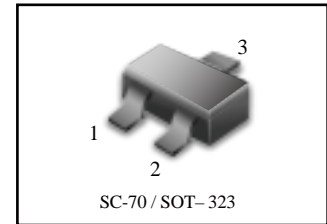


## General Purpose Transistor

- We declare that the material of product compliance with RoHS requirements.

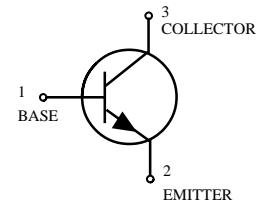
### ORDERING INFORMATION

Device	Marking	Shipping
2N3904U	AM or 1AM	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	$I_C$	200	mAdc



### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board, (1) $T_A = 25\text{ C}$	$P_D$	150	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	833	C/W
Junction and Storage Temperature	$T_J, T_{stg}$	-55 to +150	C

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

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector-Emitter Breakdown Voltage(2) ( $I_C = 1.0\text{ mAdc}$ )	$V_{(BR)CEO}$	40	-	Vdc
Collector-Base Breakdown Voltage ( $I_C = 10\text{ }\mu\text{Adc}$ )	$V_{(BR)CBO}$	60	-	Vdc
Emitter-Base Breakdown Voltage ( $I_E = 10\text{ }\mu\text{Adc}$ )	$V_{(BR)EBO}$	6.0	-	Vdc
Base Cutoff Current ( $V_{CE} = 30\text{ Vdc}, V_{EB} = 3.0\text{ Vdc},$ )	$I_{BL}$	-	50	nAdc
Collector Cutoff Current ( $V_{CE} = 30\text{ Vdc}, V_{BE} = 3.0\text{ Vdc}$ )	$I_{CEX}$	-	50	nAdc

1. FR-5 = 1.0 x 0.75 x 0.062 in.

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

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

Characteristic	Symbol	Min	Max	Unit
<b>ON CHARACTERISTICS (3)</b>				
DC Current Gain ( $I_C = 0.1 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 50 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 100 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )	$h_{FE}$	40 70 100 60 30	– – 300 – –	–
Collector–Emitter Saturation Voltage ( $I_C = 10 \text{ mAdc}$ , $I_B = 1.0 \text{ mAdc}$ ) ( $I_C = 50 \text{ mAdc}$ , $I_B = 5.0 \text{ mAdc}$ )	$V_{CE(sat)}$	– –	0.2 0.3	Vdc
Base–Emitter Saturation Voltage ( $I_C = 10 \text{ mAdc}$ , $I_B = 1.0 \text{ mAdc}$ ) ( $I_C = 50 \text{ mAdc}$ , $I_B = 5.0 \text{ mAdc}$ )	$V_{BE(sat)}$	0.65 –	0.85 0.95	Vdc
<b>SMALL–SIGNAL CHARACTERISTICS</b>				
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	k $\Omega$
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	$\mu\text{mhos}$
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	( $V_{CC} = 3.0 \text{ Vdc}$ , $I_C = 10 \text{ mAdc}$ )	$t_s$	–	200	ns
Fall Time	$I_{B1} = I_{B2} = 1.0 \text{ mAdc}$ )	$t_f$	–	50	ns

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

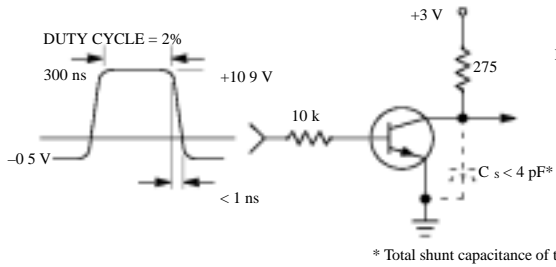


Figure 1. Delay and Rise Time  
Equivalent Test Circuit

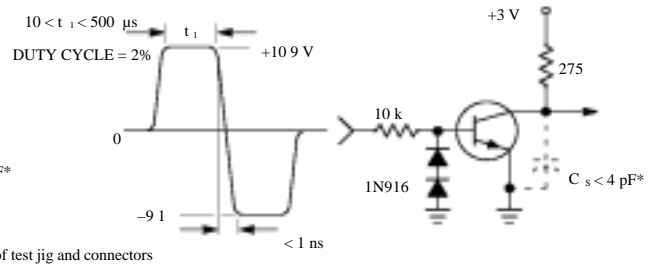


Figure 2. Storage and Fall Time  
Equivalent Test Circuit

## TYPICAL TRANSIENT CHARACTERISTICS

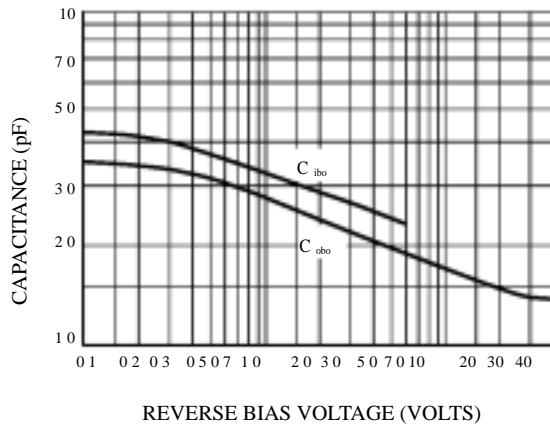


Figure 3. Capacitance

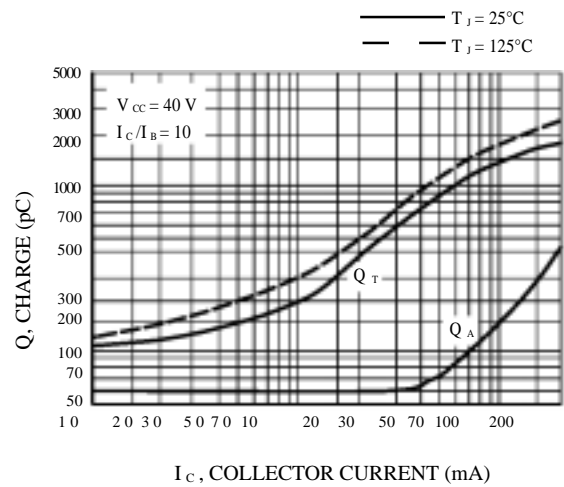


Figure 4. Charge Data

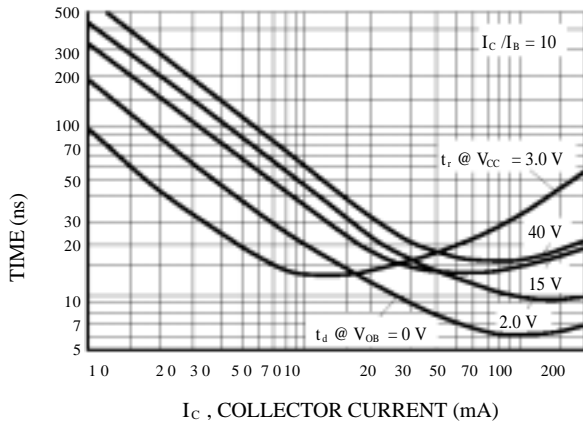


Figure 5. Turn-On Time

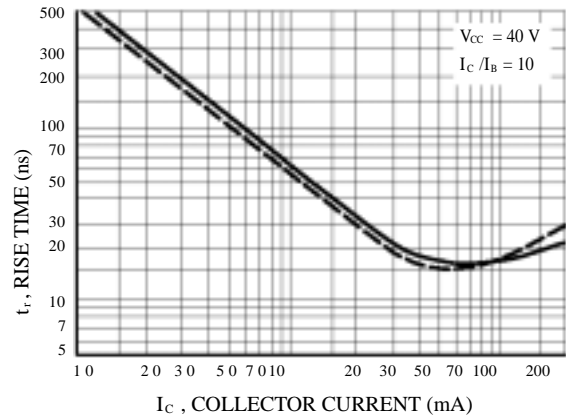


Figure 6. Rise Time

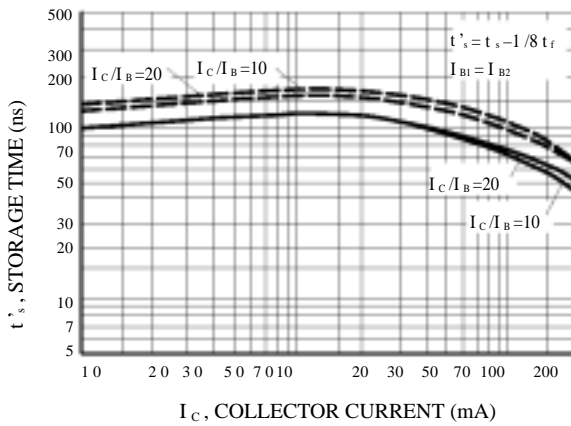


Figure 7. Storage Time

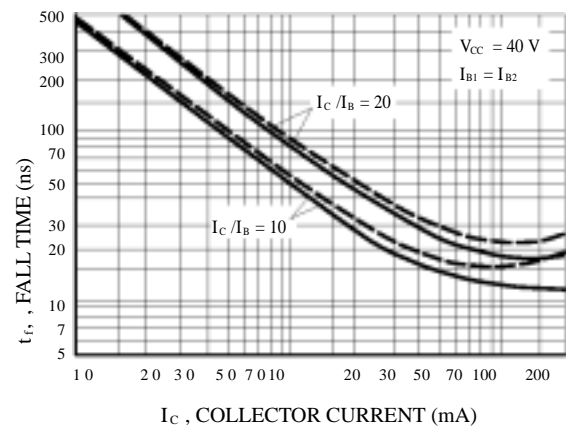


Figure 8. Fall Time

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

### NOISE FIGURE VARIATIONS

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

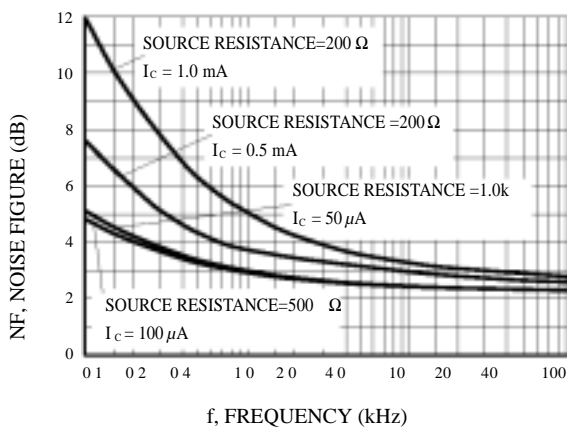


Figure 9.

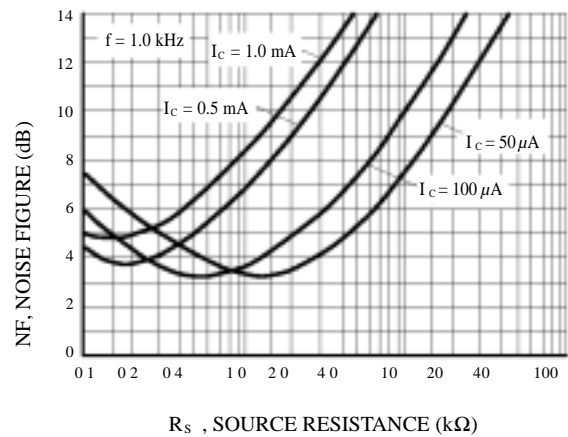
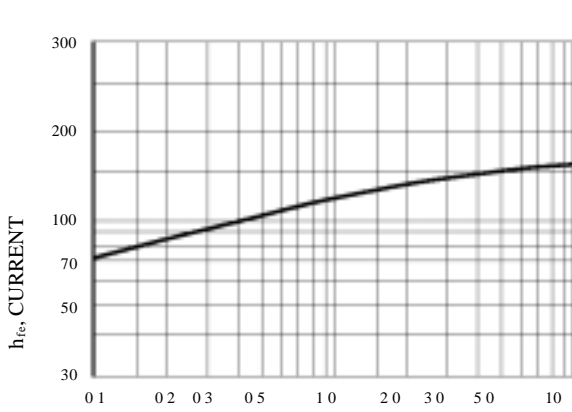


Figure 10.

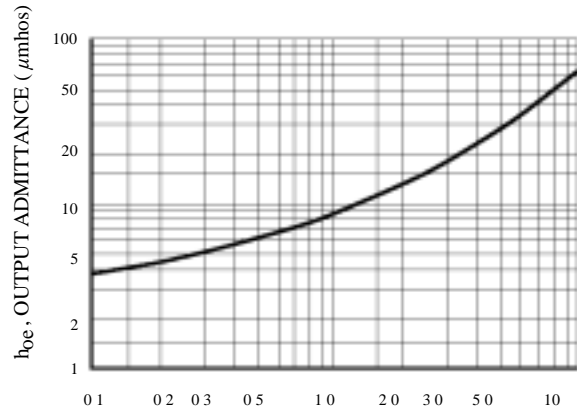
## h PARAMETERS

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



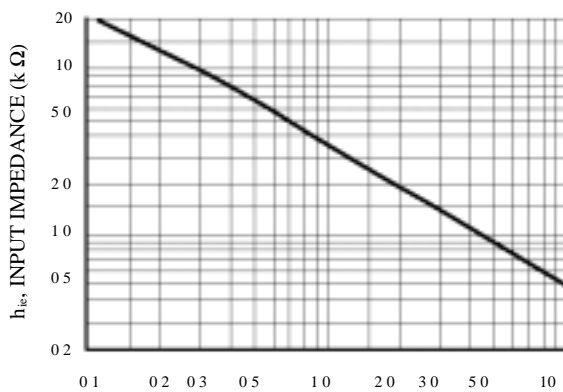
IC, COLLECTOR CURRENT (mA)

Figure 11. Current Gain



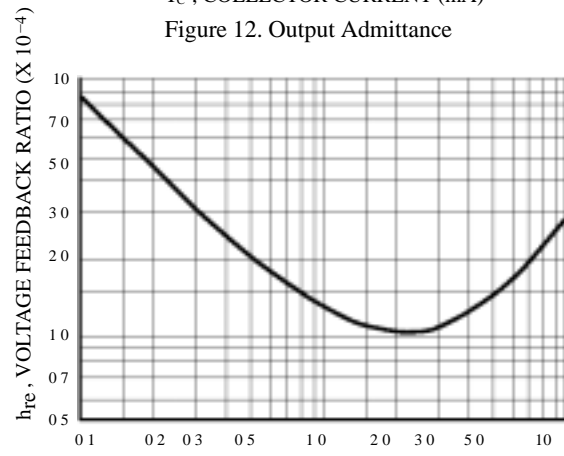
IC, COLLECTOR CURRENT (mA)

Figure 12. Output Admittance



IC, COLLECTOR CURRENT (mA)

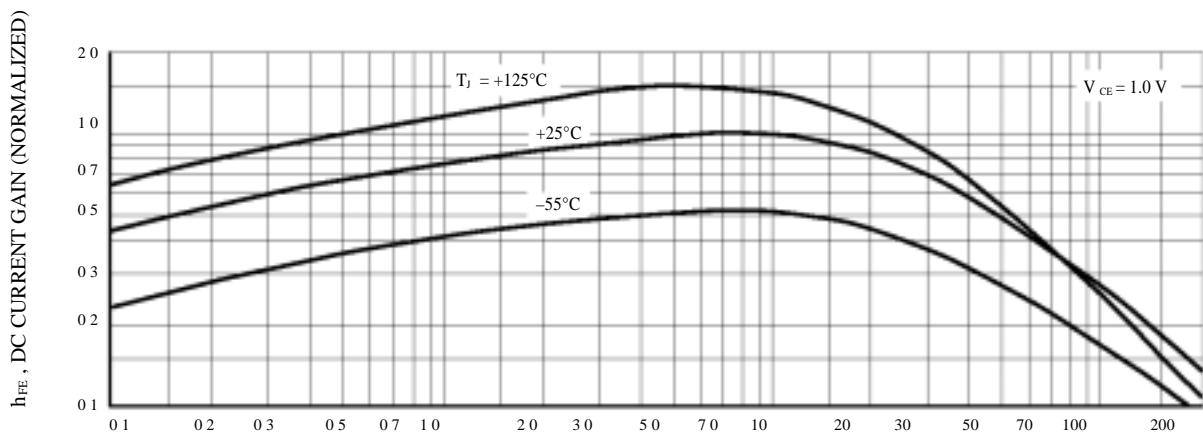
Figure 13. Input Impedance



IC, COLLECTOR CURRENT (mA)

Figure 14. Voltage Feedback Ratio

## TYPICAL STATIC CHARACTERISTICS



IC, COLLECTOR CURRENT (mA)

Figure 15. DC Current Gain

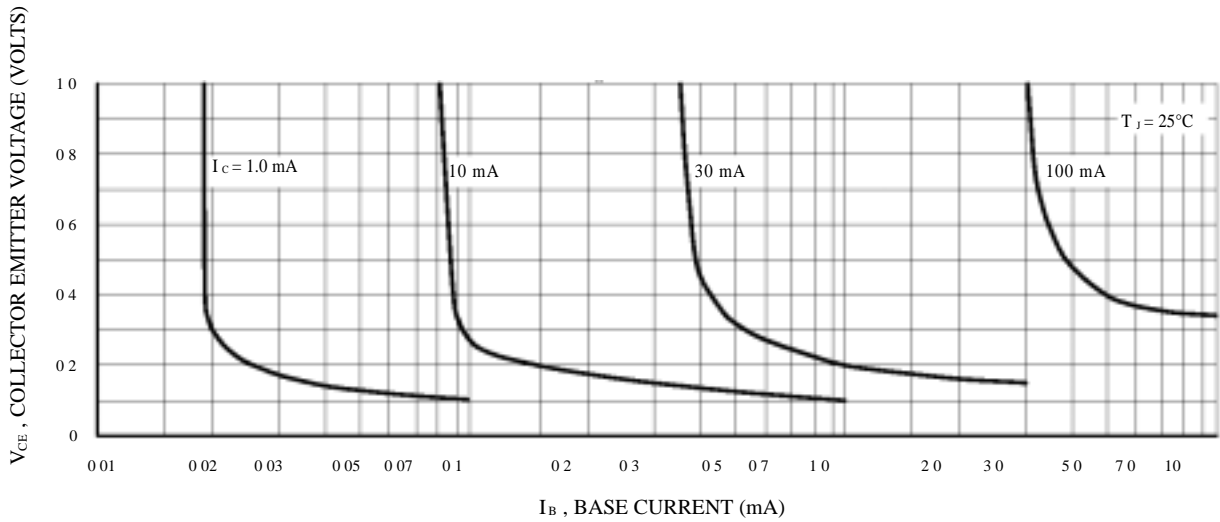
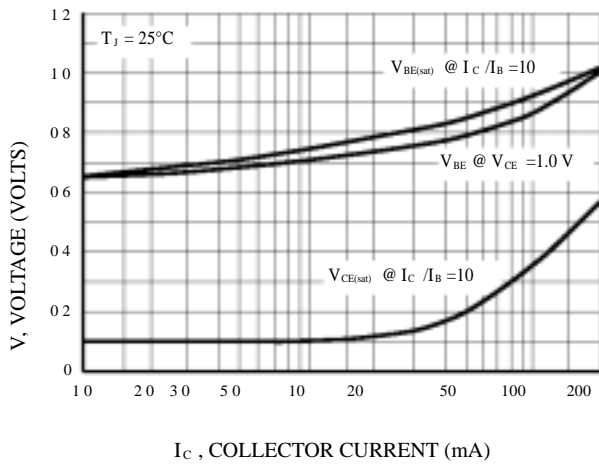
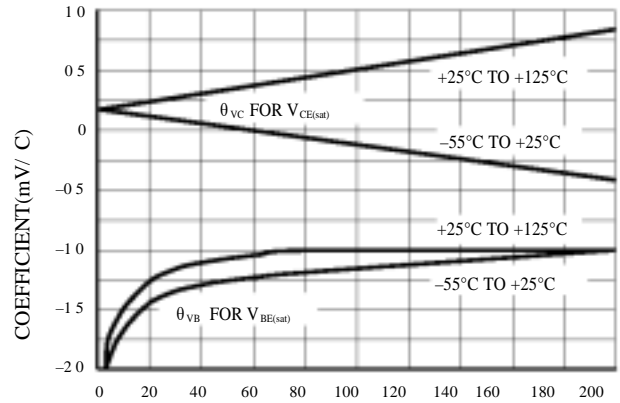


Figure 16. Collector Saturation Region



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

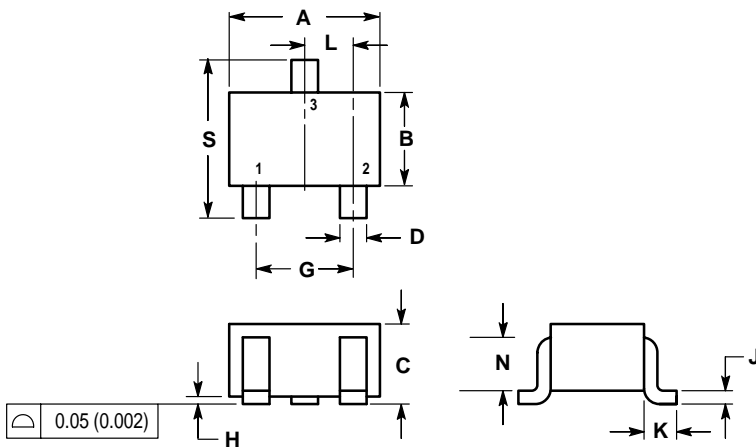


$I_C$ , COLLECTOR CURRENT (mA)  
Figure 18. Temperature Coefficients

## SC-70 / SOT-323

**NOTES:**

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



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.032	0.040	0.80	1.00
D	0.012	0.016	0.30	0.40
G	0.047	0.055	1.20	1.40
H	0.000	0.004	0.00	0.10
J	0.004	0.010	0.10	0.25
K	0.017 REF		0.425 REF	
L	0.026 BSC		0.650 BSC	
N	0.028 REF		0.700 REF	
S	0.079	0.095	2.00	2.40

