

MMBT3904TT1G, SMMBT3904TT1G

General Purpose Transistors

NPN Silicon

This transistor is designed for general purpose amplifier applications. It is housed in the SOT-416/SC-75 package which is designed for low power surface mount applications.

Features

- AEC-Q101 Qualified and PPAP Capable
- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant*

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$)

| 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 |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-----------------|-------------|----------------------------|
| Total Device Dissipation, FR-4 Board (Note 1) @ $T_A = 25^\circ\text{C}$ Derated above 25°C | P_D | 200 1.6 | mW mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient (Note 1) | $R_{\theta JA}$ | 600 | $^\circ\text{C}/\text{W}$ |
| Total Device Dissipation, FR-4 Board (Note 2) @ $T_A = 25^\circ\text{C}$ Derated above 25°C | P_D | 300 2.4 | mW mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient (Note 2) | $R_{\theta JA}$ | 400 | $^\circ\text{C}/\text{W}$ |
| Junction and Storage Temperature Range | 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.

1. FR-4 @ Minimum Pad
2. FR-4 @ 1.0×1.0 Inch Pad

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



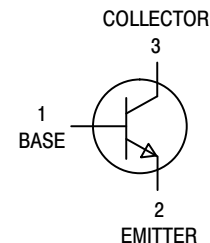
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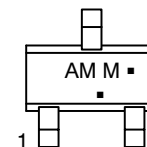
GENERAL PURPOSE AMPLIFIER TRANSISTORS SURFACE MOUNT



SOT-416/SC-75
CASE 463
STYLE 1



MARKING DIAGRAM



AM = 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† |
|---------------|----------------------|-------------------|
| MMBT3904TT1G | SOT-416 (Pb-Free) | 3,000 Tape & Reel |
| SMMBT3904TT1G | SOT-416 (Pb-Free) | 3,000 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.

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

| Characteristic | Symbol | Min | Max | Unit |
|----------------|--------|-----|-----|------|
|----------------|--------|-----|-----|------|

OFF CHARACTERISTICS

| | | | | |
|---|---------------|-----|----|------|
| Collector – Emitter Breakdown Voltage (Note 3) ($I_C = 1.0\text{ mA}$, $I_B = 0$) | $V_{(BR)CEO}$ | 40 | – | Vdc |
| Collector – Base Breakdown Voltage ($I_C = 10\text{ }\mu\text{A}$, $I_E = 0$) | $V_{(BR)CBO}$ | 60 | – | Vdc |
| Emitter – Base Breakdown Voltage ($I_E = 10\text{ }\mu\text{A}$, $I_C = 0$) | $V_{(BR)EBO}$ | 6.0 | – | Vdc |
| Base Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{EB} = 3.0\text{ Vdc}$) | I_{BL} | – | 50 | nAdc |
| Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{EB} = 3.0\text{ Vdc}$) | I_{CEX} | – | 50 | nAdc |

ON CHARACTERISTICS (Note 3)

| | | | | |
|--|---------------|-----------------------------|-------------------------|-----|
| DC Current Gain ($I_C = 0.1\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 1.0\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 10\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 50\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 100\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) | h_{FE} | 40 70 100 60 30 | – – 300 – – | – |
| Collector – Emitter Saturation Voltage ($I_C = 10\text{ mA}$, $I_B = 1.0\text{ mA}$) ($I_C = 50\text{ mA}$, $I_B = 5.0\text{ mA}$) | $V_{CE(sat)}$ | – – | 0.2 0.3 | Vdc |
| Base – Emitter Saturation Voltage ($I_C = 10\text{ mA}$, $I_B = 1.0\text{ mA}$) ($I_C = 50\text{ mA}$, $I_B = 5.0\text{ mA}$) | $V_{BE(sat)}$ | 0.65 – | 0.85 0.95 | Vdc |

SMALL-SIGNAL CHARACTERISTICS

| | | | | |
|--|-----------|-----|-----|------------------|
| Current – Gain – Bandwidth Product ($I_C = 10\text{ mA}$, $V_{CE} = 20\text{ Vdc}$, $f = 100\text{ MHz}$) | f_T | 300 | – | MHz |
| Output Capacitance ($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$) | C_{obo} | – | 4.0 | pF |
| Input Capacitance ($V_{EB} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 1.0\text{ MHz}$) | C_{ibo} | – | 8.0 | pF |
| Input Impedance ($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) | h_{ie} | 1.0 | 10 | k Ω |
| Voltage Feedback Ratio ($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) | h_{re} | 0.5 | 8.0 | $\times 10^{-4}$ |
| Small – Signal Current Gain ($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) | h_{fe} | 100 | 400 | – |
| Output Admittance ($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) | h_{oe} | 1.0 | 40 | μmhos |
| Noise Figure ($V_{CE} = 5.0\text{ Vdc}$, $I_C = 100\text{ }\mu\text{A}$, $R_S = 1.0\text{ k}\Omega$, $f = 1.0\text{ kHz}$) | NF | – | 5.0 | dB |

SWITCHING CHARACTERISTICS

| | | | | |
|---|-------|---|-----|----|
| Delay Time ($V_{CC} = 3.0\text{ Vdc}$, $V_{BE} = -0.5\text{ Vdc}$) MMBT3904TT1G, SMMBT3904TT1G | t_d | – | 35 | ns |
| Rise Time ($I_C = 10\text{ mA}$, $I_{B1} = 1.0\text{ mA}$) MMBT3904TT1G, SMMBT3904TT1G | t_r | – | 35 | |
| Storage Time ($V_{CC} = 3.0\text{ Vdc}$, $I_C = 10\text{ mA}$) MMBT3904TT1G, SMMBT3904TT1G | t_s | – | 200 | |
| Fall Time ($I_{B1} = I_{B2} = 1.0\text{ mA}$) MMBT3904TT1G, SMMBT3904TT1G | t_f | – | 50 | |

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

MMBT3904TT1G, SMMBT3904TT1G

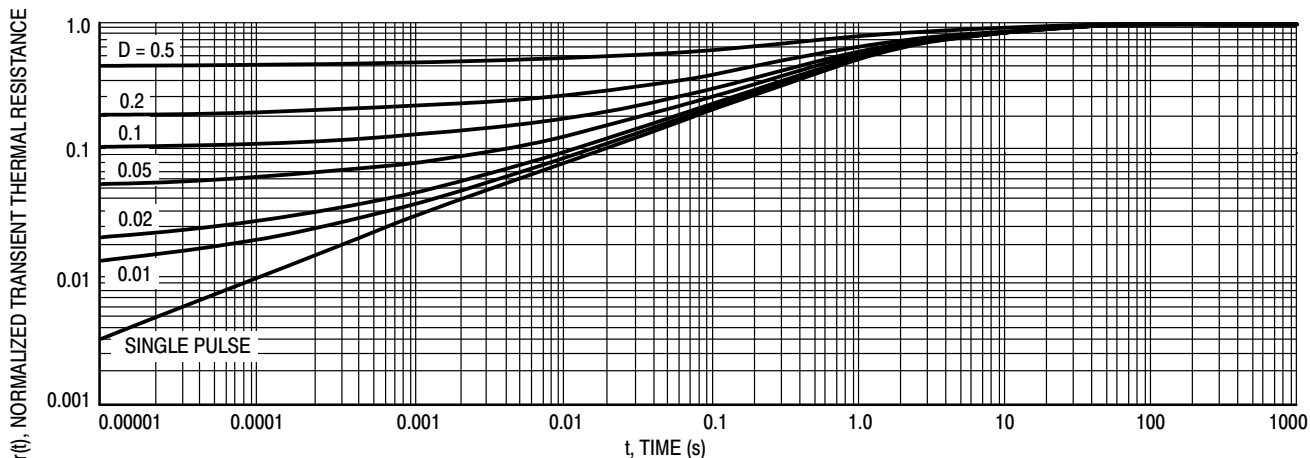


Figure 1. Normalized Thermal Response

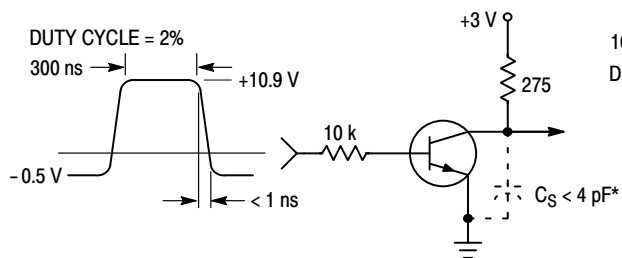


Figure 2. Delay and Rise Time Equivalent Test Circuit

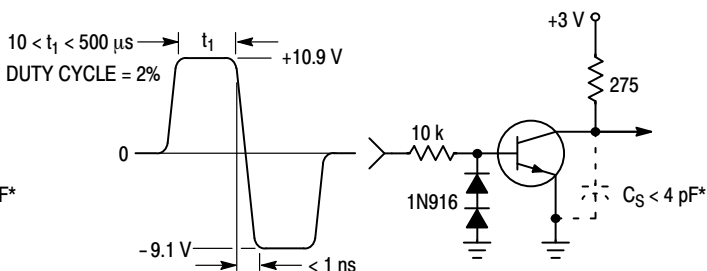


Figure 3. Storage and Fall Time Equivalent Test Circuit

* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

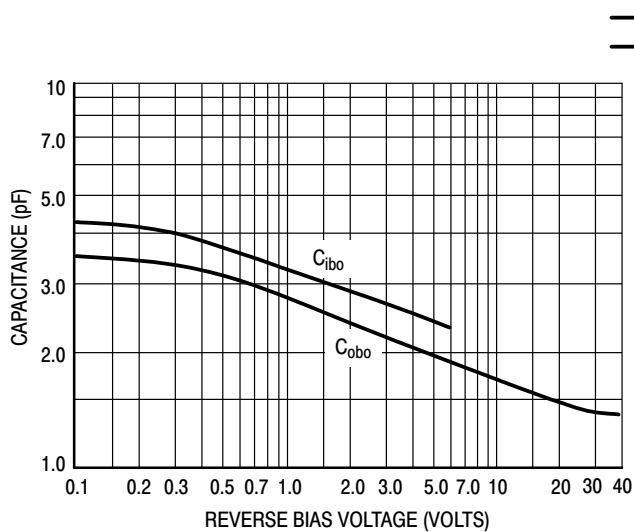


Figure 4. Capacitance

— $T_J = 25^\circ\text{C}$
 - - - $T_J = 125^\circ\text{C}$

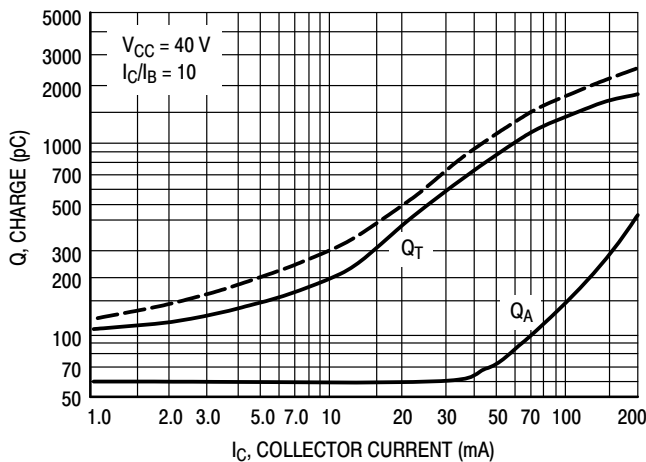


Figure 5. Charge Data

MMBT3904TT1G, SMMBT3904TT1G

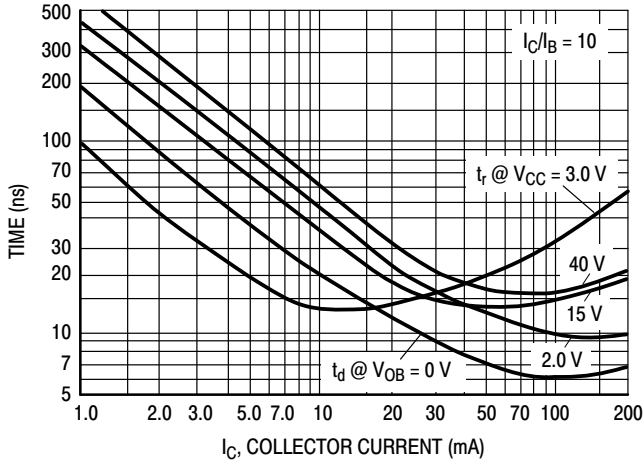


Figure 6. Turn-On Time

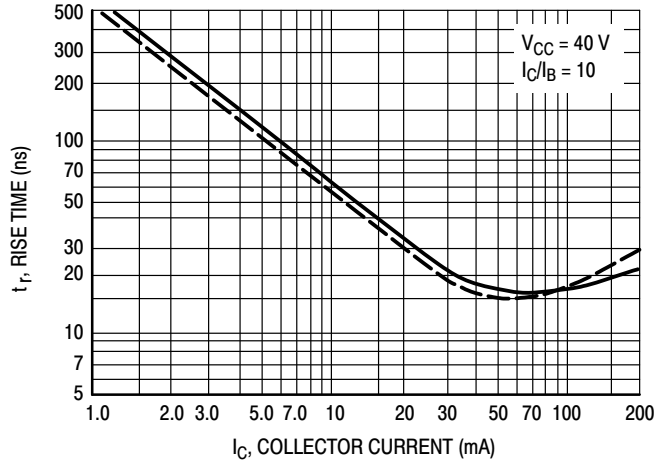


Figure 7. Rise Time

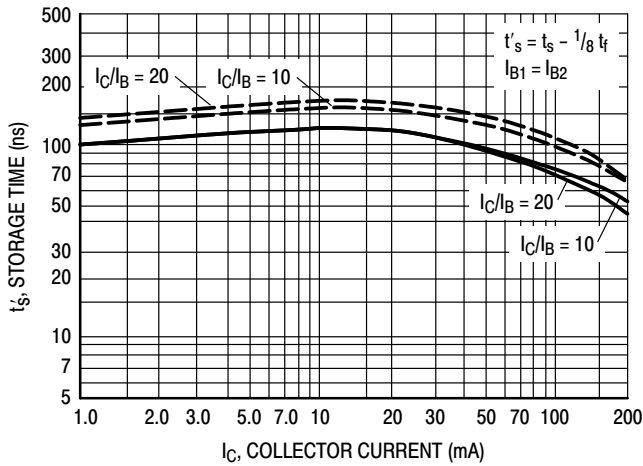


Figure 8. Storage Time

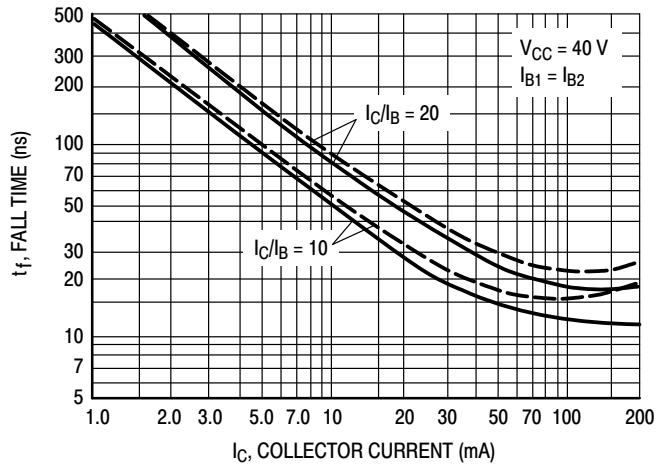


Figure 9. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

($V_{CE} = 5.0 \text{ Vdc}$, $T_A = 25^\circ\text{C}$, Bandwidth = 1.0 Hz)

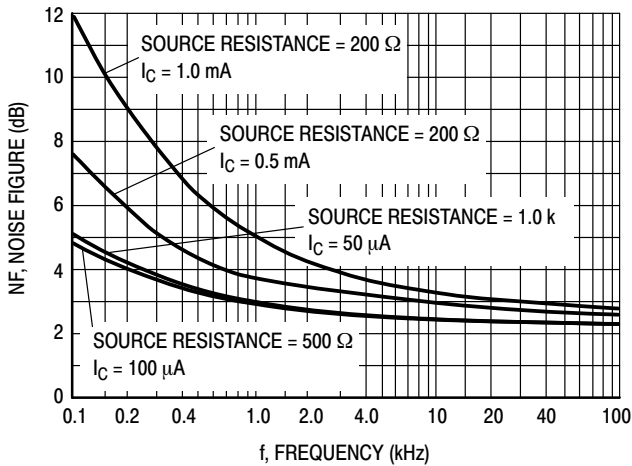


Figure 10. Noise Figure

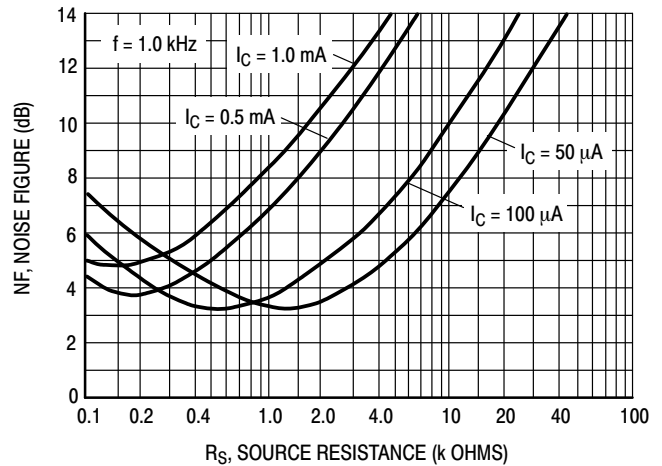


Figure 11. Noise Figure

MMBT3904TT1G, SMMBT3904TT1G

h PARAMETERS

($V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$, $T_A = 25^\circ\text{C}$)

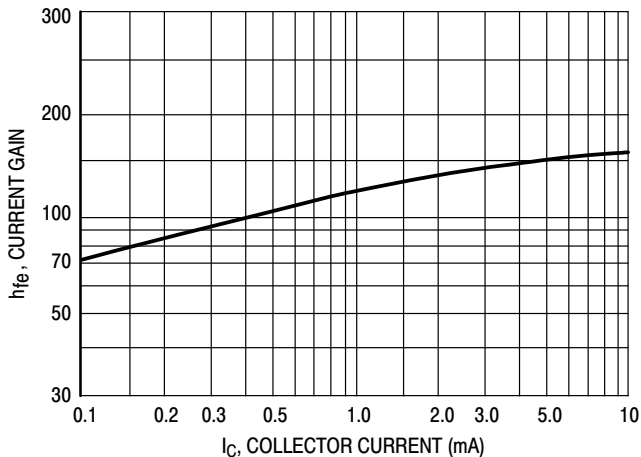


Figure 12. Current Gain

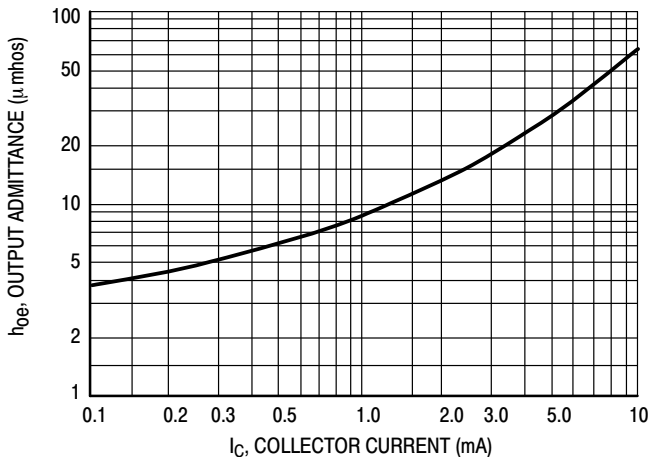


Figure 13. Output Admittance

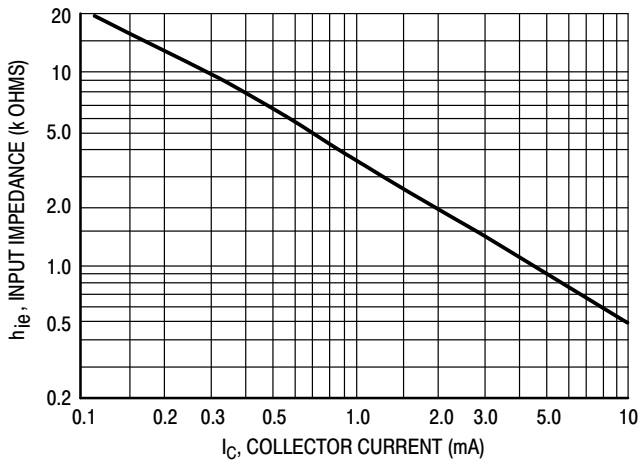


Figure 14. Input Impedance

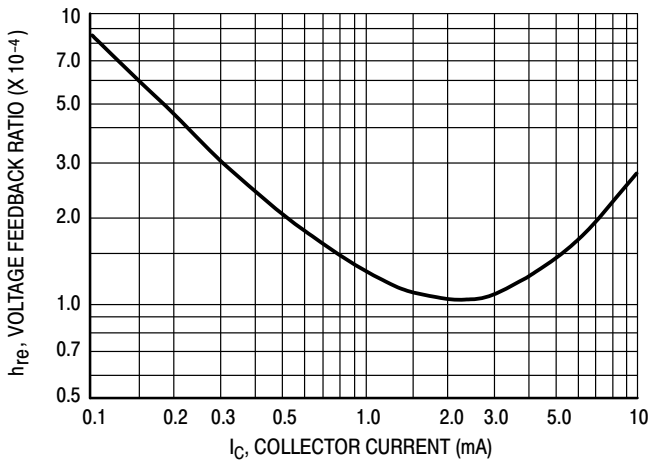


Figure 15. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

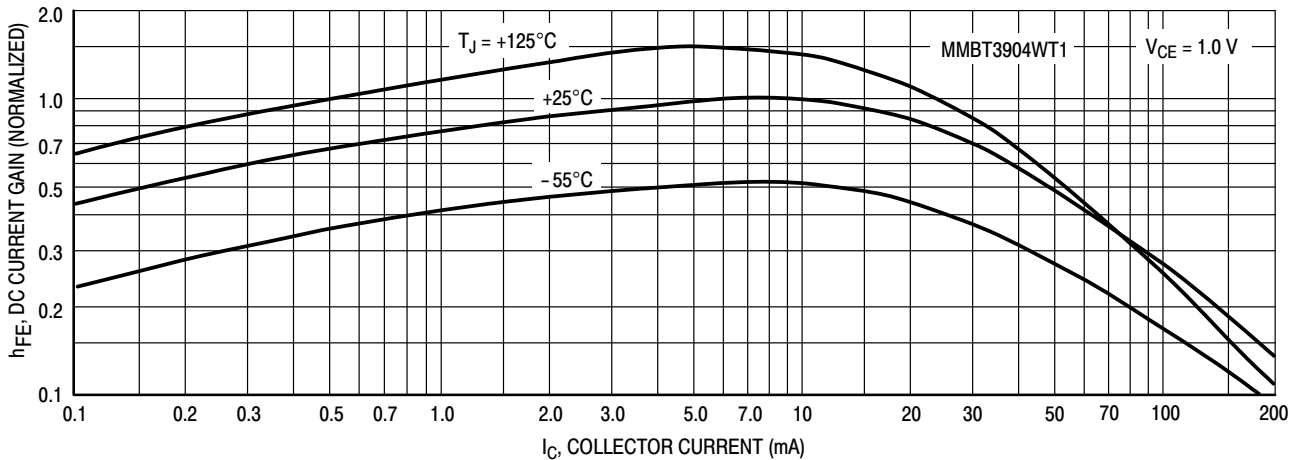


Figure 16. DC Current Gain

MMBT3904TT1G, SMMBT3904TT1G

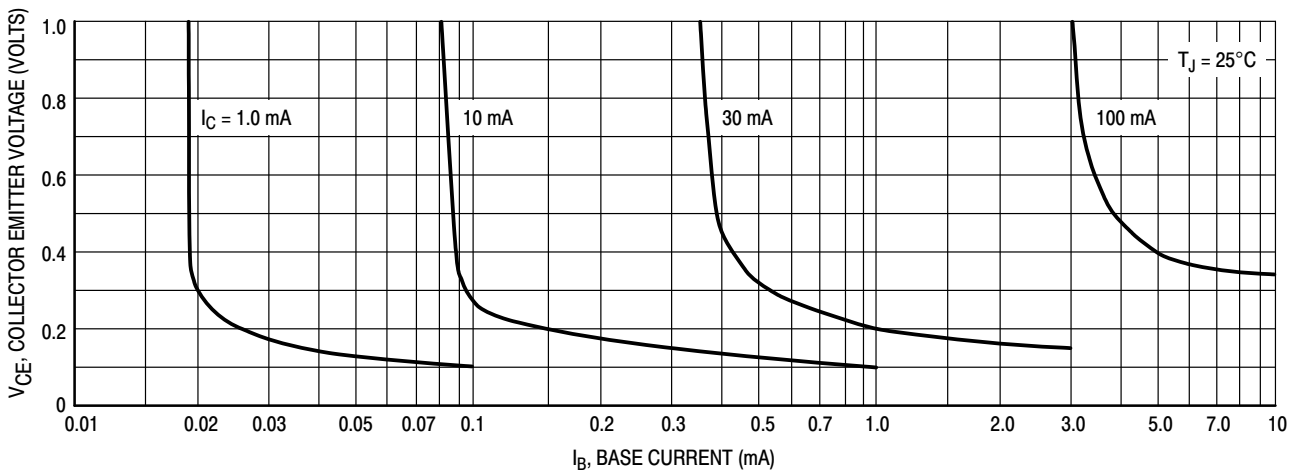


Figure 17. Collector Saturation Region

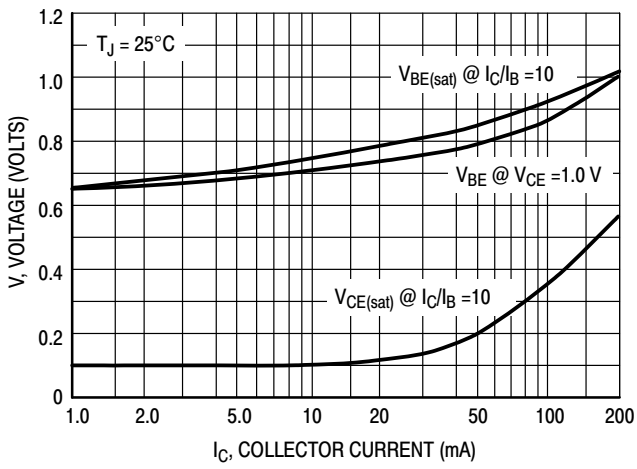


Figure 18. "ON" Voltages

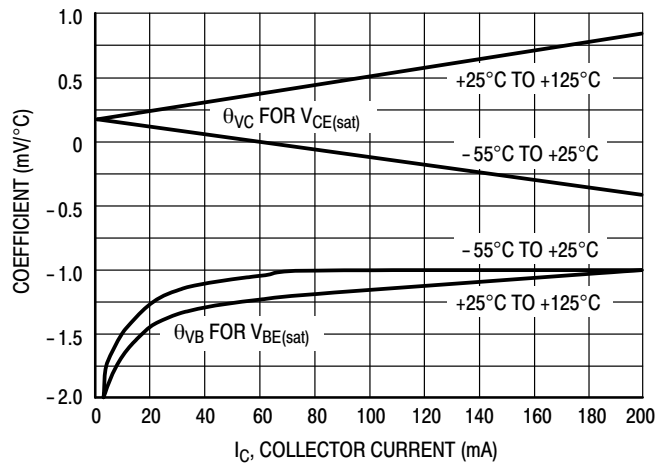
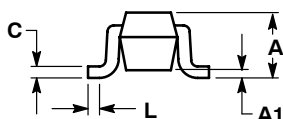
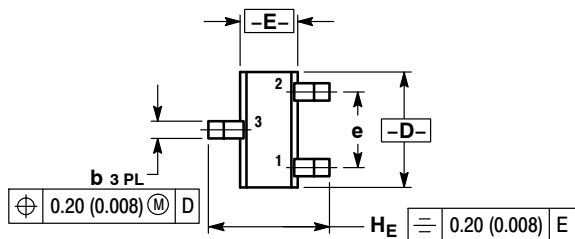


Figure 19. Temperature Coefficients

MMBT3904TT1G, SMMBT3904TT1G

PACKAGE DIMENSIONS

SC-75/SOT-416
CASE 463-01
ISSUE F



NOTES:

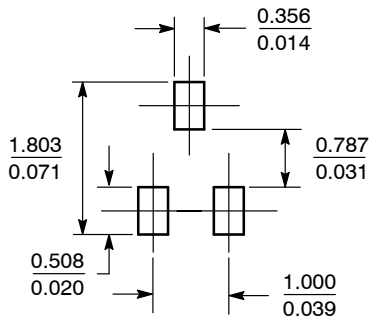
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

| DIM | MILLIMETERS | | | INCHES | | |
|----------------|-------------|------|------|----------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.70 | 0.80 | 0.90 | 0.027 | 0.031 | 0.035 |
| A1 | 0.00 | 0.05 | 0.10 | 0.000 | 0.002 | 0.004 |
| b | 0.15 | 0.20 | 0.30 | 0.006 | 0.008 | 0.012 |
| C | 0.10 | 0.15 | 0.25 | 0.004 | 0.006 | 0.010 |
| D | 1.55 | 1.60 | 1.65 | 0.059 | 0.063 | 0.067 |
| E | 0.70 | 0.80 | 0.90 | 0.027 | 0.031 | 0.035 |
| e | 1.00 BSC | | | 0.04 BSC | | |
| L | 0.10 | 0.15 | 0.20 | 0.004 | 0.006 | 0.008 |
| H _E | 1.50 | 1.60 | 1.70 | 0.061 | 0.063 | 0.065 |

STYLE 1:

1. BASE
2. EMITTER
3. COLLECTOR

SOLDERING FOOTPRINT*



SCALE 10:1 ($\frac{\text{mm}}{\text{inches}}$)

*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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