

Small Signal Transistors, FETs and Diodes

In Brief . . .

New in this revision is Motorola's GreenLine™ portfolio of devices. They feature energy-conserving traits superior to those of our existing line of standard parts for the same usage. GreenLine devices can actually help reduce the power demands of your products.

Also new are the Small Signal Multi-integrated devices. These are intended to save board space by reduced part count and functionality. Four to six devices have been integrated into one small package.

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

It covers a wide range of Small Signal plastic and metal-can 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. Plastic multiples are available in 14-pin and 16-pin dual in-line packages for insertion applications: SO-8, SO-14, and SO-16 for surface mount applications.

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Bipolar Transistors

Plastic-Encapsulated Transistors

Motorola's Small Signal TO-226 plastic transistors encompass hundreds of devices with a wide variety of characteristics for general-purpose, amplifier and switching applications. The popular high-volume package combines proven reliability, performance, economy and convenience to provide the perfect solution for industrial and consumer design problems. All devices are laser marked for ease of identification and shipped in antistatic containers, as part of Motorola's ongoing practice of maintaining the highest standards of quality and reliability.

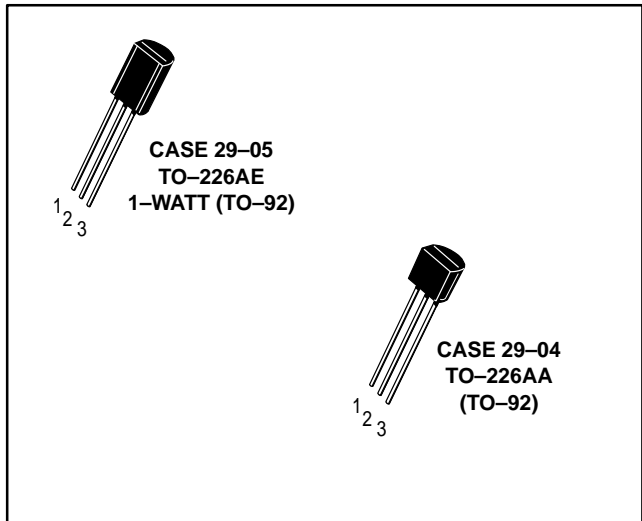


Table 1. Plastic-Encapsulated General-Purpose Transistors

These general-purpose transistors are designed for small-signal amplification from dc to low ratio frequencies. They are also useful as oscillators and general-purpose switches. Complementary devices shown where available (Tables 1-4).

NPN	PNP	V _{(BR)CEO} Volts Min	f _T @ I _C		I _C mA Max	h _{FE} @ I _C			NF dB Max	Style
			MHz Min	mA		Min	Max	mA		

Case 29-04 — TO-226AA (TO-92)

MPS8099	MPS8599	80	150	10	500	100	300	1.0	—	1
MPSA06	MPSA56	80	100	10	500	100	—	100	—	1
2N4410	—	80	60	10	250	60	400	10	—	1
BC546	BC556	65	150	10	100	120	450	2.0	10	17
BC546A	—	65	150	10	100	120	220	2.0	10	17
BC546B	BC556B	65	150	10	100	180	450	2.0	10	17
MPSA05	MPSA55	60	100	10	500	100	—	100	—	1
—	MPS2907A	60	200	50	600	100	300	150	—	1
BC182	BC212	50	200 ⁽¹⁾	10	100	120	500	2.0	10	14
BC237B	BC307B	45	150	10	100	200	460	2.0	10	17
BC337	BC327	45	210 ⁽¹⁾	10	800	100	630	100	—	17
BC547	BC557	45	150	10	100	120	800	2.0	10	17
BC547A	BC557A	45	150	10	100	120	220	2.0	10	17
BC547B	BC557B	45	150	10	100	180	450	2.0	10	17
BC547C	BC557C	45	150	10	100	380	800	2.0	10	17
MPSA20	MPSA70	40	125	5.0	100	40	400	5.0	—	1
MPS2222A	—	40	300	20	600	100	300	150	—	1
2N4401	2N4403	40	200	20	600	100	300	150	—	1
2N4400	2N4402	40	150	20	600	50	150	150	—	1
MPS6602	MPS6652	40	100	50	1000	50	—	500	—	1
2N3903	2N3905	40	200	10	200	50	150	10	6.0	1
2N3904	2N3906	40	250	10	200	100	300	10	5.0	1
BC548	—	30	300 ⁽¹⁾	10	100	110	800	2.0	10	17
BC548A	—	30	300 ⁽¹⁾	10	100	120	220	2.0	10	17
BC548B	BC558B	30	300 ⁽¹⁾	10	100	200	450	2.0	10	17
BC548C	—	30	300	10	100	420	800	2.0	10	17
2N4123	2N4125	30	200	10	200	50	150	2.0	6.0	1
2N4124	2N4126	25	250	10	200	120	360	2.0	4.0	1
BC338	BC328	25	210 ⁽¹⁾	10	800	100	630	100	—	17

(1) Typical

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Transistors (continued)

Table 1. Plastic-Encapsulated General-Purpose Transistors (continued)

NPN	PNP	V _{(BR)CEO} Volts Min	f _T @ I _C		I _C A Max	h _{FE} @ I _C			V _{CE(sat)} @ I _C @ I _B			Style
			MHz Min	mA		Min	Max	mA	Volts Max	mA	mA	
Case 29-05 — TO-226AE (1-WATT TO-92)												
BDC01D	BDB02D	100	50	200	0.5	40	400	100	0.7	1000	100	1
BDC02D	BDB02D	100	50	200	0.5	40	400	100	0.7	1000	100	14
BDB01C	BDB02C	80	50	200	0.5	40	400	100	0.7	1000	100	1
MPS6717		80	50	200	0.5	80	—	50	0.5	250	10	1
MPSW06	MPSW56	80	50	200	0.5	80	—	50	0.4	250	10	1

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

These devices are designed to use on applications where good h_{FE} linearity and low-noise characteristics are required: Instrumentation, hi-fi preamplifier.

NPN	PNP	V _{(BR)CEO} Volts	h _{FE} @ I _C			V _T ⁽⁴⁾ mV Typ	NF ⁽⁵⁾ dB Max	f _T MHz Typ	Style
			Min	Max	mA				
Case 29-04 — TO-226AA (TO-92)									
—	2N5087	50	250	800	0.1	—	2.0	40 ⁽²⁾	1
—	2N5086	50	150	500	0.1	—	3.0	40 ⁽²⁾	1
MPS6428	—	50	250	650	0.1	7.0 ⁽⁷⁾	3.5 ⁽⁸⁾	100 ⁽²⁾	1
BC239	—	45	120	800	2.0	9.5	2.0 ⁽¹⁾	280	17
BC550B	BC560B	45	180	450	2.0	—	2.5	250	17
BC550C	BC560C	45	380	800	2.0	—	2.5	250	17
MPSA18	—	45	500	—	1.0	6.5 ⁽¹⁾	—	160	1
MPS3904	MPS3906	40	100	300	10	—	5.0	200 ⁽²⁾	1
—	MPS4250	40	250	—	10	—	2.0	—	1
BC549B	BC559B	30	200	450	2.0	—	2.5	250	17
BC549C	BC559C	30	380	800	2.0	—	2.5	250	17
2N5088	—	30	350	—	1.0	—	3.0	50	1
2N5089 ⁽⁶⁾	—	25	450	—	1.0	—	2.0	50	1
MPS6521	MPS6523	25	300	600	2.0	—	3.0	—	1

(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) NF: 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

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Transistors (continued)

Table 3. Plastic-Encapsulated Darlington Transistors

Darlington amplifiers are cascade transistors used in applications requiring very high-gain and input impedance. These devices have monolithic construction.

NPN	PNP	$V_{(BR)CEO}$ Volts	I_C Max	$h_{FE} @ I_C$			$V_{CE(sat)} @ I_C \& I_B$			$f_T @ I_C$		Style
				Min	Max	mA	Volts Max	mA	mA	Min	mA	

Case 29-05 — TO-226AE (1-WATT TO-92)

MPSW45A	—	50	1000	25K	150K	200	1.5	1000	2.0	100	200	1
—	MPSW64	30	1000	20K	—	100	1.5	100	0.1	125	10	1

Case 29-04 — TO-226AA (TO-92)

MPSA29	—	100	500	10K	—	100	1.5	100	0.1	125	10	1
BC373	—	80	1000	10K	160K	100	1.1	250	0.25	100	100	1
MPSA27	MPSA77	60	500	10K	—	100	1.5	100	0.1	—	—	1
BC618	—	55	1000	10K	50K	200	1.1	200	0.2	150	500	17
—	MPSA75	40	500	10K	—	100	1.5	100	0.1	—	—	1
2N6427	—	40	500	20K	200K	100	1.5	500	0.5	—	—	1
2N6426	—	40	500	30K	300K	100	1.5	500	0.5	125	10	1
MPSA14	MPSA64	30	500	20K	—	100	1.5	100	0.1	125	10	1
MPSA13	MPSA63	30	500	10K	—	100	1.5	100	0.1	125	10	1
BC517	—	30	1000	30K	—	20	1.0	100	0.1	200 ⁽¹⁾	10	17

Table 4. Plastic-Encapsulated High-Current Transistors

The following table is a listing of devices that are capable of handling a higher current range for small-signal transistors.

NPN	PNP	$V_{(BR)CEO}$ Volts Min	$f_T @ I_C$		I_C mA Max	$h_{FE} @ I_C$			$V_{CE(sat)} @ I_C \& I_B$			Style
			MHz Min	mA		Min	Max	mA	Volts Max	mA	mA	

Case 29-05 — TO-226AE (1-WATT TO-92)

MPS6715	MPS6727	40	—	—	1000	50	—	1000	0.5	1000	100	1
MPSW01A	MPSW51A	40	50	50	1000	50	—	1000	0.5/0.7	1000	100	1

Case 29-04 — TO-226AA (TO-92)

BC489	BC490	80	200/150 ⁽¹⁾	50	1000	60	400	100	0.3/0.5	1000	100	17
BC639	BC640	80	60	10	500	40	160	150	0.5	500	50	14
MPS651	MPS751	60	75	50	2000	75	—	1000	0.5	2000	200	1
MPS650	MPS750	40	75	50	2000	75	—	1000	0.5	2000	200	1
BC368	BC369	20	65	10	1000	60	—	1000	0.5	1000	100	1

(1) Typical

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Transistors (continued)

Table 5. Plastic-Encapsulated High-Voltage Amplifier Transistors

These high-voltage transistors are designed for driving neon bulbs and indicator tubes, for direct line operation, and for other applications requiring high-voltage capability at relatively low collector current. These devices are listed in order of decreasing breakdown voltage ($V_{(BR)CEO}$).

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		Style
			Min	mA	Volts Max	mA	mA	MHz Min	mA	

Case 29-05 — TO-226AE (1-WATT TO-92) — NPN

BDC05	300	0.5	40	25	2.0	20	2.0	60	10	14
<i>MPSW42</i>	300	0.5	40	30	0.5	20	2.0	50	10	1

Case 29-05 — TO-226AE (1-WATT TO-92) — PNP

<i>MPSW92</i>	300	0.5	25	30	0.5	20	2.0	50	10	1
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Case 29-04 — TO-226AA (TO-92) — NPN

BF844	400	0.3	50	10	0.5	10	1.0	—	—	1
<i>MPSA44</i>	400	0.3	40	100	0.75	50	5.0	—	—	1
<i>2N6517</i>	350	0.5	30	30	0.3	10	1.0	40	10	1
BF393	300	0.5	40	10	0.2	20	2.0	50	10	1
<i>MPSA42</i>	300	0.5	40	10	0.5	20	2.0	50	10	1
<i>2N5551</i>	160	0.6	80	10	0.15	10	1.0	100	10	1

Case 29-04 — TO-226AA (TO-92) — PNP

BF493S	350	0.5	40	10	20	20	2.0	50	10	1
<i>2N6520</i>	350	0.5	30	30	0.3	10	1.0	40	10	1
<i>MPSA92</i>	300	0.5	40	10	0.5	20	2.0	50	10	1
2N6519	300	0.5	45	30	0.3	10	1.0	40	10	1
<i>2N5401</i>	150	0.6	60	10	0.2	10	1.0	100	10	1

Case 29-04 — TO-226AA (TO-92)

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		Style
				Min	mA	Volts Max	mA	mA	MHz Min	mA	
BF420	BF421	300	0.5	50	25	2.0	20	2.0	60	10	14
BF422	BF423	250	0.5	50	25	2.0	20	2.0	60	10	14

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Transistors (continued)

Table 6. Plastic-Encapsulated RF Transistors

The RF transistors are designed for small-signal amplification from RF to VHF/UHF frequencies. They are also used as mixers and oscillators in the same frequency ranges.

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	Style
			Min	mA	V_{CE} V					

Case 29-04 — TO-226AA (TO-92) — NPN

BF224	30	50	30	7.0	10	600	0.28	2.5	100	21
MPSH24	30	50	30	8.0	10	400 ⁽²⁾	0.36	—	—	2
MPSH20	30	100	25	4.0	10	400 ⁽²⁾	0.65	—	—	2
MPSH07A ⁽⁹⁾	30	25	20	3.0	10	400 ⁽²⁾	0.3	3.2 ⁽³⁾	100	1
MPS3866	30	400	10	50	5.0	500 ⁽²⁾	—	—	—	1
MPSH11	25	—	60	4.0	10	650 ⁽²⁾	0.9	—	—	2
MPSH10	25	—	60	4.0	10	650 ⁽²⁾	0.65	—	—	2
BF199	25	100	40	7.0	10	750	0.35	2.5	35	21
BF959	20	100	40	20	10	600 ⁽²⁾	0.65	3.0	200	21
MPSH17	15	—	25	5.0	10	800 ⁽²⁾	0.9	6.0 ⁽³⁾	200	2
MPS918	15	50	20	8.0	10	600 ⁽²⁾	1.7	6.0 ⁽³⁾	60	1
MPS5179	12	50	25	3.0	1.0	2000 ⁽³⁾	—	5.0 ⁽³⁾	200	1
MPS3563	12	50	20	8.0	10	800	1.7	6.0 ⁽³⁾	60	1
MPS6595	12	50	25	10	5.0	1200 ⁽²⁾	1.3	—	—	1

Case 29-04 — TO-266AA (TO-92) — PNP

MPSH81	20	50	60	5.0	10	600 ⁽²⁾	0.85	—	—	2
MPSH69	15	50	30	10	10	2000 ⁽²⁾	0.3	—	—	1

Table 7. Plastic-Encapsulated High-Speed Saturated Switching Transistors

Device Type	$t_{on} \& t_{off} @ I_C$			$V_{(BR)CEO}$ Volts Min	$h_{FE} @ I_C$		$V_{CE(sat)} @ I_C \& I_B$			$f_T @ I_C$		Style
	ns Max	ns Max	mA		Min	mA	Volts Max	mA	mA	MHz Min	mA	

Case 29-04 — TO-226AA (TO-92) — NPN

2N4264	25	35	10	15	40	10	0.22	10	1.0	300	10	1
2N4265	25	35	10	12	100	10	0.22	10	1.0	300	10	1
MPS3646	18	28	300	15	30	30	0.2	30	3.0	350	30	1
MPS2369A	12	18	10	15	40	10	0.2	10	1.0	—	—	1

Case 29-04 — TO-226AA (TO-92) — PNP

MPS4258	15	20	10	12	30	50	0.15	10	1.0	700	10	1
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⁽²⁾ Min

⁽³⁾ Max

⁽⁹⁾ AGC Capable

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Transistors (continued)

Table 8. Plastic-Encapsulated Choppers

Devices are listed in decreasing $V_{(BR)EBO}$.

Device Type	$V_{(BR)EBO}$ Volts Min	I_C Amp ⁽¹⁾ Max	$h_{FE} @ I_C$		$V_{CE(sat)} @ I_C \& I_B$			$f_T @ I_C$		Style
			Min	mA	Volts Max	mA	mA	MHz Min	mA	
Case 29-04 — TO-226AA (TO-92) — NPN										
<i>MPSA17</i>	15	100	200	5.0	0.25	10	1.0	80	5.0	1
MPSA16	12	100	200	5.0	0.25	10	1.0	100	5.0	1
Case 29-04 — TO-266AA (TO-92) — PNP										
<i>MPS404A</i>	-25	-150	30	-12	-0.2	-24	1.0	—	—	1

Table 9. Plastic-Encapsulated Telecom Transistors

These devices are special product ranges intended for use in telecom applications.

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	Style
				Min	Max	mA	Volts		
Case 29-04 — TO-226AA (TO-92) — NPN									
P2N2222A	40	625	600	75	—	10	10	300	17
PBF259,S ⁽¹⁰⁾	300	625	500	25	—	1.0	10	40	1
Case 29-04 — TO-226AA (TO-92) — PNP									
P2N2907A	60	625	600	100	—	10	10	200	17
PBF493,S ⁽¹¹⁾	300	625	500	40	—	1.0	10	40	1

(1) Typical

(10) "S" version, h_{FE} Min 60 @ $I_C = 20$ mA, $V_{CE} = 10$ V.

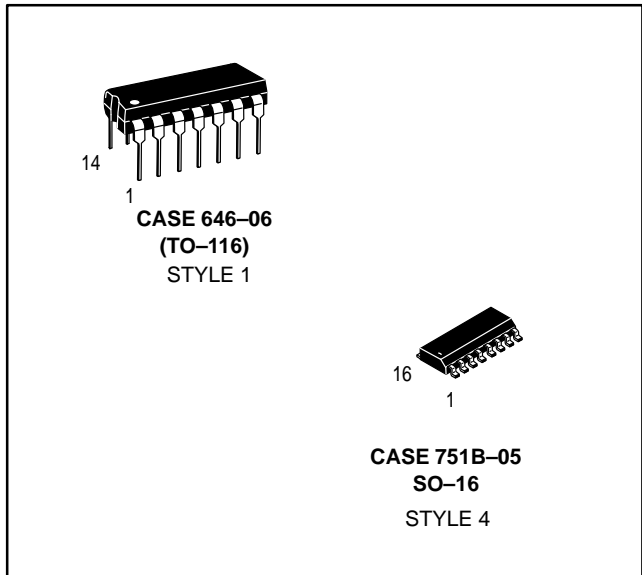
(11) "S" version, h_{FE} Min 40 @ $I_C = 0.1$ mA, $V_{CE} = 1.0$ V.

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Multiple Transistors

The manufacturing trend has been toward printed circuit board design with requirements for smaller packages with more functions. In the case of discrete components the use of the multiple device package helps to reduce board space requirements and assembly costs.

Many of the most popular devices are offered in the standard plastic DIP and surface mount IC packages. This includes small-signal NPN and PNP bipolar transistors, N-channel and P-channel FETs, as well as diode arrays.



Specification Tables

The following short form specifications include Quad and Dual transistors listed in alphanumeric order. Some columns denote two different types of data indicated by either **bold** or *italic* typeface. See key and headings for proper identification. This applies to Table 10 and 11 of this section only.

KEY												
TYPE NO.	ID	Ref. Point	Subscript	IC Amp Max	Unit	fT MHz Min	Cob pF Max	hFE1	ΔVBE	Gp	NF	@ f
		PD Watts One Die Only						VCE Volts	hFE2	mV Max	dB Min	dB Max
Alphanumeric listing type numbers					Common-emitter DC Current Gain.			ton ns Max	toff ns Max	VCE(sat) @ IC & IC		
Identification Code First Letter: Polarity C — both types in multiple device N — NPN P — PNP Second Letter: Use A — General Purpose Amplifier E — Low Noise Audio Amplifier F — Low Noise RF Amplifier G — General Purpose Amplifier and Switch H — Tuned RF/IF Amplifier M — Differential Amplifier S — High Speed Switch D — Darlington					Units for test Current: A — ampere m — mA u — μA					Gp — Power Gain NF — Noise Figure f — Test Frequency AUD — 10-15 kHz Frequency Units: H — Hertz M — MHz K — kHz G — GHz VCE(sat) — Collector-Emitter Saturation Voltage IC — Test Current Current Units: u — μA m — mA A — Amp		
Power Dissipation specified at 25°C. Single die rating. Ref. Point: A — Ambient Temperature C — Case Temperature					Current-Gain-Bandwidth Product							
					Continuous (DC) Collector Current							
					Rated Minimum Collector-Emitter Voltage Subscript letter identifies base termination listed below in order of preference. SUBSCRIPT: 0 — VCE0, open							
										Output Capacitance, common-base. Shown without distinction: Ccb — Collector-Base Capacitance Cre — Common-Emitter Reverse Transfer Capacitance		

Plastic-Encapsulated Multiple Transistors (continued)

Table 10. Plastic-Encapsulated Multiple Transistors — Quad

The following table is a listing of the most popular multiple devices available in the plastic DIP package. These devices are available in NPN, PNP, and NPN/PNP configurations. (See note.)

Device	ID	PD Watts One Die Only	V _{CEO} Volts	I _C Amp Max	hFE Min	@ I _C	f _T MHz Min	C _{ob} pF Max	hFE1	ΔV _{BE}	G _p	NF	@ f
									hFE2	mV Max	dB Min	dB Max	Typ ⁽¹⁾
								t _{on} ns Max	t _{off} ns Max	V _{CE} (sat) Volts Max	@ I _C	I _B	I _C

Case 646-06 — TO-116

MPQ2222A	NA	0.65	40	0.5	100	150 m	200	8.0	35 ⁽¹⁾	285 ⁽¹⁾	0.3	10	150 m
MPQ2369	NS	0.5	15	0.5	40	10 m	450	4.0	9.0 ⁽¹⁾	15 ⁽¹⁾	0.25	10	10 m
MPQ2483	NA	0.625	40	0.05	150	1.0 m	50					3.0⁽¹⁾	AUD
MPQ2484	NA	0.625	40	0.05	300	1.0 m	50					2.0⁽¹⁾	AUD
MPQ2907A	PA	0.65	60	0.6	100	150 m	200	8.0	45 ⁽¹⁾	180 ⁽¹⁾	0.4	10	150 m
MPQ3467	PS	0.75	40	1.0	20	500 m	125	25	40	90	0.5	10	500 m
MPQ3725	NS	1.0	40	1.0	25	500 m	250	10	35	60	0.45	10	500 m
MPQ3762	PS	0.75	40	1.5	35	150 m	150	15	50	120	0.55	10	500 m
MPQ3798	PA	0.625	40	0.05	150	0.1 m	60	4.0				3.0⁽¹⁾	AUD
MPQ3799	PA	0.625	60	0.05	300	0.1 m	60	4.0				2.0⁽¹⁾	AUD
MPQ3904	NG	0.5	40	0.2	75	10 m	250	4.0	37 ⁽¹⁾	136 ⁽¹⁾	0.2	10	10 m
MPQ3906	PG	0.5	40	0.2	75	10 m	200	4.5	43 ⁽¹⁾	155 ⁽¹⁾	0.25	10	10 m
MPQ6001	CG	0.65	30	0.5	40	150 m	200	8.0	30 ⁽¹⁾	225 ⁽¹⁾	0.4	10	150 m
MPQ6002	CG	0.65	30	0.5	100	150 m	200	8.0	30 ⁽¹⁾	225 ⁽¹⁾	0.4	10	150 m
MPQ6100A	CA	0.5	45	0.05	150	1.0 m	50	4.0				4.0⁽¹⁾	AUD
MPQ6426	ND	0.5	30	0.5	10K	100 m	125	8.0	—	—	1.5	10	100 m
MPQ6501	CG	0.65	30	0.5	40	150 m	200	8.0	30 ⁽¹⁾	225 ⁽¹⁾	0.4	10	150 m
MPQ6502	CG	0.65	30	0.5	100	150 m	200	8.0	30 ⁽¹⁾	225 ⁽¹⁾	0.4	10	150 m
MPQ6600A1	CA	0.5	45	0.05	150	1.0 m	50	4.0	0.8	20	0.25	10	1.0 m
MPQ6700	CA	0.5	40	0.2	70	10 m	200	4.5			0.25	10	1.0 m
MPQ6842	CA	0.75	40	0.5	70	10 m	300	4.5	45	150	0.15	10	0.5 m
MPQ7043	NA	0.75	250	0.5	25	1.0 m	50	5.0			0.5	10	20 m
MPQ7042	NA	0.75	200	0.5	25	1.0 m	50	5.0			0.5	10	20 m
MPQ7051	CG	0.75	150	0.5	25	1.0 m	50	6.0			0.7	10	20 m
MPQ7093	PA	0.75	250	0.5	25	1.0 m	50	5.0			0.5	10	20 m

Table 11. Plastic-Encapsulated Multiple Transistors — Quad Surface Mount

The following table is a listing of the most popular multiple devices available in the plastic SOIC surface mount package. These devices are available in NPN, PNP, and NPN/PNP configurations.

Device	V _{(BR)CEO}	V _{(BR)CBO}	hFE @ I _C		f _T @ I _C	
			Min	mA	MHz Min	mA

Case 751B-05 — SO-16

MMPQ2222A	40	75	40	500	200	20
MMPQ2369	15	40	20	100	450	10
MMPQ2907A	50	60	50	500	200	50
MMPQ3467	40	40	20	500	125	50
MMPQ3725	40	60	25	500	250	50
MMPQ3799	60	60	300	0.5	60	1.0
MMPQ3904	40	60	75	10	250	10
MMPQ3906	40	40	75	10	200	10
MMPQ6700 (12)	40	40	70	10	200	10

(1) Typical

(12) NPN/PNP

NOTE: Some columns show 2 different types of data indicated by either **bold** or *italic* typefaces. See key and headings.

Devices listed in bold, italic are Motorola preferred devices.

Plastic–Encapsulated Surface Mount Transistors

This section of the selector guide lists the small–signal plastic devices that are available for surface mount applications. These devices are encapsulated with the latest state–of–the–art mold compounds that enhance reliability and exhibit excellent performance in high temperature and high humidity environments. This package offers higher power dissipation capability for small–signal applications.

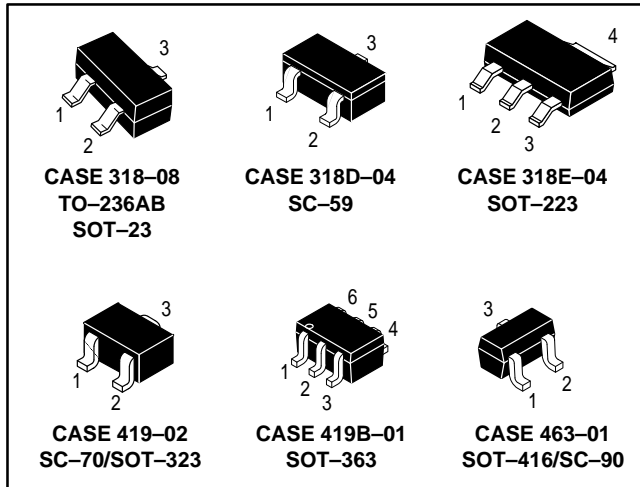


Table 12. Plastic–Encapsulated Surface Mount General–Purpose Transistors

The following tables are a listing of small–signal general–purpose transistors in the SOT–23, SC–59, SOT–223, SC–70, SC–90, and SOT–363 surface mount packages. These devices are intended for small–signal amplification for DC, audio, and lower RF frequencies. They also have applications as oscillators and general–purpose, low voltage switches.

Pinout: 1–Base, 2–Emitter, 3–Collector

Devices are listed in order of descending breakdown voltage.

Device	Marking	$V_{(BR)CEO}$	$h_{FE} @ I_C$			f_T MHz Min
			Min	Max	mA	

Case 318–08 — TO–236AB (SOT–23) — NPN

<i>BC846ALT1</i>	1A	65	110	220	2.0	100
<i>BC846BLT1</i>	1B	65	200	450	2.0	100
BC817–16LT1	6A	45	100	250	100	200
BC817–25LT1	6B	45	160	400	100	200
BC817–40LT1	6C	45	250	600	100	200
<i>BC847ALT1</i>	1E	45	110	220	2.0	100
<i>BC847BLT1</i>	1F	45	200	450	2.0	100
<i>BC847CLT1</i>	1G	45	420	800	2.0	100
<i>MMBT2222ALT1</i>	1P	40	100	300	150	200
<i>MMBT3904LT1</i>	1AM	40	100	300	10	200
<i>MMBT4401LT1</i>	2X	40	100	300	150	250
<i>BC848ALT1</i>	1J	30	110	220	2.0	100
<i>BC848BLT1</i>	1K	30	200	450	2.0	100
<i>BC848CLT1</i>	1L	30	420	800	2.0	100

Case 318–08 — TO–236AB (SOT–23) — PNP

MMBT8599LT1	2W	80	100	300	1.0	150
<i>BC856ALT1</i>	3A	65	125	250	2.0	100
<i>BC856BLT1</i>	3B	65	220	475	2.0	100
<i>MMBT2907ALT1</i>	2F	60	100	300	150	200
BC807–16LT1	5A	45	100	250	100	200
<i>BC807–25LT1</i>	5B	45	160	400	100	200
<i>BC807–40LT1</i>	5C	45	250	600	100	200
<i>BC857ALT1</i>	3E	45	125	250	2.0	100
<i>BC857BLT1</i>	3F	45	220	475	2.0	100
<i>MMBT3906LT1</i>	2A	40	100	300	10	250
<i>MMBT4403LT1</i>	2T	40	100	300	150	200
<i>BC858ALT1</i>	3J	30	125	250	2.0	100
<i>BC858BLT1</i>	3K	30	220	475	2.0	100
<i>BC858CLT1</i>	3L	30	420	800	2.0	100

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Surface Mount Transistors (continued)

Table 12. Plastic-Encapsulated Surface Mount General-Purpose Transistors (continued)

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

Device	Marking	V(BR)CEO	hFE @ IC			f _T MHz Min
			Min	Max	mA	
Case 318D-04 — SC-59 — NPN						
<i>MSD601-RT1</i>	YR	25	210	340	2.0	150 ⁽¹⁾
MSD601-ST1	YS	25	290	460	2.0	150 ⁽¹⁾
<i>MSD602-RT1</i>	WR	25	120	240	150	200 ⁽¹⁾
MSD1328-RT1	1DR	20	200	350	500	200 ⁽¹⁾
Case 318D-04 — SC-59 — PNP						
<i>MSB709-RT1</i>	AR	25	210	340	2.0	100 ⁽¹⁾
MSB709-ST1	AS	25	290	460	2.0	100 ⁽¹⁾
MSB710-QT1	CQ	25	85	170	150	200 ⁽¹⁾
<i>MSB710-RT1</i>	CR	25	120	240	150	200 ⁽¹⁾
Case 419-02 — SC-70/SOT-323 —NPN						
<i>BC818WT1</i>	6I	45	100	600	100	—
<i>BC818-25WT1</i>	6F	45	160	400	100	—
<i>BC818-40WT1</i>	6G	45	250	600	100	—
<i>BC846AWT1</i>	1A	65	110	220	2.0	100
<i>BC846BWT1</i>	1B	65	200	450	2.0	100
<i>BC847AWT1</i>	1E	45	110	220	2.0	100
<i>BC847BWT1</i>	1F	45	200	450	2.0	100
<i>BC847CWT1</i>	1G	45	420	800	2.0	100
<i>BC848AWT1</i>	1J	30	110	220	2.0	100
<i>BC848BWT1</i>	1K	30	200	450	2.0	100
<i>BC848CWT1</i>	1L	30	420	800	2.0	100
<i>MMBT2222AWT1</i>	1P	40	100	300	150	300
<i>MMBT3904WT1</i>	AM	40	100	300	10	300
<i>MSC3930-BT1</i>	VB	20	70	140	1.0	150
<i>MSD1819A-RT1</i>	ZR	50	210	340	2.0	—
Case 419-02 — SC-70/SOT-323 —PNP						
<i>BC808-25WT1</i>	5F	45	160	400	100	—
<i>BC808-40WT1</i>	6F	45	250	600	100	—
<i>BC856AWT1</i>	3A	65	125	250	2.0	100
<i>BC856BWT1</i>	3B	65	220	475	2.0	100
<i>BC857AWT1</i>	3E	45	125	250	2.0	100
<i>BC857BWT1</i>	3F	45	220	475	2.0	100
<i>BC858AWT1</i>	3J	30	110	220	2.0	100
<i>BC858BWT1</i>	3K	30	200	450	2.0	100
<i>BC858CWT1</i>	3L	30	420	800	2.0	100
<i>MMBT2907AWT1</i>	20	60	100	300	150	200
<i>MMBT3906WT1</i>	2A	40	100	300	10	250
<i>MSB1218A-RT1</i>	BR	45	210	340	2.0	—
Case 419B-01 — SOT-363 — Dual NPN						
<i>MBT3904DW1T1</i>	MA	40	100	300	10	300
<i>MBT3904DW9T1</i>	MB	40	100	300	10	300
Case 419B-01 — SOT-363 — Dual PNP						
<i>MBT3906DW1T1</i>	A2	-40	100	300	10	250
<i>MBT3906DW9T1</i>	A3	-40	100	300	10	250

(1) Typical

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Surface Mount Transistors (continued)

Table 12. Plastic-Encapsulated Surface Mount General-Purpose Transistors (continued)

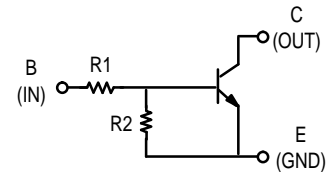
Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

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

Table 13. Plastic-Encapsulated Surface Mount Bias Resistor Transistors for General Purpose Applications

Pinout: 1-Base, 2-Emitter, 3-Collector



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									
<i>MUN2211T1</i>	<i>MUN2111T1</i>	8A	6A	50	35	5.0	100	10K	10K
<i>MUN2212T1</i>	<i>MUN2112T1</i>	8B	6B	50	60	5.0	100	22K	22K
<i>MUN2213T1</i>	<i>MUN2113T1</i>	8C	6C	50	80	5.0	100	47K	47K
<i>MUN2214T1</i>	<i>MUN2114T1</i>	8D	6D	50	80	5.0	100	10K	47K
<i>MUN2215T1</i>	<i>MUN2115T1</i>	8E	6E	50	160	5.0	100	10K	∞
<i>MUN2216T1</i>	<i>MUN2116T1</i>	8F	6F	50	160	5.0	100	4.7K	∞
<i>MUN2230T1</i>	<i>MUN2130T1</i>	8G	6G	50	3.0	5.0	100	1.0K	1.0K
<i>MUN2231T1</i>	<i>MUN2131T1</i>	8H	6H	50	8.0	5.0	100	2.2K	2.2K
<i>MUN2232T1</i>	<i>MUN2132T1</i>	8J	6J	50	15	5.0	100	4.7K	4.7K
<i>MUN2233T1</i>	<i>MUN2133T1</i>	8K	6K	50	80	5.0	100	4.7K	47K
<i>MUN2234T1</i>	<i>MUN2134T1</i>	8L	6L	50	80	5.0	100	22K	47K
Case 318-08 — TO-236AB (SOT-23)									
<i>MMUN2211LT1</i>	<i>MMUN2111LT1</i>	A8A	A6A	50	35	5.0	100	10K	10K
<i>MMUN2212LT1</i>	<i>MMUN2112LT1</i>	A8B	A6B	50	60	5.0	100	22K	22K
<i>MMUN2213LT1</i>	<i>MMUN2113LT1</i>	A8C	A6C	50	80	5.0	100	47K	47K
<i>MMUN2214LT1</i>	<i>MMUN2114LT1</i>	A8D	A6D	50	80	5.0	100	10K	47K
<i>MMUN2215LT1</i>	<i>MMUN2115LT1</i>	A8E	A6E	50	160	5.0	100	10K	∞
<i>MMUN2216LT1</i>	<i>MMUN2116LT1</i>	A8F	A6F	50	160	5.0	100	4.7K	∞
<i>MMUN2230LT1</i>	<i>MMUN2130LT1</i>	A8G	A6G	50	3.0	5.0	100	1.0K	1.0K
<i>MMUN2231LT1</i>	<i>MMUN2131LT1</i>	A8H	A6H	50	8.0	5.0	100	2.2K	2.2K
<i>MMUN2232LT1</i>	<i>MMUN2132LT1</i>	A8J	A6J	50	15	5.0	100	4.7K	4.7K
<i>MMUN2233LT1</i>	<i>MMUN2133LT1</i>	A8K	A6K	50	80	5.0	100	4.7K	47K
<i>MMUN2234LT1</i>	<i>MMUN2134LT1</i>	A8L	A6L	50	80	5.0	100	22K	47K

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Surface Mount Transistors (continued)

Table 13. Plastic-Encapsulated Surface Mount Bias Resistor Transistors for General Purpose Applications (continued)

Pinout: 1-Base, 2-Emitter, 3-Collector

Device		Marking		V(BR)CEO Volts (Min)	hFE @ IC		IC mA Max	R1 Ohm	R2 Ohm
NPN	PNP	NPN	PNP		Min	mA			

Case 419-02 — SC-70/SOT-323

<i>MUN5211T1</i>	<i>MUN5111T1</i>	8A	6A	50	35	5.0	50	10K	10K
<i>MUN5212T1</i>	<i>MUN5112T1</i>	8B	6B	50	60	5.0	50	22K	22K
<i>MUN5213T1</i>	<i>MUN5113T1</i>	8C	6C	50	80	5.0	50	47K	47K
<i>MUN5214T1</i>	<i>MUN5114T1</i>	8D	6D	50	80	5.0	50	10K	47K
<i>MUN5215T1</i>	<i>MUN5115T1</i>	8E	6E	50	160	5.0	50	10K	∞
<i>MUN5216T1</i>	<i>MUN5116T1</i>	8F	6F	50	160	5.0	50	4.7K	∞
<i>MUN5230T1</i>	<i>MUN5130T1</i>	8G	6G	50	3.0	5.0	50	1.0K	1.0K
<i>MUN5231T1</i>	<i>MUN5131T1</i>	8H	6H	50	8.0	5.0	50	2.2K	2.2K
<i>MUN5232T1</i>	<i>MUN5132T1</i>	8J	6J	50	15	5.0	50	4.7K	4.7K
<i>MUN5233T1</i>	<i>MUN5133T1</i>	8K	6K	50	80	5.0	50	4.7K	47K
<i>MUN5234T1</i>	<i>MUN5134T1</i>	8L	6L	50	80	5.0	50	22K	47K

Case 419B-01 — SOT-363 Duals

<i>MUN5211DW1T1</i>	<i>MUN5111DW1T1</i>	7A	8A	50	35	5.0	100	10K	10K
<i>MUN5212DW1T1</i>	<i>MUN5112DW1T1</i>	7B	8B	50	60	5.0	100	22K	22K
<i>MUN5213DW1T1</i>	<i>MUN5113DW1T1</i>	7C	8C	50	80	5.0	100	47K	47K
<i>MUN5214DW1T1</i>	<i>MUN5114DW1T1</i>	7D	8D	50	80	5.0	100	10K	47K
<i>MUN5215DW1T1</i>	<i>MUN5115DW1T1</i>	7E	8E	50	160	5.0	100	10K	∞
<i>MUN5216DW1T1</i>	<i>MUN5116DW1T1</i>	7F	8F	50	160	5.0	100	4.7K	∞
<i>MUN5230DW1T1</i>	<i>MUN5130DW1T1</i>	7G	8G	50	3.0	5.0	100	1.0K	1.0K
<i>MUN5231DW1T1</i>	<i>MUN5131DW1T1</i>	7H	8H	50	8.0	5.0	100	2.2K	2.2K
<i>MUN5232DW1T1</i>	<i>MUN5132DW1T1</i>	7J	8J	50	15	5.0	100	4.7K	4.7K
<i>MUN5233DW1T1</i>	<i>MUN5133DW1T1</i>	7K	8K	50	80	5.0	100	4.7K	47K
<i>MUN5234DW1T1</i>	<i>MUN5134DW1T1</i>	7L	8L	50	80	5.0	100	22K	47K
<i>MUN5235DW1T1</i>	<i>MUN5135DW1T1</i>	7M	8M	50	80	5.0	100	2.2K	47K

Device	Marking	V(BR)CEO	hFE @ IC		IC mA Max	R1 Ohm	R2 Ohm
			Min	mA			

Case 419B-01 — SOT-363 — Dual Combination NPN and PNP

<i>MUN5311DW1T1</i>	11	50	35	5.0	100	10K	10K
<i>MUN5312DW1T1</i>	12	50	60	5.0	100	22K	22K
<i>MUN5313DW1T1</i>	13	50	80	5.0	100	47K	47K
<i>MUN5314DW1T1</i>	14	50	80	5.0	100	10K	47K
<i>MUN5315DW1T1</i>	15	50	160	5.0	100	10K	∞
<i>MUN5316DW1T1</i>	16	50	160	5.0	100	4.7K	∞
<i>MUN5330DW1T1</i>	3X	50	3.0	5.0	100	1.0K	1.0K
<i>MUN5331DW1T1</i>	31	50	8.0	5.0	100	2.2K	2.2K
<i>MUN5332DW1T1</i>	32	50	15	5.0	100	4.7K	4.7K
<i>MUN5333DW1T1</i>	33	50	80	5.0	100	4.7K	47K
<i>MUN5334DW1T1</i>	34	50	80	5.0	100	22K	47K
<i>MUN5335DW1T1</i>	35	50	80	5.0	100	2.2K	47K

Device		Marking		V(BR)CEO Volts (Min)	hFE @ IC		IC mA Max	R1 Ohm	R2 Ohm
NPN	PNP	NPN	PNP		Min	mA			

Case 463-01 — SOT-416/SC-90

<i>DTC114TE</i>	—	94	—	50	100	1.0	100	10K	∞
<i>DTC114YE</i>	<i>DTA114YE</i>	69	59	50	80	5.0	100	10K	47K
—	<i>DTA143EE</i>	—	43	50	15	5.0	100	4.7K	4.7K

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Surface Mount Transistors (continued)

Table 14. Plastic-Encapsulated Surface Mount Switching Transistors

The following tables are a listing of devices intended for high-speed, low saturation voltage, switching applications. These devices have very fast switching times and low output capacitance for optimized switching performance.

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	Switching Time (ns)		$V_{(BR)CEO}$	$h_{FE} @ I_C$			f_T MHz Min
		t_{on}	t_{off}		Min	Max	mA	
Case 318-08 — TO-236AB (SOT-23) — NPN								
<i>MMBT2369LT1</i>	M1J	12	18	15	20	—	100	—
<i>MMBT2369ALT1</i>	1JA	12	18	15	20	—	100	—
<i>BSV52LT1</i>	B2	12	18	12	40	120	10	400

Case 318-08 — TO-236AB (SOT-23) — PNP

<i>MMBT3640LT1</i>	2J	25	35	12	20	—	50	500
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Pinout: 1-Emitter, 2-Base, 3-Collector

Case 318D-04 — SC-59 — NPN

<i>MSC1621T1</i>	RB	20	40	20	40	180	1.0	200
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Table 15. Plastic-Encapsulated Surface Mount VHF/UHF Amplifiers, Mixers, Oscillators

The following table is a listing of devices intended for small-signal RF amplifier applications to VHF/UHF frequencies. These devices may also be used as VHF/UHF oscillators and mixers.

Pinout: 1-Base, 2-Emitter, 3-Collector

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					
<i>MMBTH10LT1</i>	3EM	25	0.7	0.65	4.0
<i>MMBT918LT1</i>	M3B	15	1.7 ⁽¹⁴⁾	0.6	4.0
<i>MMBTH24LT1</i>	M3A	30	0.45	0.4	8.0

Case 318-08 — TO-236AB (SOT-23) — PNP

<i>MMBTH81LT1</i>	3D	20	0.85	0.6	5.0
<i>MMBTH69LT1</i>	M3J	15	0.35 ⁽¹³⁾	2.0	10

Pinout: 1-Emitter, 2-Base, 3-Collector

Case 318D-04 — SC-59 — NPN

<i>MSC2295-BT1</i>	VB	20	1.5 ⁽¹³⁾	0.15	1.0
<i>MSC2295-CT1</i>	VC	20	1.5 ⁽¹³⁾	0.15	1.0
<i>MSC2404-CT1</i>	UC	20	1.0 ⁽¹³⁾	0.45	1.0
<i>MSC3130T1</i>	1S	10	—	1.4	5.0

Case 318D-04 — SC-59 — PNP

<i>MSA1022-BT1</i>	EB	20	2.0 ⁽¹³⁾	0.15	1.0
<i>MSA1022-CT1</i>	EC	20	2.0 ⁽¹³⁾	0.15	1.0

Case 419-02 — SC-70/SOT-323 — PNP

<i>MSB81T1</i>	J3D	20	0.85 ⁽¹³⁾	0.6	5.0
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⁽¹³⁾ C_{re}

⁽¹⁴⁾ C_{ob}

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Surface Mount Transistors (continued)

Table 16. Plastic-Encapsulated Surface Mount Choppers

The following table is a listing of small-signal devices intended for chopper applications where a higher than normal $V_{(BR)CEO}$ is required in the circuit application.

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	$V_{(BR)CEO}$	$V_{(BR)EBO}$	$h_{FE} @ I_C$		
				Min	Max	mA
Case 318-08 — TO-236AB (SOT-23) — PNP						
<i>MMBT404ALT1</i>	2N	35	25	30	400	12

Table 17. Plastic-Encapsulated Surface Mount Darlingtontons

The following table is a listing of small-signal devices that have very high h_{FE} and input impedance characteristics. These devices utilize monolithic, cascade transistor construction.

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending h_{FE} .

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						
<i>MMBTA14LT1</i>	1N	30	1.5	20K	—	100
<i>MMBTA13LT1</i>	1M	30	1.5	10K	—	100
Case 318-08 — TO-236AB (SOT-23) — PNP						
<i>MMBTA64LT1</i>	2V	30	1.5	20K	—	100

Table 18. Plastic-Encapsulated Surface Mount Low-Noise Transistors

The following table is a listing of small-signal devices intended for low noise applications in the audio range. These devices exhibit good linearity and are candidates for hi-fi and instrumentation equipment.

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of ascending NF.

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

⁽¹⁵⁾ Max

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Surface Mount Transistors (continued)

Table 19. Plastic-Encapsulated Surface Mount High-Voltage Transistors

The following table is a listing of small-signal high-voltage devices designed for direct line operation requiring high voltage breakdown and relatively low current capability.

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

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

Table 20. Plastic-Encapsulated Surface Mount Drivers

The following is a listing of small-signal devices intended for medium voltage driver applications at fairly high current levels.

Pinout: 1-Base, 2-Emitter, 3-Collector

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

The following devices are designed to conserve energy. They offer ultra-low collector saturation voltage.

Case 318-08 — TO-236AB (SOT-23) — PNP

<i>MMBT1010LT1</i>	GLP	15	0.1	1.1	300	600	100
Case 318-03 — SC-59 — PNP							
<i>MSD1010T1</i>	GLP	15	0.1	1.1	300	600	100

Table 21. Plastic-Encapsulated Surface Mount General Purpose Amplifiers

Pinout: 1-Base, 2-Collector, 3-Emitter, 4-Collector

Device	Marking	$V_{(BR)CEO}$	$h_{FE@ I_C}$		
			Min	Max	mA
Case 318E-04 — SOT-223 — NPN					
<i>BCP56T1</i>	BH	80	40	250	150
Case 318E-04 — SOT-223 — PNP					
Pinout: 1-Gate, 2-Drain, 3-Source, 4-Drain					
<i>BCP53T1</i>	AH	80	40	25	150

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Surface Mount Transistors (continued)

Table 22. Plastic-Encapsulated Surface Mount Switching Transistors

Pinout: 1-Base, 2-Collector, 3-Emitter, 4-Collector

Device	Marking	t _{on}	t _{off}	V _{(BR)CEO}	h _{FE}		f _T	
					Min	Max	@ I _C (mA)	Min (MHz)
Case 318E-04 — SOT-223 — NPN								
<i>PZT2222AT1</i>	P1F	35	285	40	100	300	20	300
Case 318E-04 — SOT-223 — PNP								
<i>PZT2907AT1</i>	P2F	45	100	60	100	300	50	200

Table 23. Plastic-Encapsulated Surface Mount Darlingtonts

Pinout: 1-Base, 2-Collector, 3-Emitter, 4-Collector

Device	Marking	V _{(BR)CER}	V _{CE(sat)} Max (V)	h _{FE}		@ I _C (mA)
				Min	Max	
Case 318E-04 — SOT-223 — NPN						
<i>BSP52T1</i>	AS3	80	1.3	2000	—	500
<i>PZTA14T1</i>	P1N	30	1.5	20k	—	100
Case 318E-04 — SOT-223 — PNP						
<i>BSP62T1</i>	BS3	90	1.3	2000	—	500
<i>PZTA64T1</i>	P2V	30	1.5	20k	—	100

Table 24. Plastic-Encapsulated Surface Mount High-Voltage Transistors

Pinout: 1-Base, 2-Collector, 3-Emitter, 4-Collector

Device	Marking	V _{(BR)CEO}	h _{FE}		f _T	
			Min	Max	@ I _C (mA)	Min (MHz)
Case 318E-04 — SOT-223 — NPN						
<i>BSP19AT1</i>	SP19A	350	40	—	20	70
<i>PZTA42T1</i>	P1D	300	40	—	10	50
<i>BF720T1</i>	BF720	250	50	—	10	60
<i>BSP20AT1</i>	SP20A	250	40	—	20	70
Case 318E-04 — SOT-223 — PNP						
<i>PZTA96T1</i>	ZTA96	450	50	150	10	50
<i>PZTA92T1</i>	P2D	300	40	—	10	50
<i>BSP16T1</i>	BSP16	300	30	150	10	15
<i>BF721T1</i>	BF721	250	50	—	10	60

Table 25. Plastic-Encapsulated Surface Mount High Current Transistors

Pinout: 1-Base, 2-Collector, 3-Emitter, 4-Collector

Device	Marking	V _{(BR)CEO}	V _{CE(sat)} Volts	h _{FE} @ I _C		
				Min	Max	mA
Case 318E-04 — SOT-223 — NPN						
<i>PZT651T1</i>	651	60	0.5	75	—	1000
<i>BCP68T1</i>	CA	20	0.5	60	—	1000
Case 318E-04 — SOT-223 — PNP						
<i>PZT751T1</i>	ZT751	60	0.5	75	—	1000
<i>BCP69T1</i>	CE	20	0.5	60	—	1000

Devices listed in bold, italic are Motorola preferred devices.

Metal-Can Transistors

Metal-can packages are intended for use in industrial applications where harsh environmental conditions are encountered. These packages enhance reliability of the end products due to their resistance to varying humidity and extreme temperature ranges.

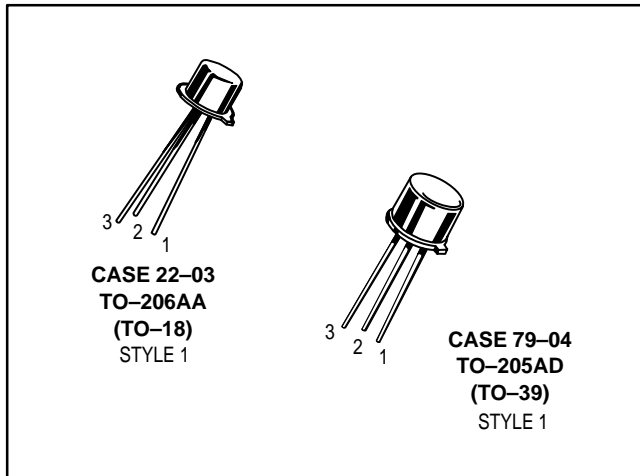


Table 26. Metal-Can General-Purpose Transistors

These transistors are designed for DC to VHF amplifier applications, general-purpose switching applications, and complementary circuitry. Devices are listed in decreasing order of $V_{(BR)CEO}$ within each package group.

Device Type	$V_{(BR)CEO}$ Volts Min	$f_T @ I_C$		I_C mA Max	$h_{FE} @ I_C$		
		MHz Min	mA		Min	Max	mA
Case 22-03 — TO-206AA (TO-18) — NPN							
2N3700	80	80	50	1000	50	—	500
BC107	45	150	10	200	110	450	2.0
BC107B	45	150	10	200	200	450	2.0
2N2222A	40	300	20	800	100	300	150
BC109C	25	150	10	200	420	800	2.0
Case 22-03 — TO-206AA (TO-18) — PNP							
2N2906A	60	200	50	600	40	120	150
2N2907A	60	200	50	600	100	300	150
2N3251A	60	300	10	200	100	300	10
BC177B	45	200	10	200	180	460	2.0
Case 79-04 — TO-205AD (TO-39) — NPN							
2N3019	80	100	50	1000	100	300	150
2N3020	80	80	50	1000	40	120	150
2N1893	80	50	50	500	40	120	150
2N2219A	40	300	20	800	100	300	150
Case 79-04 — TO-205AD (TO-39) — PNP							
2N4033	80	—	—	1000	25	—	1000
2N4036	65	60	50	1000	40	140	150
2N2904A	60	200	50	600	40	120	150
2N2905A	60	200	50	600	100	300	150
2N4032	60	—	—	1000	40	—	1000

Devices listed in bold, italic are Motorola preferred devices.

Metal-Can Transistors (continued)

Table 27. Metal-Can High-Gain/Low-Noise Transistors

These transistors are characterized for high-gain and low-noise applications. Devices are listed in decreasing order of NF.

Device Type	NF Wideband dB Typ Max	$V_{(BR)CEO}$ Volts Min	I_C mA Max	$h_{FE} @ I_C$			$f_T @ I_C$	
				Min	Max	μA mA	MHz Min	mA
Case 22-03 — TO-206AA (TO-18) — NPN								
2N2484	8.0(1)	60	50	100	500	10	15	0.05
2N930A	3.0	45	30	—	600	10	45	0.5
2N930	3.0	45	30	—	600	10	30	0.5

Case 22-03 — TO-206AA (TO-18) — PNP

2N3964	4.0	45	200	250	600	1.0(24)	50	0.5
2N3799	2.5	60	50	300	900	500	30	0.5

Table 28. Metal-Can High-Voltage/High-Current Transistors

The following table lists Motorola standard devices that have high collector-emitter breakdown voltage. Devices are listed in decreasing order of $V_{(BR)CEO}$ within each package type.

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	$h_{FE} @ I_C$		$V_{CE(sat)} @ I_C \& I_B$			$f_T @ I_C$	
			Min	mA	Volts Max	mA	mA	MHz Min	mA
Case 22-03 — TO-206AA (TO-18) — NPN									
2N6431	300	50	50	30	0.5	20	2.0	50	10
BSS73	300	500	40	30	1.0	50	5.0	50	20
Case 22-03 — TO-206AA (TO-18) — PNP									
BSS76	300	500	35	30	0.5	50	5.0	50	20
Case 79-04 — TO-205AD (TO-39) — PNP									
2N3637	175	1000	100	50	0.5	50	5.0	200	30

(1) Typical

(24) $T_A = 25^\circ C$

Table 29. Metal-Can Switching Transistors

The following devices are intended for use in general-purpose switching and amplifier applications. Within each package group shown, the devices are listed in order of decreasing turn-on time (t_{on}).

Device Type	$t_{on} \& t_{off} @ I_C$			$V_{(BR)CEO}$ Volts Min	I_C mA Max	$h_{FE} @ I_C$		$V_{CE(sat)} @ I_C @ I_B$			f_T MHz Min	I_C mA
	ns Max	ns Max	mA			Min	mA	Volts Max	mA	mA		
Case 22-03 — TO-206AA (TO-18) — NPN												
2N2369A	12	18	10	15	200	40	10	0.2	10	1.0	500	10
BSX20	7.0	21	100	15	500	20	10	0.25	10	1.0	500	10
Case 79-04 — TO-205AD (TO-39) — PNP												
2N3467	40	90	500	40	1000	40	500	0.5	500	50	175	50

Devices listed in bold, italic are Motorola preferred devices.

Field-Effect Transistors

JFETs

JFETs operate in the depletion mode. They are available in both P- and N-channel and are offered in both Through-hole and Surface Mount packages. Applications include general-purpose amplifiers, switches and choppers, and RF amplifiers and mixers. These devices are economical and very rugged. The drain and source are interchangeable on many typical FETs.

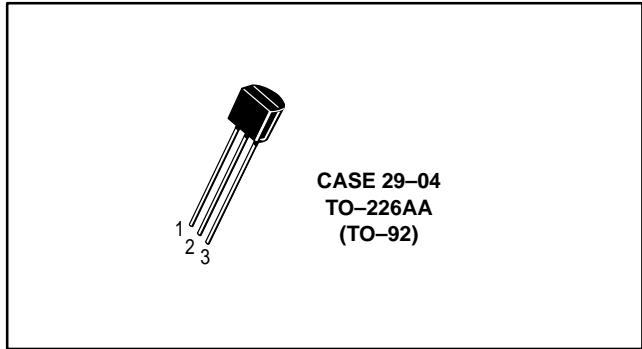


Table 30. JFET Low-Frequency/Low-Noise

The following table is a listing of small-signal JFETs intended for low-noise applications in the audio range. These devices exhibit good linearity and are candidates for hi-fi and instrumentation equipment.

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		Style
	mmho Min	kHz	μ mho Max	kHz				Min	Max	Min	Max	

Case 29-04 — TO-226AA (TO-92) — N-Channel

J202	—	—	—	—	—	—	40	0.8	4.0	0.9	4.5	5
2N5458	1.5	1.0	50	1.0	7.0	3.0	25	1.0	7.0	2.0	9.0	5
MPF3821	1.5	1.0	10	1.0	6.0	3.0	50	—	4.0	0.5	2.5	5
2N5457	1.0	1.0	50	1.0	7.0	3.0	25	0.5	6.0	1.0	5.0	5
2N5459	2.0	1.0	50	1.0	7.0	3.0	25	2.0	8.0	4.0	16	5

Case 29-04 — TO-226AA (TO-92) — P-Channel

2N5460	1.0	1.0	75	1.0	7.0	2.0	40	0.75	6.0	1.0	5.0	7
2N5461	1.5	1.0	75	1.0	7.0	2.0	40	1.0	7.5	2.0	9.0	7
2N5462	2.0	1.0	75	1.0	7.0	2.0	40	1.8	9.0	4.0	16	7

Table 31. JFET High-Frequency Amplifiers

The following is a listing of small-signal JFETs that are intended for hi-frequency applications. These are candidates for VHF/UHF oscillators, mixers and front-end 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		Style
	mmho Min	MHz	μ mho Max	MHz			dB Max	f MHz		Min	Max	Min	Max	

Case 29-04 — TO-226AA (TO-92) — N-Channel

MPF102	1.6	100	200	100	7.0	3.0	—	—	25	—	8.0	2.0	20	5
2N5668	1.0	100	50	100	7.0	3.0	2.5	100	25	0.2	4.0	1.0	5.0	5
2N5484	2.5	100	75	100	5.0	1.0	3.0	100	25	0.3	3.0	1.0	5.0	5
2N5485	3.0	400	100	400	5.0	1.0	4.0	400	25	0.5	4.0	4.0	10	5
2N5486	3.5	400	100	400	5.0	1.0	4.0	400	25	2.0	6.0	8.0	20	5
J308	12 ⁽¹⁾	100	250 ⁽¹⁾	100	7.5	2.5	1.5 ⁽¹⁾	100	25	1.0	6.5	12	60	5
J309	12 ⁽¹⁾	100	250 ⁽¹⁾	100	7.5	2.5	1.5 ⁽¹⁾	100	25	1.0	4.0	12	30	5
J310	12 ⁽¹⁾	100	250 ⁽¹⁾	100	7.5	2.5	1.5 ⁽¹⁾	100	25	2.0	6.5	24	60	5

(1) Typical

Devices listed in bold, italic are Motorola preferred devices.

JFETs (continued)

Table 32. JFET Switches and Choppers

The following is a listing of JFETs intended for switching and chopper applications.

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	Style
	Ω Max	mA	Min	Max	Min	Max						
Case 29-04 — TO-226AA (TO-92) — N-Channel												
MPF4856	25	—	4.0	10	50	—	40	18	8.0	9.0	25	5
MPF4859	25	—	4.0	10	50	—	30	18	8.0	9.0	25	5
J111	30	—	3.0	10	20	—	35	28	5.0	—	—	5
MPF4857	40	—	2.0	6.0	20	100	40	18	8.0	10	50	5
MPF4860	40	—	2.0	6.0	20	100	30	18	8.0	10	50	5
J112	50	—	1.0	5.0	5.0	—	35	28	5.0	—	—	5
MPF4392	60	—	—	—	25	75	30	10	3.5	15	35	5
2N5639	60	1.0	—	(8.0) ⁽¹⁾	25	—	30	10	4.0	—	—	5
MPF4861	60	—	0.8	4.0	8.0	80	30	18	8.0	20	100	5
MPF4393	100	—	—	(12) ⁽¹⁾	5.0	30	30	10	3.5	15	55	5
2N5640	100	1.0	—	(6.0) ⁽¹⁾	5.0	—	30	10	4.0	18	45	5
J113	100	—	0.5	3.0	2.0	—	35	28	5.0	—	—	5
2N5555	150	—	—	1.0 ⁽¹⁶⁾	15	—	25	5.0	1.2	10	25	5
BF246A	35 ⁽¹⁾	1.0	0.6	14	30	80	25	—	—	—	—	22
BF246B	50 ⁽¹⁾	1.0	0.6	14	60	140	25	—	—	—	—	22
J110	18	—	0.5	4.0	10	—	25	—	—	—	—	5
Case 29-04 — TO-226AA (TO-92) — P-Channel												
MPF970	100	1.0	5.0	12	15	100	30	12	5.0	8.0	25	5
MPF971	250	1.0	1.0	7.0	2.0	50	30	12	5.0	10	120	5

⁽¹⁾ Typical
⁽¹⁶⁾ V_{GS(f)}

Devices listed in bold, italic are Motorola preferred devices.



TMOS FETs

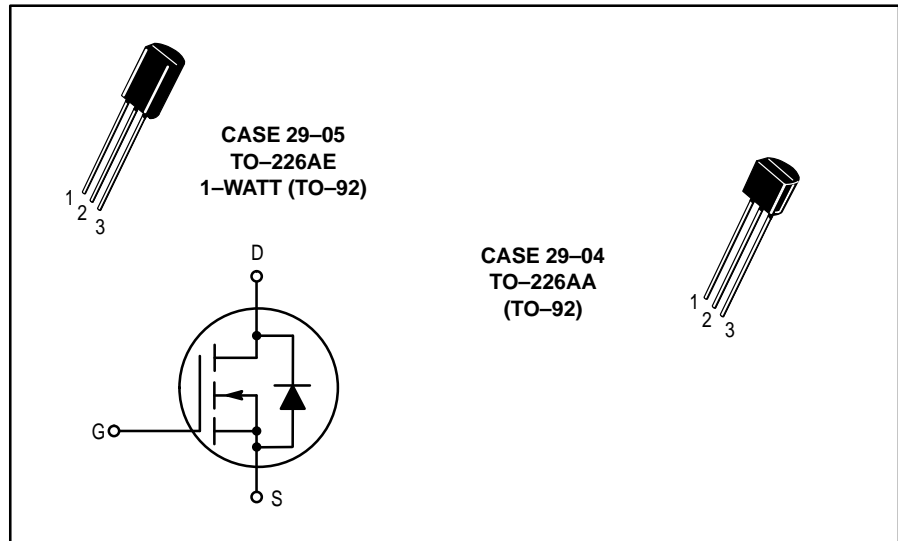


Table 33. TMOS Switches and Choppers

The following is a listing of small-signal TMOS devices that are intended for switching and chopper applications. These devices offer low $R_{DS(on)}$ characteristics.

Device	$R_{DS(on)}$ @ I_D		$V_{GS(th)}$ Volts		$V_{(BR)DSS}$ Volts Min	C_{iss} pF Max	C_{rss} pF Max	t_{on} ns Max	t_{off} ns Max	Style
	Ω Max	A	Min	Max						
Case 29-05 — TO-226AE (1-WATT TO-92) — N-Channel										
MPF930	1.4	1.0	1.0	3.5	35	70(1)	20(1)	15	15	22
MPF960	1.7	1.0	1.0	3.5	60	70(1)	20(1)	15	15	22
MPF6659	1.8	1.0	0.8	2.0	35	30(1)	4(1)	5.0	5.0	22
MPF990	2.0	1.0	1.0	3.5	90	70(1)	20(1)	15	15	22
MPF6660	3.0	1.0	0.8	2.0	60	30(1)	4(1)	5.0	5.0	22
MPF6661	4.0	1.0	0.8	2.0	90	30(1)	4(1)	5.0	5.0	22
MPF910	5.0	0.5	0.3	2.5	60	—	—	—	—	22
VN10LM	5.0	0.5	0.8	2.5	60	60	5.0	10	10	22
Case 29-04 — TO-226AA (TO-92) — N-Channel										
VN0300L	1.2	1.0	0.8	2.5	60	100	25	30	30	22
2N7000	5.0	0.5	0.8	3.0	60	60	5.0	10	10	22
BS170	5.0	0.2	0.8	3.0	60	25(1)	3.0(1)	10	10	30
VN0610LL	5.0	0.5	0.8	2.5	60	60	5.0	10	10	22
VN1706L	6.0	0.5	0.8	2.0	170	125	20	8.0	18	22
VN2406L	6.0	0.5	0.8	2.0	240	125	20	8.0	23	22
BSS89	6.0	0.30	1.0	2.7	200	72(1)	3.0(1)	6.0(1)	12(1)	7
BS107A	6.4	0.25	1.0	3.0	200	60(1)	6.0(1)	15	15	30
2N7008	7.5	0.5	1.0	2.5	60	50	5.0	20	20	22
VN2222LL	7.5	0.5	0.6	2.5	60	60	5.0	10	10	22
VN2410L	10	0.5	0.8	2.0	240	125	20	8.0	23	22
BS107	14	0.2	1.0	3.0	200	60(1)	6.0(1)	15	15	30

(1) Typical

Devices listed in bold, italic are Motorola preferred devices.

Surface Mount FETs

This section contains the FET plastic packages available for surface mount applications. Most of these devices are the most popular metal-can and insertion type parts carried over to the new surface mount packages.

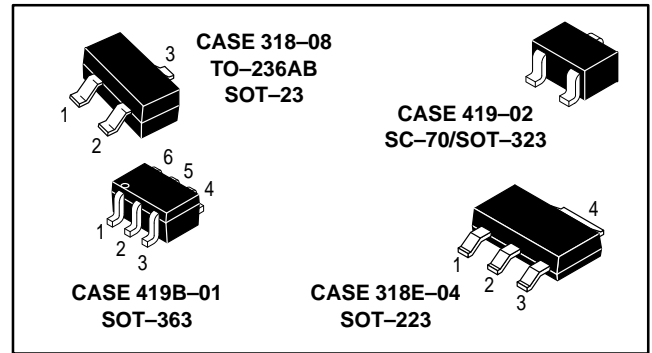


Table 34. Surface Mount RF JFETs

The following is a list of surface mount FETs which are intended for VHF/UHF RF amplifier applications.
Pinout: 1–Drain, 2–Source, 3–Gate

Device	Marking	NF		Y _{fs} @ V _{DS}			V _{(BR)GSS}	Style
		dB Typ	f MHz	mmhos Min	mmhos Max	Volts		
Case 318-08 — TO-236AB (SOT-23) — N-Channel								
<i>MMBFJ309LT1</i>	6U	1.5	450	10	20	10	25	10
<i>MMBFJ310LT1</i>	6T	1.5	450	8.0	18	10	25	10
<i>MMBFU310LT1</i>	M6C	1.5	450	10	18	10	25	10
<i>MMBF4416LT1</i>	M6A	2 ⁽³⁾	100	4.5	7.5	15	30	10
<i>MMBF5484LT1</i>	M6B	2.0	100	3.0	6.0	15	25	10
<i>MMBF5486LT1</i>	6H	2.0	100	4.0	8.0	15	25	10
Case 419B-01 — SOT-363 — Dual N-Channel								
<i>MBF4416DW1T1</i>	M6	2.0	100	4.5	7.5	15	30	7

⁽³⁾ Max

Table 35. Surface Mount General-Purpose JFETs

The following table is a listing of surface mount small-signal general purpose FETs. These devices are intended for small-signal amplification for DC, audio, and lower RF frequencies. They also have applications as oscillators and general-purpose, low-voltage switches.

Pinout: 1–Drain, 2–Source, 3–Gate

Device	Marking	V _{(BR)GSS}	Y _{fs} @ V _{DS}			I _{DSS}		Style
			mmhos Min	mmhos Max	Volts	mA Min	mA Max	
Case 318-08 — TO-236AB (SOT-23) — N-Channel								
<i>MMBF5457LT1</i>	6D	25	1.0	5.0	15	1.0	5.0	10
<i>MMBF5459LT1</i>	6L	25	2.0	6.0	15	4.0	16	10
Case 318-08 — TO-236AB (SOT-23) — P-Channel								
<i>MMBF5460LT1</i>	M6E	40	1.0	4.0	15	1.0	5.0	10
Case 419B-01 — SOT-363 — Dual N-Channel								
<i>MBF5457DW1T1</i>	6D	25	1.0	5.0	15	1.0	5.0	7

⁽³⁾ Max

Devices listed in bold, italic are Motorola preferred devices.

Surface Mount FETs (continued)

Table 36. Surface Mount Choppers/Switches JFETs

The following is a listing of small-signal surface mount JFET devices intended for switching and chopper applications.

Pinout: 1–Drain, 2–Source, 3–Gate

Device	Marking	R _{DS(on)} Ohms Max	t _{off} ns Max	V _{(BR)GSS}	V _{GS(off)}		I _{DSS}		Style
					Volts Min	Volts Max	mA Min	mA Max	
Case 318–08 — TO–236AB (SOT–23) — N–Channel									
<i>MMBF4856LT1</i>	AAA	25	25	40	–4.0	–10	50	—	10
<i>MMBF4391LT1</i>	6J	30	20	30	–4.0	–10	50	150	10
<i>MMBF4860LT1</i>	6F	40	50	30	–2.0	–6.0	20	100	10
<i>MMBF4392LT1</i>	6K	60	35	30	–2.0	–5.0	25	75	10
<i>MMBF4393LT1</i>	6G	100	50	30	–0.5	–3.0	5.0	30	10
Case 318–08 — TO–236AB (SOT–23) — P–Channel									
<i>MMBFJ175LT1</i>	6W	125	—	30	3.0	6.0	7.0	60	10
<i>MMBFJ177LT1</i>	6Y	300	—	30	0.8	2.5	1.5	20	10

Table 37. TMOS FETs

The following is a listing of small-signal surface mount TMOS FETs which exhibit low R_{DS(on)} characteristics.

Pinout: 1–Gate, 2–Source, 3–Drain

Device	Marking	R _{DS(on)} @ I _D		V _{DSS}	V _{GS(th)}		Switching Time		Style
		Ohm	mA		Volts Min	Volts Max	t _{on} ns	t _{off} ns	
Case 318–08 — TO–236AB (SOT–23) — N–Channel									
<i>MMBF170LT1</i>	6Z	5.0	200	60	0.8	3.0	10	10	21
<i>BSS123LT1</i>	SA	6.0	100	100	0.8	2.8	20	40	21
<i>BSS138LT1</i>	J1	3.5	200	50	0.5	1.5	20	20	21
<i>2N7002LT1</i>	702	7.5	500	60	1.0	2.5	20	20	21
<i>MMBF0201NLT1</i>	N1	1.0	300	20	1.0	2.4	2.5	15	21
<i>MGSF1N02LT1</i>	N2	0.085	1200	20	1.0	2.4	2.5	16	21
<i>MGSF1N03LT1</i>	N3	0.09	1200	30	1.0	2.4	2.5	16	21
Case 318–08 — TO–236 (SOT–23) — P–Channel									
<i>BSS84LT1</i>	PD	6.0	100	50	1.0	2.4	2.5	16	21
<i>MMBF0202PLT1</i>	P3	1.4	200	20	1.0	2.0	2.5	16	21
<i>MGSF1P02LT1</i>	PC	0.35	1500	20	1.0	2.4	2.5	16	21
<i>MGSF1P02ELT1</i>	PE	0.16	1500	20	0.7	1.0	2.5	16	21

Pinout: 1–Gate, 2–Drain, 3–Source, 4–Drain

Device	Marking	R _{DS(on)}		V _{DSS}	V _{GS(th)}		Switching Time		Style
		Ohm	mA		Volts Min	Volts Max	t _{on} ns	t _{off} ns	
Case 318E–04 — SOT–223 — N–Channel									
<i>MMFT960T1</i>	FT960	1.7	1000	60	1.0	3.5	15	15	3
<i>MMFT6661T1</i>	T6661	4.0	1000	90	0.8	2.0	5.0	5.0	3
<i>MMFT2406T1</i>	T2406	10	200	240	0.8	2.0	—	—	3
<i>MMFT107T1</i>	FT107	14	200	200	1.0	3.0	15	15	3
Case 419–02 — SC–70/SOT–323 — N–Channel									
<i>MMBF2201NT1</i>	N1	1.0	300	20	1.0	2.4	2.5	15	8
Case 419–02 — SC–70/SOT–323 — P–Channel									
<i>MMBF2202PT1</i>	P3	2.2	200	20	1.0	2.4	2.5	16	8

Devices listed in bold, italic are Motorola preferred devices.

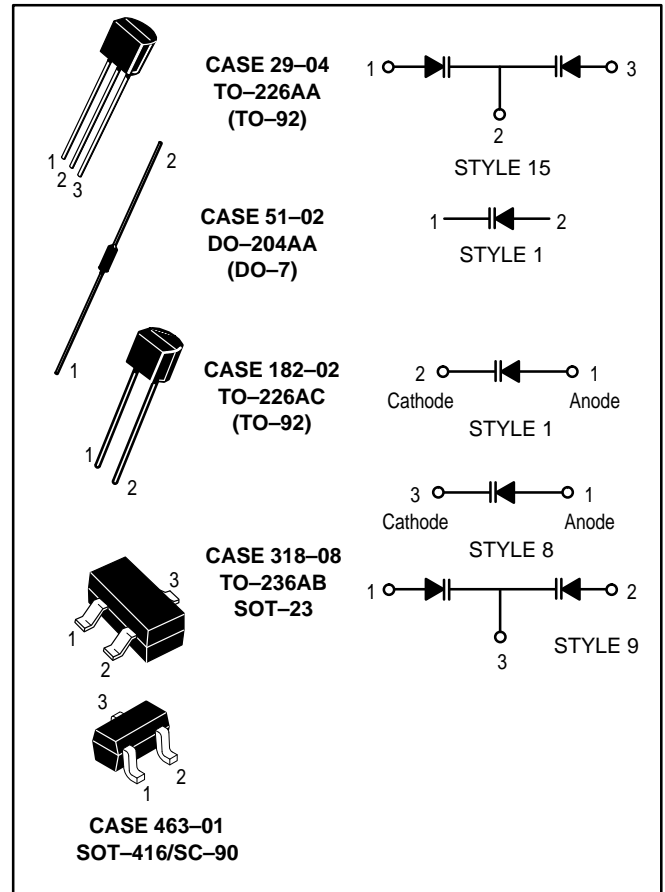
Tuning and Switching Diodes

Tuning Diodes — Abrupt Junction

Motorola supplies voltage-variable capacitance diodes serving the entire range of frequencies from HF through UHF. Used in RF receivers and transmitters, they have a variety of applications, including:

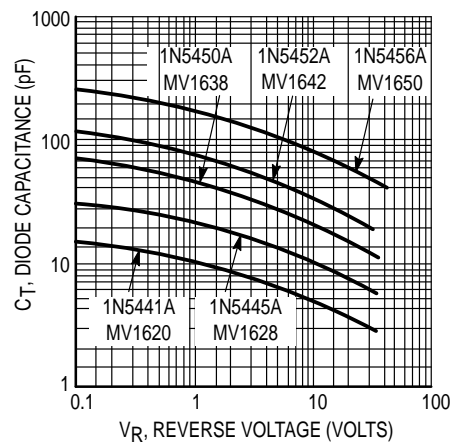
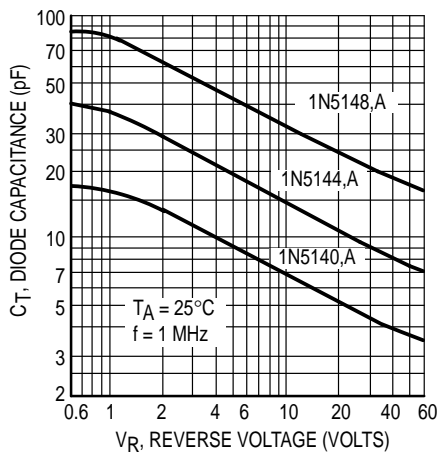
- Phase-locked loop tuning systems
- Local oscillator tuning
- Tuned RF preselectors
- RF filters
- RF phase shifters
- RF amplifiers
- Automatic frequency control
- Video filters and delay lines
- Harmonic generators
- FM modulators

Two families of devices are available: Abrupt Junction and Hyper Abrupt Junction. The Abrupt Junction family includes devices suitable for virtually all tuned-circuit and narrow-range tuning applications throughout the spectrum.

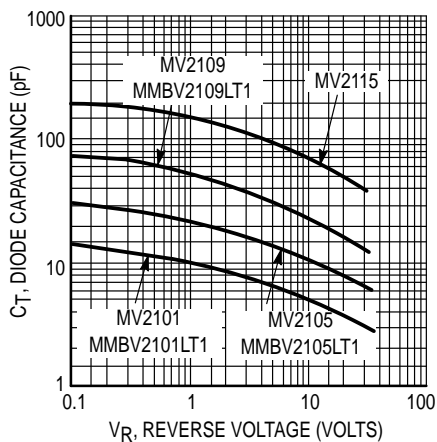


Typical Characteristics

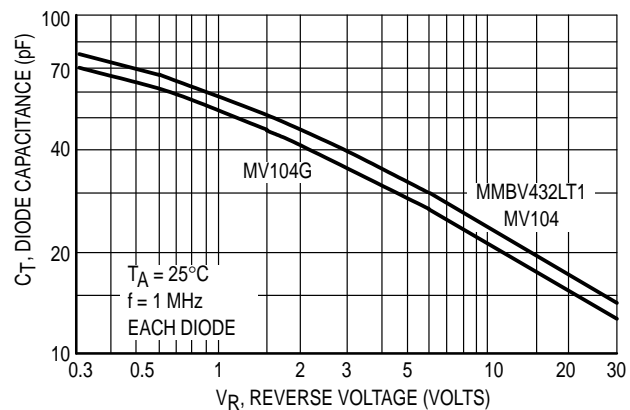
Diode Capacitance versus Reverse Voltage



(See Tables 38 Thru 40)



(See Tables 41 and 42)



(See Table 43)

Tuning Diodes — Abrupt Junction (continued)

**Table 38. General-Purpose Glass Abrupt Tuning Diodes
High Q Capacitance Ratio @ 4.0 Volts/60 Volts**

The following is a listing of axial leaded, general-purpose, abrupt tuning diodes. These devices exhibit high Q characteristics.

Device(19)	C _T @ V _R = 4.0 V, 1.0 MHz			V _{R(BR)R} Volts	Cap Ratio C ₄ /C ₆₀ Min	Q 4.0 V, 50 MHz Min
	pF Min	pF Nominal	pF Max			
Case 51-02 — DO-204AA (DO-7)						
1N5139	6.1	6.8	7.5	60	2.7	350
1N5140	9.0	10	11	60	2.8	300
1N5143	16.2	18	19.8	60	2.8	250
1N5144	19.8	22	24.2	60	3.2	200
1N5145	24.3	27	29.7	60	3.2	200
1N5148	42.3	47	51.7	60	3.2	200

**Table 39. General-Purpose Glass Abrupt Tuning Diodes
High Q Capacitance Ratio @ 2.0 Volts/30 Volts**

The following is a listing of axial leaded, general-purpose, abrupt tuning diodes. These devices exhibit very high Q characteristics.

Device(20)	C _T @ V _R = 4.0 V, 1.0 MHz			V _{R(BR)R} Volts	Cap Ratio C ₂ /C ₃₀ Min	Q 4.0 V, 50 MHz Min
	pF Min	pF Nominal	pF Max			
Case 51-02 — DO-204AA (DO-7)						
1N5441A	6.1	6.8	7.5	30	2.5	450
1N5444A	10.8	12	13.2	30	2.6	400
1N5446A	16.2	18	19.8	30	2.6	350
1N5448A	19.8	22	24.2	30	2.6	350
1N5449A	24.3	27	29.7	30	2.6	350
1N5450A	29.7	33	36.3	30	2.6	350
1N5451A	35.1	39	42.9	30	2.6	300
1N5452A	42.3	47	51.7	30	2.6	250
1N5453A	50.4	56	61.6	30	2.6	200
1N5455A	73.8	82	90.2	30	2.7	175
1N5456A	90	100	110	30	2.7	175

(19) Suffix A = 10.0%

(20) Suffix B = 5.0%

Tuning Diodes — Abrupt Junction (continued)

**Table 40. General-Purpose Glass Abrupt Tuning Diodes
Capacitance Ratio @ 2.0 Volts/20 Volts**

The following is a listing of axial leaded, general-purpose, abrupt tuning diodes. These devices exhibit high Q characteristics.

Device	$C_T @ V_R = 4.0 \text{ V}, 1.0 \text{ MHz}$			$V_{R(BR)}$ Volts	Cap Ratio C2/C20 Min	Q 4.0 V, 50 MHz Typ
	pF Min	pF Nominal	pF Max			
Case 51-02 — DO-204AA (DO-7)						
MV1620	6.1	6.8	7.5	20	2.0	300
MV1624	9.0	10	11	20	2.0	300
MV1626	10.8	12	13.2	20	2.0	300
MV1628	13.5	15	16.5	20	2.0	250
MV1630	16.2	18	19.8	20	2.0	250
MV1634	19.8	22	24.2	20	2.0	250
MV1636	24.3	27	29.7	20	2.0	200
MV1638	29.7	33	36.3	20	2.0	200
MV1640	35.1	39	42.9	20	2.0	200
MV1642	42.3	47	51.7	20	2.0	200
MV1644	50.4	56	61.6	20	2.0	150
MV1648	73.8	82	90.2	20	2.0	150
MV1650	90	100	110	20	2.0	150

**Table 41. General-Purpose Plastic Abrupt Tuning Diodes
Capacitance Ratio @ 2.0 Volts/30 Volts**

The following is a listing of plastic package, general-purpose, abrupt tuning diodes. These devices exhibit high Q characteristics.

Device	$C_T @ V_R = 4.0 \text{ V}, 1.0 \text{ MHz}$			$V_{R(BR)}$ Volts	Cap Ratio C4/C30 Min	Q 4.0 V, 50 MHz Typ
	pF Min	pF Nominal	pF Max			
Case 182-02 — TO-226AC (TO-92) — 2-Lead						
<i>MV2101</i>	6.1	6.8	7.5	30	2.5	400
MV2103	9.0	10	11	30	2.5	350
<i>MV2104</i>	10.8	12	13.2	30	2.5	350
MV2105	13.5	15	16.5	30	2.5	350
MV2107	19.8	22	24.2	30	2.5	300
<i>MV2108</i>	24.3	27	29.7	30	2.5	250
<i>MV2109</i>	29.7	33	36.3	30	2.5	200
<i>MV2111</i>	42.3	47	51.7	30	2.5	150
<i>MV2113</i>	61.2	68	74.8	30	2.5	150
MV2114	73.8	82	90.2	30	2.5	100
<i>MV2115</i>	90	100	110	30	2.6	100

Devices listed in bold, italic are Motorola preferred devices.

Tuning Diodes — Abrupt Junction (continued)

**Table 42. Surface Mount Abrupt Tuning Diodes
Capacitance Ratio @ 2.0 Volts/30 Volts**

The following is a listing of surface mount abrupt junction tuning diodes intended for general-purpose variable capacitance circuit applications.

Device	C _T @ V _R = 4.0 V, 1.0 MHz			V _{R(BR)R} Volts	Cap Ratio C ₂ /C ₃₀ Min	Q 4.0 V, 50 MHz Typ
	pF Min	pF Nominal	pF Max			
Case 318-08 — DO-236AB (SOT-23)						
MMBV2101LT1	6.1	6.8	7.5	30	2.5	400
MMBV2103LT1	9.0	10	11	30	2.5	350
MMBV2104LT1	10.8	12	13.2	30	2.5	350
MMBV2105LT1	13.5	15	16.5	30	2.5	350
MMBV2107LT1	19.8	22	24.2	30	2.5	300
MMBV2108LT1	24.3	27	29.7	30	2.5	250
MMBV2109LT1	29.7	33	36.3	30	2.5	200

Table 43. Abrupt Tuning Diodes for FM Radio — Dual

The following is a listing of abrupt tuning diodes that are available as dual units in a single package.

Device	C _T @ V _R ⁽²²⁾			Cap Ratio C ₃ /C ₃₀ Min	Q 3.0 V, 50 MHz Min	V _{(BR)R} Volts	Device Marking	Style
	pF Min	pF Max	Volts					
Case 29-04 — TO-226AA (TO-92)								
MV104	37	42	3.0	2.5	100	32	—	15
Case 318-08 — TO-236AB (SOT-23)								
MMBV432LT1	43	48.1	2.0	1.5 ⁽²¹⁾	100	14	M4B	9

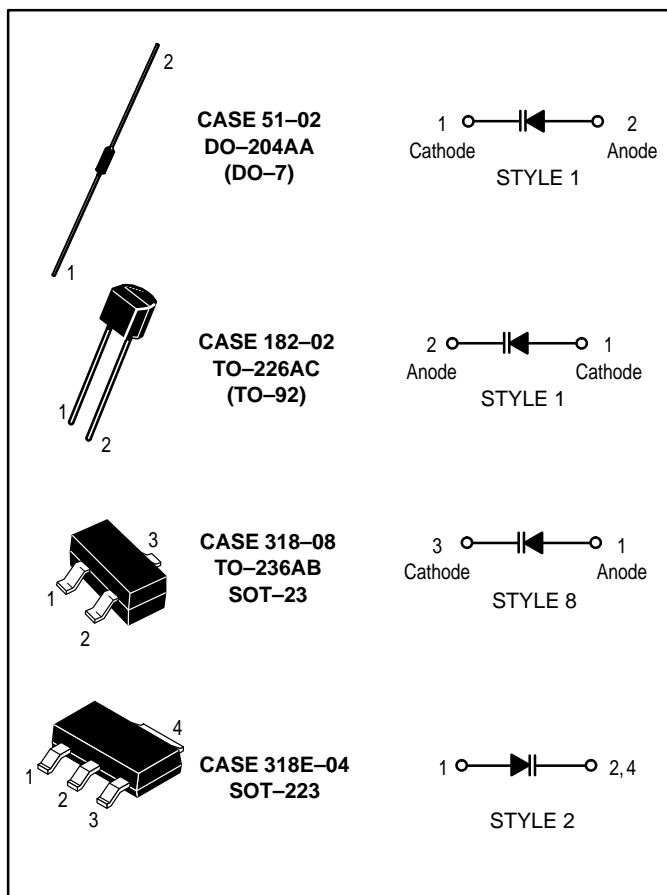
⁽²¹⁾C₂/C₈

⁽²²⁾Each Diode

Devices listed in bold, italic are Motorola preferred devices.

Tuning Diodes — Hyper–Abrupt Junction

The Hyper–Abrupt family exhibits higher capacitance, and a much larger capacitance ratio. It is particularly well suited for wider–range applications such as AM/FM radio and TV tuning.



Typical Characteristics

Diode Capacitance versus Reverse Voltage

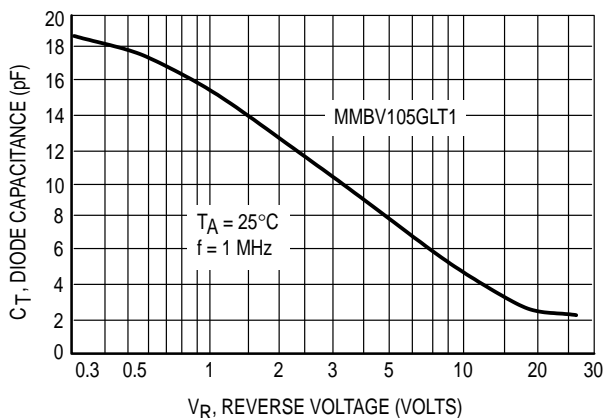


Figure 1. Diode Capacitance

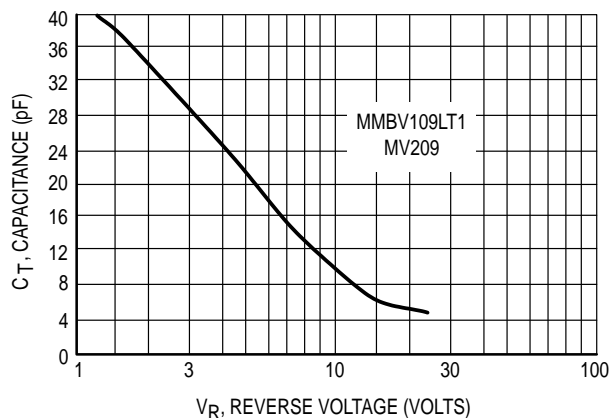


Figure 2. Diode Capacitance

Tuning Diodes — Hyper-Abrupt Junction (continued)

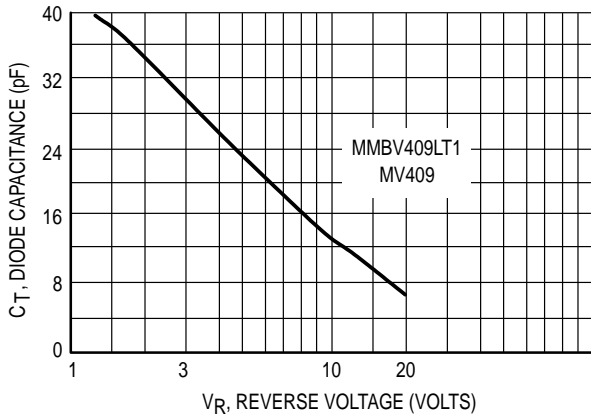


Figure 3. Diode Capacitance

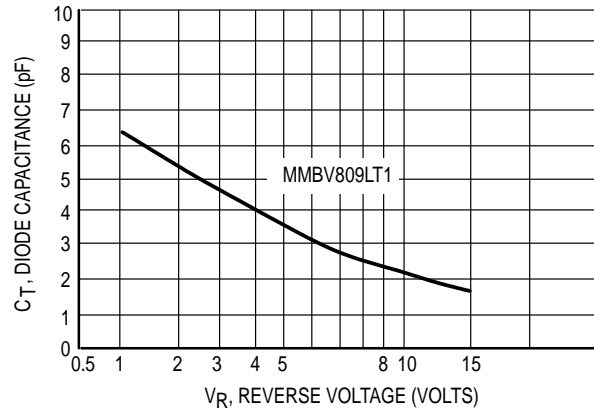


Figure 4. Diode Capacitance

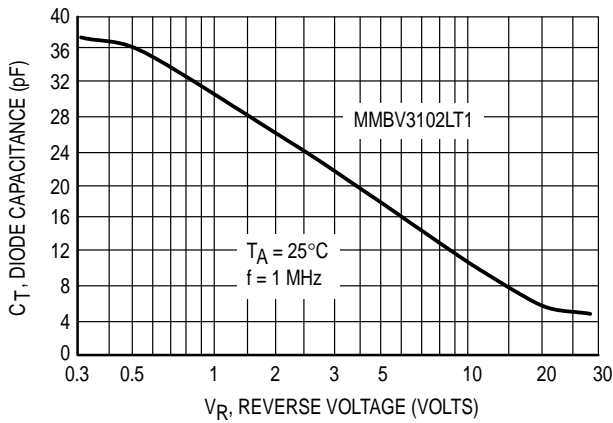


Figure 5. Diode Capacitance

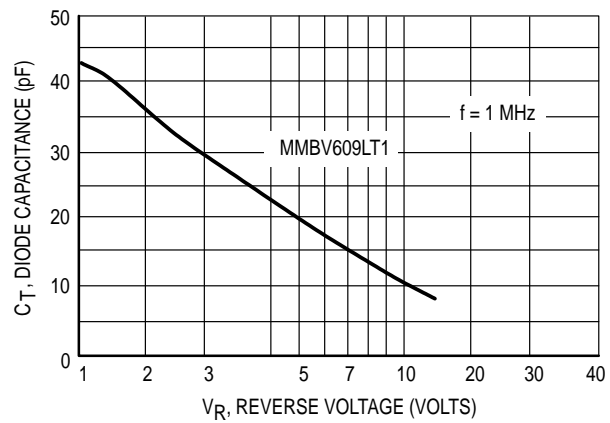


Figure 6. Diode Capacitance Each Die

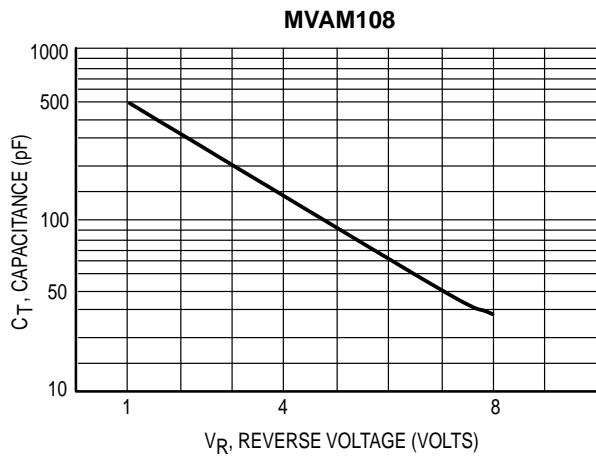


Figure 7. Capacitance versus Reverse Voltage

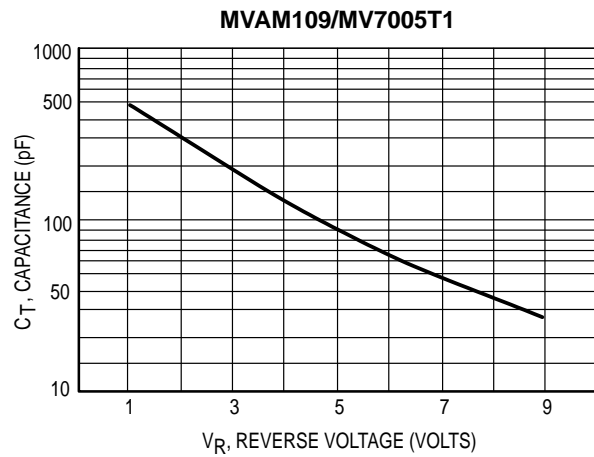


Figure 8. Capacitance versus Reverse Voltage

Tuning Diodes — Hyper-Abrupt Junction (continued)

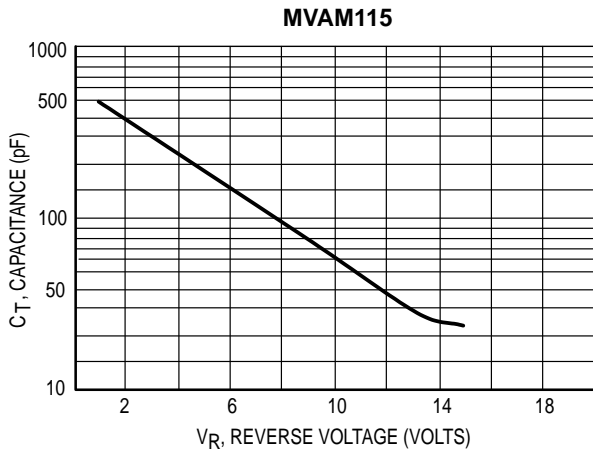


Figure 9. Capacitance versus Reverse Voltage

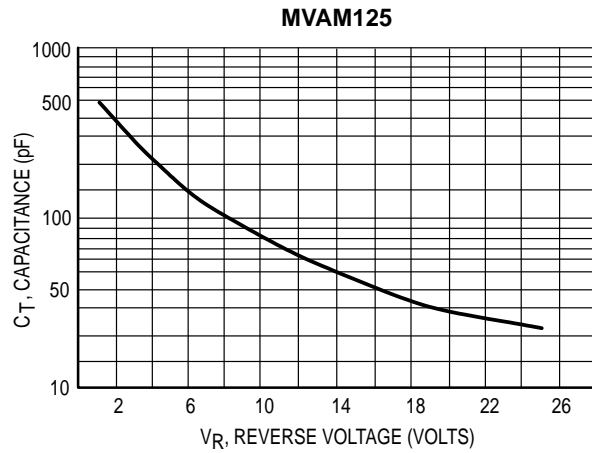


Figure 10. Capacitance versus Reverse Voltage

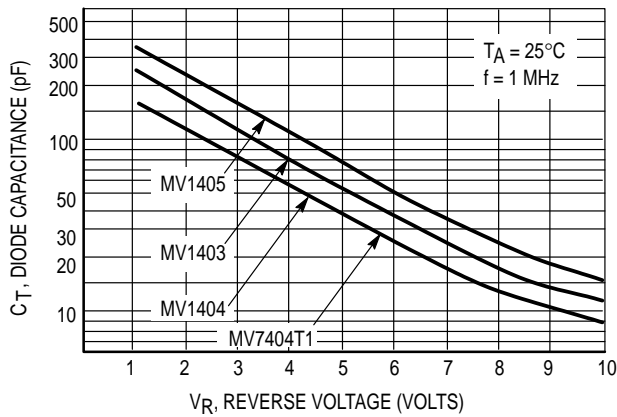


Figure 11. Diode Capacitance versus Reverse Voltage

Table 44. Hyper-Abrupt Tuning Diodes for Telecommunications — Single

The following is a listing of hyper-abrupt tuning diodes intended for high frequency, FM radio, and TV tuner applications.

Device	C_T @ V_R (f = 1.0 MHz)			Cap Ratio @ V_R			Q		$V_{(BR)R}$ Volts	Device Marking	Case Style	CV Curve Fig
	pF Min	pF Max	Volts	Min	Max	Volts	3.0 V Min	50 MHz Max				
Case 182-02 — TO-226AC (TO-92)												
<i>MV209</i>	26	32	3.0	5.0	6.5	3/25	200	—	30	—	1	2
<i>MV409</i>	26	32	3.0	1.5	2.0	3/8	200	—	20	—	1	3
Case 318-08 — TO-236AB (SOT-23)												
<i>MMBV105GLT1</i>	1.5	2.8	25	4.0	6.5	3/25	200	—	30	M4E	8	1
<i>MMBV109LT1</i>	26	32	3.0	5.0	6.5	3/25	200	—	30	M4A	8	2
<i>MMBV409LT1</i>	26	32	3.0	1.5	1.9	3/8	200	—	20	X5	8	3
<i>MMBV809LT1</i>	4.5	6.1	2.0	1.8	2.6	2/8	300	—	20	5K	8	4
<i>MMBV3102LT1</i>	20	25	3.0	4.5	—	3/25	200	—	30	M4C	8	5
Case 419-02 — SC-70/SOT-323												
<i>MBV109T1</i>	26	32	3.0	5.0	6.5	3/25	200	—	30	M4A	8	—

Devices listed in bold, italic are Motorola preferred devices.

Tuning Diodes — Hyper-Abrupt Junction (continued)

Table 45. Hyper-Abrupt Tuning Diodes for Communications — Dual

Device	C _T @ V _R (f = 1.0 MHz)			Cap Ratio @ V _R			Q		V _{(BR)R} Volts	Device Marking	Case Style	CV Curve Fig
	pF Min	pF Max	Volts	Min	Max	Volts	3.0 V Min	50 MHz Max				

Case 318-08 — TO-236AB (SOT-23)

MMBV609LT1	26	32	3.0	1.8	2.4	3/8	250	—	20	5L	9	6
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Table 46. Hyper-Abrupt Tuning Diodes for Low Frequency Applications — Single

The following is a listing of AM, hyper-abrupt tuning diodes that have a large capacity range and are designed for low frequency circuit applications.

Device	C _T @ 1.0 MHz			Cap Ratio @ V _R		V _{(BR)R} Volts	Style	CV Curve Figure
	pF Min	pF Max	Volts	Min	Volts			

Case 182-02 — TO-226AC (TO-92)

MVAM108	440	560	1.0	15	1.0/8.0	12	1	7
MVAM109	400	520	1.0	12	1.0/9.0	15	1	8
MVAM115	440	560	1.0	15	1.0/15	18	1	9
MVAM125	440	560	1.0	15	1.0/25	28	1	10

Table 47. Hyper-Abrupt High Capacitance Voltage Variable Diode — Surface Mount

The following are high capacitance voltage variable diodes intended for low frequency applications and circuits requiring large tuning capacitance.

Device	V _{(BR)R} Volts	I _R nA	C _T @ f = 1.0 MHz		Cap Ratio Min	Q Min	Style	CV Curve Figure
			Min pF	Max pF				

Case 318E-04 — SOT-223

Pinout: 1—Anode, 2, 4—Cathode, 3—NC

MV7005T1	15	100	400	520	12 ⁽²⁶⁾	150 ⁽²⁸⁾	2	8
MV7404T1	12	100	96	144	10 ⁽²⁷⁾	200 ⁽²⁹⁾	2	11

Table 48. Hyper-Abrupt High Capacitance Tuning Diodes — Axial Lead Glass Package

Device	C _T @ V _R			Cap Ratio C ₂ /C ₁₀ Min	Q 2.0 V, 1.0 MHz Min	V _{(BR)R} Volts	Style	CV Curve Figure
	pF Min	pF Max	Volts					

Case 51-02 — DO-204AA (DO-7)

MV1404	96	144	2.0	10	200	12	1	11
MV1403	140	210	2.0	10	200	12	1	11
MV1405	200	300	2.0	10	200	12	1	11

⁽²⁶⁾ V_R = 1.0 V/V_R = 9.0 V

⁽²⁷⁾ V_R = 2.0 V/V_R = 10 V

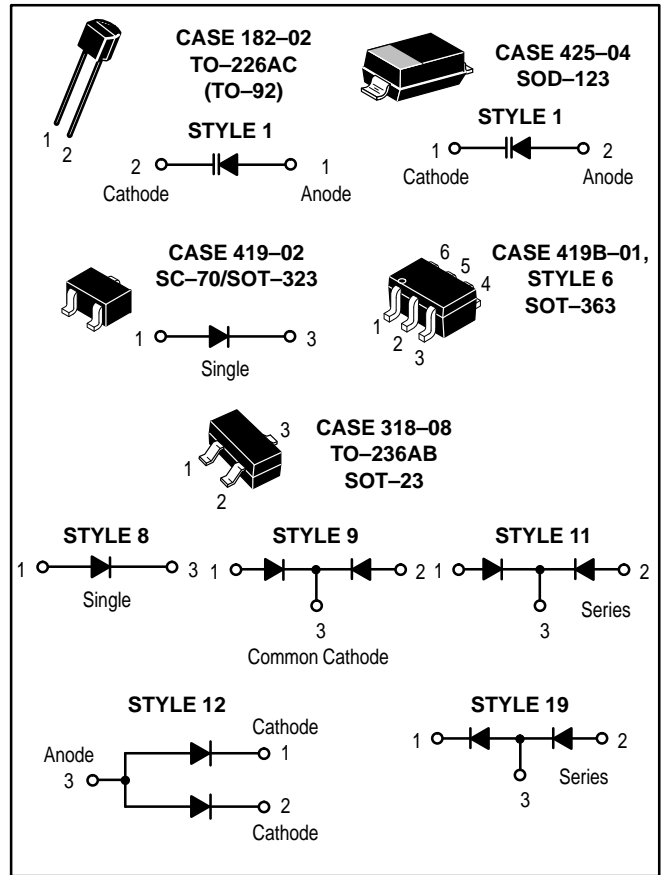
⁽²⁸⁾ V_R = 1.0 V, f = 1.0 MHz

⁽²⁹⁾ V_R = 2.0 V, f = 1.0 MHz

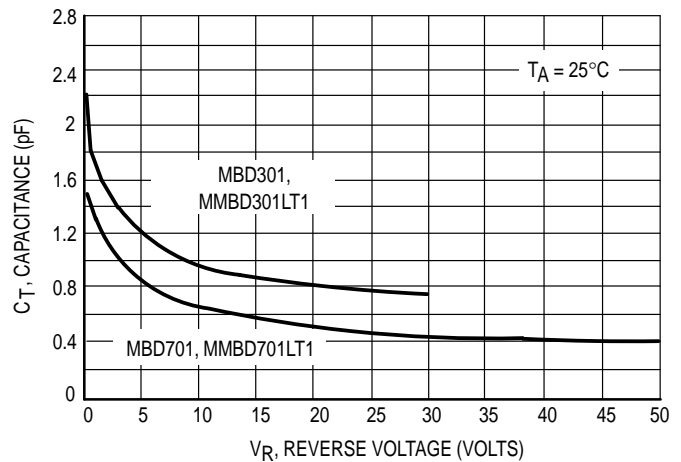
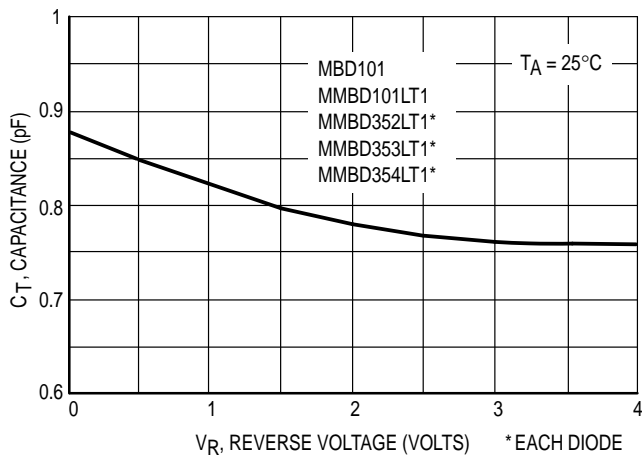
Devices listed in bold, italic are Motorola preferred devices.

Schottky Diodes

Schottky diodes are ideal for VHF and UHF mixer and detector applications as well as many higher frequency applications. They provide stable electrical characteristics by eliminating the point-contact diode presently used in many applications.



Typical Characteristics Capacitance versus Reverse Voltage



(See Table 49)

Devices listed in bold, italic are Motorola preferred devices.

Schottky Diodes (continued)

Table 49. Schottky Diodes

The following is a listing of Schottky diodes that exhibit low forward voltage drop for improved circuit efficiency.

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	Style
Case 182-02 — TO-226AC (TO-92)							
<i>MBD701</i>	70	1.0 @ 20 V	1.0	200 @ 35 V	15	—	1
<i>MBD301</i>	30	1.5 @ 15 V	0.6	200 @ 25 V	15	—	1
<i>MBD101</i>	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	—	—	1
Case 318-08 — TO-236AB (SOT-23)							
<i>MMBD701LT1</i>	70	1.0 @ 20 V	1.0	200 @ 35 V	15	5H	8
<i>MMBD301LT1</i>	30	1.5 @ 15 V	0.6	200 @ 25 V	15	4T	8
<i>MMBD101LT1</i>	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	15	4M	8
<i>MMBD352LT1</i> (23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	15	M5G	11
<i>MMBD353LT1</i> (23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	15	M4F	19
<i>MMBD354LT1</i> (23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	15	M6H	9
<i>MMBD355LT1</i> (23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	15	MJ1	12
<i>MMBD452LT1</i> (23)	30	1.5 @ 1.5 V	0.6	200 @ 25 V	15	5N	11
Case 425-04 — (SOD-123)							
<i>MMSD701T1</i>	70	1.0 @ 20 V	1.2	0.2 @ 35 V	15	5H	1
<i>MMSD301T1</i>	30	1.5 @ 15 V	0.6	0.2 @ 25 V	15	4T	1
<i>MMSD101T1</i>	4	1.0 @ 0 V	0.6	0.25 @ 3 V	15	4M	1
Case 419-02 — (SC-70/SOT-323)							
<i>MMBD330T1</i>	30	1.5 @ 15 V	0.6	0.2 @ 25 V	—	4T	2
<i>MMBD770T1</i>	70	1.0 @ 20 V	1.0	0.2 @ 35 V	—	5H	2

(23) Dual Diodes

Case 419B-01 — SOT-363 – Duals

Device	Marking	V _{(BR)R}		I _R		V _F			C _T (30) Max (pF)	t _{rr} Max (ns)	Case Style
		Min Volts	@ I _{BR} (μA)	Max (μA)	@ V _R Volts	Min Volts	Max Volts	@ I _F (mA)			
<i>MBD110DWT1</i>	M4	7	10	200	25	—	0.6	1.0	1.0	—	6
<i>MBD330DWT1</i>	T4	30	10	200	25	—	0.4	1.0	1.5	—	6
<i>MBD770DWT1</i>	H5	70	10	200	25	—	0.5	1.0	1.0	—	6

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

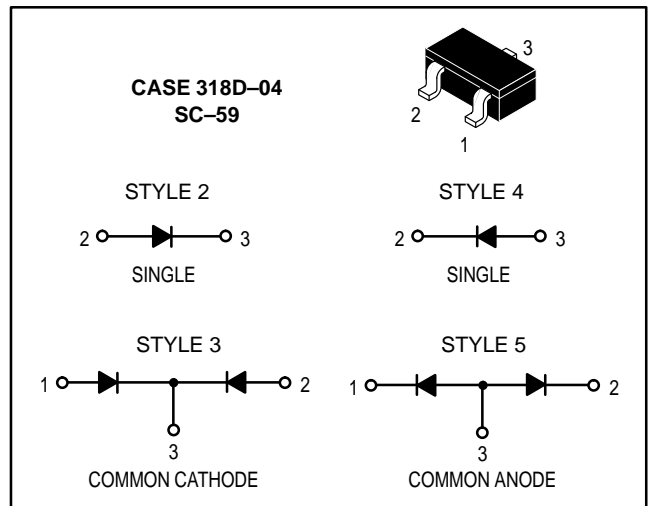
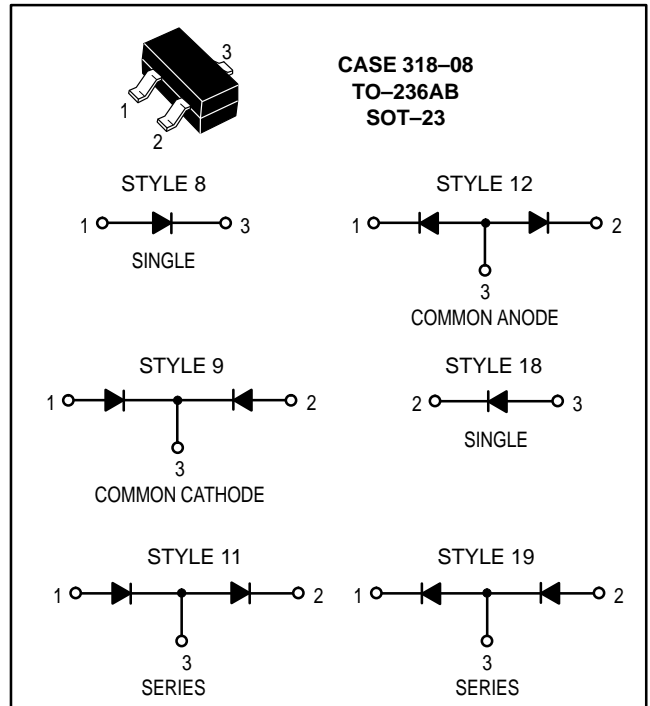
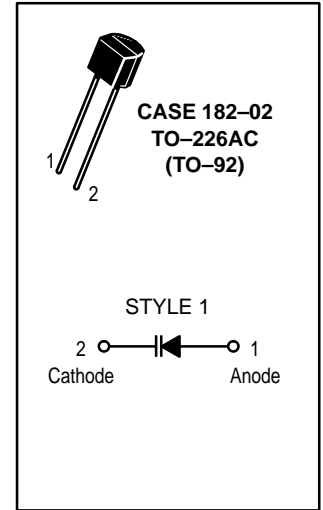
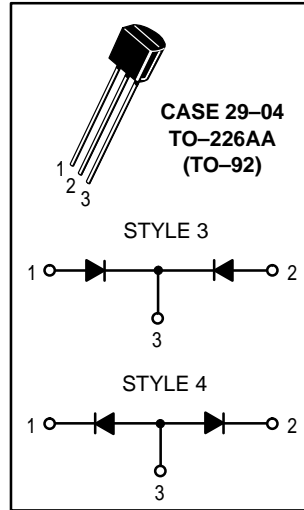
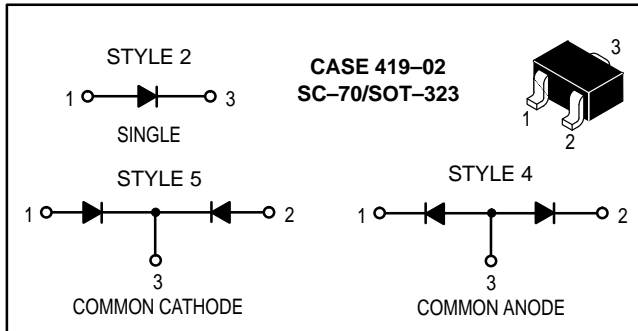
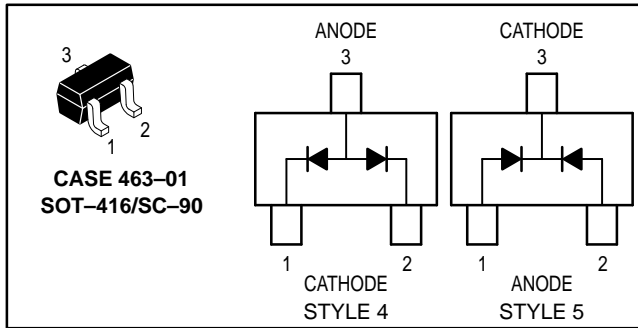
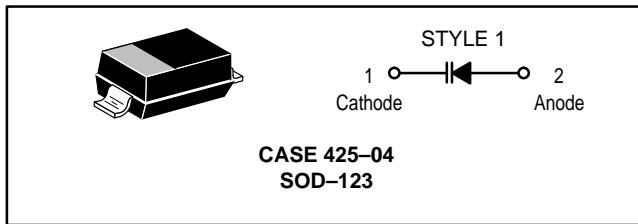
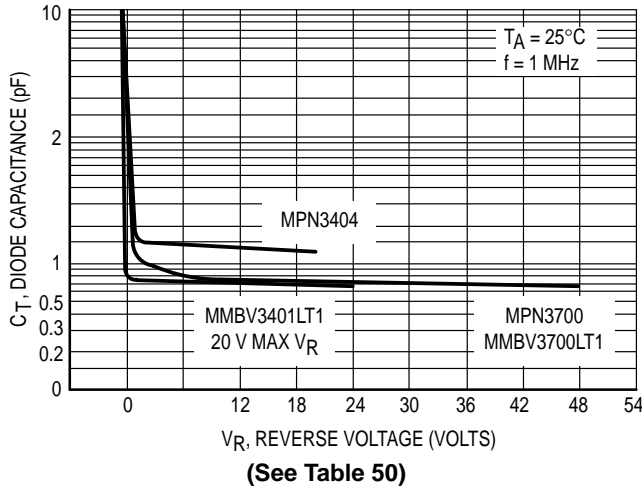
Devices listed in bold, italic are Motorola preferred devices.

Switching Diodes

Small-signal switching diodes are intended for low current switching and steering applications. Hot-Carrier, PIN and general-purpose diodes allow a wide selection for specific application requirements.

Typical Characteristics

Capacitance versus Reverse Voltage



Switching Diodes (continued)

Table 50. PIN Switching Diodes

The following PIN diodes are designed for VHF band switching and general-purpose low current switching applications.

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	Style
		pF Max	Volts				
Case 182-02 — TO-226AC (TO-92)							
MPN3700 <i>MPN3404</i>	200 20	1.0 2.0	20 15	0.1 @ 150 0.1 @ 25 V	1.0 @ 10 mA 0.85 @ 10 mA	— —	1 1
Case 318-08 — TO-236AB (SOT-23)							
MMBV3700LT1 <i>MMBV3401LT1</i>	200 35	1.0 1.0	20 20	0.1 @ 150 0.1 @ 25 V	1.0 @ 10 mA 0.7 @ 10 mA	4R 4D	8 8

Table 51. General-Purpose Signal and Switching Diodes — Single

The following is a listing of small-signal switching diodes in surface mount packages. These diodes are intended for low current switching and signal steering applications.

Device	Marking	V _{(BR)R}		I _R		V _F			C _T (³⁰)	t _{rr}	Case Style
		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)											
<i>BAS21LT1</i>	JS	250	100	0.1	200	—	1.0	100	5.0	50	8
<i>MMBD914LT1</i>	5D	100	100	5.0	75	—	1.0	10	4.0	4.0	8
<i>BAS16LT1</i>	A6	75	100	1.0	75	—	1.0	50	2.0	6.0	8
<i>MMBD6050LT1</i>	5A	70	100	0.1	50	0.85	1.1	100	2.5	4.0	8
<i>BAL99LT1</i>	JF	70	100	2.5	70	—	1.0	50	1.5	6.0	18
Case 318D-04 — SC-59											
<i>M1MA151AT1</i>	MA	40	100	0.1	35	—	1.2	100	2.0	3.0	4
<i>M1MA151KT1</i>	MH	40	100	0.1	35	—	1.2	100	2.0	3.0	2
Case 419-02 — SC-70/SOT-323											
<i>BAS16WT1</i>	A6	75	1.0	0.02	20	—	1.25	150	2.0	6.0	2
<i>M1MA141KT1</i>	MH	40	100	0.1	35	—	1.2	100	2.0	3.0	2
<i>M1MA142KT1</i>	MI	80	100	0.1	75	—	1.2	100	2.0	3.0	2
<i>M1MA174T1</i>	J6	100	100	5.0	75	—	1.0	10	4.0	4.0	2
Case 425-04 — SOD-123											
<i>MMSD914T1</i>	5D	100	100	5.0	75	—	1.0	10	4.0	4.0	1
MMSD4148T1	5I	100	100	5.0	75	—	1.0	10	4.0	4.0	1
MMSD71RKT1	6S	—	—	0.5	80	—	1.2	100	2.0	4.0	1

(³⁰) V_R = 0 V, f = 1.0 MHz

Devices listed in bold, italic are Motorola preferred devices.

Switching Diodes (continued)

Table 52. General-Purpose Signal and Switching Diodes — Dual

The following is a listing of small-signal switching diodes in surface mount packages. These diodes are intended for low current switching and signal steering applications.

Device	Marking	$V_{(BR)R}$		I_R		V_F			$C_T^{(30)}$	t_{rr}	Case Style
		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	11
MMBD2836LT1	A2	75	100	0.1	50	—	1.0	10	4.0	4.0	12
MMBD2838LT1	A6	75	100	0.1	50	—	1.0	10	4.0	4.0	9
BAV70LT1	A4	70	100	5.0	70	—	1.0	50	1.5	6.0	9
BAV99LT1	A7	70	100	2.5	70	—	1.0	50	1.5	4.0	11
BAW56LT1	A1	70	100	2.5	70	—	1.0	50	2.0	6.0	12
MMBD6100LT1	5BM	70	100	0.1	50	0.85	1.1	100	2.5	4.0	9
BAV74LT1	JA	50	5.0	0.1	50	—	1.0	100	2.0	4.0	9
MMBD2835LT1	A3	35	100	0.1	30	—	1.0	10	4.0	4.0	12
MMBD2837LT1	A5	35	100	0.1	30	—	1.0	10	4.0	4.0	9

Case 318D-04 — SC-59

M1MA151WAT1	MN	40	100	0.1	35	—	1.2	100	15	10	5
M1MA151WKT1	MT	40	100	0.1	35	—	1.2	100	2.0	3.0	3

Case 419-02 — SC-70/SOT-323

M1MA142WKT1	MU	80	100	0.1	75	—	1.2	100	2.0	3.0	5
M1MA142WAT1	MO	80	100	0.1	75	—	1.2	100	15	10	4
BAW56WT1	A1	70	100	2.5	70	—	1.0	50	2.0	6.0	4
BAV70WT1	A4	70	100	5.0	70	—	1.0	50	1.5	6.0	5
BAV99WT1	A7	70	100	2.5	70	—	1.0	50	1.5	6.0	9
BAV99RWT1	F7	70	100	2.5	70	—	1.0	50	1.5	6.0	10
M1MA141WKT1	MT	40	100	0.1	35	—	1.2	100	2.0	3.0	5
M1MA141WAT1	MN	40	100	0.1	35	—	1.2	100	15	10	4

Case 463-01 — SOT-416/SC-90 (Common Anode)

DAP222	P9	80	100	100	70	—	1.2	100	3.5	4.0	4
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Case 463-01 — SOT-416/SC-90 (Common Cathode)

DAN222	N9	80	100	100	70	—	1.2	100	3.5	4.0	5
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Table 53. Low-Leakage Medium Speed Switching Diodes — Single

Device	Marking	$V_{(BR)R}$		I_R		V_F			$C_T^{(30)}$	t_{rr}	Case Style
		Min Volts	@ I_{BR} (μA)	Max (nA)	@ V_R Volts	Min Volts	Max Volts	@ I_F (mA)	Max (pF)	Max (ns)	

Case 318-08 — TO-236AB (SOT-23)

BAS116LT1	JV	75	100	5.0	75	—	1.0	10	2.0	3000	8
MMBD1000LT1	AY	30	100	0.5	30	—	0.95	10	2.0	3000	6

Case 419-02 — (SOT-323)/(SC-70)

MMBD2000T1	DH	30	100	0.5	30	—	0.95	10	2.0	3000	2
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Case 318D-04 — (SC-59)

MMBD3000T1	XP	30	100	0.5	30	—	0.95	10	2.0	3000	2
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Case 425-04 — (SOD-123)

MMSD1000T1	4K	30	100	0.5	30	—	0.95	10	2.0	3000	1
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Devices listed in bold, italic are Motorola preferred devices.

Switching Diodes (continued)

Table 54. Low-Leakage Medium Speed Switching Diodes — Dual

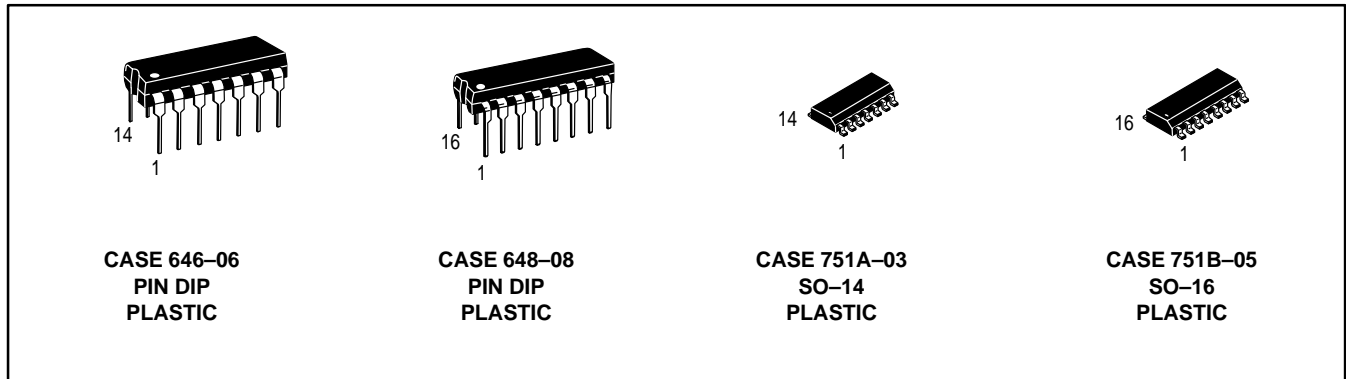
Device	Marking	$V_{(BR)R}$		I_R		V_F			$C_T^{(30)}$	t_{rr}	Case Style
		Min Volts	@ I_{BR} (μA)	Max (nA)	@ V_R Volts	Min Volts	Max Volts	@ I_F (mA)	Max (pF)	Max (ns)	
Case 318-08 — TO-236AB (SOT-23)											
<i>BAV170LT1</i>	JX	70	100	5.0	70	—	1.0	10	2.0	3000	9
<i>BAV199LT1</i>	JY	70	100	5.0	70	—	1.0	10	2.0	3000	11
<i>BAW156LT1</i>	JZ	70	100	5.0	70	—	1.0	10	2.0	3000	12
<i>MMBD1005LT1</i>	A3	30	100	0.5	30	—	0.95	10	2.0	3000	12
<i>MMBD1010LT1</i>	A5	30	100	0.5	30	—	0.95	10	2.0	3000	9
Case 419-02 — (SOT-323)/(SC-70) — DUAL											
<i>MMBD2005T1</i>	DI	30	100	0.5	30	—	0.95	10	2.0	3000	4
<i>MMBD2010T1</i>	DP	30	100	0.5	30	—	0.95	10	2.0	3000	5
Case 318D-04 — (SC-59) — DUAL											
<i>MMBD3005T1</i>	XQ	30	100	0.5	30	—	0.95	10	2.0	3000	5
<i>MMBD3010T1</i>	XS	30	100	0.5	30	—	0.95	10	2.0	3000	3

⁽³⁰⁾ $V_R = 0 V, f = 1.0 MHz$

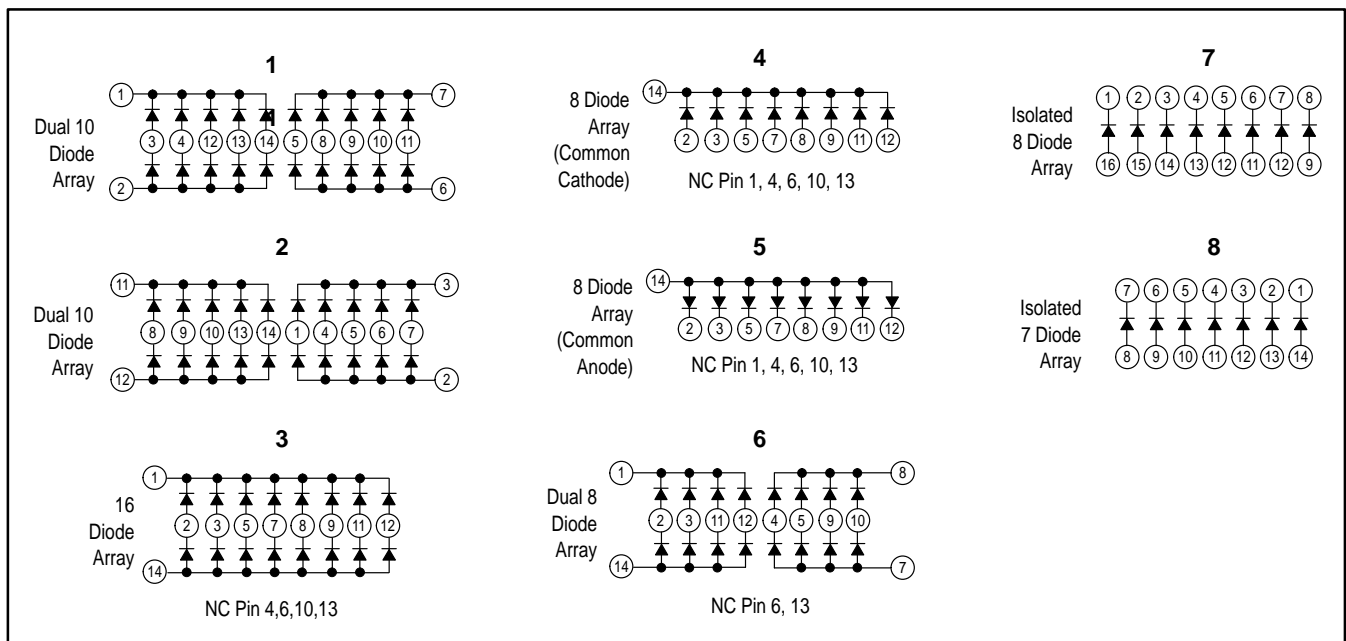
Devices listed in bold, italic are Motorola preferred devices.

Multiple Switching Diodes

Multiple diode configurations utilize monolithic structures fabricated by the planar process. They are designed to satisfy fast switching requirements as in core driver and encoding/decoding applications where their monolithic configurations offer lower cost, higher reliability and space savings.



Diode Array Diagrams



Multiple Switching Diodes (continued)

Table 55. Diode Arrays

Case 646 — TO-116

Device	Function	Pin Connections Diagram Number
<i>MAD130P</i>	Dual 10 Diode Array	1
<i>MAD1103P</i>	16 Diode Array	3
<i>MAD1107P</i>	Dual 8 Diode Array	6
<i>MAD1109P</i>	7 Isolated Diode Array	8

Case 648-08

<i>MAD1108P</i>	8 Isolated Diode Array	7
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Case 751A-03 — SO-14

<i>MMAD130</i>	Dual 10 Diode Array	2
<i>MMAD1103</i>	16 Diode Array	3
MMAD1105	8 Diode Common Cathode Array	4
MMAD1106	8 Diode Common Anode Array	5
<i>MMAD1107</i>	Dual 8 Diode Array	6
<i>MMAD1109</i>	7 Isolated Diode Array	8

Case 751B-05 — SO-16

<i>MMAD1108</i>	8 Isolated Diode Array	7
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Devices listed in bold, italic are Motorola preferred devices.



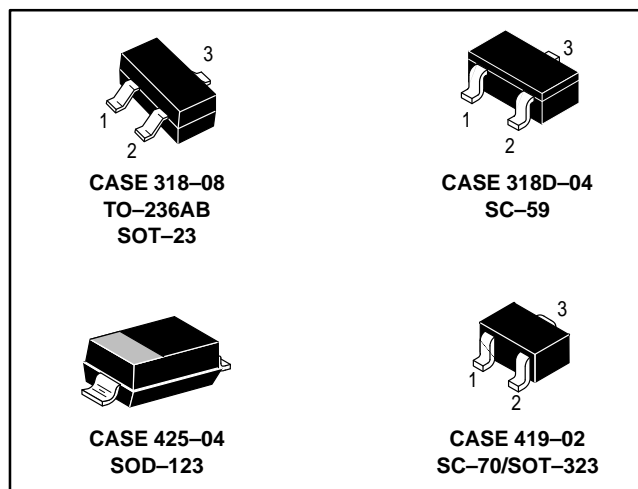
Plastic-Encapsulated Surface Mount Devices

Energy. It's something Motorola is putting a lot of energy into helping save. That's why we're introducing our GreenLine™ portfolio of devices, featuring energy-conserving traits superior to those of our existing line of standard parts for the same usage. GreenLine devices can actually help reduce the power demands of your products.

Wide Range of Applications

Currently, our portfolio consists of three families.

- **Low-Leakage Switching Diodes:** With reverse leakage specifications guaranteed to 500 pA, they help extend battery life, making them ideal for small battery-operated systems in which standby power is essential. Applications include ESD protection, reverse voltage protection, and steering logic.
- **Bipolar Output Driver Transistors:** Offering ultra-low collector saturation voltage, they deliver more energy to the intended load with less power wasted through dissipation loss. They are especially effective in today's lower voltage battery-powered applications, and prolong battery life in portable and hand-held communications and personal digital equipment.



- **Small Signal HDTMOS™:** These devices provide our lowest ever drain-source resistance versus package size. Lower $r_{DS(on)}$ means less wasted energy through dissipation loss, making them especially effective for low-current applications where energy conservation is crucial, such as low current switchmode power supplies, uninterruptable power supplies (UPS), power management systems, and bias switching. This makes them ideal for portable computer-type products or any system where the combination of power management and energy conservation is key.

Save Energy — Save Money

In an increasingly power-hungry world, Motorola's GreenLine portfolio makes powerful sense. So much sense that we plan to continue adding devices to the portfolio. Chances are, there are Motorola GreenLine devices applicable to one or more of your products — ones that can help save energy, dollars — and the environment.

Table 56. Bipolar Driver Transistor — PNP

These offer ultra-low collector saturation voltage.

Pinout: 1-Base, 2-Emitter, 3-Collector

Device Type	Marking	Case	$V_{(BR)CEO}$	$V_{CE(sat)}$	$V_{BE(sat)}$	$h_{FE} @ I_C$		
						Min	Max	mA
<i>MMBT1010LT1</i>	GLP	SOT-23	15	0.1	1.1	300	600	100
<i>MSD1010T1</i>	GLP	SC-59	15	0.1	1.1	300	600	100

Devices listed in bold, italic are Motorola preferred devices.

GreenLine (continued)

Table 57. Low Leakage Switching Diodes

These offer reverse leakage specifications guaranteed to 500 pA. Versions available in single and dual.

Device Type	Marking	Case	Style	$V_{(BR)R}$		I_R	
				Min Volts	@ I_{BR} (μA)	Max (nA)	@ V_R Volts
<i>MMBD1000LT1</i>	AY	SOT-23	Single	30	100	0.5	30
<i>MMBD1005LT1</i>	A3	SOT-23	Dual Anode	30	100	0.5	30
<i>MMBD1010LT1</i>	A5	SOT-23	Dual Cathode	30	100	0.5	30
<i>MMBD2000T1</i>	DH	SC-70	Single	30	100	0.5	30
<i>MMBD2005T1</i>	DI	SC-70	Dual Anode	30	100	0.5	30
<i>MMBD2010T1</i>	DP	SC-70	Dual Cathode	30	100	0.5	30
<i>MMBD3000T1</i>	XP	SC-59	Single	30	100	0.5	30
<i>MMBD3005T1</i>	XQ	SC-59	Dual Anode	30	100	0.5	30
<i>MMBD3010T1</i>	XS	SC-59	Dual Cathode	30	100	0.5	30
<i>MMSD1000T1</i>	4K	SOD-123	Single	30	100	0.5	30

Table 58. Small Signal HDTMOS™

These provide the lowest drain-source resistance versus package size.

Device Type	Marking	Channel	$R_{DS(on)}$		V_{DSS}	$V_{GS(th)}$		Switching Time		Style
			Ohm	mA		Volts Min	Volts Max	$t_{(on)}$ ns	$t_{(off)}$ ns	

Case 318-08 — TO-236AB (SOT-23) — P-Channel and N-Channel

<i>MMBF0201NLT1</i>	N1	N	1.0	300	20	1.0	2.4	2.5	15	21
<i>MMBF0202PLT1</i>	P3	P	1.4	200	20	1.0	2.4	2.5	16	21
<i>MGSF1N02LT1</i>	—	N	0.08	2000	20	1.0	2.4	2.5	16	21
<i>MGSF1N03LT1</i>	—	N	0.09	2000	30	1.0	2.4	2.5	16	21
<i>MGSF1P02LT1</i>	—	P	0.20	1500	20	1.0	2.4	2.5	16	21
<i>MGSF1P02ELT1</i>	—	P	0.16	1500	20	0.7	1.0	2.5	16	21

Case 419-02 — SC-70/SOT-323

<i>MMBF2202PT1</i>	P3	P	1.5	200	20	1.0	2.4	2.5	16	7
<i>MMBF2201NT1</i>	N1	N	0.7	300	20	1.0	2.4	2.5	15	7

Devices listed in bold, italic are Motorola preferred devices.

Small Signal Multi-integrated Devices

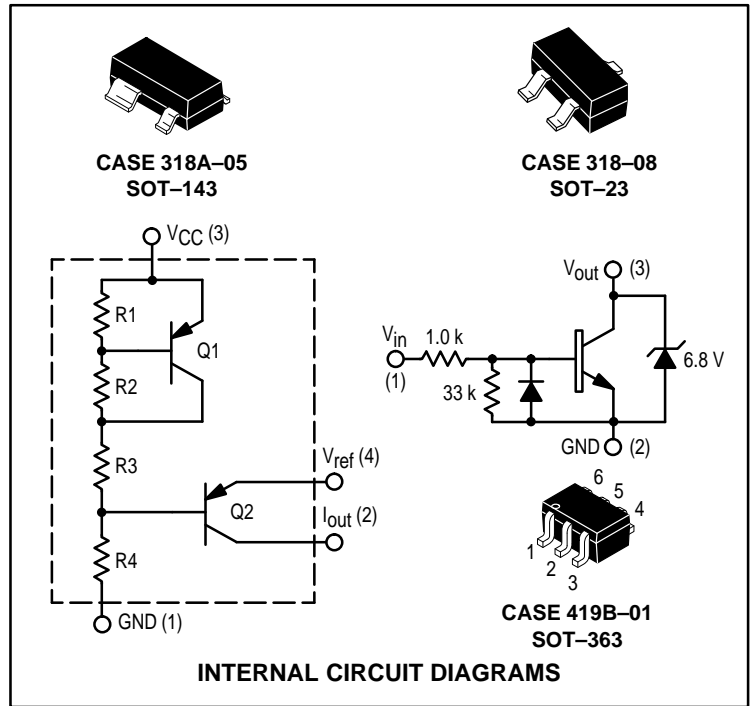


Table 59. Low Voltage Bias Stabilizer

A silicon SMALLBLOCK™ integrated circuit which maintains stable bias current in various discrete bipolar junction and field effect transistors.

Device Type	Marking	V _{CC} (Volts)		I _{CC} μA	V _{ref} Volts	ΔV _{ref} Volts
		Min	Max			
Case 318A-05 — SOT-143						
MDC5000T1	E5	1.8	10	200	2.1	±50
Case 419B-01 — SOT-363						
MDC5001T1	E6	1.8	10	200	2.1	±50

Table 60. Integrated Relay/Solenoid Driver

Monolithic circuit block to switch 3.0 V to 5.0 V relays. It is intended to replace an array of three to six discrete components.

Device Type	V _{CC} (Volts)		V _{in} (Volts)		V _{sat} (Volts)	I _{in} (mA)	I _{C(on)} (mA)
	Min	Max	Min	Max			
Case 318-08 — SOT-23							
<i>MDC3105LT1</i>	2.0	5.5	2.0	5.5	0.4	2.5	250

Devices listed in bold, italic are Motorola preferred devices.