

6367254 MOTOROLA SC (XSTRS/R F)

96D 82031 D

T-29-15

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	45	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	30	mA _{dc}

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	225	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	$^\circ\text{C}/\text{mW}$
Total Device Dissipation Alumina Substrate,** $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	300	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	$^\circ\text{C}/\text{mW}$
Junction and Storage Temperature	T_J, T_{stg}	150	$^\circ\text{C}$

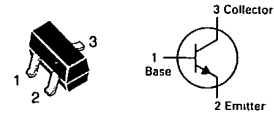
*FR-5 = 1.0 x 0.75 x 0.62 in.

**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT930 = 1X

MMBT930

CASE 318-02/03, STYLE 6
SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to MPS3904 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mA}_{dc}, I_B = 0$)	$V_{(BR)CEO}$	45	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu\text{A}_{dc}, I_E = 0$)	$V_{(BR)CBO}$	45	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu\text{A}_{dc}, I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 5.0 \text{ Vdc}, I_B = 0$)	I_{CEO}	—	10	nA _{dc}
Collector Cutoff Current ($V_{CB} = 45 \text{ Vdc}, I_E = 0$)	I_{CBO}	—	10	nA _{dc}
Collector Cutoff Current ($V_{CE} = 45 \text{ Vdc}, V_{BE} = 0$)	I_{CES}	—	10	nA _{dc}
Emitter Cutoff Current ($V_{EB} = 5.0 \text{ Vdc}, I_C = 0$)	I_{EBO}	—	10	nA _{dc}
ON CHARACTERISTICS				
DC Current Gain ($I_C = 10 \mu\text{A}_{dc}, V_{CE} = 5.0 \text{ Vdc}$) ($I_C = 500 \mu\text{A}_{dc}, V_{CE} = 5.0 \text{ Vdc}$) ($I_C = 10 \text{ mA}_{dc}, V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	100 150 —	300 — 600	—
Collector-Emitter Saturation Voltage ($I_C = 10 \text{ mA}_{dc}, I_B = 0.5 \text{ mA}_{dc}$)	$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 10 \text{ mA}_{dc}, I_B = 0.5 \text{ mA}_{dc}$)	$V_{BE(sat)}$	0.6	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 500 \mu\text{A}_{dc}, V_{CE} = 5.0 \text{ Vdc}, f = 30 \text{ MHz}$)	f_T	30	—	MHz
Output Capacitance ($V_{CB} = 5.0 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$)	C_{obo}	—	8.0	pF
Noise Figure ($I_C = 10 \mu\text{A}_{dc}, V_{CE} = 5.0 \text{ Vdc}, R_S = 10 \text{ k}\Omega$, $f = 10 \text{ Hz to } 15.7 \text{ kHz}$)	NF	—	3.0	dB

6367254 MOTOROLA SC (XSTRS/R F)

96D 82032 D

T-29-15

MAXIMUM RATINGS

Rating	Symbol	MMBT2222	MMBT2222A	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	Vdc
Collector-Base Voltage	V_{CBO}	60	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	6.0	Vdc
Collector Current — Continuous	I_C	600		mAdc

THERMAL CHARACTERISTICS

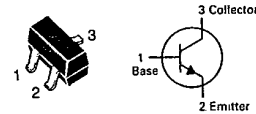
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	225	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	$^\circ\text{C}/\text{mW}$
Total Device Dissipation Alumina Substrate,** $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	300	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	2.4	$\text{mW}/^\circ\text{C}$
Junction and Storage Temperature	T_J, T_{stg}	150	$^\circ\text{C}$

*FR-5 = 1.0 x 0.75 x 0.62 in.

**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT2222 = 1B; MMBT2222A = 1P

MMBT2222
MMBT2222ACASE 318-02/03, STYLE 6
SOT-23 (TO-236AA/AB)

TRANSISTOR

NPN SILICON

Refer to MPS2222 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mAdc}, I_B = 0$)	$V_{(BR)CEO}$	30 40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu\text{Adc}, I_E = 0$)	$V_{(BR)CBO}$	60 75	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu\text{Adc}, I_C = 0$)	$V_{(BR)EBO}$	5.0 6.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 60 \text{ Vdc}, V_{EB(off)} = 3.0 \text{ Vdc}$)	I_{CEX}	—	10	nAdc
Collector Cutoff Current ($V_{CB} = 50 \text{ Vdc}, I_E = 0$) ($V_{CB} = 60 \text{ Vdc}, I_E = 0$) ($V_{CB} = 50 \text{ Vdc}, I_E = 0, T_A = 125^\circ\text{C}$) ($V_{CB} = 50 \text{ Vdc}, I_E = 0, T_A = 125^\circ\text{C}$)	I_{CBO}	—	0.01 0.01 10 10	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0 \text{ Vdc}, I_C = 0$)	I_{EBO}	—	10	nAdc
Base Cutoff Current ($V_{CE} = 60 \text{ Vdc}, V_{EB(off)} = 3.0 \text{ Vdc}$)	I_{BL}	—	20	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 0.1 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}$) ($I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = -55^\circ\text{C}$) ($I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}$)(1) ($I_C = 150 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$)(1) ($I_C = 500 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}$)(1)	h_{FE}	35 50 75 35 100 50 30 40	— — — — 300 — — —	—
Collector-Emitter Saturation Voltage(1) ($I_C = 150 \text{ mAdc}, I_B = 15 \text{ mAdc}$)	$V_{CE(sat)}$	— —	0.4 0.3	Vdc
($I_C = 500 \text{ mAdc}, I_B = 50 \text{ mAdc}$)		— —	1.6 1.0	

MOTOROLA SMALL-SIGNAL SEMICONDUCTORS

6367254 MOTOROLA SC (XSTRS/R F)

96D 82033 D

MMBT2222,A

T-29-15

ELECTRICAL CHARACTERISTICS (continued) ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit	
Base-Emitter Saturation Voltage(1) ($I_C = 150\text{ mAdc}$, $I_B = 15\text{ mAdc}$)	MMBT2222 MMBT2222A	V _{BE(sat)}	—	1.3	Vdc
			0.6	1.2	
(I _C = 500 mAdc, I _B = 50 mAdc)	MMBT2222 MMBT2222A		—	2.6	
			—	2.0	

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product(2) (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	MMBT2222 MMBT2222A	f _T	250 300	—	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	—	8.0	pF
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	MMBT2222 MMBT2222A	C _{ibo}	—	30 25	pF
Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h _{ie}	2.0 0.25	8.0 1.25	kΩ
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h _{re}	—	8.0 4.0	X 10 ⁻⁴
Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h _{fe}	50 75	300 375	—
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h _{oe}	5.0 25	35 200	μmhos
Collector Base Time Constant (I _E = 20 mAdc, V _{CB} = 20 Vdc, f = 31.8 MHz)	MMBT2222A	r _b 'C _c	—	150	ps
Noise Figure (I _C = 100 μAdc, V _{CE} = 10 Vdc, R _S = 1.0 kΩ, f = 1.0 kHz)	MMBT2222A	NF	4.0	4.0	dB

SWITCHING CHARACTERISTICS MMBT2222A only

Delay Time	(V _{CC} = 30 Vdc, V _{BE(off)} = 0.5 Vdc, I _C = 150 mAdc, I _{B1} = 15 mAdc)	t _d	—	10	ns
Rise Time		t _r	—	25	ns
Storage Time	(V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc)	t _s	—	225	ns
Fall Time		t _f	—	60	ns

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

(2) f_T is defined as the frequency at which |h_{fe}| extrapolates to unity.

6367254 MOTOROLA SC (XSTRS/R F)

96D 82034 D

T-35-09

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Emitter Voltage	V_{CES}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	225	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	1.8	$\text{mW}/^\circ\text{C}$
Total Device Dissipation Alumina Substrate,** $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	300	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	2.4	$\text{mW}/^\circ\text{C}$
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	$^\circ\text{C}/\text{mW}$
Junction and Storage Temperature	T_J, T_{stg}	150	$^\circ\text{C}$

*FR-5 = 1.0 x 0.75 x 0.62 in.

**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

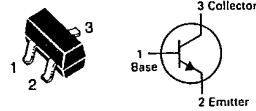
MMBT2369 = 1J

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10 \text{ mAdc}, I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10 \mu\text{Adc}, V_{BE} = 0$)	$V_{(BR)CES}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu\text{Adc}, I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu\text{Adc}, I_C = 0$)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 20 \text{ Vdc}, I_E = 0$) ($V_{CB} = 20 \text{ Vdc}, I_E = 0, T_A = 125^\circ\text{C}$)	I_{CBO}	—	—	0.4 30	μAdc
ON CHARACTERISTICS					
DC Current Gain(1) ($I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}, T_A = -55^\circ\text{C}$) ($I_C = 100 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc}$)	h_{FE}	40 20 20	— — —	120 — —	—
Collector-Emitter Saturation Voltage(1) ($I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc}$)	$V_{CE(sat)}$	—	—	0.25	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc}$)	$V_{BE(sat)}$	0.70	—	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance ($V_{CB} = 5.0 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$)	C_{obo}	—	—	4.0	pF
Small Signal Current Gain ($I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 100 \text{ MHz}$)	h_{fe}	5.0	—	—	—
SWITCHING CHARACTERISTICS					
Storage Time ($I_{B1} = I_{B2} = I_C = 10 \text{ mAdc}$)	t_s	—	5.0	13	ns
Turn-On Time ($V_{CC} = 3.0 \text{ Vdc}, I_C = 10 \text{ mAdc}, I_{B1} = 3.0 \text{ mAdc}$)	t_{on}	—	8.0	12	ns
Turn-Off Time ($V_{CC} = 3.0 \text{ Vdc}, I_C = 10 \text{ mAdc}, I_{B1} = 3.0 \text{ mAdc}, I_{B2} = 1.5 \text{ mAdc}$)	t_{off}	—	10	18	ns

(1) Pulse Test: Pulse Width $\leq 300 \mu\text{s}$, Duty Cycle $\leq 2.0\%$.

MMBT2369

CASE 318-02/03, STYLE 6
SOT-23 (TO-236AA/AB)

SWITCHING TRANSISTOR

NPN SILICON

Refer to MPS2369 for graphs.

6367254 MOTOROLA SC (XSTRS/R F)

96D 82035 D

T-29-15

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	60	Vdc
Collector-Base Voltage	V _{CBO}	60	Vdc
Emitter-Base Voltage	V _{EBO}	6.0	Vdc
Collector Current — Continuous	I _C	50	mA _{dc}

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T _A = 25°C Derate above 25°C	P _D	225	mW
Thermal Resistance Junction to Ambient	R _{θJA}	556	°C/mW
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	P _D	300	mW
Thermal Resistance Junction to Ambient	R _{θJA}	417	°C/mW
Junction and Storage Temperature	T _J , T _{stg}	150	°C

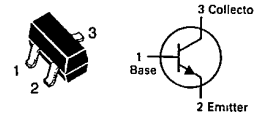
*FR-5 = 1.0 x 0.75 x 0.62 in.

**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT2484 = 1U

MMBT2484

CASE 318-02/03, STYLE 6
SOT-23 (TO-236AA/AB)

LOW NOISE TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I _C = 10 mA _{dc} , I _B = 0)	V _{(BR)CEO}	60	—	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μA _{dc} , I _E = 0)	V _{(BR)CBO}	60	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μA _{dc} , I _C = 0)	V _{(BR)EBO}	5.0	—	Vdc
Collector Cutoff Current (V _{CB} = 45 Vdc, I _E = 0) (V _{CB} = 45 Vdc, I _E = 0, T _A 150°C)	I _{CBO}	—	10	nA _{dc} μA _{dc}
Emitter Cutoff Current (V _{BE} = 5.0 Vdc, I _C = 0)	I _{EBO}	—	10	nA _{dc}
ON CHARACTERISTICS				
DC Current Gain (I _C = 1.0 mA _{dc} , V _{CE} = 5.0 Vdc) (I _C = 10 mA _{dc} , V _{CE} = 5.0 Vdc)	h _{FE}	250 —	— 800	—
Collector-Emitter Saturation Voltage (I _C = 1.0 mA _{dc} , I _B = 0.1 mA _{dc})	V _{CE(sat)}	—	0.35	Vdc
Base-Emitter On Voltage (I _C = 1.0 mA _{dc} , V _{CE} = 5.0 Vdc)	V _{BE(on)}	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1 MHz)	C _{obo}	—	6.0	pF
Input Capacitance (V _{BE} = 0.5 Vdc, I _C = 0, f = 1 MHz)	C _{ibo}	—	6.0	pF
Noise Figure (I _C = 10 μA _{dc} , V _{CE} = 5.0 Vdc, R _S = 10 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	3.0	dB