# MMBT3904L, SMMBT3904L

# General Purpose Transistor

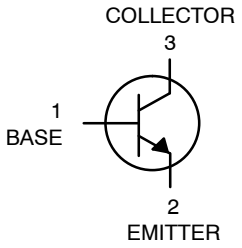
## NPN Silicon

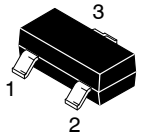
**ON Semiconductor®**

**http://onsemi.com**

### 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




**SOT−23 (TO−236)**
**CASE 318**
**STYLE 6**

### MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector − Emitter Voltage | $V_{CEO}$ | 40 | Vdc |
| Collector − Base Voltage | $V_{CBO}$ | 60 | Vdc |
| Emitter − Base Voltage | $V_{EBO}$ | 6.0 | Vdc |
| Collector Current − Continuous | $I_C$ | 200 | mAdc |
| Collector Current − Peak (Note 3) | $I_{CM}$ | 900 | mAdc |

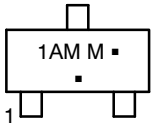
### THERMAL CHARACTERISTICS

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

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




1AM = Specific Device Code
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

| Device | Package | Shipping† |
|---|---|---|
| MMBT3904LT1G<br>SMMBT3904LT1G | SOT−23<br>(Pb−Free) | 3000 / Tape & Reel |
| MMBT3904LT3G<br>SMMBT3904LT3G | SOT−23<br>(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.

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

| Characteristic | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | |
| Collector – Emitter Breakdown Voltage ($I_C$ = 1.0 mAdc, $I_B$ = 0) | $V_{(BR)CEO}$ | 40 | – | Vdc |
| Collector – Base Breakdown Voltage ($I_C$ = 10 μAdc, $I_E$ = 0) | $V_{(BR)CBO}$ | 60 | – | Vdc |
| Emitter – Base Breakdown Voltage ($I_E$ = 10 μAdc, $I_C$ = 0) | $V_{(BR)EBO}$ | 6.0 | – | Vdc |
| Base Cutoff Current ($V_{CE}$ = 30 Vdc, $V_{EB}$ = 3.0 Vdc) | $I_{BL}$ | – | 50 | nAdc |
| Collector Cutoff Current ($V_{CE}$ = 30 Vdc, $V_{EB}$ = 3.0 Vdc) | $I_{CEX}$ | – | 50 | nAdc |
| **ON CHARACTERISTICS** (Note 4) | | | | |
| DC Current Gain<br>($I_C$ = 0.1 mAdc, $V_{CE}$ = 1.0 Vdc)<br>($I_C$ = 1.0 mAdc, $V_{CE}$ = 1.0 Vdc)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc)<br>($I_C$ = 50 mAdc, $V_{CE}$ = 1.0 Vdc)<br>($I_C$ = 100 mAdc, $V_{CE}$ = 1.0 Vdc) | $H_{FE}$ | <br>40<br>70<br>100<br>60<br>30 | <br>–<br>–<br>300<br>–<br>– | – |
| Collector – Emitter Saturation Voltage<br>($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc)<br>($I_C$ = 50 mAdc, $I_B$ = 5.0 mAdc) | $V_{CE(sat)}$ | <br>–<br>– | <br>0.2<br>0.3 | Vdc |
| Base – Emitter Saturation Voltage<br>($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc)<br>($I_C$ = 50 mAdc, $I_B$ = 5.0 mAdc) | $V_{BE(sat)}$ | <br>0.65<br>– | <br>0.85<br>0.95 | Vdc |
| **SMALL–SIGNAL CHARACTERISTICS** | | | | |
| Current – Gain – Bandwidth Product ($I_C$ = 10 mAdc, $V_{CE}$ = 20 Vdc, f = 100 MHz) | $f_T$ | 300 | – | MHz |
| Output Capacitance ($V_{CB}$ = 5.0 Vdc, $I_E$ = 0, f = 1.0 MHz) | $C_{obo}$ | – | 4.0 | pF |
| Input Capacitance ($V_{EB}$ = 0.5 Vdc, $I_C$ = 0, f = 1.0 MHz) | $C_{ibo}$ | – | 8.0 | pF |
| Input Impedance ($V_{CE}$ = 10 Vdc, $I_C$ = 1.0 mAdc, f = 1.0 kHz) | $h_{ie}$ | 1.0 | 10 | kΩ |
| Voltage Feedback Ratio ($V_{CE}$ = 10 Vdc, $I_C$ = 1.0 mAdc, f = 1.0 kHz) | $h_{re}$ | 0.5 | 8.0 | X $10^{-4}$ |
| Small – Signal Current Gain ($V_{CE}$ = 10 Vdc, $I_C$ = 1.0 mAdc, f = 1.0 kHz) | $h_{fe}$ | 100 | 400 | – |
| Output Admittance ($V_{CE}$ = 10 Vdc, $I_C$ = 1.0 mAdc, f = 1.0 kHz) | $h_{oe}$ | 1.0 | 40 | μmhos |
| Noise Figure ($V_{CE}$ = 5.0 Vdc, $I_C$ = 100 μAdc, $R_S$ = 1.0 k ohms, f = 1.0 kHz) | NF | – | 5.0 | dB |
| **SWITCHING CHARACTERISTICS** | | | | |
| Delay Time | ($V_{CC}$ = 3.0 Vdc, $V_{BE}$ = –0.5 Vdc, $I_C$ = 10 mAdc, $I_{B1}$ = 1.0 mAdc) | $t_d$ | – | 35 | ns |
| Rise Time | | $t_r$ | – | 35 | |
| Storage Time | ($V_{CC}$ = 3.0 Vdc, $I_C$ = 10 mAdc, $I_{B1}$ = $I_{B2}$ = 1.0 mAdc) | $t_s$ | – | 200 | ns |
| Fall Time | | $t_f$ | – | 50 | |

4. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

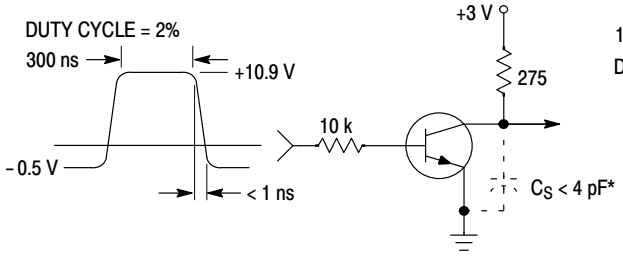



**Figure 1. Delay and Rise Time Equivalent Test Circuit**

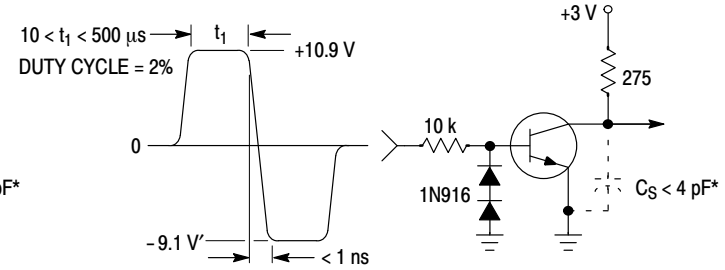



**Figure 2. Storage and Fall Time Equivalent Test Circuit**

* Total shunt capacitance of test jig and connectors

## TYPICAL TRANSIENT CHARACTERISTICS

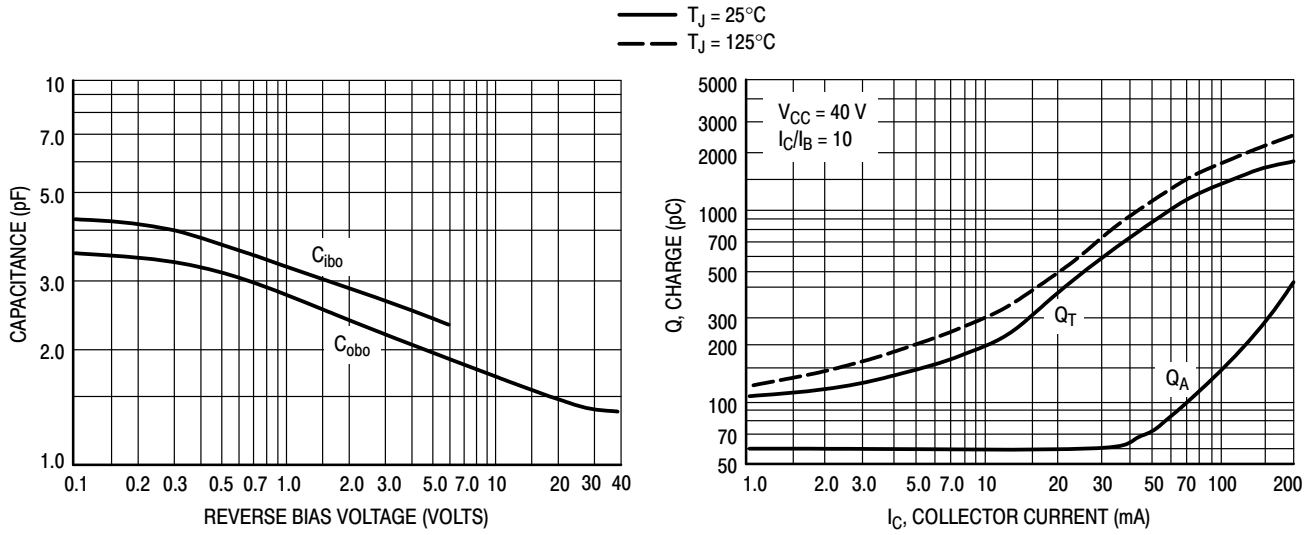



**Figure 3. Capacitance**

**Figure 4. Charge Data**

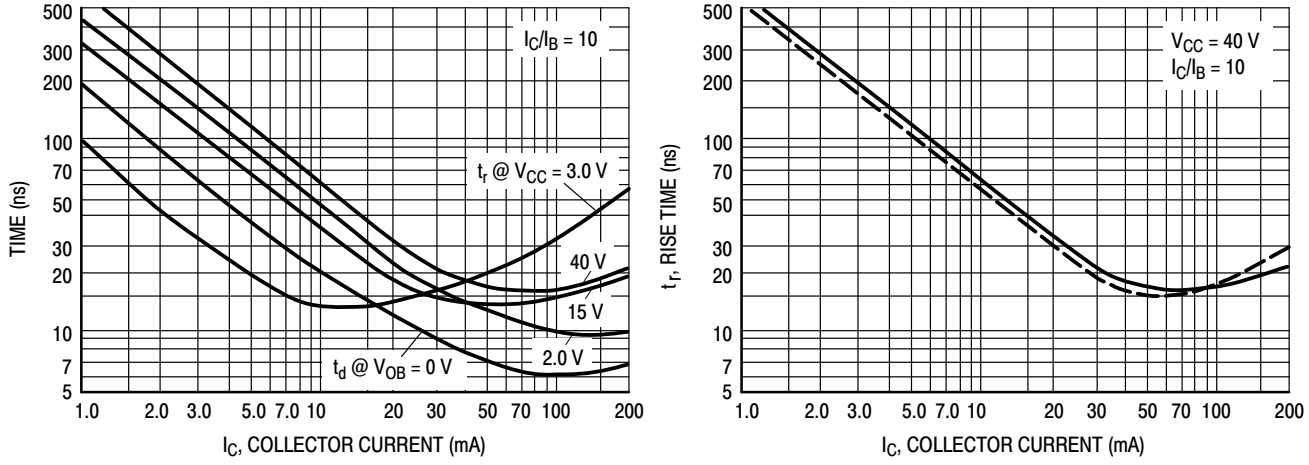



**Figure 5. Turn – On Time**

**Figure 6. Rise Time**

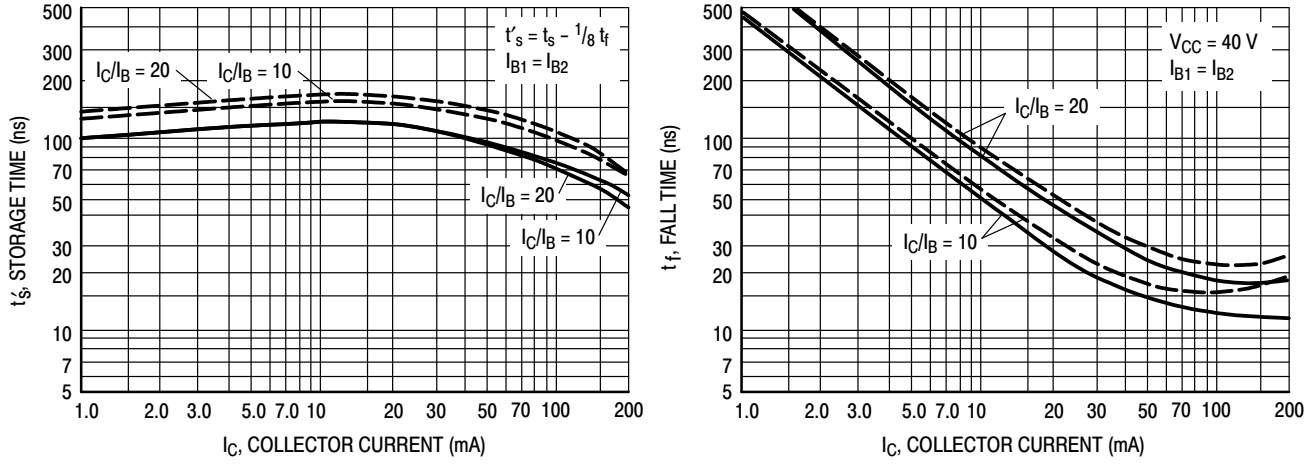



**Figure 7. Storage Time**

**Figure 8. Fall Time**

## TYPICAL AUDIO SMALL−SIGNAL CHARACTERISTICS
## NOISE FIGURE VARIATIONS

($V_{CE}$ = 5.0 Vdc, $T_A$ = 25°C, Bandwidth = 1.0 Hz)

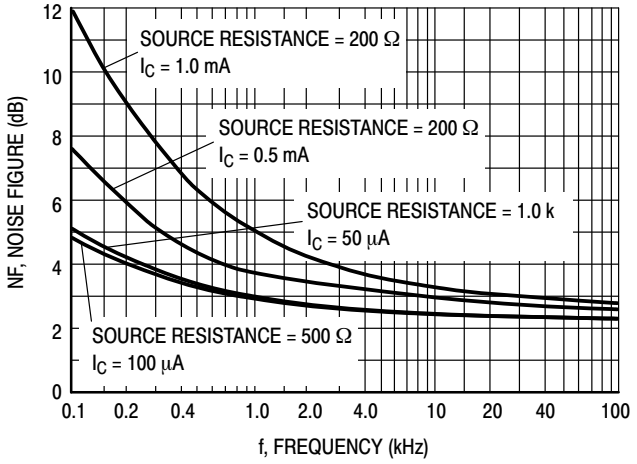



**Figure 9.**

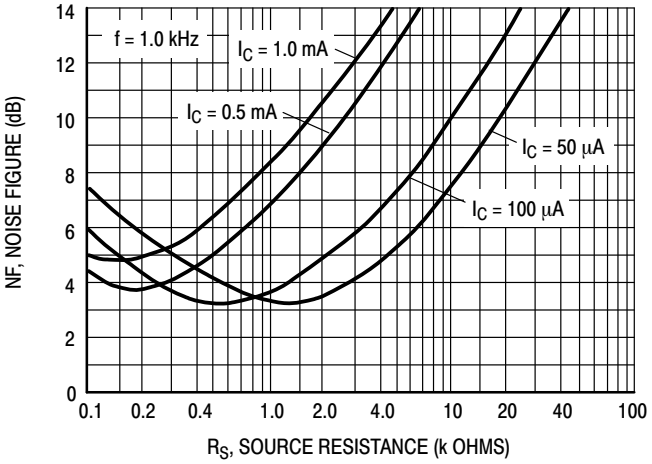



**Figure 10.**

## h PARAMETERS

($V_{CE}$ = 10 Vdc, f = 1.0 kHz, $T_A$ = 25°C)

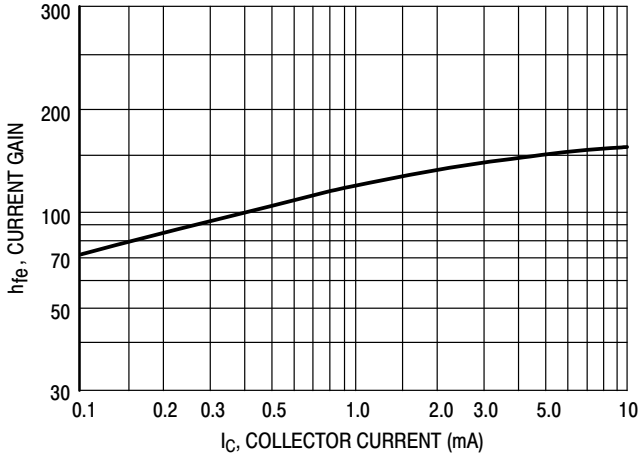



**Figure 11. Current Gain**

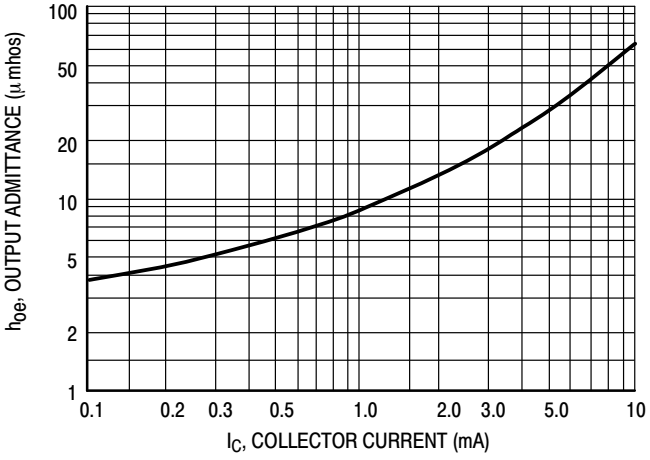



**Figure 12. Output Admittance**

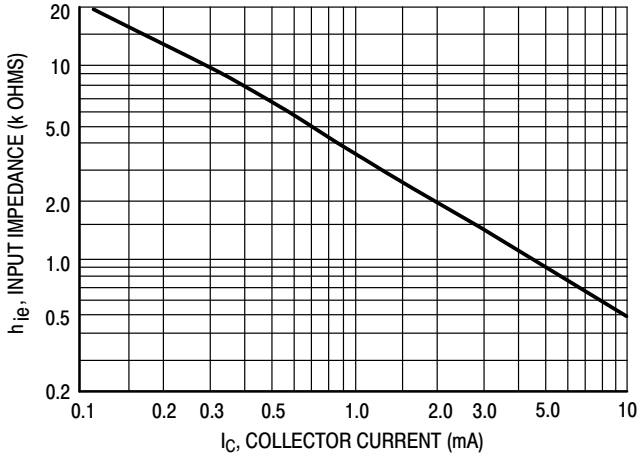



**Figure 13. Input Impedance**

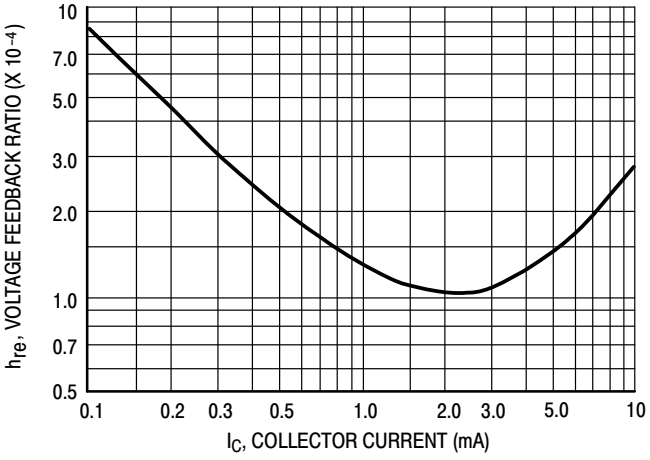



**Figure 14. Voltage Feedback Ratio**

## TYPICAL STATIC CHARACTERISTICS

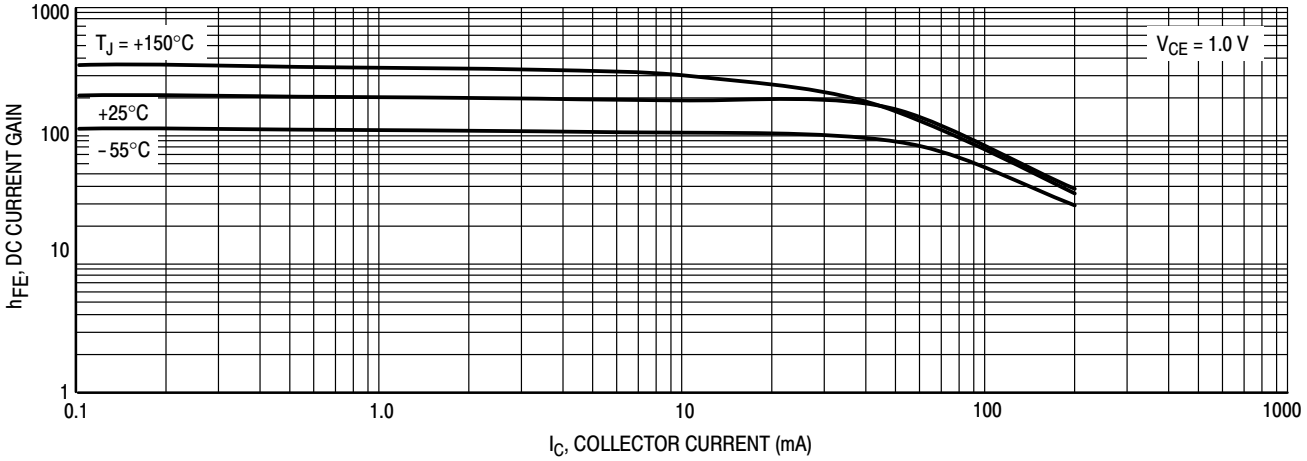



**Figure 15. DC Current Gain**

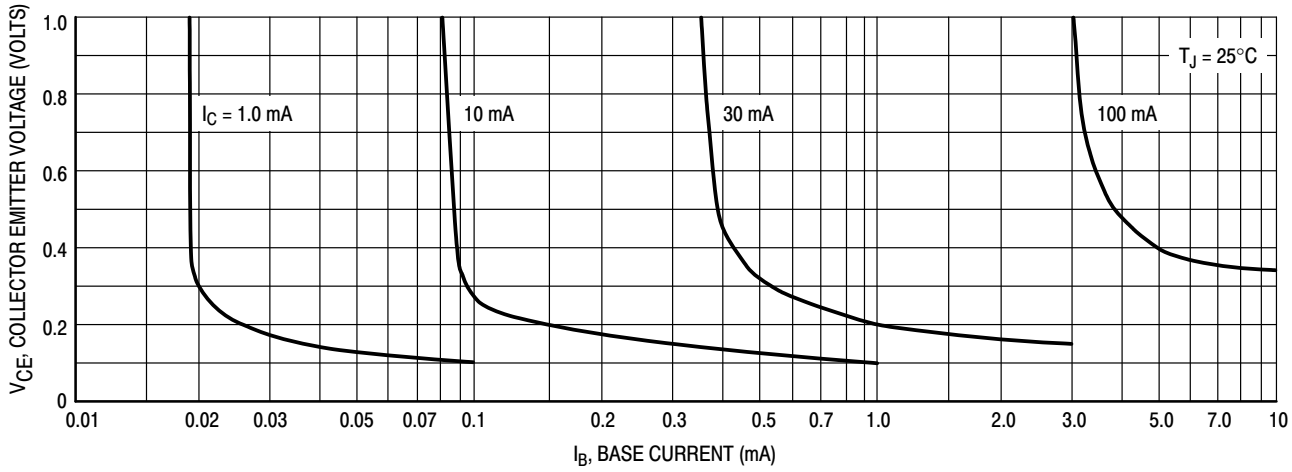



**Figure 16. Collector Saturation Region**

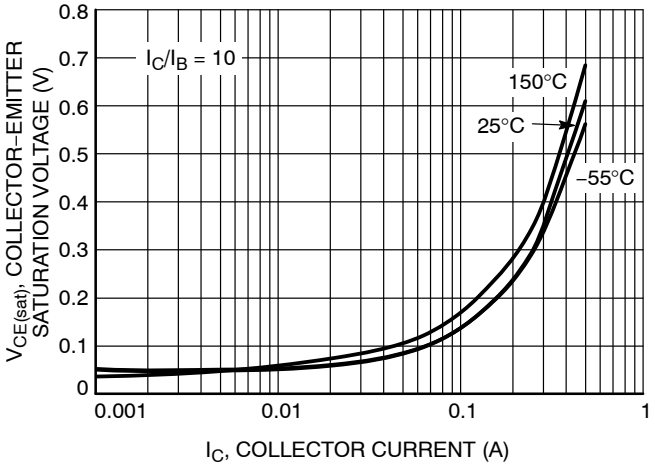



**Figure 17. Collector Emitter Saturation Voltage vs. Collector Current**

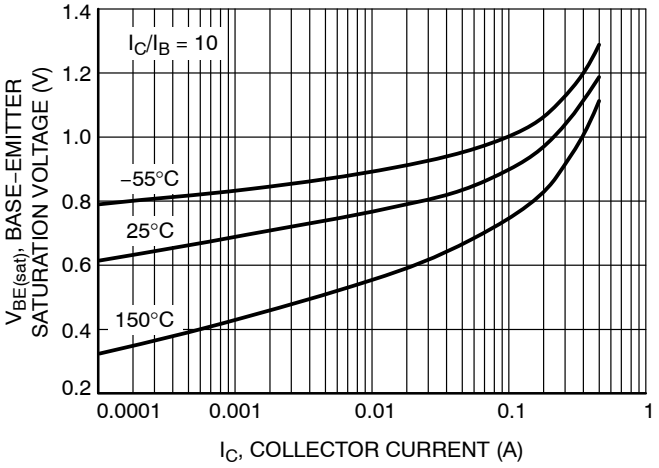



**Figure 18. Base Emitter Saturation Voltage vs. Collector Current**

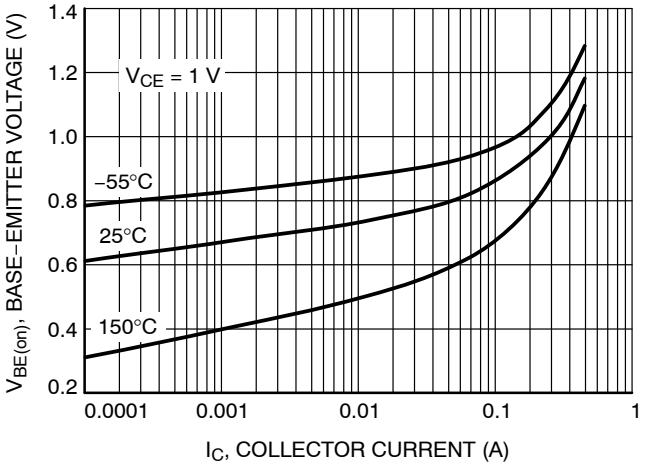



**Figure 19. Base Emitter Voltage vs. Collector Current**

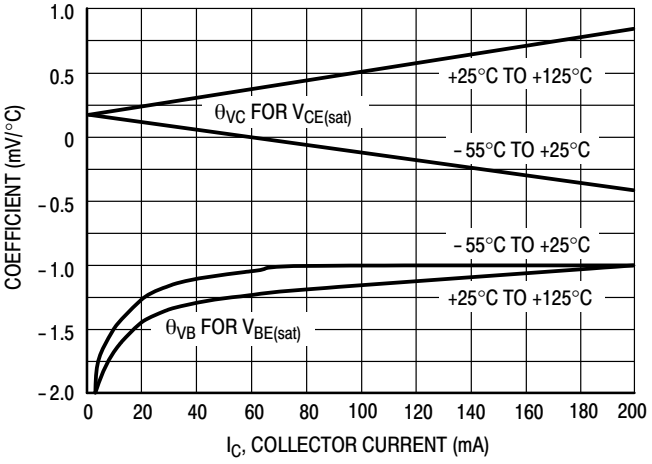



**Figure 20. Temperature Coefficients**

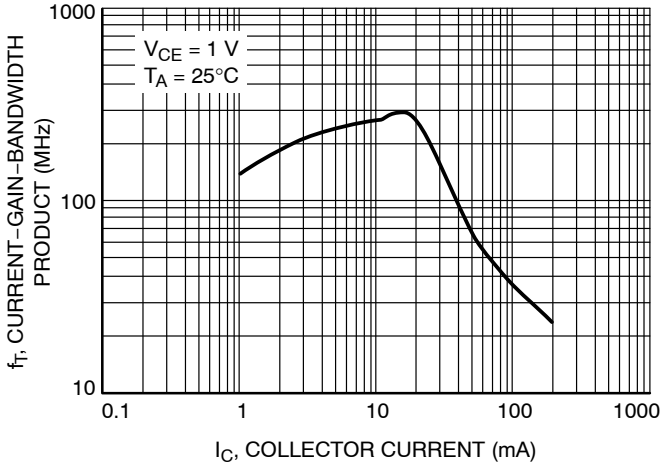



**Figure 21. Current Gain Bandwidth vs. Collector Current**

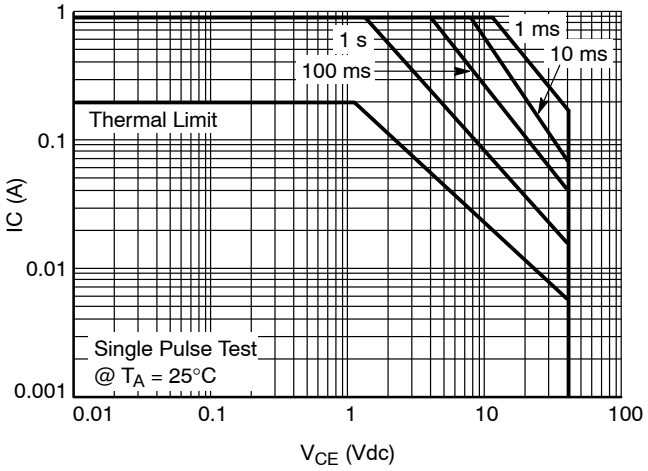
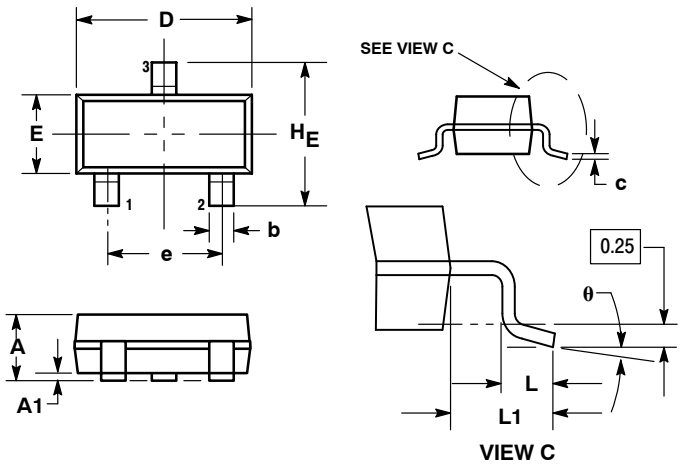



**Figure 22. Safe Operating Area**

## PACKAGE DIMENSIONS

**SOT−23 (TO−236)**
CASE 318−08
ISSUE AP

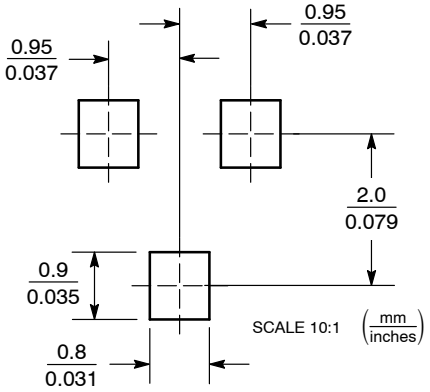



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| DIM | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.89 | 1.00 | 1.11 | 0.035 | 0.040 | 0.044 |
| A1 | 0.01 | 0.06 | 0.10 | 0.001 | 0.002 | 0.004 |
| b | 0.37 | 0.44 | 0.50 | 0.015 | 0.018 | 0.020 |
| c | 0.09 | 0.13 | 0.18 | 0.003 | 0.005 | 0.007 |
| 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 | 0.081 |
| L | 0.10 | 0.20 | 0.30 | 0.004 | 0.008 | 0.012 |
| L1 | 0.35 | 0.54 | 0.69 | 0.014 | 0.021 | 0.029 |
| $H_E$ | 2.10 | 2.40 | 2.64 | 0.083 | 0.094 | 0.104 |
| θ | 0° | −−− | 10° | 0° | −−− | 10° |

STYLE 6:
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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**Fax**: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
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