Small Signal Transistors, FETs and Diodes

In Brief . . .

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

It covers a wide range of Small Signal plastic semiconductors.

A large selection of encapsulated plastic transistors, FETs and diodes are available for surface mount and insertion assembly technology. Plastic packages include TO–92 (TO–226AA), 1 Watt TO–92 (TO–226AE), SOT–23, SC–59, SC–70/SOT–323 and SOT–223.

Bipolar Transistors
Plastic–Encapsulated Transistors

Table 1. Plastic–Encapsulated General–Purpose Transistors

NPN	PNP	$V_{(BR)CEO}$ Volts Min	f_T @ I_C MHz Min	f_T @ I_C mA	I_C mA Max	h_{FE} @ I_C Min	h_{FE} @ I_C Max	h_{FE} @ I_C mA	NF dB Max
Case 29–11 — TO–226AA (TO–92)									
MPS8099	—	80	150	10	500	100	300	1.0	—
MPSA06	***MPSA56***	80	100	10	500	100	—	100	—
2N4410	—	80	60	10	250	60	400	10	—
BC546	—	65	150	10	100	120	450	2.0	10
BC546B	BC556B	65	150	10	100	180	450	2.0	10
MPSA05	MPSA55	60	100	10	500	100	—	100	—
—	***MPS2907A***	60	200	50	600	100	300	150	—
BC182	BC212	50	200(1)	10	100	120	500	2.0	10
BC237B	BC307B	45	150	10	100	200	460	2.0	10
BC337	BC327	45	210(1)	10	800	100	630	100	—
—	BC557	45	150	10	100	120	800	2.0	10
BC547A	BC557A	45	150	10	100	120	220	2.0	10
BC547B	BC557B	45	150	10	100	180	450	2.0	10
BC547C	BC557C	45	150	10	100	380	800	2.0	10
MPSA20	—	40	125	5.0	100	40	400	5.0	—
MPS2222A	—	40	300	20	600	100	300	150	—
2N4401	***2N4403***	40	200	20	600	100	300	150	—
MPS6602	***MPS6652***	40	100	50	1000	50	—	500	—
2N3904	***2N3906***	40	250	10	200	100	300	10	5.0
BC548B	BC558B	30	300(1)	10	100	200	450	2.0	10
BC548C	—	30	300	10	100	420	800	2.0	10

(1) Typical

NPN	PNP	$V_{(BR)CEO}$ Volts Min	f_T @ I_C MHz Min	f_T @ I_C mA	I_C A Max	h_{FE} @ I_C Min	h_{FE} @ I_C Max	h_{FE} @ I_C mA	$V_{CE(sat)}$ @ I_C @ I_B Volts Max	$V_{CE(sat)}$ @ I_C @ I_B mA	$V_{CE(sat)}$ @ I_C @ I_B mA
Case 29–10 — TO–226AE (1–WATT TO–92)											
MPSW06	***MPSW56***	80	50	200	0.5	80	—	50	0.4	250	10

Devices listed in ***bold, italic*** are Motorola preferred devices.

Plastic–Encapsulated Transistors (continued)

Table 2. Plastic–Encapsulated Low–Noise and Good h_{FE} Linearity

NPN	PNP	$V_{(BR)CEO}$ Volts	h_{FE} @ I_C			V_T(4) mV	NF(5) dB	f_T MHz
			Min	Max	mA	Typ	Max	Typ
Case 29–11 — TO–226AA (TO–92)								
—	***2N5087***	50	250	800	0.1	—	2.0	40(2)
BC550C	BC560C	45	380	800	2.0	—	2.5	250
MPSA18	—	45	500	—	1.0	6.5(1)	—	160
MPS3904	—	40	100	300	10	—	5.0	200(2)
2N5088	—	30	350	—	1.0	—	3.0	50
2N5089(6)	—	25	450	—	1.0	—	2.0	50
MPS6521	MPS6523	25	300	600	2.0	—	3.0	—

(1) Typical
(2) Min
(4) V_T: Total Input Noise Voltage (see BC413/BC414 and BC415/BC416 Data Sheets) at R_S = 2.0 kΩ, I_C = 200 μA, V_{CE} = 5.0 Volts.
(5) N_F: Noise Figure at R_S = 2.0 kΩ, I_C = 200 μA, V_{CE} = 5.0 Volts. f = 30 Hz to 15 kHz.
(7) R_S = 10 kΩ, BW = 1.0 Hz, f = 100 MHz
(8) R_S = 500 Ω, BW = 1.0 Hz, f = 10 MHz

Table 3. Plastic–Encapsulated Darlington Transistors

NPN	PNP	$V_{(BR)CEO}$ Volts	I_C Max	h_{FE} @ I_C			$V_{CE(sat)}$ @ I_C & I_B			f_T @ I_C	
				Min	Max	mA	Volts Max	mA	mA	Min	mA
Case 29–10 — TO–226AE (1–WATT TO–92)											
MPSW45A	—	50	1000	25K	150K	200	1.5	1000	2.0	100	200
—	***MPSW64***	30	1000	20K	—	100	1.5	100	0.1	125	10
Case 29–11 — TO–226AA (TO–92)											
MPSA29	—	100	500	10K	—	100	1.5	100	0.1	125	10
BC373	—	80	1000	10K	160K	100	1.1	250	0.25	100	100
MPSA27	MPSA77	60	500	10K	—	100	1.5	100	0.1	—	—
BC618	—	55	1000	10K	50K	200	1.1	200	0.2	150	500
—	MPSA75	40	500	10K	—	100	1.5	100	0.1	—	—
2N6427	—	40	500	20K	200K	100	1.5	500	0.5	—	—
2N6426	—	40	500	30K	300K	100	1.5	500	0.5	125	10
MPSA14	***MPSA64***	30	500	20K	—	100	1.5	100	0.1	125	10
MPSA13	MPSA63	30	500	10K	—	100	1.5	100	0.1	125	10
BC517	—	30	1000	30K	—	20	1.0	100	0.1	200(1)	10

(1) Typical

Table 4. Plastic–Encapsulated High–Current Transistors

NPN	PNP	$V_{(BR)CEO}$ Volts Min	f_T @ I_C		I_C mA Max	h_{FE} @ I_C			$V_{CE(sat)}$ @ I_C & I_B		
			MHz Min	mA		Min	Max	mA	Volts Max	mA	mA
Case 29–10 — TO–226AE (1–WATT TO–92)											
MPSW01A	***MPSW51A***	40	50	50	1000	50	—	1000	0.5/0.7	1000	100
Case 29–11 — TO–226AA (TO–92)											
BC489	BC490	80	200/150(1)	50	1000	60	400	100	0.3/0.5	1000	100
BC639	BC640	80	60	10	500	40	160	150	0.5	500	50
MPS651	***MPS751***	60	75	50	2000	75	—	1000	0.5	2000	200
BC368	BC369	20	65	10	1000	60	—	1000	0.5	1000	100

(1) Typical

Table 5. Plastic–Encapsulated High–Voltage Amplifier Transistors

Device Type	$V_{(BR)CEO}$ Volts Min	I_C Amp Max	h_{FE} @ I_C		$V_{CE(sat)}$ @ I_C & I_B			f_T @ I_C		Polarity
			Min	mA	Volts Max	mA	mA	MHz Min	mA	
Case 29–10 — TO–226AE (1–WATT TO–92)										
MPSW42	300	0.5	40	30	0.5	20	2.0	50	10	**NPN**
MPSW92	300	0.5	25	30	0.5	20	2.0	50	10	**PNP**
2N6517	350	0.5	30	30	0.3	10	1.0	40	10	**NPN**
BF393	300	0.5	40	10	0.2	20	2.0	50	10	**NPN**
MPSA42	300	0.5	40	10	0.5	20	2.0	50	10	**NPN**
2N5551	160	0.6	80	10	0.15	10	1.0	100	10	**NPN**
BF493S	350	0.5	40	10	20	20	2.0	50	10	**PNP**
2N6520	350	0.5	30	30	0.3	10	1.0	40	10	**PNP**
MPSA92	300	0.5	40	10	0.5	20	2.0	50	10	**PNP**
2N6519	300	0.5	45	30	0.3	10	1.0	40	10	**PNP**
2N5401	150	0.6	60	10	0.2	10	1.0	100	10	**PNP**

NPN	PNP	$V_{(BR)CEO}$ Volts Min	I_C Amp Cont	h_{FE} @ I_C		$V_{CE(sat)}$ @ I_C & I_B			f_T @ I_C	
				Min	mA	Volts Max	mA	mA	MHz Min	mA
Case 29–11 — TO–226AA (TO–92)										
BF422	BF423	250	0.5	50	25	2.0	20	2.0	60	10

Table 6. Plastic–Encapsulated RF Transistors

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} @ I_C			f_T MHz Typ	CRE/CRB pF Max	NF dB Typ	f MHz	Polarity
			Min	mA	V_{CE} V					
Case 29–11 — TO–226AA (TO–92)										
MPSH10	25	—	60	4.0	10	650(2)	0.65	—	—	**NPN**
BF959	20	100	40	20	10	600(2)	0.65	3.0	200	**NPN**
MPSH17	15	—	25	5.0	10	800(2)	0.9	6.0(3)	200	**NPN**
MPS918	15	50	20	8.0	10	600(2)	1.7	6.0(3)	60	**NPN**
MPS5179	12	50	25	3.0	1.0	2000(3)	—	5.0(3)	200	**NPN**
MPS3563	12	50	20	8.0	10	800	1.7	6.0(3)	60	**NPN**

(2) Min
(3) Max

Table 7. Plastic–Encapsulated Telecom Transistors

Device Type	$V_{(BR)CEO}$ Volts	P_D mW 25°C Amb	I_C mA Cont	h_{FE} @ I_C @ V_{CE}				f_T MHz Min	Polarity
				Min	Max	mA	Volts		
Case 29–11 — TO–226AA (TO–92)									
P2N2222A	40	625	600	75	—	10	10	300	**NPN**
P2N2907A	60	625	600	100	—	10	10	200	**PNP**

Plastic–Encapsulated Surface Mount Transistors

Table 8. Plastic–Encapsulated Surface Mount General–Purpose Transistors

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C			f_T	Polarity
			Min	Max	mA	MHz Min	
Case 318–08 — TO–236AB (SOT–23)							
BC846ALT1	1A	65	110	220	2.0	100	**NPN**
BC846BLT1	1B	65	200	450	2.0	100	**NPN**
BC817–16LT1	6A	45	100	250	100	200	**NPN**
BC817–25LT1	6B	45	160	400	100	200	**NPN**
BC817–40LT1	6C	45	250	600	100	200	**NPN**
BC847ALT1	1E	45	110	220	2.0	100	**NPN**
BC847BLT1	1F	45	200	450	2.0	100	**NPN**
BC847CLT1	1G	45	420	800	2.0	100	**NPN**
MMBT2222ALT1	1P	40	100	300	150	200	**NPN**
MMBT3904LT1	1AM	40	100	300	10	200	**NPN**
MMBT4401LT1	2X	40	100	300	150	250	**NPN**
BC848ALT1	1J	30	110	220	2.0	100	**NPN**
BC848BLT1	1K	30	200	450	2.0	100	**NPN**
BC848CLT1	1L	30	420	800	2.0	100	**NPN**
BC856ALT1	3A	65	125	250	2.0	100	**PNP**
BC856BLT1	3B	65	220	475	2.0	100	**PNP**
MMBT2907ALT1	2F	60	100	300	150	200	**PNP**
BC807–16LT1	5A	45	100	250	100	200	**PNP**
BC807–25LT1	5B	45	160	400	100	200	**PNP**
BC807–40LT1	5C	45	250	600	100	200	**PNP**
BC857ALT1	3E	45	125	250	2.0	100	**PNP**
BC857BLT1	3F	45	220	475	2.0	100	**PNP**
MMBT3906LT1	2A	40	100	300	10	250	**PNP**
MMBT4403LT1	2T	40	100	300	150	200	**PNP**
BC858ALT1	3J	30	125	250	2.0	100	**PNP**
BC858BLT1	3K	30	220	475	2.0	100	**PNP**
BC858CLT1	3L	30	420	800	2.0	100	**PNP**

Table 8. Plastic–Encapsulated Surface Mount General–Purpose Transistors (continued)

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C			f_T	Polarity
			Min	Max	mA	MHz Min	
Case 318D–04 — SC–59							
MSD601–RT1	YR	25	210	340	2.0	150(1)	**NPN**
MSD601–ST1	YS	25	290	460	2.0	150(1)	**NPN**
MSD602–RT1	WR	25	120	240	150	200(1)	**NPN**
MSD1328–RT1	1DR	20	200	350	500	200(1)	**NPN**
MSB709–RT1	AR	25	210	340	2.0	100(1)	**PNP**
MSB710–RT1	CR	25	120	240	150	200(1)	**PNP**
Case 419–02 — SC–70/SOT–323							
BC846AWT1	1A	65	110	220	2.0	100	**NPN**
BC847AWT1	1E	45	110	220	2.0	100	**NPN**
BC847BWT1	1F	45	200	450	2.0	100	**NPN**
BC848AWT1	1J	30	110	220	2.0	100	**NPN**
BC848BWT1	1K	30	200	450	2.0	100	**NPN**
MMBT2222AWT1	1P	40	100	300	150	300	**NPN**
MMBT3904WT1	AM	40	100	300	10	300	**NPN**
MSC3930–BT1	VB	20	70	140	1.0	150	**NPN**
MSD1819A–RT1	ZR	50	210	340	2.0	—	**NPN**
BC856BWT1	3B	65	220	475	2.0	100	**PNP**
BC857BWT1	3F	45	220	475	2.0	100	**PNP**
BC858AWT1	3J	30	110	220	2.0	100	**PNP**
BC858BWT1	3K	30	200	450	2.0	100	**PNP**
MMBT2907AWT1	20	60	100	300	150	200	**PNP**
MMBT3906WT1	2A	40	100	300	10	250	**PNP**
MSB1218A–RT1	BR	45	210	340	2.0	—	**PNP**
Case 419B–01 — SOT–363							
MBT3904DW1T1	MA	40	100	300	10	300	**Dual NPN**
MBT3906DW1T1	A2	–40	100	300	10	250	**Dual PNP**

(1) Typical

Table 8. Plastic–Encapsulated Surface Mount General–Purpose Transistors (continued)

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C			f_T MHz Min	Polarity
			Min	Max	mA		
Case 419B–01 — SOT–363							
MBT3946DW1T1	46	40	100	300	10	250	**Dual NPN & PNP**
Case 463–01 — SOT–416/SC–90							
2SC4617	B9	50	120	560	1.0	180	**NPN**
2SA1774	F9	50	120	560	1.0	140	**PNP**

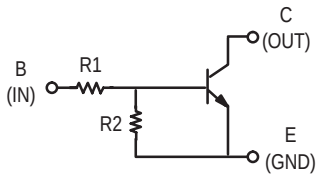


Table 9. Plastic–Encapsulated Surface Mount Bias Resistor Transistors for General Purpose Applications

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

Device		Marking		$V_{(BR)CEO}$ Volts (Min)	h_{FE}@ I_C		I_C mA Max	R_1 Ohm	R_2 Ohm
NPN	PNP	NPN	PNP		Min	mA			
Case 318D–04 — SC–59									
MUN2211T1	***MUN2111T1***	8A	6A	50	35	5.0	100	10K	10K
MUN2212T1	***MUN2112T1***	8B	6B	50	60	5.0	100	22K	22K
MUN2213T1	***MUN2113T1***	8C	6C	50	80	5.0	100	47K	47K
MUN2214T1	***MUN2114T1***	8D	6D	50	80	5.0	100	10K	47K
MUN2215T1	***MUN2115T1***	8E	6E	50	160	5.0	100	10K	∞
MUN2216T1	***MUN2116T1***	8F	6F	50	160	5.0	100	4.7K	∞
MUN2230T1	***MUN2130T1***	8G	6G	50	3.0	5.0	100	1.0K	1.0K
MUN2231T1	***MUN2131T1***	8H	6H	50	8.0	5.0	100	2.2K	2.2K
MUN2232T1	***MUN2132T1***	8J	6J	50	15	5.0	100	4.7K	4.7K
MUN2233T1	***MUN2133T1***	8K	6K	50	80	5.0	100	4.7K	47K
MUN2234T1	***MUN2134T1***	8L	6L	50	80	5.0	100	22K	47K
Case 318–08 — TO–236AB (SOT–23)									
MMUN2211LT1	***MMUN2111LT1***	A8A	A6A	50	35	5.0	100	10K	10K
MMUN2212LT1	***MMUN2112LT1***	A8B	A6B	50	60	5.0	100	22K	22K
MMUN2213LT1	***MMUN2113LT1***	A8C	A6C	50	80	5.0	100	47K	47K
MMUN2214LT1	***MMUN2114LT1***	A8D	A6D	50	80	5.0	100	10K	47K
MMUN2215LT1	***MMUN2115LT1***	A8E	A6E	50	160	5.0	100	10K	∞
MMUN2216LT1	***MMUN2116LT1***	A8F	A6F	50	160	5.0	100	4.7K	∞
MMUN2230LT1	***MMUN2130LT1***	A8G	A6G	50	3.0	5.0	100	1.0K	1.0K
MMUN2231LT1	***MMUN2131LT1***	A8H	A6H	50	8.0	5.0	100	2.2K	2.2K
MMUN2232LT1	***MMUN2132LT1***	A8J	A6J	50	15	5.0	100	4.7K	4.7K
MMUN2233LT1	***MMUN2133LT1***	A8K	A6K	50	80	5.0	100	4.7K	47K
MMUN2234LT1	***MMUN2134LT1***	A8L	A6L	50	80	5.0	100	22K	47K

Table 9. Plastic–Encapsulated Surface Mount Bias Resistor Transistors for General Purpose Applications (continued)

Device		Marking		$V_{(BR)CEO}$ Volts	h_{FE} @ I_C		I_C mA	R_1	R_2
NPN	PNP	NPN	PNP	(Min)	Min	mA	Max	Ohm	Ohm
Case 419–02 — SC–70/SOT–323									
MUN5211T1	***MUN5111T1***	8A	6A	50	35	5.0	50	10K	10K
MUN5212T1	***MUN5112T1***	8B	6B	50	60	5.0	50	22K	22K
MUN5213T1	***MUN5113T1***	8C	6C	50	80	5.0	50	47K	47K
MUN5214T1	***MUN5114T1***	8D	6D	50	80	5.0	50	10K	47K
MUN5215T1	***MUN5115T1***	8E	6E	50	160	5.0	50	10K	∞
MUN5216T1	***MUN5116T1***	8F	6F	50	160	5.0	50	4.7K	∞
MUN5230T1	***MUN5130T1***	8G	6G	50	3.0	5.0	50	1.0K	1.0K
MUN5231T1	***MUN5131T1***	8H	6H	50	8.0	5.0	50	2.2K	2.2K
MUN5232T1	***MUN5132T1***	8J	6J	50	15	5.0	50	4.7K	4.7K
MUN5233T1	***MUN5133T1***	8K	6K	50	80	5.0	50	4.7K	47K
MUN5234T1	***MUN5134T1***	8L	6L	50	80	5.0	50	22K	47K
Case 419B–01 — SOT–363 Duals									
MUN5211DW1T1	***MUN5111DW1T1***	7A	8A	50	35	5.0	100	10K	10K
MUN5212DW1T1	***MUN5112DW1T1***	7B	8B	50	60	5.0	100	22K	22K
MUN5213DW1T1	***MUN5113DW1T1***	7C	8C	50	80	5.0	100	47K	47K
MUN5214DW1T1	***MUN5114DW1T1***	7D	8D	50	80	5.0	100	10K	47K
MUN5215DW1T1	***MUN5115DW1T1***	7E	8E	50	160	5.0	100	10K	∞
MUN5216DW1T1	***MUN5116DW1T1***	7F	8F	50	160	5.0	100	4.7K	∞
MUN5230DW1T1	***MUN5130DW1T1***	7G	8G	50	3.0	5.0	100	1.0K	1.0K
MUN5231DW1T1	***MUN5131DW1T1***	7H	8H	50	8.0	5.0	100	2.2K	2.2K
MUN5232DW1T1	***MUN5132DW1T1***	7J	8J	50	15	5.0	100	4.7K	4.7K
MUN5233DW1T1	***MUN5133DW1T1***	7K	8K	50	80	5.0	100	4.7K	47K
MUN5234DW1T1	***MUN5134DW1T1***	7L	8L	50	80	5.0	100	22K	47K
MUN5235DW1T1	***MUN5135DW1T1***	7M	8M	50	80	5.0	100	2.2K	47K

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C		I_C mA	R_1	R_2
			Min	mA	Max	Ohm	Ohm
Case 419B–01 — SOT–363 — Dual Combination NPN and PNP							
MUN5311DW1T1	11	50	35	5.0	100	10K	10K
MUN5312DW1T1	12	50	60	5.0	100	22K	22K
MUN5313DW1T1	13	50	80	5.0	100	47K	47K
MUN5314DW1T1	14	50	80	5.0	100	10K	47K
MUN5315DW1T1	15	50	160	5.0	100	10K	∞
MUN5316DW1T1	16	50	160	5.0	100	4.7K	∞
MUN5330DW1T1	3X	50	3.0	5.0	100	1.0K	1.0K
MUN5331DW1T1	31	50	8.0	5.0	100	2.2K	2.2K
MUN5332DW1T1	32	50	15	5.0	100	4.7K	4.7K
MUN5333DW1T1	33	50	80	5.0	100	4.7K	47K
MUN5334DW1T1	34	50	80	5.0	100	22K	47K
MUN5335DW1T1	35	50	80	5.0	100	2.2K	47K

Device		Marking		$V_{(BR)CEO}$ Volts	h_{FE} @ I_C		I_C mA	R_1	R_2
NPN	PNP	NPN	PNP	(Min)	Min	mA	Max	Ohm	Ohm
Case 463–01 — SOT–416/SC–90									
DTC114TE	—	94	—	50	100	1.0	100	10K	∞
DTC114YE	***DTA114YE***	69	59	50	80	5.0	100	10K	47K
—	***DTA143EE***	—	43	50	15	5.0	100	4.7K	4.7K

Plastic–Encapsulated Surface Mount Transistors (continued)

Table 10. Plastic–Encapsulated Surface Mount VHF/UHF Amplifiers, Mixers, Oscillators

Device	Marking	$V_{(BR)CEO}$	C_{cb}(13) pF Max	f_T @ I_C	
				GHz Min	mA
Case 318–08 — TO–236AB (SOT–23) — NPN					
MMBTH10LT1	3EM	25	0.7	0.65	4.0
MMBT918LT1	M3B	15	1.7(14)	0.6	4.0
Case 318D–04 — SC–59 — NPN					
MSC2295–BT1	VB	20	1.5(13)	0.15	1.0
MSC2295–CT1	VC	20	1.5(13)	0.15	1.0
MSC3130T1	1S	10	—	1.4	5.0

(13) C_{re}
(14) C_{ob}

Table 11. Plastic–Encapsulated Surface Mount Darlingtons

Device	Marking	$V_{(BR)CES}$	$V_{CE(sat)}$ Volts Max	h_{FE} @ I_C		
				Min	Max	mA
Case 318–08 — TO–236AB (SOT–23) — NPN						
MMBTA14LT1	1N	30	1.5	20K	—	100
Case 318–08 — TO–236AB (SOT–23) — PNP						
MMBTA64LT1	2V	30	1.5	20K	—	100

Table 12. Plastic–Encapsulated Surface Mount Low–Noise Transistors

Device	Marking	NF dB Typ	$V_{(BR)CEO}$	h_{FE}@ I_C			f_T MHz Min	Polarity
				Min	Max	mA		
Case 318–08 — TO–236AB (SOT–23)								
MMBT5089LT1	1R	2.0(15)	25	400	—	10	50	**NPN**
MMBT2484LT1	1U	3.0(15)	60	—	800	10	—	**NPN**
MMBT6428LT1	1KM	3.0	50	250	—	10	100	**NPN**
MMBT6429LT1	1L	3.0	45	500	—	10	100	**NPN**
MMBT5087LT1	2Q	2.0(15)	50	250	—	10	40	**PNP**

(15) Max

Table 13. Plastic–Encapsulated Surface Mount High–Voltage Transistors

Device	Marking	$V_{(BR)CEO}$	h_{FE}@ I_C			f_T MHz Min	Polarity
			Min	Max	mA		
Case 318–08 — TO–236AB (SOT–23)							
MMBT6517LT1	1Z	350	15	—	100	40	**NPN**
MMBTA42LT1	1D	300	40	—	30	50	**NPN**
MMBT5551LT1	G1	160	30	—	50	100	**NPN**
MMBT6520LT1	2Z	350	15	—	100	40	**PNP**
MMBTA92LT1	2D	300	25	—	30	50	**PNP**
MMBT5401LT1	2L	150	50	—	50	100	**PNP**

Table 14. Plastic–Encapsulated Surface Mount Drivers

Device	Marking	$V_{(BR)CEO}$	$V_{CE(sat)}$	$V_{BE(sat)}$	h_{FE}@ I_C			Polarity
					Min	Max	mA	
Case 318–08 — TO–236AB (SOT–23)								
MMBTA06LT1	1GM	80	0.25	—	100	—	100	**NPN**
BSS64LT1	AM	80	0.15	—	20	—	10	**NPN**
BSS63LT1	T1	100	–0.25	–0.90	30	—	25	**PNP**
MMBTA56LT1	2GM	80	–0.25	—	100	—	100	**PNP**

Table 15. Plastic–Encapsulated Surface Mount General Purpose Amplifiers

Device	Marking	$V_{(BR)CEO}$	h_{FE}@ I_C			Polarity
			Min	Max	mA	
Case 318E–04 — SOT–223						
BCP56T1	BH	80	40	250	150	**NPN**
BCP53T1	AH	80	40	25	150	**PNP**

Table 16. Plastic–Encapsulated Surface Mount Switching Transistors

Device	Marking	t_{on}	t_{off}	$V_{(BR)CEO}$	h_{FE}		f_T		Polarity
					Min	Max	@ I_C (mA)	Min (MHz)	
Case 318E–04 — SOT–223									
PZT2222AT1	P1F	35	285	40	100	300	20	300	**NPN**
PZT2907AT1	P2F	45	100	60	100	300	50	200	**PNP**

Table 17. Plastic–Encapsulated Surface Mount Darlingtons

Device	Marking	$V_{(BR)CER}$	$V_{CE(sat)}$ Max (V)	h_{FE}		@ I_C (mA)	Polarity
				Min	Max		
Case 318E–04 — SOT–223							
BSP52T1	AS3	80	1.3	2000	—	500	**NPN**

Table 18. Plastic–Encapsulated Surface Mount High–Voltage Transistors

Device	Marking	$V_{(BR)CEO}$	h_{FE}		f_T		Polarity
			Min	Max	@ I_C (mA)	Min (MHz)	
Case 318E–04 — SOT–223							
BSP19AT1	SP19A	350	40	—	20	70	**NPN**
PZTA42T1	P1D	300	40	—	10	50	**NPN**
BF720T1	BF720	250	50	—	10	60	**NPN**
PZTA92T1	P2D	300	40	—	10	50	**PNP**
BSP16T1	BSP16	300	30	150	10	15	**PNP**
BF721T1	BF721	250	50	—	10	60	**PNP**

Table 19. Plastic–Encapsulated Surface Mount High Current Transistors

Device	Marking	$V_{(BR)CEO}$	$V_{CE(sat)}$ Volts	h_{FE}@ I_C			Polarity
				Min	Max	mA	
Case 318E–04 — SOT–223							
PZT651T1	651	60	0.5	75	—	1000	**NPN**
BCP68T1	CA	20	0.5	60	—	1000	**NPN**
PZT751T1	ZT751	60	0.5	75	—	1000	**PNP**
BCP69T1	CE	20	0.5	60	—	1000	**PNP**

Field–Effect Transistors

JFETs

Table 20. JFET Low–Frequency/Low–Noise

Device	$R_e\|Y_{fs}\|$ @ f		$R_e\|Y_{os}\|$ @ f		C_{iss} pF Max	C_{rss} pF Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ Volts Min	$V_{GS(off)}$ Volts		I_{DSS} mA		Polarity
	mmho Min	kHz	μmho Max	kHz				Min	Max	Min	Max	
Case 29–11 — TO–226AA (TO–92)												
2N5457	1.0	1.0	50	1.0	7.0	3.0	25	0.5	6.0	1.0	5.0	**N–Channel**
2N5458	1.5	1.0	50	1.0	7.0	3.0	25	1.0	7.0	2.0	9.0	**N–Channel**
2N5460	1.0	1.0	75	1.0	7.0	2.0	40	0.75	6.0	1.0	5.0	**P–Channel**
2N5461	1.5	1.0	75	1.0	7.0	2.0	40	1.0	7.5	2.0	9.0	**P–Channel**
2N5462	2.0	1.0	75	1.0	7.0	2.0	40	1.8	9.0	4.0	16	**P–Channel**

Table 21. JFET High–Frequency Amplifiers

Device	$R_e\|Y_{fs}\|$ @ f		$R_e\|Y_{os}\|$ @ f		C_{iss} pF Max	C_{rss} pF Max	NF @ R_G = 1K		$V_{(BR)GSS}$ $V_{(BR)GDO}$ Volts Min	$V_{GS(off)}$ Volts		I_{DSS} mA		Polarity
	mmho Min	MHz	μmho Max	MHz			dB Max	f MHz		Min	Max	Min	Max	
Case 29–11 — TO–226AA (TO–92)														
MPF102	1.6	100	200	100	7.0	3.0	—	—	25	—	8.0	2.0	20	**N–Channel**
2N5485	3.0	400	100	400	5.0	1.0	4.0	400	25	0.5	4.0	4.0	10	**N–Channel**
2N5486	3.5	400	100	400	5.0	1.0	4.0	400	25	2.0	6.0	8.0	20	**N–Channel**
J309	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	1.0	4.0	12	30	**N–Channel**
J310	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	2.0	6.5	24	60	**N–Channel**

(1) Typical

Table 22. JFET Switches and Choppers

Device	$R_{DS(on)}$ @ I_D		$V_{GS(off)}$ Volts		I_{DSS} mA		$V_{(BR)GSS}$ $V_{(BR)GDO}$ Volts Min	C_{iss} pF Max	C_{rss} pF Max	t_{on} ns Max	t_{off} ns Max	Polarity
	Ω Max	mA	Min	Max	Min	Max						
Case 29–11 — TO–226AA (TO–92)												
J112	50	—	1.0	5.0	5.0	—	35	28	5.0	—	—	**N–Channel**
MPF4392	60	—	—	—	25	75	30	10	3.5	15	35	**N–Channel**
2N5639	60	1.0	—	(8.0)(1)	25	—	30	10	4.0	—	—	**N–Channel**
MPF4393	100	—	—	(12)(1)	5.0	30	30	10	3.5	15	55	**N–Channel**
J110	18	—	0.5	4.0	10	—	25	—	—	—	—	**N–Channel**

(1) Typical
(16) $V_{GS(f)}$

TMOS FETs

Table 23. TMOS Switches and Choppers

Device	$R_{DS(on)}$ @ I_D Ω Max	$R_{DS(on)}$ @ I_D A	$V_{GS(th)}$ Volts Min	$V_{GS(th)}$ Volts Max	$V_{(BR)DSS}$ Volts Min	C_{iss} pF Max	C_{rss} pF Max	t_{on} ns Max	t_{off} ns Max	Polarity
Case 29–11 — TO–226AA (TO–92)										
2N7000	5.0	0.5	0.8	3.0	60	60	5.0	10	10	**N–Channel**
BS170	5.0	0.2	0.8	3.0	60	25(1)	3.0(1)	10	10	**N–Channel**
VN0610LL	5.0	0.5	0.8	2.5	60	60	5.0	10	10	**N–Channel**
2N7008	7.5	0.5	1.0	2.5	60	50	5.0	20	20	**N–Channel**
VN2222LL	7.5	0.5	0.6	2.5	60	60	5.0	10	10	**N–Channel**

(1) Typical

Surface Mount FETs

Table 24. Surface Mount RF JFETs

Device	Marking	NF dB Typ	NF f MHz	Y_{fs} @ V_{DS} mmhos Min	Y_{fs} @ V_{DS} mmhos Max	Y_{fs} @ V_{DS} Volts	$V_{(BR)GSS}$	Polarity
Case 318–08 — TO–236AB (SOT–23)								
MMBFJ309LT1	6U	1.5	450	10	20	10	25	**N–Channel**
MMBFJ310LT1	6T	1.5	450	8.0	18	10	25	**N–Channel**
MMBFU310LT1	M6C	1.5	450	10	18	10	25	**N–Channel**
MMBF4416LT1	M6A	2(3)	100	4.5	7.5	15	30	**N–Channel**
MMBF5484LT1	M6B	2.0	100	3.0	6.0	15	25	**N–Channel**

(3) Max

Table 25. Surface Mount General–Purpose JFETs

Device	Marking	$V_{(BR)GSS}$	Y_{fs} @ V_{DS} mmhos Min	Y_{fs} @ V_{DS} mmhos Max	Y_{fs} @ V_{DS} Volts	I_{DSS} mA Min	I_{DSS} mA Max	Polarity
Case 318–08 — TO–236AB (SOT–23)								
MMBF5457LT1	6D	25	1.0	5.0	15	1.0	5.0	**N–Channel**
MMBF5460LT1	M6E	40	1.0	4.0	15	1.0	5.0	**P–Channel**

Table 26. Surface Mount Choppers/Switches JFETs

Device	Marking	$R_{DS(on)}$ Ohms Max	t_{off} ns Max	$V_{(BR)GSS}$	$V_{GS(off)}$ Volts Min	$V_{GS(off)}$ Volts Max	I_{DSS} mA Min	I_{DSS} mA Max	Polarity
Case 318–08 — TO–236AB (SOT–23)									
MMBF4391LT1	6J	30	20	30	–4.0	–10	50	150	**N–Channel**
MMBF4392LT1	6K	60	35	30	–2.0	–5.0	25	75	**N–Channel**
MMBF4393LT1	6G	100	50	30	–0.5	–3.0	5.0	30	**N–Channel**
MMBFJ175LT1	6W	125	—	30	3.0	6.0	7.0	60	**P–Channel**
MMBFJ177LT1	6Y	300	—	30	0.8	2.5	1.5	20	**P–Channel**

Table 27. TMOS FETs

Device	Marking	$R_{DS(on)}$ @ I_D Ohm	$R_{DS(on)}$ @ I_D mA	V_{DSS}	$V_{GS(th)}$ Volts Min	$V_{GS(th)}$ Volts Max	Switching Time t_{on} ns	Switching Time t_{off} ns	Polarity
Case 318–08 — TO–236AB (SOT–23)									
MMBF170LT1	6Z	5.0	200	60	0.8	3.0	10	10	**N–Channel**
BSS123LT1	SA	6.0	100	100	0.8	2.8	20	40	**N–Channel**
2N7002LT1	702	7.5	500	60	1.0	2.5	20	20	**N–Channel**
MMBF0201NLT1	N1	1.0	300	20	1.0	2.4	2.5	15	**N–Channel**
MGSF1N02LT1	N2	0.085	1200	20	1.0	2.4	2.5	16	**N–Channel**
MGSF1N03LT1	N3	0.09	1200	30	1.0	2.4	2.5	16	**N–Channel**
BSS84LT1	PD	6.0	100	50	1.0	2.4	2.5	16	**P–Channel**
MMBF0202PLT1	P3	1.4	200	20	1.0	2.0	2.5	16	**P–Channel**
MGSF1P02LT1	PC	0.35	1500	20	1.0	2.4	2.5	16	**P–Channel**
MGSF1P02ELT1	PE	0.16	1500	20	0.7	1.2	2.5	15	**P–Channel**

Device	Marking	$R_{DS(on)}$ Ohm	$R_{DS(on)}$ mA	V_{DSS}	$V_{GS(th)}$ Volts Min	$V_{GS(th)}$ Volts Max	Switching Time t_{on} ns	Switching Time t_{off} ns	Polarity
Case 419–02 — SC–70/SOT–323									
MMBF2201NT1	N1	1.0	300	20	1.0	2.4	2.5	15	**N–Channel**
MMBF2202PT1	P3	2.2	200	20	1.0	2.4	2.5	16	**P–Channel**

Tuning and Switching Diodes

Tuning Diodes — Abrupt Junction

Table 28. General–Purpose Plastic Abrupt Tuning Diodes
Capacitance Ratio @ 2.0 Volts/30 Volts

Device	C_T @ V_R = 4.0 V, 1.0 MHz			$V_{R(BR)R}$	Cap Ratio	Q
	pF Min	pF Nominal	pF Max	Volts	C4/C30 Min	4.0 V, 50 MHz Typ
Case 182–06 — TO–226AC (TO–92) — 2–Lead						
MV2105	13.5	15	16.5	30	2.5	350
MV2109	29.7	33	36.3	30	2.5	200

Table 29. Surface Mount Abrupt Tuning Diodes
Capacitance Ratio @ 2.0 Volts/30 Volts

Device	C_T @ V_R = 4.0 V, 1.0 MHz			$V_{R(BR)R}$	Cap Ratio	Q
	pF Min	pF Nominal	pF Max	Volts	C2/C30 Min	4.0 V, 50 MHz Typ
Case 318–08 — TO–236AB (SOT–23)						
MMBV2105LT1	13.5	15	16.5	30	2.5	350
MMBV2107LT1	19.8	22	24.2	30	2.5	300
MMBV2109LT1	29.7	33	36.3	30	2.5	200

Tuning Diodes — Hyper–Abrupt Junction

Table 30. Hyper–Abrupt Tuning Diodes for Telecommunications — Single

Device	C_T @ V_R (f = 1.0 MHz)			Cap Ratio @ V_R			Q		$V_{(BR)R}$	Device	Case	CV Curve
	pF Min	pF Max	Volts	Min	Max	Volts	3.0 V Min	50 MHz Max	Volts	Marking	Style	Fig
Case 182–06 — TO–226AC (TO–92)												
MV209	26	32	3.0	5.0	6.5	3/25	200	—	30	—	1	2
Case 318–08 — TO–236AB (SOT–23)												
MMBV105GLT1	1.5	2.8	25	4.0	6.5	3/25	200	—	30	M4E	8	1
MMBV109LT1	26	32	3.0	5.0	6.5	3/25	200	—	30	M4A	8	2
MMBV409LT1	26	32	3.0	1.5	1.9	3/8	200	—	20	X5	8	3
MMBV809LT1	4.5	6.1	2.0	1.8	2.6	2/8	300	—	20	5K	8	4

Table 31. Hyper–Abrupt Tuning Diodes for Communications — Dual

Device	C_T @ V_R (f = 1.0 MHz)			Cap Ratio @ V_R			Q		$V_{(BR)R}$	Device	Case	CV Curve
	pF Min	pF Max	Volts	Min	Max	Volts	3.0 V Min	50 MHz Max	Volts	Marking	Style	Fig
Case 318–08 — TO–236AB (SOT–23)												
MMBV609LT1	26	32	3.0	1.8	2.4	3/8	250	—	20	5L	9	6

Schottky Diodes

Table 32. Schottky Diodes

Device	$V_{(BR)R}$ Volts	C_T @ V_R pF Max	V_F @ 10 mA Volts Max	I_R @ V_R nA Max	Minority Lifetime pS (TYP)	Device Marking
Case 182–06 — TO–226AC (TO–92)						
MBD701	70	1.0 @ 20 V	1.0	200 @ 35 V	15	—
MBD301	30	1.5 @ 15 V	0.6	200 @ 25 V	15	—
Case 318–08 — TO–236AB (SOT–23) – Single						
BAS40LT1	40	5.0 @ 1.0 V	0.5 @ 30 mA	1000 @ 25 V	—	B1
BAS40–04LT1	40	5.0 @ 1.0 V	0.5 @ 30 mA	1000 @ 25 V	—	—
BAS70LT1	70	2.0 @ 0 V	0.75	100 @ 50 V	—	BE
BAT54ALT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	—
BAT54LT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	LV3
BAT54SLT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	LD3
MMBD701LT1	70	1.0 @ 20 V	1.0	200 @ 35 V	15	5H
MMBD301LT1	30	1.5 @ 15 V	0.6	200 @ 25 V	15	4T
Case 318–08 — TO–236AB (SOT–23) – Dual						
BAS40–06LT1	40	5.0 @ 1.0 V	0.5 @ 30 mA	1000 @ 25 V	—	—
BAS70–04LT1(23)	70	2.0 @ 0 V	0.75	100 @ 50 V	—	—
MMBD452LT1	30	1.5 @ 1.5 V	0.6	200 @ 25 V	15	5N
Case 425–04 — (SOD–123)						
BAT54T1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	—
MMSD301T1	30	1.5 @ 15 V	0.6	0.2 @ 25 V	15	XT
Case 419–02 — (SC–70/SOT–323) – Single						
BAT54WT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	—
MMBD330T1	30	1.5 @ 15 V	0.6	0.2 @ 25 V	—	—
MMBD770T1	70	1.0 @ 20 V	1.0	0.2 @ 35 V	—	—
Case 419–02 — (SC–70/SOT–323) – Dual						
BAT54SWT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	—
MMBD717LT1(23)	20	2.5 @ 1.0 V	0.37 @ 1 mA	0.2 @ 10 V	—	B3

(23) Common Anode

Case 419B–01 — SOT–363 – Duals

Device	Marking	$V_{(BR)R}$		I_R		V_F			C_T(30) Max (pF)	t_{rr} Max (ns)
		Min Volts	@ I_{BR} (μA)	Max (μA)	@ V_R Volts	Min Volts	Max Volts	@ I_F (mA)		
MBD54DWT1	BL	30	10	2.0	25	—	0.32	1.0	1.0	5.0
MBD330DWT1	T4	30	10	200	25	—	0.4	1.0	1.5	—
MBD770DWT1	H5	70	10	200	25	—	0.5	1.0	1.0	—

(30) V_R = 0 V, f = 1.0 MHz

Switching Diodes

Table 33. PIN Switching Diodes

Device	$V_{(BR)R}$ Volts Min	C_T @ V_R @ 1.0 MHz		I_R @ V_R μA Max	Series Resistance Ohm Max	Device Marking
		pF Max	Volts			
Case 182–06 — TO–226AC (TO–92)						
MPN3700	200	1.0	20	0.1 @ 150	1.0 @ 10 mA	—
MPN3404	20	2.0	15	0.1 @ 25 V	0.85 @ 10 mA	—
Case 318–08 — TO–236AB (SOT–23)						
MMBV3700LT1	200	1.0	20	0.1 @ 150	1.0 @ 10 mA	4R
MMBV3401LT1	35	1.0	20	0.1 @ 25 V	0.7 @ 10 mA	4D

Table 34. General–Purpose Signal and Switching Diodes — Single

Device	Marking	$V_{(BR)R}$		I_R		V_F			C_T(30)	t_{rr}
		Min Volts	@ I_{BR} (μA)	Max (μA)	@ V_R Volts	Min Volts	Max Volts	@ I_F (mA)	Max (pF)	Max (ns)
Case 318–08 — TO–236AB (SOT–23)										
BAS21LT1	JS	250	100	0.1	200	—	1.0	100	5.0	50
MMBD914LT1	5D	100	100	5.0	75	—	1.0	10	4.0	4.0
BAS16LT1	A6	75	100	1.0	75	—	1.0	50	2.0	6.0
MMBD6050LT1	5A	70	100	0.1	50	0.85	1.1	100	2.5	4.0
BAL99LT1	JF	70	100	2.5	70	—	1.0	50	1.5	6.0
Case 318D–04 — SC–59										
M1MA151AT1	MA	40	100	0.1	35	—	1.2	100	2.0	3.0
M1MA151KT1	MH	40	100	0.1	35	—	1.2	100	2.0	3.0
Case 419–02 — SC–70/SOT–323										
BAS16WT1	A6	75	1.0	0.02	20	—	1.25	150	2.0	6.0
M1MA141KT1	MH	40	100	0.1	35	—	1.2	100	2.0	3.0
M1MA142KT1	MI	80	100	0.1	75	—	1.2	100	2.0	3.0
M1MA174T1	J6	100	100	5.0	75	—	1.0	10	4.0	4.0
Case 425–04— SOD–123										
MMSD914T1	5D	100	100	5.0	75	—	1.0	10	4.0	4.0
MMSD71RKT1	6S	—	—	0.5	80	—	1.2	100	2.0	4.0

(30) V_R = 0 V, f = 1.0 MHz

Switching Diodes (continued)

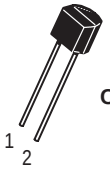
Table 35. General–Purpose Signal and Switching Diodes — Dual

Device	Marking	$V_{(BR)R}$		I_R		V_F			C_T(30)	t_{rr}
		Min Volts	@ I_{BR} (μA)	Max (μA)	@ V_R Volts	Min Volts	Max Volts	@ I_F (mA)	Max (pF)	Max (ns)
Case 318–08 — TO–236AB (SOT–23)										
MMBD7000LT1	M5C	100	100	1.0	50	0.75	1.1	100	1.5	4.0
MMBD2836LT1	A2	75	100	0.1	50	—	1.0	10	4.0	4.0
MMBD2838LT1	A6	75	100	0.1	50	—	1.0	10	4.0	4.0
BAV70LT1	A4	70	100	5.0	70	—	1.0	50	1.5	6.0
BAV99LT1	A7	70	100	2.5	70	—	1.0	50	1.5	4.0
BAW56LT1	A1	70	100	2.5	70	—	1.0	50	2.0	6.0
MMBD6100LT1	5BM	70	100	0.1	50	0.85	1.1	100	2.5	4.0
BAV74LT1	JA	50	5.0	0.1	50	—	1.0	100	2.0	4.0
MMBD2835LT1	A3	35	100	0.1	30	—	1.0	10	4.0	4.0
MMBD2837LT1	A5	35	100	0.1	30	—	1.0	10	4.0	4.0
Case 318D–04 — SC–59										
M1MA151WAT1	MN	40	100	0.1	35	—	1.2	100	15	10
M1MA151WKT1	MT	40	100	0.1	35	—	1.2	100	2.0	3.0
Case 419–02 — SC–70/SOT–323										
M1MA142WKT1	MU	80	100	0.1	75	—	1.2	100	2.0	3.0
M1MA142WAT1	MO	80	100	0.1	75	—	1.2	100	15	10
BAW56WT1	A1	70	100	2.5	70	—	1.0	50	2.0	6.0
BAV70WT1	A4	70	100	5.0	70	—	1.0	50	1.5	6.0
BAV99WT1	A7	70	100	2.5	70	—	1.0	50	1.5	6.0
BAV99RWT1	F7	70	100	2.5	70	—	1.0	50	1.5	6.0
M1MA141WKT1	MT	40	100	0.1	35	—	1.2	100	2.0	3.0
M1MA141WAT1	MN	40	100	0.1	35	—	1.2	100	15	10
Case 463–01 — SOT–416/SC–90 (Common Anode)										
DAP222	P9	80	100	100	70	—	1.2	100	3.5	4.0
Case 463–01 — SOT–416/SC–90 (Common Cathode)										
DAN222	N9	80	100	100	70	—	1.2	100	3.5	4.0

(30) V_R = 0 V, f = 1.0 MHz

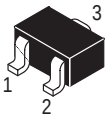
CASE 29–11
TO–226AA
(TO–92)

CASE 29–10
TO–226AE
1–WATT (TO–92)

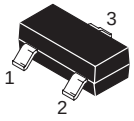


CASE 182–06
TO–226AC
(TO–92)

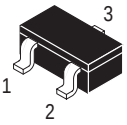
CASE 425–04
SOD–123



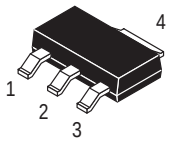
CASE 419–02
SC–70/SOT–323



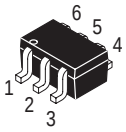
CASE 318–08
TO–236AB
SOT–23



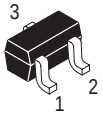
CASE 318D–04
SC–59



CASE 318E–04
SOT–223



CASE 419B–01
SOT–363



CASE 463–01
SOT–416/SC–90