

# 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

### MAXIMUM RATINGS

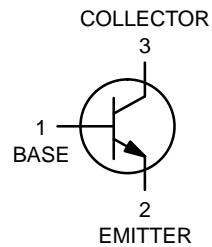
Rating	Symbol	Value	Unit
Collector-Emitter Voltage MMBT2222L MMBT2222AL, SMMBT2222AL	$V_{CEO}$	30 40	Vdc
Collector-Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL	$V_{CBO}$	60 75	Vdc
Emitter-Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL	$V_{EBO}$	5.0 6.0	Vdc
Collector Current – Continuous	$I_C$	600	mAdc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

### THERMAL CHARACTERISTICS

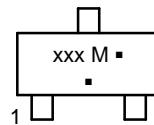
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (Note 1) $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	225 1.8	mW mW/ $^\circ\text{C}$
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	556	$^\circ\text{C}/\text{W}$
Total Device Dissipation Alumina Substrate (Note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

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 =  $1.0 \times 0.75 \times 0.062$  in.
2. Alumina =  $0.4 \times 0.3 \times 0.024$  in. 99.5% alumina.
3. Reference SOA curve.



### MARKING DIAGRAM



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.

# MMBT2222L, MMBT2222AL, SMMBT2222AL

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

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector–Emitter Breakdown Voltage ( $I_C = 10 \text{ mA}_\text{dc}$ , $I_B = 0$ ) MMBT2222 MMBT2222A	$V_{(\text{BR})\text{CEO}}$	30 40	—	$\text{V}_\text{dc}$
Collector–Base Breakdown Voltage ( $I_C = 10 \mu\text{A}_\text{dc}$ , $I_E = 0$ ) MMBT2222 MMBT2222A	$V_{(\text{BR})\text{CBO}}$	60 75	—	$\text{V}_\text{dc}$
Emitter–Base Breakdown Voltage ( $I_E = 10 \mu\text{A}_\text{dc}$ , $I_C = 0$ ) MMBT2222 MMBT2222A	$V_{(\text{BR})\text{EBO}}$	5.0 6.0	—	$\text{V}_\text{dc}$
Collector Cutoff Current ( $V_{CE} = 60 \text{ V}_\text{dc}$ , $V_{EB(\text{off})} = 3.0 \text{ V}_\text{dc}$ ) MMBT2222A, SMMBT2222A	$I_{\text{CEX}}$	—	10	nAdc
Collector Cutoff Current ( $V_{CB} = 50 \text{ V}_\text{dc}$ , $I_E = 0$ ) ( $V_{CB} = 60 \text{ V}_\text{dc}$ , $I_E = 0$ ) ( $V_{CB} = 50 \text{ V}_\text{dc}$ , $I_E = 0$ , $T_A = 125^\circ\text{C}$ ) ( $V_{CB} = 60 \text{ V}_\text{dc}$ , $I_E = 0$ , $T_A = 125^\circ\text{C}$ ) MMBT2222A, SMMBT2222A MMBT2222 MMBT2222A, SMMBT2222A	$I_{\text{CBO}}$	— — — —	0.01 0.01 10 10	$\mu\text{A}_\text{dc}$
Emitter Cutoff Current ( $V_{EB} = 3.0 \text{ V}_\text{dc}$ , $I_C = 0$ ) MMBT2222A, SMMBT2222A	$I_{\text{EBO}}$	—	100	nAdc
Base Cutoff Current ( $V_{CE} = 60 \text{ V}_\text{dc}$ , $V_{EB(\text{off})} = 3.0 \text{ V}_\text{dc}$ ) MMBT2222A, SMMBT2222A	$I_{\text{BL}}$	—	20	nAdc
<b>ON CHARACTERISTICS</b>				
DC Current Gain ( $I_C = 0.1 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ ) ( $I_C = 1.0 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ ) ( $I_C = 10 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ ) ( $I_C = 10 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ , $T_A = -55^\circ\text{C}$ ) ( $I_C = 150 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ ) (Note 4) ( $I_C = 150 \text{ mA}_\text{dc}$ , $V_{CE} = 1.0 \text{ V}_\text{dc}$ ) (Note 4) ( $I_C = 500 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ ) (Note 4) MMBT2222A only MMBT2222 MMBT2222A, SMMBT2222A	$h_{\text{FE}}$	35 50 75 35 100 50 30 40	— — — — 300 — — —	—
Collector–Emitter Saturation Voltage (Note 4) ( $I_C = 150 \text{ mA}_\text{dc}$ , $I_B = 15 \text{ mA}_\text{dc}$ ) MMBT2222 MMBT2222A, SMMBT2222A  ( $I_C = 500 \text{ mA}_\text{dc}$ , $I_B = 50 \text{ mA}_\text{dc}$ ) MMBT2222 MMBT2222A, SMMBT2222A	$V_{CE(\text{sat})}$	— —	0.4 0.3  — —	$\text{V}_\text{dc}$
Base–Emitter Saturation Voltage (Note 4) ( $I_C = 150 \text{ mA}_\text{dc}$ , $I_B = 15 \text{ mA}_\text{dc}$ ) MMBT2222 MMBT2222A, SMMBT2222A  ( $I_C = 500 \text{ mA}_\text{dc}$ , $I_B = 50 \text{ mA}_\text{dc}$ ) MMBT2222 MMBT2222A, SMMBT2222A	$V_{BE(\text{sat})}$	— 0.6	1.3 1.2  — —	$\text{V}_\text{dc}$
<b>SMALL-SIGNAL CHARACTERISTICS</b>				
Current–Gain – Bandwidth Product (Note 5) ( $I_C = 20 \text{ mA}_\text{dc}$ , $V_{CE} = 20 \text{ V}_\text{dc}$ , $f = 100 \text{ MHz}$ ) MMBT2222 MMBT2222A, SMMBT2222A	$f_T$	250 300	—	MHz
Output Capacitance ( $V_{CB} = 10 \text{ V}_\text{dc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{\text{obo}}$	—	8.0	pF
Input Capacitance ( $V_{EB} = 0.5 \text{ V}_\text{dc}$ , $I_C = 0$ , $f = 1.0 \text{ MHz}$ ) MMBT2222 MMBT2222A, SMMBT2222A	$C_{\text{ibo}}$	— —	30 25	pF
Input Impedance ( $I_C = 1.0 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ , $f = 1.0 \text{ kHz}$ ) MMBT2222A, SMMBT2222A MMBT2222A, SMMBT2222A	$h_{ie}$	2.0 0.25	8.0 1.25	k $\Omega$
Voltage Feedback Ratio ( $I_C = 1.0 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ , $f = 1.0 \text{ kHz}$ ) MMBT2222A, SMMBT2222A MMBT2222A, SMMBT2222A	$h_{re}$	— —	8.0 4.0	$\times 10^{-4}$
Small-Signal Current Gain ( $I_C = 1.0 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ V}_\text{dc}$ , $f = 1.0 \text{ kHz}$ ) MMBT2222A, SMMBT2222A MMBT2222A, SMMBT2222A	$h_{fe}$	50 75	300 375	—

# MMBT2222L, MMBT2222AL, SMMBT2222AL

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

Characteristic	Symbol	Min	Max	Unit
<b>SMALL-SIGNAL CHARACTERISTICS</b>				
Output Admittance ( $I_C = 1.0 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mA}_\text{dc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{oe}$	5.0 25	35 200	$\mu\text{mhos}$
Collector Base Time Constant ( $I_E = 20 \text{ mA}_\text{dc}$ , $V_{CB} = 20 \text{ Vdc}$ , $f = 31.8 \text{ MHz}$ )	$r_b, C_c$	—	150	ps
Noise Figure ( $I_C = 100 \mu\text{A}_\text{dc}$ , $V_{CE} = 10 \text{ Vdc}$ , $R_S = 1.0 \text{ k}\Omega$ , $f = 1.0 \text{ kHz}$ ) MMBT2222A, SMMBT2222A	NF	—	4.0	dB

## SWITCHING CHARACTERISTICS (MMBT2222A only)

Delay Time	$t_d$	—	10	ns
Rise Time	$t_r$	—	25	ns
Storage Time	$t_s$	—	225	ns
Fall Time	$t_f$	—	60	ns

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  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

5.  $f_T$  is defined as the frequency at which  $|h_{fe}|$  extrapolates to unity.

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

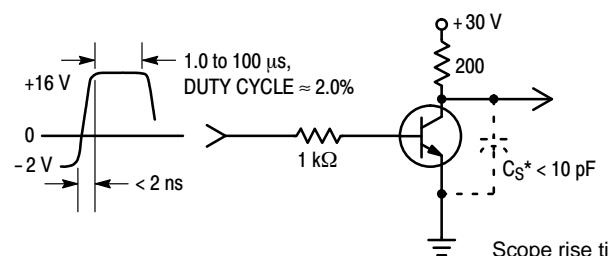


Figure 1. Turn-On Time

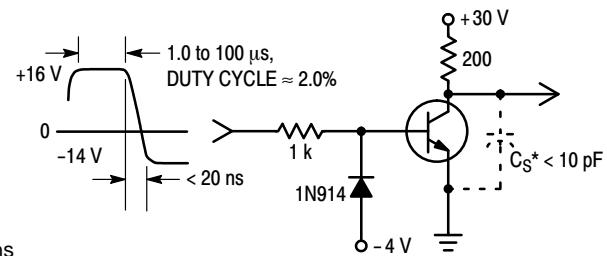


Figure 2. Turn-Off Time

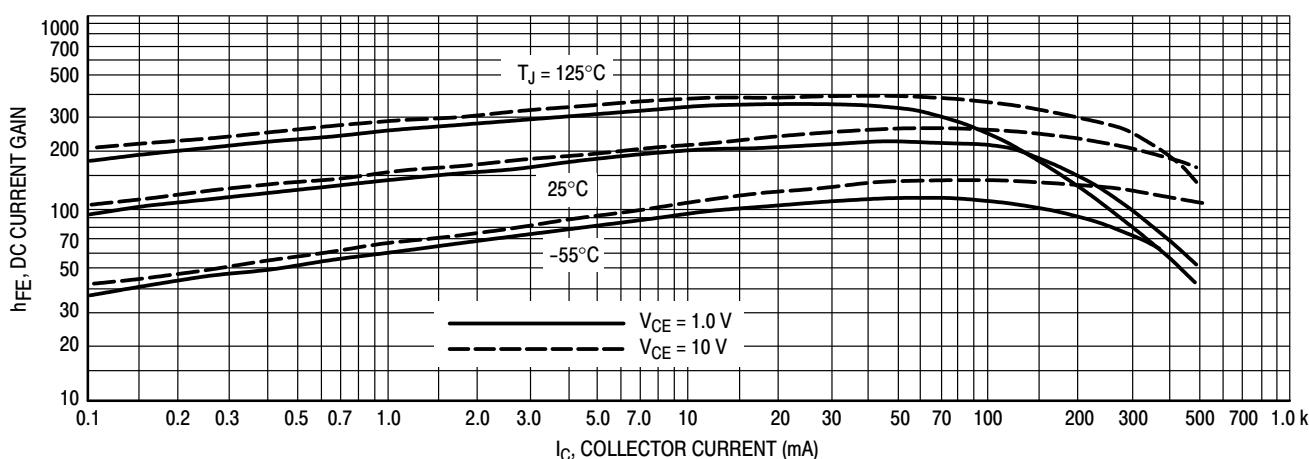
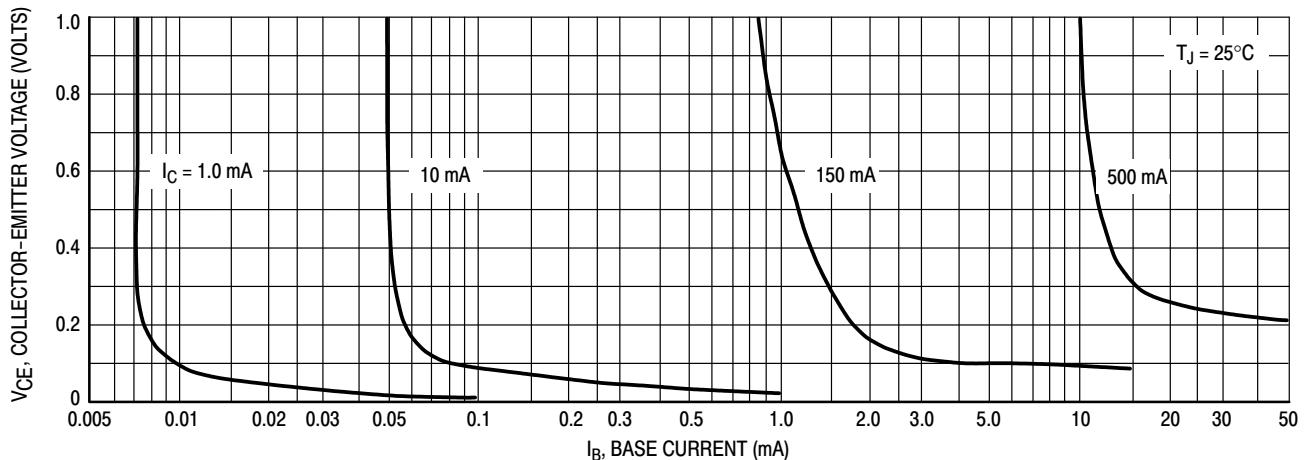
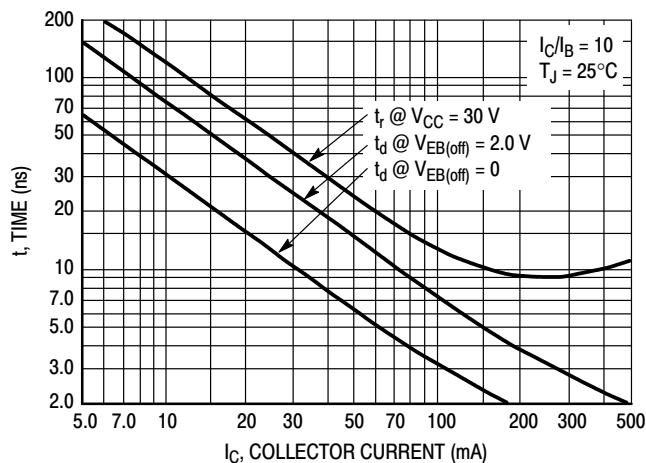


Figure 3. DC Current Gain

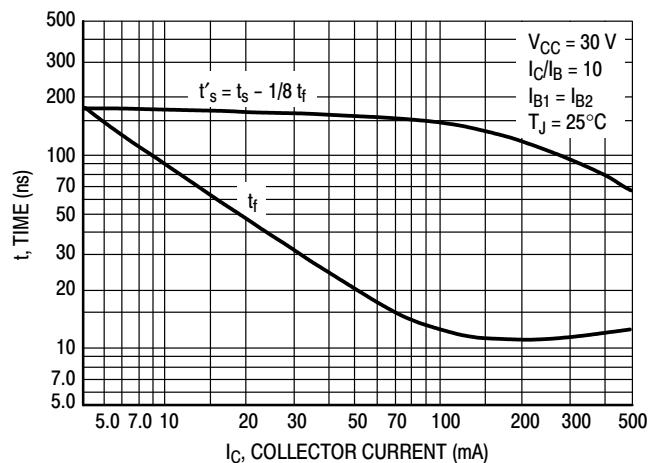
## MMBT2222L, MMBT2222AL, SMMBT2222AL



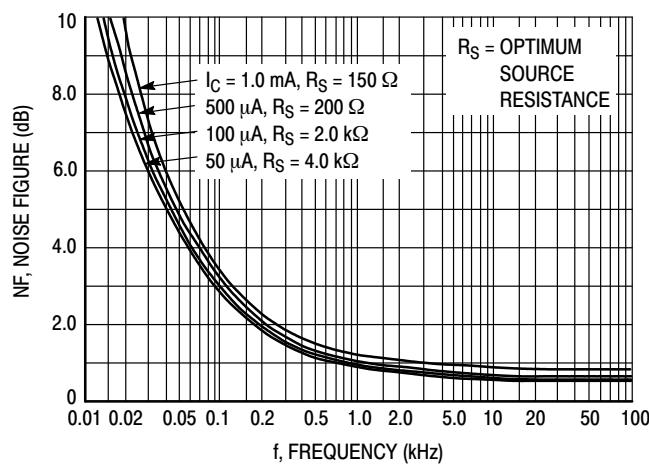
**Figure 4. Collector Saturation Region**



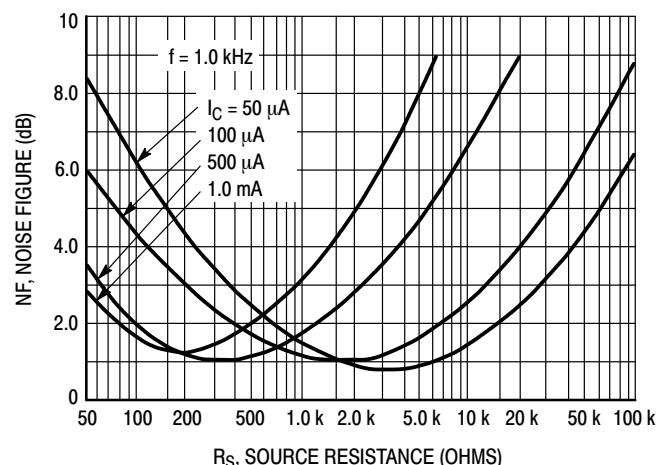
**Figure 5. Turn-On Time**



**Figure 6. Turn-Off Time**

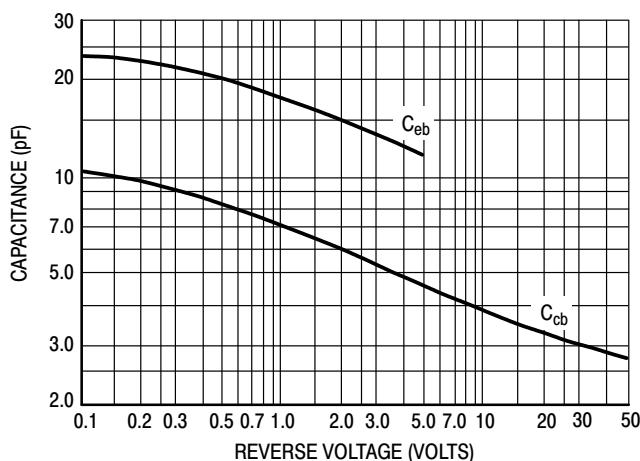


**Figure 7. Frequency Effects**

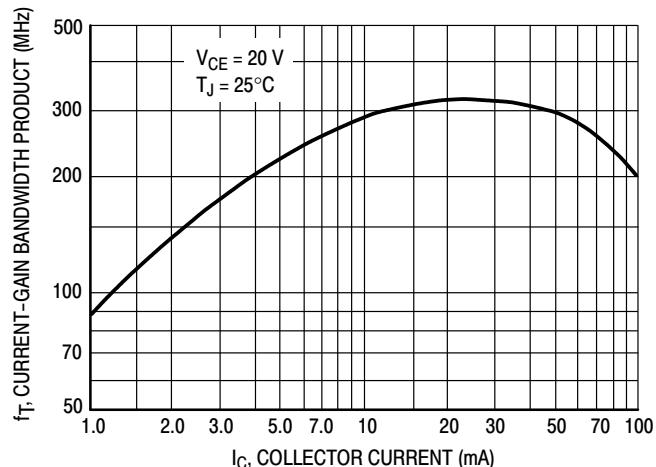


**Figure 8. Source Resistance Effects**

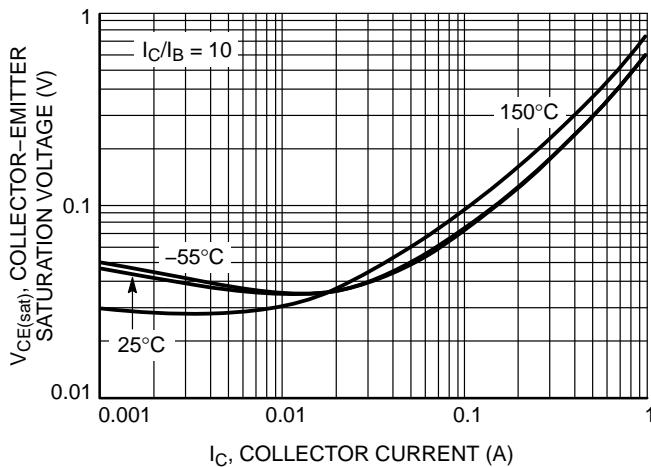
# MMBT2222L, MMBT2222AL, SMMBT2222AL



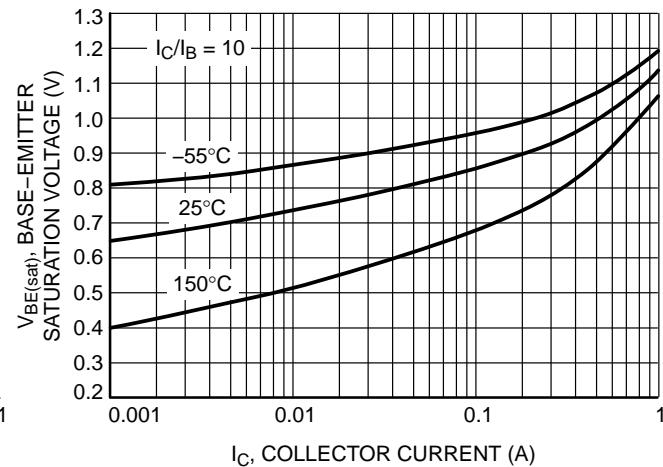
**Figure 9. Capacitances**



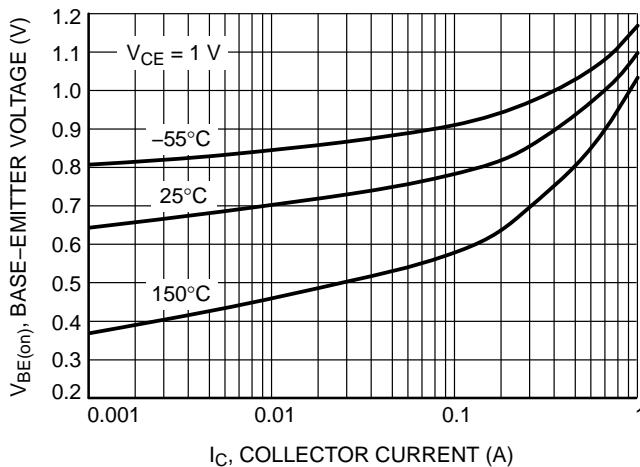
**Figure 10. Current-Gain Bandwidth Product**



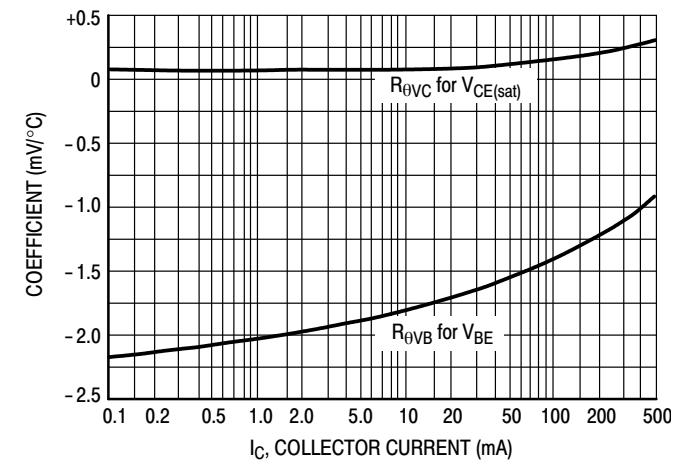
**Figure 11. Collector Emitter Saturation Voltage vs. Collector Current**



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



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



**Figure 14. Temperature Coefficients**

## MMBT2222L, MMBT2222AL, SMMBT2222AL

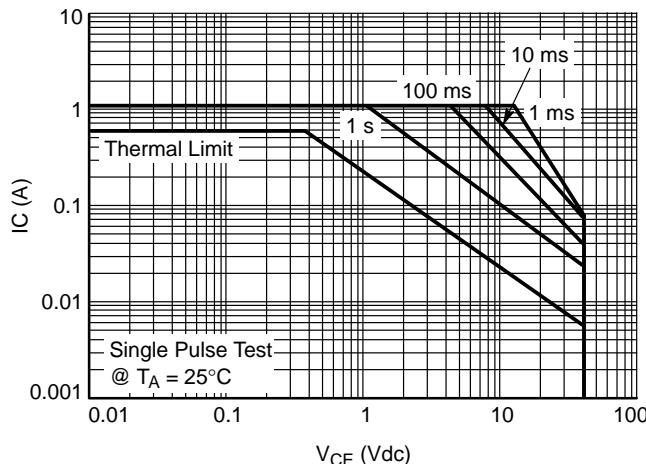


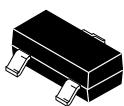
Figure 15. Safe Operating Area

### ORDERING INFORMATION

Device	Specific Marking Code	Package	Shipping <sup>†</sup>
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

<sup>†</sup>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.

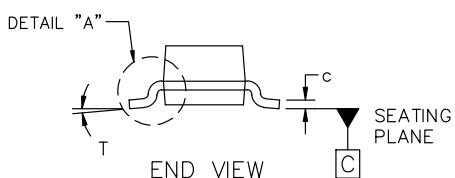
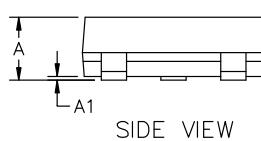
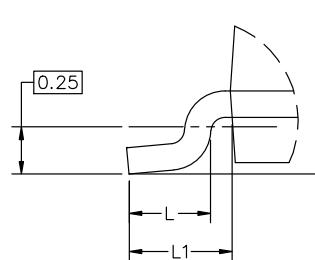
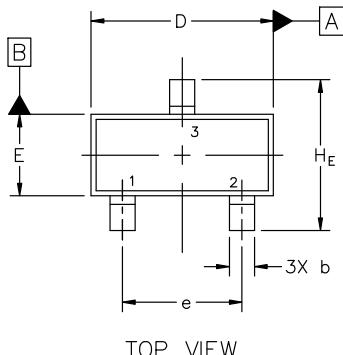
\*S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable.



SCALE 4:1

SOT-23 (TO-236) 2.90x1.30x1.00 1.90P  
CASE 318  
ISSUE AU

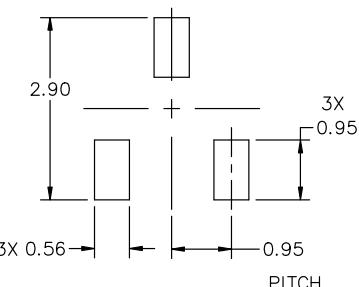
DATE 14 AUG 2024



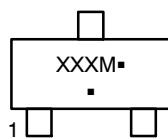
MILLIMETERS			
DIM	MIN	NOM	MAX
A	0.89	1.00	1.11
A1	0.01	0.06	0.10
b	0.37	0.44	0.50
c	0.08	0.14	0.20
D	2.80	2.90	3.04
E	1.20	1.30	1.40
e	1.78	1.90	2.04
L	0.30	0.43	0.55
L1	0.35	0.54	0.69
H <sub>E</sub>	2.10	2.40	2.64
T	0°	---	10°

## NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. CONTROLLING DIMENSIONS: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

RECOMMENDED  
MOUNTING FOOTPRINT

\* For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

GENERIC  
MARKING DIAGRAM\*

XXX = Specific Device Code

M = Date Code

■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present. Some products may not follow the Generic Marking.

## STYLES ON PAGE 2

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**SOT-23 (TO-236) 2.90x1.30x1.00 1.90P**

CASE 318

ISSUE AU

DATE 14 AUG 2024

**STYLE 1 THRU 5:**  
CANCELLED

**STYLE 6:**  
PIN 1. BASE  
2. Emitter  
3. Collector

**STYLE 7:**  
PIN 1. Emitter  
2. Base  
3. Collector

**STYLE 8:**  
PIN 1. Anode  
2. No Connection  
3. Cathode

**STYLE 9:**  
PIN 1. Anode  
2. Anode  
3. Cathode

**STYLE 10:**  
PIN 1. Drain  
2. Source  
3. Gate

**STYLE 11:**  
PIN 1. Anode  
2. Cathode  
3. Cathode-Anode

**STYLE 12:**  
PIN 1. Cathode  
2. Cathode  
3. Anode

**STYLE 13:**  
PIN 1. Source  
2. Drain  
3. Gate

**STYLE 14:**  
PIN 1. Cathode  
2. Gate  
3. Anode

**STYLE 15:**  
PIN 1. Gate  
2. Cathode  
3. Anode

**STYLE 16:**  
PIN 1. Anode  
2. Cathode  
3. Cathode

**STYLE 17:**  
PIN 1. No Connection  
2. Anode  
3. Cathode

**STYLE 18:**  
PIN 1. No Connection  
2. Cathode  
3. Anode

**STYLE 19:**  
PIN 1. Cathode  
2. Anode  
3. Cathode-Anode

**STYLE 20:**  
PIN 1. Cathode  
2. Anode  
3. Gate

**STYLE 21:**  
PIN 1. Gate  
2. Source  
3. Drain

**STYLE 22:**  
PIN 1. Return  
2. Output  
3. Input

**STYLE 23:**  
PIN 1. Anode  
2. Anode  
3. Cathode

**STYLE 24:**  
PIN 1. Gate  
2. Drain  
3. Source

**STYLE 25:**  
PIN 1. Anode  
2. Cathode  
3. Gate

**STYLE 26:**  
PIN 1. Cathode  
2. Anode  
3. No Connection

**STYLE 27:**  
PIN 1. Cathode  
2. Cathode  
3. Cathode

**STYLE 28:**  
PIN 1. Anode  
2. Anode  
3. Anode

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