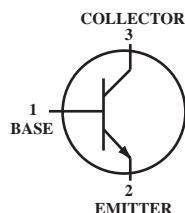


### General Purpose NPN Silicon Transistor

 Lead(Pb)-Free



SC-89  
SOT-523F

### 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>EBO</sub>	6.0	Vdc
Collector Current-Continuous	I <sub>C</sub>	200	mAdc

### Thermal Characteristics

Characteristics	Symbol	Max	Unit
Total Device Dissipation FR-5 Board <sup>(1)</sup> T <sub>A</sub> =25°C Derate above 25°C	P <sub>D</sub>	200 1.6	mW mW/°C
Thermal Resistance, Junction to Ambient	R <sub>θJA</sub>	600	°C/W
Total Device Dissipation Alumina Substrate, <sup>(2)</sup> T <sub>A</sub> =25°C Derate above 25°C	P <sub>D</sub>	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	R <sub>θJA</sub>	400	°C/W
Junction Temperature	T <sub>J</sub>	-55 to +150	°C
Storage Temperature	T <sub>stg</sub>	-55 to +150	°C

### Device Marking

MMBT3904T=AM

### Electrical Characteristics (T<sub>A</sub>=25°C Unless Otherwise noted)

Characteristics	Symbol	Min	Max	Unit
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### Off Characteristics

Collector-Emitter Breakdown Voltage <sup>(3)</sup> (I <sub>C</sub> =1.0mA, I <sub>B</sub> =0)	V <sub>(BR)CEO</sub>	40	-	V
Collector-Base Breakdown Voltage (I <sub>C</sub> =10 μA, I <sub>E</sub> =0)	V <sub>(BR)CBO</sub>	60	-	V
Emitter-Base Breakdown Voltage (I <sub>E</sub> =10 μA, I <sub>C</sub> =0)	V <sub>(BR)EBO</sub>	6.0	-	V
Base Cutoff Current (V <sub>CE</sub> =30V, V <sub>EB</sub> =3.0V)	I <sub>BL</sub>	-	50	nA
Collector Cutoff Current (V <sub>CE</sub> =30V, V <sub>EB</sub> =3.0V)	I <sub>CEx</sub>	-	50	nA

1. FR-4 Minimum Pad.

2. FR-4 1.0 x 1.0 Inch Pad.

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

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

Characteristics	Symbol	Min	Max	Unit
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**On Characteristics** <sup>(3)</sup>

DC Current Gain ( $I_C=0.1\text{ mA}, V_{CE}=1.0\text{V}$ ) ( $I_C=1.0\text{ mA}, V_{CE}=1.0\text{V}$ ) ( $I_C=10\text{ mA}, V_{CE}=1.0\text{V}$ ) ( $I_C=50\text{ mA}, V_{CE}=1.0\text{V}$ ) ( $I_C=100\text{ mA}, V_{CE}=1.0\text{V}$ )	$H_{FE}$	40 70 100 60 30	- - 300 - -	-
Collector-Emitter Saturation Voltage <sup>(3)</sup> ( $I_C=10\text{ mA}, I_B=1.0\text{mA}$ ) ( $I_C=50\text{ mA}, I_B=5.0\text{mA}$ )	$V_{CE(sat)}$	- -	0.2 0.3	V
Base-Emitter Saturation Voltage <sup>(3)</sup> ( $I_C=10\text{ mA}, I_B=1.0\text{ mA}$ ) ( $I_C=50\text{ mA}, I_B=5.0\text{ mA}$ )	$V_{BE(sat)}$	0.65 -	0.85 0.95	V

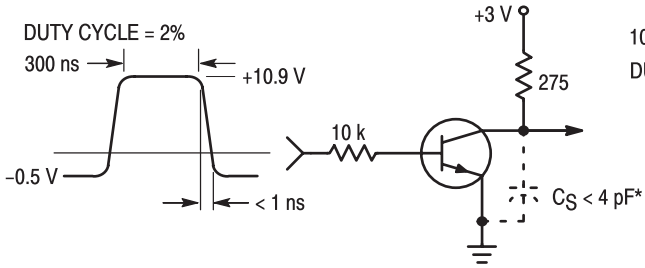
**Small-signal Characteristics**

Current-Gain-Bandwidth Product ( $I_C=10\text{ mA}, V_{CE}=20\text{V}, f=100\text{MHz}$ )	$f_T$	200	-	MHz
Output Capacitance ( $V_{CB}=5.0\text{V}, I_E=0, f=1.0\text{MHz}$ )	$C_{obo}$	-	4.0	pF
Input Capacitance ( $V_{EB}=0.5\text{V}, I_C=0, f=1.0\text{MHz}$ )	$C_{ibo}$	-	8.0	pF
Input Impedance ( $V_{CE}=10\text{V}, I_C=1.0\text{ mA}, f=1.0\text{ kHz}$ )	$h_{ie}$	1.0	10	k $\Omega$
Voltage Feedback Ratio ( $V_{CE}=10\text{V}, I_C=1.0\text{ mA}, f=1.0\text{ kHz}$ )	$h_{re}$	0.5	8.0	$\times 10^{-4}$
Small-Signal Current Gain ( $V_{CE}=10\text{V}, I_C=1.0\text{ mA}, f=1.0\text{ kHz}$ )	$h_{fe}$	100	400	-
Output Admittance ( $V_{CE}=10\text{V}, I_C=1.0\text{ mA}, f=1.0\text{kHz}$ )	$h_{oe}$	1.0	40	umhos
Noise Figure ( $V_{CE}=5.0\text{V}, I_C=100\text{ }\mu\text{A}, R_S=1.0\text{k}\Omega, f=1.0\text{kHz}$ )	NF	-	5.0	dB

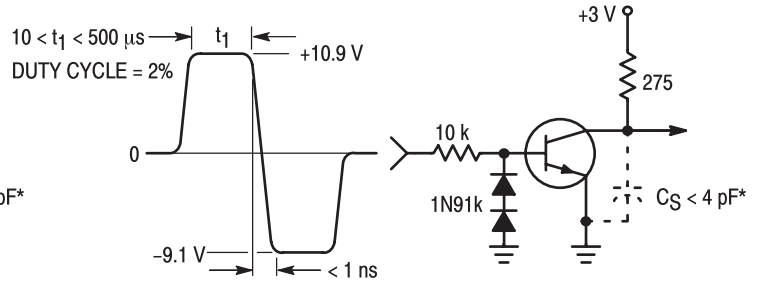
**Switching Characteristics**

Delay Time	(V <sub>cc</sub> = 3.0 V, V <sub>BE</sub> = 0.5 V I <sub>c</sub> = 10 mA, I <sub>B1</sub> = 1.0 mA)	t <sub>d</sub>	-	35	ns
Rise Time		t <sub>r</sub>	-	35	
Storage Time	(V <sub>cc</sub> = 3.0 V, I <sub>c</sub> = 10 mA, I <sub>B1</sub> =I <sub>B2</sub> = 1.0 mA)	t <sub>s</sub>	-	200	ns
Fall Time		t <sub>f</sub>	-	50	

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

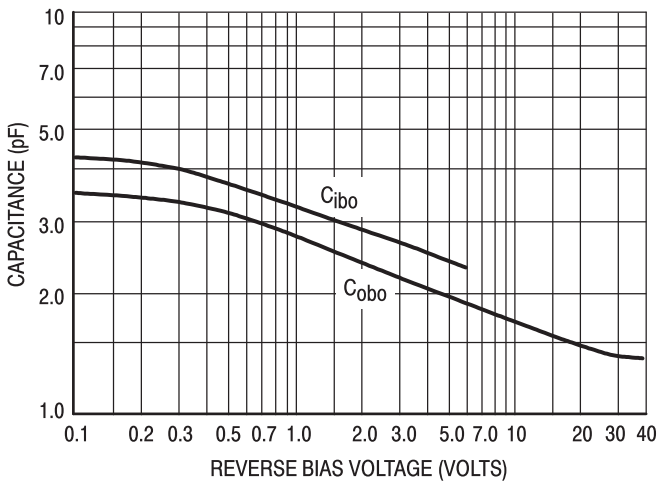


**Figure 1. Delay and Rise Time Equivalent Test Circuit**

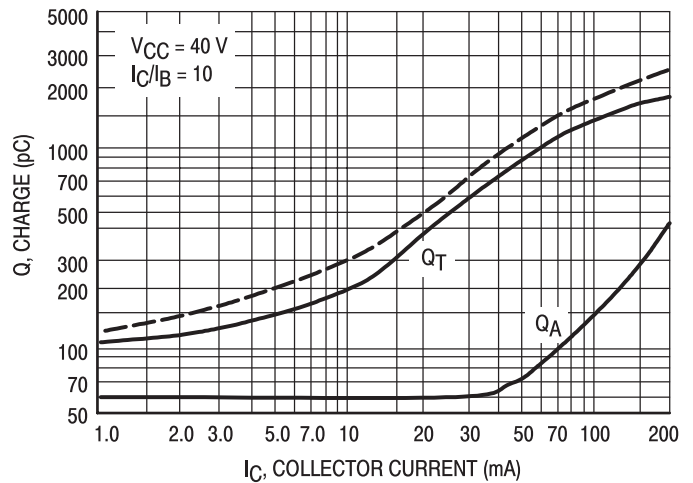


**Figure 2. Storage and Fall Time Equivalent Test Circuit**

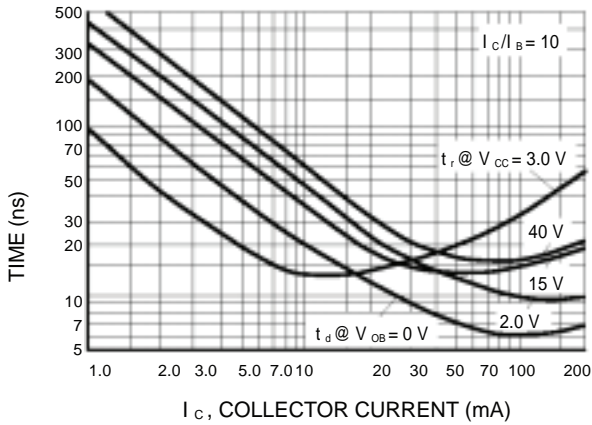
\* Total shunt capacitance of test jig and connectors



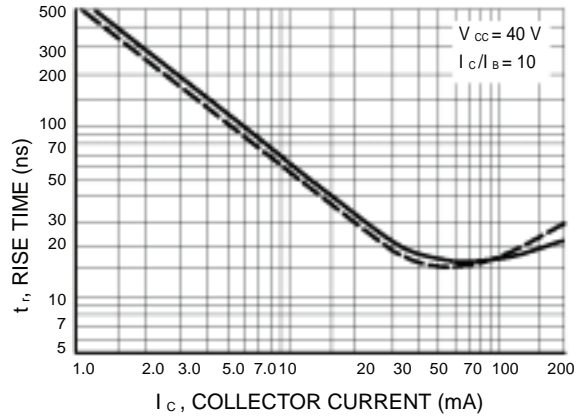
**Figure 3. Capacitance**



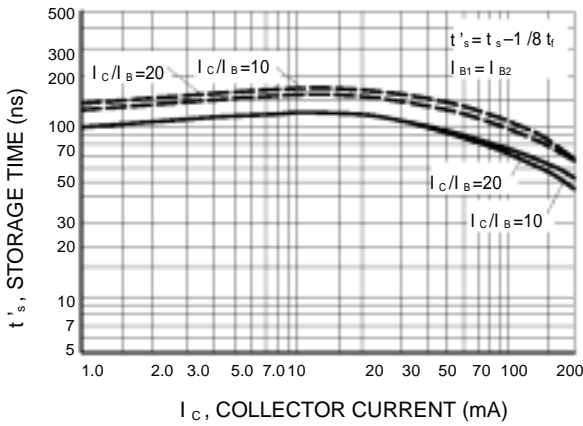
**Figure 4. Charge Data**



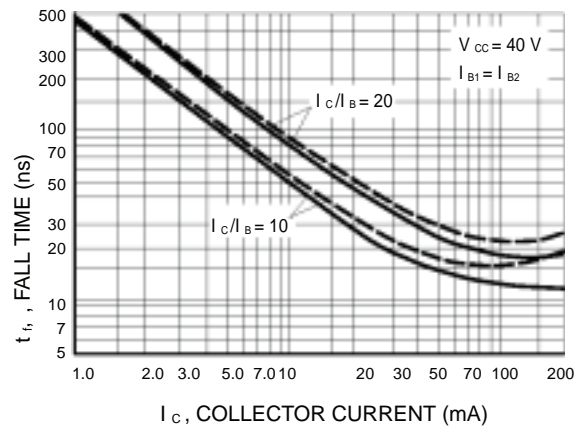
**Figure 5. Turn-On Time**



**Figure 6. Rise Time**



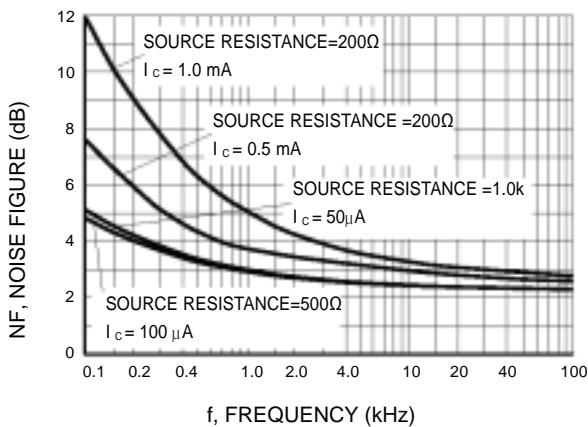
**Figure 7. Storage Time**



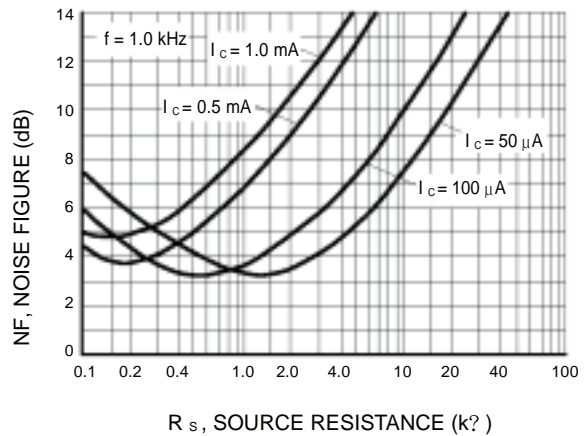
**Figure 8. Fall Time**

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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



**Figure 9.**



**Figure 10.**

## h PARAMETERS

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

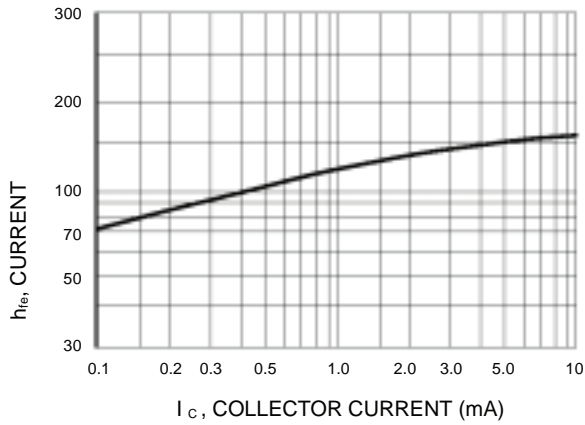


Figure 11. Current Gain

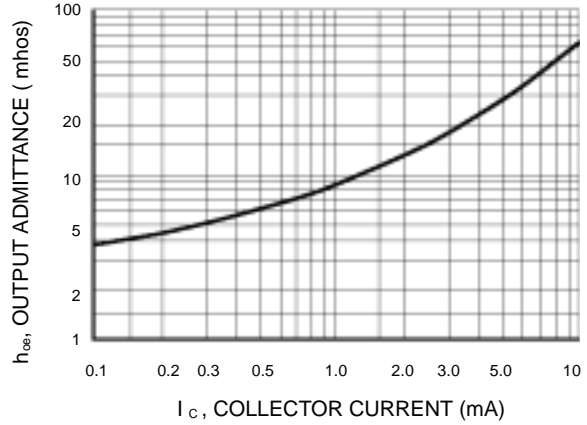


Figure 12. Output Admittance

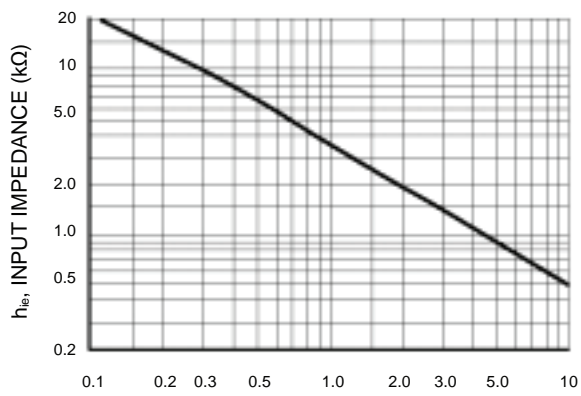


Figure 13. Input Impedance

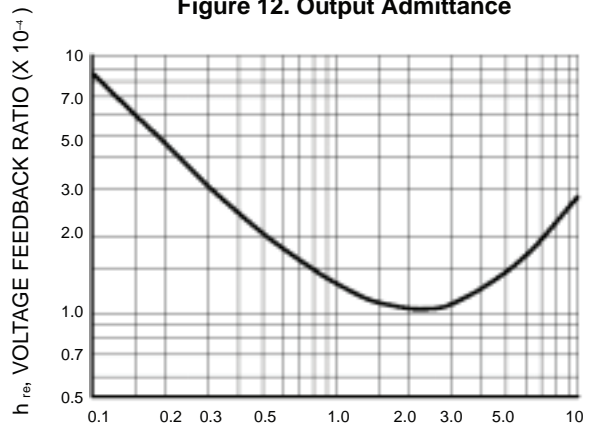


Figure 14. Voltage Feedback Ratio

## TYPICAL STATIC CHARACTERISTICS

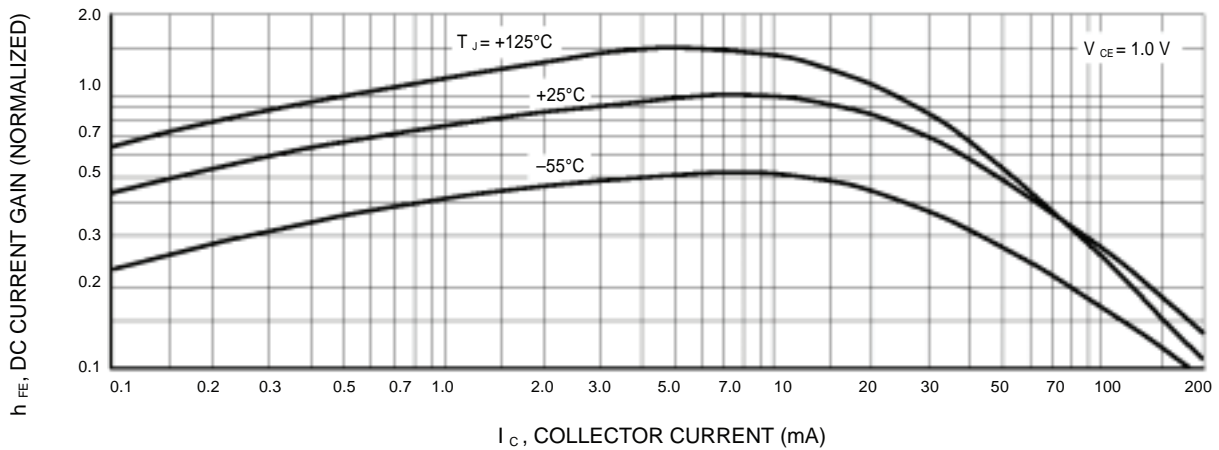


Figure 15. DC Current Gain

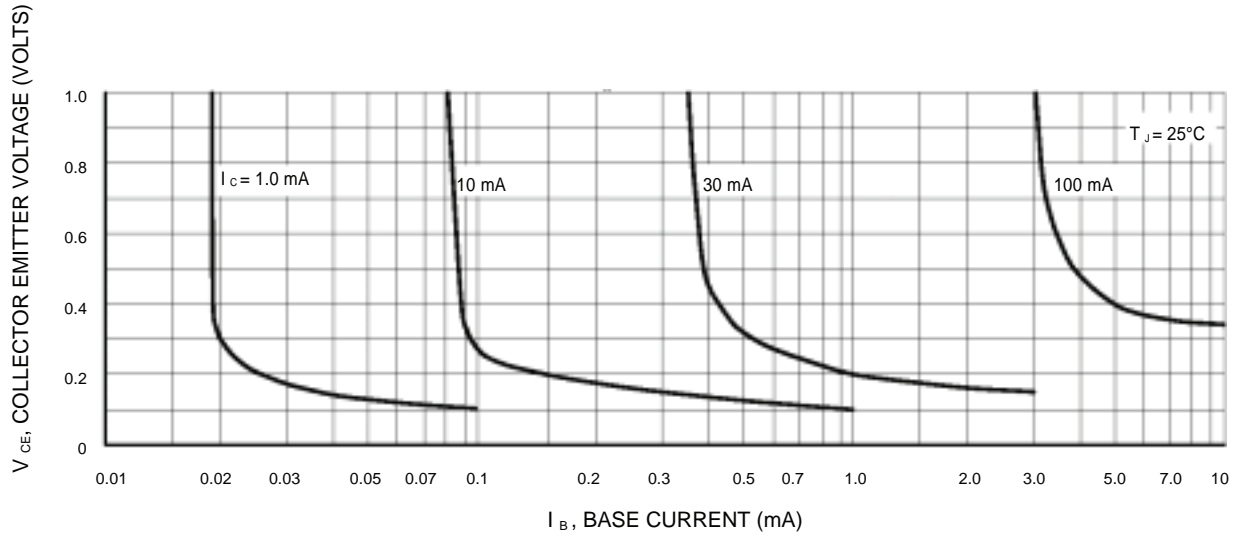


Figure 16. Collector Saturation Region

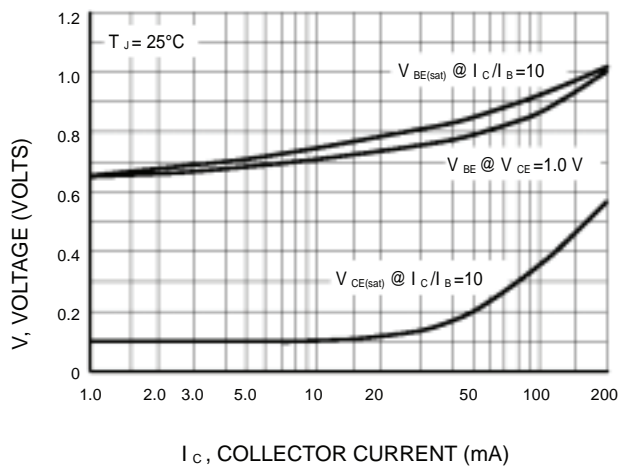


Figure 17. "ON" Voltages

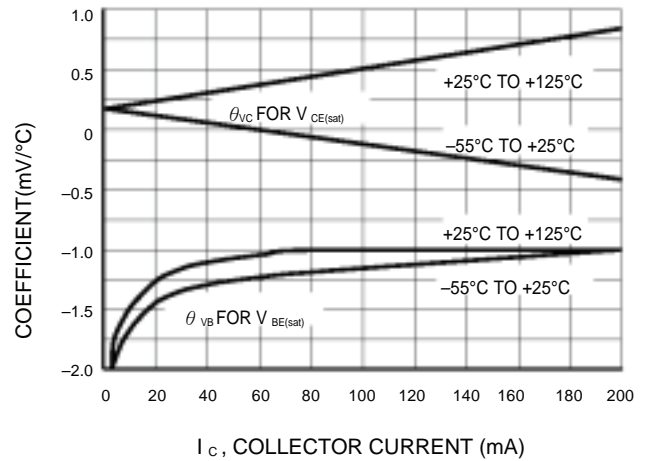


Figure 18. Temperature Coefficients

SC-89 Package Outline Dimensions

Unit:mm

