General Purpose Transistors

NPN Silicon

MMBT2222L, MMBT2222AL, SMMBT2222AL

Features

- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant
- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable

COLLECTOR
3

1
BASE

2
EMITTER

SOT−23
CASE 318
STYLE 6

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector−Emitter Voltage MMBT2222L MMBT2222AL, SMMBT2222AL	V_{CEO}	30 40	Vdc
Collector−Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL	V_{CBO}	60 75	Vdc
Emitter−Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL	V_{EBO}	5.0 6.0	Vdc
Collector Current − Continuous	I_C	600	mAdc
Collector Current − Peak (Note 3)	I_{CM}	1100	mAdc

THERMAL CHARACTERISTICS

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

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.
1. FR−5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. Reference SOA curve.
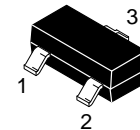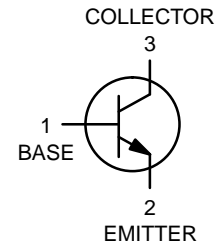
MARKING DIAGRAM

xxx M ▪

1
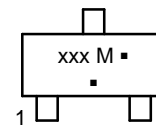
xxx = 1P or M1B
M = Date Code*
▪ = Pb−Free Package
(Note: Microdot may be in either location)
*Date Code orientation and/or overbar may vary depending upon manufacturing location.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector – Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0) MMBT2222 MMBT2222A		$V_{(BR)CEO}$	30 40	– –	Vdc
Collector – Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0) MMBT2222 MMBT2222A		$V_{(BR)CBO}$	60 75	– –	Vdc
Emitter – Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0) MMBT2222 MMBT2222A		$V_{(BR)EBO}$	5.0 6.0	– –	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MMBT2222A, SMMBT2222A	I_{CEX}	–	10	nAdc

Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)   MMBT2222
   (V_{CB} = 60 Vdc, I_E = 0)   MMBT2222A, SMMBT2222A
   (V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C)   MMBT2222
   (V_{CB} = 60 Vdc, I_E = 0, T_A = 125°C)   MMBT2222A, SMMBT2222A
		I_{CBO}	–
			–
			–
			–
				0.01
				0.01
				10
				10
					μAdc

Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	MMBT2222A, SMMBT2222A	I_{EBO}	–	100	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MMBT2222A, SMMBT2222A	I_{BL}	–	20	nAdc
ON CHARACTERISTICS					

DC Current Gain
   (I_C = 0.1 mAdc, V_{CE} = 10 Vdc)
   (I_C = 1.0 mAdc, V_{CE} = 10 Vdc)
   (I_C = 10 mAdc, V_{CE} = 10 Vdc)
   (I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = −55°C)   MMBT2222A only
   (I_C = 150 mAdc, V_{CE} = 10 Vdc) (Note 4)
   (I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (Note 4)
   (I_C = 500 mAdc, V_{CE} = 10 Vdc) (Note 4)   MMBT2222
   MMBT2222A, SMMBT2222A
		h_{FE}	35
			50
			75
			35
			100
			50
			30
			40
				–
				–
				–
				–
				300
				–
				–
				–
					–

Collector – Emitter Saturation Voltage (Note 4)
   (I_C = 150 mAdc, I_B = 15 mAdc)   MMBT2222
   MMBT2222A, SMMBT2222A
 	
   (I_C = 500 mAdc, I_B = 50 mAdc)   MMBT2222
   MMBT2222A, SMMBT2222A
		$V_{CE(sat)}$	–
			–
			
			–
			–
				0.4
				0.3
				
				1.6
				1.0
					Vdc

Base – Emitter Saturation Voltage (Note 4)
   (I_C = 150 mAdc, I_B = 15 mAdc)   MMBT2222
   MMBT2222A, SMMBT2222A
 	
(I_C = 500 mAdc, I_B = 50 mAdc)   MMBT2222
   MMBT2222A, SMMBT2222A
		$V_{BE(sat)}$	–
			0.6
			
			–
			–
				1.3
				1.2
				
				2.6
				2.0
					Vdc

SMALL – SIGNAL CHARACTERISTICS					

Current – Gain – Bandwidth Product (Note 5)
   (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)   MMBT2222
   MMBT2222A, SMMBT2222A
		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, SMMBT2222A
		C_{ibo}	–
			–
				30
				25
					pF

Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A, SMMBT2222A MMBT2222A, SMMBT2222A	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)	MMBT2222A, SMMBT2222A MMBT2222A, SMMBT2222A	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)	MMBT2222A, SMMBT2222A MMBT2222A, SMMBT2222A	h_{fe}	50 75	300 375	–

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

Characteristic		Symbol	Min	Max	Unit
SMALL−SIGNAL CHARACTERISTICS					
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, SMMBT2222A MMBT2222A, SMMBT2222A	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, SMMBT2222A	rb, C_c	–	150	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	MMBT2222A, SMMBT2222A	NF	–	4.0	dB
SWITCHING CHARACTERISTICS (MMBT2222A only)					
Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = −0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	–	10	ns
Rise Time		t_r	–	25	
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	–	225	ns
Fall Time		t_f	–	60	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
5. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS
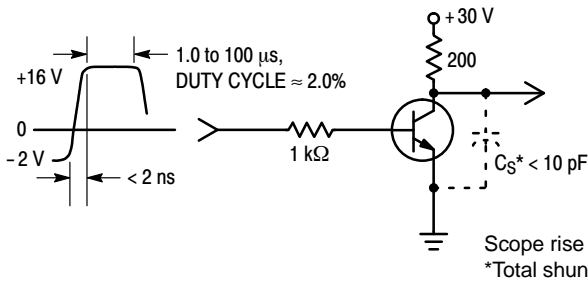
Figure 1. Turn−On Time

Figure 2. Turn−Off Time
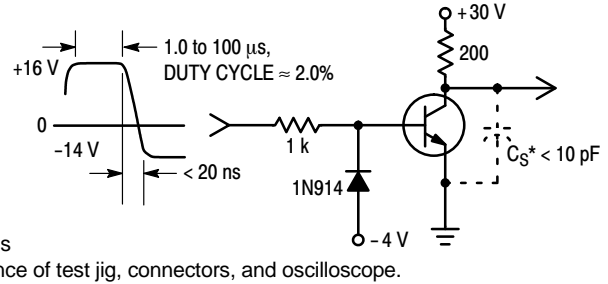
*Total shunt capacitance of test jig, connectors, and oscilloscope.
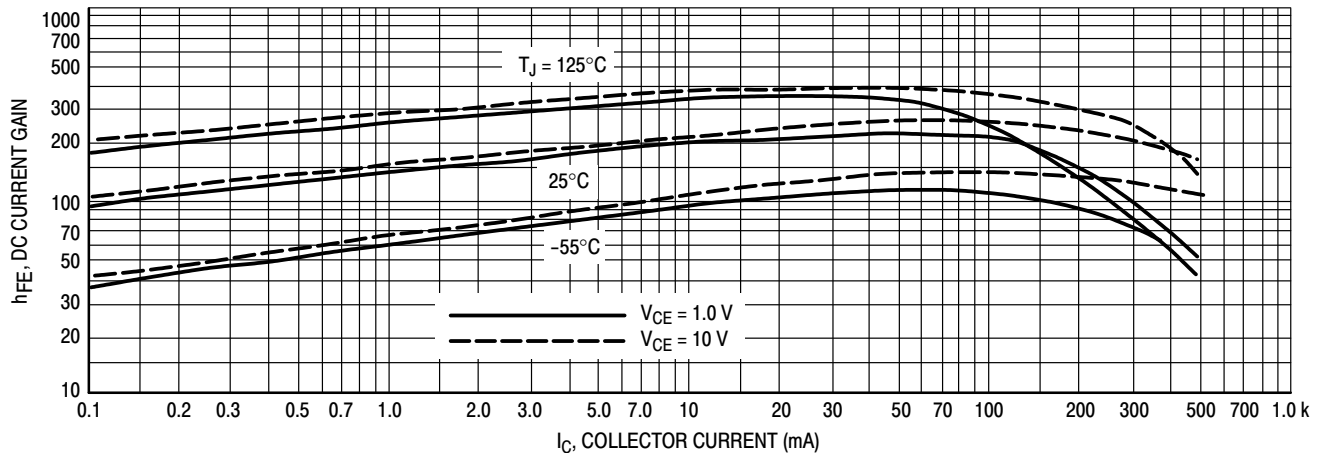
Figure 3. DC Current Gain

MMBT2222L, MMBT2222AL, SMMBT2222AL
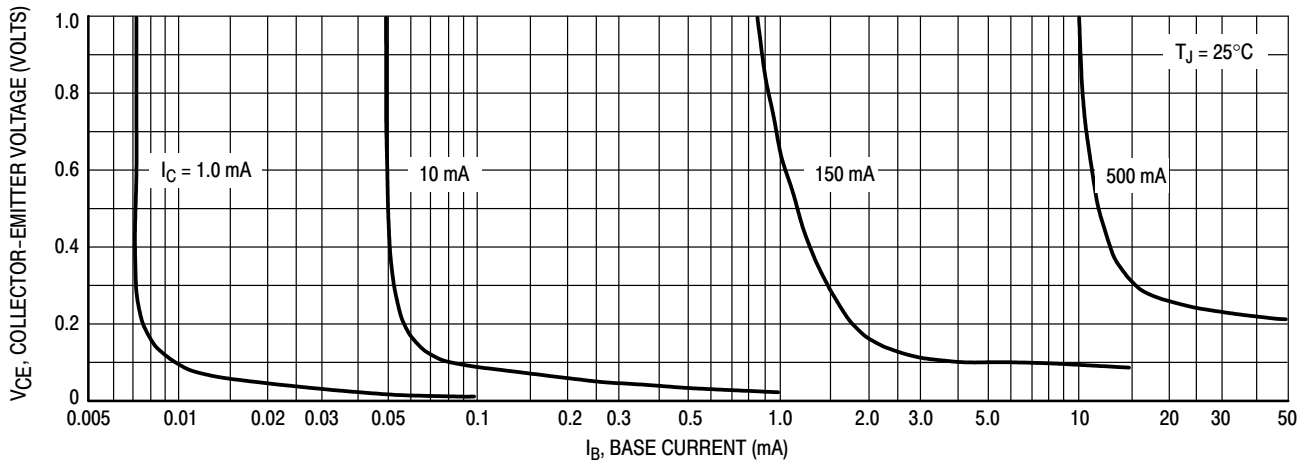
Figure 4. Collector Saturation Region
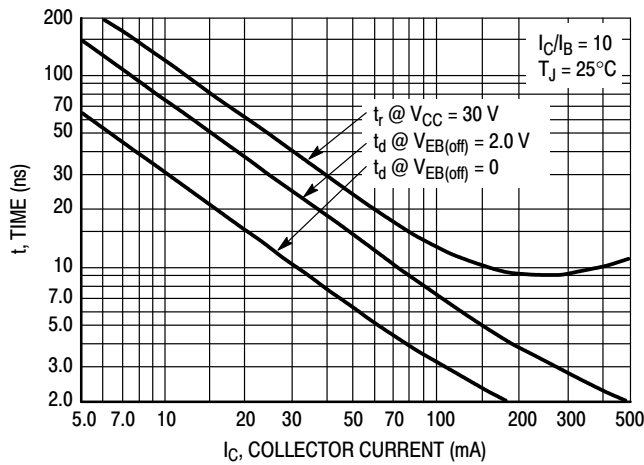
Figure 5. Turn–On Time
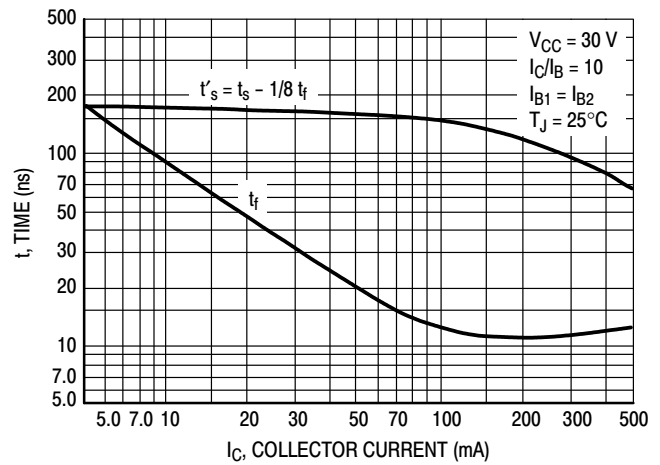
Figure 6. Turn–Off Time
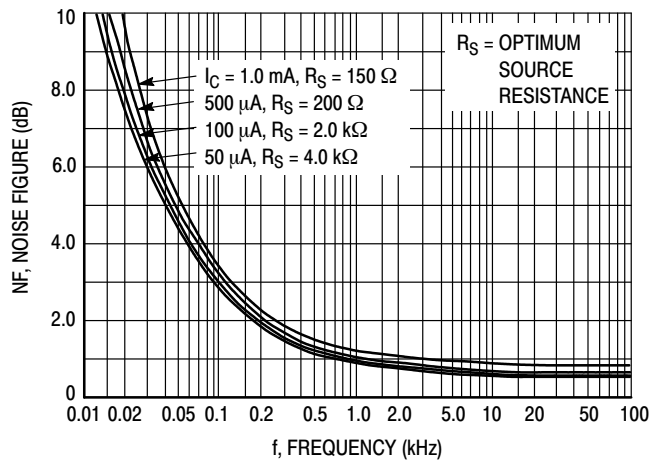
Figure 7. Frequency Effects
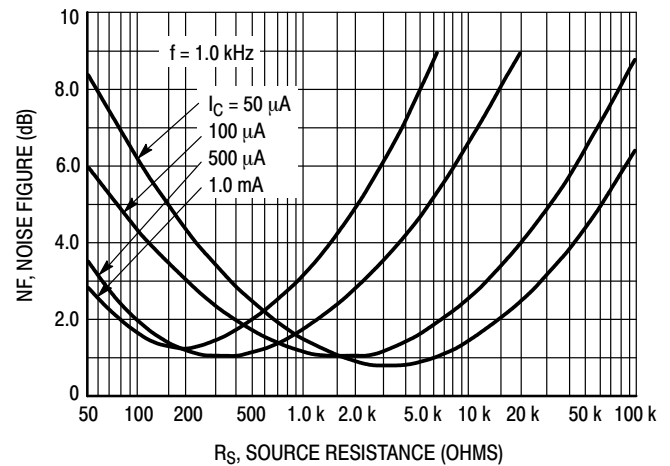
Figure 8. Source Resistance Effects
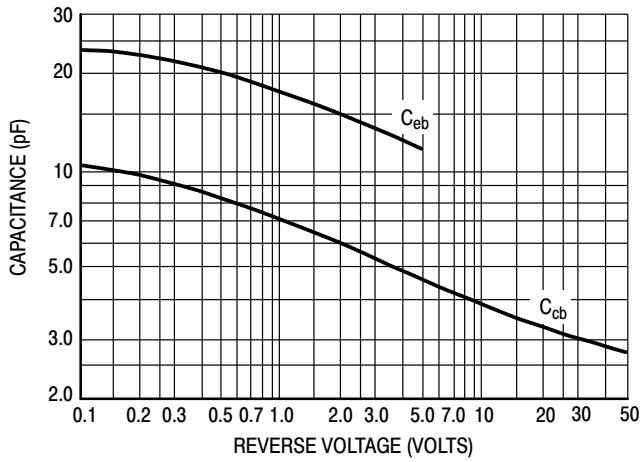
Figure 9. Capacitances
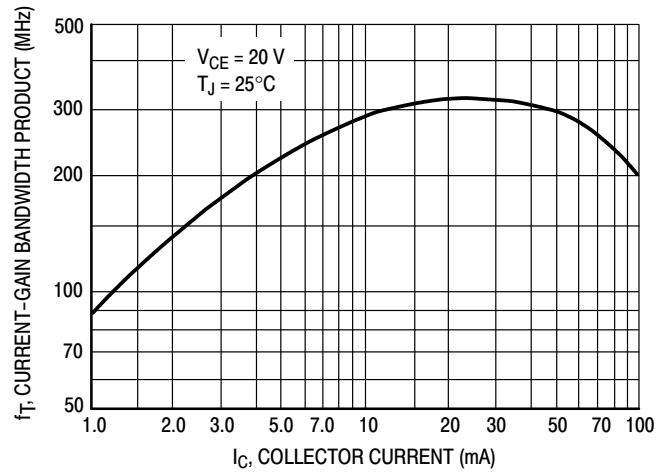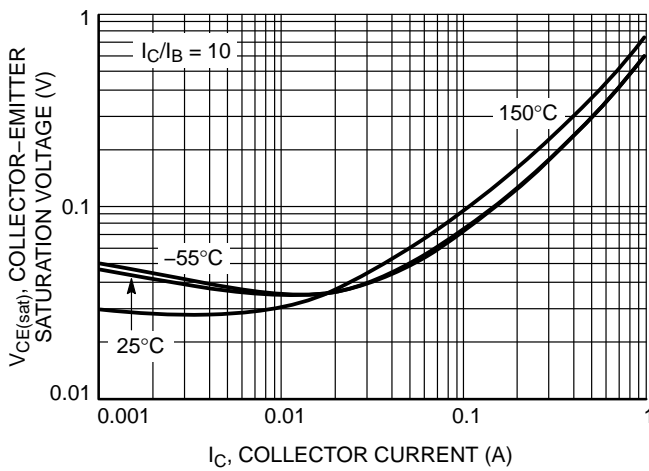
Figure 10. Current–Gain Bandwidth Product

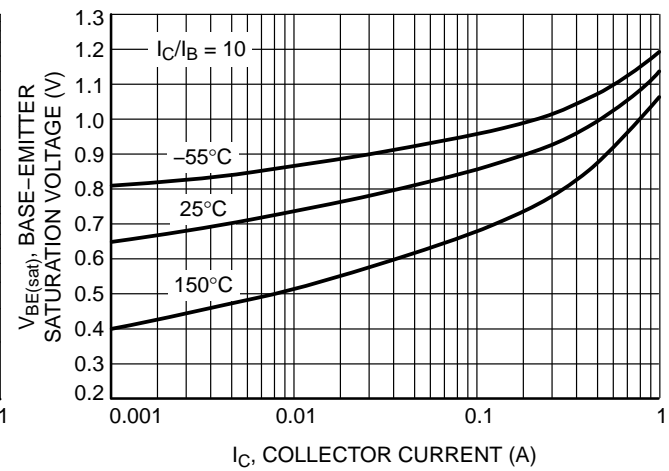**Figure 11. Collector Emitter Saturation Voltage vs. Collector Current**

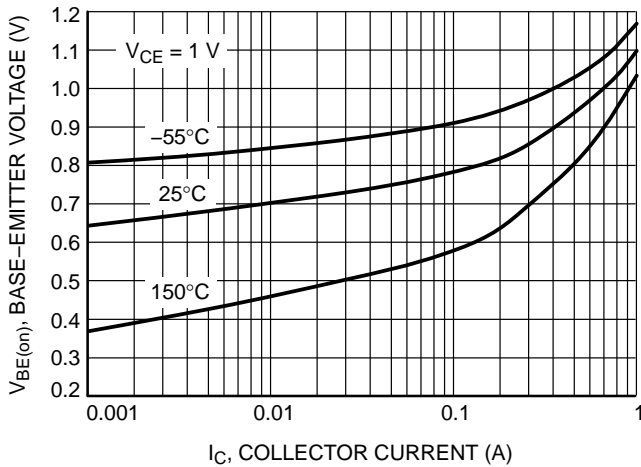**Figure 12. Base Emitter Saturation Voltage vs. Collector Current**
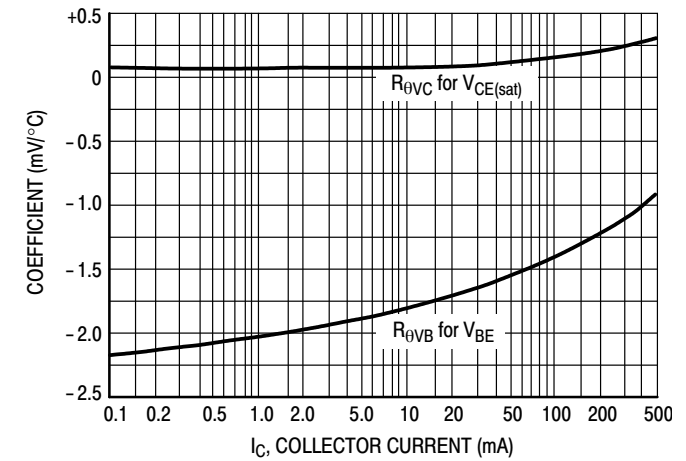
Figure 13. Base Emitter Voltage vs. Collector Current

Figure 14. Temperature Coefficients

MMBT2222L, MMBT2222AL, SMMBT2222AL
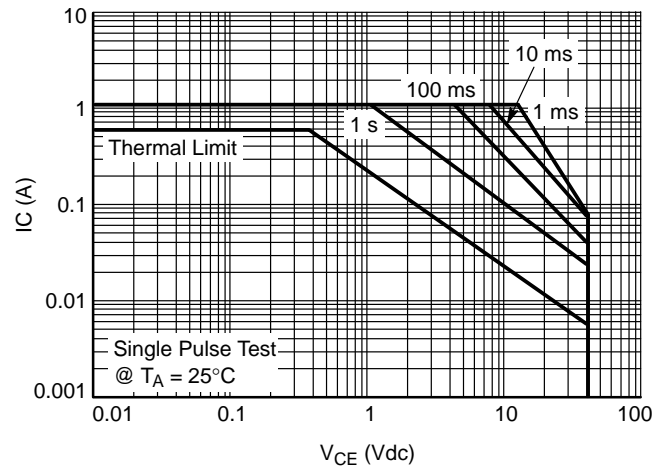
Figure 15. Safe Operating Area

ORDERING INFORMATION

Device	Specific Marking Code	Package	Shipping†
MMBT2222LT1G	M1B	SOT−23 (Pb−Free)	3000 / Tape & Reel
MMBT2222ALT1G, SMMBT2222ALT1G	1P	SOT−23 (Pb−Free)	3000 / Tape & Reel
MMBT2222LT3G	M1B	SOT−23 (Pb−Free)	10,000 / Tape & Reel
MMBT2222ALT3G, SMMBT2222ALT3G	1P	SOT−23 (Pb−Free)	10,000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
*S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:
Technical Library: www.onsemi.com/design/resources/technical–documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support
For additional information, please contact your local Sales Representative at
www.onsemi.com/support/sales

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