

# 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

- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- 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,<br>FR-4 Board (Note 1) @ $T_A = 25^\circ\text{C}$<br>Derated above $25^\circ\text{C}$ | $P_D$           | 200<br>1.6  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient<br>(Note 1)                                                             | $R_{\theta JA}$ | 600         | $^\circ\text{C/W}$         |
| Total Device Dissipation,<br>FR-4 Board (Note 2) @ $T_A = 25^\circ\text{C}$<br>Derated above $25^\circ\text{C}$ | $P_D$           | 300<br>2.4  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient<br>(Note 2)                                                             | $R_{\theta JA}$ | 400         | $^\circ\text{C/W}$         |
| Junction and Storage Temperature Range                                                                          | $T_J, T_{stg}$  | -65 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.

1. FR-4 @ Minimum Pad
2. FR-4 @  $1.0 \times 1.0$  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.



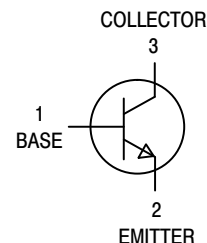
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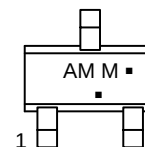
## GENERAL PURPOSE AMPLIFIER TRANSISTORS SURFACE MOUNT



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<br>(Pb-Free) | 3,000 Tape & Reel |
| SMMBT3904TT1G | SOT-416<br>(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<sub>A</sub> = 25°C unless otherwise noted)

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

### OFF CHARACTERISTICS

|                                                                                                   |                      |     |    |      |
|---------------------------------------------------------------------------------------------------|----------------------|-----|----|------|
| Collector – Emitter Breakdown Voltage (Note 3)<br>(I <sub>C</sub> = 1.0 mAdc, I <sub>B</sub> = 0) | V <sub>(BR)CEO</sub> | 40  | –  | Vdc  |
| Collector – Base Breakdown Voltage<br>(I <sub>C</sub> = 10 μAdc, I <sub>E</sub> = 0)              | V <sub>(BR)CBO</sub> | 60  | –  | Vdc  |
| Emitter – Base Breakdown Voltage<br>(I <sub>E</sub> = 10 μAdc, I <sub>C</sub> = 0)                | V <sub>(BR)EBO</sub> | 6.0 | –  | Vdc  |
| Base Cutoff Current<br>(V <sub>CE</sub> = 30 Vdc, V <sub>EB</sub> = 3.0 Vdc)                      | I <sub>BL</sub>      | –   | 50 | nAdc |
| Collector Cutoff Current<br>(V <sub>CE</sub> = 30 Vdc, V <sub>EB</sub> = 3.0 Vdc)                 | I <sub>CEX</sub>     | –   | 50 | nAdc |

### ON CHARACTERISTICS (Note 3)

|                                                                                                                                                                                                                                                                                                                 |                      |                             |                         |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------------------|-------------------------|-----|
| DC Current Gain<br>(I <sub>C</sub> = 0.1 mAdc, V <sub>CE</sub> = 1.0 Vdc)<br>(I <sub>C</sub> = 1.0 mAdc, V <sub>CE</sub> = 1.0 Vdc)<br>(I <sub>C</sub> = 10 mAdc, V <sub>CE</sub> = 1.0 Vdc)<br>(I <sub>C</sub> = 50 mAdc, V <sub>CE</sub> = 1.0 Vdc)<br>(I <sub>C</sub> = 100 mAdc, V <sub>CE</sub> = 1.0 Vdc) | h <sub>FE</sub>      | 40<br>70<br>100<br>60<br>30 | –<br>–<br>300<br>–<br>– | –   |
| Collector – Emitter Saturation Voltage<br>(I <sub>C</sub> = 10 mAdc, I <sub>B</sub> = 1.0 mAdc)<br>(I <sub>C</sub> = 50 mAdc, I <sub>B</sub> = 5.0 mAdc)                                                                                                                                                        | V <sub>CE(sat)</sub> | –<br>–                      | 0.2<br>0.3              | Vdc |
| Base – Emitter Saturation Voltage<br>(I <sub>C</sub> = 10 mAdc, I <sub>B</sub> = 1.0 mAdc)<br>(I <sub>C</sub> = 50 mAdc, I <sub>B</sub> = 5.0 mAdc)                                                                                                                                                             | V <sub>BE(sat)</sub> | 0.65<br>–                   | 0.85<br>0.95            | Vdc |

### SMALL – SIGNAL CHARACTERISTICS

|                                                                                                               |                  |     |     |                    |
|---------------------------------------------------------------------------------------------------------------|------------------|-----|-----|--------------------|
| Current – Gain – Bandwidth Product<br>(I <sub>C</sub> = 10 mAdc, V <sub>CE</sub> = 20 Vdc, f = 100 MHz)       | f <sub>T</sub>   | 300 | –   | MHz                |
| Output Capacitance<br>(V <sub>CB</sub> = 5.0 Vdc, I <sub>E</sub> = 0, f = 1.0 MHz)                            | C <sub>obo</sub> | –   | 4.0 | pF                 |
| Input Capacitance<br>(V <sub>EB</sub> = 0.5 Vdc, I <sub>C</sub> = 0, f = 1.0 MHz)                             | C <sub>ibo</sub> | –   | 8.0 | pF                 |
| Input Impedance<br>(V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mAdc, f = 1.0 kHz)                         | h <sub>ie</sub>  | 1.0 | 10  | k Ω                |
| Voltage Feedback Ratio<br>(V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mAdc, f = 1.0 kHz)                  | h <sub>re</sub>  | 0.5 | 8.0 | X 10 <sup>-4</sup> |
| Small – Signal Current Gain<br>(V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mAdc, f = 1.0 kHz)             | h <sub>fe</sub>  | 100 | 400 | –                  |
| Output Admittance<br>(V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mAdc, f = 1.0 kHz)                       | h <sub>oe</sub>  | 1.0 | 40  | μmhos              |
| Noise Figure<br>(V <sub>CE</sub> = 5.0 Vdc, I <sub>C</sub> = 100 μAdc, R <sub>S</sub> = 1.0 k Ω, f = 1.0 kHz) | NF               | –   | 5.0 | dB                 |

### SWITCHING CHARACTERISTICS

|              |                                                                                        |                |   |     |    |
|--------------|----------------------------------------------------------------------------------------|----------------|---|-----|----|
| Delay Time   | (V <sub>CC</sub> = 3.0 Vdc, V <sub>BE</sub> = –0.5 Vdc)<br>MMBT3904TT1G, SMMBT3904TT1G | t <sub>d</sub> | – | 35  | ns |
| Rise Time    | (I <sub>C</sub> = 10 mAdc, I <sub>B1</sub> = 1.0 mAdc)<br>MMBT3904TT1G, SMMBT3904TT1G  | t <sub>r</sub> | – | 35  |    |
| Storage Time | (V <sub>CC</sub> = 3.0 Vdc, I <sub>C</sub> = 10 mAdc)<br>MMBT3904TT1G, SMMBT3904TT1G   | t <sub>s</sub> | – | 200 |    |
| Fall Time    | (I <sub>B1</sub> = I <sub>B2</sub> = 1.0 mAdc)<br>MMBT3904TT1G, SMMBT3904TT1G          | t <sub>f</sub> | – | 50  |    |

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

# MMBT3904TT1G, SMMBT3904TT1G

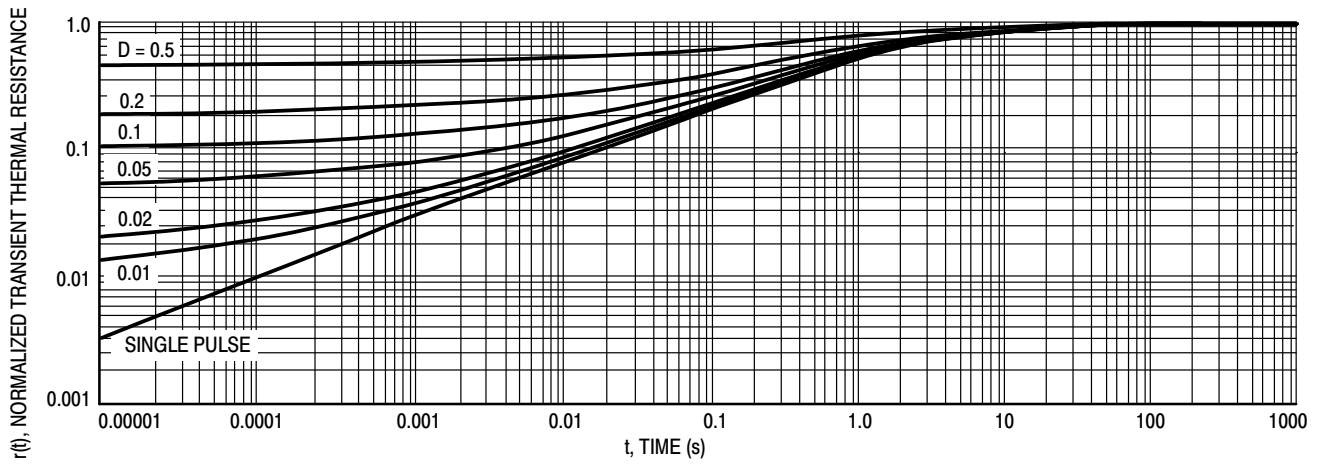


Figure 1. Normalized Thermal Response

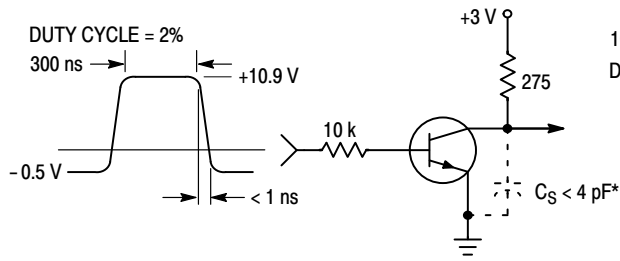


Figure 2. Delay and Rise Time Equivalent Test Circuit

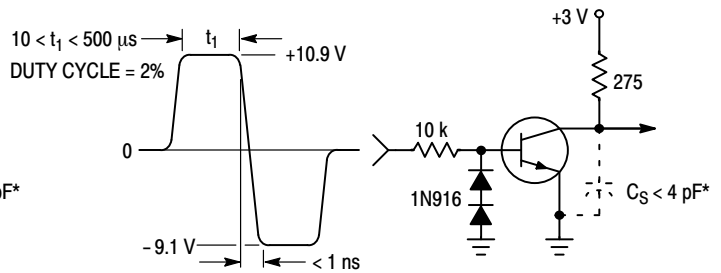


Figure 3. Storage and Fall Time Equivalent Test Circuit

\* Total shunt capacitance of test jig and connectors

## TYPICAL TRANSIENT CHARACTERISTICS

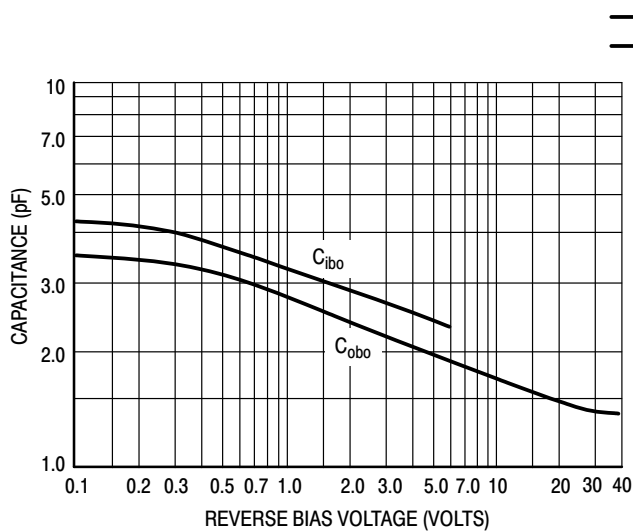


Figure 4. Capacitance

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

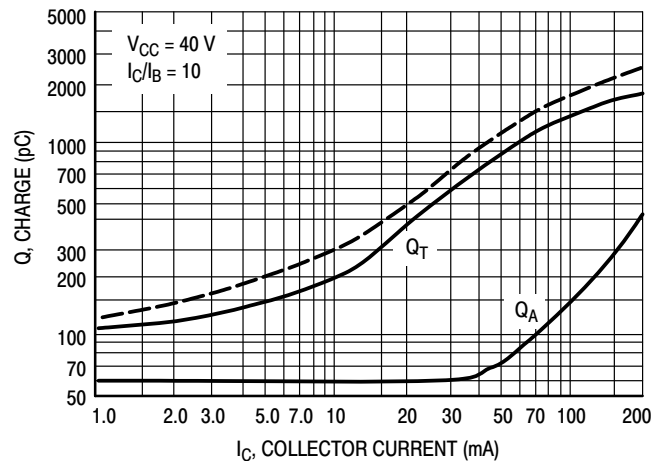


Figure 5. Charge Data

# MMBT3904TT1G, SMMBT3904TT1G

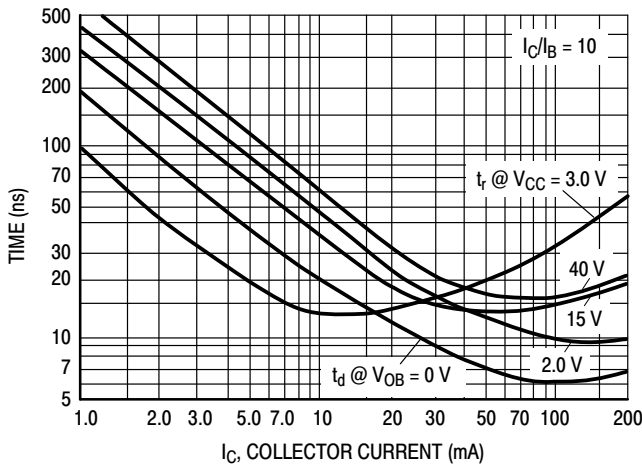


Figure 6. Turn-On Time

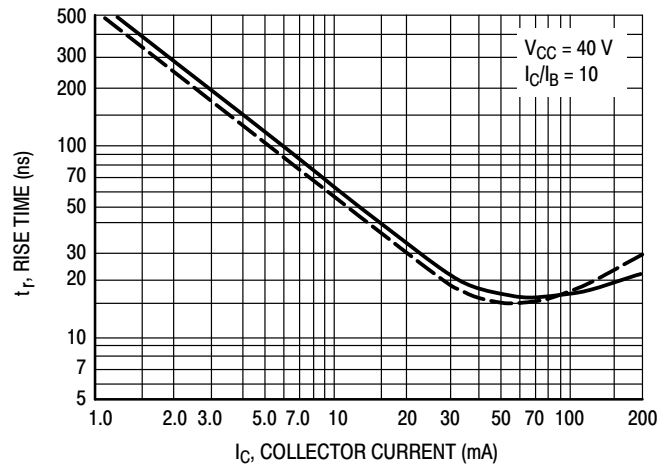


Figure 7. Rise Time

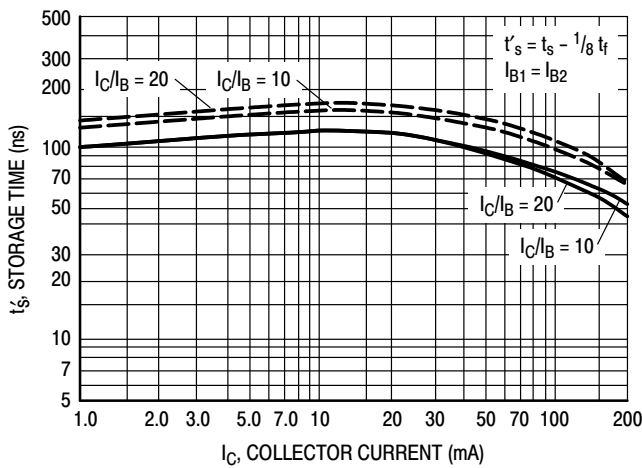


Figure 8. Storage Time

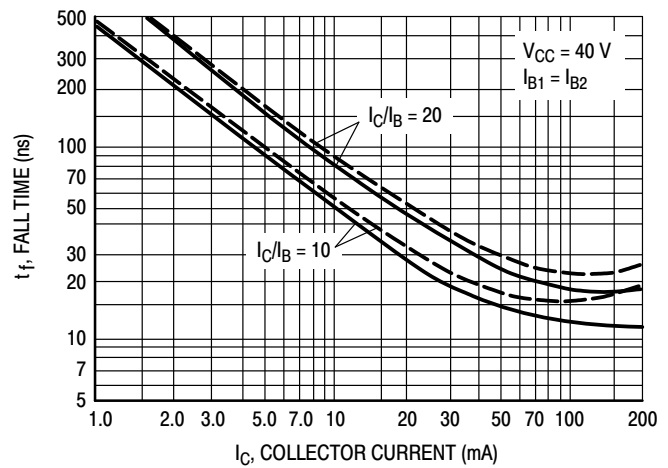


Figure 9. Fall Time

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

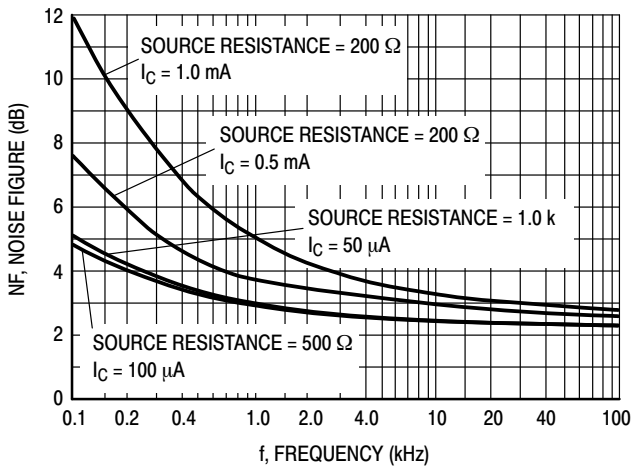


Figure 10. Noise Figure

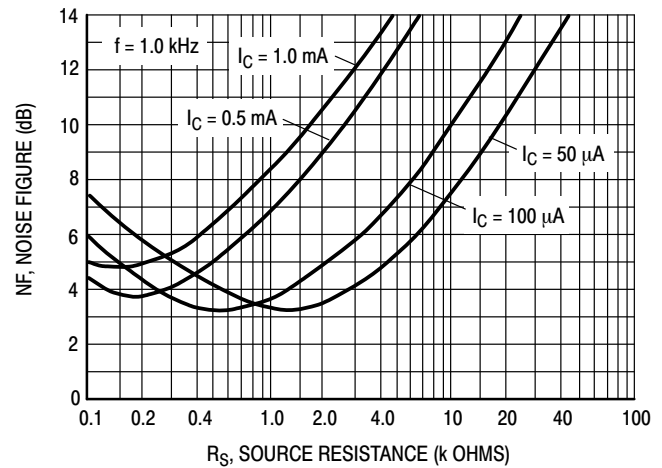


Figure 11. Noise Figure

# MMBT3904TT1G, SMMBT3904TT1G

## h PARAMETERS

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

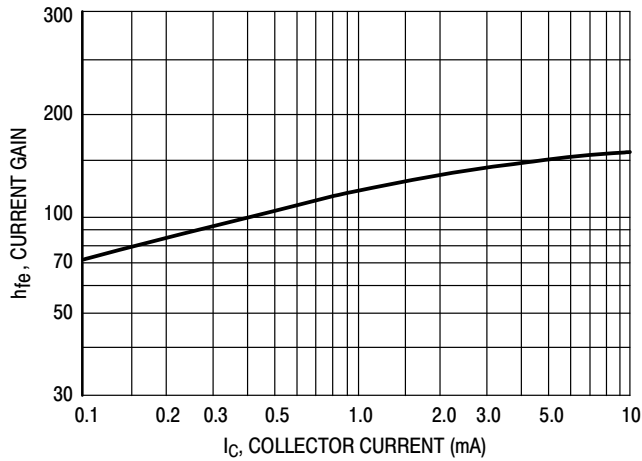


Figure 12. Current Gain

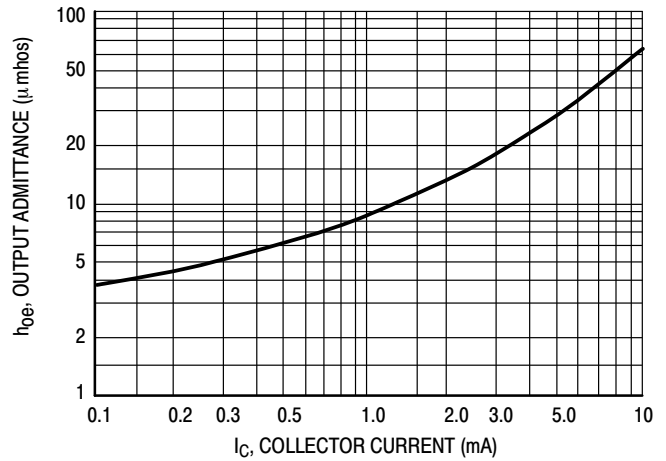


Figure 13. Output Admittance

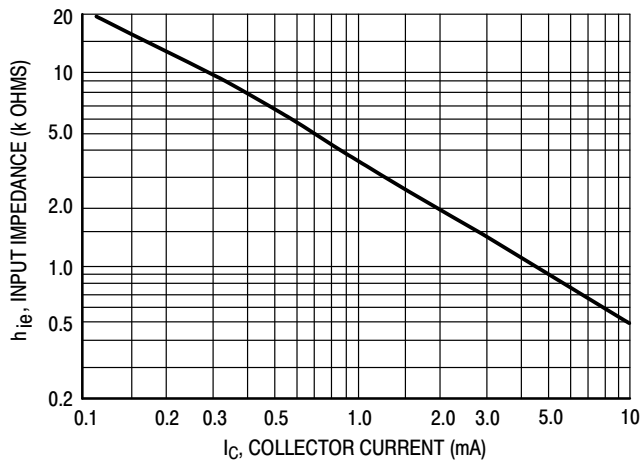


Figure 14. Input Impedance

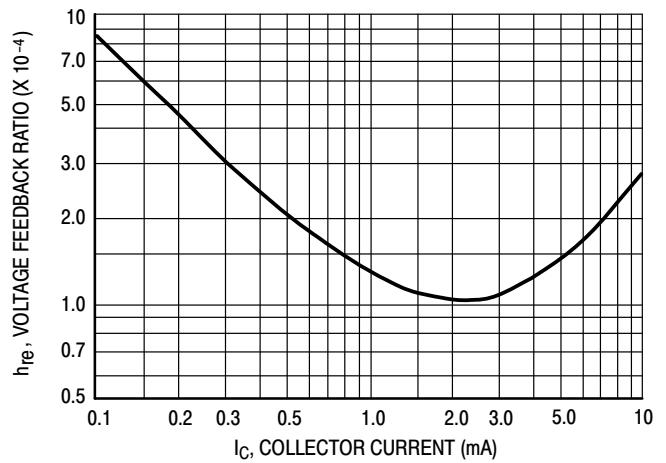


Figure 15. Voltage Feedback Ratio

## TYPICAL STATIC CHARACTERISTICS

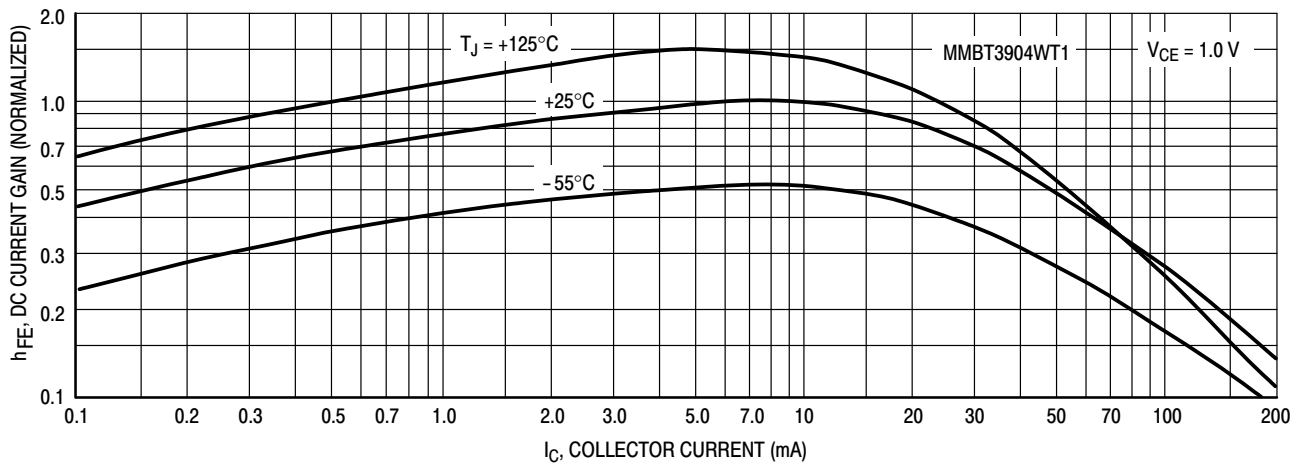


Figure 16. DC Current Gain

# MMBT3904TT1G, SMMBT3904TT1G

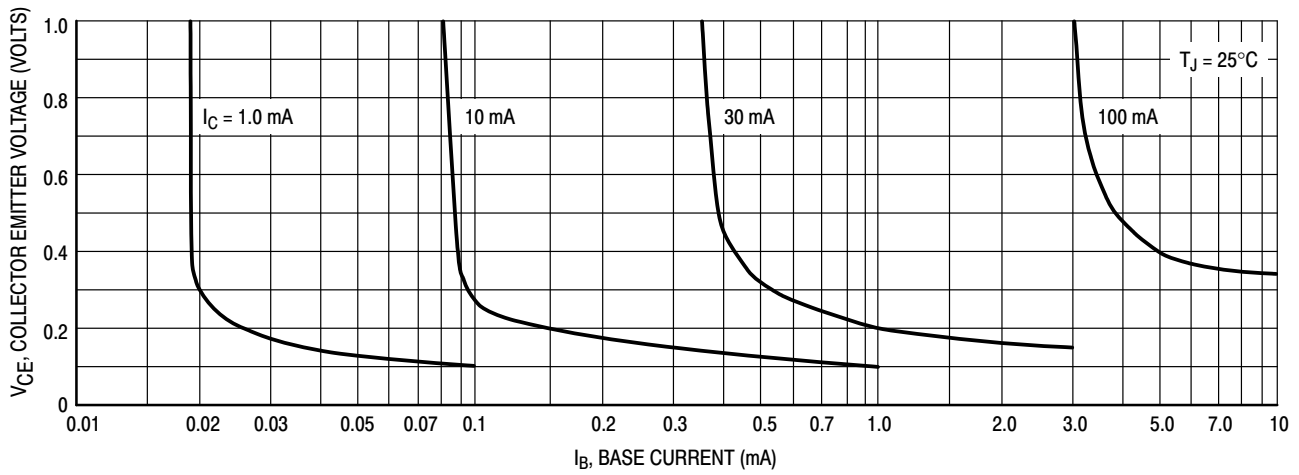


Figure 17. Collector Saturation Region

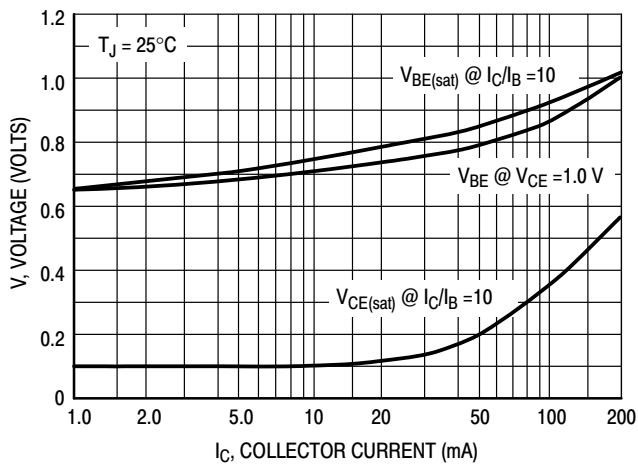


Figure 18. "ON" Voltages

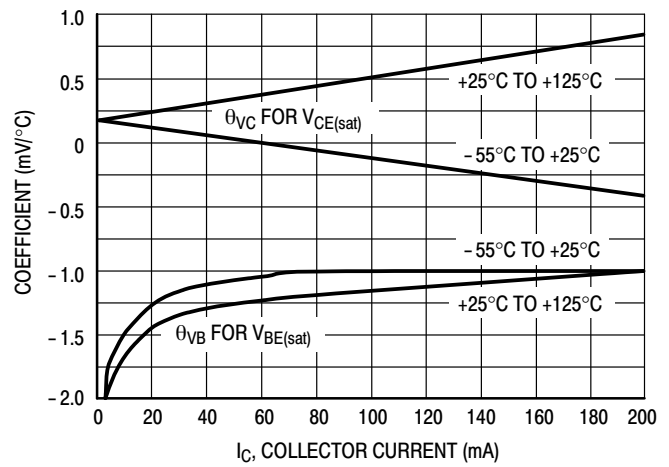


Figure 19. Temperature Coefficients



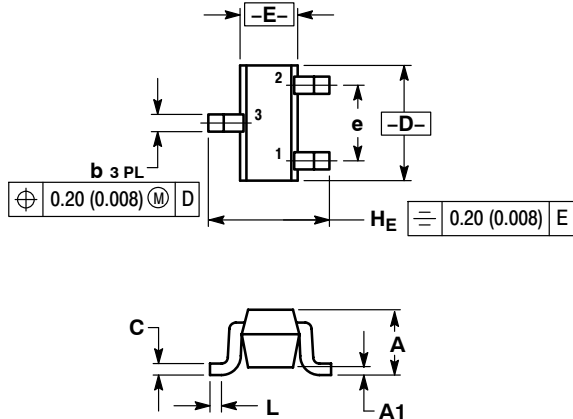
SCALE 4:1

### SC-75/SOT-416

#### CASE 463-01

#### ISSUE G

DATE 07 AUG 2015



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

STYLE 2:  
PIN 1. ANODE  
2. N/C  
3. CATHODE

STYLE 3:  
PIN 1. ANODE  
2. ANODE  
3. CATHODE

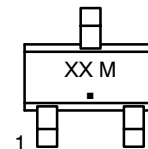
STYLE 4:  
PIN 1. CATHODE  
2. CATHODE  
3. ANODE

STYLE 5:  
PIN 1. GATE  
2. SOURCE  
3. DRAIN

- 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 | 0.061    | 0.063 | 0.065 |
| 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 <sub>E</sub> | 1.50        | 1.60 | 1.70 | 0.060    | 0.063 | 0.067 |

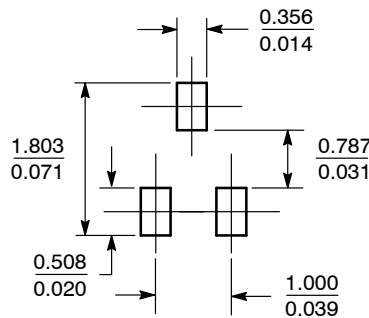
### GENERIC MARKING DIAGRAM\*



XX = 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.

### SOLDERING FOOTPRINT\*



SCALE 10:1 (mm/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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| DESCRIPTION:     | SC-75/SOT-416 | PAGE 1 OF 1                                                                                                                                                                      |

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