

# MMBT2222AWT1

## General Purpose Transistor

### NPN Silicon

These transistors are designed for general purpose amplifier applications. They are housed in the SOT-323/SC-70 package which is designed for low power surface mount applications.

#### Features

- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

#### MAXIMUM RATINGS

| Rating                         | Symbol    | Value | Unit |
|--------------------------------|-----------|-------|------|
| Collector - Emitter Voltage    | $V_{CEO}$ | 40    | Vdc  |
| Collector - Base Voltage       | $V_{CBO}$ | 75    | Vdc  |
| Emitter - Base Voltage         | $V_{EBO}$ | 6.0   | Vdc  |
| Collector Current - Continuous | $I_C$     | 600   | mAdc |

#### THERMAL CHARACTERISTICS

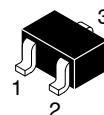
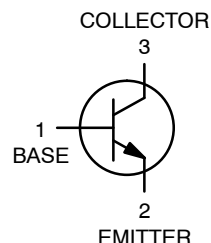
| Characteristic  | Symbol          | Max         | Unit                      |
|---|-----------------|-------------|---------------------------|
| Total Device Dissipation FR-5 Board<br>$T_A = 25^\circ\text{C}$ | $P_D$           | 150         | mW                        |
| Thermal Resistance, Junction-to-Ambient                         | $R_{\theta JA}$ | 833         | $^\circ\text{C}/\text{W}$ |
| Junction and Storage Temperature                                | $T_J, T_{stg}$  | -55 to +150 | $^\circ\text{C}$          |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.



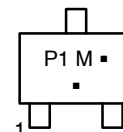
ON Semiconductor®

<http://onsemi.com>



SC-70  
CASE 419  
STYLE 3

#### MARKING DIAGRAM



P1 = Specific Device Code

M = Date Code\*

■ = Pb-Free Package

(Note: Microdot may be in either location)

\*Date Code orientation may vary depending upon manufacturing location.

#### ORDERING INFORMATION

| Device        | Package            | Shipping†        |
|---------------|--------------------|------------------|
| MMBT2222AWT1G | SC-70<br>(Pb-Free) | 3000/Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

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

| Characteristic  | Symbol        | Min | Max | Unit |
|---|---------------|-----|-----|------|
| <b>OFF CHARACTERISTICS</b>  |               |     |     |      |
| Collector–Emitter Breakdown Voltage (Note 1)<br>( $I_C = 1.0\text{ mAdc}$ , $I_B = 0$ ) | $V_{(BR)CEO}$ | 40  | –   | Vdc  |
| Collector–Base Breakdown Voltage<br>( $I_C = 10\text{ }\mu\text{Adc}$ , $I_E = 0$ )     | $V_{(BR)CBO}$ | 75  | –   | Vdc  |
| Emitter–Base Breakdown Voltage<br>( $I_E = 10\text{ }\mu\text{Adc}$ , $I_C = 0$ )       | $V_{(BR)EBO}$ | 6.0 | –   | Vdc  |
| Base Cutoff Current<br>( $V_{CE} = 60\text{ Vdc}$ , $V_{EB} = 3.0\text{ Vdc}$ )         | $I_{BL}$      | –   | 20  | nAdc |
| Collector Cutoff Current<br>( $V_{CE} = 60\text{ Vdc}$ , $V_{EB} = 3.0\text{ Vdc}$ )    | $I_{CEX}$     | –   | 10  | nAdc |

## ON CHARACTERISTICS (Note 1)

|   |               |                             |                         |     |
|---|---------------|-----------------------------|-------------------------|-----|
| DC Current Gain (Note 1)<br>( $I_C = 0.1\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 1.0\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 10\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 150\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 500\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ ) | $H_{FE}$      | 35<br>50<br>75<br>100<br>40 | –<br>–<br>–<br>300<br>– | –   |
| Collector–Emitter Saturation Voltage (Note 1)<br>( $I_C = 150\text{ mAdc}$ , $I_B = 15\text{ mAdc}$ )<br>( $I_C = 500\text{ mAdc}$ , $I_B = 50\text{ mAdc}$ )   | $V_{CE(sat)}$ | –<br>–                      | 0.3<br>1.0              | Vdc |
| Base–Emitter Saturation Voltage (Note 1)<br>( $I_C = 150\text{ mAdc}$ , $I_B = 15\text{ mAdc}$ )<br>( $I_C = 500\text{ mAdc}$ , $I_B = 50\text{ mAdc}$ )  | $V_{BE(sat)}$ | 0.6<br>–                    | 1.2<br>2.0              | Vdc |

## SMALL-SIGNAL CHARACTERISTICS

|   |           |      |      |                  |
|---|-----------|------|------|------------------|
| Current–Gain–Bandwidth Product<br>( $I_C = 20\text{ mAdc}$ , $V_{CE} = 20\text{ Vdc}$ , $f = 100\text{ MHz}$ )                      | $f_T$     | 300  | –    | MHz              |
| Output Capacitance<br>( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )   | $C_{obo}$ | –    | 8.0  | pF               |
| Input Capacitance<br>( $V_{EB} = 0.5\text{ Vdc}$ , $I_C = 0$ , $f = 1.0\text{ MHz}$ )   | $C_{ibo}$ | –    | 30   | pF               |
| Input Impedance<br>( $V_{CE} = 10\text{ Vdc}$ , $I_C = 10\text{ mAdc}$ , $f = 1.0\text{ kHz}$ )                                     | $h_{ie}$  | 0.25 | 1.25 | k $\Omega$       |
| Voltage Feedback Ratio<br>( $V_{CE} = 10\text{ Vdc}$ , $I_C = 10\text{ mAdc}$ , $f = 1.0\text{ kHz}$ )                              | $h_{re}$  | –    | 4.0  | $\times 10^{-4}$ |
| Small–Signal Current Gain<br>( $V_{CE} = 10\text{ Vdc}$ , $I_C = 10\text{ mAdc}$ , $f = 1.0\text{ kHz}$ )                           | $h_{fe}$  | 75   | 375  | –                |
| Output Admittance<br>( $V_{CE} = 10\text{ Vdc}$ , $I_C = 10\text{ mAdc}$ , $f = 1.0\text{ kHz}$ )                                   | $h_{oe}$  | 25   | 200  | $\mu\text{mhos}$ |
| Noise Figure<br>( $V_{CE} = 10\text{ Vdc}$ , $I_C = 100\text{ }\mu\text{Adc}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ ) | NF        | –    | 4.0  | dB               |

## SWITCHING CHARACTERISTICS

|              |  |       |   |     |    |
|--------------|--|-------|---|-----|----|
| Delay Time   | $(V_{CC} = 3.0\text{ Vdc}$ , $V_{BE} = -0.5\text{ Vdc}$ ,<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  |    |

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

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## SWITCHING TIME EQUIVALENT TEST CIRCUITS

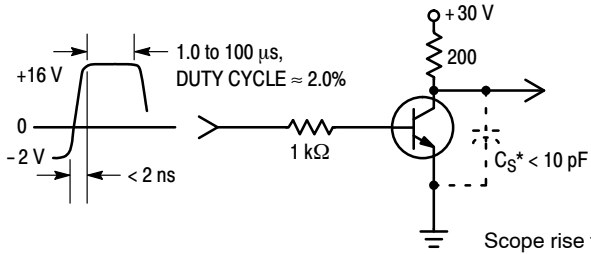


Figure 1. Turn-On Time

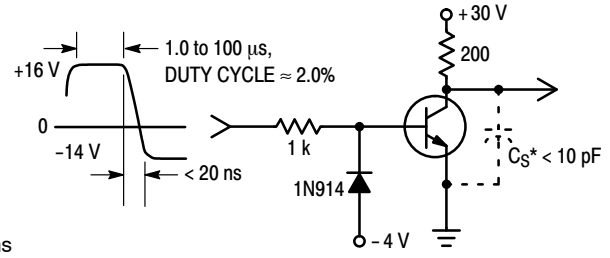


Figure 2. Turn-Off Time

Scope rise time  $< 4 \text{ ns}$   
 \*Total shunt capacitance of test jig, connectors, and oscilloscope.

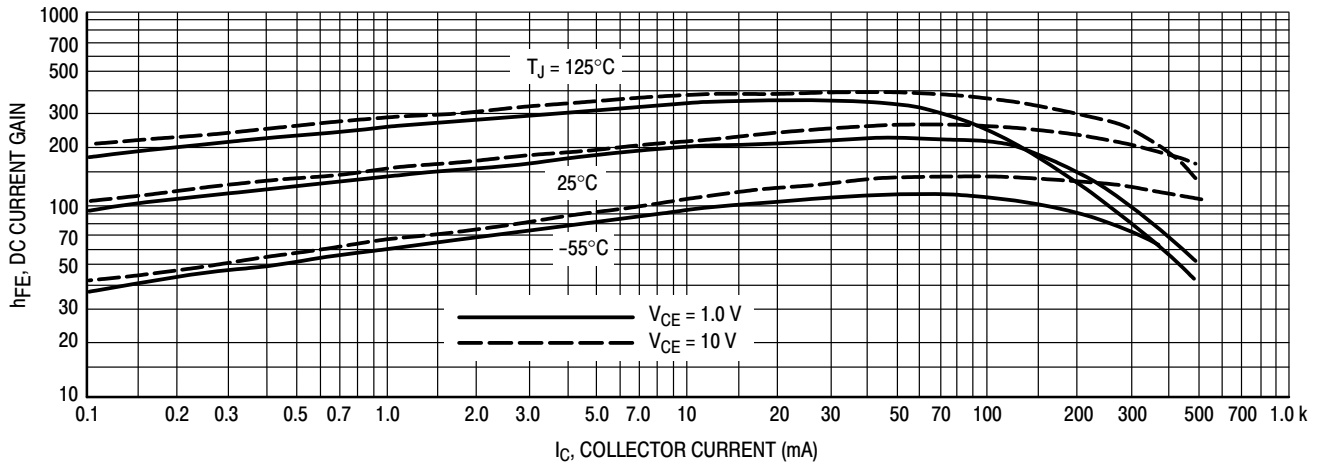


Figure 3. DC Current Gain

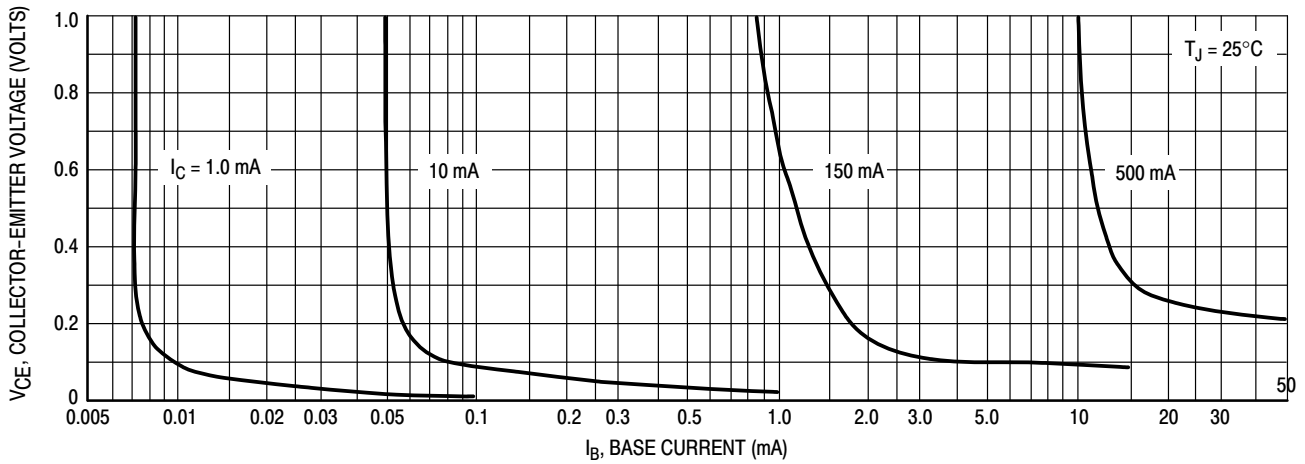


Figure 4. Collector Saturation Region

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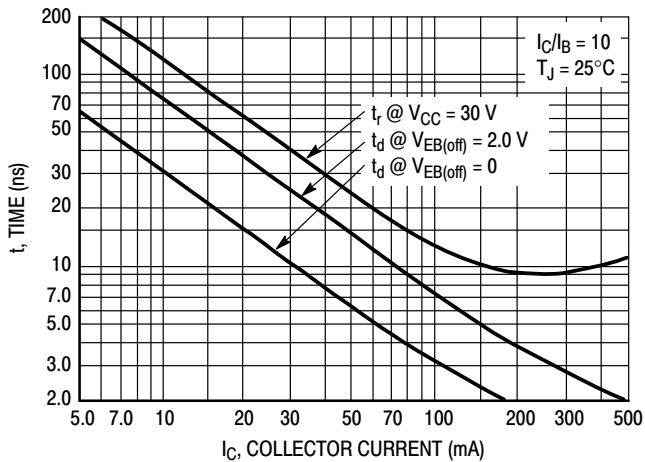


Figure 5. Turn-On Time

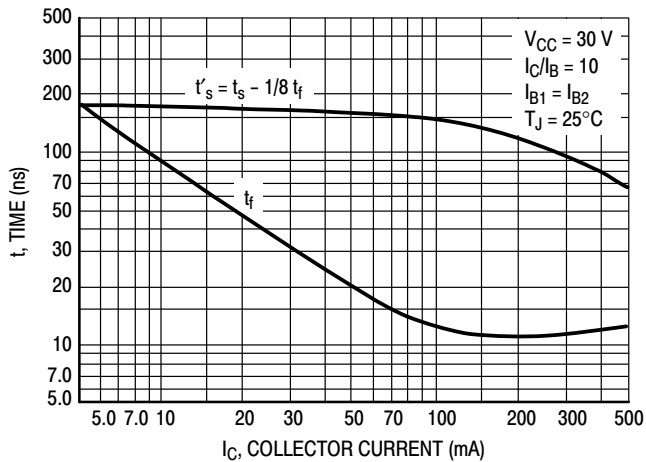


Figure 6. Turn-Off Time

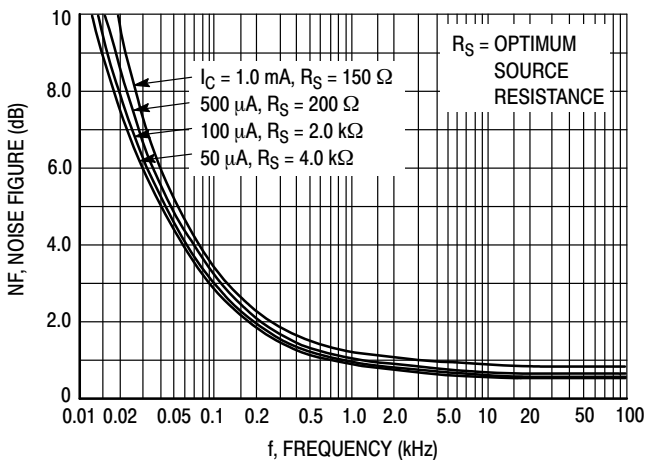


Figure 7. Frequency Effects

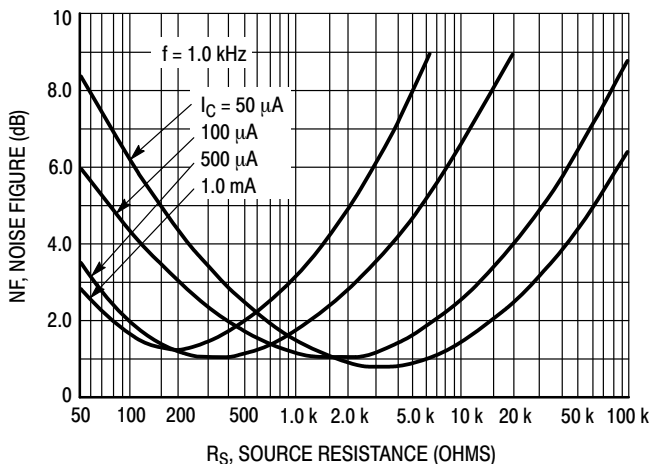


Figure 8. Source Resistance Effects

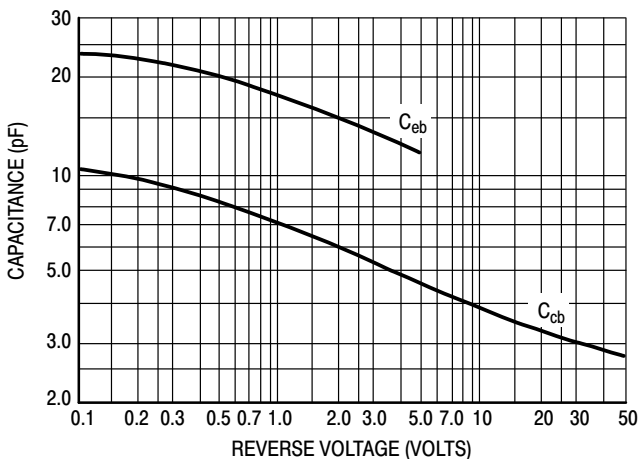


Figure 9. Capacitances

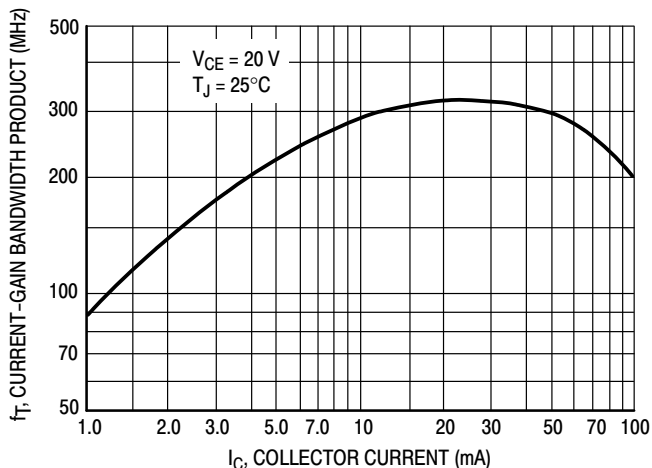
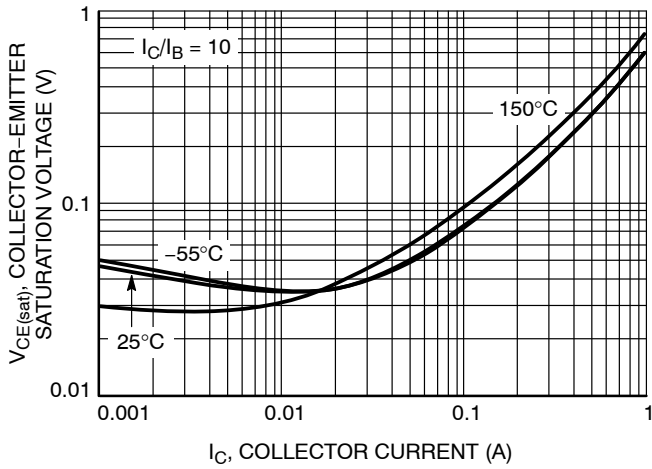
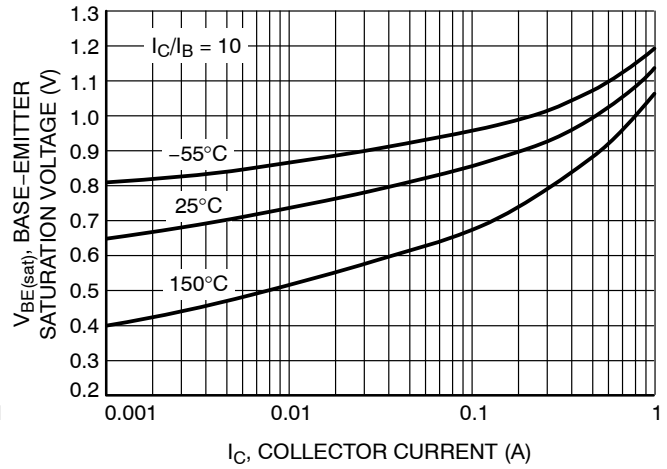


Figure 10. Current-Gain Bandwidth Product

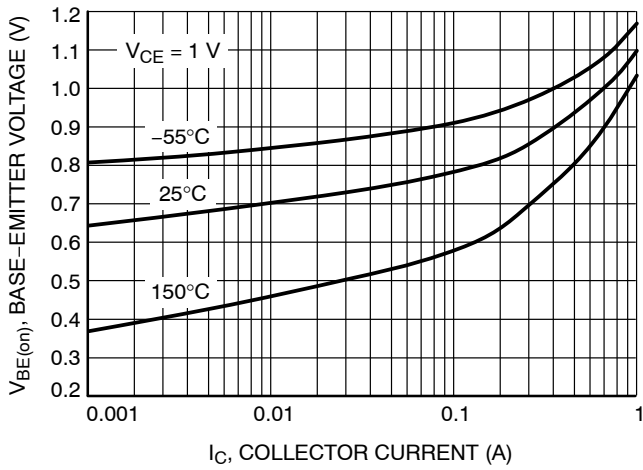
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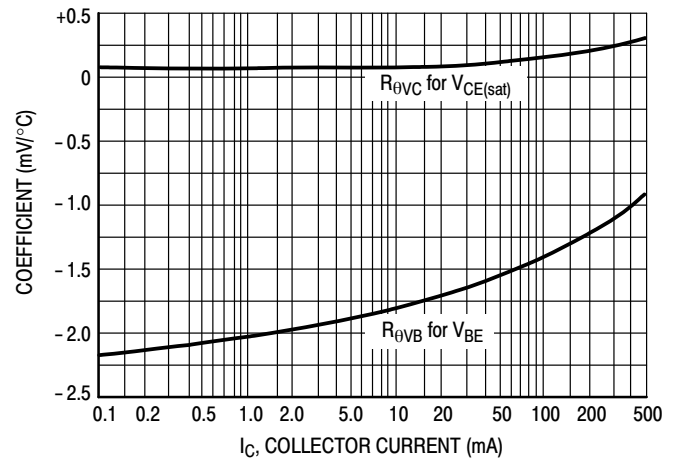
**Figure 11. Collector Emitter Saturation Voltage vs. Collector Current**



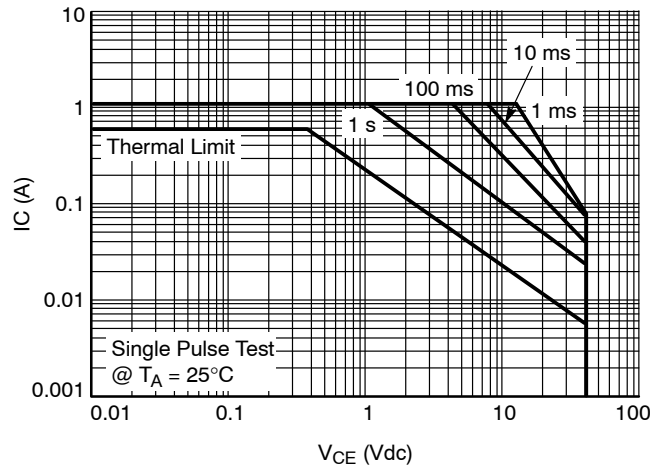
**Figure 12. Base Emitter Saturation Voltage vs. Collector Current**



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



**Figure 14. Temperature Coefficients**

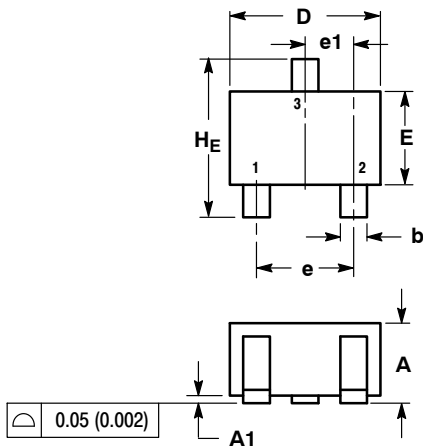


**Figure 15. Safe Operating Area**

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## PACKAGE DIMENSIONS

SC-70 (SOT-323)  
CASE 419-04  
ISSUE M

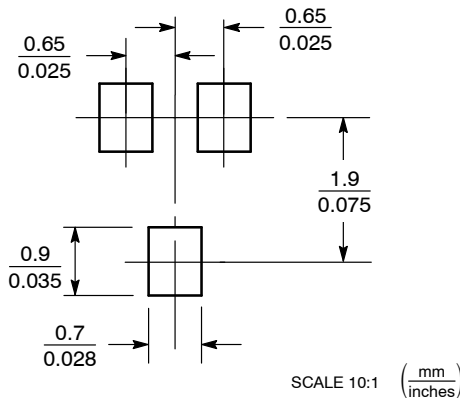


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

| DIM | MILLIMETERS |      |      | INCHES    |       |       |
|-----|-------------|------|------|-----------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN       | NOM   | MAX   |
| A   | 0.80        | 0.90 | 1.00 | 0.032     | 0.035 | 0.040 |
| A1  | 0.00        | 0.05 | 0.10 | 0.000     | 0.002 | 0.004 |
| A2  | 0.7 REF     |      |      | 0.028 REF |       |       |
| b   | 0.30        | 0.35 | 0.40 | 0.012     | 0.014 | 0.016 |
| c   | 0.10        | 0.18 | 0.25 | 0.004     | 0.007 | 0.010 |
| D   | 1.80        | 2.10 | 2.20 | 0.071     | 0.083 | 0.087 |
| E   | 1.15        | 1.24 | 1.35 | 0.045     | 0.049 | 0.053 |
| e   | 1.20        | 1.30 | 1.40 | 0.047     | 0.051 | 0.055 |
| e1  | 0.65 BSC    |      |      | 0.026 BSC |       |       |
| L   | 0.425 REF   |      |      | 0.017 REF |       |       |
| HE  | 2.00        | 2.10 | 2.40 | 0.079     | 0.083 | 0.095 |

- STYLE 3:  
PIN 1. BASE  
2. EMITTER  
3. COLLECTOR

### SOLDERING 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.

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