

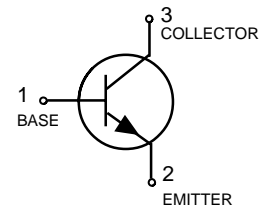
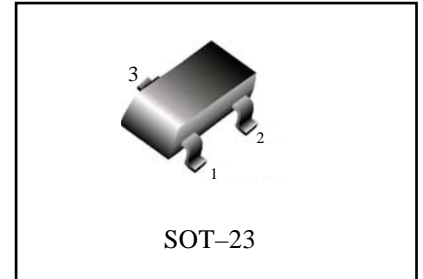
# General Purpose Transistor

## ORDERING INFORMATION

Device	Marking	Shipping
2N4401	2X	3000/Tape & Reel

## 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	$I_C$	600	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	$^\circ\text{C}$

## 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 ( $I_C = 0.1 \text{ mAdc}, I_E = 0$ )	$V_{(BR)CBO}$	60	—	Vdc
Emitter–Base Breakdown Voltage ( $I_E = 0.1 \text{ mAdc}, I_C = 0$ )	$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current ( $V_{CE} = 35 \text{ Vdc}, V_{EB} = 0.4 \text{ Vdc}$ )	$I_{BEV}$	—	0.1	$\mu\text{Adc}$
Collector Cutoff Current ( $V_{CE} = 35 \text{ Vdc}, V_{EB} = 0.4 \text{ Vdc}$ )	$I_{CEX}$	—	0.1	$\mu\text{Adc}$

- FR–5 =  $1.0 \times 0.75 \times 0.062 \text{ in.}$
- Alumina =  $0.4 \times 0.3 \times 0.024 \text{ in.}$  99.5% alumina.
- Pulse Test: Pulse Width  $< 300 \mu\text{s}$ ; Duty Cycle  $< 2.0\%$ .

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

Characteristic	Symbol	Min	Max	Unit
<b>ON CHARACTERISTICS ( 3 )</b>				
DC Current Gain ( $I_C = 0.1 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )	$h_{FE}$	20	—	—
( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )		40	—	
( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )		80	—	
( $I_C = 150 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )		100	300	
( $I_C = 500 \text{ mAdc}$ , $V_{CE} = 2.0 \text{ Vdc}$ )		40	—	
Collector–Emitter Saturation Voltage ( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ )	$V_{CE(sat)}$	—	0.4	Vdc
( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )		—	0.75	
Base–Emitter Saturation Voltage ( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ )	$V_{BE(sat)}$	0.75	0.95	Vdc
( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )		—	1.2	

**SMALL–SIGNAL CHARACTERISTICS**

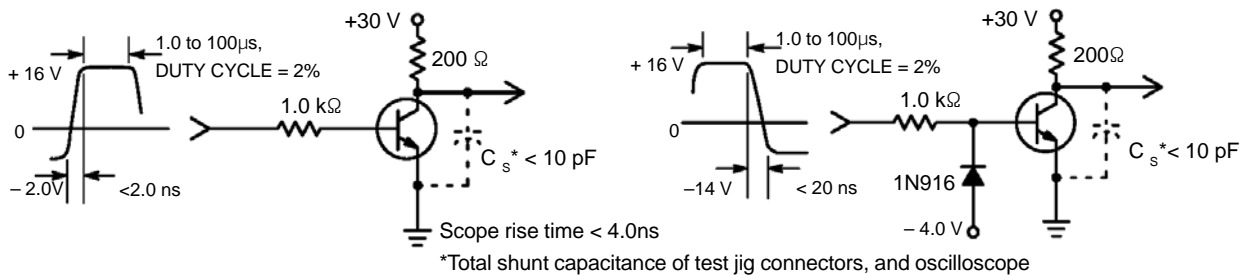
Current–Gain — Bandwidth Product ( $I_C = 20 \text{ mAdc}$ , $V_{CE} = 10\text{Vdc}$ , $f = 100 \text{ MHz}$ )	$f_T$	250	—	MHz
Collector–Base Capacitance ( $V_{CB} = 5.0 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{cb}$	—	6.5	pF
Emitter–Base Capacitance ( $V_{EB} = 0.5 \text{ Vdc}$ , $I_C = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{eb}$	—	30	pF
Input Impedance ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{ie}$	1.0	15	$k\Omega$
Voltage Feedback Ratio ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{re}$	0.1	8.0	$\times 10^{-4}$
Small–Signal Current Gain ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{fe}$	40	500	—
Output Admittance ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{oe}$	1.0	30	$\mu\text{mhos}$

**SWITCHING CHARACTERISTICS**

Delay Time	$(V_{CC} = 30 \text{ Vdc}$ , $V_{EB} = 2.0 \text{ Vdc}$ )	$t_d$	—	15	ns
Rise Time	$I_C = 150 \text{ mAdc}$ , $I_{B1} = 15 \text{ mAdc}$ )	$t_r$	—	20	
Storage Time	$(V_{CC} = 30 \text{ Vdc}$ , $I_C = 150 \text{ mAdc}$ )	$t_s$	—	225	ns
Fall Time	$I_{B1} = I_{B2} = 15 \text{ mAdc}$ )	$t_f$	—	30	

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

**SWITCHING TIME EQUIVALENT TEST CIRCUITS**

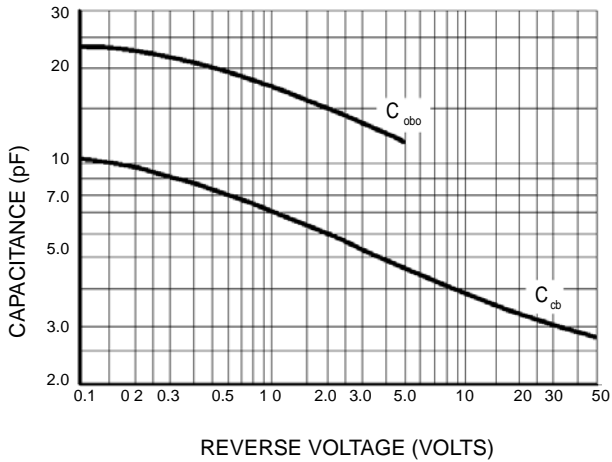


**Figure 1. Turn–On Time**

**Figure 2. Turn–Off Time**



TRANSIENT CHARACTERISTICS



REVERSE VOLTAGE (VOLTS)  
Figure 3. Capacitance

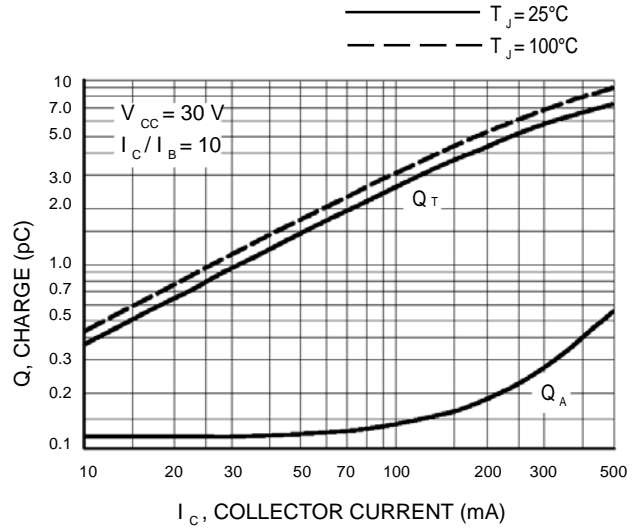


Figure 4. Charge Data

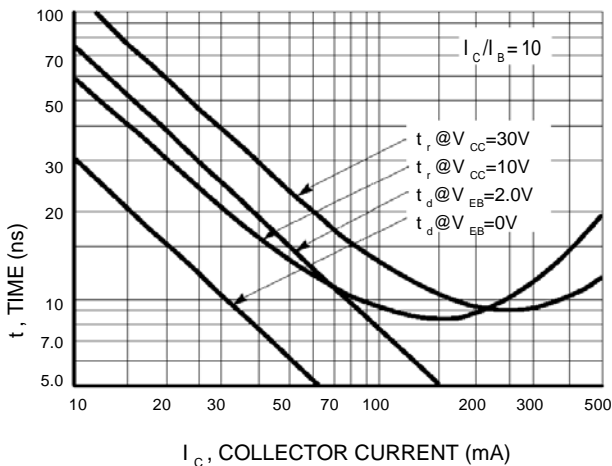


Figure 5. Turn-On Time

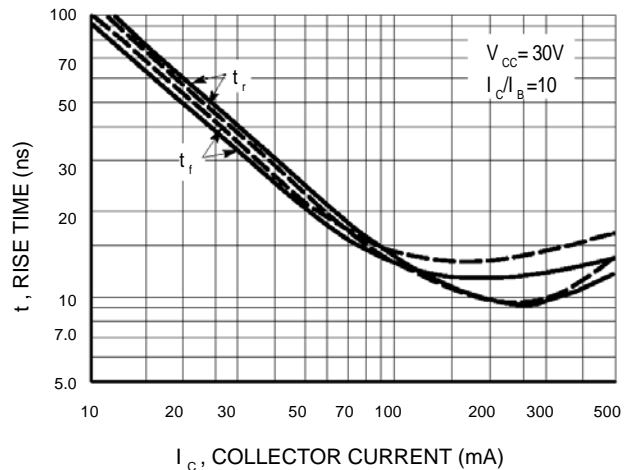


Figure 6. Rise and Fall Time

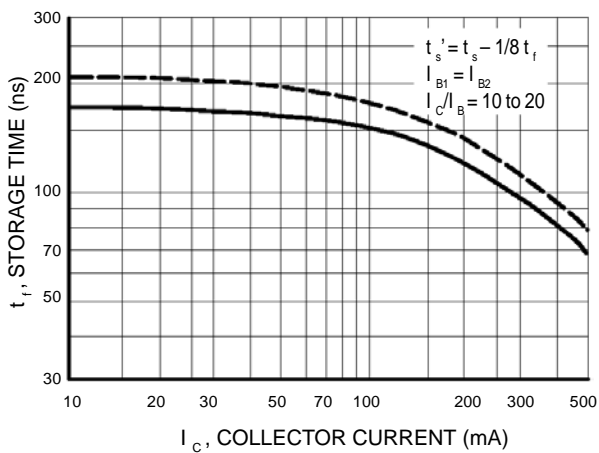


Figure 7. Storage Time

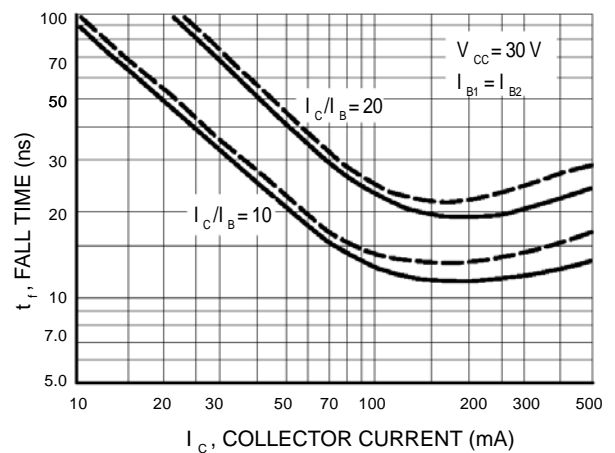


Figure 8. Fall Time

### SMALL-SIGNAL CHARACTERISTICS

#### NOISE FIGURE

$V_{CE} = 10 \text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$

Bandwidth = 1.0 Hz

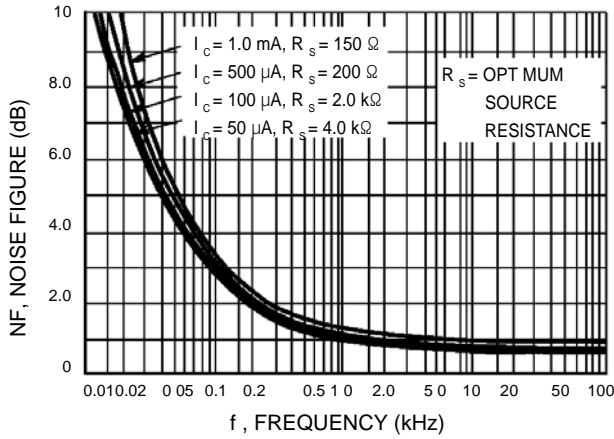


Figure 9. Frequency Effects

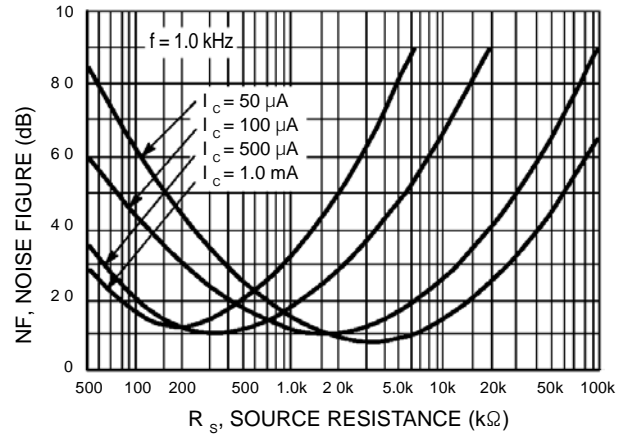


Figure 10. Source Resistance Effects

#### h PARAMETERS

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

This group of graphs illustrates the relationship between  $h_{fe}$  and other "h" parameters for this series of resistors. To obtain these curves, a high-gain and a low-gain unit were selected from the LMBT4401LT1 lines, and the same units were used to develop the correspondingly numbered curves on each graph.

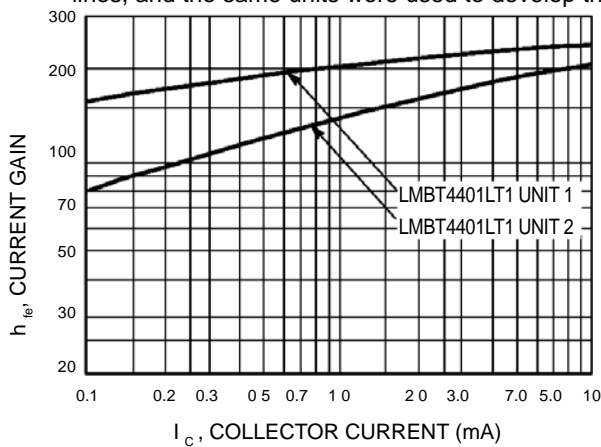


Figure 11. Current Gain

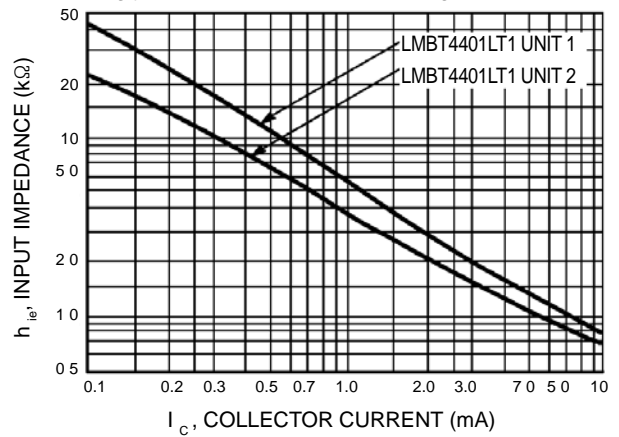


Figure 12. Input Impedance

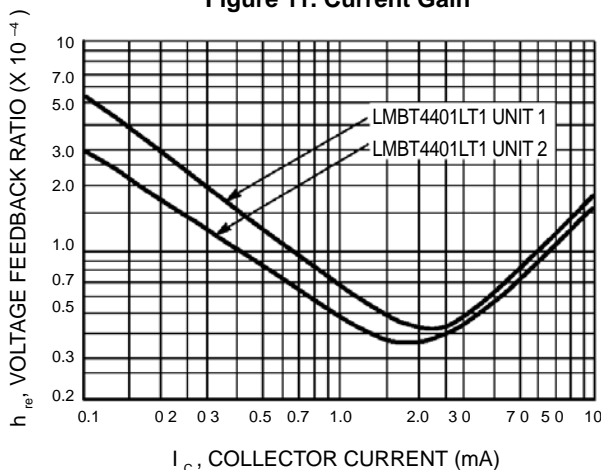


Figure 13. Voltage Feedback Ratio

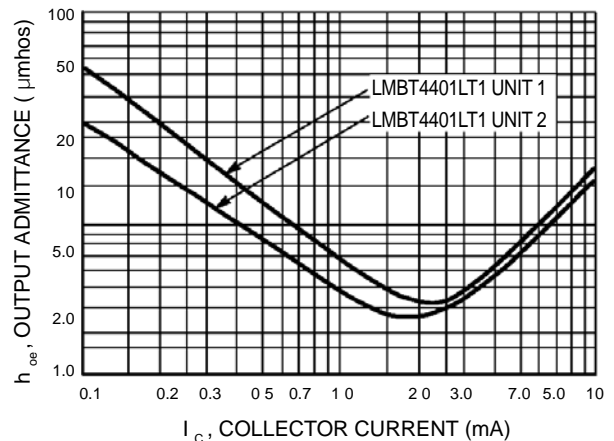


Figure 14. Output Admittance



STATIC CHARACTERISTICS

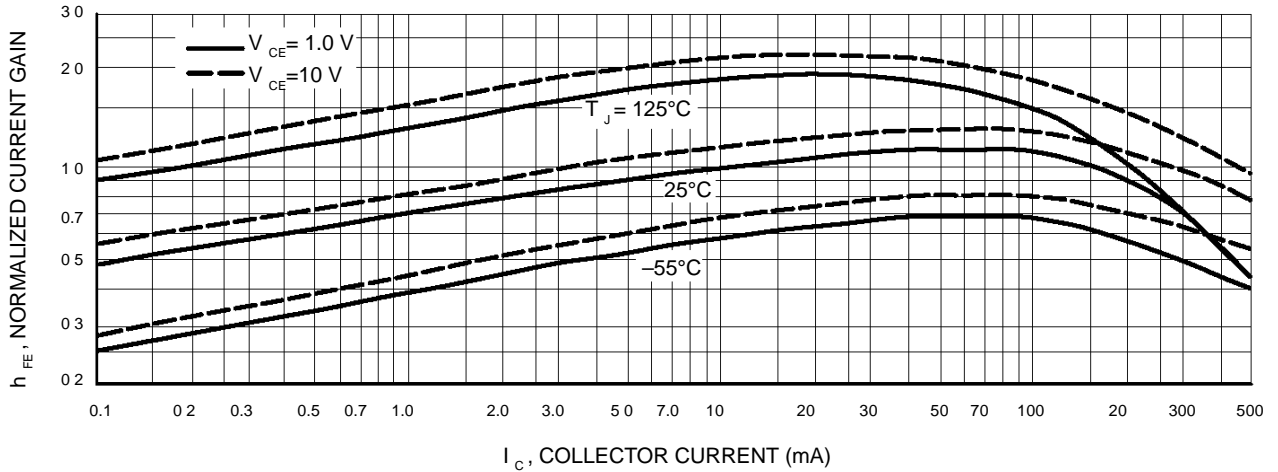


Figure 15. DC Current Gain

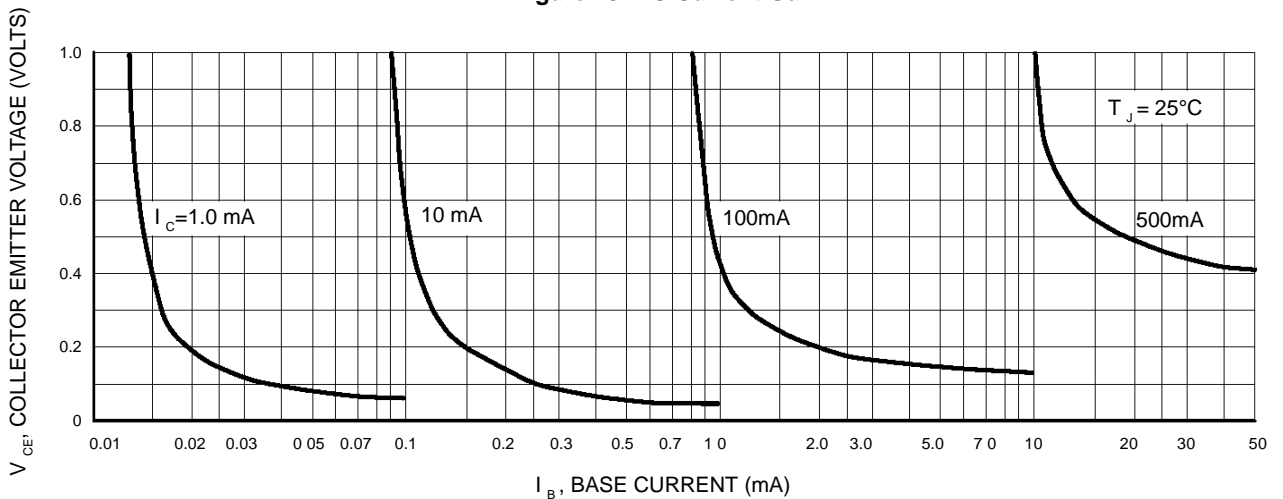


Figure 16. Collector Saturation Region

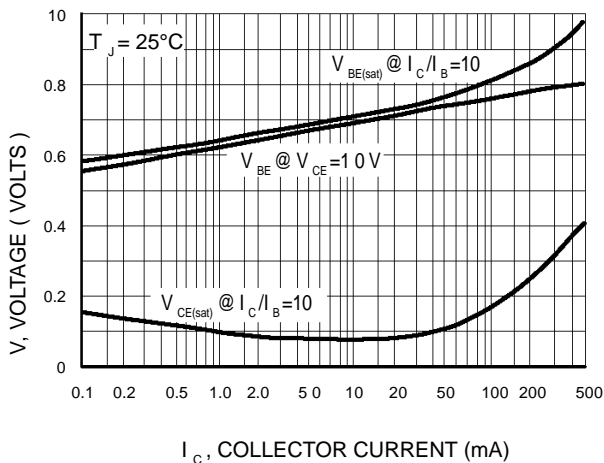


Figure 17. "On" Voltages

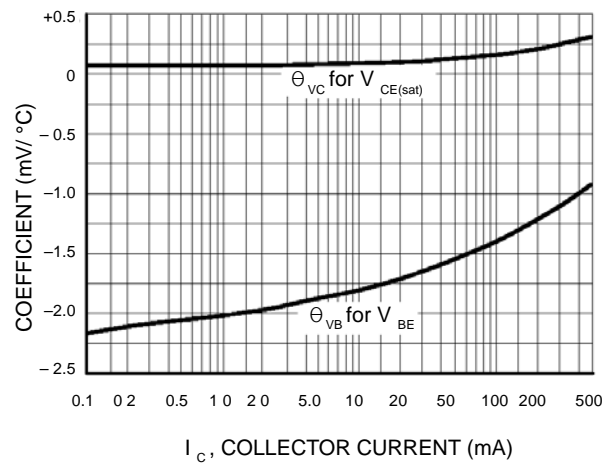
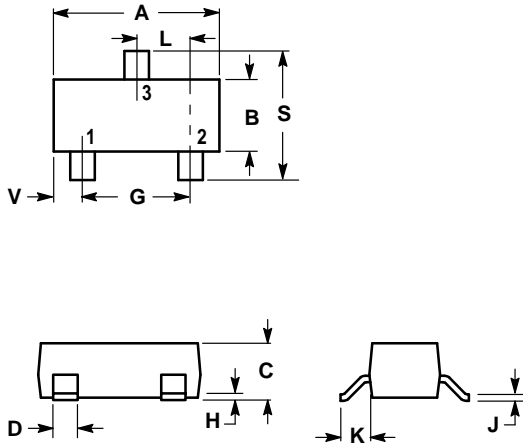


Figure 18. Temperature Coefficients



**SOT-23**



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.1102	0.1197	2.80	3.04
B	0.0472	0.0551	1.20	1.40
C	0.0350	0.0440	0.89	1.11
D	0.0150	0.0200	0.37	0.50
G	0.0701	0.0807	1.78	2.04
H	0.0005	0.0040	0.013	0.100
J	0.0034	0.0070	0.085	0.177
K	0.0140	0.0285	0.35	0.69
L	0.0350	0.0401	0.89	1.02
S	0.0830	0.1039	2.10	2.64
V	0.0177	0.0236	0.45	0.60

- P N 1. BASE  
2. EMITTER  
3. COLLECTOR

