

# 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

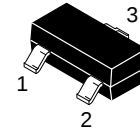
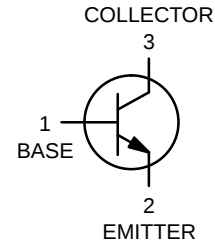
| Rating                                                              | Symbol    | Value      | Unit |
|---------------------------------------------------------------------|-----------|------------|------|
| Collector – Emitter Voltage<br>MMBT2222L<br>MMBT2222AL, SMMBT2222AL | $V_{CEO}$ | 30<br>40   | Vdc  |
| Collector – Base Voltage<br>MMBT2222L<br>MMBT2222AL, SMMBT2222AL    | $V_{CBO}$ | 60<br>75   | Vdc  |
| Emitter – Base Voltage<br>MMBT2222L<br>MMBT2222AL, SMMBT2222AL      | $V_{EBO}$ | 5.0<br>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<br>(Note 1) $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$        | $P_D$           | 225<br>1.8  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient                                                                            | $R_{\theta JA}$ | 556         | $^\circ\text{C/W}$         |
| Total Device Dissipation Alumina<br>Substrate (Note 2) $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$           | 300<br>2.4  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient                                                                            | $R_{\theta JA}$ | 417         | $^\circ\text{C/W}$         |
| Junction and Storage Temperature Range                                                                             | $T_J, T_{stg}$  | -55 to +150 | $^\circ\text{C}$           |

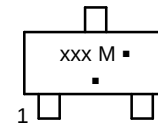
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

- FR-5 =  $1.0 \times 0.75 \times 0.062$  in.
- Alumina =  $0.4 \times 0.3 \times 0.024$  in. 99.5% alumina.
- Reference SOA curve.



SOT-23  
CASE 318  
STYLE 6

### 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<sub>A</sub> = 25°C unless otherwise noted)

| Characteristic                                                                                                                                                                                                                                                                                                                                          | Symbol               | Min              | Max                      | Unit |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------------------|--------------------------|------|
| <b>OFF CHARACTERISTICS</b>                                                                                                                                                                                                                                                                                                                              |                      |                  |                          |      |
| Collector – Emitter Breakdown Voltage (I <sub>C</sub> = 10 mAdc, I <sub>B</sub> = 0)<br>MMBT2222<br>MMBT2222A                                                                                                                                                                                                                                           | V <sub>(BR)CEO</sub> | 30<br>40         | –<br>–                   | Vdc  |
| Collector – Base Breakdown Voltage (I <sub>C</sub> = 10 µAdc, I <sub>E</sub> = 0)<br>MMBT2222<br>MMBT2222A                                                                                                                                                                                                                                              | V <sub>(BR)CBO</sub> | 60<br>75         | –<br>–                   | Vdc  |
| Emitter – Base Breakdown Voltage (I <sub>E</sub> = 10 µAdc, I <sub>C</sub> = 0)<br>MMBT2222<br>MMBT2222A                                                                                                                                                                                                                                                | V <sub>(BR)EBO</sub> | 5.0<br>6.0       | –<br>–                   | Vdc  |
| Collector Cutoff Current<br>(V <sub>CE</sub> = 60 Vdc, V <sub>EB(off)</sub> = 3.0 Vdc)<br>MMBT2222A, SMMBT2222A                                                                                                                                                                                                                                         | I <sub>CEX</sub>     | –                | 10                       | nAdc |
| Collector Cutoff Current (V <sub>CB</sub> = 50 Vdc, I <sub>E</sub> = 0)<br>(V <sub>CB</sub> = 60 Vdc, I <sub>E</sub> = 0)<br>(V <sub>CB</sub> = 50 Vdc, I <sub>E</sub> = 0, T <sub>A</sub> = 125°C)<br>(V <sub>CB</sub> = 60 Vdc, I <sub>E</sub> = 0, T <sub>A</sub> = 125°C)<br>MMBT2222<br>MMBT2222A, SMMBT2222A<br>MMBT2222<br>MMBT2222A, SMMBT2222A | I <sub>CBO</sub>     | –<br>–<br>–<br>– | 0.01<br>0.01<br>10<br>10 | µAdc |
| Emitter Cutoff Current (V <sub>EB</sub> = 3.0 Vdc, I <sub>C</sub> = 0)<br>MMBT2222A, SMMBT2222A                                                                                                                                                                                                                                                         | I <sub>EBO</sub>     | –                | 100                      | nAdc |
| Base Cutoff Current (V <sub>CE</sub> = 60 Vdc, V <sub>EB(off)</sub> = 3.0 Vdc)<br>MMBT2222A, SMMBT2222A                                                                                                                                                                                                                                                 | I <sub>BL</sub>      | –                | 20                       | nAdc |

## ON CHARACTERISTICS

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                      |                                               |                                        |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------------------------------------|----------------------------------------|-----|
| DC Current Gain<br>(I <sub>C</sub> = 0.1 mAdc, V <sub>CE</sub> = 10 Vdc)<br>(I <sub>C</sub> = 1.0 mAdc, V <sub>CE</sub> = 10 Vdc)<br>(I <sub>C</sub> = 10 mAdc, V <sub>CE</sub> = 10 Vdc)<br>(I <sub>C</sub> = 10 mAdc, V <sub>CE</sub> = 10 Vdc, T <sub>A</sub> = –55°C)<br>(I <sub>C</sub> = 150 mAdc, V <sub>CE</sub> = 10 Vdc) (Note 4)<br>(I <sub>C</sub> = 150 mAdc, V <sub>CE</sub> = 1.0 Vdc) (Note 4)<br>(I <sub>C</sub> = 500 mAdc, V <sub>CE</sub> = 10 Vdc) (Note 4)<br>MMBT2222A only<br>MMBT2222<br>MMBT2222A, SMMBT2222A | h <sub>FE</sub>      | 35<br>50<br>75<br>35<br>100<br>50<br>30<br>40 | –<br>–<br>–<br>–<br>300<br>–<br>–<br>– | –   |
| Collector – Emitter Saturation Voltage (Note 4)<br>(I <sub>C</sub> = 150 mAdc, I <sub>B</sub> = 15 mAdc)<br>MMBT2222<br>MMBT2222A, SMMBT2222A<br><br>(I <sub>C</sub> = 500 mAdc, I <sub>B</sub> = 50 mAdc)<br>MMBT2222<br>MMBT2222A, SMMBT2222A                                                                                                                                                                                                                                                                                         | V <sub>CE(sat)</sub> | –<br>–<br>–<br>–                              | 0.4<br>0.3<br>1.6<br>1.0               | Vdc |
| Base – Emitter Saturation Voltage (Note 4)<br>(I <sub>C</sub> = 150 mAdc, I <sub>B</sub> = 15 mAdc)<br>MMBT2222<br>MMBT2222A, SMMBT2222A<br><br>(I <sub>C</sub> = 500 mAdc, I <sub>B</sub> = 50 mAdc)<br>MMBT2222<br>MMBT2222A, SMMBT2222A                                                                                                                                                                                                                                                                                              | V <sub>BE(sat)</sub> | –<br>0.6<br>–<br>–                            | 1.3<br>1.2<br>2.6<br>2.0               | Vdc |

## SMALL-SIGNAL CHARACTERISTICS

|                                                                                                                                                                                                                          |                  |             |             |                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------|-------------|--------------------|
| Current – Gain – Bandwidth Product (Note 5)<br>(I <sub>C</sub> = 20 mAdc, V <sub>CE</sub> = 20 Vdc, f = 100 MHz)<br>MMBT2222<br>MMBT2222A, SMMBT2222A                                                                    | f <sub>T</sub>   | 250<br>300  | –<br>–      | MHz                |
| Output Capacitance<br>(V <sub>CB</sub> = 10 Vdc, I <sub>E</sub> = 0, f = 1.0 MHz)                                                                                                                                        | C <sub>obo</sub> | –           | 8.0         | pF                 |
| Input Capacitance<br>(V <sub>EB</sub> = 0.5 Vdc, I <sub>C</sub> = 0, f = 1.0 MHz)<br>MMBT2222<br>MMBT2222A, SMMBT2222A                                                                                                   | C <sub>ibo</sub> | –<br>–      | 30<br>25    | pF                 |
| Input Impedance<br>(I <sub>C</sub> = 1.0 mAdc, V <sub>CE</sub> = 10 Vdc, f = 1.0 kHz)<br>(I <sub>C</sub> = 10 mAdc, V <sub>CE</sub> = 10 Vdc, f = 1.0 kHz)<br>MMBT2222A, SMMBT2222A<br>MMBT2222A, SMMBT2222A             | h <sub>ie</sub>  | 2.0<br>0.25 | 8.0<br>1.25 | kΩ                 |
| Voltage Feedback Ratio<br>(I <sub>C</sub> = 1.0 mAdc, V <sub>CE</sub> = 10 Vdc, f = 1.0 kHz)<br>(I <sub>C</sub> = 10 mAdc, V <sub>CE</sub> = 10 Vdc, f = 1.0 kHz)<br>MMBT2222A, SMMBT2222A<br>MMBT2222A, SMMBT2222A      | h <sub>re</sub>  | –<br>–      | 8.0<br>4.0  | X 10 <sup>–4</sup> |
| Small – Signal Current Gain<br>(I <sub>C</sub> = 1.0 mAdc, V <sub>CE</sub> = 10 Vdc, f = 1.0 kHz)<br>(I <sub>C</sub> = 10 mAdc, V <sub>CE</sub> = 10 Vdc, f = 1.0 kHz)<br>MMBT2222A, SMMBT2222A<br>MMBT2222A, SMMBT2222A | h <sub>fe</sub>  | 50<br>75    | 300<br>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<br>( $I_C = 1.0\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = 10\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ ) | $h_{oe}$      | 5.0<br>25 | 35<br>200 | $\mu\text{mhos}$ |
| Collector Base Time Constant<br>( $I_E = 20\text{ mAdc}$ , $V_{CB} = 20\text{ Vdc}$ , $f = 31.8\text{ MHz}$ )                                                                      | $r_b$ , $C_c$ | —         | 150       | ps               |
| Noise Figure ( $I_C = 100\text{ }\mu\text{Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ )                                                   | NF            | —         | 4.0       | dB               |

## SWITCHING CHARACTERISTICS (MMBT2222A only)

|              |                                                                                                                               |       |   |     |    |
|--------------|-------------------------------------------------------------------------------------------------------------------------------|-------|---|-----|----|
| Delay Time   | $(V_{CC} = 30\text{ Vdc}$ , $V_{BE(\text{off})} = -0.5\text{ Vdc}$ ,<br>$I_C = 150\text{ mAdc}$ , $I_{B1} = 15\text{ mAdc}$ ) | $t_d$ | — | 10  | ns |
| Rise Time    |                                                                                                                               | $t_r$ | — | 25  |    |
| Storage Time | $(V_{CC} = 30\text{ Vdc}$ , $I_C = 150\text{ mAdc}$ ,<br>$I_{B1} = I_{B2} = 15\text{ mAdc}$ )                                 | $t_s$ | — | 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  $\leq 300\text{ }\mu\text{s}$ , 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

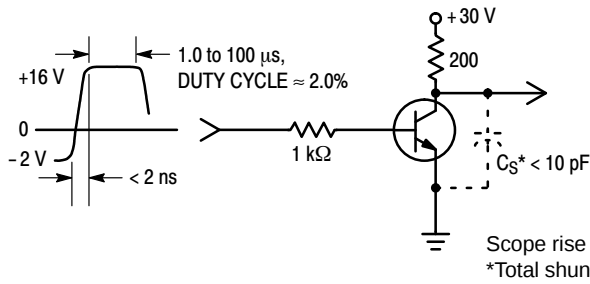


Figure 1. Turn-On Time

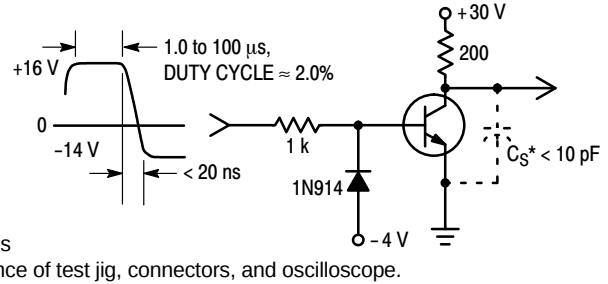


Figure 2. Turn-Off Time

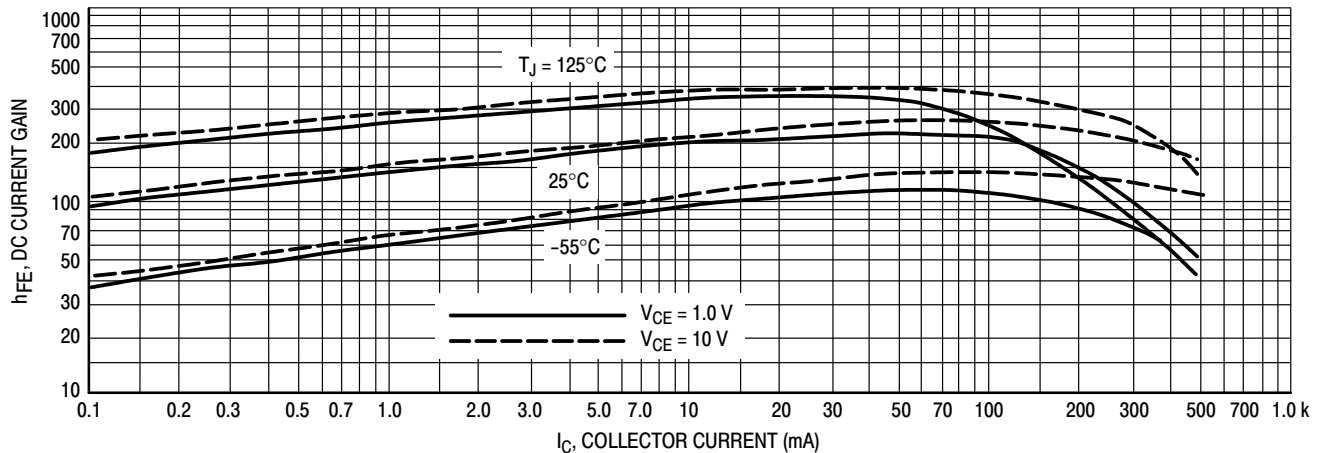


Figure 3. DC Current Gain

# MMBT2222L, MMBT2222AL, SMMBT2222AL

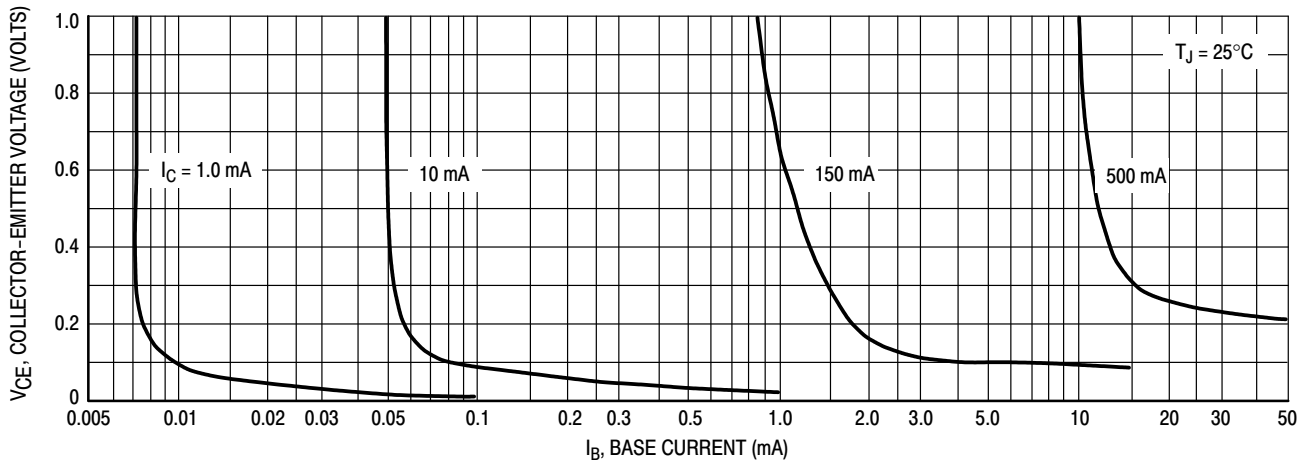


Figure 4. Collector Saturation Region

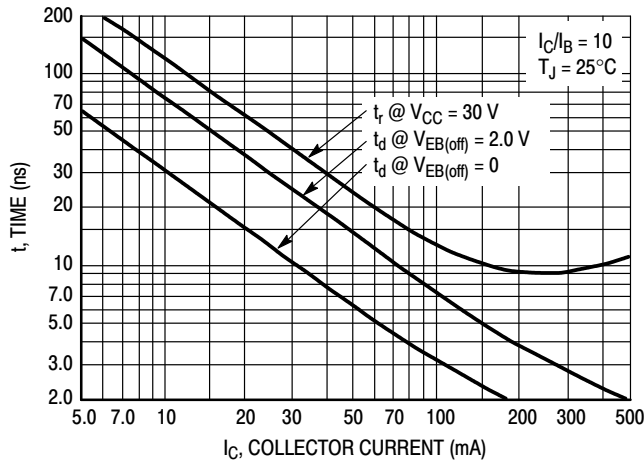


Figure 5. Turn-On Time

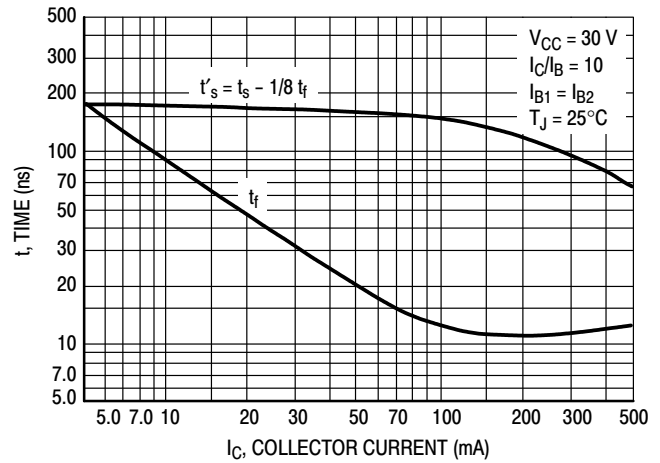


Figure 6. Turn-Off Time

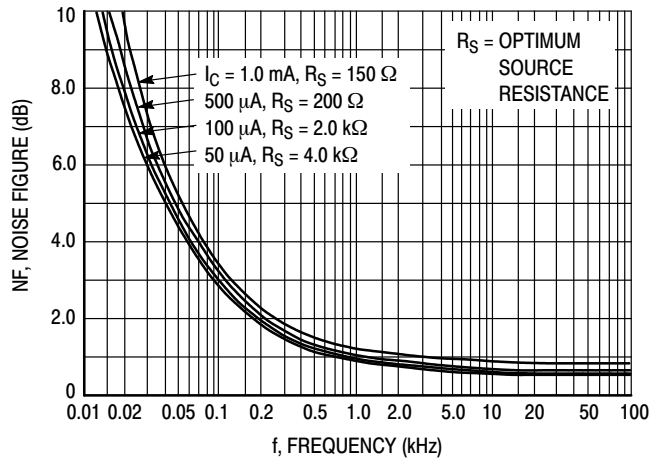


Figure 7. Frequency Effects

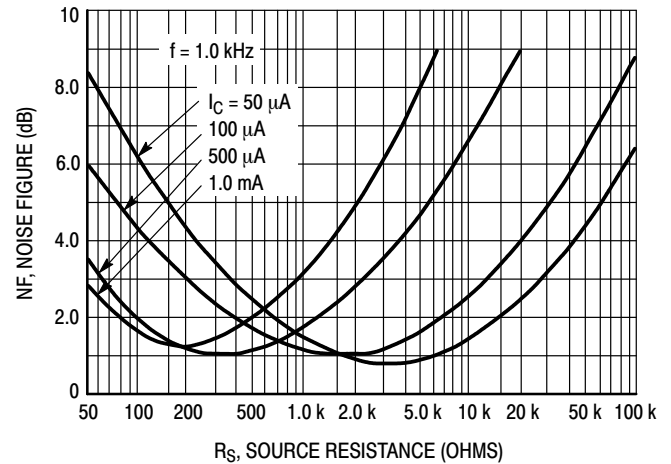


Figure 8. Source Resistance Effects

# MMBT2222L, MMBT2222AL, SMMBT2222AL

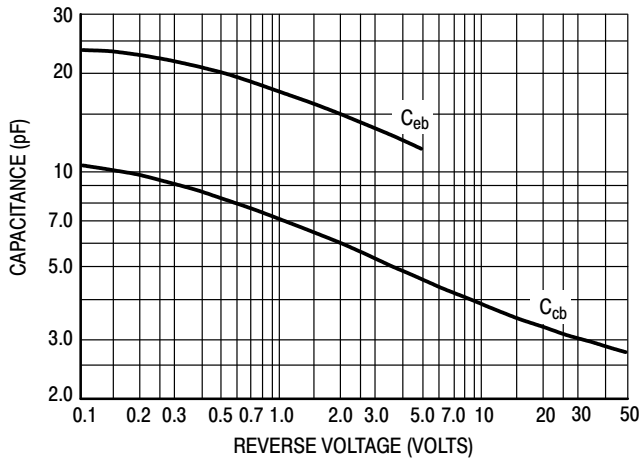


Figure 9. Capacitances

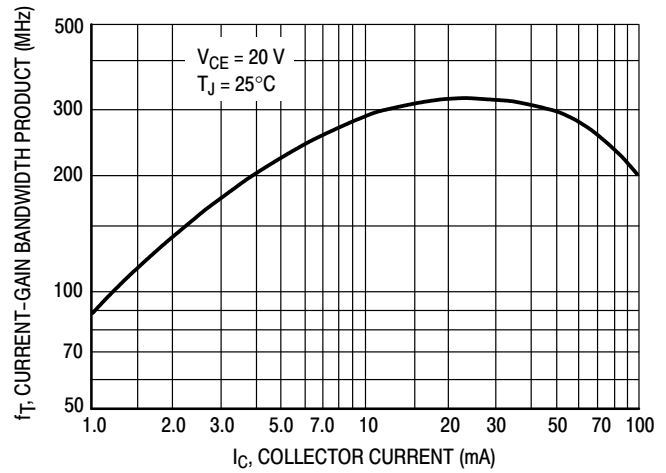


Figure 10. Current-Gain Bandwidth Product

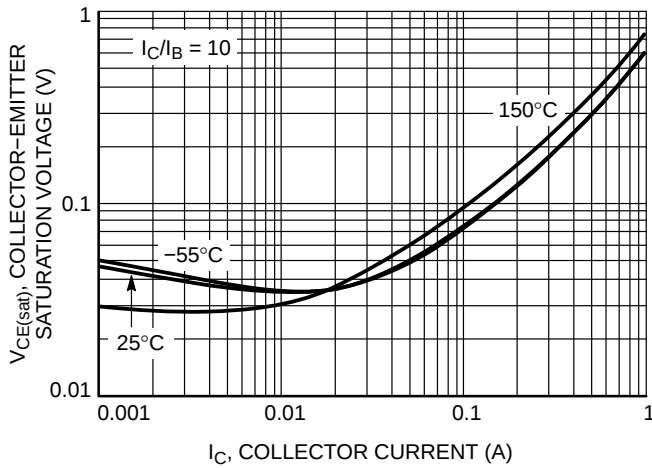


Figure 11. Collector Emitter Saturation Voltage vs. Collector Current

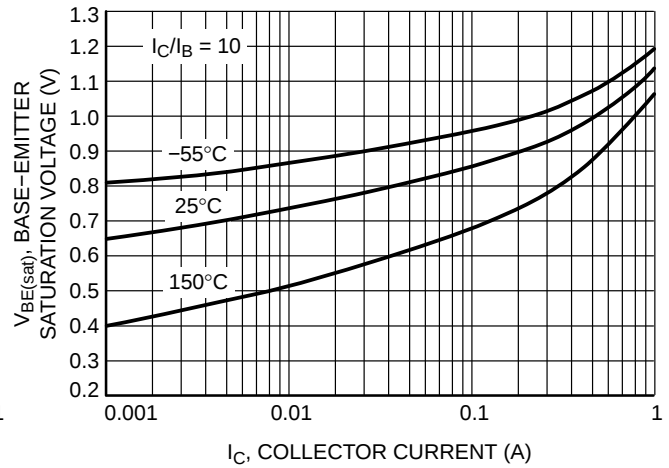


Figure 12. Base Emitter Saturation Voltage vs. Collector Current

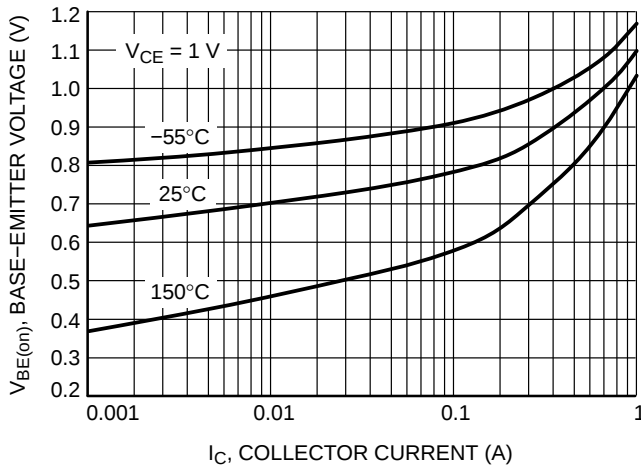


Figure 13. Base Emitter Voltage vs. Collector Current

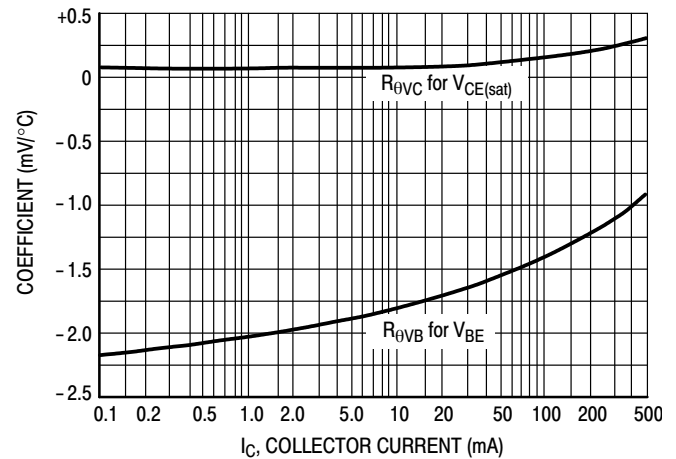


Figure 14. Temperature Coefficients

## MMBT2222L, MMBT2222AL, SMMBT2222AL

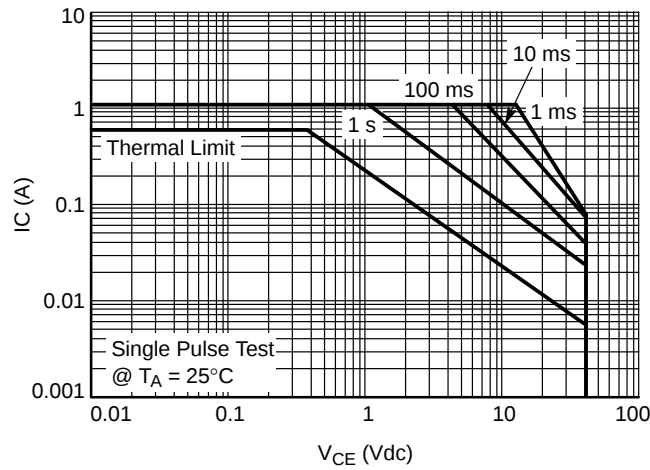


Figure 15. Safe Operating Area

### ORDERING INFORMATION

| Device                           | Specific Marking Code | Package             | Shipping <sup>†</sup> |
|----------------------------------|-----------------------|---------------------|-----------------------|
| MMBT2222LT1G                     | M1B                   | SOT-23<br>(Pb-Free) | 3000 / Tape & Reel    |
| MMBT2222ALT1G,<br>SMMBT2222ALT1G | 1P                    | SOT-23<br>(Pb-Free) | 3000 / Tape & Reel    |
| MMBT2222LT3G                     | M1B                   | SOT-23<br>(Pb-Free) | 10,000 / Tape & Reel  |
| MMBT2222ALT3G,<br>SMMBT2222ALT3G | 1P                    | SOT-23<br>(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.

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

ON Semiconductor®



### SOT-23 (TO-236) CASE 318-08 ISSUE AS

DATE 30 JAN 2018

SCALE 4:1



#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: 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.

| DIM | MILLIMETERS |      |      | INCHES |       |       |
|-----|-------------|------|------|--------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN    | NOM   | MAX   |
| A   | 0.89        | 1.00 | 1.11 | 0.035  | 0.039 | 0.044 |
| A1  | 0.01        | 0.06 | 0.10 | 0.000  | 0.002 | 0.004 |
| b   | 0.37        | 0.44 | 0.50 | 0.015  | 0.017 | 0.020 |
| c   | 0.08        | 0.14 | 0.20 | 0.003  | 0.006 | 0.008 |
| D   | 2.80        | 2.90 | 3.04 | 0.110  | 0.114 | 0.120 |
| E   | 1.20        | 1.30 | 1.40 | 0.047  | 0.051 | 0.055 |
| e   | 1.78        | 1.90 | 2.04 | 0.070  | 0.075 | 0.080 |
| L   | 0.30        | 0.43 | 0.55 | 0.012  | 0.017 | 0.022 |
| L1  | 0.35        | 0.54 | 0.69 | 0.014  | 0.021 | 0.027 |
| HE  | 2.10        | 2.40 | 2.64 | 0.083  | 0.094 | 0.104 |
| T   | 0°          | ---  | 10°  | 0°     | ---   | 10°   |

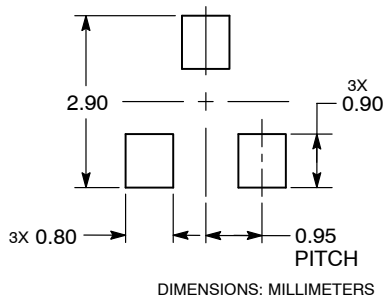
#### GENERIC MARKING DIAGRAM\*



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.

#### RECOMMENDED SOLDERING FOOTPRINT



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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| <b>DESCRIPTION:</b>     | <b>SOT-23 (TO-236)</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                               |

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