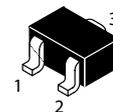
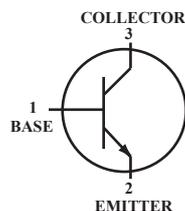


### General Purpose Transistor

### NPN Silicon

 Lead(Pb)-Free



SOT-323(SC-70)

### Maximum Ratings

| Rating                       | Symbol           | Value | Unit |
|------------------------------|------------------|-------|------|
| Collector-Emitter Voltage    | V <sub>CEO</sub> | 40    | Vdc  |
| Collector-Base Voltage       | V <sub>CBO</sub> | 60    | Vdc  |
| Emitter-Base Voltage         | V <sub>EB0</sub> | 6.0   | Vdc  |
| Collector Current-Continuous | I <sub>C</sub>   | 200   | mAdc |

### Thermal Characteristics

| Characteristics                         | Symbol                            | Max         | Unit |
|---|-----------------------------------|-------------|------|
| Total Device Dissipation TA=25°C        | P <sub>D</sub>                    | 150         | mW   |
| Thermal Resistance, Junction to Ambient | R <sub>θJA</sub>                  | 833         | °C/W |
| Junction and Storage, Temperature       | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C   |

### Device Marking

MMBT3904W=AM

### Electrical Characteristics (TA=25°C Unless Otherwise noted)

| Characteristics | Symbol | Min | Max | Unit |
|-----------------|--------|-----|-----|------|
|-----------------|--------|-----|-----|------|

### Off Characteristics

|   |                  |     |    |      |
|---|------------------|-----|----|------|
| Collector-Emitter Breakdown Voltage <sup>(2)</sup> (I <sub>C</sub> =1.0mAdc, I <sub>B</sub> =0) | V(BR)CEO         | 40  | -  | Vdc  |
| Collector-Base Breakdown Voltage (I <sub>C</sub> =10 μAdc, I <sub>E</sub> =0)                   | V(BR)CBO         | 60  | -  | Vdc  |
| Emitter-Base Breakdown Voltage (I <sub>E</sub> =10 μAdc, I <sub>C</sub> =0)                     | V(BR)EBO         | 6.0 | -  | Vdc  |
| Base Cutoff Current (V <sub>CE</sub> =30 Vdc, V <sub>EB</sub> =3.0 Vdc)                         | I <sub>BL</sub>  | -   | 50 | nAdc |
| Collector Cutoff Current (V <sub>CE</sub> =30Vdc, V <sub>EB</sub> =3.0Vdc)                      | I <sub>CEx</sub> | -   | 50 | nAdc |

1. Device Mounted FR4 glass epoxy printed circuit board using the minimum recommended footprint.

2. Pulse Test: Pulse Width ≤300uS, Duty Cycle ≤2.0%

**Electrical Characteristics** ( $T_A=25^\circ\text{C}$  unless otherwise noted) (Continued)

| Characteristics | Symbol | Min | Max | Unit |
|-----------------|--------|-----|-----|------|
|-----------------|--------|-----|-----|------|

**On Characteristics (2)**

|  |               |                             |                         |     |
|--|---------------|-----------------------------|-------------------------|-----|
| DC Current Gain<br>( $I_C=0.1\text{ mA}$ , $V_{CE}=1.0\text{ Vdc}$ )<br>( $I_C=1.0\text{ mA}$ , $V_{CE}=1.0\text{ Vdc}$ )<br>( $I_C=10\text{ mA}$ , $V_{CE}=1.0\text{ Vdc}$ )<br>( $I_C=50\text{ mA}$ , $V_{CE}=1.0\text{ Vdc}$ )<br>( $I_C=100\text{ mA}$ , $V_{CE}=1.0\text{ Vdc}$ ) | $H_{FE}$      | 40<br>70<br>100<br>60<br>30 | .<br>.<br>300<br>.<br>. | -   |
| Collector-Emitter Saturation Voltage (2)<br>( $I_C=10\text{ mA}$ , $I_B=1.0\text{ mA}$ )<br>( $I_C=50\text{ mA}$ , $I_B=5.0\text{ mA}$ )   | $V_{CE(sat)}$ | .<br>.                      | 0.2<br>0.3              | Vdc |
| Base-Emitter Saturation Voltage (2)<br>( $I_C=10\text{ mA}$ , $I_B=1.0\text{ mA}$ )<br>( $I_C=50\text{ mA}$ , $I_B=5.0\text{ mA}$ )  | $V_{BE(sat)}$ | 0.65<br>.                   | 0.85<br>0.95            | Vdc |

**Small-signal Characteristics**

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

**Switching Characteristics**

|              |   |       |   |     |    |
|--------------|---|-------|---|-----|----|
| Delay Time   | (Vcc= 3.0 Vdc, VBE= -0.5 Vdc<br>Ic= 10 mA, IB1= 1.0 mA) | $t_d$ | - | 35  | ns |
| Rise Time    |   | $t_r$ | - | 35  |    |
| Storage Time | (Vcc= 3.0 Vdc,<br>Ic= 10 mA, IB1=IB2= 1.0 mA)           | $t_s$ | - | 200 | ns |
| Fall Time    |   | $t_f$ | - | 50  |    |

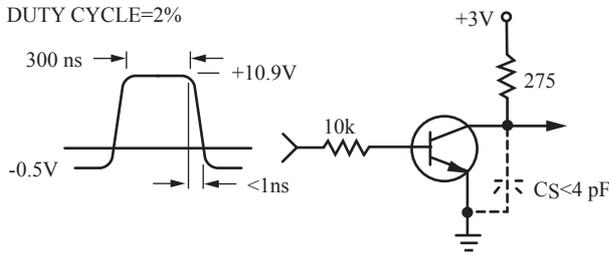


Figure 1. Delay and Rise Time Equivalent Test Circuit

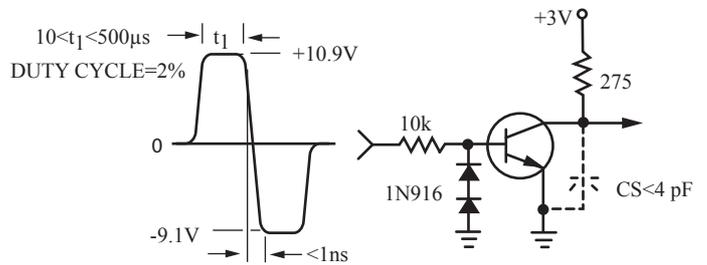


Figure 2. Storage and Fall Time Equivalent Test Circuit

\*Total shunt capacitance of test jig and connectors

## TYPICAL TRANSIENT CHARACTERISTICS

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

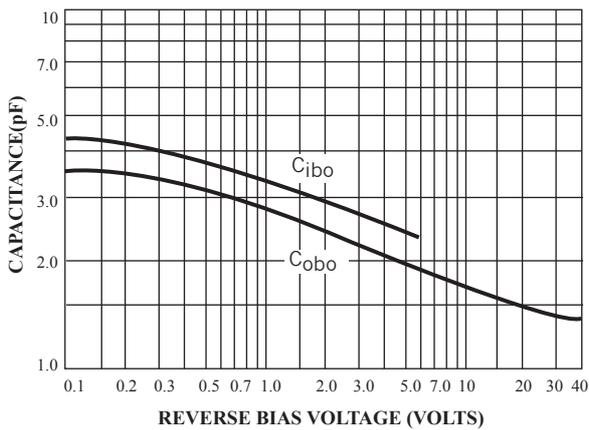


Figure 3. Capacitance

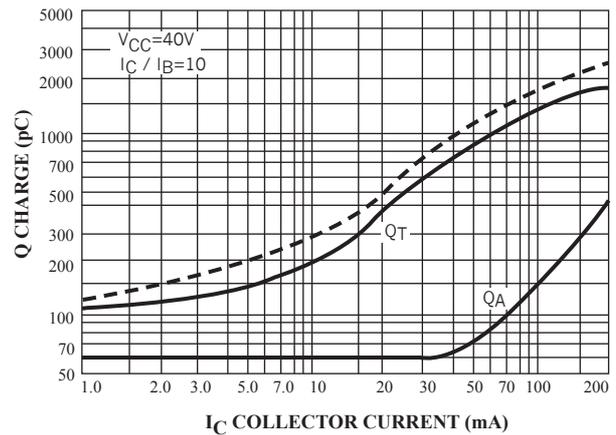


Figure 4. Charge Data

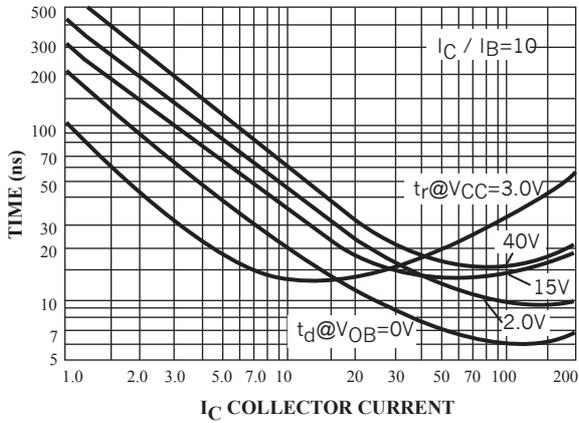


Figure 5. Turn-On Time

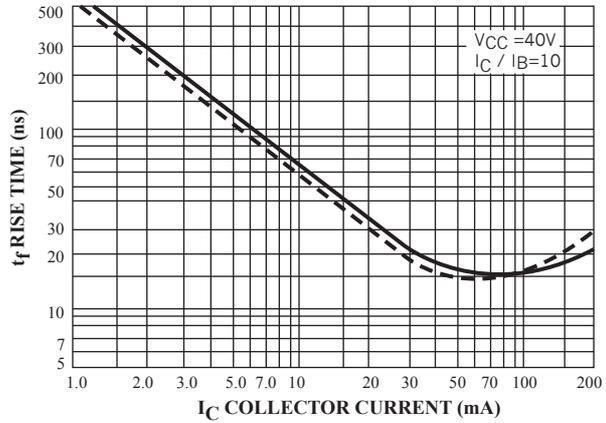


Figure 6. Rise Time

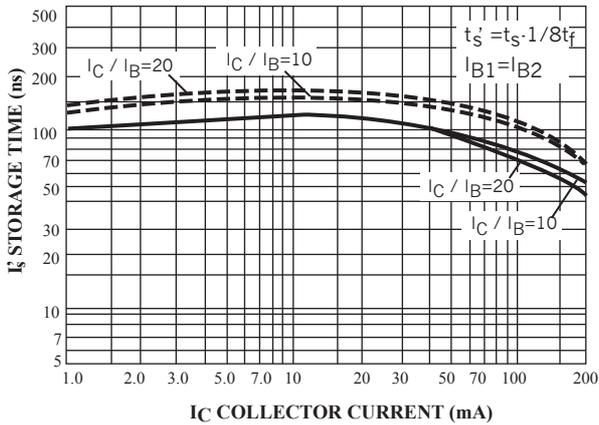


Figure 7. Storage Time

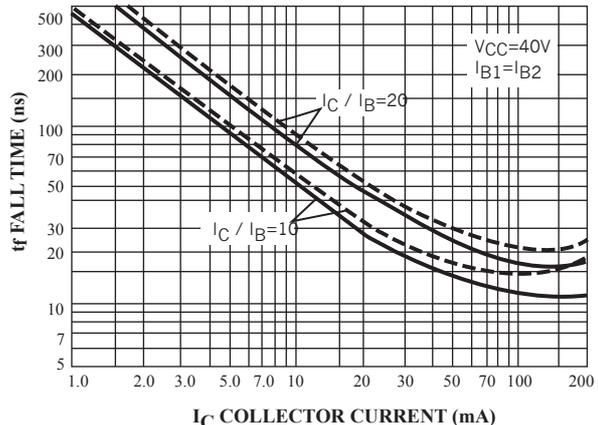


Figure 8. Fall Time

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

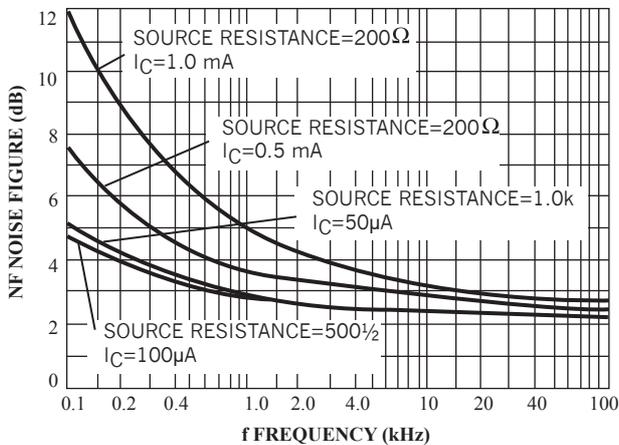


Figure 9.

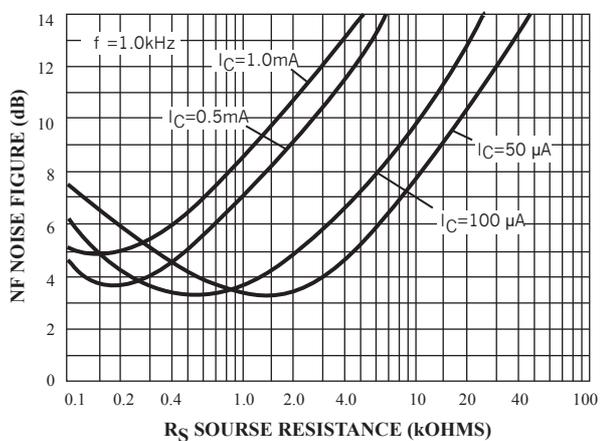


Figure 10.

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

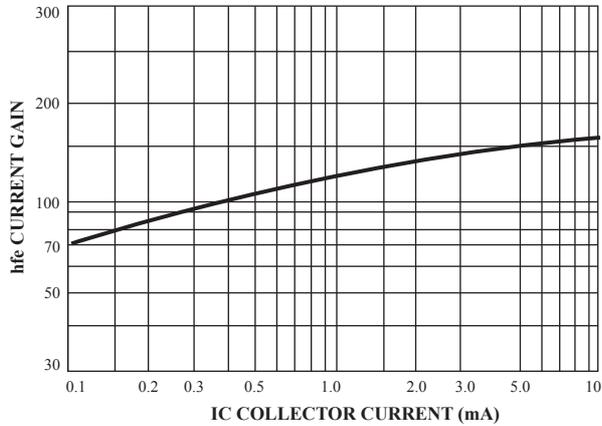


Figure 11. Current Gain

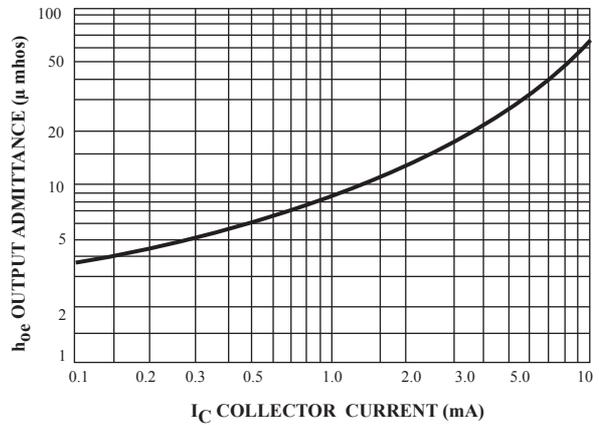


Figure 12. Output Admittance

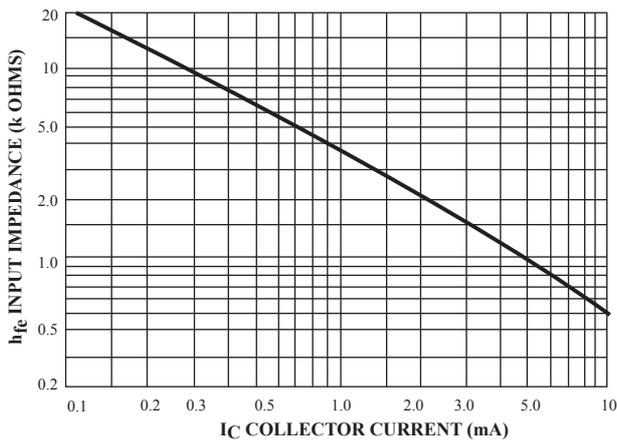


Figure 13. Input Impedance

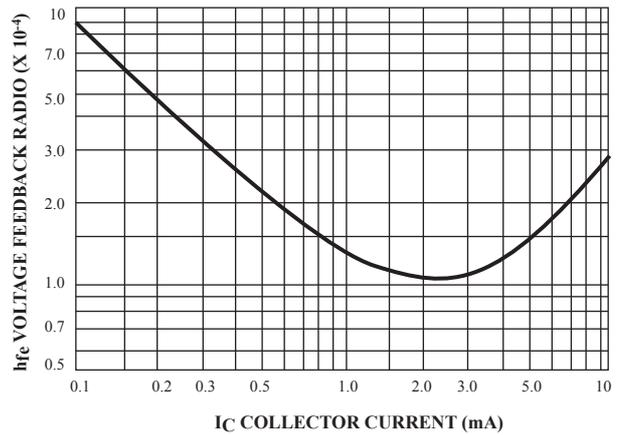


Figure 14. Voltage Feedback Ratio

## TYPICAL STATIC CHARACTERISTICS

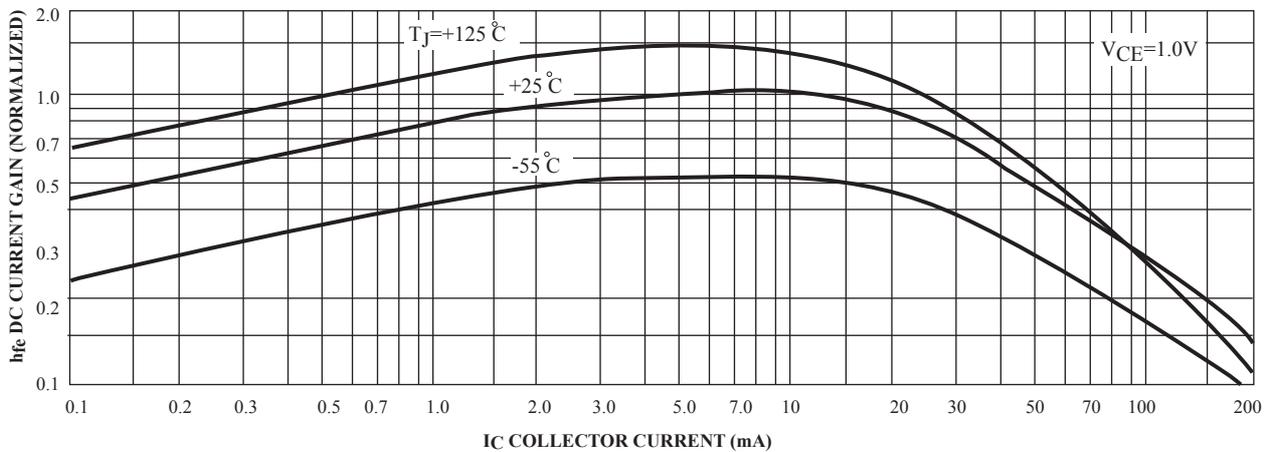


Figure 15. DC Current Gain

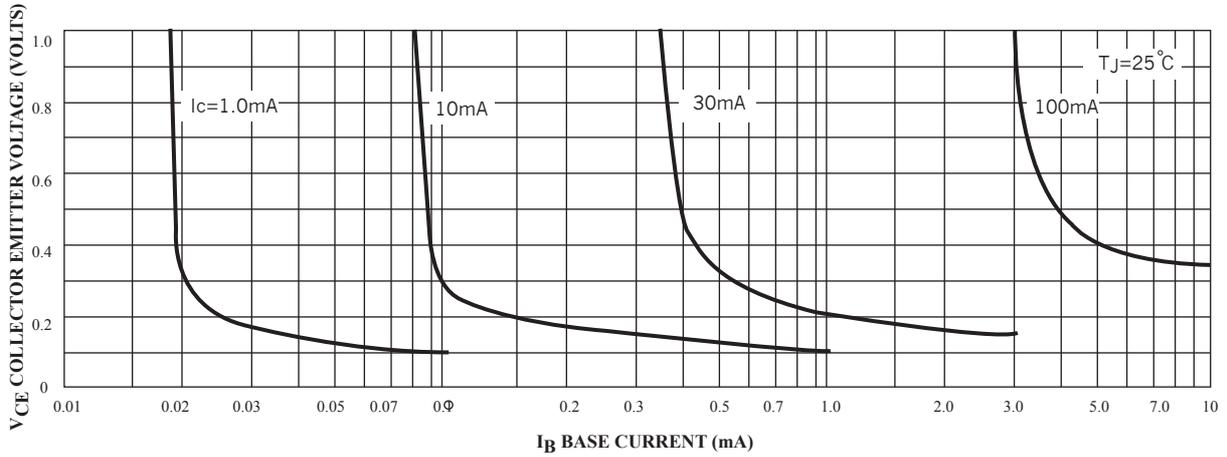


Figure 16. Collector Saturation Region

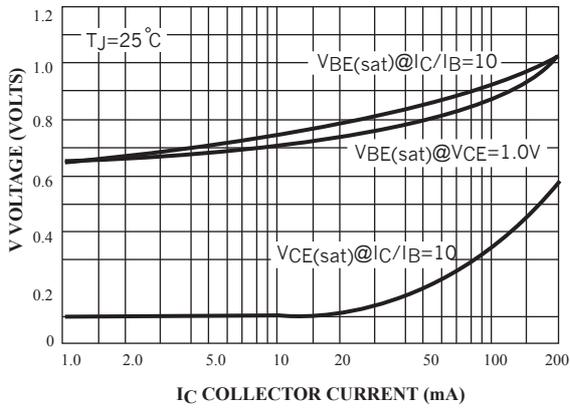


Figure 17. "ON" Voltage

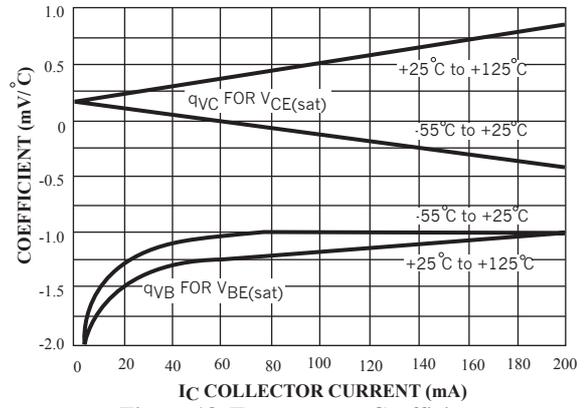
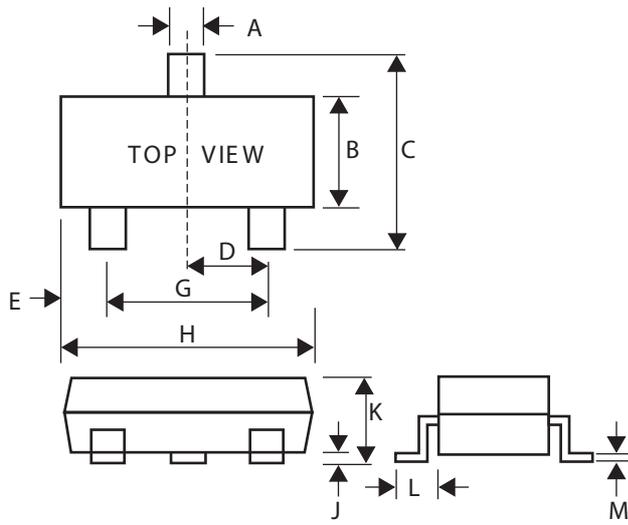


Figure 18. Temperature Coefficients

**SOT-323 Outline Demensions**

Unit:mm



| <b>SOT-323</b> |            |            |
|----------------|------------|------------|
| <b>Dim</b>     | <b>Min</b> | <b>Max</b> |
| <b>A</b>       | 0.30       | 0.40       |
| <b>B</b>       | 1.15       | 1.35       |
| <b>C</b>       | 2.00       | 2.40       |
| <b>D</b>       | -          | 0.65       |
| <b>E</b>       | 0.30       | 0.40       |
| <b>G</b>       | 1.20       | 1.40       |
| <b>H</b>       | 1.80       | 2.20       |
| <b>J</b>       | 0.00       | 0.10       |
| <b>K</b>       | 0.80       | 1.00       |
| <b>L</b>       | 0.42       | 0.53       |
| <b>M</b>       | 0.10       | 0.25       |