

# 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

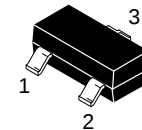
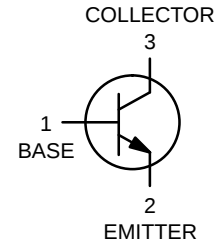
| Rating                                                              | Symbol    | Value      | Unit |
|---------------------------------------------------------------------|-----------|------------|------|
| Collector – Emitter Voltage<br>MMBT2222L<br>MMBT2222AL, SMMBT2222AL | $V_{CEO}$ | 30<br>40   | 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 | $^\circ\text{C}$           |

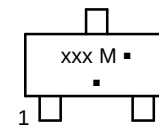
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

- 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

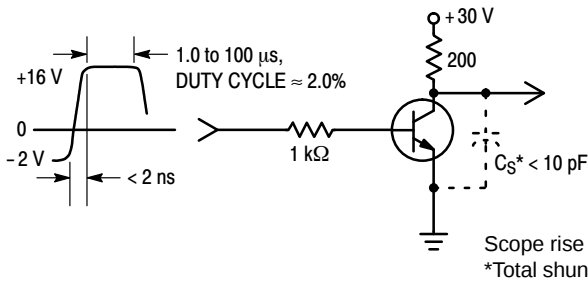


Figure 1. Turn-On Time

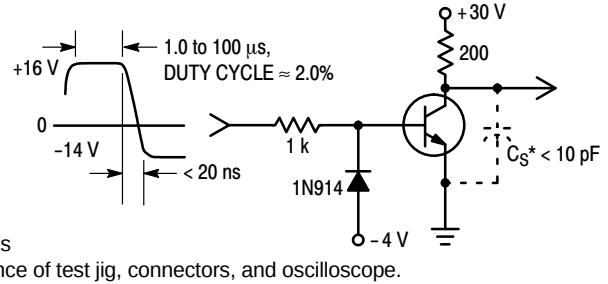


Figure 2. Turn-Off Time

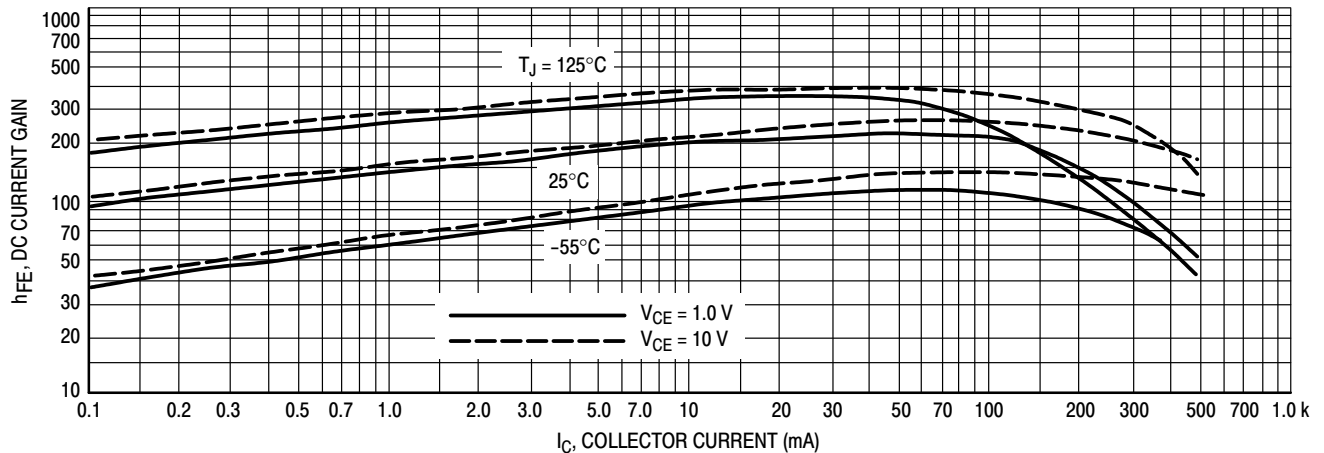


Figure 3. DC Current Gain

# MMBT2222L, MMBT2222AL, SMMBT2222AL

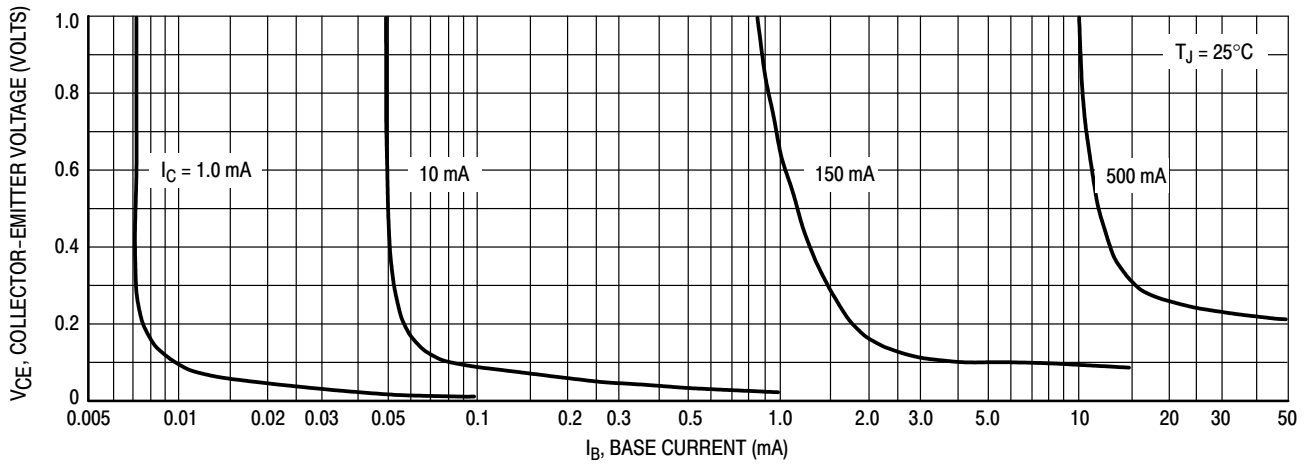


Figure 4. Collector Saturation Region

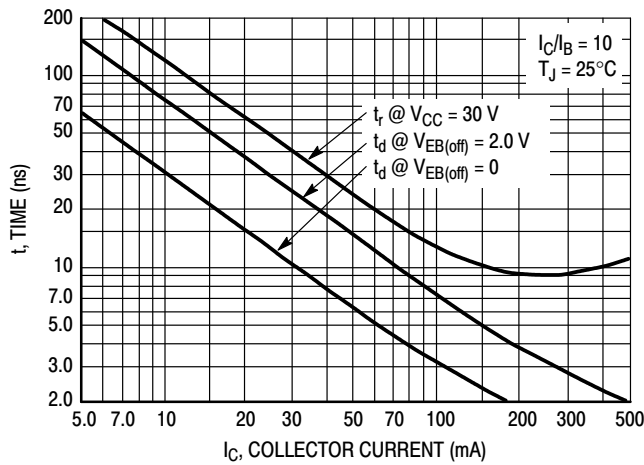


Figure 5. Turn-On Time

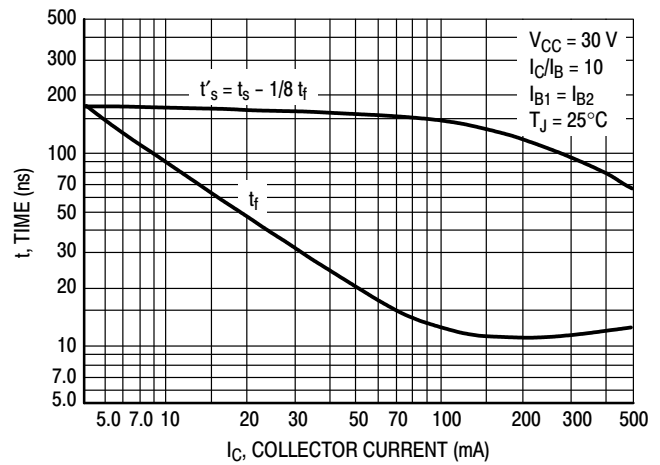


Figure 6. Turn-Off Time

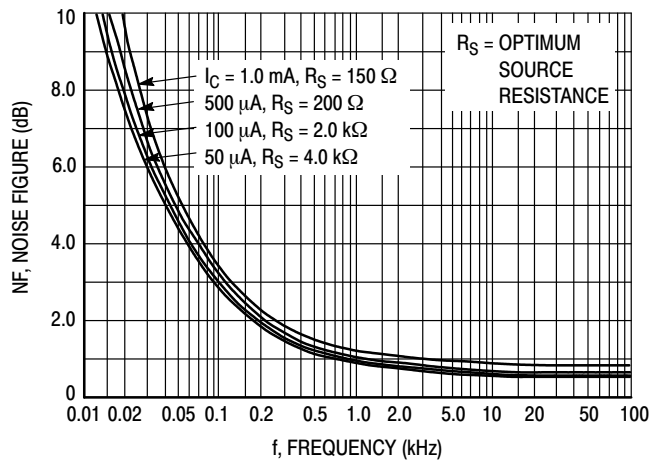


Figure 7. Frequency Effects

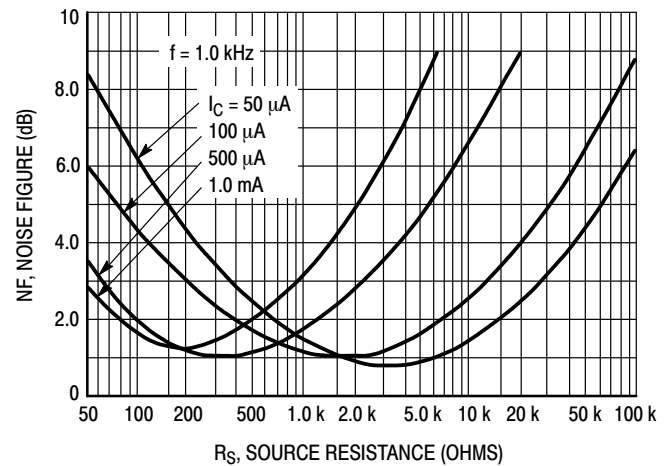


Figure 8. Source Resistance Effects

# MMBT2222L, MMBT2222AL, SMMBT2222AL

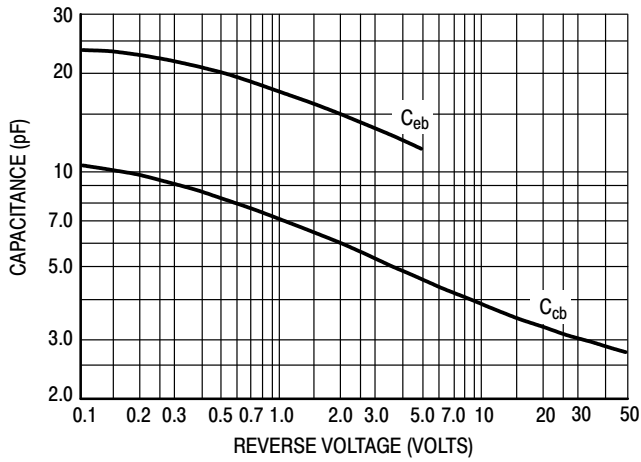


Figure 9. Capacitances

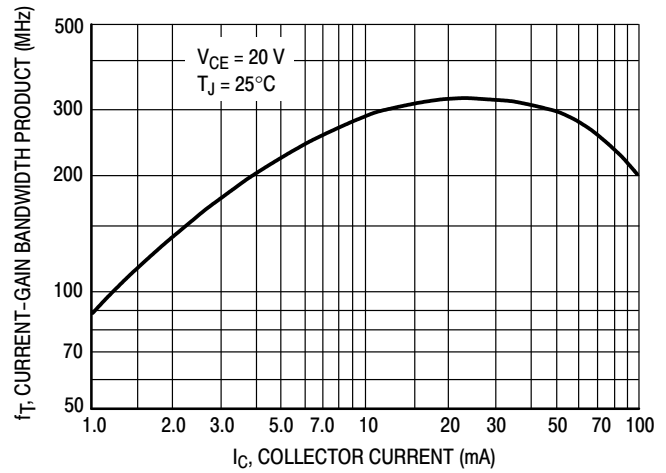


Figure 10. Current-Gain Bandwidth Product

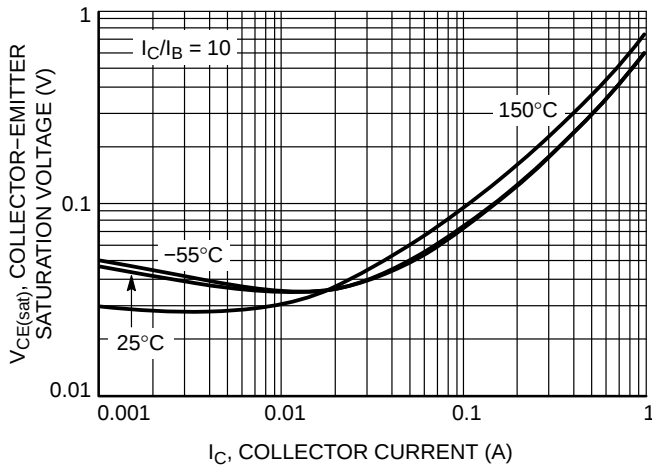


Figure 11. Collector Emitter Saturation Voltage vs. Collector Current

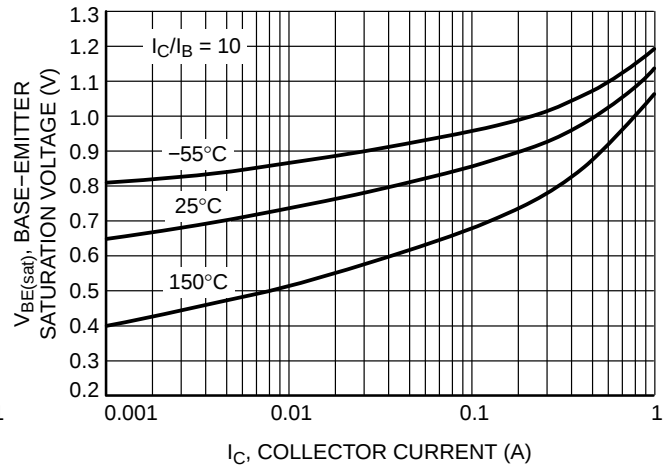


Figure 12. Base Emitter Saturation Voltage vs. Collector Current

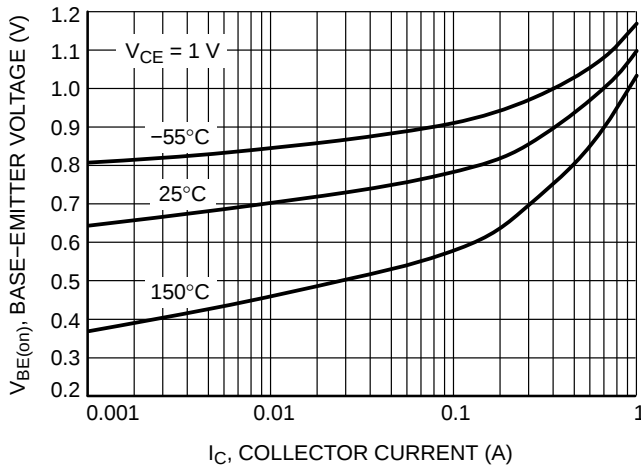


Figure 13. Base Emitter Voltage vs. Collector Current

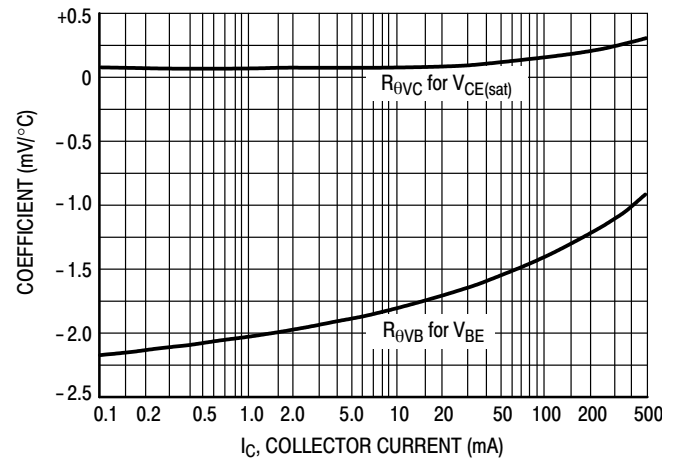


Figure 14. Temperature Coefficients

## MMBT2222L, MMBT2222AL, SMMBT2222AL

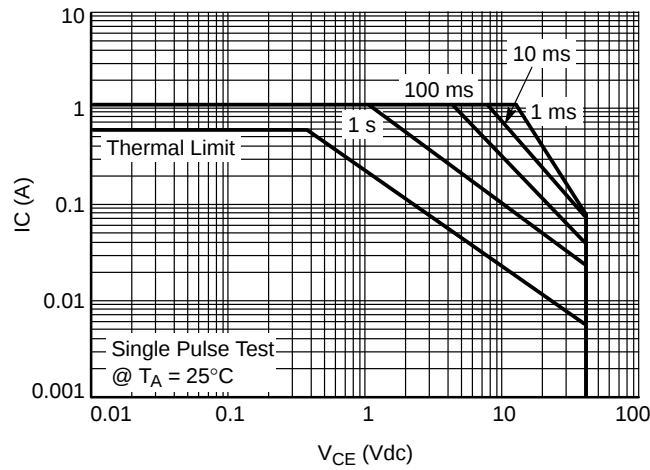


Figure 15. Safe Operating Area

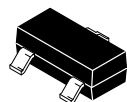
### ORDERING INFORMATION

| 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.

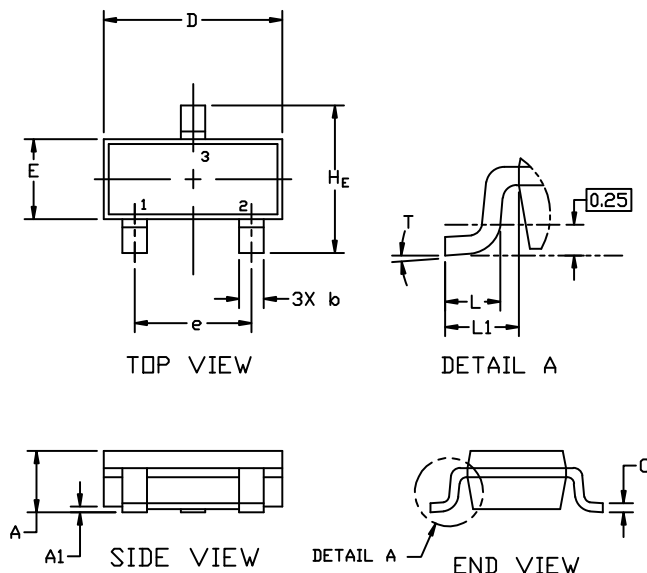
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 4:1

**SOT-23 (TO-236)**  
CASE 318  
ISSUE AT

DATE 01 MAR 2023

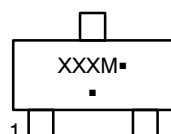


## NOTES:

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.

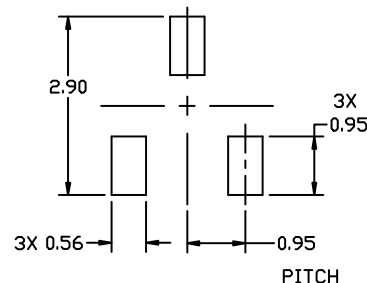
| DIM            | MILLIMETERS |      |      | INCHES |       |       |
|----------------|-------------|------|------|--------|-------|-------|
|                | MIN.        | NOM. | MAX. | MIN.   | NOM.  | MAX.  |
| A              | 0.89        | 1.00 | 1.11 | 0.035  | 0.039 | 0.044 |
| A1             | 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 |
| H <sub>E</sub> | 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. Some products may not follow the Generic Marking.



## RECOMMENDED MOUNTING FOOTPRINT

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

## STYLES ON PAGE 2

|                         |                        |                                                                                                                                                                                  |
|-------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NUMBER:</b> | <b>98ASB42226B</b>     | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| <b>DESCRIPTION:</b>     | <b>SOT-23 (TO-236)</b> | <b>PAGE 1 OF 2</b>                                                                                                                                                               |

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# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS



### SOT-23 (TO-236) CASE 318 ISSUE AT

DATE 01 MAR 2023

|                                                         |                                                       |                                                             |                                                             |                                                             |                                                             |
|---------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| STYLE 1 THRU 5:<br>CANCELLED                            | STYLE 6:<br>PIN 1. BASE<br>2. EMITTER<br>3. COLLECTOR | STYLE 7:<br>PIN 1. EMITTER<br>2. BASE<br>3. COLLECTOR       | STYLE 8:<br>PIN 1. ANODE<br>2. NO CONNECTION<br>3. CATHODE  |                                                             |                                                             |
| STYLE 9:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE      | STYLE 10:<br>PIN 1. DRAIN<br>2. SOURCE<br>3. GATE     | STYLE 11:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE-ANODE | STYLE 12:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. ANODE       | STYLE 13:<br>PIN 1. SOURCE<br>2. DRAIN<br>3. GATE           | STYLE 14:<br>PIN 1. CATHODE<br>2. GATE<br>3. ANODE          |
| STYLE 15:<br>PIN 1. GATE<br>2. CATHODE<br>3. ANODE      | STYLE 16:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE | STYLE 17:<br>PIN 1. NO CONNECTION<br>2. ANODE<br>3. CATHODE | STYLE 18:<br>PIN 1. NO CONNECTION<br>2. CATHODE<br>3. ANODE | STYLE 19:<br>PIN 1. CATHODE<br>2. ANODE<br>3. CATHODE-ANODE | STYLE 20:<br>PIN 1. CATHODE<br>2. ANODE<br>3. GATE          |
| STYLE 21:<br>PIN 1. GATE<br>2. SOURCE<br>3. DRAIN       | STYLE 22:<br>PIN 1. RETURN<br>2. OUTPUT<br>3. INPUT   | STYLE 23:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE         | STYLE 24:<br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE           | STYLE 25:<br>PIN 1. ANODE<br>2. CATHODE<br>3. GATE          | STYLE 26:<br>PIN 1. CATHODE<br>2. ANODE<br>3. NO CONNECTION |
| STYLE 27:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. CATHODE | STYLE 28:<br>PIN 1. ANODE<br>2. ANODE<br>3. ANODE     |                                                             |                                                             |                                                             |                                                             |

|                  |                 |                                                                                                                                                                                     |
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| DESCRIPTION:     | SOT-23 (TO-236) | PAGE 2 OF 2                                                                                                                                                                         |

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