purpose applications with high impedance signal sources. Sourced from Process 89.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	- 40	V
V_{GS}	Gate-Source Voltage	40	V
I_{GF}	Forward Gate Current	10	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N5460	*MMBF5460	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

P-Channel General Purpose Amplifier
(continued)

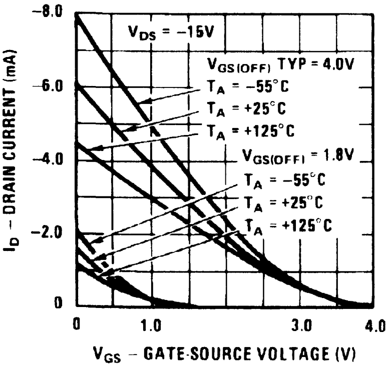
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 10\ \mu A$, $V_{DS} = 0$	40			V
I_{GSS}	Gate Reverse Current	$V_{GS} = 20$ V, $V_{DS} = 0$			5.0	nA
		$V_{GS} = 20$ V, $V_{DS} = 0$, $T_A = 100°C$			1.0	µA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 15$ V, $I_D = 1.0\ \mu A$ **2N5460**	0.75		6.0	V
		2N5461	1.0		7.5	V
		2N5462	1.8		9.0	V
V_{GS}	Gate-Source Voltage	$V_{DS} = 15$ V, $I_D = 0.1$ mA **2N5460**	0.5		4.0	V
		$V_{DS} = 15$ V, $I_D = 0.2$ mA **2N5461**	0.8		4.5	V
		$V_{DS} = 15$ V, $I_D = 0.4$ mA **2N5462**	1.5		6.0	V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = 15$ V, $V_{GS} = 0$ **2N5460**	- 1.0		- 5.0	mA
		2N5461	- 2.0		- 9.0	mA
		2N5462	- 4.0		- 16	mA
SMALL SIGNAL CHARACTERISTICS						
g_{fs}	Forward Transfer Conductance	$V_{DS} = 15$, $V_{GS} = 0$, f = 1.0 kHz				
		2N5460	1000		4000	µmhos
		2N5461	1500		5000	µmhos
		2N5462	2000		6000	µmhos
g_{os}	Output Conductance	$V_{DS} = 15$, $V_{GS} = 0$, f = 1.0 kHz			75	µmhos
C_{iss}	Input Capacitance	$V_{DS} = 15$, $V_{GS} = 0$, f = 1.0 MHz		5.0	7.0	pF
C_{rss}	Reverse Transfer Capacitance	$V_{DS} = 15$, $V_{GS} = 0$, f = 1.0 MHz		1.0	2.0	pF
NF	Noise Figure	$V_{DS} = 15$ V, $V_{GS} = 0$, $R_G = 1.0$ megohm, f = 100 Hz, BW = 1.0 Hz		1.0	2.5	dB
e_n	Equivalent Short-Circuit Input Noise Voltage	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 100 Hz, BW = 1.0 Hz		60	115	$nV/\sqrt{Hz}$

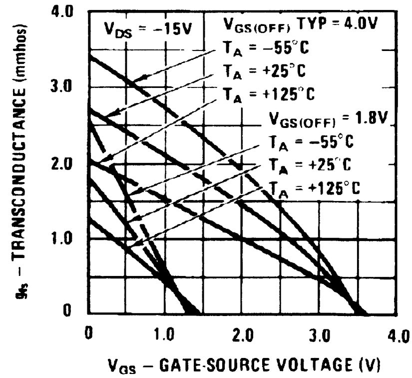
*Pulse Test: Pulse Width ≤ 300 ms, Duty Cycle ≤ 2%

Typical Characteristics (continued)

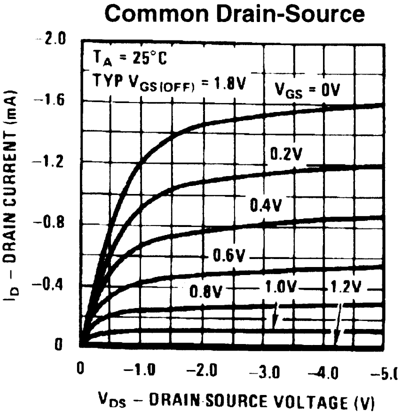
Transfer Characteristics



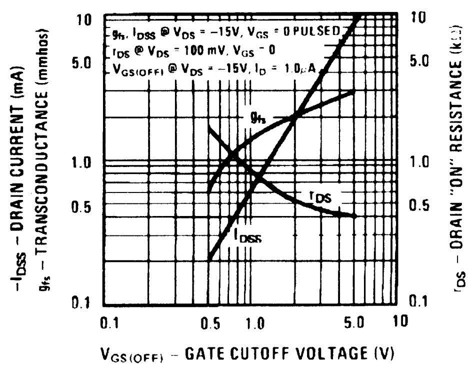
Transfer Charactersitics



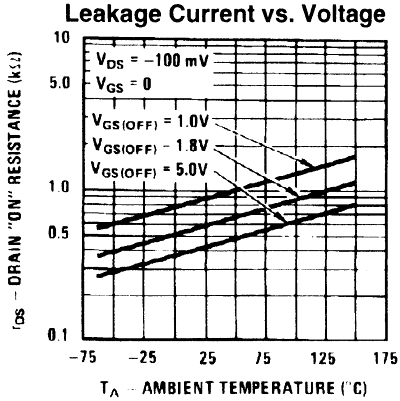
Common Drain-Source



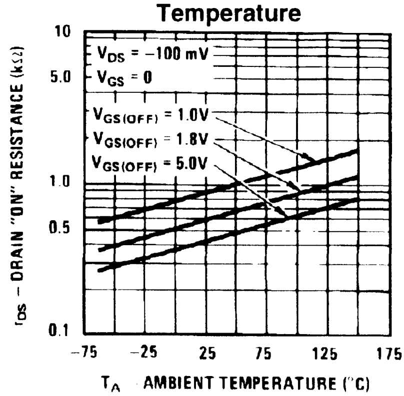
Parameter Interactions



Leakage Current vs. Voltage



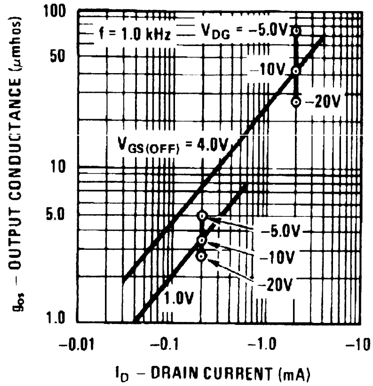
Channel Resistance vs. Temperature



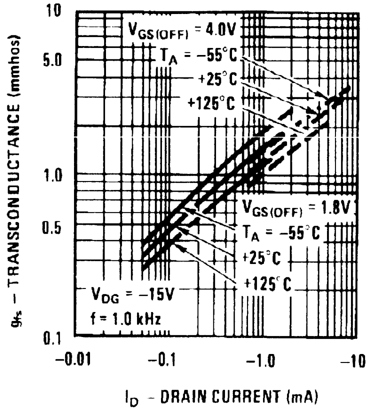
P-Channel General Purpose Amplifier
(continued)

Typical Characteristics (continued)

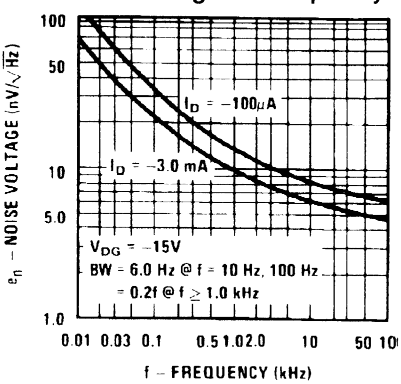
Output Conductance vs. Drain Current



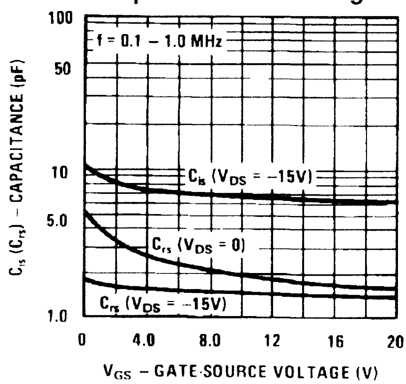
Transconductance vs. Drain Current



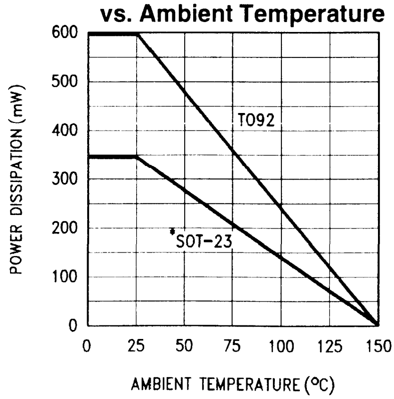
Noise Voltage vs. Frequency



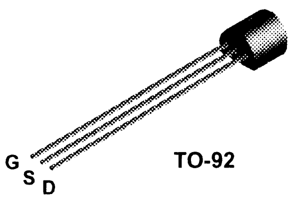
Capacitance vs. Voltage

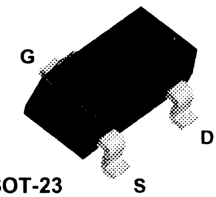


Maximum Power Dissipation vs. Ambient Temperature



2N5484 2N5485 2N5486 MMBF5484 MMBF5485 MMBF5486





SOT-23
Mark: 6B / 6M / 6H

N-Channel RF Amplifier

This device is designed primarily for electronic switching applications such as low On Resistance analog switching. Sourced from Process 50.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	25	V
V_{GS}	Gate-Source Voltage	- 25	V
I_{GF}	Forward Gate Current	10	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N5484	*MMBF5484	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	225 1.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

N-Channel RF Amplifier
(continued)

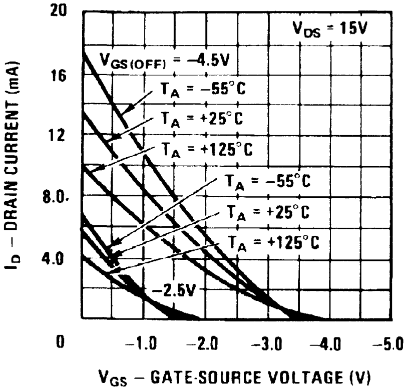
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	I_G = - 1.0 µA, V_{DS} = 0	- 25			V
I_{GSS}	Gate Reverse Current	V_{GS} = - 20 V, V_{DS} = 0 V_{GS} = - 20 V, V_{DS} = 0, T_A = 100°C			- 1.0 - 0.2	nA µA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	V_{DS} = 15 V, I_D = 10 nA **2N5484** **2N5485** **2N5486**	- 0.3 - 0.5 - 2.0		- 3.0 - 4.0 - 6.0	V V V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current*	V_{DS} = 15 V, V_{GS} = 0 **2N5484** **2N5485** **2N5486**	1.0 4.0 8.0		5.0 10 20	mA mA mA
SMALL SIGNAL CHARACTERISTICS						
g_{fs}	Forward Transfer Conductance	V_{DS} = 15, V_{GS} = 0, f = 1.0 kHz **2N5484** **2N5485** **2N5486**	 3000 3500 4000		 6000 7000 8000	 µmhos µmhos µmhos
$Re(y_{is})$	Input Conductance	V_{DS} = 15, V_{GS} = 0, f = 100 MHz **2N5484** V_{DS} = 15, V_{GS} = 0, f = 400 MHz **2N5485 / 2N5486**			 100 1000	 µmhos µmhos
g_{os}	Output Conductance	V_{DS} = 15, V_{GS} = 0, f = 1.0 kHz **2N5484** **2N5485** **2N5486**			 50 60 75	 µmhos µmhos µmhos
$Re(y_{os})$	Output Conductance	V_{DS} = 15, V_{GS} = 0, f = 100 MHz **2N5484** V_{DS} = 15, V_{GS} = 0, f = 400 MHz **2N5485 / 2N5486**			 75 100	 µmhos µmhos
$Re(y_{fs})$	Forward Transconductance	V_{DS} = 15, V_{GS} = 0, f = 100 MHz **2N5484** V_{DS} = 15, V_{GS} = 0, f = 400 MHz **2N5485** **2N5486**	 2500 3000 3500			 µmhos µmhos µmhos
C_{iss}	Input Capacitance	V_{DS} = 15, V_{GS} = 0, f = 1.0 MHz			5.0	pF
C_{rss}	Reverse Transfer Capacitance	V_{DS} = 15, V_{GS} = 0, f = 1.0 MHz			1.0	pF
C_{oss}	Output Capacitance	V_{DS} = 15, V_{GS} = 0, f = 1.0 MHz			2.0	pF
NF	Noise Figure	V_{DS}= 15 V, R_G = 1.0 kΩ, f = 100 MHz **2N5484** V_{DS}= 15 V, R_G = 1.0 kΩ, f = 400 MHz **2N5484** V_{DS}= 15 V , R_G = 1.0 kΩ, f = 100 MHz **2N5485 / 2N5486** V_{DS}= 15 V, R_G = 1.0 kΩ, f = 400 MHz **2N5485 / 2N5486**		 4.0 	 3.0 2.0 4.0	 dB dB dB dB

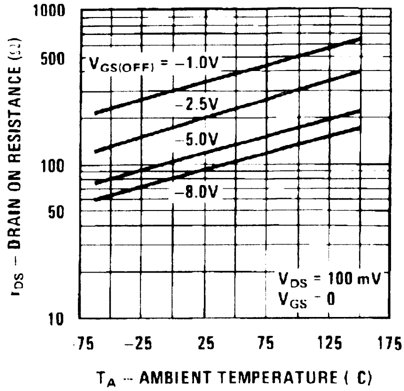
*Pulse Test: Pulse Width ≤ 300 ms, Duty Cycle ≤ 2%

Typical Characteristics

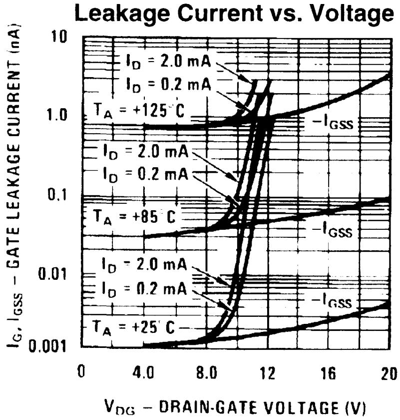
Transfer Characteristics



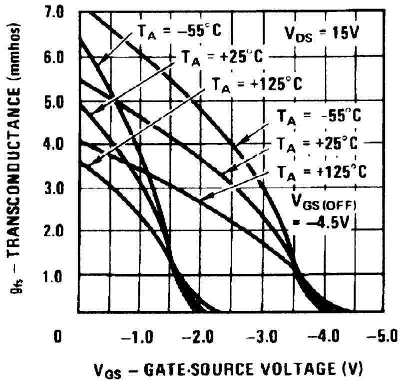
Channel Resistance vs. Temperature



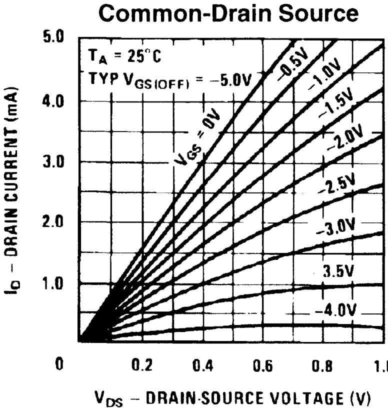
Leakage Current vs. Voltage



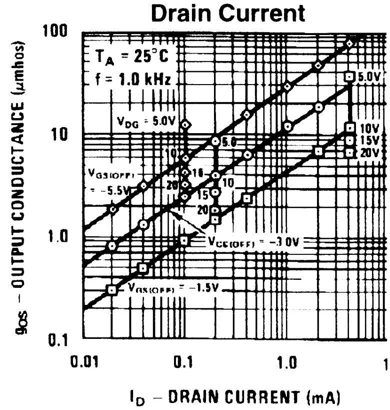
Transconductance



Common-Drain Source



Output Conductance vs. Drain Current

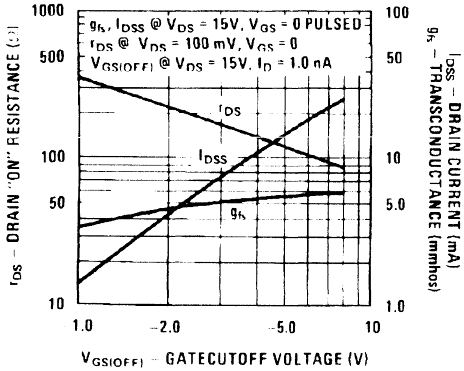


N-Channel RF Amplifier

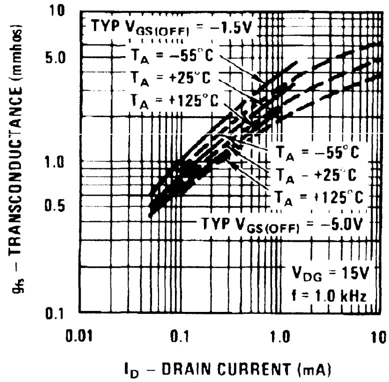
(continued)

Typical Characteristics (continued)

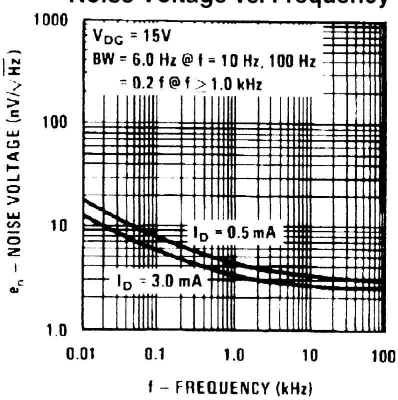
Parameter Interactions



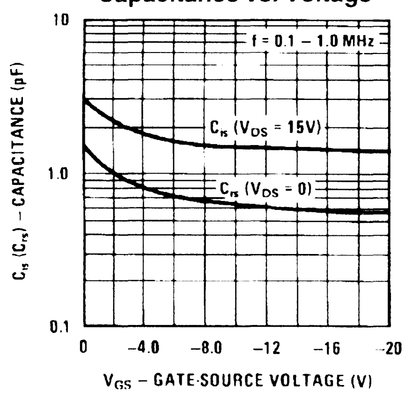
Transconductance vs. Drain Current



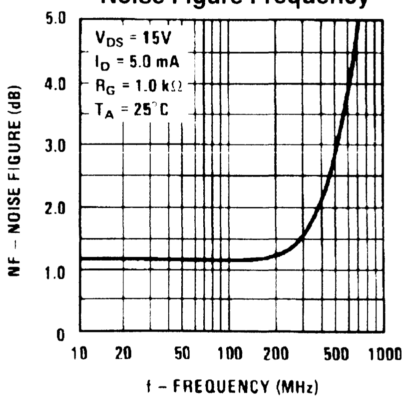
Noise Voltage vs. Frequency



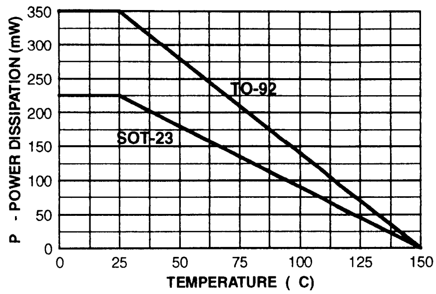
Capacitance vs. Voltage



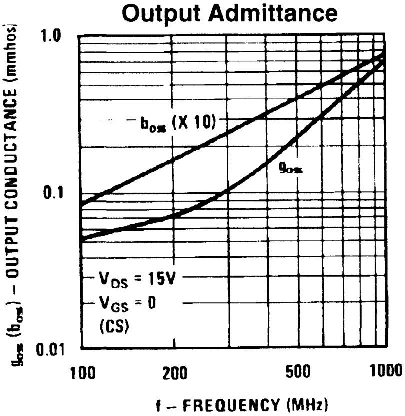
Noise Figure Frequency

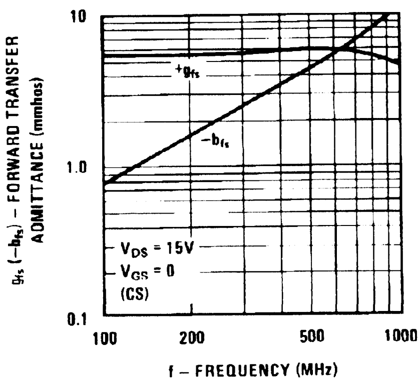


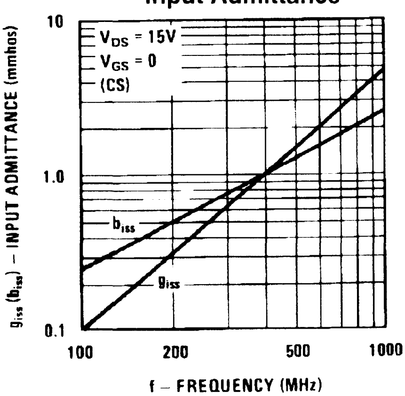
Typical Characteristics (continued)

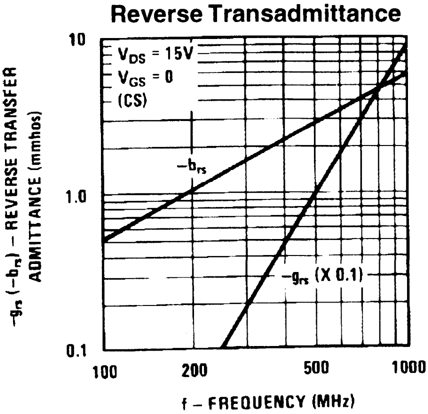


Common Source Characteristics









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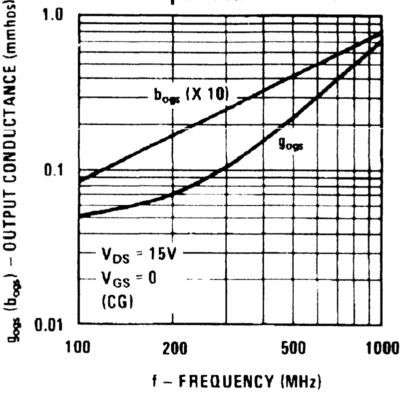
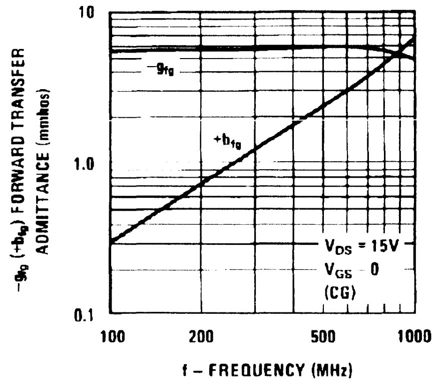
N-Channel RF Amplifier
(continued)

Common Gate Characteristics

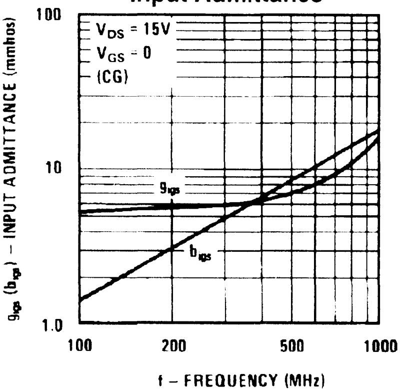
Output Admittance



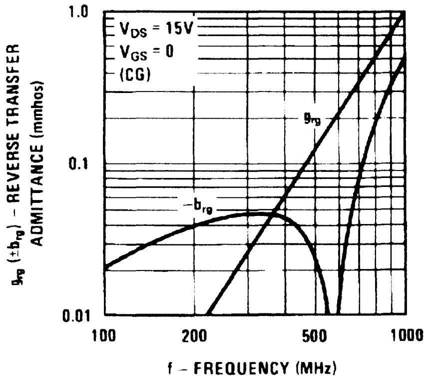
Forward Transadmittance



Input Admittance



Reverse Transadmittance



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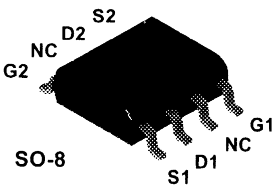
NPDS5565
NPDS5566



N-Channel General Purpose Dual Amplifier

Sourced from Process 96.

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	40	V
V_{GS}	Gate-Source Voltage	40	V
I_{GF}	Gate Current	10	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

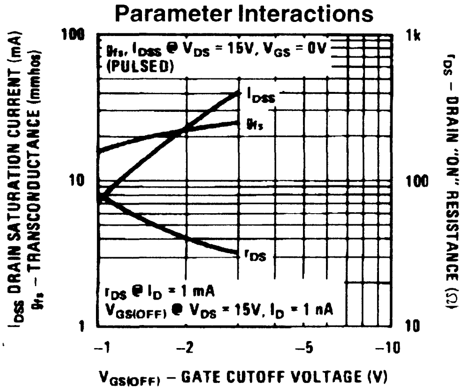
NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

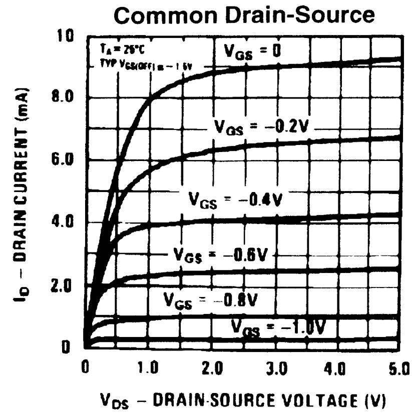
General Purpose Dual Amplifier
(continued)

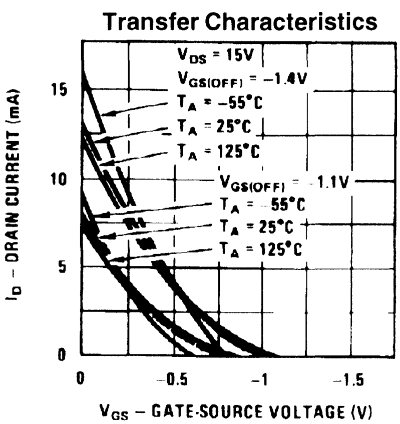
Electrical Characteristics
TA = 25°C unless otherwise noted

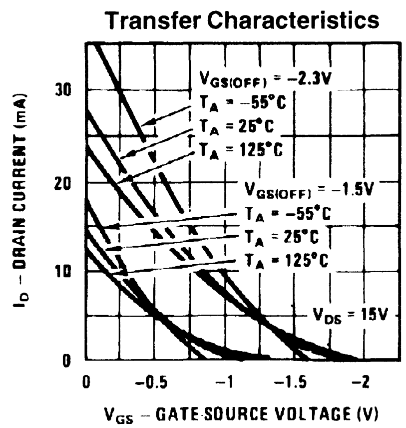
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	- 40		V
I_{GSS}	Gate Reverse Current	$V_{GS} = 20$ V, $V_{DS} = 0$ $V_{GS} = 20$ V, $V_{DS} = 0$, $T_A = 150$ °C		100 200	pA µA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 15$ V, $I_D = 1.0$ nA	- 0.5	- 3.0	V
$V_{GS(f)}$	Forward Gate-Source Voltage	$V_{DS} = 0$, $I_D = 2.0$ mA		1.0	V
V_{G1-G2}	Voltage Gate 1 - Gate 2	$V_{DS} = 0$, $I_G = +/- 1.0\ \mu A$	+ / - 40		V
ON CHARACTERISTICS					
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = 15$ V, $V_{GS} = 0$	5.0	30	mA
$r_{DS(on)}$	Drain-Source On Resistance	$I_D = 1.0$ mA, $V_{GS} = 0$		100	Ω
SMALL SIGNAL CHARACTERISTICS					
g_{fs}	Common Source Forward Transconductance	$V_{DS} = 15$ V, $I_D = 2.0$mA, f = 1.0 kHz $V_{DS} = 15$ V, $I_D = 2.0$ mA, f = 100 MHz	7500 7000	12,500	µmhos µmhos
g_{oss}	Common Source Output Conductance	$V_{DS} = 15$ V, $I_D = 2.0$mA, f = 1.0 kHz		45	µmhos
C_{iss}	Input Capacitance	$V_{DG} = 15$ V, $I_D = 2.0$mA, f = 1.0MHz		12	pF
C_{rss}	Reverse Transfer Capacitance	$V_{DS} = 15$ V, $I_D = 2.0$mA, f = 1.0 kHz		3.0	pF
e_n	Equivalent Short-Circuit Input Noise Voltage	$V_{DG} = 15$ V, $I_D = 2.0$ mA, f = 10 Hz		50	nV/$\sqrt{Hz}$
NF	Noise Figure	$V_{DG} = 15$ V, $I_D = 2.0$ mA, f = 10 Hz $R_G = 1.0$ mΩ		1.0	dB
$I_{DSS1} - I_{DSS2}$	I_{DSS} Match	$V_{DS} = 15$ V, $V_{GS} = 0$		5.0	%
$g_{fs1} - g_{fs2}$	g_{fs} Match	$V_{DS} = 15$ V, $I_D = 2.0$mA, f = 1.0 kHz		10	%
$V_{GS1} - V_{GS2}$	Differential Match	$V_{DG} = 15$ V, $I_D = 2.0$ mA, **NPDS5565** **NPDS5566**		 10 20	 mV mV
$\Delta V_{GS1} - V_{GS2}$	Differential Drift	$V_{DS} = 10$ V, $V_{GS} = 0$, f = 1.0 kHz $T_A = 25$ to 125 °C **NPDS5565** **NPDS5566** $V_{DG} = 15$ V, $I_D = 2.0$ mA, $T_A = -55$ to 25 °C **NPDS5565** **NPDS5566**		 25 50 25 50	 µV/°C µV/°C µV/°C µV/°C

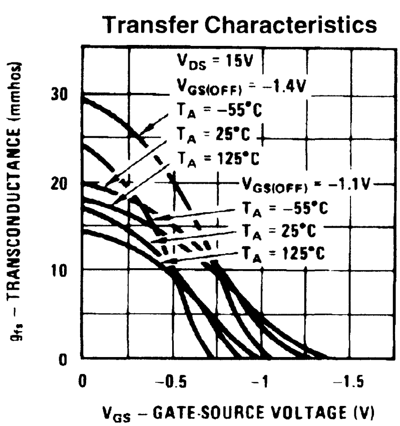
Typical Characteristics (continued)

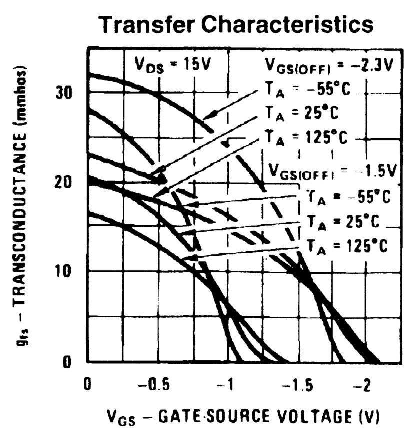








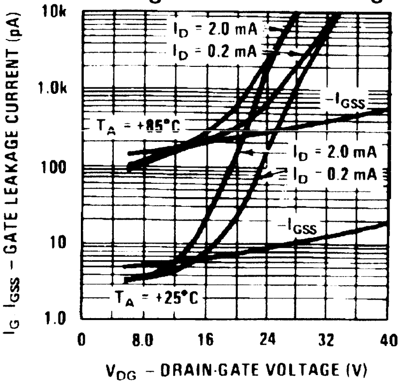




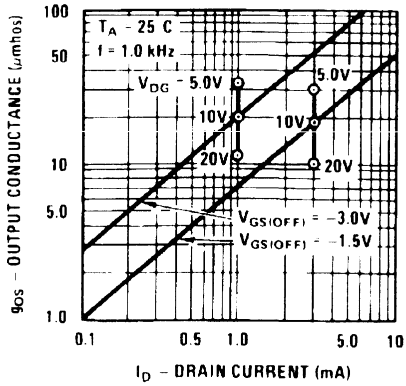
General Purpose Dual Amplifier
(continued)

Typical Characteristics (continued)

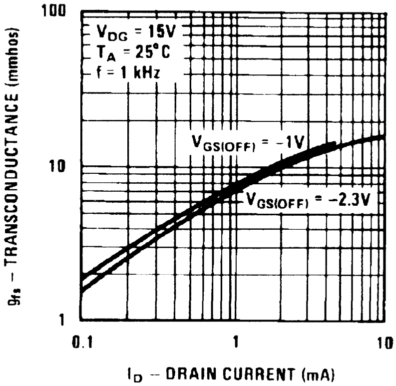
Leakage Current vs. Voltage



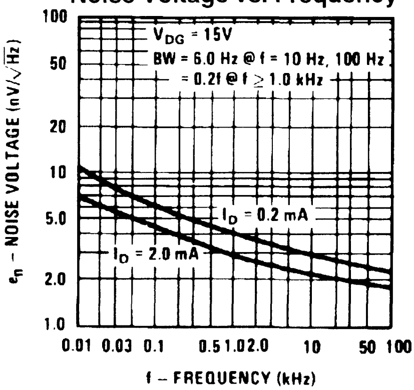
Output Conductance vs. Drain Current



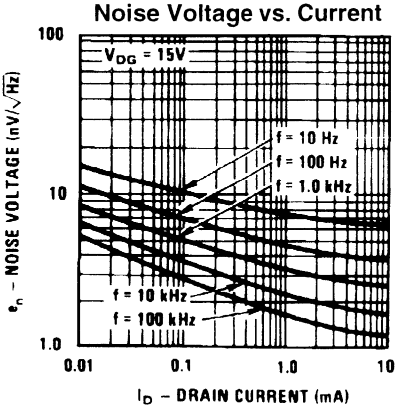
Transconductance vs. Drain Current



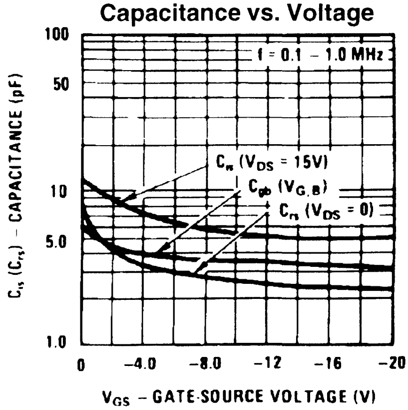
Noise Voltage vs. Frequency



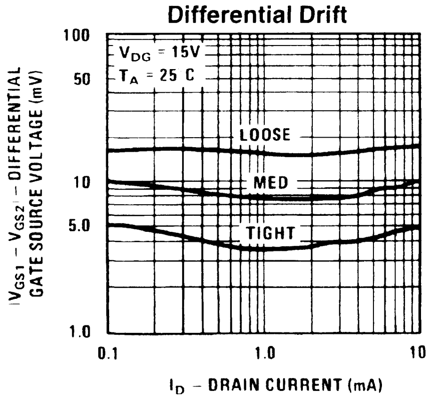
Noise Voltage vs. Current

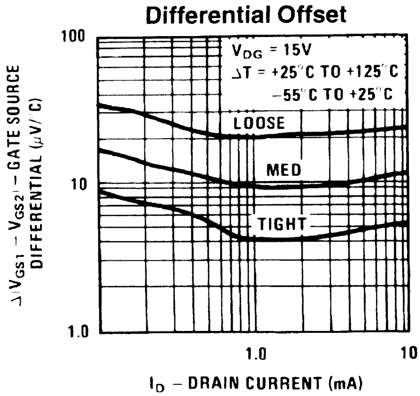


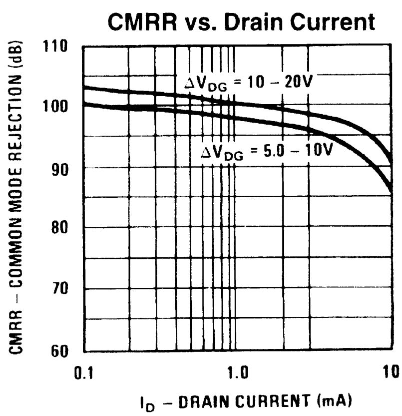
Capacitance vs. Voltage



Typical Characteristics (continued)







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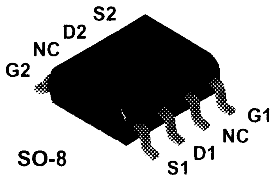
NPDS5911
NPDS5912



N-Channel General Purpose Dual Amplifier

Sourced from Process 93.

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	25	V
V_{GS}	Gate-Source Voltage	25	V
I_{GF}	Forward Gate Current	10	mA
T_J ,T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

General Purpose Dual Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

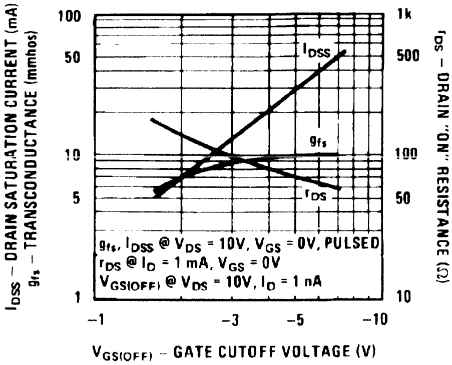
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	- 25		V
I_{GSS}	Gate Reverse Current	$V_{GS} = 15\ V$, $V_{DS} = 0$ $V_{GS} = 15\ V$, $V_{DS} = 0$, $T_A = 150\ °C$		100 250	pA nA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 10\ V$, $I_D = 1.0\ nA$	- 1.0	- 5.0	V
V_{GS}	Gate-Source Voltage	$V_{DG} = 10\ V$, $I_D = 5.0\ mA$	- 0.3	- 4.0	V
V_{G1-G2}	Voltage Gate 1 - Gate 2	$V_{DS} = 0$, $I_G = +/- 1.0\ \mu A$	+/- 25		V
ON CHARACTERISTICS					
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = 10\ V$, $V_{GS} = 0$	7.0	40	mA
SMALL SIGNAL CHARACTERISTICS					
g_{fs}	Common Source Forward Transconductance	$V_{DS} = 10\ V$, $I_D = 5.0mA$, $f = 1.0\ kHz$ $V_{DS} = 10\ V$, $I_D = 5.0\ mA$, $f = 100\ MHz$	5000 5000	10,000 10,000	μmhos μmhos
g_{oss}	Common Source Output Conductance	$V_{DS} = 10\ V$, $I_D = 5.0mA$, $f = 1.0\ kHz$ $V_{DS} = 10V$, $I_D = 5.0mA$, $f = 100\ MHz$		100 150	μmhos μmhos
C_{iss}	Input Capacitance	$V_{DG} = 10\ V$, $I_D = 5.0mA$, $f = 1.0\ MHz$		5.0	pF
C_{rss}	Reverse Transfer Capacitance	$V_{DS} = 10\ V$, $I_D = 5.0mA$, $f = 1.0\ kHz$		1.2	pF
e_n	Equivalent Short-Circuit Input Noise Voltage	$V_{DG} = 10\ V$, $I_D = 5.0\ mA$, $f = 10\ kHz$		20	$nV/\sqrt{Hz}$
NF	Noise Figure	$V_{DG} = 10\ V$, $I_D = 5.0\ mA$, $f = 10\ kHz$ $R_G = 100\ k\Omega$		1.0	dB
$I_{DSS1} - I_{DSS2}$	I_{DSS} Match	$V_{DS} = 10\ V$, $V_{GS} = 0$		5.0	%
$g_{fs1} - g_{fs2}$	g_{fs} Match	$V_{DS} = 10\ V$, $I_D = 5.0mA$, $f = 1.0\ kHz$		5.0	%
$g_{oss1} - g_{oss2}$	g_{oss} Match	$V_{DS} = 10\ V$, $I_D = 5.0mA$, $f = 1.0\ kHz$		20	μmhos
$I_{G1} - I_{G2}$	I_G Match	$V_{DS} = 10\ V$, $I_D = 5.0mA$, $T_A = 125°C$		20	nA
$V_{GS1} - V_{GS2}$	Differential Match	$V_{DG} = 10\ V$, $I_D = 5.0\ mA$, **NPDS5911** **NPDS5912**		 10 15	 mV mV
$\Delta V_{GS1} - V_{GS2}$	Differential Drift	$V_{DG} = 10\ V$, $V_{GS} = 0$, $I_D = 5.0\ mA$, $T_A = 25$ to $125\ °C$ **NPDS5911** **NPDS5912** $V_{DG} = 10\ V$, $I_D = 5.0\ mA$, $T_A = -55$ to $25\ °C$ **NPDS5911** **NPDS5912**		 20 40 20 40	 μV/°C μV/°C μV/°C μV/°C

*Pulse Test: Pulse Width ≤ 300 ms, Duty Cycle ≤ 2%

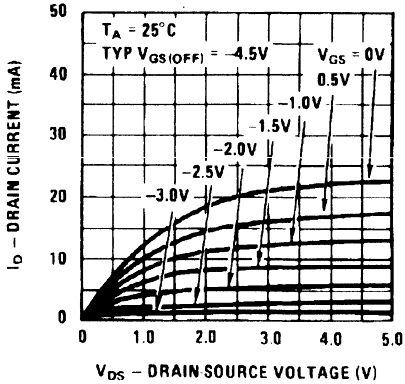
General Purpose Dual Amplifier
(continued)

Typical Characteristics (continued)

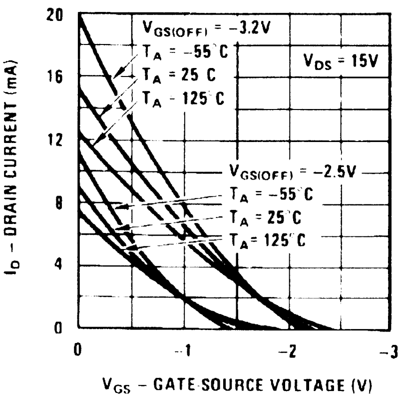
Parameter Interactions



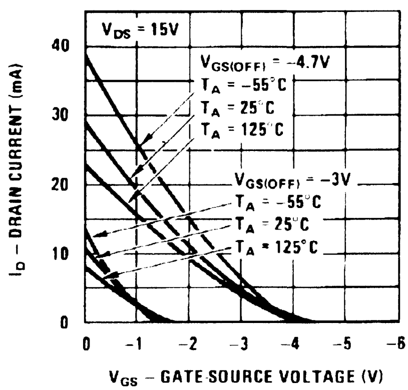
Common Drain-Source



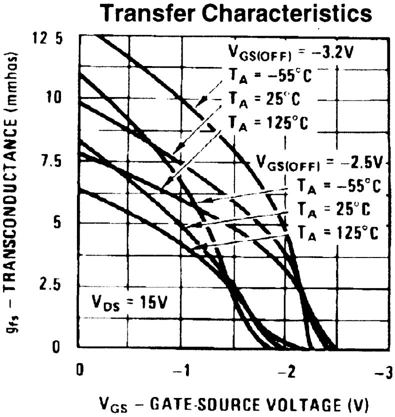
Transfer Characteristics



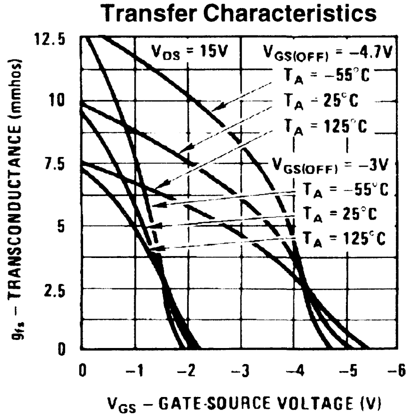
Transfer Characteristics



Transfer Characteristics

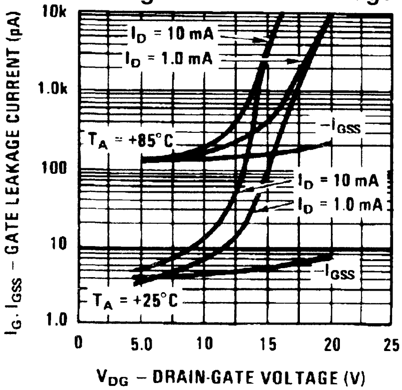


Transfer Characteristics

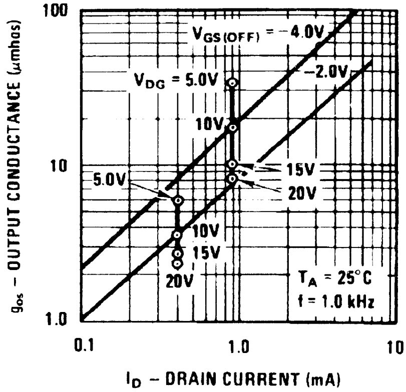


Typical Characteristics (continued)

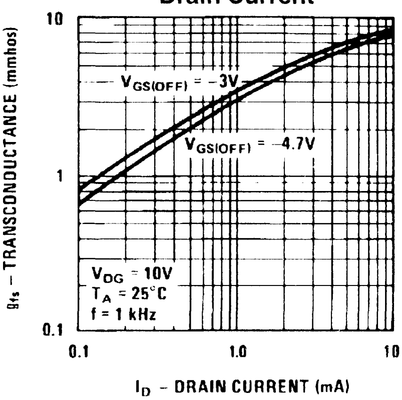
Leakage Current vs. Voltage



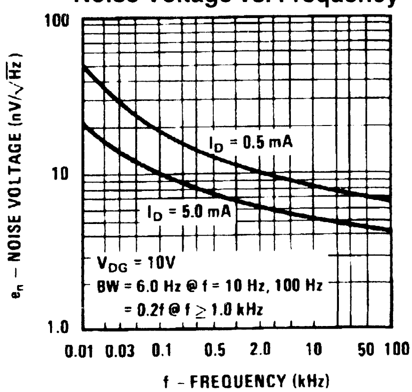
Output Conductance vs. Drain Current



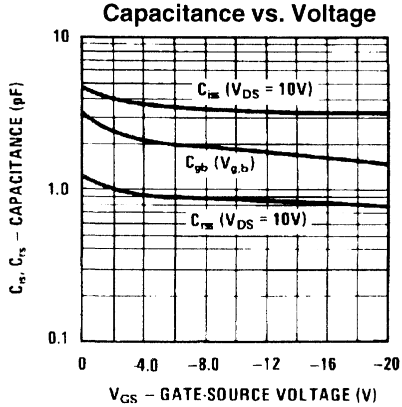
Transconductance vs. Drain Current



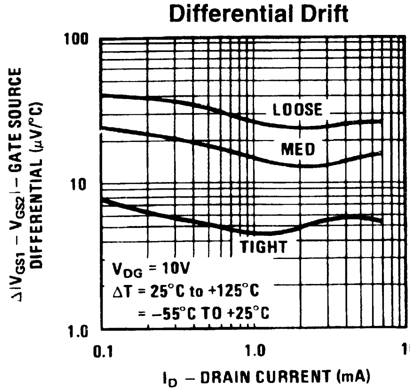
Noise Voltage vs. Frequency



Capacitance vs. Voltage



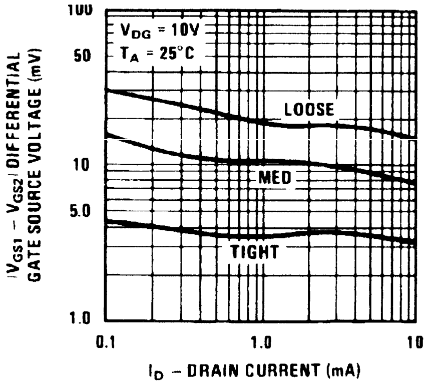
Differential Drift



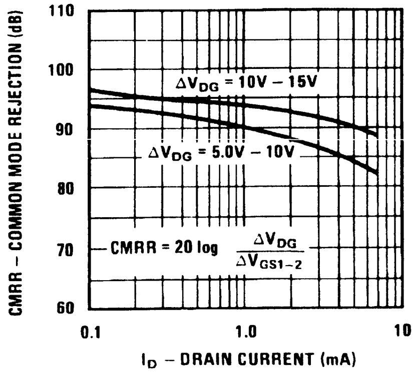
General Purpose Dual Amplifier
(continued)

Typical Characteristics (continued)

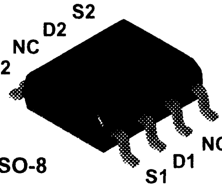
Differential Offset



CMRR vs. Drain Current



NPDS8301
NPDS8302
NPDS8303



N-Channel General Purpose Dual Amplifier

Sourced from Process 83.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	40	V
V_{GS}	Gate-Source Voltage	40	V
I_{GF}	Forward Gate Current	10	mA
T_J , T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

General Purpose Dual Amplifier
(continued)

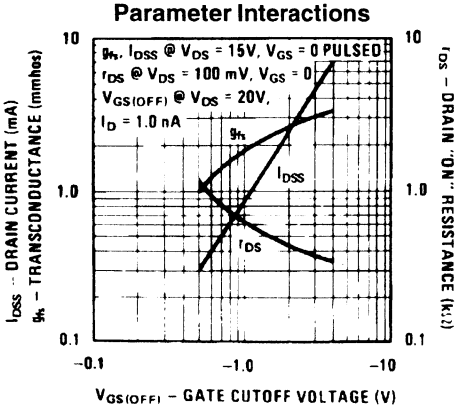
Electrical Characteristics
TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	- 40		V
I_{GSS}	Gate Reverse Current	$V_{GS} = 20\ V$, $V_{DS} = 0$		100	pA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 20\ V$, $I_D = 1.0\ nA$	- 0.5	- 3.5	V
V_{GS}	Gate-Source Voltage	$V_{DS} = 20\ V$, $I_D = 200\ \mu A$	- 0.3	- 3.5	V
ON CHARACTERISTICS					
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = 20\ V$, $V_{GS} = 0$	0.5	6.0	mA
SMALL SIGNAL CHARACTERISTICS					
g_{fs}	Common Source Forward Transconductance	$V_{DS} = 20\ V$, $V_{GS} = 0$, $f = 1.0\ kHz$	1000	4000	μmhos
		$V_{DS} = 20\ V$, $I_D = 200\ \mu A$, $f = 1.0\ kHz$	700	1200	μmhos
g_{oss}	Common Source Output Conductance	$V_{DS} = 20\ V$, $I_D = 200\ \mu A$, $f = 1.0\ kHz$		20	μmhos
g_{os}	Common Source Output Conductance	$V_{DS} = 20\ V$, $I_D = 200\ \mu A$, $f = 1.0\ kHz$		5.0	μmhos
$V_{GS1} - V_{GS2}$	Differential Match	$V_{DG} = 20\ V$, $I_D = 200\ \mu A$, **NPDS8301**		5.0	mV
		NPDS8302		10	mV
		NPDS8303		15	mV
$\Delta V_{GS1} - V_{GS2}$	Differential Drift	$V_{DS} = 20\ V$, $I_D = 200\ \mu A$, $T_A = 25$ to $85\ ^\circ C$ **NPDS8301**		10	μV/°C
		NPDS8302		15	μV/°C
		NPDS8303		25	μV/°C

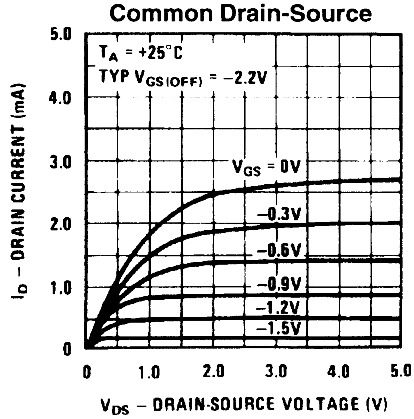
*Pulse Test: Pulse Width ≤ 300 ms, Duty Cycle ≤ 2%

Typical Characteristics

Parameter Interactions

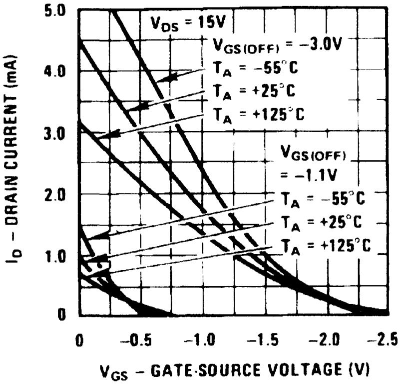


Common Drain-Source

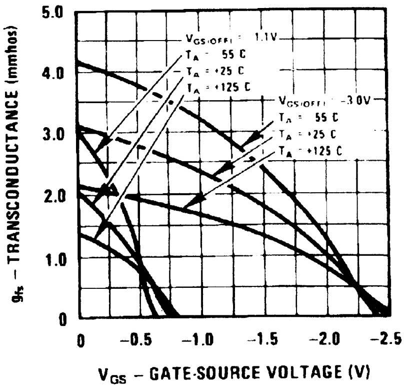


Typical Characteristics (continued)

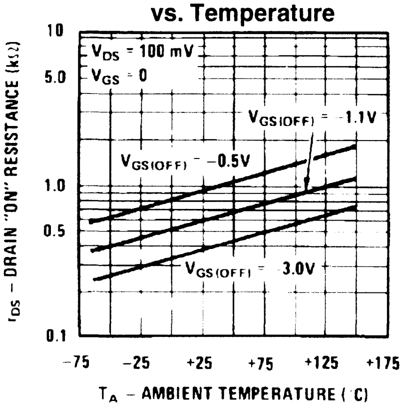
Transfer Characteristics



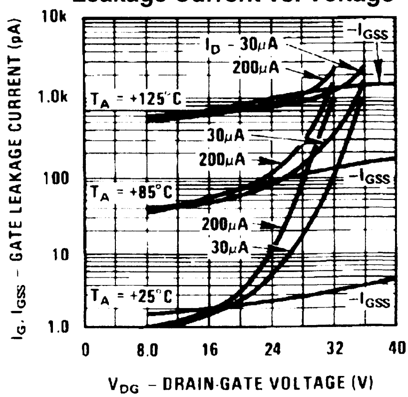
Transfer Characteristics



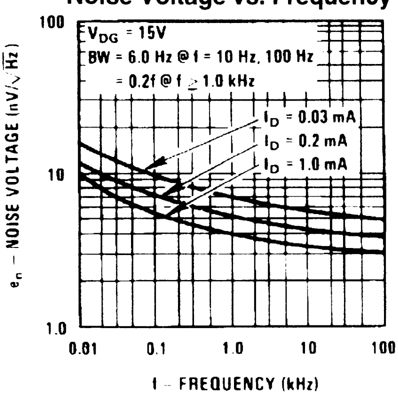
Channel Resistance vs. Temperature



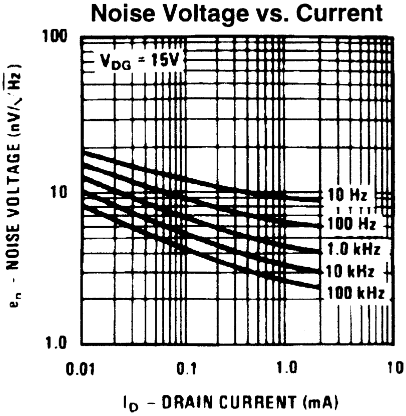
Leakage Current vs. Voltage



Noise Voltage vs. Frequency



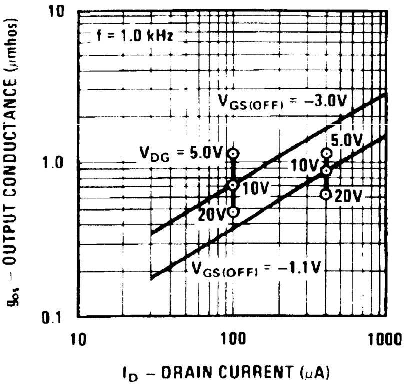
Noise Voltage vs. Current



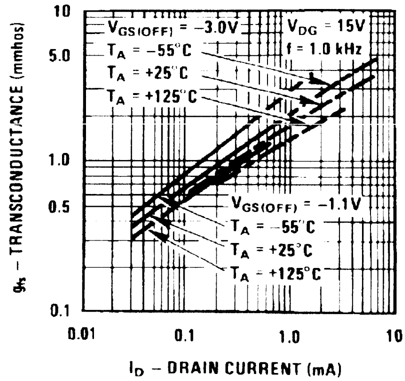
General Purpose Dual Amplifier
(continued)

Typical Characteristics (continued)

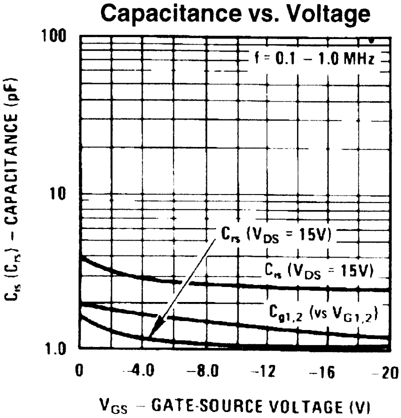
Output Conductance vs. Drain Current



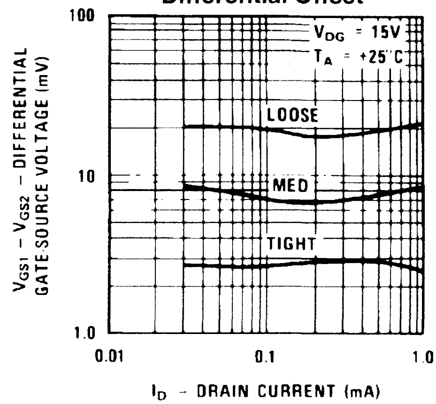
Transconductance vs. Drain Current



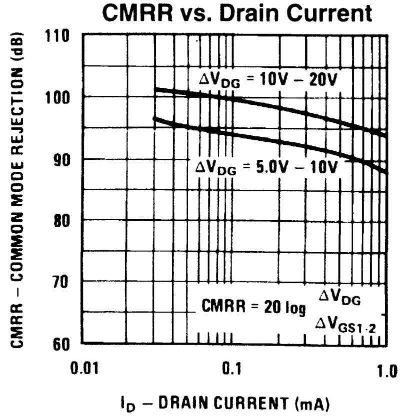
Capacitance vs. Voltage



Differential Offset



CMRR vs. Drain Current



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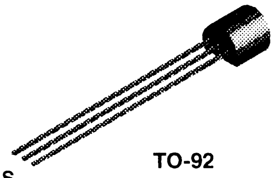
TIS73
TIS74



N-Channel General Purpose Amplifier

This device is designed for low level analog switching, sample and hold circuits and chopper stabalized amplifiers. Sourced from Process 54.

Absolute Maximum Ratings*
TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{DG}	Drain-Gate Voltage	30	V
V_{GS}	Gate-Source Voltage	- 30	V
I_{GF}	Forward Gate Current	10	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

7

Thermal Characteristics
TA = 25°C unless otherwise noted

Symbol	Characteristic	Max	Units
		TIS73 / TIS74	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	°C/W

N-Channel General Purpose Amplifier
(continued)

Electrical Characteristics
TA = 25°C unless otherwise noted

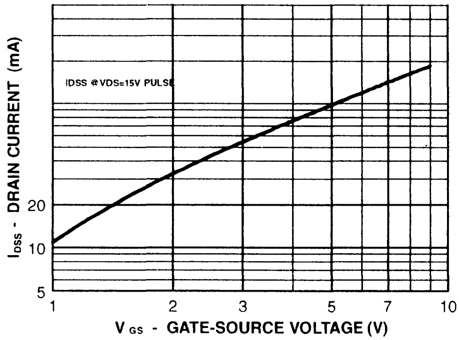
Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	- 30		V
I_{GSS}	Gate Reverse Current	$V_{GS} = 15$ V, $V_{DS} = 0$ $V_{GS} = 15$ V, $V_{DS} = 0$, $T_A = 100°C$		- 2.0 - 5.0	nA µA
$I_{D(off)}$	Drain Cutoff Leakage Current	$V_{DS} = 15$ V, $V_{GS} = 10$ V $V_{DS} = 15$ V, $V_{GS} = 10$ V, $T_A = 100°C$		- 2.0 - 5.0	nA µA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 15$ V, $I_D = 4.0$ nA **TIS73** **TIS74**	- 4.0 - 2.0	- 10 - 6.0	V V
ON CHARACTERISTICS					
I_{DSS}	Zero-Gate Voltage Drain Current*	$V_{DS} = 15$ V, $V_{GS} = 0$	50 20	 100	mA mA
$r_{DS(on)}$	Drain-Source On Resistance	$V_{DS} \leq 0.1$ V, $V_{GS} = 0$, **TIS73** f = 1.0 kHz **TIS74**		25 40	Ω Ω
SMALL-SIGNAL CHARACTERISTICS					
C_{iss}	Input Capacitance	$V_{DS} = 0$, $V_{GS} = 10$ V, f = 1.0 MHz		18	pF
C_{rss}	Reverse Transfer Capacitance	$V_{DS} = 0$, $V_{GS} = 10$ V, f = 1.0 MHz		8.0	pF
SWITCHING CHARACTERISTICS					
t_r	Rise Time	$V_{GS(off)} = 10$ mA, $V_{GS(on)} = 0$, $I_D = 20$ mA, $V_{DS} = 10$ V **TIS73** **TIS74**		 3.0 4.0	 ns ns
t_{on}	Turn-On Time	$V_{GS(off)} = 10$ mA, $V_{GS(on)} = 0$, $I_D = 20$ mA, $V_{DS} = 10$ V		 6.0	 ns
t_{off}	Turn-Off Time	$V_{GS(off)} = 10$ mA, $V_{GS(on)} = 0$, $I_D = 20$ mA, $V_{DS} = 10$ V **TIS73** **TIS74**		 25 50	 ns ns

*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 3.0%

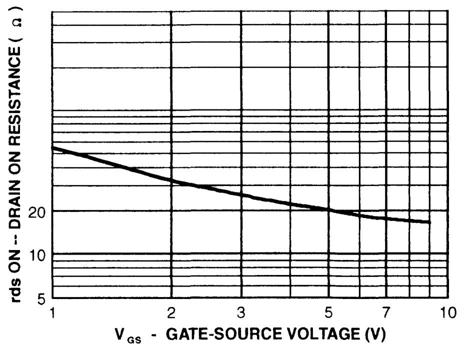
N-Channel General Purpose Amplifier
(continued)

Typical Characteristics

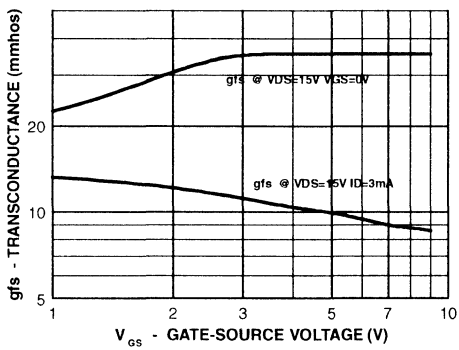
Parametric Interaction



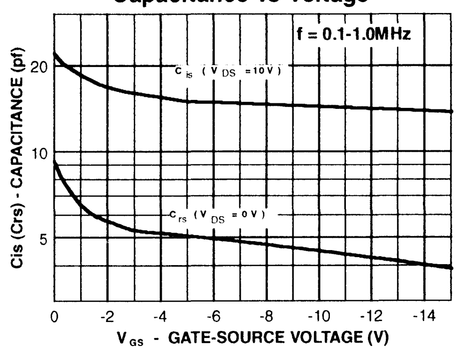
Parametric Interaction



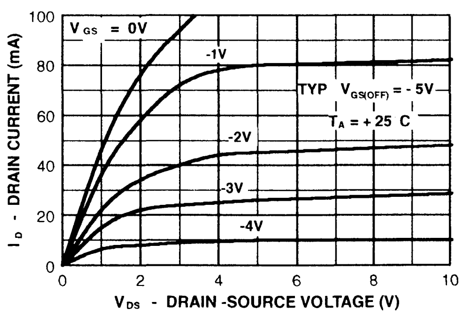
Parametric Interaction



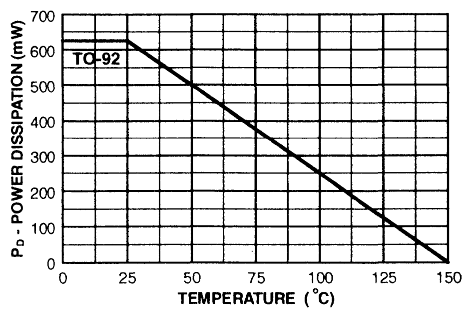
Capacitance vs Voltage



Common Drain-Source Characteristics



POWER DISSIPATION vs AMBIENT TEMPERATURE



Section 8

Die Process Information

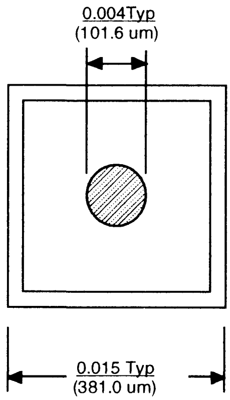
Section 8 Contents

Bipolar Transistor Dice (continued)

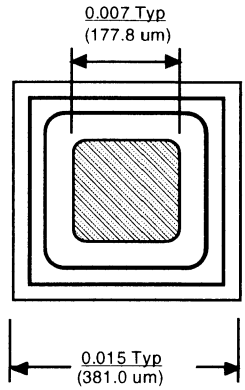
JFET Dice

Diode Dice

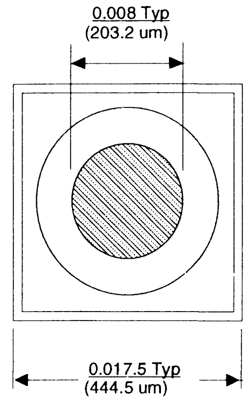
1D



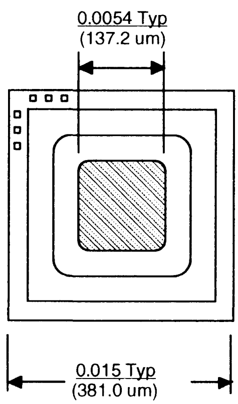
1H, 1J



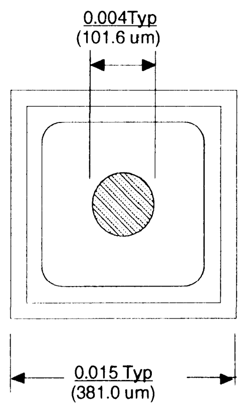
1L, 1M



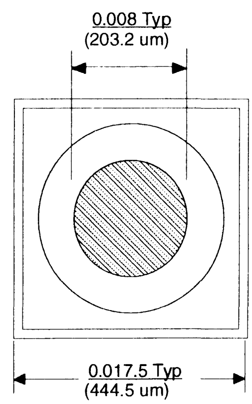
1P, 1R



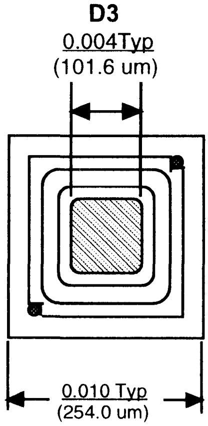
1S, 1T



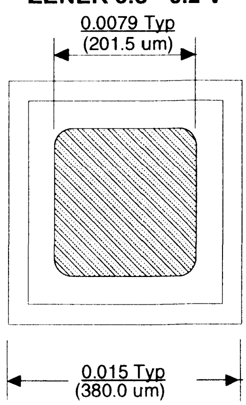
1V, 2V



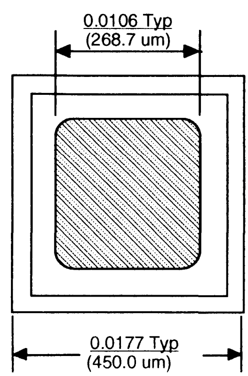
D3



ZENER 3.3 - 6.2 V



ZENER 6.8 - 33.0 V



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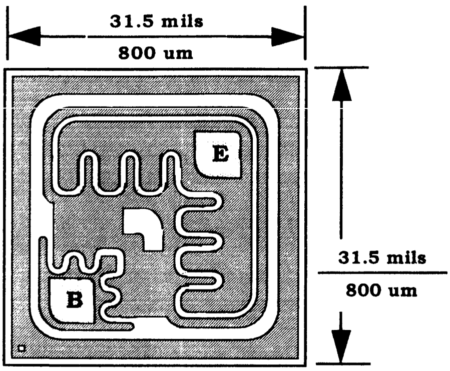
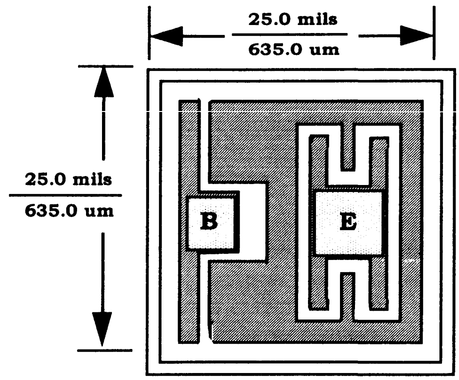
Bipolar Transistor Dice



PROCESS 03

Bond Pads

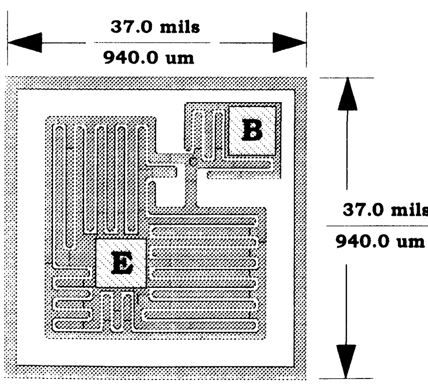
(Emitter)	(Base)
7.0 mil Square	6.7 mil Square
178.0 um	170.2 um



PROCESS 05

Bond Pads

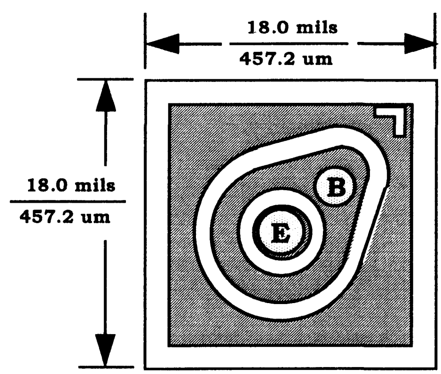
(Emitter)	(Base)
6.1 X 4.0 mil	4.3 X 4.1 mil
154.9 X 101.6 um	109.2 X 104.1 um



PROCESS 06

Bond Pads

(Emitter)	(Base)
7.0 mil Square	7.0 mil Square
178.0 um	178.0 um

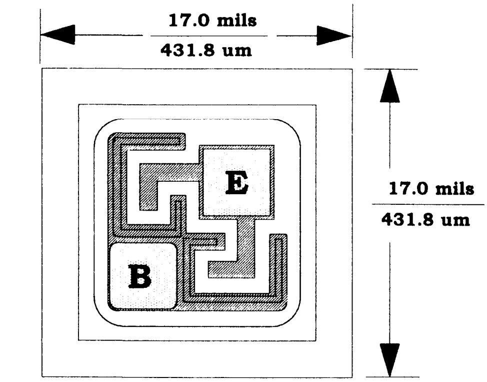


PROCESS 07

Bond Pads

(Emitter)	(Base)
3.1 mil Diameter	2.7 mil Diameter
78.7 um	68.6 um

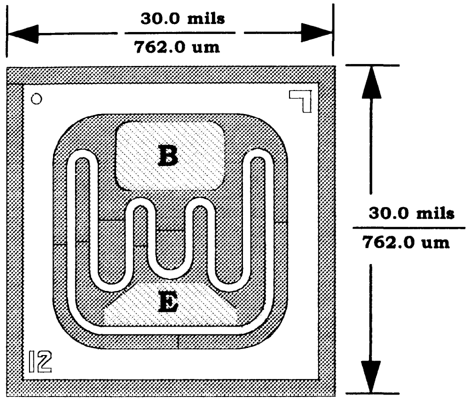
Bipolar Transistor Dice
(continued)



Process 10

Bond Pads

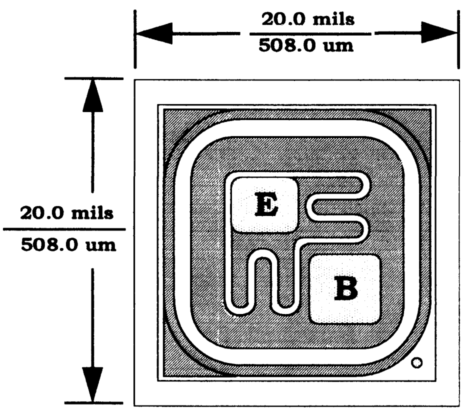
(Emitter)	(Base)
5.0 mil Square	6.0 mil Square
127.0 um	152.4 um



Process 12

Bond Pads

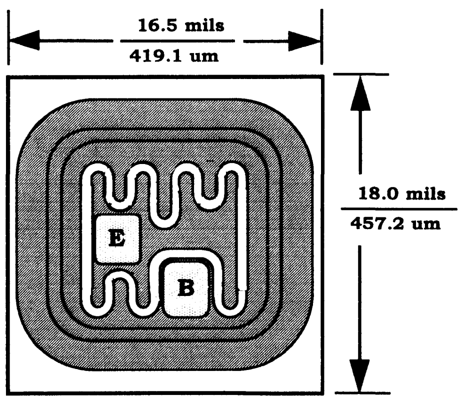
(Emitter)	(Base)
6.1 X 4.0 mil	4.3 X 4.1 mil
154.9 X 101.6 um	109.2 X 104.1 um



Process 16

Bond Pads

(Emitter)	(Base)
3.6 mil Square	4.3 mil Square
91.44 um	109.2 um

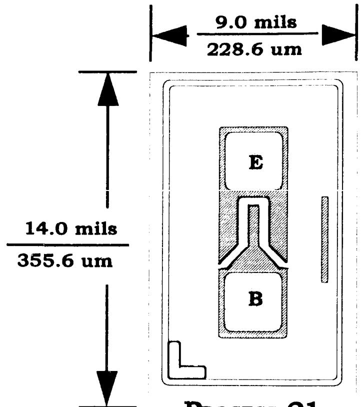


Process 19

Bond Pads

(Emitter)	(Base)
3.3 X 3.5 mil	3.3 X 4.0 mil
83.8 X 88.9 um	83.8 X 101.6 um

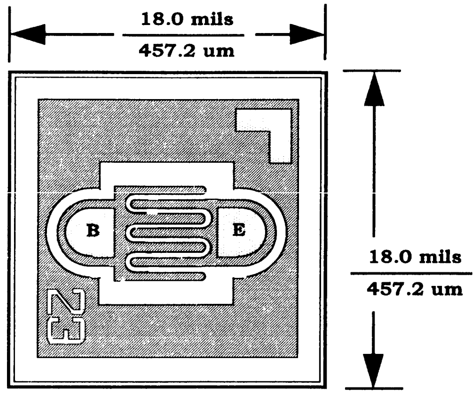
Bipolar Transistor Dice
(continued)



Process 21

Bond Pads

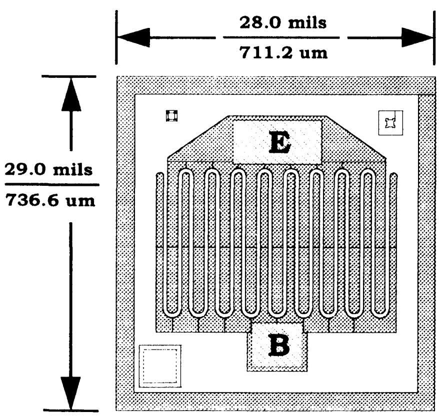
(Emitter)	(Base)
3.1 X 2.9 mil	3.1 X 2.9 mil
78.1 X 73.7 um	78.1 X 73.7 um



Process 23

Bond Pads

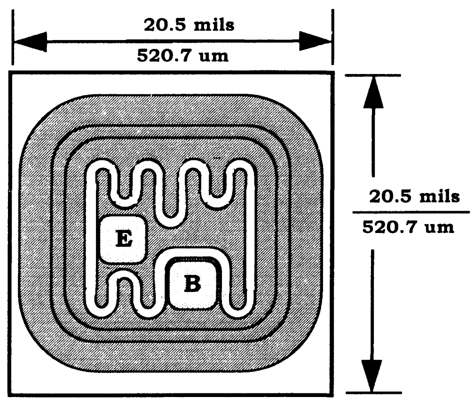
(Emitter)	(Base)
3.4 X 3.4 mil	3.4 X 3.4 mil
86.4 X 86.4 um	86.4 X 86.4 um



Process 25

Bond Pads

(Emitter)	(Base)
7.8 X 3.8 mil	4.3 X 3.8 mil
198.2 X 96.5 um	109.2 X 88.9 um

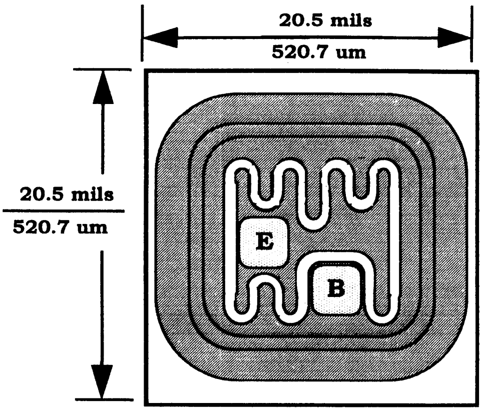


Process 30

Bond Pads

(Emitter)	(Base)
4.0 mil Square	4.0 mil Square
101.6 um	101.6 um

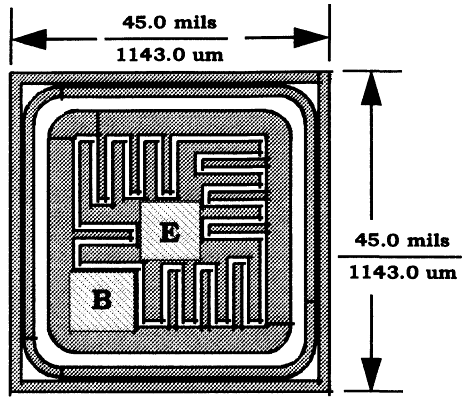
Bipolar Transistor Dice
(continued)



PROCESS 33

Bond Pads

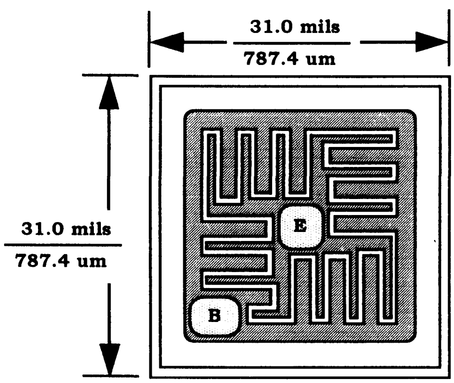
(Emitter)	(Base)
4.0 mil Square	4.0 mil Square
101.6 um	101.6 um



PROCESS 36

Bond Pads

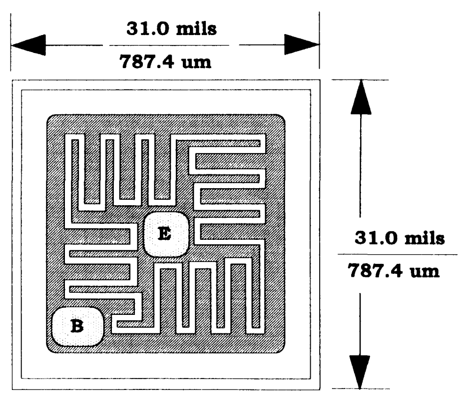
(Emitter)	(Base)
8.1 X 8.3 mil	8.3 X 9.1 mil
206.8 X 210.0 um	210.0 X 230.0 um



PROCESS 37

Bond Pads

(Emitter)	(Base)
4.9 mil Square	5.4 X 4.4 mil
124.5 um	137.2 X 111.8 um



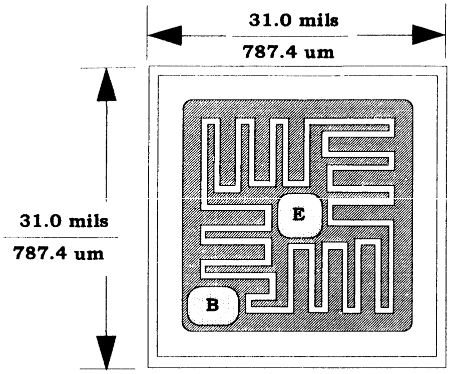
PROCESS 38

Bond Pads

(Emitter)	(Base)
4.9 mil Square	5.4 X 4.4 mil
124.5 um	137.2 X 111.8 um

Bipolar Transistor Dice

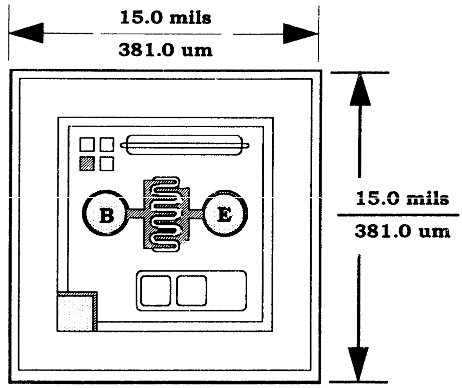
(continued)



Process 39

Bond Pads

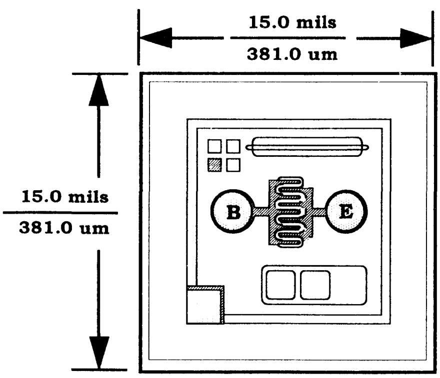
(Emitter)	(Base)
4.9 mil Square	5.4 X 4.4 mil
124.5 um	137.2 X 111.8 um



Process 40

Bond Pads

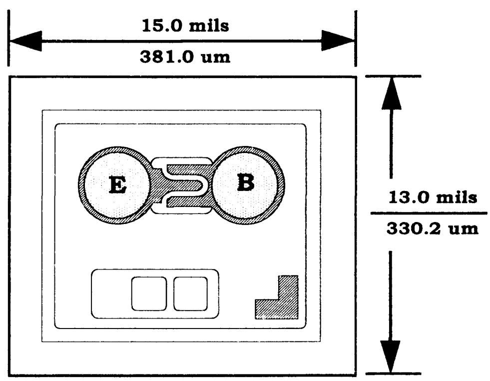
(Emitter)	(Base)
2.4 mil Diameter	2.4 mil Diameter
61.0 um	61.0 um



Process 42

Bond Pads

(Emitter)	(Base)
2.4 mil Diameter	2.4 mil Diameter
61.0 um	61.0 um

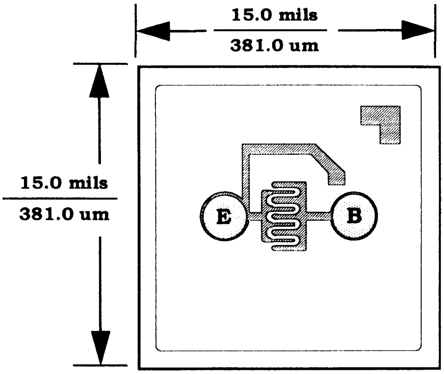


Process 43

Bond Pads

(Emitter)	(Base)
3.5 mil Diameter	3.1 mil Diameter
88.9 um	78.7 um

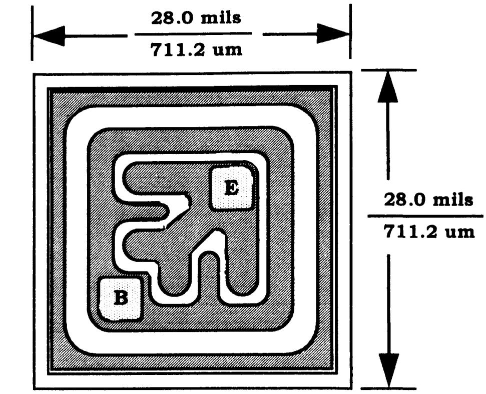
Bipolar Transistor Dice
(continued)



PROCESS 47

Bond Pads

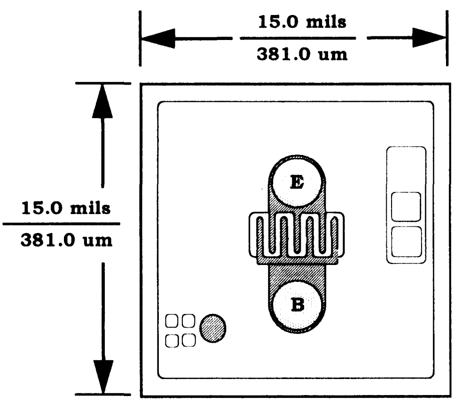
(Emitter)	(Base)
2.4 mil Diameter	2.4 mil Diameter
61.0 um	61.0 um



PROCESS 48

Bond Pads

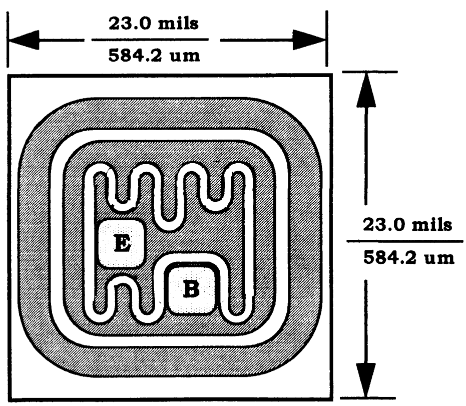
(Emitter)	(Base)
4.0 mil Square	4.1 mil Square
101.6 um	104.1 um



PROCESS 49

Bond Pads

(Emitter)	(Base)
2.3 mil Diameter	2.3 mil Diameter
58.4 um	58.4 um



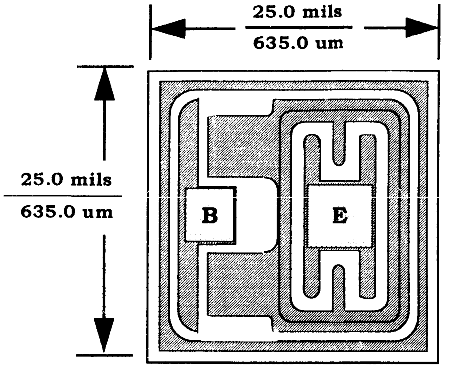
PROCESS 60

Bond Pads

(Emitter)	(Base)
4.0 mil Square	4.0 mil Square
101.6 um	101.6 um

Bipolar Transistor Dice

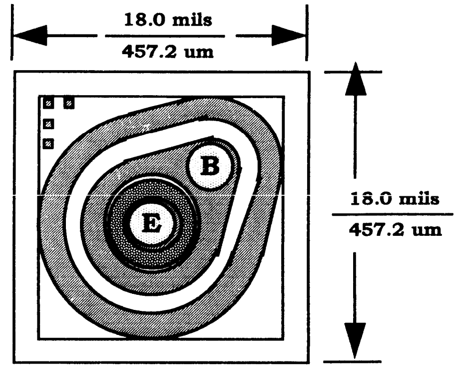
(continued)



PROCESS 61

Bond Pads

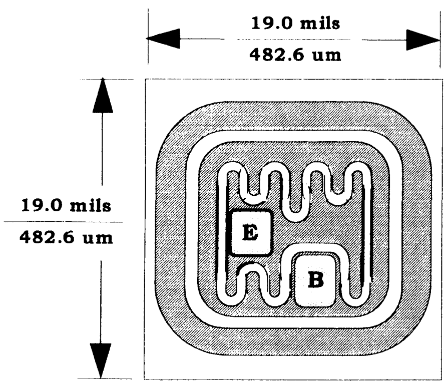
(Emitter)	(Base)
6.1 X 4.0 mil	4.3 X 4.1 mil
154.9 X 101.6 um	109.2 X 104.1 um



PROCESS 62

Bond Pads

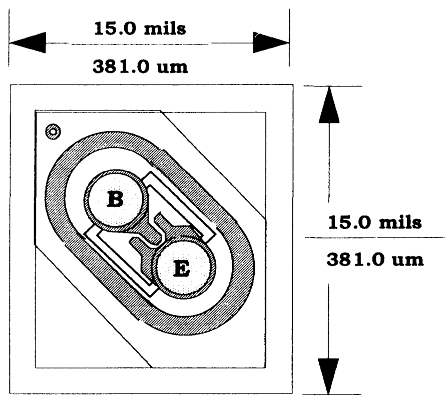
(Emitter)	(Base)
3.5 mil Diameter	3.5 mil Diameter
88.9 um	88.9 um



PROCESS 63

Bond Pads

(Emitter)	(Base)
3.0 X 3.2 mil	3.0 X 3.5 mil
76.2 X 88.3 um	76.2 X 88.9 um

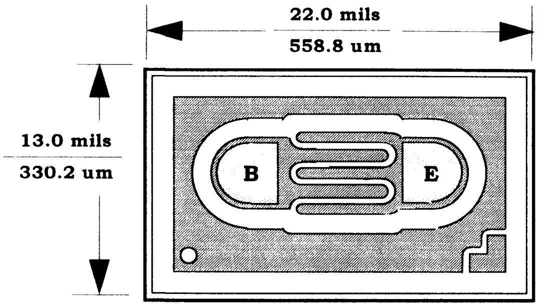


PROCESS 65

Bond Pads

(Emitter)	(Base)
3.6 mil Diameter	3.6 mil Diameter
91.44 um	91.44 um

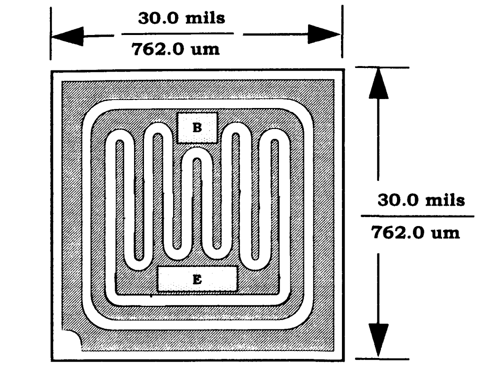
Bipolar Transistor Dice
(continued)



PROCESS 66

Bond Pads

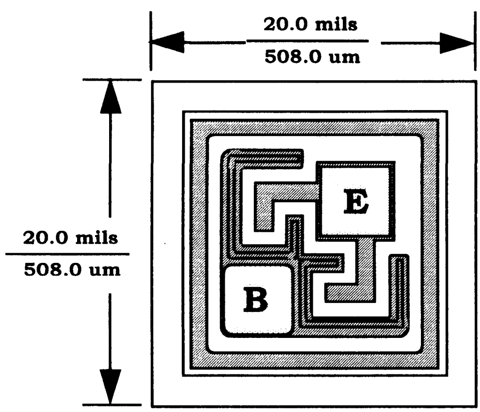
(Emitter)	(Base)
3.6 X 3.6 mil	3.6 X 3.6 mil
91.44 X 91.44 um	91.44 X 91.44 um



PROCESS 67

Bond Pads

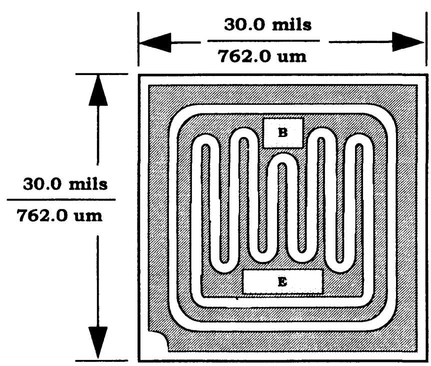
(Emitter)	(Base)
9.0 X 3.5 mil	5.0 X 4.0 mil
228.6 X 88.9 um	127.0 X 101.6 um



PROCESS 68

Bond Pads

(Emitter)	(Base)
5.0 mil Square	6.0 mil Square
127.0 um	152.4 um



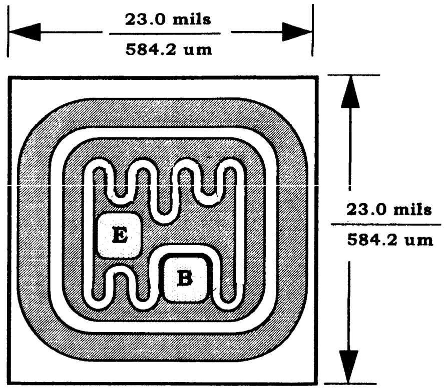
PROCESS 70

Bond Pads

(Emitter)	(Base)
9.0 X 3.5 mil	5.0 X 4.0 mil
228.6 X 88.9 um	127.0 X 101.6 um

Bipolar Transistor Dice

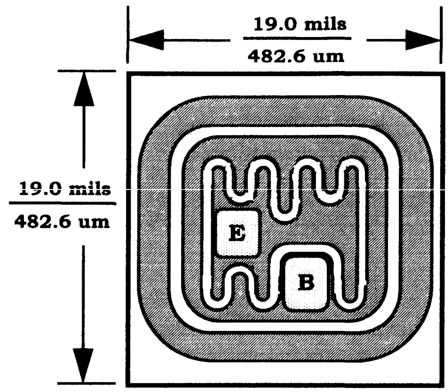
(continued)



Process 73

Bond Pads

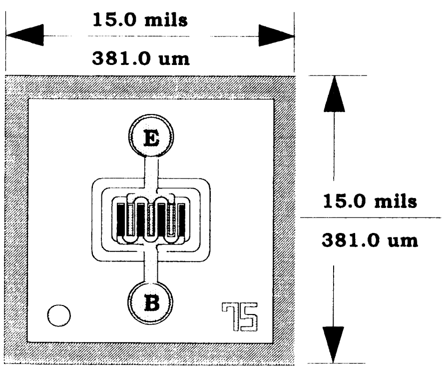
(Emitter)	(Base)
4.0 mil Square	4.0 mil Square
101.6 um	101.6 um



Process 74

Bond Pads

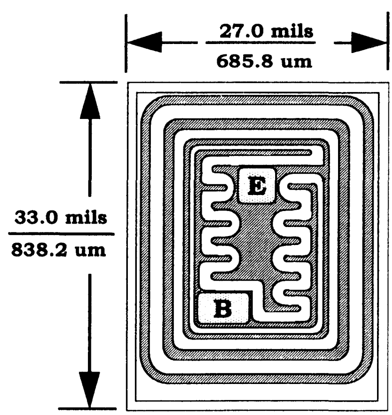
(Emitter)	(Base)
3.0 mil Square	3.0 X 3.5 mil
76.2 um	76.2 X 88.9 um



Process 75

Bond Pads

(Emitter)	(Base)
2.3 mil Diameter	2.3 mil Diameter
58.4 um	58.4 um

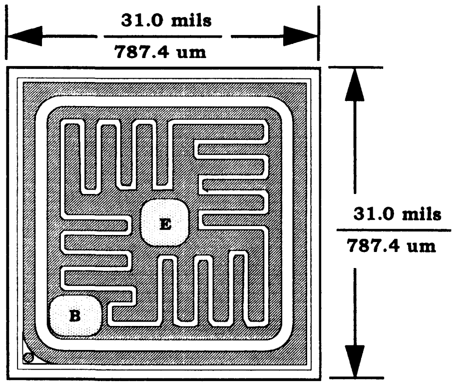


Process 76

Bond Pads

(Emitter)	(Base)
4.5 mil Square	5.5 X 3.7 mil
114.3 um	139.7 X 94.0 um

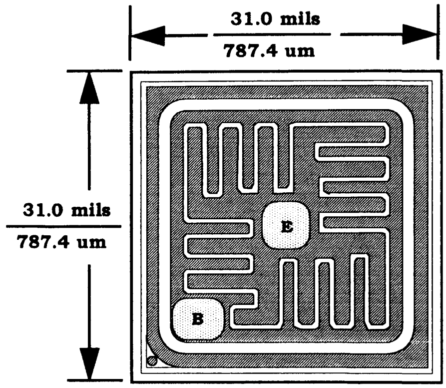
Bipolar Transistor Dice
(continued)



Process 77

Bond Pads

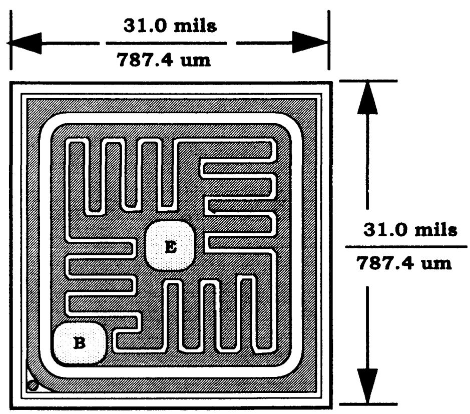
(Emitter)	**(Base)**
4.9 mil Square	**5.4 X 4.4 mil**
124.5 um	**137.2 X 111.8 um**



Process 78

Bond Pads

(Emitter)	**(Base)**
4.9 mil Square	**5.4 X 4.4 mil**
124.5 um	**137.2 X 111.8 um**



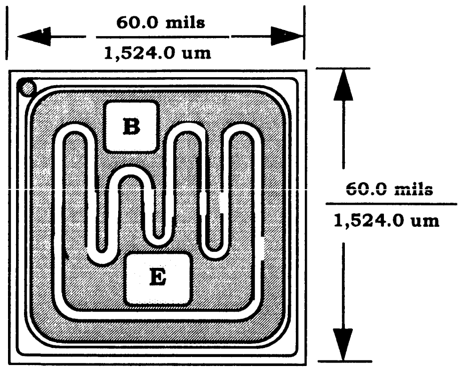
Process 79

Bond Pads

(Emitter)	**(Base)**
4.9 mil Square	**5.4 X 4.4 mil**
124.5 um	**137.2 X 111.8 um**

Bipolar Transistor Dice

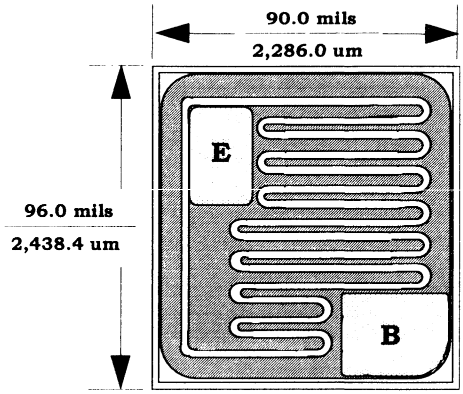
(continued)



PROCESS 4P

Bond Pads

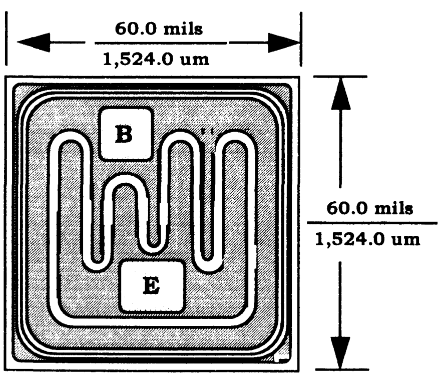
(Emitter)	(Base)
11.0 mil Square	11 X 17 mil
279.4 um	279.4 X 431.8 um



PROCESS 4Q

Bond Pads

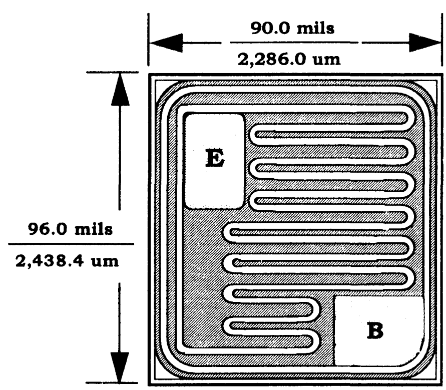
(Emitter)	(Base)
18 X 30 mil	20 X 26 mil
457.2 X 762.0 um	508.0 X 660.4 um



PROCESS 5P

Bond Pads

(Emitter)	(Base)
11.0 mil Square	11 X 17 mil
279.4 um	279.4 X 431.8 um

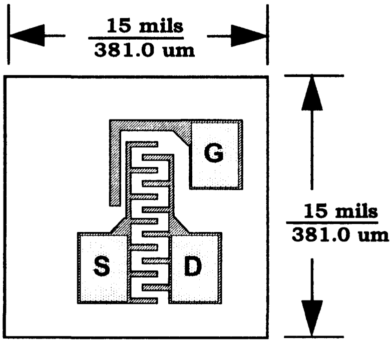


PROCESS 5Q

Bond Pads

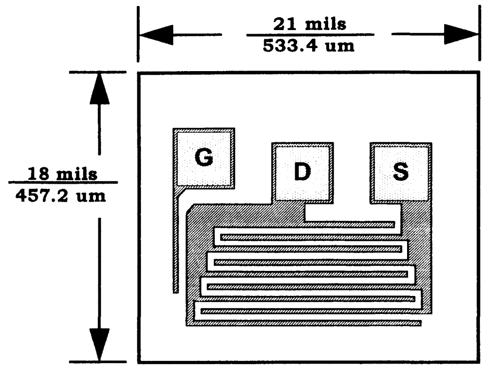
(Emitter)	(Base)
18 X 30 mil	20 X 26 mil
457.2 X 762.0 um	508.0 X 660.4 um

JFET Dice



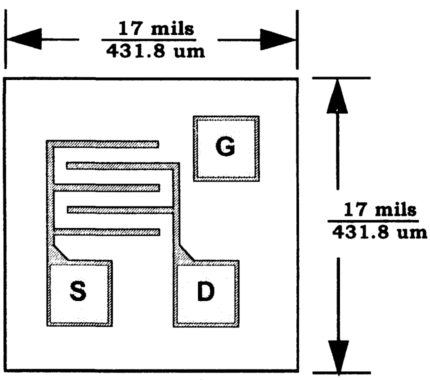
Process 50

Bond Pads
3.2 X 4.0 mil
81.3 X 101.6 um



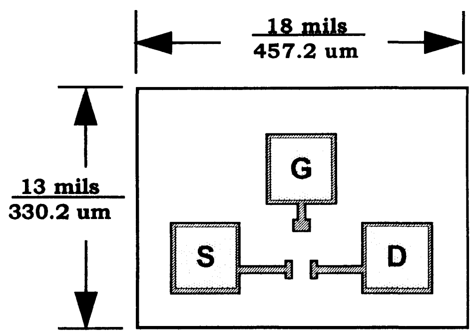
Process 51

Square Bond Pads
3.8 mil
96.56 um



Process 52

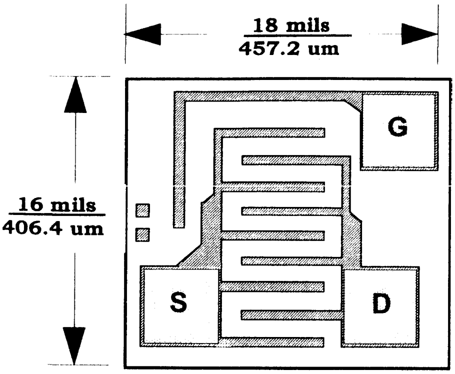
Square Bond Pads
3.8 mil
96.56 um



Process 53

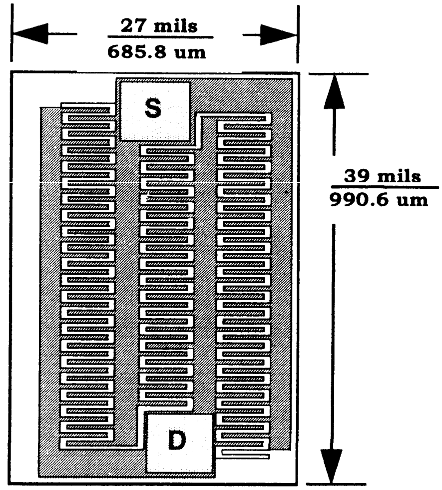
Square Bond Pads
4.0 mil
101.6 um

JFET Dice
(continued)



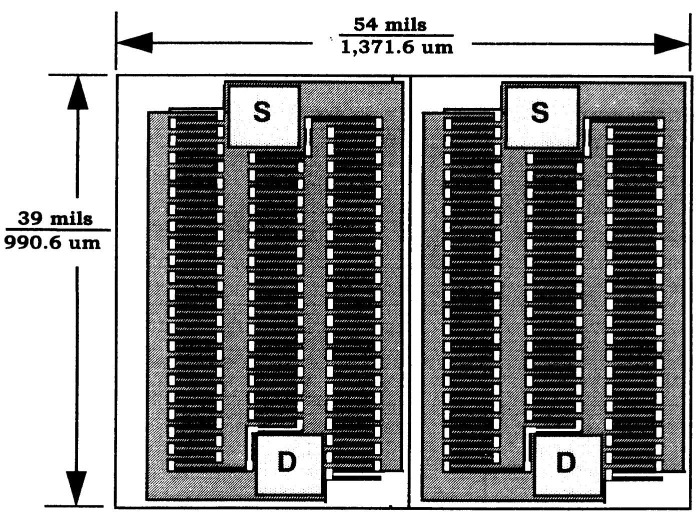
PROCESS 55

Square Bond Pads
3.0 mil
76.2 um



PROCESS 58

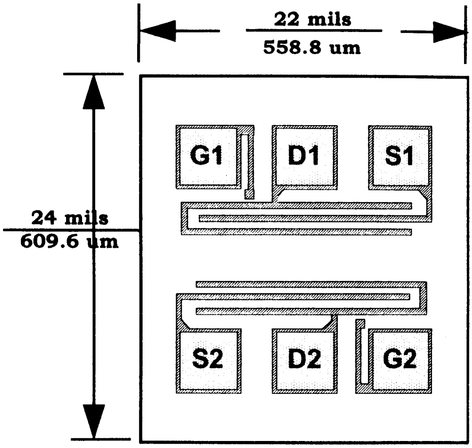
Bond Pads
6.0 X 5.4 mil
152.40 X 137.16 um



PROCESS 59

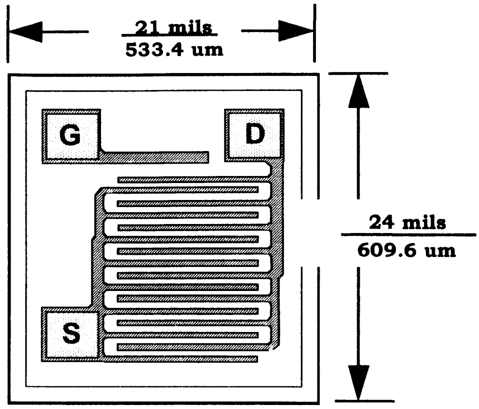
Bond Pads
6.0 X 5.4 mil
152.40 X 137.16 um

JFET Dice
(continued)



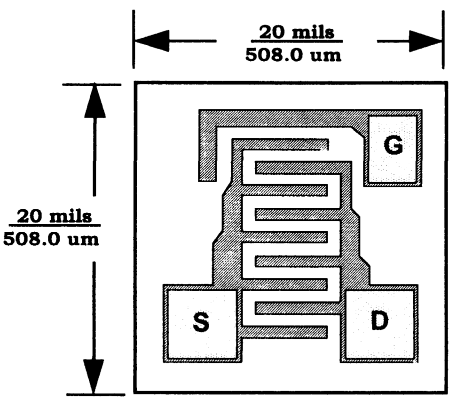
PROCESS 83

Square Bond Pads
3.8 mil
96.56 um



PROCESS 88

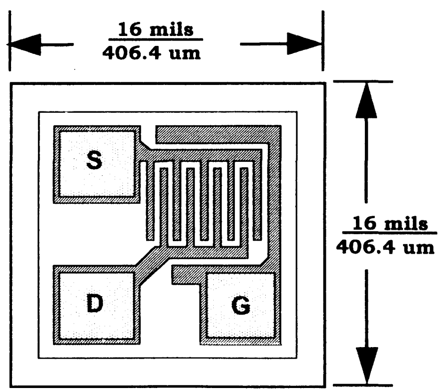
Square Bond Pads
3.0 mil
76.2 um



PROCESS 89

Bond Pads

(Gate)	(Source & Drain)
3.0 X 4.0 mil	4.0 mil Square
76.2 X 101.6 um	101.6 um

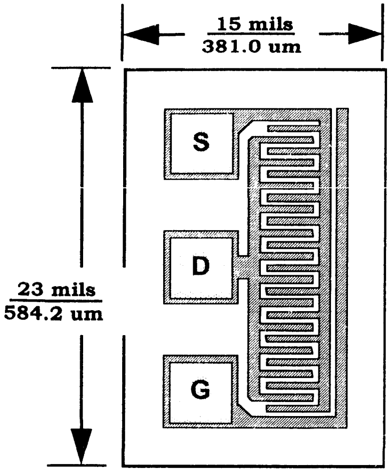


PROCESS 90

Square Bond Pads
3.8 mil
96.56 um

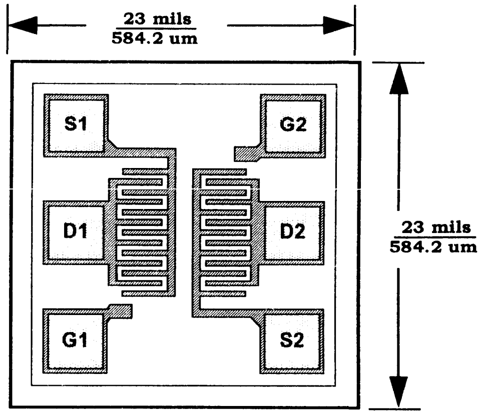
JFET Dice

(continued)



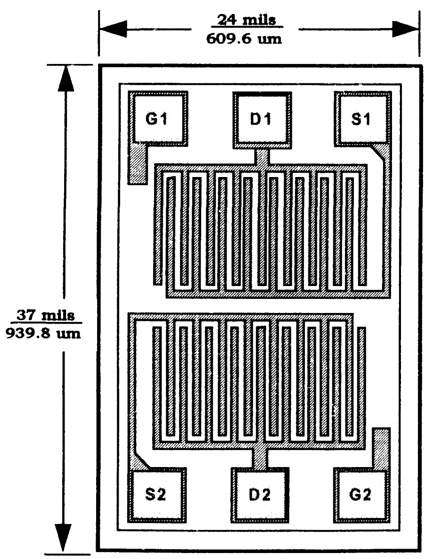
PROCESS 92

Square Bond Pads
3.8 mil
96.56 um



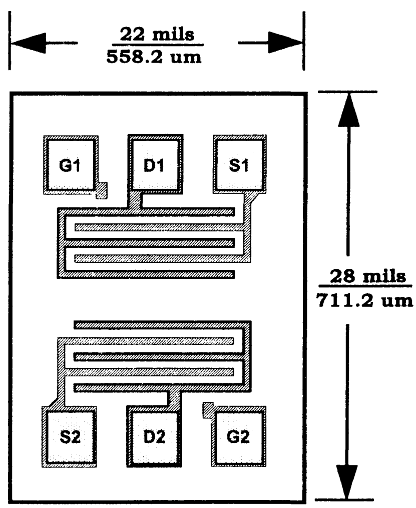
PROCESS 93

Square Bond Pads
3.8 mil
96.56 um



PROCESS 96

Square Bond Pads
3.8 mil
96.56 um



PROCESS 98

Square Bond Pads
3.8 mil
96.56 um

Section 9

Package Outlines and Ordering Information

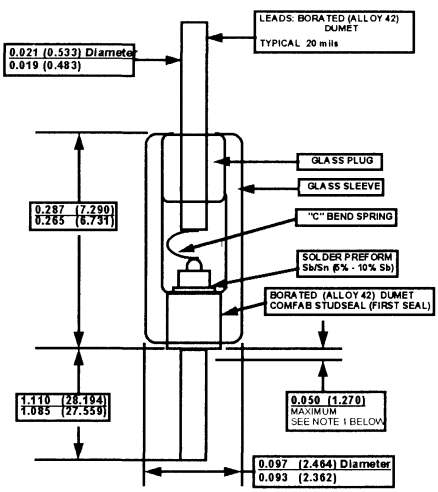
Section 9 Contents

Package Outlines

- Dimensions are: inches [millimeters]
- Numbers in parentheses following package titles are NS internal package codes.
- Dimensions and package codes shown are applicable at time of printing. Factory should be consulted to confirm dimensions, packages codes and other information.

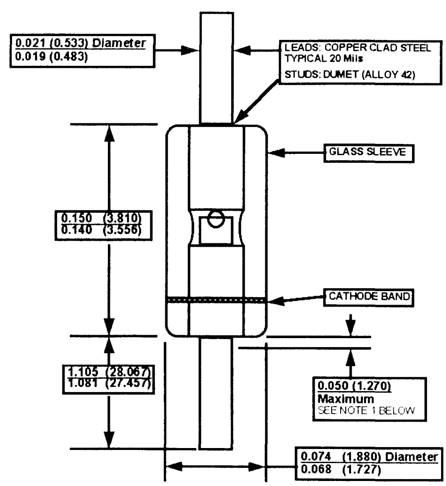
NS Package Code	JEDEC Code	NS Package Code	JEDEC Code
D1	DO-7 Axial Diode	37	TO-220
D2	DO-35 Axial Diode	45	TO-263AB (D2Pak)
D3	LL-34 Diode SMD	47	SOT-223 (TO-261)
D4	DO-41 Axial Diode	49	SOT-23 (TO-236AB)
S1	SOIC 8-Lead SMD	69	SOIC 8-Lead SMD (JFETs)
S3	SOIC 16-Lead SMD	92	TO-92 Plastic (TO-226AA)
		94	TO-92 Plastic (TO-226AA)
31	SuperSot-6 (Dual)	95	TO-226AE (Tall TO-92)
32	Sot-23 (SuperSot)	96	TO-92 Plastic (TO-226AA)
33	SuperSot-6 (Single)	97	TO-92 Plastic (TO-226AA)
34	SuperSot-8 (Single)	98	TO-92 Plastic (TO-226AA)
35	SuperSot-8 (Dual)	99	TO-226AE (Tall TO-92)

DO-7 (D1)



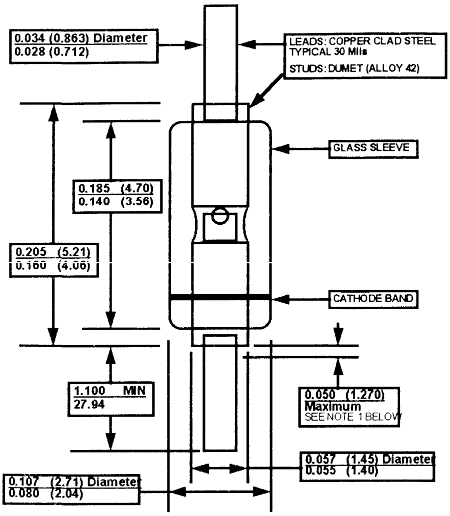
NOTE 1: Lead diameter is not controlled in this zone, allowing for flash, lead finish build-up and minor irregularities other than slugs.

DO-35 (D2)



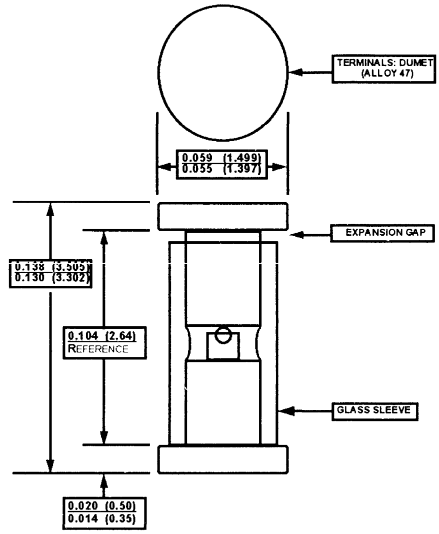
NOTE 1: Lead diameter is not controlled in this zone, allowing for flash, lead finish build-up and minor irregularities other than slugs.

DO-41 (D4)

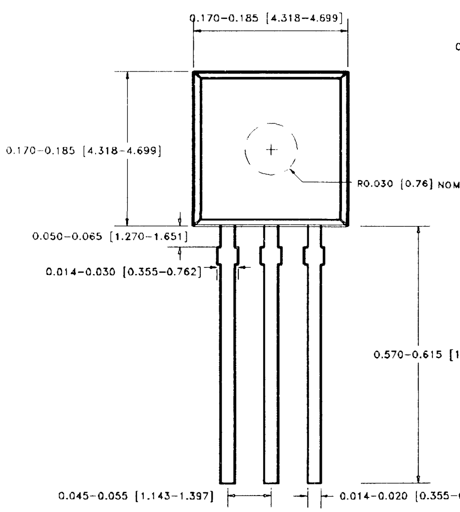


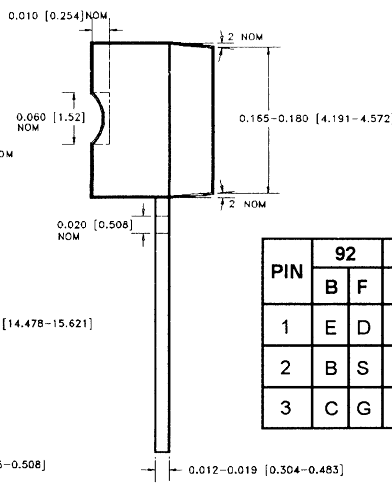
NOTE 1: Lead diameter is not controlled in this zone, allowing for flash, lead finish build-up and minor irregularities other than slugs.

LL-34 (D3)

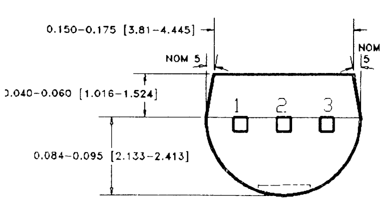


TO-92 (92, 94, 96, 97*, 98*)





PIN	92		94		96	
	B	F	B	F	B	F
1	E	D	E	D	B	S
2	B	S	C	G	E	D
3	C	G	B	S	C	G

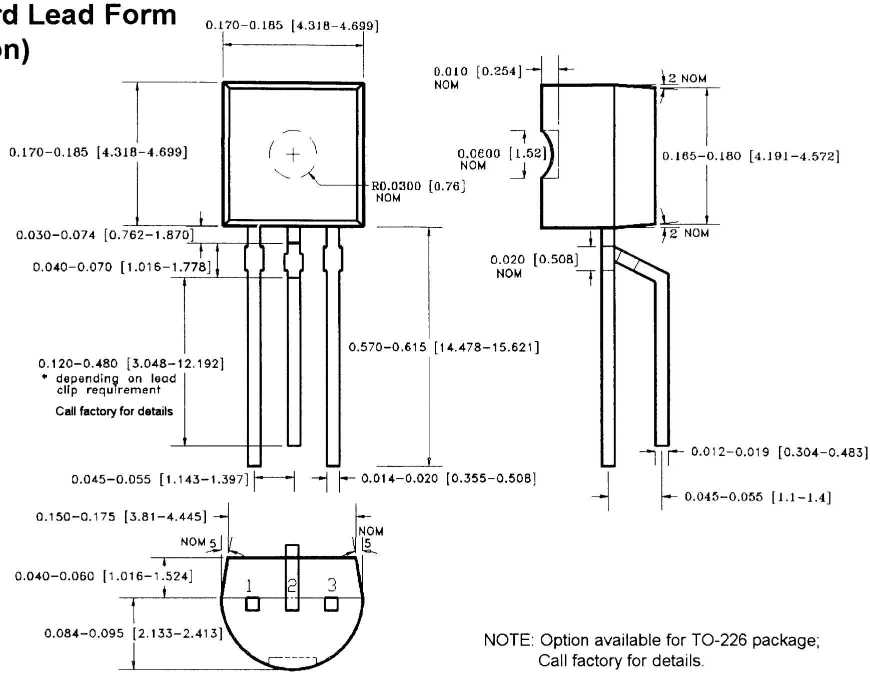


PIN	97*		98*	
	B	F	B	F
1	C	G	C	G
2	B	S	E	S
3	E	D	B	D

*Leadformed to TO-18 configuration prior to bulk shipment. For in-line leads, order option L34Z.

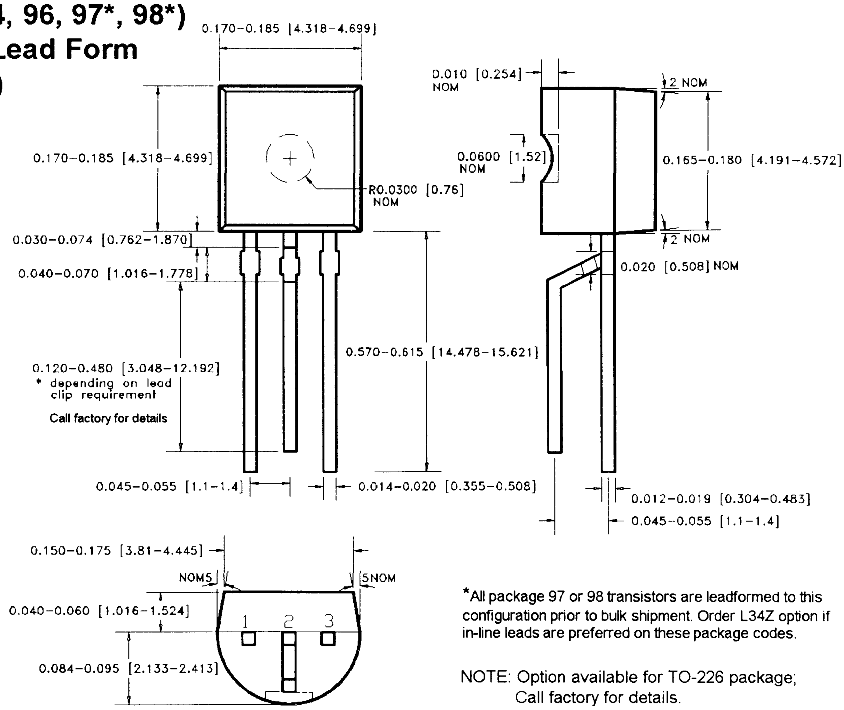
Drain-Source interchangeable on most JFET devices.

TO-92 (92, 94, 96) -18 Standard Lead Form (J18Z Option)



NOTE: Option available for TO-226 package;
Call factory for details.

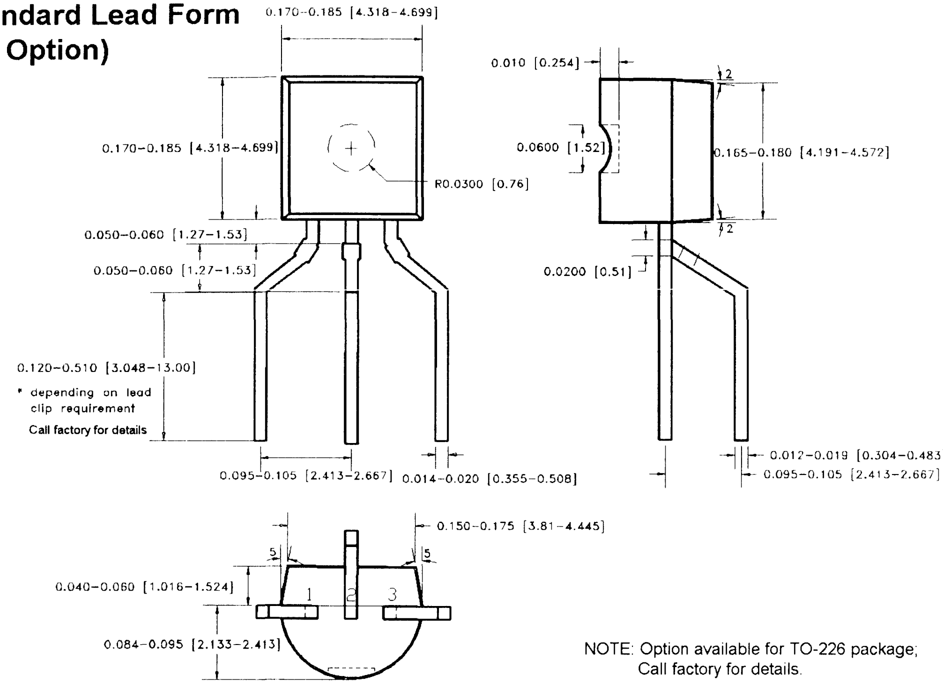
TO-92 (92, 94, 96, 97*, 98*) -18 Reverse Lead Form (J35Z Option)



*All package 97 or 98 transistors are leadformed to this configuration prior to bulk shipment. Order L34Z option if in-line leads are preferred on these package codes.

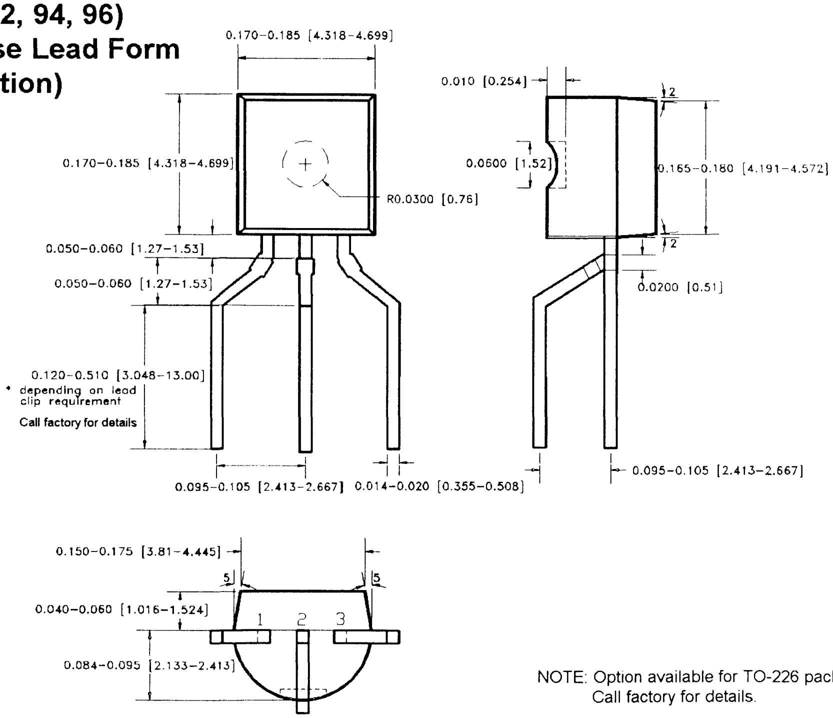
NOTE: Option available for TO-226 package;
Call factory for details.

TO-92 (92, 94, 96) -5 Standard Lead Form (J05Z Option)



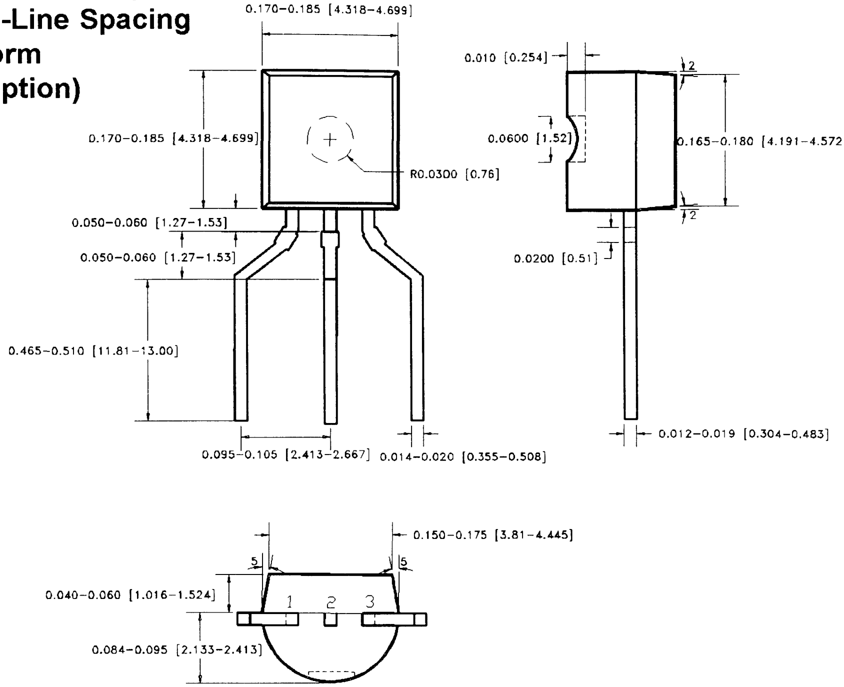
NOTE: Option available for TO-226 package; Call factory for details.

TO-92 (92, 94, 96) -5 Reverse Lead Form (J60Z Option)

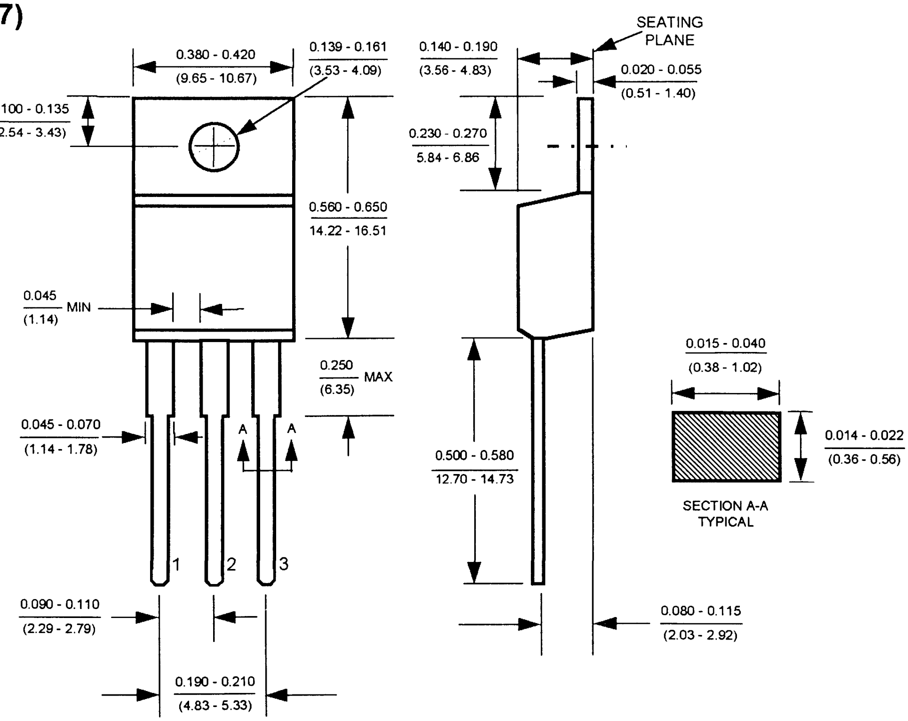


NOTE: Option available for TO-226 package; Call factory for details.

TO-92 (92, 94, 96) 0.200 In-Line Spacing Lead Form (J61Z Option)

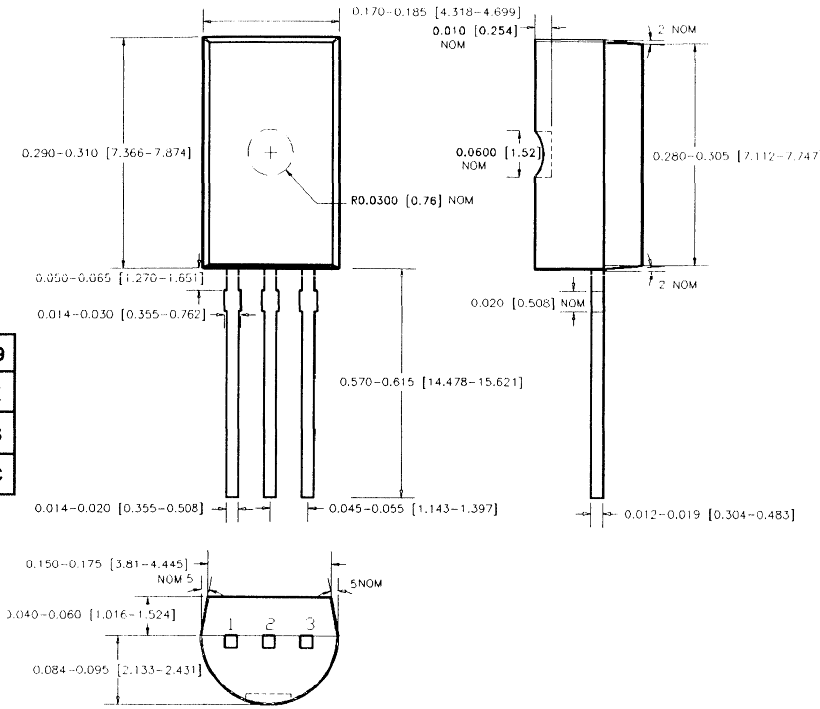


TO-220 (37)



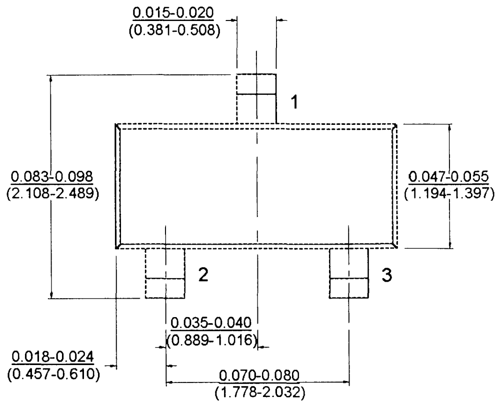
PIN	B	F
1	B	G
2	C	D
3	E	S

TO-226 (95, 99)

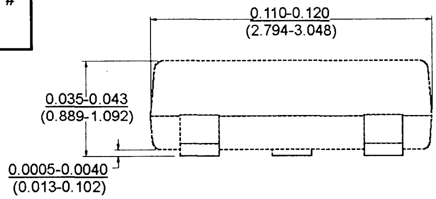


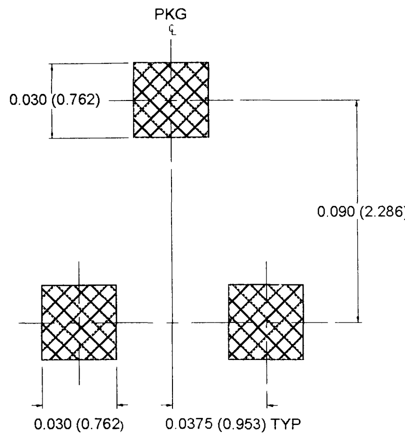
PIN	95	99
1	E	E
2	C	B
3	B	C

SOT-23 (49)

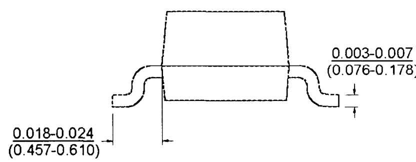


PIN	B	F	D
1	C	G	See Part #
2	B	S	
3	E	D	

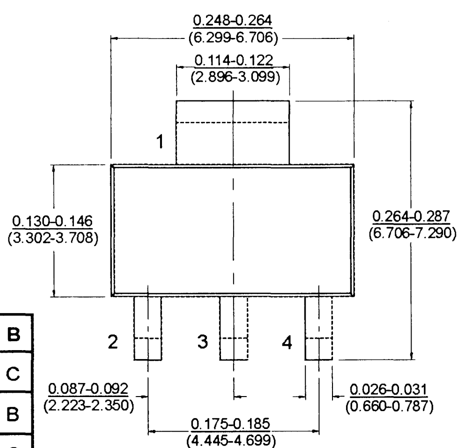




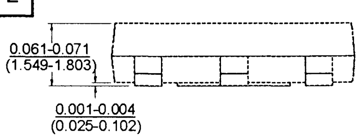
LAND PATTERN RECOMMENDATION

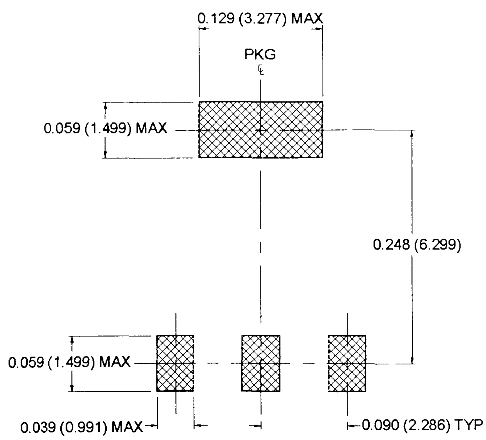


SOT-223 (47)

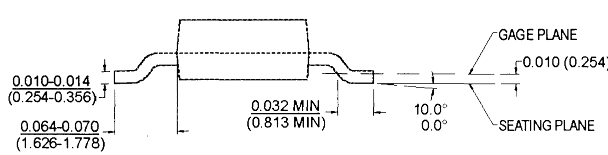


PIN	B
1	C
2	B
3	C
4	E



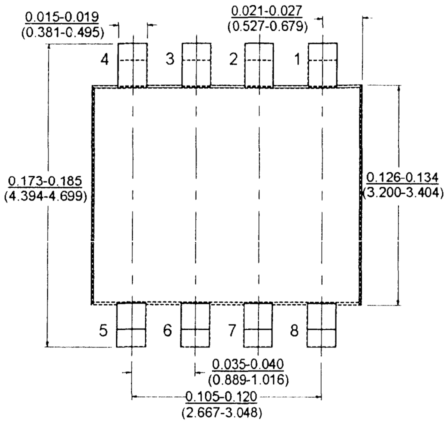


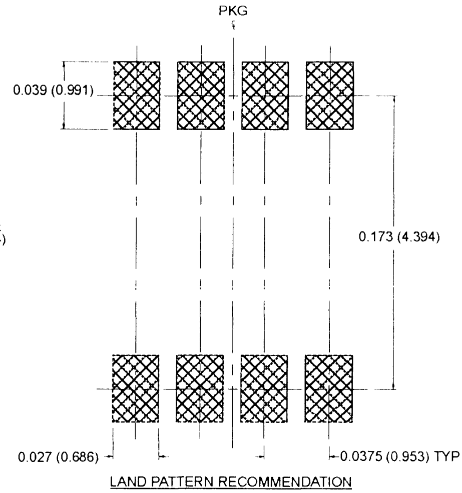
LAND PATTERN RECOMMENDATION

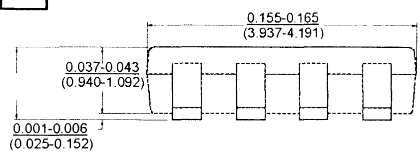


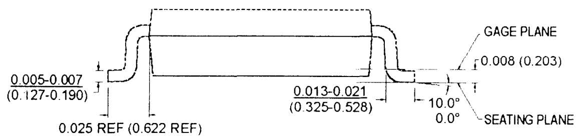
SO-8 (S1, 69)

PIN	B
1	S1
2	D1
3	NC
4	G1
5	S2
6	D2
7	NC
8	G2



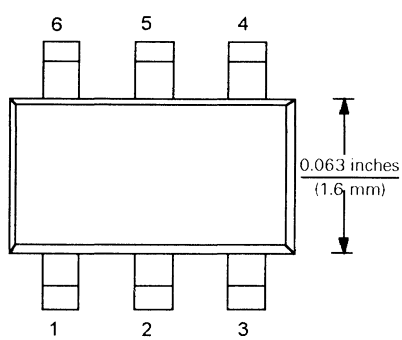


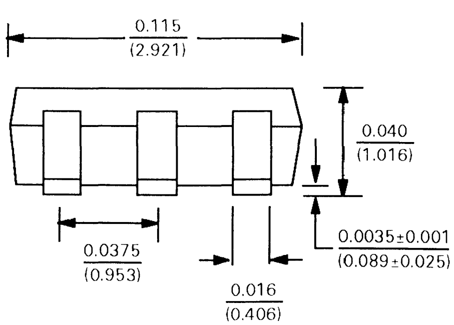


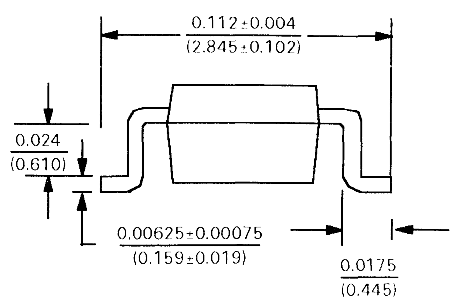


SOT-6 (33)

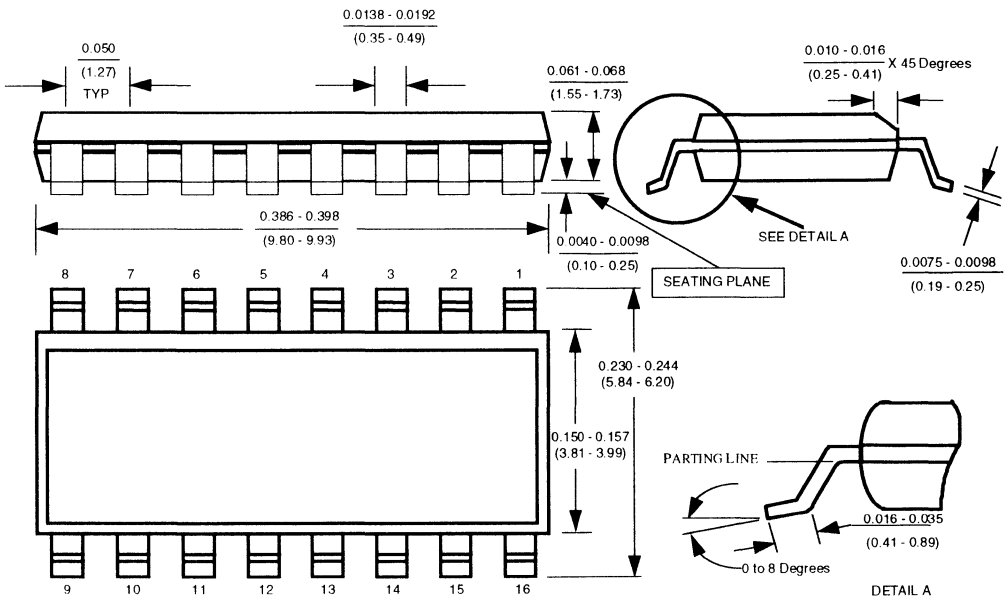
PIN	B
1	B1
2	E2
3	B2
4	C2
5	E1
6	C1





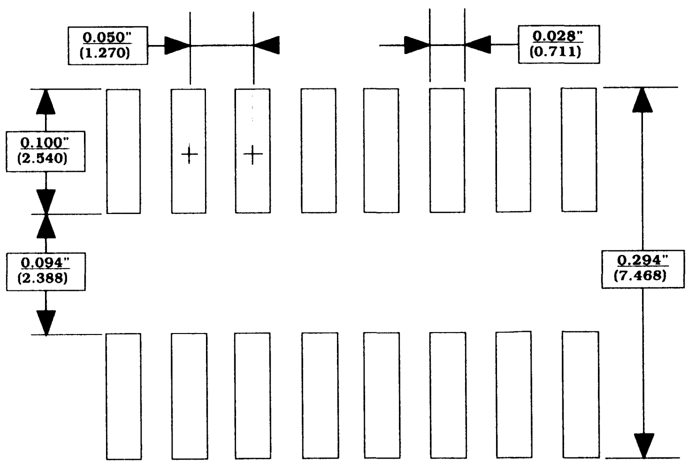


SOIC-16 (S3)



PIN	B
1	C1
2	C1
3	C2
4	C2
5	C3
6	C3
7	C4
8	C4

PIN	B
9	B1
10	E1
11	B2
12	E2
13	B3
14	E3
15	B4
16	E4



Land Pattern Recommendation

National Semiconductor™

Discrete POWER & Signal Technologies

Recommended Soldering Profiles

		Wave Solder	IR Profile	Vapor Phase
RAMP-UP (°C / second)	MAXIMUM RECOMMENDED MINIMUM	6 °C / second *4 °C / second **	4 °C / second *2 °C / second **	24 °C / second *2 °C / second **
TEMPERATURE DIFFERENTIAL	MAXIMUM RECOMMENDED MINIMUM	135 °C 120 °C 110 °C	N/A N/A N/A	N/A N/A N/A
DWELL TIME ≥ 183 °C	MAXIMUM RECOMMENDED MINIMUM	N/A N/A N/A	85 seconds *75 seconds **30 seconds	85 seconds *75 seconds **
SOLDER TEMPERATURE	MAXIMUM RECOMMENDED MINIMUM	260 °C 245 °C **	240 °C *215 °C **	219 °C *215 °C **
DWELL TIME @ MAXIMUM	MAXIMUM RECOMMENDED MINIMUM	4 seconds 3 seconds **	10 seconds 5 seconds 1 second	75 seconds 70 seconds **
RAMP-DOWN (°C / second)	MAXIMUM RECOMMENDED MINIMUM	4 °C / second	4 °C / second 2 °C / second **	4 °C / second *2 °C / second **
ULTRASONIC CLEANING	MAXIMUM RECOMMENDED MINIMUM	Recommend caution with close controls of process variation. Energy level, along with TEMPERATURE & DURATION, must be tightly controlled to prevent damage.		

*Will vary depending on the board density, geometry & package type.

**Will vary depending on board density & package type.

NOTES:
1) N/A = not applicable
2) The temperature differential is between the final preheat stage & the soldering stage temperature measured at the component lead area.

Ordering Information for Discrete Products

The Discrete Division "*Discrete POWER and Signal Technologies*" offers 4 product families. They are: **Diodes, Bipolar Transistors, JFET** and **DMOS**. These can be purchased in bulk or tape and reel/ammo packaging. We offer the most popular style of packaging for each family of products as "standard". A variety of non-standard options are also available. You will find each of these options outlined in the flow code section.

National Semiconductor offers product in surface mount and through hole.
All our surface mount packages come standard as tape and reel. Our taping meets the EIA 481 specification with our carrier tape being "conductive cavity".

For **axial diode** the most popular packaging is axial tape and reel. To order this package, you simply add ".TR" to the end of the part number.

Options available:

1N4148	Bulk
1N4148.TR	Tape and Reel
1N4148 flow code T50R	Tape and Reel "(same as .TR - flow code call out)"
Non-standard options:	
1N4148 flow code "T50A'	Tape and Ammo
1N4148 flow code "T26R"	Tape and Reel 26mm lead length
1N4148 flow code "T26A"	Tape and Ammo 26mm lead length

For **through hole transistors** we have two popular packaging options — tape and reel and tape and ammo. Our most popular option for tape and reel is flow code **"D26Z"**. For tape and ammo we offer two styles - "**D74Z**" and "**D75Z**". All options listed in our flow code section.

Standard options:

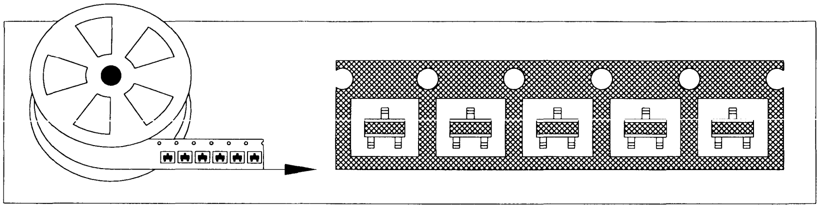
NSID:	Flow code	
2N3904		Bulk
2N3904	D26Z	Tape and Reel - Round side toward adhesive tape. (equiv. to RA)
2N3904	D74Z	Tape and Ammo - Flat side toward adhesive tape. (equiv. to RM)
2N3904	D75Z	Tape and Ammo Round side toward adhesive tape. (equiv. to RP)

Please note: The **TO-220** through hole transistor is available in bulk and rails.
We do not offer tape and reel with this package style. (NDBXXX, D4XXX)

Ordering Information
(continued)

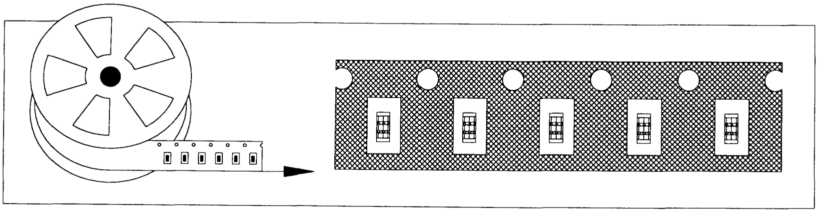
Ordering information and Flow code options for:

1 Surface mount packages SOT-23/TO-236
Part automatically comes 3K per reel - 7" reel. No flow code needed.



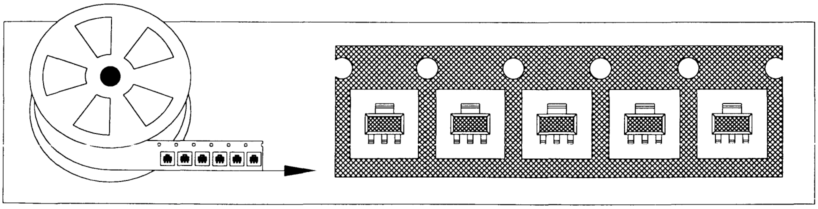
Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
L99Z	3K	7" dia.	8mm wide	Conductive cavity	No marking on device
D87Z	10K	13" dia.	8mm wide	Conductive cavity	
S62Z	3K	bag	none	none	Bulk

2 Surface mount packages LL34
Part automatically comes 2.5K per reel - 7" reel. No flow code needed.



Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
L99Z	2.5K	7" dia.	8mm wide	Conductive cavity	No marking on device
D87Z	10K	13" dia.	8mm wide	Conductive cavity	
S62Z	2.5K	bag	none	none	Bulk

3 Surface mount packages SOT-223/TO-261
Part automatically comes 2.5K per reel - 13" reel. No flow code needed.

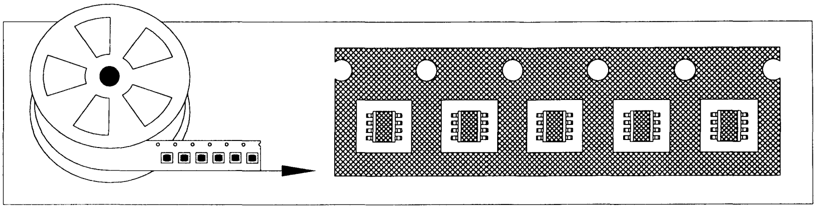


Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
L99Z	2.5K	13" dia.	12mm wide	Conductive cavity	No marking on device
D84Z	500pc	7" dia.	12mm wide	Conductive cavity	
S62Z	2.5K	Bag	None	None	Bulk

Ordering information and Flow code options for:

4 Surface Mount SO-8/SOT-8

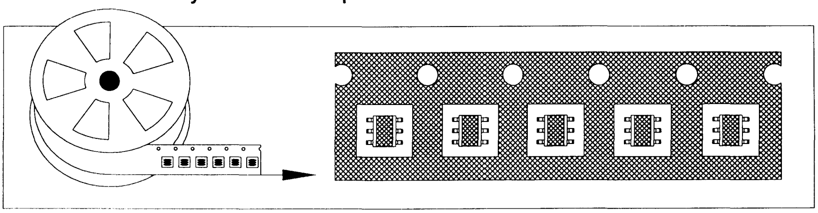
Part automatically comes 2.5K per reel - 13" reel. No flow code needed.



Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
L99Z	2.5K	13" dia.	12mm wide	Conductive cavity	No marking on device
D84Z	500	7" dia.	12mm wide	Conductive cavity	
L86Z	98pc	Rail	Note: for Jfet, qty is 100 pc per rail.		
S62Z	495pc	Bag	None	None	Bulk

5 Surface Mount SOT-6

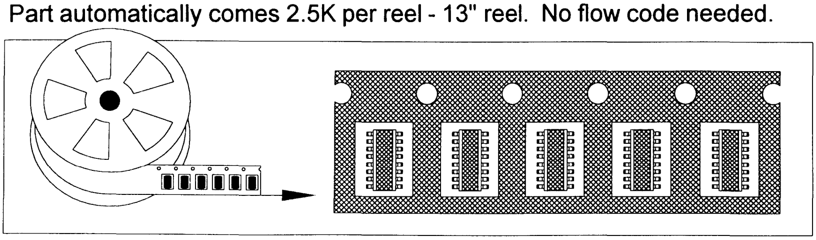
Part automatically comes 3.0K per reel - 7" reel. No flow code needed.



Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
L99Z	3K	7" dia.	8mm wide	Conductive cavity	No marking on device
D87Z	10	13" dia.	8mm wide	Conductive cavity	
S62Z	3K	Bag	None	None	Bulk

6 Surface Mount SO-16

Part automatically comes 2.5K per reel - 13" reel. No flow code needed.

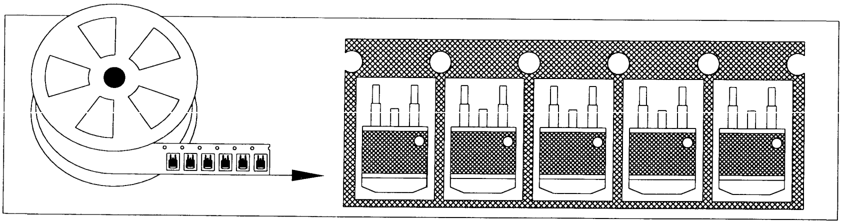


Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
L99Z	2.5K	13" dia.	16mm wide	Conductive cavity	No marking on device
D84Z	500pc	7" dia.	16mm wide	Conductive cavity	
L86Z	100pc	Rail			
S62Z	2.5K	Bag	None	None	Bulk

Ordering Information
(continued)

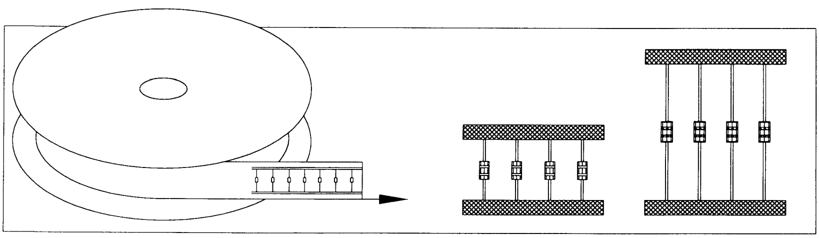
Ordering information and Flow code options for:

7 Surface Mount TO-263AB
Part automatically comes 2.5K per reel - 13" reel. No flow code needed.



Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
L99Z	800pc	13" dia.	24mm wide	Conductive cavity	No marking on device
L86Z	Tube/Rail 45pcs per. rail				
S62Z	800pc	Bag	None	None	Bulk

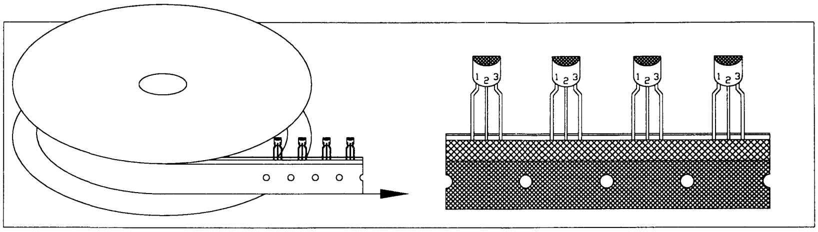
8 Axial tape and reel for (1N) diodes DO-35/DO-41
1NXXXX.TR comes 10K per reel - 13" reel.



Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
T50R	10K	13" dia.	50mm	Axial	Same as .TR
T50A	5K	Box	50mm	Axial	
T26R	10K	13" dia.	26mm	Axial	
T26A	5K	Box	26mm	Axial	

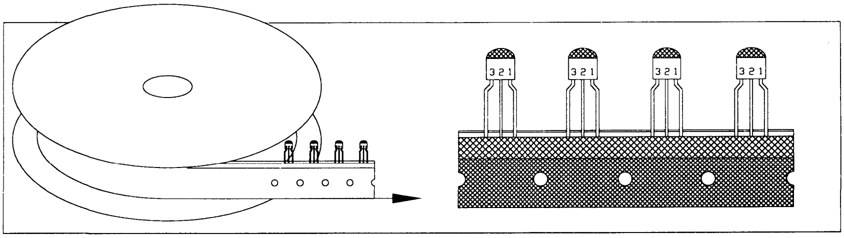
Ordering information and Flow code options for:

9 TO-92/TO-226 (BC,BD,MPS,PN,TN,2N).
Product **automatically comes in bulk** - 2K per box. No flow code needed.
Radial tape and reel



Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
D26Z	2K	13" dia.	18mm wide	Radial	Round side toward adhesive. (Equiv. to RA)

10 TO-92/TO-226 (BC,BD,MPS,PN,TN,2N).
Product **automatically comes in bulk** - 2K per box. No flow code needed.
Radial tape and reel

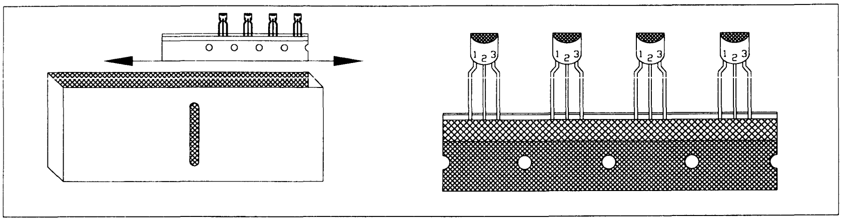


Flow code	Qty.	Reel size	Tape size	Tape Style	Notes
D27Z	2K	13" dia.	18mm wide	Radial	Flat side toward adhesive. (Equiv. to RE)

Ordering Information
(continued)

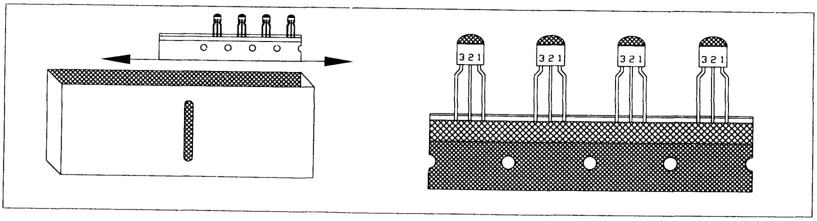
Ordering information and Flow code options for:

11 TO-92/TO-226 (BC,BD,MPS,PN,TN,2N).
Radial tape and ammo



Flow code	Qty.	Box size	Tape size	Tape Style	Notes
D75Z	2K	12 3/4 x 6 x 1 3/4	18mm	Radial	Round side toward adhesive. (Equiv. to RP). Options D26Z, D28Z, D10Z, D11Z can all be pulled from this box. Option dependant on which corner the product is pulled from.

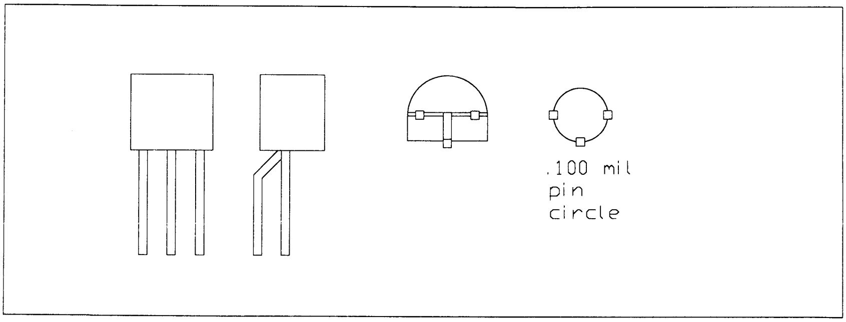
12 TO-92/TO-226 (BC,BD,MPS,PN,TN,2N).
Radial tape and ammo



Flow code	Qty.	Box size	Tape size	Tape Style	Notes
D74Z	2K	12 3/4 x 6 x 1 3/4	18mm	Radial	Flat side toward adhesive. (Equiv. to RM). Options D27Z, D29Z, D81Z, D89Z can all be pulled from this box. Option dependant on which corner the product is pulled from.

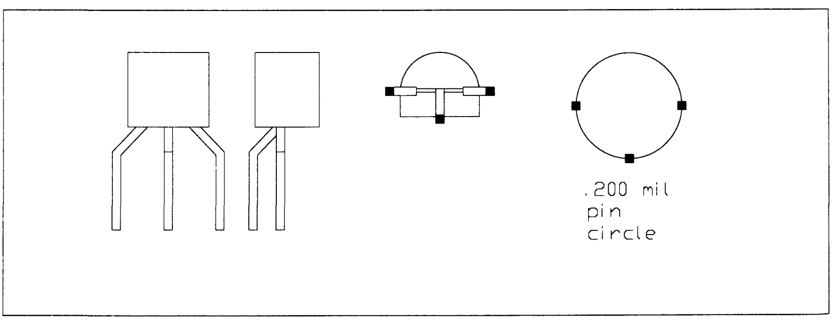
Ordering information and Flow code options for:

13 Leadforming TO-92/TO-226



Flow code	**Qty.**	**Notes**
J18Z	2K	Center lead toward the flat side to form TO-18 pin circle - .100 mils.

14 Leadforming TO-92/TO-226

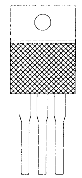


Flow code	**Qty.**	**Notes**
J05Z	2K	Center lead toward the flat side to form TO-5 pin circle - .200 mils.

Ordering Information
(continued)

Ordering information and Flow code options for:

15 TO-220
Product comes in bulk - order increments of 45pc.



Flow code	**Qty.**	**Notes**
J69Z	45	Center lead toward front to form .200 mil pin circle.

Section 10

Quality and Reliability

National Semiconductor™

Section 10 Contents

Quality and Reliability Assurance

QUALITY

Most discrete products from National Semiconductor are available in two forms:

1) Industrial / Commercial identified by a standard part number having various commonly-known prefixes and tested to a published National Semiconductor, JEDEC, Proelectron or other specification.

2) Customer-specific identified by an assigned "stamp-off" number, and tested and marked as determined by the customer for their specific requirements. This may range from a custom-marked industrial/commercial part to product meeting various additional/special electrical needs specified at -40 and 125 °C.

Device lots are subjected to 100% processing at final test to the datasheet or other applicable electrical specifications reflected on internal documentation. All products are then transferred to QA where they are subjected to sample electrical testing, usually to the same electrical specifications, and additional mechanical inspection requirements.

RELIABILITY

Discrete POWER & Signal Technologies utilizes two programs to insure reliability performance of various products delivered to our customers. They are the **1) Reliability Qualification Program** for new product and product manufacturing variations/locations, and the **2) Reliability Audit Program** applicable to existing qualified products, with the goal of continuous improvement.

Reliability Qualification Program

A standard procedure was developed and put in place defining the reliability requirements for product qualification. Tests used are indicated in **Table 1.** The scope includes all new products, products from new manufacturing facilities, changes in manufacturing locations, and major engineering changes on existing products. Major changes may include, but are not limited to:

- New product -- either in a new device design, new package design, or new fab technology
- New assembly location -- new assembly subcontractor, vendor, product transfer site
- Major process changes -- wafer fabrication process, manufacturing assembly process
- Package -- new or change in package design such as mold compound formulation
- Lead frames -- change in material composition, design, trim and form process
- Die layout / recipe -- wafer fabrication (i.e., new mask), epitaxy layer
- Fab location -- new fabrication site, new wafer vendor

Tests	Conditions	Timepoints	Sample Size
Autoclave (ACLV)	15 PSIG, 121°C	96, 168 Hours	77
High Temperature Storage Life (HTSL)	T_A = 150°C	168, 500, 1K Hours	77
High Temperature Reverse Bias (HTRB)	T_A = 150°C	168, 500, 1K Hours	77
High Temperature Gate Bias (H3TRB)	T_A = 150°C	168, 500, 1K Hours	77
Temperature Humidity Bias (THBT)	T_A = 150°C RH = 85%	168, 500, 1K Hours	77
Power Cycle (PRCL)	ΔT_J = 150°C	5K, 10K Cycles	77
Temperature Cycle (TMCL)	T_A = -65 to +150°C	100, 500 Cycles	77

Table 1: RELIABILITY REQUIREMENTS FOR DISCRETE SEMICONDUCTOR DEVICES

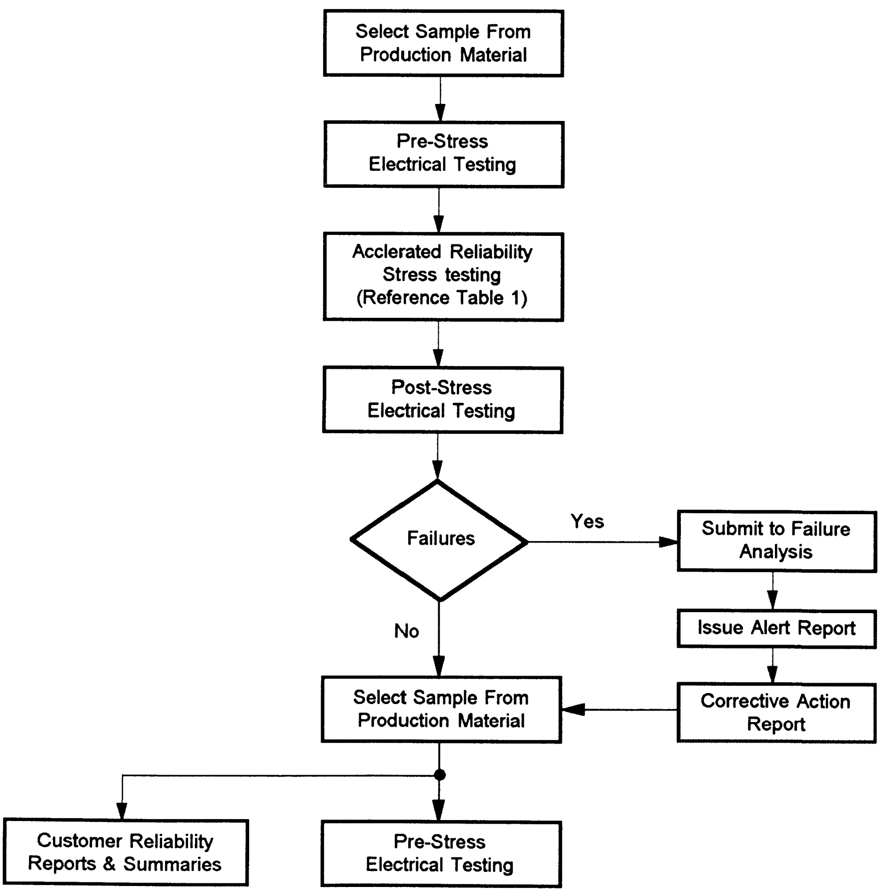


Figure 1: RELIABILITY ASSURANCE AUDIT PROGRAM TEST FLOW

Reliability Audit Program

Existing Products are evaluated on a routine basis to insure the reliability performance of products delivered to our valued customers. Two audit programs are in place to meet our customer reliability performance requirements. These include a **Fast Reaction Program** and a **Long Term Audit Program**. Both programs are tested per a generic family basis. The FRP refers to evaluating products at 48-168hr reliability stress tests while LTA refers to continued stress testing of products to 100hrs or equivalent duration. Tests used are listed in **Table 1**.

Examples of generic families would include: package iterations wherein the manufacturing process is benign to the die inside, type of die topography (overlay, non-overlay, MOS, etc.), primary polarity alignment, die recipe depths and concentrations, target BVs, etc. At any time, there is at least one iteration of each generic family designation in production undergoing long term reliability testing. Criteria includes pre- and postcomparisons of parametric distribution shapes in addition to GNG limits.

RELIABILITY VIS-A-VIS QUALITY

The words "reliability" and "quality" are often used interchangeably, as though they connote identical facets of a product's merit. However, reliability and quality are different, and discrete component users must understand the essential difference between the two concepts in order to properly evaluate the various vendors' programs for product integrity.

The concept of quality gives us information about the population of faulty components among good components, and generally relates to the number of faulty components that arrive at a user's facility. Viewed in another way, quality can instead relate to the number of faulty components that escape detection at the component vendor's facility.

It is the function of a vendor's Quality Control arm to monitor the degree of success of that vendor in reducing the number of faulty components that escape detection. QC does this by testing the outgoing parts on a sampled basis. The Acceptable Quality Level (AQL) determines the stringency of the sampling. As the AQL decreases, it becomes more difficult for bad parts to escape detection, thus the quality of the shipped parts increases.

The concept of reliability, on the other hand, refers to how well a part that is initially good will withstand its environment. Reliability is measured by the percentage of parts that fail in a given time period.

QUALITY IMPROVEMENT

When purchasing a component or a system, it is expected that each item delivered has been thoroughly tested and will perform according to datasheet or detailed specifications.

Additional programs can be implemented to improve quality. To be effective, a program must not only reduce escapes but also be tailored specifically to detect and remove the types of residual defects that are predicated by process and line monitor control data. The proper analysis and application of this data is a primary objective at National. With emphasis on "ship-to-stock" programs and the need to measure quality levels in ppm's, National Semiconductor has taken a leadership role in an on-going effort to strive for "zero defects."

In Discretes, the benefits derived as a result of this increased emphasis includes the following:

- Escapes caused by mishandling are reduced significantly.
- Residual thermo-mechanical defects not detected during normal room temperature testing or high temperatures buy-off are removed.
- Anomalous high temperature parametric effects that may have been created during wafer fabrication or in subsequent manufacturing are removed.
- An AQL of 0.05% is guaranteed.

RELIABILITY THROUGH DESIGN

With increased component density in modern electronic products has come an increased concern with component failures in such products. Virtually all equipment manufacturers thoroughly exercise their products before shipment. This is designed to stimulate, as closely as possible, field operating conditions. A high failure rate of discrete components at this level can dramatically increase manufacturing costs.

The most important factor affecting a component's reliability is its construction; i.e., the materials used and the method by which they are fabricated and assembled.

ON-GOING RELIABILITY IMPROVEMENT PROBLEM

Transistor reliability improvement at National Semiconductor is a continuous program.

Implementation of a program for field reliability improvement requires knowledge of field ambient and electrical environments and their influence on device performance. National's broad experience in commercial reliability programs has led to the development of an extensive in-house reliability monitoring program that permits us to monitor device performance under combinations of the following stresses:

- Thermal
- Thermo-Mechanical
- Mechanical
- Voltage
- Humidity

The data generated by these monitors is continually ranked and analyzed to determine appropriate corrective action necessary for any failure mechanisms noted. Rigorous analysis of SPC data that is routinely generated at critical stages of the fabrication and manufacturing process is integrated into the corrective actions loop. This continuous cycle of testing, analysis and corrective action assures the continued improvement of transistor field reliability.

Test Descriptions

The following tests are fequently used for screening, acceptance and evaluation of semiconductor devices.

A. Steady State Operating Life (SSOL or OPL)

The purpose of this test is to evaluate the bulk stability of the die and to generate defects resulting from manufacturing aberrations that are manifested as time and stress-dependent failures.

Conditions: T_A = 25°C, PD = max rated power

B. Intermittent Operating Life (IOPL or PRCL)

Sometimes referred to as the "power cycle." The purpose of this test is the same as Operating Life in addition to checking the integrity of both wire and die bonds by means of thermal stressing.

Conditions: T_A = 25°C, PD as required to obtain a specified Δtemperature

C. High Temperature Storage Life (HTS)

The purpose of this test is to generate time/temperature failure mechanisms and to evaluate long-term storage stability.

Conditions: T_A = 150°C, no bias applied

D. High Temperature Reverse Bias (HTRB)

The purpose of this test is to align mobile ions by means of temperature and voltage stresses to form a high-current leakage path between two or more terminals.

Conditions: T_A = 150°C, V_{CB} = 80% max rated V_{CB}

E. Temperature Humidity Bias (THBT)

The purpose of this test is to evaluate the moisture resistance of non-hermetic components. The addition of voltage bias accelerates the corrosive effect after moisture penetration has taken place. With time, this is a catastrophically destructive test.

Conditions: T_A = 150°C, RH = 85%

F. High Temperature High Humidity, High Reverse Bias (H3TRB)

This is an accelerated test. It's effect is to evaluate the individual items related to HTRB and various forms of moisture-resistance testing simultaneously. With time, this is a catastrophically destructive test.

Conditions: T_A = 150°C, RH = 85%, V_{CB} = 80% max rated V_{CB}

G. Autoclave (ACLV)

Sometimes referred to as "pressure cooker," the purpose of this test is to evaluate the moisture resistance of non-hermetic components under pressure/temperature conditions.

Conditions: T_A = 121°C, P = 1 atmosphere (15 psig)

H. Temperature Cycle Air-to-Air (TMCL)

The purpose of this test is to evaluate the ability of the device to withstand both exposure to extreme temperatures and the transition between temperature extremes, and to expose excessive thermal mismatch between materials.

Conditions: Mil-Std-750, Method 1051, -65°C to 150°C, 15 seconds dwell time at each temperature

I. Thermal Shock Liquid-to-Liquid (THSK)

This test is an accelerated version of temperature cycle.

Conditions: Mil-Std-750, Method 1056, -0°C to 100°C, 15 seconds dwell time at each temperature

J. Terminal Strength

The purpose of this test is to evaluate the ability of the device terminals to withstand the lead forming and tension associated with component installation into a circuit.

Conditions: Mil-Std-750, Method 2036, Condition E

K. Solderability

The purpose of this test is to determine the solderability of the device terminals.

Conditions: Mil-Std-750, Method 2026

L. Salt Atmosphere (Corrosion)

The purpose of this test is to accelerate the corrosion effects of an environment in which salt (NaCl) is present.

Conditions: Mil-Std-750, Method 1041

M. Mechanical Stress Test

Vibration, shock and constant acceleration tests are infrequently used since they rarely generate failures in small-signal transistors. However, they are still specified for acceptance of military product.

Glossary of Quality and Reliability Terms

Acceptance Quality Level (AQL) - A measure of quality for which a given lot will be accepted most of the time. This is usually established at a probability of acceptance equal to 95%.

Acceptance Number (Ac) - The largest number of defectives in an inspection sample under consideration that will permit acceptance of the lot.

Average Outgoing Quality (AOQ) - The average quality of outgoing product after 100% screening of rejected lots. This is usually measured in parts per million (PPM)

Average Outgoing Quality Limit (AOQL) - The maximum average outgoing quality that is possible for a given sampling plan.

Defect - Any deviation of a device that does not conform to specified requirements.

Defective - Any device which contains one or more defects.

Double Sampling - Sampling inspection in which the inspection of the first sample leads to a decision to accept, to reject, or to take a second sample. The inspection of a second sample, when required, always leads to a decision to accept or to reject.

Failure - The inability of a device to perform a specified function within previously-established limits.

Failure Rate - The statistical probability of a failure occurring within a stated period of time. The failure rate of semiconductor devices is generally given in percent per thousand hours.

Infant Mortality - Premature failures occurring at a failure rate substantially greater than that observed during subsequent life prior to wear-out.

Lot - A group of devices from which samples are drawn and inspected to determine compliance with acceptance criteria (inspection lot).

Lot Tolerance Percent Defective (LTPD) - A measure of quality for which a given lot will be rejected most of the time. A single lot sampling concept that statistically ensures rejection of 90% of all lots having a greater percent defective than the specified LPTD.

Mean Time Between Failures (MTBF) - The average number of total unit operating hours after a device has failed that would occur before the next device failure would be expected to occur.

Operating Characteristic Curve (OC curve) - A graph of the probability of acceptance as a function of the lot quality or process average quality, whichever is applicable.

Percent Defective - The number of defective devices in a lot divided by the total number of devices in that lot, multiplied by 100.

Probability of Acceptance (Pa) - The fractional probability that a lot will be accepted, usually expressed as a decimal.

Process Average Quality - The expected quality of product from a given process, usually estimated from first sample results of previous inspection lots.

Quality - A measure of the degree to which a product conforms to specification and workmanship requirements.

Rejection Number (Re) - The smallest number of defectives in an inspection sample under consideration that will prevent acceptance of the lot.

Reliability - A measure of the performance of a product over a specified period of time.

Sample - One or more devices selected at random from an inspection lot to represent that lot for acceptance purposes.

Sampling Plan - A specific plan which defines the sample size and the criteria for accepting or rejecting a lot.

Screening Tests - Tests employing nondestructive environmental, electrical, thermal and/or mechanical stresses, for the purpose of identifying anomalous devices.

Single Sampling - Sampling inspection in which a decision to accept or reject is reached after the inspection of a single sample.

Wearout Failures - Those failures which occur as a result of normal deterioration processes.

100% Inspection - Inspection of every device, in which each device is accepted or rejected individually for the characteristic concerned.

Section 11

Glossary of Terms

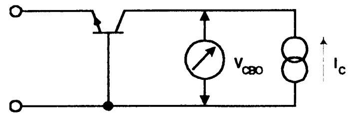
Section 11 Contents

Transistor Glossary of Symbols

DC PARAMETERS

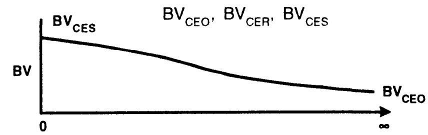
BV_{CBO}

Collector-Base Breakdown Voltage with Emitter Open-Circuited
The breakdown voltage of the collector-base junction, measured at a specified current, with the emitter open-circuited.



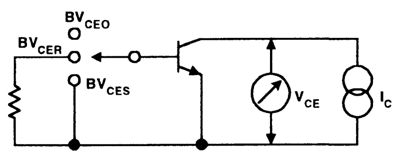
BV_{CEO}

Collector-Emitter Breakdown Voltage with Base Open-Circuited
The collector-emitter breakdown voltage, measured at a specified collector current, with the base open-circuited.



BV_{CER}

Collector-Emitter Breakdown Voltage with Resistance between Emitter and Base
The collector-emitter breakdown voltage measured at a specified current with a specified resistance R connected between the base and the emitter.

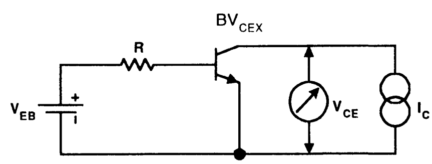


BV_{CES}

Collector-Emitter Breakdown Voltage with Base Shorted to Emitter
The collector-emitter breakdown, measured at a specified current, with the base shorted to the emitter.

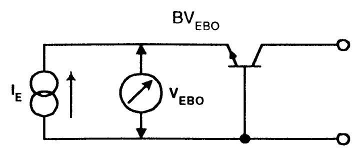
BV_{CEX}

Collector-Emitter Breakdown Voltage at a Specified Condition
The collector-emitter breakdown voltage measured at a specified current with the base-emitter junction forward or reverse biased by a specified voltage or current.

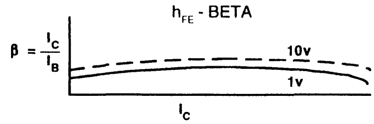


BV_{EBO}

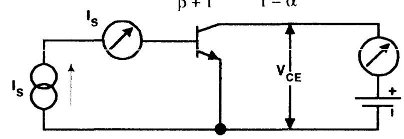
Emitter-Base Breakdown Voltage with Collector Open-Circuited
The emitter-base breakdown voltage, measured at a specified current, with the collector open-circuited.

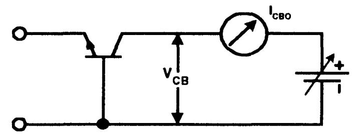


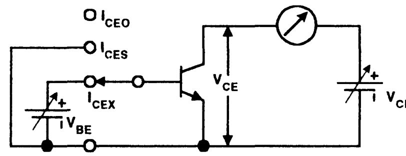
DC PARAMETERS (continued)

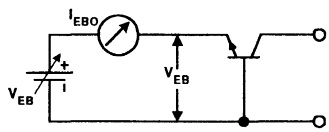
<table>
<tr>
<td>h_{FE}</td>
<td>Common-Emitter DC Current Gain
The ratio of DC collector current to DC base current measured at a specified collector-emitter voltage and a specified collector current.</td>
<td>


$\alpha = \frac{\beta}{\beta + 1}$ $\beta = \frac{\alpha}{1 - \alpha}$

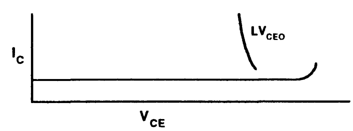


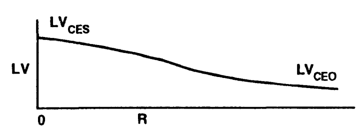
</td>
</tr>
<tr>
<td>I_{CBO}</td>
<td>Inverse Collector-Base Current
The collector-base current with the junction reverse biased by a specified voltage, with the emitter open-circuited.</td>
<td>


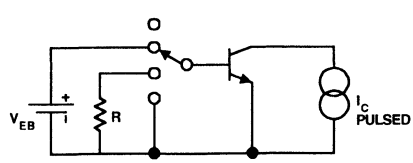
$I_{CEO} = (\beta + 1)\, I_{CBO}$
</td>
</tr>
<tr>
<td>I_{CEO}
I_{CEX},
I_{CES}</td>
<td>Inverse Collector-Emitter Current at a Specified Condition
The collector-emitter current measured at a specified collector-emitter voltage with the base forward or reverse biased by a specified voltage or current, or with the base shorted to the emitter.</td>
<td>


</td>
</tr>
<tr>
<td>I_{EBO}</td>
<td>Inverse Emitter-Base Current
The emitter-base current with the junction reverse biased by a specified voltage with collector open-circuited.</td>
<td>


</td>
</tr>
<tr>
<td>LV_{CEO},
LV_{CER},
LV_{CES},
LV_{CEX}, or
$V_{CEO(SUST)}$
$V_{CER(SUST)}$
$V_{CES(SUST)}$
$V_{CEX(SUST)}$</td>
<td>Pulsed Limiting Breakdown Voltage
These are similar to the corresponding, above defined, BV parameters but are measured at a specified high current point where collector-emitter voltage is lowest. The duration of the pulse and its duty cycle must be specified. The letter "L" indicates LIMITING Value and is measured outside the negative resistance zone of the reverse characteristic.</td>
<td>
LV_{CEO}, LV_{CER}, LV_{CES}, LV_{CEX}





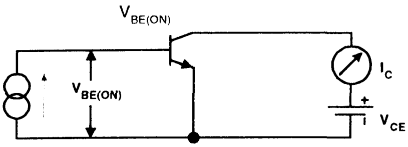


</td>
</tr>
</table>

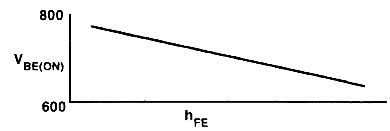
DC PARAMETERS (continued)

$V_{BE(ON)}$

Unsaturated Base-Emitter Voltage
The base-emitter voltage measured in the common-emitter connection at a specified collector to emitter voltage and specified collector current.



$\Delta V_{BE(ON)} \cong \Delta t \cong 1.8V/°C - 2.4\ mV/°C$



$V_{BE(SAT)}$

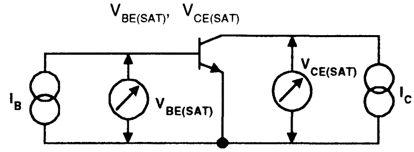
Base-Emitter Saturation
The base-emitter voltage measured in the common-emitter connection at a specified collector and base saturation current.

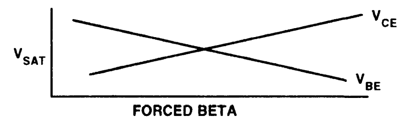
$V_{CE(SAT)}$

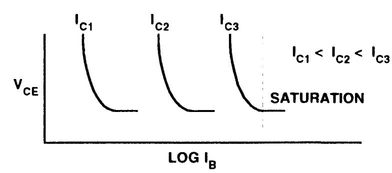
Collector-Emitter Saturation Voltage
The collector-emitter voltage measured in the common-emitter connection at a specified collector and base saturation current.

$V_{BE(SAT)}, V_{CE(SAT)}$

$\beta_{CKT} = \frac{I_C}{I_B}$







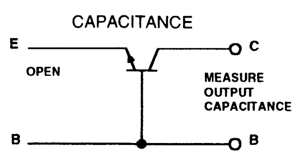
V_{RT}
V_{PT}

Reach Through Voltage
Punch Through Voltage
The collector-emitter voltage measured in the common-emitter connection at a specified collector and base saturation current.

SMALL SIGNAL PARAMETERS

C_{ob}

Common-Base Output Capacitance
The common-base output capacitance with input AC open.



C_{re}

Common-Emitter Reverse Transfer Capacitance
This parameter is the imaginary port of Y_{re}.
When $I_C = 0$, C_{re} is identical to C_{CB}.

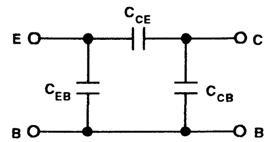
SMALL SIGNAL PARAMETERS (continued)

C_{te}, C_{ib}, C_{EB}

Base-Emitter Capacitance
The capacity of the base-emitter junction at a specified inverse voltage with the collector open.

C_{CB}

Collector-Base Capacitance
Collector-base capacitance measured at some specified collector-base voltage.



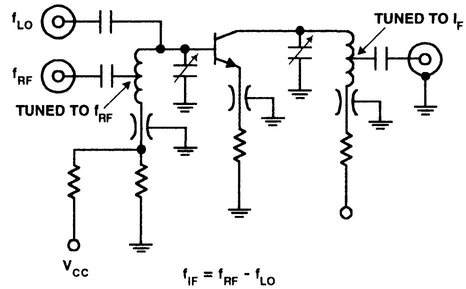
$$C_{ob} = C_{CB} + \frac{C_{CE}C_{EB}}{C_{CE} + C_{EB}} = C_{CB} + C_{CE}$$

2) C_{CB}
$C_{CB} = C_{ob}$ (WITH EMITTER GUARDED)

CG_e, CG_b

Conversion Gain, Common-Emitter or Common-Base
The ratio of the output power of a mixer, at one specified frequency, to its input power, at another specified frequency. This parameter is a function of an oscillator injection voltage and the mixer operating point.

CONVERSION GAIN
1) SPECIFY I_C, V_{CE}
2) f_{RF}, f_{IF}, LO LEVEL, CIRCUIT



$f_{IF} = f_{RF} - f_{LO}$

$f_{\alpha b}$, f_{hfb}

Common-Base Cut Off Frequency
The frequency at which the h_{fb} (α) is reduced to 0.707 of its low frequency value.

f_{β}, f_{hfe}

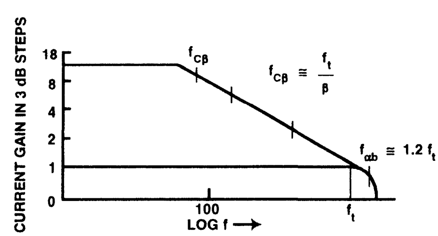
Common-Emitter Cut Off Frequency
The frequency at which the h_{fe} (β) is reduced to 0.707 of its low frequency value.

Gain Band-Width Product
The common-emitter current gain bandwidth product in the frequency range where the current gain is falling at approximately 6 db per octave.

f_t

Transition Frequency
The frequency at which the h_{fe} (β) is equal to 1.0. This is a device figure of merit that is often specified at a V_{CE} and I_C.

$f_{\alpha b}$, f_{β}, f_t



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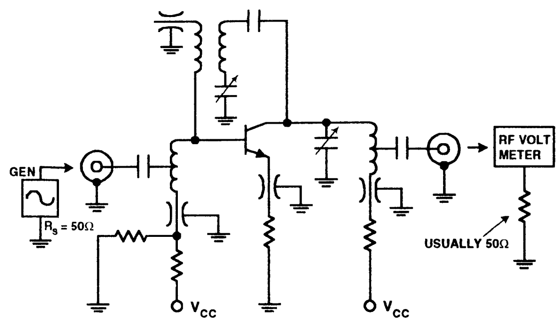
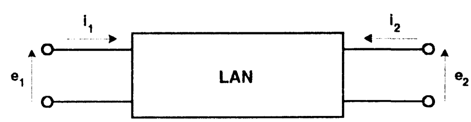
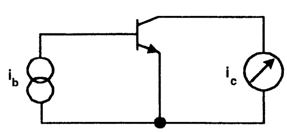
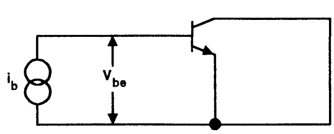
f_{MAX}

Maximum Frequency of Oscillation
This parameter is a device figure of merit that is calculated from ft and rb'Cc.

f_{MAX} = MAX FREQUENCY OF OSCILLATION
FREQUENCY AT WHICH MAG = 1

$$2)\ f_{MAX} = \sqrt{\frac{f_t}{8\pi\ rb\ Cc}} = f\ \sqrt{PG}$$

SMALL SIGNAL PARAMETERS (continued)

Symbol	Term	Illustration
GP_e, PG G_{TE}	**Common-Emitter Power Gain** **Power Gain** Can be common-emitter or common-base. Usually stability-limited gains involved, thus is effectively a transducer gain measurement. **Common-Emitter Transducer Gain** A test fixture must be specified.	POWER GAIN, TRANSCONDUCER GAIN 1) SPECIFY I_C, V_{CE} 2) fo, $\beta\omega$, CIRCUIT, NEUTRALIZED?  $G_{TE} = \frac{\text{POWER DELIVERED TO THE LOAD}}{\text{POWER AVAILABLE FROM THE SOURCE}}$
GMA	**Stability Limited Gain or Gain Maximum Available** This parameter is a device figure of merit and must be calculated from the two port "y" parameters.	$\mathrm{GMA} = 10\ \mathrm{LOG}\left[\frac{\lvert Y_{fe}\rvert}{\lvert Y_{re}\rvert}\left(k - \sqrt{K^2 - 1}\right)\right]$ NOT DEFINED FOR K < 1
	h Parameters	h - PARAMETERS  WHERE e_1, I_1, i_2, e_2, ARE SMALL SIGNAL VOLTAGES AND CURRENTS, THE h - (HYBRID) PARAMETERS ARE DEFINED BY $e_1 = h_{11} i_1 + h_{12} e_2$ $i_2 = h_{21} i_1 + h_{22} e_2$ AND FOR COMMON EMITTER OPERATION THESE E Q BECOME $e_1 = h_{ie} i_1 + h_{re} e_2$ $i_2 = h_{fe} i_1 + h_{oe} e_2$
h_{fe}	**Common-Emitter Current Gain** The common-emitter forward current transfer ratio with the output AC shorted. This is a complex quantity.	h - PARAMETERS - COMMON EMITTER  $h_{ie} = \left.\frac{V_{be}}{I_b}\right\rvert V_{ce} = 0$
h_{fe}	**Common-Emitter Input Impedance** The common-emitter input impedance with the output AC shorted. This is a complex quantity.	 $h_{fe} = \left.\frac{I_C}{I_b}\right\rvert V_{ce} = 0$

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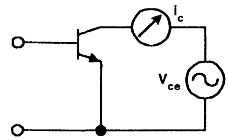
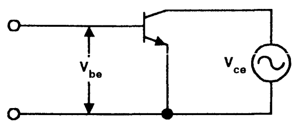
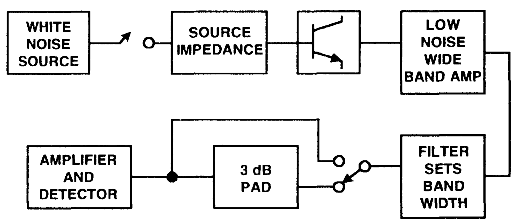
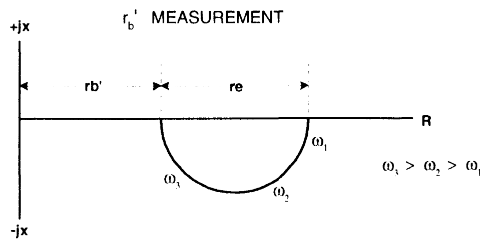
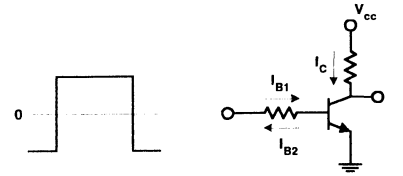
SMALL SIGNAL PARAMETERS (continued)

h_{oe}	**Common-Emitter Output Admittance** The common-emitter output admittance with the input AC open. This is a complex quantity.	 $h_{oe} = \frac{i_e}{V_{ce}}\Big\|_{i_b = 0}$
h_{re}	**Common-Emitter Reverse Voltage Transfer** The common-emitter reverse voltage transfer ratio with the input AC open. This is a complex quantity.	 $h_{re} = \frac{V_{be}}{V_{co}}\Big\|_{i_b = 0}$
MAG	**Maximum Available Gain** Device figure of merit that must be calculated from the port "y" parameters.	$MAG = 10\ LOG \frac{\|Y_{21}\|}{4\ Re\ (Y_{11})\ Re\ (Y_{11})}$
MSG	**Maximum Stable Gain** This parameter is a device figure of merit that is calculated from the port "y" parameters.	$MSG = 10\ LOG \frac{\|Y_{fe}\|}{\|Y_{re}\|}$
NF	**Noise Figure** Noise figure = 10 $\log_{10}F$, where F is the ratio of total output noise power to the output power due solely to the thermal noise of the source impedance.	NOISE FIGURE MUST SPECIFY 1) V_{CE}, I_C 2) R_S, f_o, PBW 
$r_{bb'}$, $r_{b'}$	**Base <<Spreading>> Resistance** Equivalent to the real part of h_{ie} at some specified very high frequency.	
	Collector Base Time Constant This parameter is a device figure of merit and is measured in a specified test circuit.	r_b', C_C = COLLECTOR BASE TIME CONSTANT SPECIFY - I_C, V_{CE}, FREQUENCY

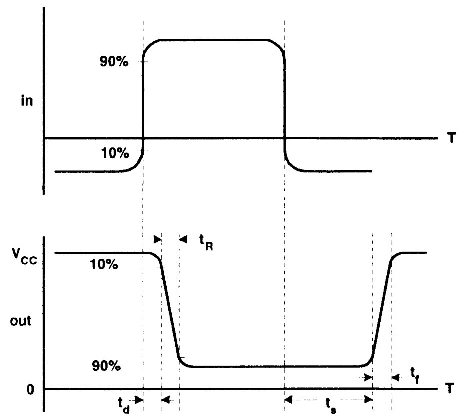
SMALL SIGNAL PARAMETERS (continued)

Common-Emitter Switching Parameters
In the following, drive circuit conditions and collector circuit conditions must be specified. The transition times of the input must be negligible compared to the measured times.

SWITCHING PARAMETERS



$T_{ON} = t_d + t_r$
$T_{OFF} = t_s + t_f$



t_d } t_{ON}

Delay Time
The time interval during turn-on from the point when the input pulse at the base reaches 10% of its full amplitude to the point when the collector pulse changes from 0% to 10% of its maximum amplitude.

t_r

Rise Time
The time interval during turn-on in which the collector pulse changes from 10% to 90% of its maximum amplitude.

t_s } t_{OFF}

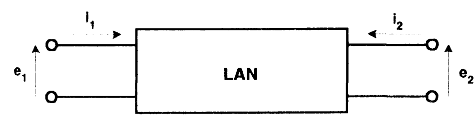
Storage Time
The time interval during turn-off from the point when the turn-off pulse at the base changes from 100% to 90% of its full amplitude to the time when the collector current has changed from 100% to 90% of its maximum amplitude.

t_f

Fall Time
The time interval during turn-off in which the collector pulse decreases from 90% to 10% of its maximum amplitude.

Y Parameters

Y PARAMETERS



Y PARAMETERS ARE DEFINED BY

$e_1 = h_{11} i_1 + h_{12} e_2$

$i_2 = h_{21} i_1 + h_{22} e_2$

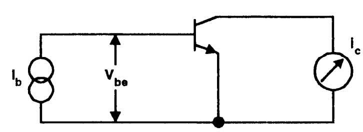
OR IN COMMON EMITTER NOTATIONS

$e_1 = h_{ie} i_1 + h_{re} e_2$

$i_2 = h_{fe} i_1 + h_{oe} e_2$

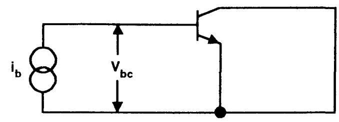
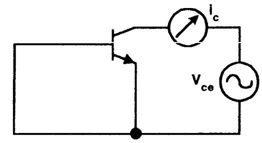
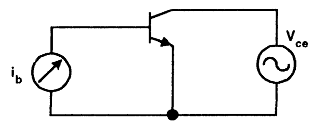
Y_{fe}

Common-Emitter Forward Transfer Admittance
The common-emitter forward transfer admittance with output AC shorted. This is a complex quantity ($g_{fe} + jb_{fe}$).

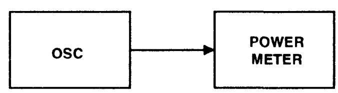


$$Y_{fe} = \left.\frac{i_c}{V_{be}}\right| V_{ce} \equiv 0$$

SMALL SIGNAL PARAMETERS (continued)

Y_{fe}	**Common-Emitter Input Admittance** The common-emitter input admittance with output AC shorted. This is a complex quantity ($g_{ie} + jb_{ie}$).	Y PARAMETERS - COMMON EMITTERS  $Y_{ie} = \frac{i_b}{V_{be}}\Big\vert V_{ce} = 0$
Y_{oe}	**Common-Emitter Output Admittance** The common-emitter output admittance with input AC shorted. This is a complex quantity ($g_{oe} + jb_{oe}$).	 $Y_{oe} = \frac{I_c}{V_{ce}}\Big\vert V_{be} = 0$
Y_{re}	**Common-Emitter Reverse Transfer Admittance** The common-emitter input admittance with output AC shorted. This is a complex quantity ($g_{re} + jb_{re}$).	 $Y_{ro} = \frac{I_b}{V_{ce}}\Big\vert V_{be} = 0$

LARGE SIGNAL PARAMETERS

η	**Collector Efficiency** This parameter applies to oscillators and class C amplifiers, predominantly. It is defined as the ratio of RF Power Out/DC Power In.	η - COLLECTOR EFFICIENCY $\eta = \frac{P_O\,(RF)}{P_{IN(DC)}} = \frac{vi}{I_C \times V_{CE}}$
P_o	**Power Out** This parameter applies to oscillators. The units are Watts and a test circuit must be specified.	 SPECIFY - I_C V_{CE} UNDER QUIESCENT CONDITIONS f_O, R_{LOAD}

THERMAL PARAMETERS

R_{TH}	**Internal Junction-to-Case Thermal Resistance** The rated increase of junction temperatures with respect to the case junction temperature per unit of dissipated power. It is called Thermal Resistance with infinite heat sink.	
θ_{JC}	**Junction-to-Case Thermal Rating**	
θ_{JA}	**Junction-to-Ambient Thermal Rating**	

Diode Glossary of Symbols and Terms

BV Breakdown Voltage: *Figure 1* shows the reverse characteristic of a typical silicon diode. Breakdown voltage is generally the reverse voltage at a point beyond the "knee" of the reverse characteristic. In *Figure 1*, the breakdown voltage is specified at a reverse current of I_{R2}.

C Capacitance: Diode capacitance is measured at a specified reverse voltage using an AC signal of specified frequency. When capacitance is measured at V_R = 0, this is sometimes denoted by the symbol C_o.

C_C Case Capacitance: The part of a diode's total capacitance which is attributable to the diode package.

f_o Series Resonant Frequency: The frequency of oscillation of the tuned circuit formed by the capacitance and inherent series inductance of the diode.

I_F Continuous Forward Current (Rating): The maximum direct current that can be safely passed through a diode in the forward direction.

I_F Forward Current: The direct current passing through a diode in the forward direction.

I_f Forward Current: The forward current passing through a diode operated under switching conditions. *See Figure 3.*

I_f Peak Repetitive Forward Current: The maximum value of the peak point of a single cycle of current that can safely be passed through a diode in the forward direction. This is a continuous (i.e. repetitive) rating.

I_f Peak Forward Surge Current: The maximum value of the peak point of a single cycle of current that can be safely passed through a diode in the forward direction. This is not a continuous rating.

I_{FSM} Peak Forward Surge Current: This rating is the same as $I_{f(surge)}$ but is more generally applied to rectifiers.

I_O Average Rectified Current: The average value of the forward current passing through a diode; as a rating, the maximum value of such current that can be safely passed.

I_R Reverse Current: The leakage current which flows in the reverse direction through a diode when a reverse voltage is applied to the diode. Referring to *Figure 1*, I_R is typically measured at a specified reverse voltage at a point below the "knee" on the reverse characteristic.

I_r Reverse Current: The peak value of reverse current which occurs immediately after switch-off. The value of I_r is limited by the circuit, which determines the rate at which stored charge can be dissipated. See *Figure 3.*

I_{rr} Reverse Current: The steady value of reverse current at equilibrium after switch-off. See *Figure 3.*

I_{RAV} Average Reverse Current: The average reverse current which flows when AC voltage is applied across a diode.

I_{RM} Reverse Recovery Current: The peak value of reverse current which flows immediately after switching applied voltage from the forward to the reverse direction. I_{RM} is the same as I_r, generally used for rectifiers.

I_{RX} Reverse Current: The symbol used to denote the reverse current of a single diode in an array at a time when all other diodes in the array are passing forward current. It is a measure of cross-talk between diodes.

I_Z Zener Current: The reverse current which flows in a zener diode at a point beyond the "knee" in the reverse characteristic. See Figure 2.

I_{Zsurge} Maximum Zener Surge Current: The maximum value of the peak point of a single cycle of current that can safely be passed through a zener diode in the reverse direction. This is not a continuous rating.

I_{ZM} Maximum Zener Current: The maximum value of direct current that can be safely passed through a zener diode in the reverse direction.

L_S Series Inductance: Inductance that is inherent in the construction of a diode, normally measured between two specified points on the diode lead.

N_D Noise Density: A measurement of the noise generated within a zener diode, both due to zener breakdown and internal resistance. Noise density, measured in microvolts rms per square root cycle, can be used to calculate rms noise over any frequency range.

NF Noise Figure: A ratio used to measure the noise generated within a diode. The ratio used is total output noise compared to the part of output noise due to input noise. This ratio, when multiplied by 10 $\log_{10}$, is known as noise figure and is measured in decibels (dB).

Q Figure of Merit: Generally used as a measure of the "quality" of varactor diodes, the figure of merit is defined as the ratio of energy stored to energy dissipated.

Q_S Stored Charge: The charge stored in a diode when passing current in the forward direction. Stored charge is usually measured by switching the diode off and measuring the area of the "I" versus "t" curve from switch-off to equilibrium. See *Figure 3.*

R_D Dynamic Resistance: Small signal resistance of a diode operating in the reverse direction determined by the small signal or AC values or reverse current and reverse voltage. This parameter is of particular importance in varactor diodes.

r_{diff} Differential Resistance: Small signal resistance of a diode operating in the forward direction determined by the small signal or AC values of forward current and forward voltage.

RE Rectification Efficiency: The ratio of DC load voltage to peak RF input voltage to a detector.

Diode Glossary of Symbols and Terms
(continued)

Reverse Characteristic

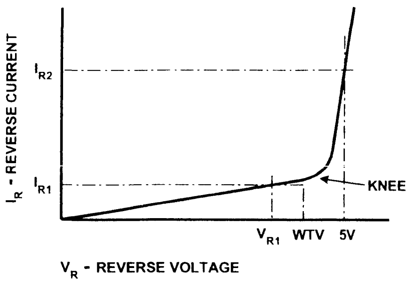


FIGURE 1

Zener Diode Reverse Characteristic

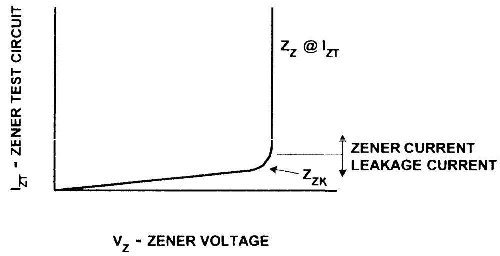


FIGURE 2

Reverse Recovery Characteristic

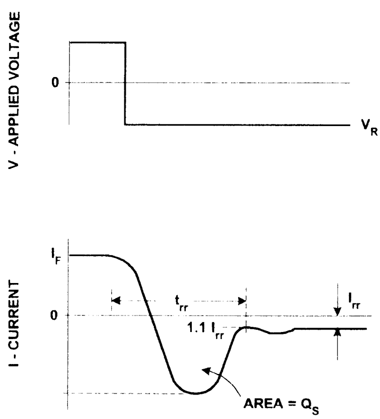


FIGURE 3

Forward Recovery Characteristic

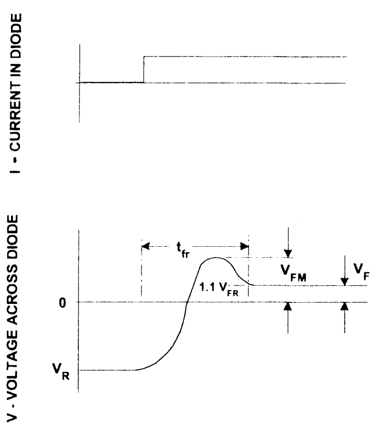


FIGURE 4

R_S Series Resistance: Small signal resistance of a diode operating in the forward direction determined by the small signal or AC values of forward current and forward voltage. Same as r_{diff}.

TC Temperature Coefficient: A coefficient which determines the variation of various parameters (e.g. Capacitance, Zener voltage, forward voltage) with temperature. A subscript is often used to denote the parameter to which the temperature coefficient refers.

t_{fr} Forward Recovery Time: The time interval between the point at which a diode is turned on and the point at which the forward voltage comes to within 10% of its equilibrium level. See *Figure 4*.

t_{rr} Reverse Recovery Time: The time interval between the point at which a diode is turned off and the point at which the reverse current comes to within 10% of its equilibrium level. See *Figure 3*.

V_F Forward Voltage: The voltage applied across a diode in the forward direction (anode more positive than cathode).

V_{FAV} Average Forward Voltage: The average value of forward voltage when current is being passed through a diode in the forward direction.

V_{fr} Forward Recovery Voltage: The peak value of forward voltage reached immediately after switch-on. The value of V_{fr} is limited by the circuit in which the diode is operating.

V_{FX} Forward Voltage: The symbol used to denote the forward voltage of a single diode in an array at a time when the condition of the other diodes in the array is defined. It can be used as a measure of cross-talk between diodes.

V_{PM} Peak Forward Voltage: The peak value of forward voltage reached immediately after switch-on. Same as V_{PK}.

V_R DC Blocking Voltage Rating: The continuous reverse voltage at which a rectifier can be safely operated without going beyond the "knee" in the reverse characteristic. See *Figure 3*.

Diode Glossary of Symbols and Terms
(continued)

V_R **Reverse Voltage:** The voltage applied across a diode in the reverse direction (anode more negative than cathode).

V_{RRM} **Peak Repetitive Reverse Voltage:** The maximum value of the peak point of a reverse voltage that can be safely applied to a diode. This is a continuous (i.e. repetitive) rating and includes all repetitive transient voltages.

V_{Rrms} **rms Reverse Voltage:** The maximum rms value of a reverse voltage that can be safely applied to a diode.

V_{RWM} **Working Peak Reverse Voltage:** The maximum value of the peak point of a reverse voltage that can be safely applied to a diode. This is not a continuous rating and does not include transient voltages.

V_Z **Zener Voltage:** The reverse voltage across a zener diode at a point where the zener current is flowing. See *Figure 2*.

WIV **Working Inverse Voltage:** The maximum reverse voltage at which a diode can be operated below the "knee" on the reverse characteristic. See *Figure 1*.

Z_Z **Zener Impedance:** The small signal impedance of a zener diode operating in the zener region, determined by the small signal of AC values of zener current and zener voltage.

Z_{ZK} **Zener Knee Impedance:** Zener impedance measured at a defined point on the "knee" of the zener characteristic. See *Figure 2*.

I_R **Reverse Current Match:** The difference in reverse current between any two diodes measured under the same conditions.

V_F **Forward Voltage Match:** The difference in forward voltage between any two diodes measured under the same conditions.

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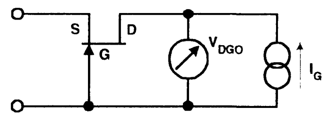
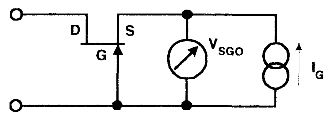
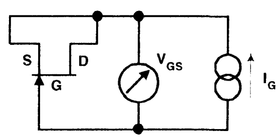
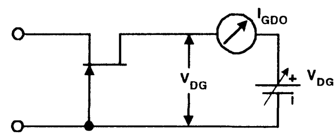
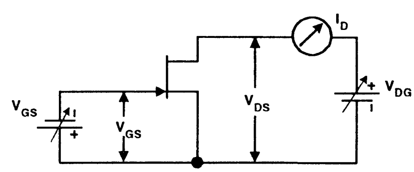
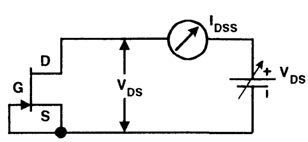
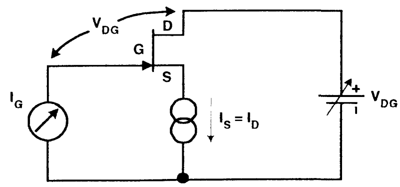
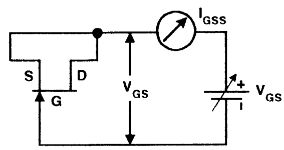
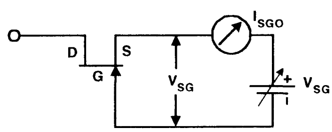
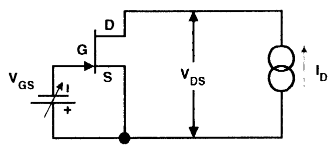
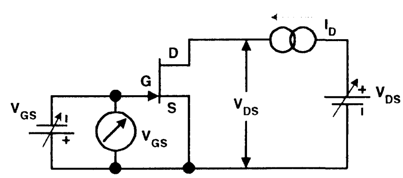
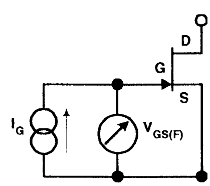
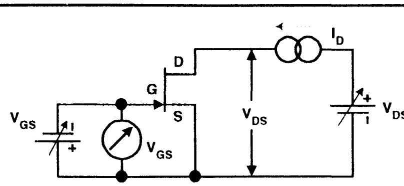
JFET Glossary of Symbols

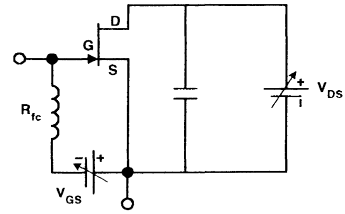
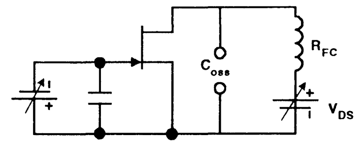
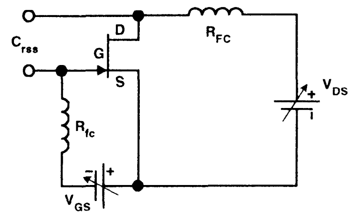
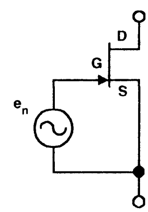
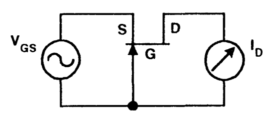
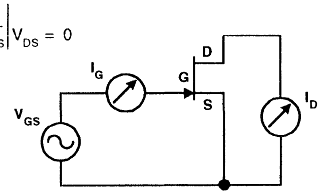
DC PARAMETERS

BV_{DGO}(V) or BV_{GDO}	**Drain-Gate Breakdown Voltage with Source Open Circuit** The breakdown voltage of the drain-gate junction, measured at a specified current, with the source open-circuited.	
BV_{SGO}(V) or BV_{GSO}	**Source-Gate Breakdown Voltage with Drain Open Circuited** The breakdown voltage of the source-gate and drain-gate junctions, measured at a specified collector current, with the drain open-circuited.	
BV_{GSS}(V) or BV or $V_{(BR)GSS}$	**Source-Gate Breakdown Voltage with Drain-Source Shorted** The breakdown voltage of the source-gate and drain junctions, measured at a specified current with the drain-source shorted.	
I_{DGO}(pA) or I_{GDO}	**Drain-Gate Leakage Current with Source Open-Circuited** The leakage current of the drain-gate junction, measured at a specified voltage, with the source open circuited.	
I_D(μA) or $I_{D(ON)}$ $I_{D(OFF)}$(pA)	**Drain ON Current** The drain current, measured at a specified drain-source voltage and gate-source voltage. **Drain Cutoff Current** The drain cutoff current, measured at a specified drain-source voltage and gate-source voltage.	
I_{DSS}(mA)	**Drain Saturation Current** The drain current, measured at a specified drain-source voltage with the source shorted to the gate (V_{GS} = 0).	

DC PARAMETERS (continued)

I_G (pA) or $I_{G\,(ON)}$	**Gate Leakage Current with Drain Current Flowing** The gate leakage current, measured at a specified drain current and drain-gate voltage.	
I_{GSS} (pA)	**Gate-Source Reverse Leakage Current with Drain-Source Shorted** The gate-source reverse leakage current, measured at a specified gate-source voltage.	
I_{SGO}(pA) or I_{GSO}	**Source-Gate, Reverse Leakage Current with Drain Open-Circuited** The leakage current of the source-gate junction, measured at a specified voltage, with the drain open-circuited.	
DS(Ω) or r_{ds}, R_{DS}, $r_{DS(ON)}$ $V_{DS(ON)}$(mV)	**Drain-Source ON Resistance** The drain-source ON resistance, measured at a specified gate-source voltage and drain current. **Drain Source ON Voltage** The drain-source ON voltage, measured at a specified gate-source voltage and drain current.	
V_{GS} (V) or $V_{GS(ON)}$, V_G	**Operating Gate-Source Voltage** The gate-source voltage, measured at a specified drain current and drain-source voltage.	
$V_{GS(F)}$ (V)	**Forward Gate-Source Voltage** The forward gate-source voltage, measured at a specified current.	
$V_{GS(OFF)}$ (V) or V_p	**Gate-Source Cutoff (Pinch-Off) Voltage** The gate-source cutoff voltage, measured at a specified drain current and drain-source voltage.	

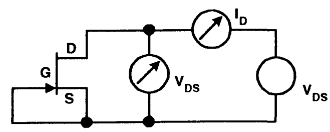
SMALL SIGNAL PARAMETERS

C_{iss}(pF) or C_{is}, C_{gss}	**Common-Source Input Capacitance** The common-source input capacitance, measured between the drain and source with the drain AC shorted to the source at specified drain-source and gate-source voltages.	
C_{oss}(pF) or C_{os}, C_{dss}	**Common-Source Output Capacitance** The common-source output capacitance, measured between the drain and source with the source AC shorted to the gate at specified drain-source and gate-source voltages.	
C_{rss}(pF) or C_{rs}, C_{dg}	**Common-Source Reverse Transfer Capacitance** The common-source reverse transfer capacitance, measured between the drain and gate at specified drain-source and gate-source voltages.	
e_n (nV/$\sqrt{Hz}$) e_n, V_n, E_n	**Equivalent Input Noise Voltage** The equivalent input noise voltage per unit bandwidth, measured with the input AC shorted to the source at a specified operating condition.	
g_{fg}(mV)(mΩ) or y_{fg}	**Common-Gate Forward Transconductance** The common-gate forward transconductance with the output AC shorted. This is a complex quantity ($g_{fg} + j_{bfg}$).	 $Y_{fg} = \frac{I_D}{V_{GS}}\Big\vert V_{DS} = 0$
g_{fs}(mV)(mΩ) or g_m, Y_{fs}, or Re Y_{fs}	**Common-Source Forward Transconductance** The common-source forward transconductance with the output AC shorted. This is a complex quantity ($g_{fs} + j_{bfs}$).	$Y_{fs} = \frac{I_D}{V_{GS}}\Big\vert V_{DS} = 0$ 
g_{iss} (μV)(μΩ) or V_p	**Common-Source Input Conductance** The common-source input conductance with the output AC shorted. This is a complex quantity ($g_{is} + j_{bis}$).	$Y_{is} = \frac{I_G}{V_{GS}}\Big\vert V_{DS} = 0$

SMALL SIGNAL PARAMETERS (continued)

g_{oss} (µV)(µΩ) or Y_{os}

Common-Source Output Conductance
The common-source output conductance with the input AC shorted. This is a complex quantity ($g_{os} + j_{bos}$).



$$Y_{os} = \frac{I_D}{V_{DS}}\bigg|_{V_{GS} = 0}$$

G_{pg}(dB)

Common-Gate Power Gain
The common-gate power gain is the ratio of output power to input power.

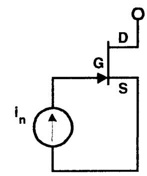
G_{ps}(dB)

Common-Source Power Drain
The common-source power gain is the ratio of output power to input power.

$$G_P = 10 \log_{10} \frac{|P_O|}{|P_I|}$$

i_n (pA/√Hz)

Equivalent Input Noise Current
The equivalent input noise current measured with the input open-circuited under specific operating conditions.



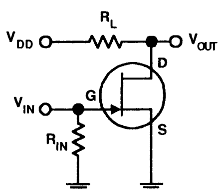
NF (dB)

Spot Noise Figure
Noise figure = 10 $\log_{10}$F where F is noise factor which is the ratio of the total output noise power to the output noise power of the source. Measured at specified operating conditions and source resistance.

$$F = \frac{\text{TOTAL OUTPUT NOISE POWER}}{\text{SOURCE OUTPUT NOISE POWER}}$$

COMMON SOURCE SWITCHING PARAMETERS

In the following, drive circuit conditions and drain circuit conditions must be specified. The transition times of the input must be neglible compared to the measured times.



$$I_{D(ON)} = \frac{V_{DD} - V_{DS(ON)}}{R_L}$$

t_d(ns)

Turn-On Delay Time
The time interval during turn-on from the point when the input pulse at the gate reaches 10% of its full amplitude to the point when the drain pulse changes from 0% to 10% of its maximum amplitude.

t_r(ns)

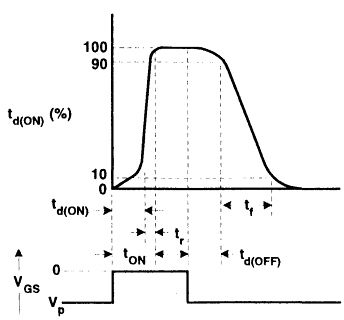
Rise Time
The time interval during turn-on in which the drain current pulse changes from 10% to 90% of its maximum amplitude.

t_d(ns)

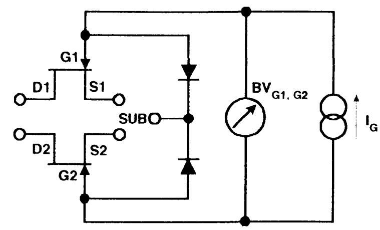
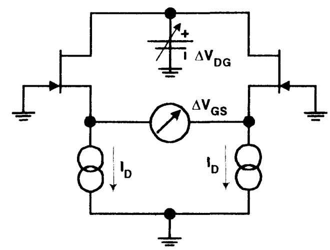
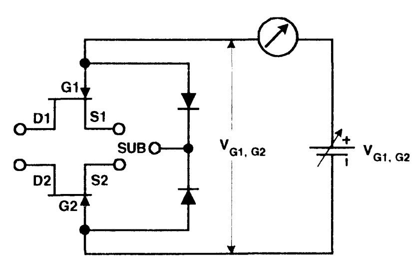
Turn-Off Delay Time
The time interval during turn-off from the point when the turn-off pulse at the gate changes from 100% to 90% of its full amplitude to the point when the drain current changes from 100% to 90% of its maximum amplitude.

t_f(ns)

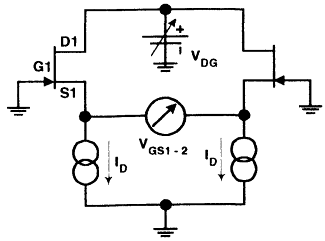
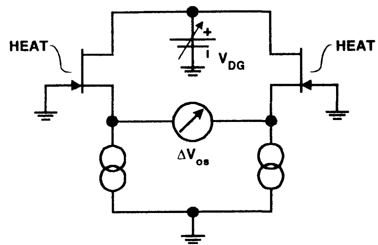
Fall Time
The time interval during turn-off in which the drain current pulse decreases from 10% to 90% of its maximum amplitude.



DUAL FET PARAMETERS

$BV_{G1,\ G2}$ (V) or BV_{G1-2}	**Gate to Gate Breakdown Voltage** The breakdown voltage of the gate to gate junctions, measured at a specified current.	
CMRR (dB) or CMR	**Common-Mode Rejection Ratio** The common-mode rejection ratio is the ratio of the change in differential gate voltage with a change in the drain to gate voltage. $CMRR = 20 \log_{10} \frac{\Delta V_{DG}}{\Delta V_{os}}$	
g_{fs1-2} (%) or g_{fs1} / g_{fs2}	**Common-Source Forward Transconductance Ratio (Match)** The transconductance ratio $= g_{fs1} / g_{fs2} \times$ 100% measured at a specified drain-gate voltage and drain current.	
g_{oss1-2} (μV) or g_{os1-2}	**Common-Source Output Conductance (Match)** Output conductance match $= \lvert g_{os1} - g_{os2} \rvert$ measured at specified drain-gate voltage and drain current.	
I_{DSS1-2} (%) or I_{DSS1-2}, I_{DSS1} / I_{DSS2}	**Drain Saturation Current Ratio (Match)** The drain saturation current ratio = $I_{DSS1} / I_{DSS2} \times$ 100% measured at specified drain-source voltages.	
I_{G1-2} (pA)	**Differential Gate Leakage Current** Differential gate leakage current $= \lvert I_{G1} - I_{G2} \rvert$ measured at specified drain-gate voltage and drain current.	
I_{G1-G2} (pA)	**Gate to Gate Reverse Leakage Current** The gate to gate reverse leakage current measured at a specified voltage monolithic dual with diode isolation shown.	

DUAL FET PARAMETERS (continued)

V_{GS1-2} (mV) or ΔV_{GS}, V_{os}, $\lvert V_{GS1} - V_{GS2} \rvert$	**Differential Gate-Source Voltage** The differential gate-source voltage, measured at a specified drain-gate voltage and drain current.	
ΔV_{GS1-2} (μV/°C) or $\Delta \lvert V_{GS1} - V_{GS2} \rvert / \Delta T$ $\Delta V_{OS} / \Delta T$	**Differential Gate-Source Voltage Drift** The differential gate-source voltage drift is the change in the differential gate-source voltage with a change in device temperature at a specified operating condition. $\frac{\Delta V_{OS}}{\Delta T} = \left\lvert \frac{(V_{GS1} - V_{GS2}) \lvert T_1 - (V_{GS1} - V_{GS2}) T_2 \rvert}{T_1 - T_2} \right\rvert$	

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