

RoHS Compliant Product  
A suffix of "-C" specifies halogen & lead-free

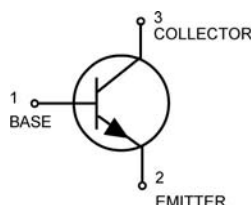
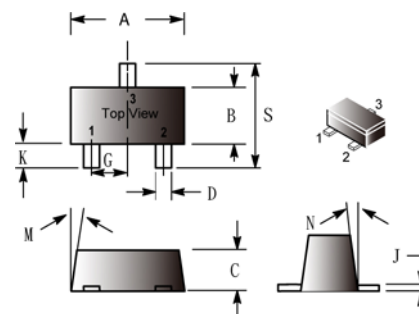
**SOT-523**

## FEATURES

- Simplifies Circuit Design.
- We Declare that the material of product compliance with RoHS requirements.

## ORDERING INFORMATION

| Device    | Marking | Shipping       |
|-----------|---------|----------------|
| MMBT3904T | MA      | 3000/Tape&Reel |



| REF. | Min.    | Max. | REF. | Min. | Max. |
|------|---------|------|------|------|------|
| A    | 1.50    | 1.70 | K    | 0.30 | 0.50 |
| B    | 0.75    | 0.95 | M    | ---  | 10°  |
| C    | 0.60    | 0.80 | N    | ---  | 10°  |
| D    | 0.23    | 0.33 | S    | 1.50 | 1.70 |
| G    | 0.50BSC |      |      |      |      |
| J    | 0.10    | 0.20 |      |      |      |

## MAXIMUM RATINGS (at $T_a = 25^\circ\text{C}$ unless otherwise specified)

| PARAMETER                                                                                                      | SYMBOL          | RATINGS   | 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                        |
| Total Device Dissipation FR-4 Board <sup>(1)</sup><br>$T_A=25^\circ\text{C}$ , Derate above $25^\circ\text{C}$ | $P_D$           | 200       | mW                          |
|                                                                                                                |                 | 1.6       | mW/ $^\circ\text{C}$        |
| Thermal Resistance, Junction to Ambient                                                                        | $R_{\theta JA}$ | 600       | $^\circ\text{C} / \text{W}$ |
| Total Device Dissipation FR-4 Board <sup>(2)</sup><br>$T_A=25^\circ\text{C}$ , Derate above $25^\circ\text{C}$ | $P_D$           | 300       | mW                          |
|                                                                                                                |                 | 2.4       | mW/ $^\circ\text{C}$        |
| Thermal Resistance, Junction to Ambient                                                                        | $R_{\theta JA}$ | 400       | $^\circ\text{C} / \text{W}$ |
| Junction & Storage Temperature                                                                                 | $T_J, T_{STG}$  | -55 ~ 150 | $^\circ\text{C}$            |

1. FR-4 Minimum Pad.
2. FR-4 1.0 X 1.0 Inch Pad.
3. Pulse Test : Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

## DEVICE MARKING

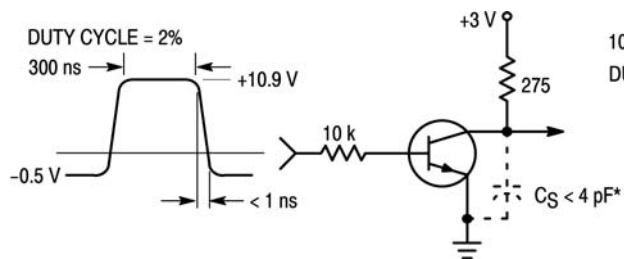
MMBT3904T1G=AM

**ELECTRICAL CHARACTERISTICS** (at  $T_a = 25^\circ\text{C}$  unless otherwise specified)

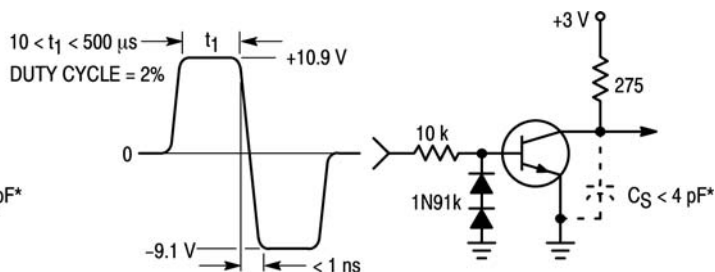
| CHARACTERISTIC                                      | SYMBOL               | MIN. | MAX. | UNIT              | TEST CONDITIONS                                                                                            |
|-----------------------------------------------------|----------------------|------|------|-------------------|------------------------------------------------------------------------------------------------------------|
| Off Characteristics                                 |                      |      |      |                   |                                                                                                            |
| Collector-Emitter Breakdown Voltage <sup>(3)</sup>  | V <sub>(BR)CEO</sub> | 40   | -    | Vdc               | I <sub>C</sub> = 1.0 mAdc                                                                                  |
| Collector-Base Breakdown Voltage                    | V <sub>(BR)CBO</sub> | 60   | -    | Vdc               | I <sub>C</sub> = 10 μAdc                                                                                   |
| Emitter-Base Breakdown Voltage                      | V <sub>(BR)EBO</sub> | 6.0  | -    | Vdc               | I <sub>E</sub> = 10 μAdc                                                                                   |
| Collector Cut-Off Current                           | I <sub>BL</sub>      | -    | 50   | nAdc              | V <sub>CE</sub> = 30 Vdc, V <sub>EB</sub> = 3.0 Vdc                                                        |
| Emitter Cut-Off Current                             | I <sub>CEX</sub>     | -    | 50   | nAdc              | V <sub>CE</sub> = 30 Vdc, V <sub>BE</sub> = 3.0 Vdc                                                        |
| On Characteristics <sup>(3)</sup>                   |                      |      |      |                   |                                                                                                            |
| DC Current Gain <sup>(1)</sup>                      | h <sub>FE</sub>      | 40   | -    | -                 | I <sub>C</sub> = 0.1 mAdc, V <sub>CE</sub> = 1.0 Vdc                                                       |
|                                                     |                      | 70   | -    |                   | I <sub>C</sub> = 1.0 mAdc, V <sub>CE</sub> = 1.0 Vdc                                                       |
|                                                     |                      | 100  | 300  |                   | I <sub>C</sub> = 10 mAdc, V <sub>CE</sub> = 1.0 Vdc                                                        |
|                                                     |                      | 60   | -    |                   | I <sub>C</sub> = 50 mAdc, V <sub>CE</sub> = 1.0 Vdc                                                        |
|                                                     |                      | 30   | -    |                   | I <sub>C</sub> = 100 mAdc, V <sub>CE</sub> = 1.0 Vdc                                                       |
| Collector-Emitter Saturation Voltage <sup>(3)</sup> | V <sub>CE(sat)</sub> | -    | 0.2  | Vdc               | I <sub>C</sub> = 10 mAdc, I <sub>B</sub> = 1.0 mAdc                                                        |
|                                                     |                      | -    | 0.3  |                   | I <sub>C</sub> = 50 mAdc, I <sub>B</sub> = 5.0 mAdc                                                        |
| Base-Emitter Saturation Voltage <sup>(3)</sup>      | V <sub>BE(sat)</sub> | 0.65 | 0.85 | Vdc               | I <sub>C</sub> = 10 mAdc, I <sub>B</sub> = 1.0 mAdc                                                        |
|                                                     |                      | -    | 0.95 |                   | I <sub>C</sub> = 50 mAdc, I <sub>B</sub> = 5.0 mAdc                                                        |
| Small-Signal Characteristics                        |                      |      |      |                   |                                                                                                            |
| Curren-Gain-Bandwidth Product                       | f <sub>T</sub>       | 200  | -    | MHz               | V <sub>CE</sub> = 20 Vdc, I <sub>C</sub> = 10 mAdc, f = 100 MHz                                            |
| Output Capacitance                                  | C <sub>obo</sub>     | -    | 4.0  | pF                | V <sub>CB</sub> = 5.0 Vdc, I <sub>E</sub> = 0, f = 1.0 MHz                                                 |
| Input Capacitance                                   | C <sub>ibo</sub>     | -    | 8.0  | pF                | V <sub>BE</sub> = 0.5 Vdc, I <sub>E</sub> = 0, f = 1.0 MHz                                                 |
| Input Impedancen                                    | h <sub>ie</sub>      | 1.0  | 10   | pF                | V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mAdc, f = 1.0 kHz                                           |
| Voltage Feedback Ratio                              | h <sub>re</sub>      | 0.5  | 8.0  | X10 <sup>-4</sup> | V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mAdc, f = 1.0 kHz                                           |
| Small-Signal Current Gain                           | h <sub>fe</sub>      | 100  | 400  | -                 | V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mAdc, f = 1.0 kHz                                           |
| Output Admittance                                   | h <sub>oe</sub>      | 1.0  | 40   | θmhos             | V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mAdc, f = 1.0 kHz                                           |
| Noise Figure                                        | NF                   | -    | 5.0  | dB                | V <sub>CE</sub> = 5.0 Vdc, I <sub>C</sub> = 100 μAdc, R <sub>S</sub> = 1.0k Ω, f = 1.0 kHz                 |
| Switching Characteristics                           |                      |      |      |                   |                                                                                                            |
| Delay Time                                          | T <sub>d</sub>       | -    | 35   | nS                | V <sub>CC</sub> = 3.0 Vdc, V <sub>BE</sub> = 0.5 Vdc, I <sub>C</sub> = 10 mAdc, I <sub>B1</sub> = 1.0 mAdc |
| Rise Time                                           | T <sub>r</sub>       | -    | 35   | nS                |                                                                                                            |
| Storage Time                                        | T <sub>S</sub>       | -    | 200  | nS                | V <sub>CC</sub> = 3.0 Vdc, I <sub>C</sub> = 10 mAdc, I <sub>B1</sub> = I <sub>B2</sub> = 1.0 mAdc          |
| Fall Time                                           | T <sub>F</sub>       | -    | 50   | nS                |                                                                                                            |

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

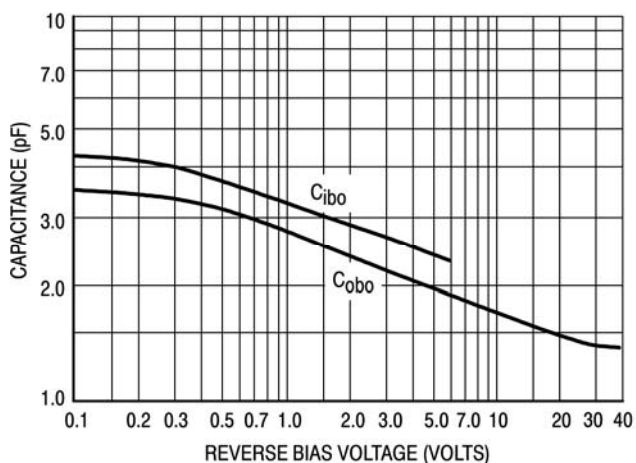
## CHARACTERISTIC CURVES



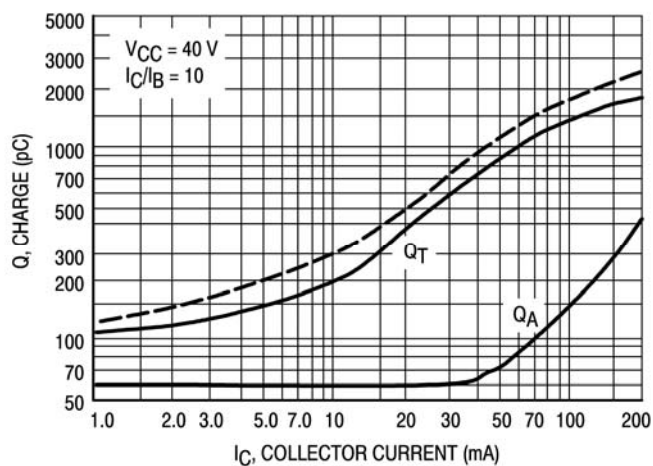
**Figure 1. Delay and Rise Time  
Equivalent Test Circuit**



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



**Figure 3. Capacitance**



**Figure 4. Charge Data**

## CHARACTERISTIC CURVES

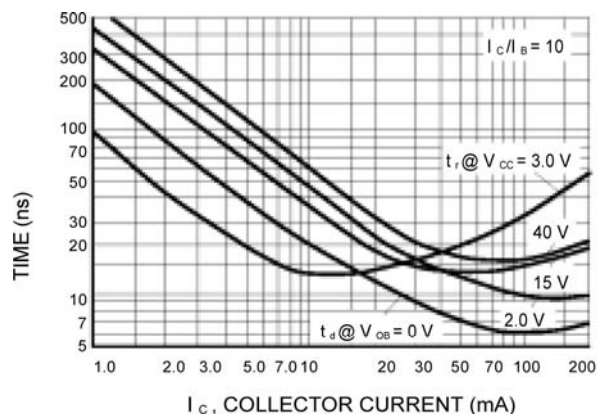


Figure 5. Turn-On Time

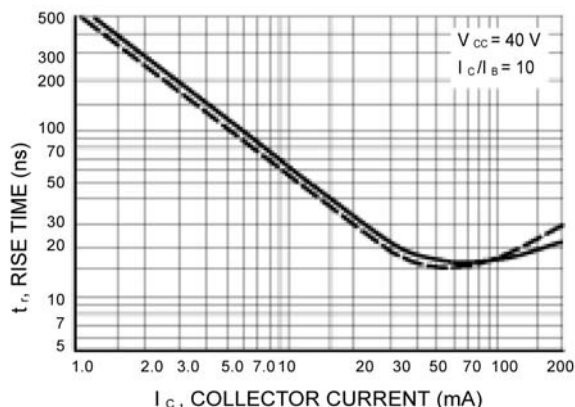


Figure 6. Rise Time

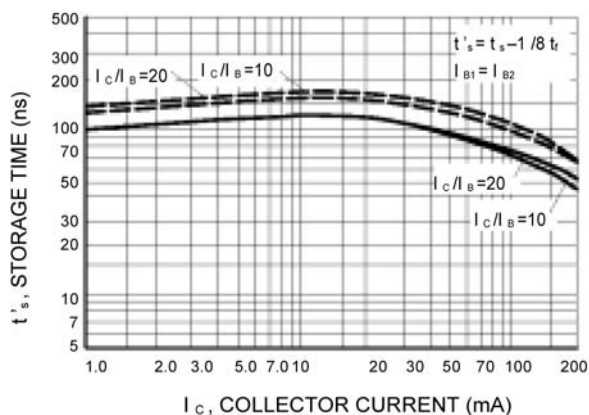


Figure 7. Storage Time

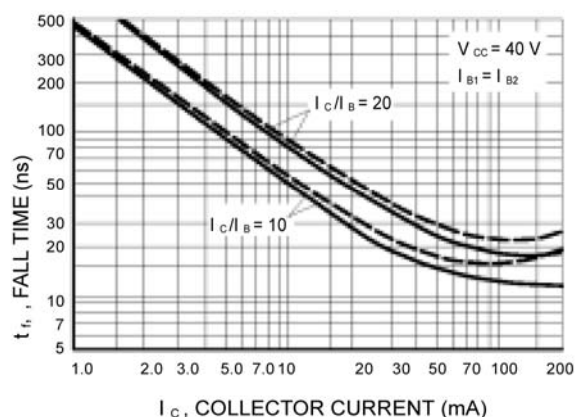


Figure 8. Fall Time

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

### NOISE FIGURE VARIATIONS

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

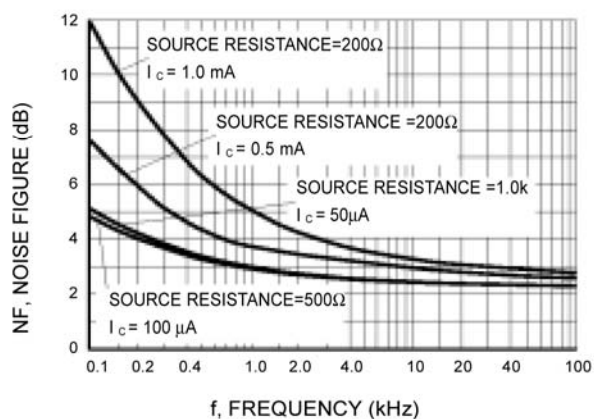


Figure 9.

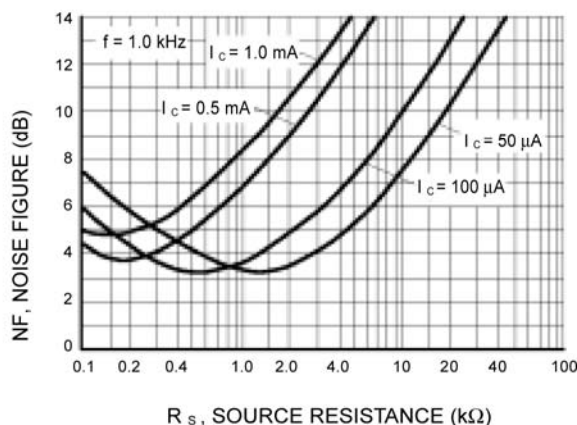


Figure 10.

## CHARACTERISTIC CURVES

### h PARAMETERS

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

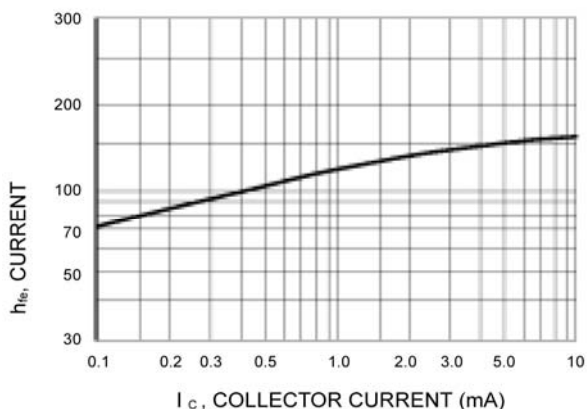


Figure 11. Current Gain

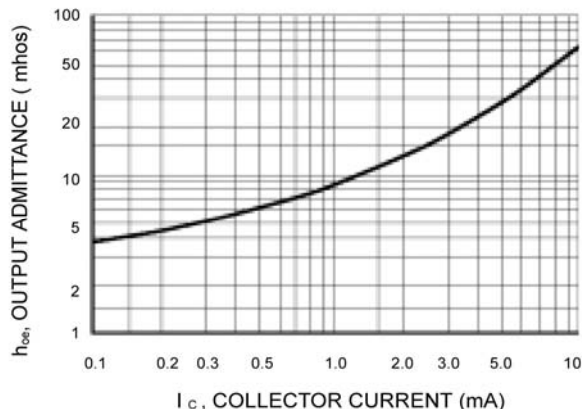


Figure 12. Output Admittance

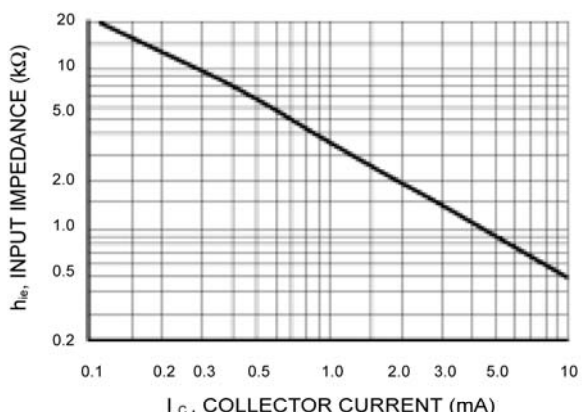


Figure 13. Input Impedance

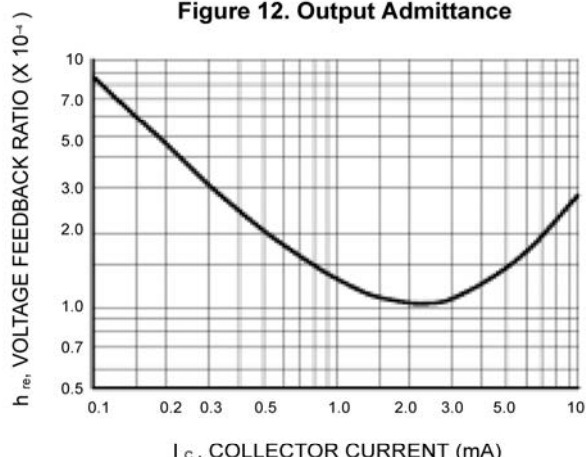


Figure 14. Voltage Feedback Ratio

### TYPICAL STATIC CHARACTERISTICS

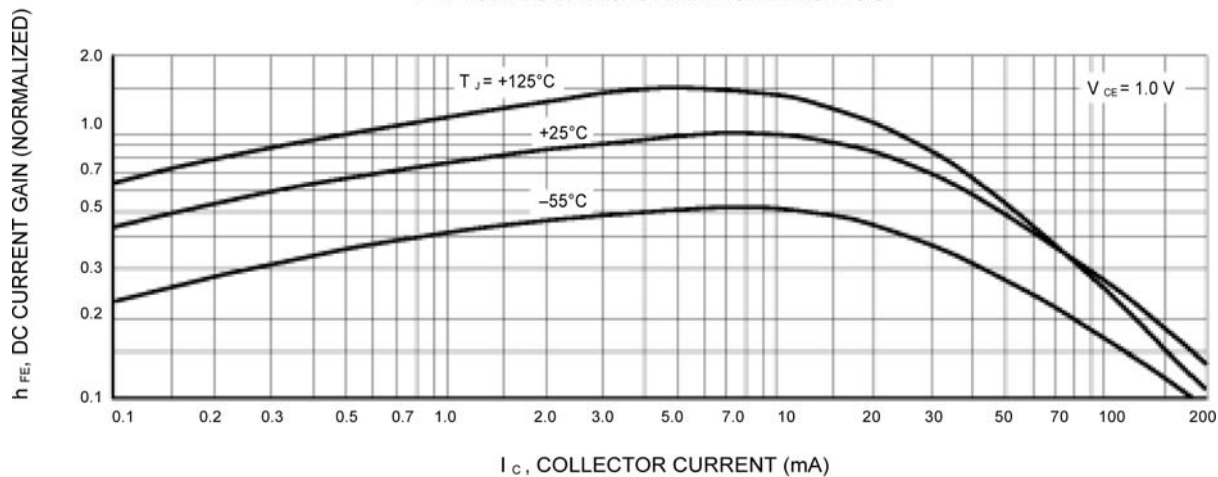


Figure 15. DC Current Gain

## CHARACTERISTIC CURVES

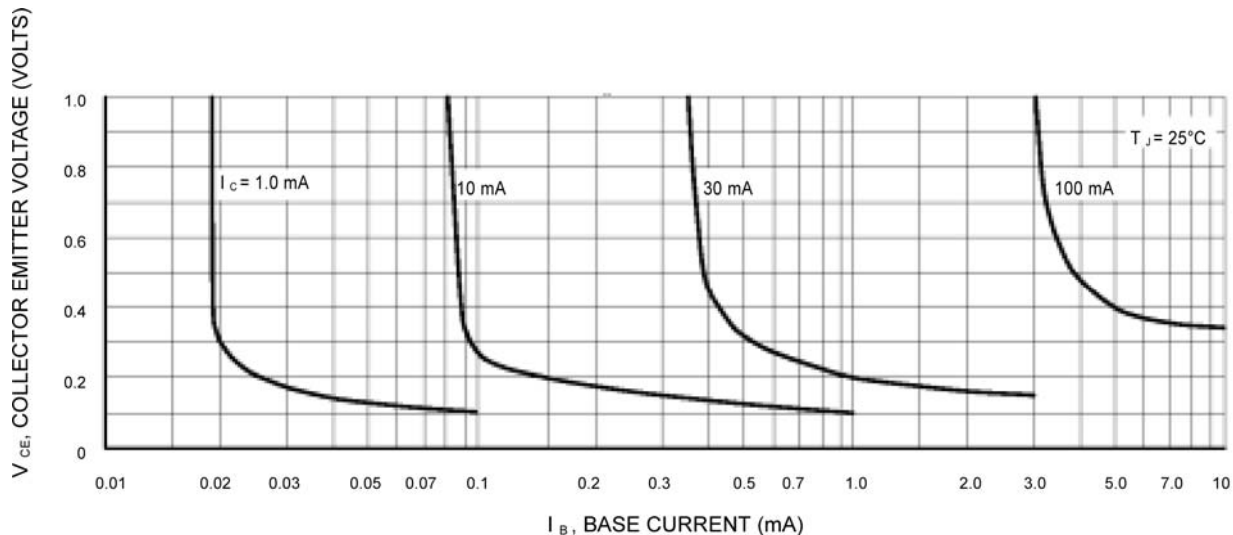


Figure 16. Collector Saturation Region

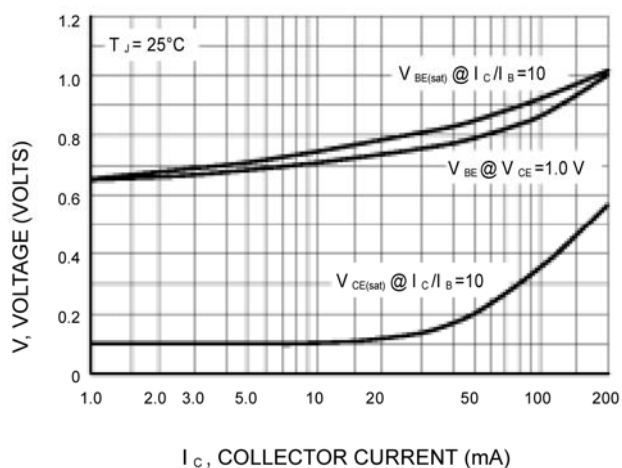


Figure 17. "ON" Voltages

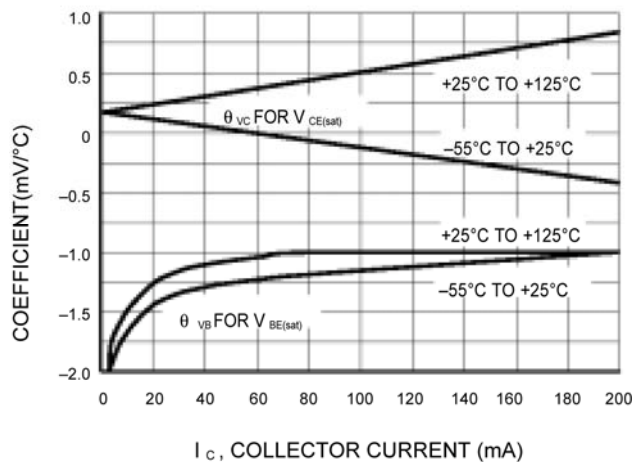


Figure 18. Temperature Coefficients