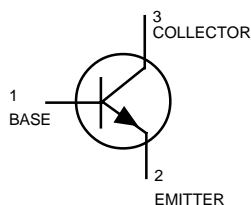
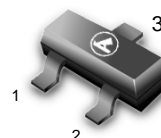


# General Purpose Transistor

## NPN Silicon


**MMBT3904LT1**

 CASE 318-08, STYLE 6  
 SOT-23 (TO-236AB)

### MAXIMUM RATINGS

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– 5 Board, (1) $T_A = 25^\circ\text{C}$	$P_D$	225	mW
Derate above $25^\circ\text{C}$		1.8	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	$^\circ\text{C}/\text{W}$
Total Device Dissipation Alumina Substrate, (2) $T_A = 25^\circ\text{C}$	$P_D$	300	mW
Derate above $25^\circ\text{C}$		2.4	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	$^\circ\text{C}/\text{W}$
Junction and Storage Temperature	$T_J, T_{stg}$	–55 to +150	$^\circ\text{C}$

### DEVICE MARKING

MMBT3904LT1 = 1AM

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

Characteristic	Symbol	Min	Max	Unit
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### OFF CHARACTERISTICS

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

 1. FR–5 =  $1.0 \times 0.75 \times 0.062$  in.

 2. Alumina =  $0.4 \times 0.3 \times 0.024$  in. 99.5% alumina.

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

**MMBT3904LT1**
**ELECTRICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$  unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
<b>DC CHARACTERISTICS (3)</b>				
DC Current Gain(1) ( $I_C = 0.1 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 50 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 100 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )	$h_{FE}$	40 70 100 60 30	— — 300 — —	—
Collector–Emitter Saturation Voltage ( $I_C = 10 \text{ mAdc}$ , $I_B = 1.0 \text{ mAdc}$ )(3) ( $I_C = 50 \text{ mAdc}$ , $I_B = 5.0 \text{ mAdc}$ )	$V_{CE(sat)}$	— —	0.2 0.3	Vdc
Base–Emitter Saturation Voltage(3) ( $I_C = 10 \text{ mAdc}$ , $I_B = 1.0 \text{ mAdc}$ ) ( $I_C = 50 \text{ mAdc}$ , $I_B = 5.0 \text{ mAdc}$ )	$V_{BE(sat)}$	0.65 —	0.85 0.95	Vdc

**SMALL–SIGNAL CHARACTERISTICS**

Current–Gain — Bandwidth Product ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 20 \text{ Vdc}$ , $f = 100 \text{ MHz}$ )	$f_T$	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 ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{ie}$	1.0	10	pF
Voltage Feedback Ratio ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{re}$	0.5	8.0	$\times 10^{-4}$
Small–Signal Current Gain ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{fe}$	100	400	—
Output Admittance ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{oe}$	1.0	40	$\text{mhos}$
Noise Figure ( $V_{CE} = 5.0 \text{ Vdc}$ , $I_C = 100 \mu\text{Adc}$ , $R_S = 1.0 \text{ k}\Omega$ , $f = 1.0 \text{ kHz}$ )	NF	—	5.0	dB

**SWITCHING CHARACTERISTICS**

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

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

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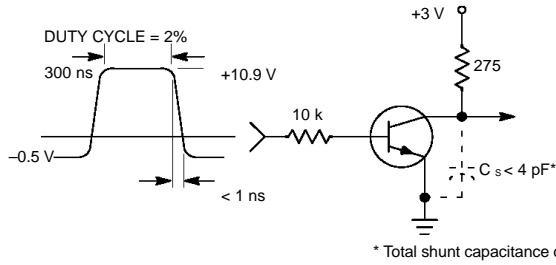


Figure 1. Delay and Rise Time Equivalent Test Circuit

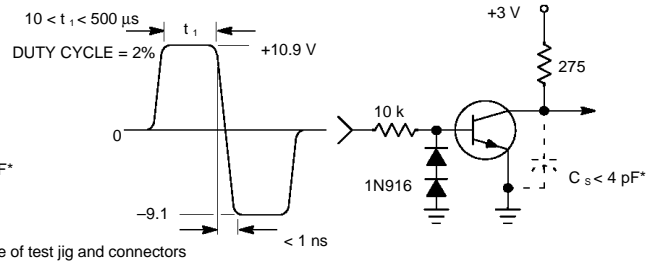


Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

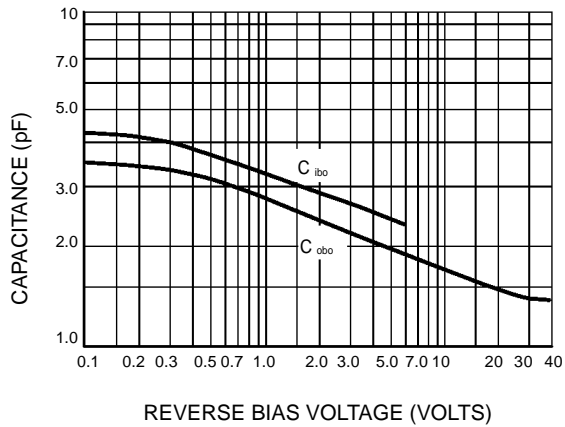


Figure 3. Capacitance

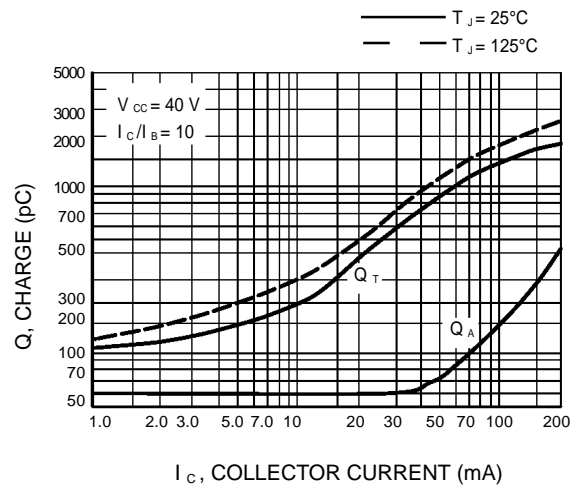
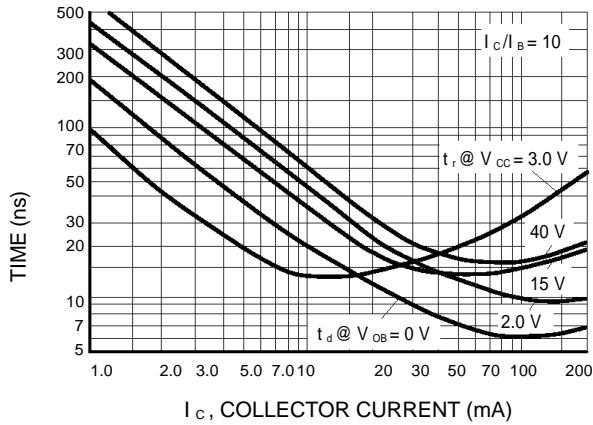
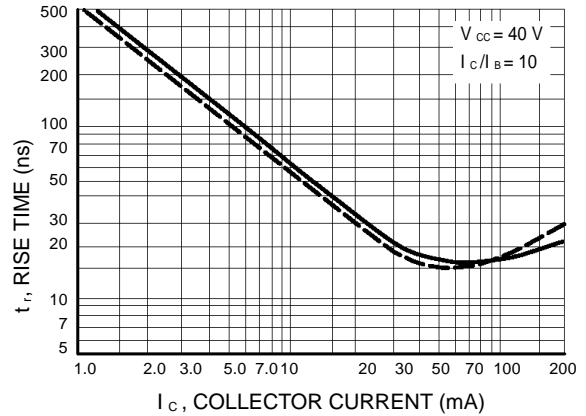


Figure 4. Charge Data

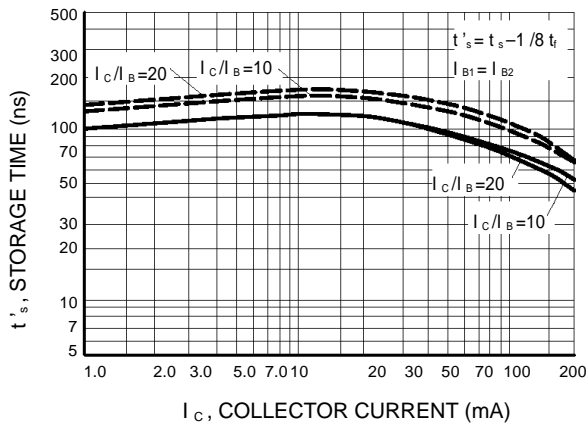
**MMBT3904LT1**



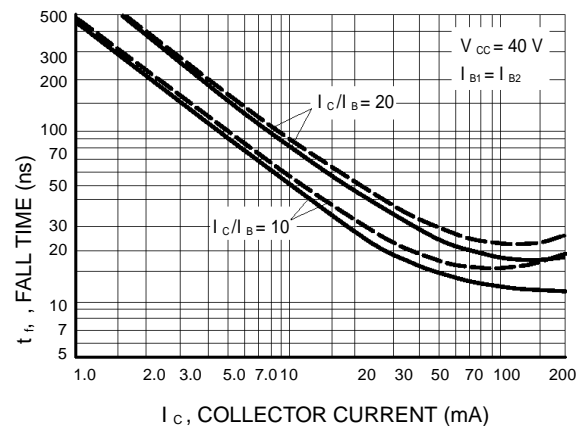
**Figure 5. Turn-On Time**



**Figure 6. Rise Time**



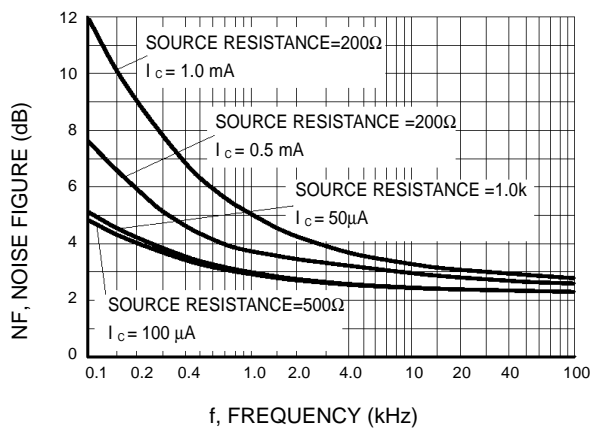
**Figure 7. Storage Time**



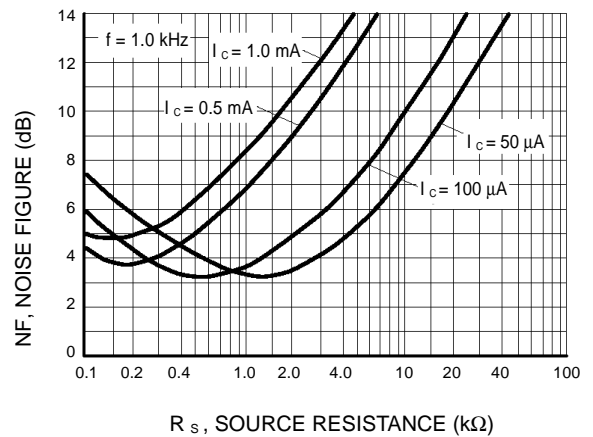
**Figure 8. Fall Time**

**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.**

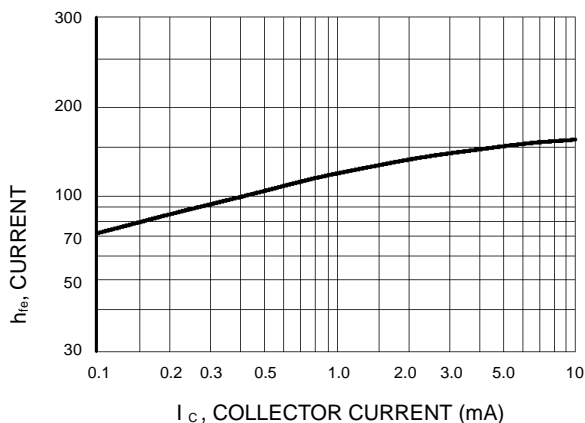


**Figure 10.**

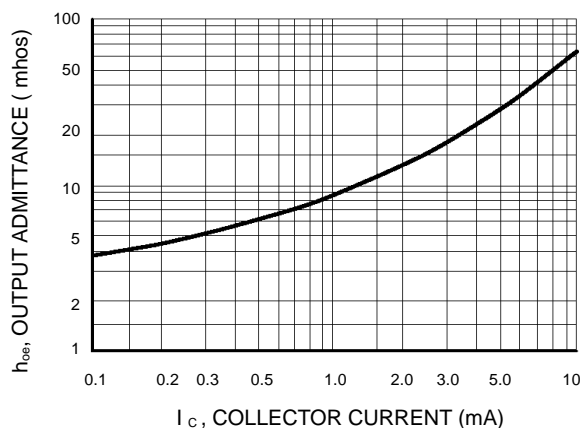
**MMBT3904LT1**

**h PARAMETERS**

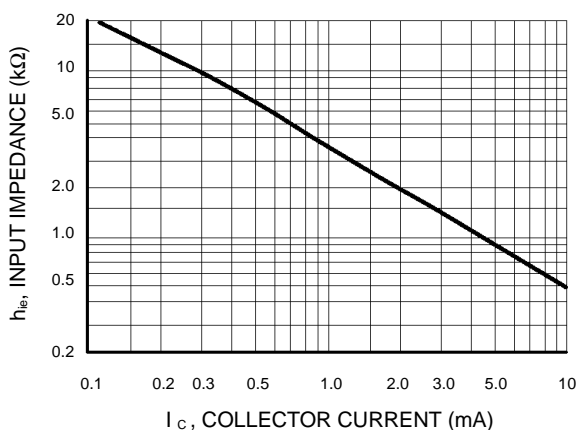
( $V_{CE} = 10\text{ Vdc}$ ,  $f = 1.0\text{ kHz}$ ,  $T_A = 25^\circ\text{C}$ )



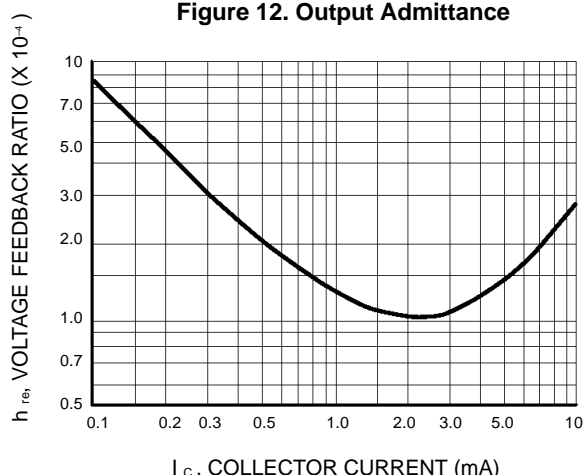
**Figure 11. Current Gain**



**Figure 12. Output Admittance**

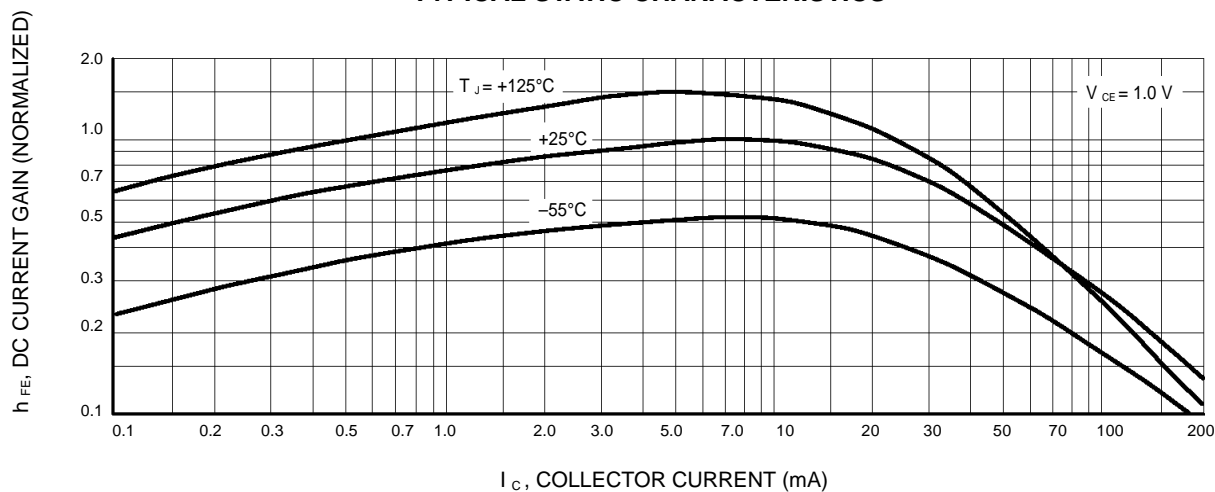


**Figure 13. Input Impedance**



**Figure 14. Voltage Feedback Ratio**

**TYPICAL STATIC CHARACTERISTICS**



**Figure 15. DC Current Gain**

MMBT3904LT1

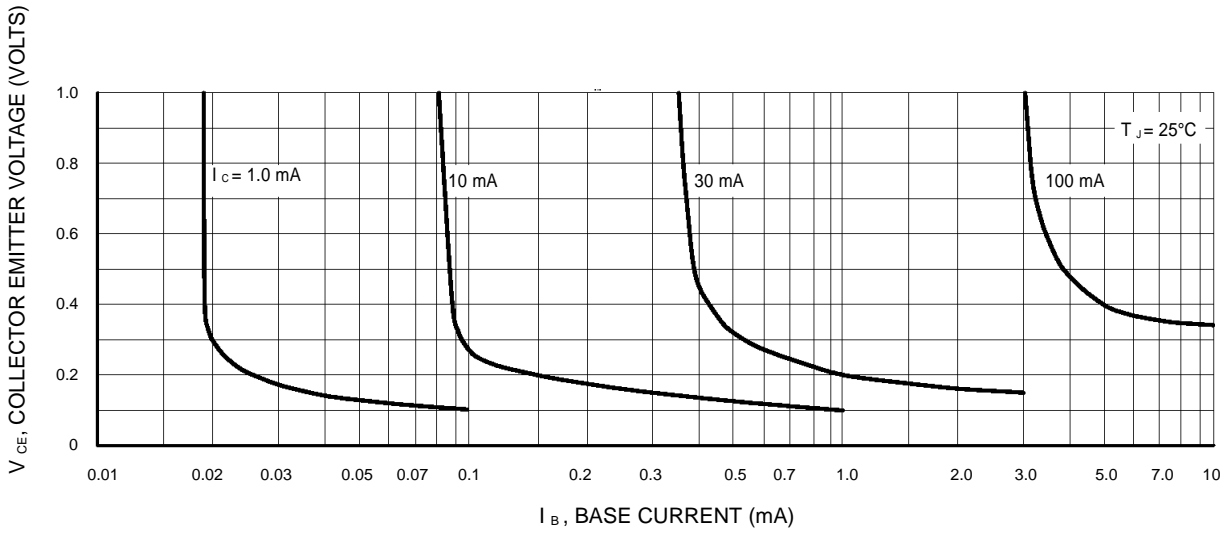
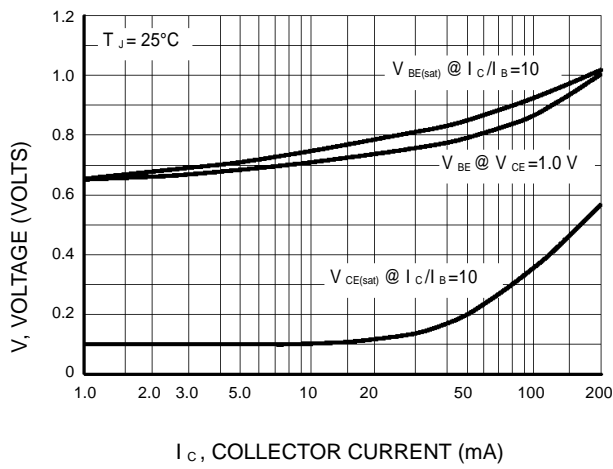
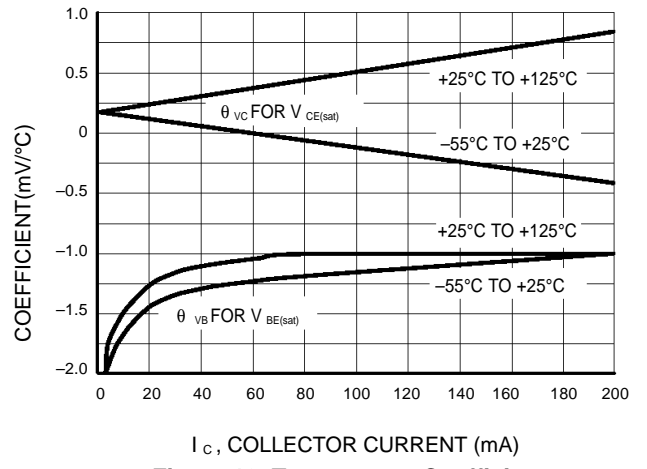


Figure 16. Collector Saturation Region



$I_C$ , COLLECTOR CURRENT (mA)  
Figure 17. "ON" Voltages



$I_C$ , COLLECTOR CURRENT (mA)  
Figure 18. Temperature Coefficients