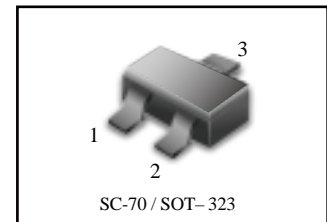


## General Purpose Transistor

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

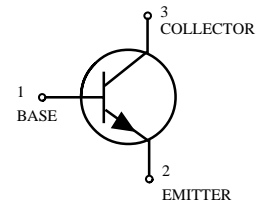
### ORDERING INFORMATION

Device	Marking	Shipping
2N3904U	AM	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°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
<b>ON CHARACTERISTICS (3)</b>				
DC Current Gain ( $I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc) ( $I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ( $I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ( $I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc) ( $I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc)	$h_{FE}$	40 70 100 60 30	– – 300 – –	–
Collector–Emitter Saturation Voltage ( $I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ( $I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	– –	0.2 0.3	Vdc
Base–Emitter Saturation Voltage ( $I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ( $I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{BE(sat)}$	0.65 –	0.85 0.95	Vdc
<b>SMALL–SIGNAL CHARACTERISTICS</b>				
Current–Gain – Bandwidth Product ( $I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, $f = 100$ MHz)	$f_T$	300	–	MHz
Output Capacitance ( $V_{CB} = 5.0$ Vdc, $I_E = 0$ , $f = 1.0$ MHz)	$C_{obo}$	–	4.0	pF
Input Capacitance ( $V_{EB} = 0.5$ Vdc, $I_C = 0$ , $f = 1.0$ MHz)	$C_{ibo}$	–	8.0	pF
Input Impedance ( $V_{CE} = 10$ Vdc, $I_C = 1.0$ mAdc, $f = 1.0$ kHz)	$h_{ie}$	1.0	10	k $\Omega$
Voltage Feedback Ratio ( $V_{CE} = 10$ Vdc, $I_C = 1.0$ mAdc, $f = 1.0$ kHz)	$h_{re}$	0.5	8.0	$\times 10^{-4}$
Small–Signal Current Gain ( $V_{CE} = 10$ Vdc, $I_C = 1.0$ mAdc, $f = 1.0$ kHz)	$h_{fe}$	100	400	–
Output Admittance ( $V_{CE} = 10$ Vdc, $I_C = 1.0$ mAdc, $f = 1.0$ kHz)	$h_{oe}$	1.0	40	$\mu$ mhos
Noise Figure ( $V_{CE} = 5.0$ Vdc, $I_C = 100$ $\mu$ Adc, $R_S = 1.0$ k $\Omega$ , $f = 1.0$ kHz)	NF	–	5.0	dB

## SWITCHING CHARACTERISTICS

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

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

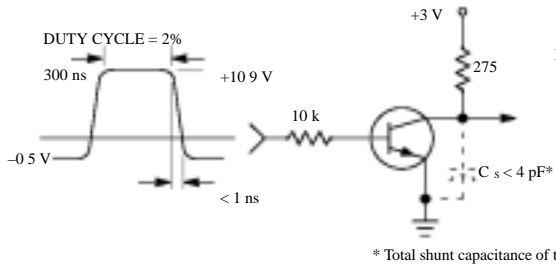


Figure 1. Delay and Rise Time  
Equivalent Test Circuit

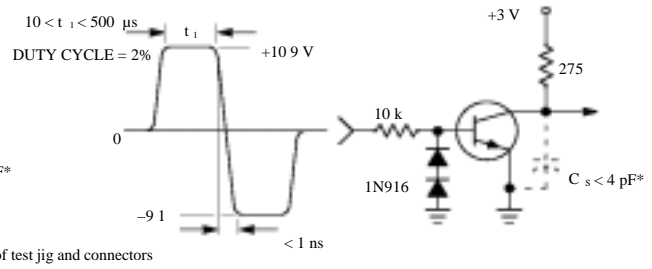


Figure 2. Storage and Fall Time  
Equivalent Test Circuit

## TYPICAL TRANSIENT CHARACTERISTICS

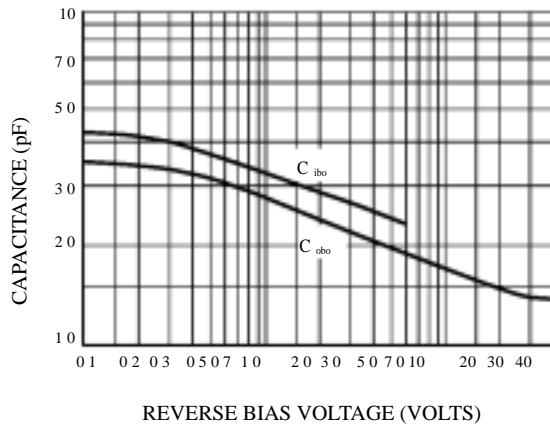


Figure 3. Capacitance

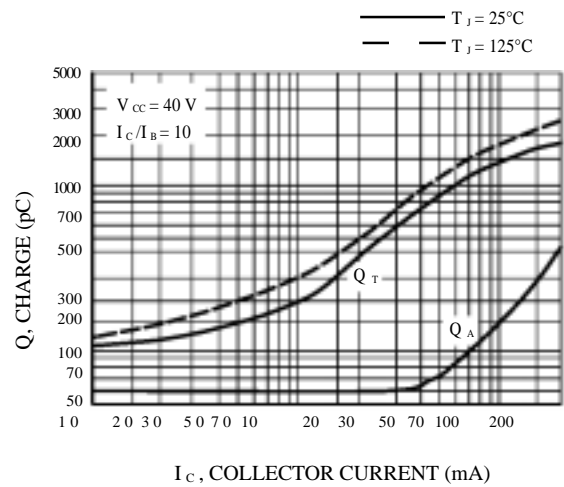


Figure 4. Charge Data

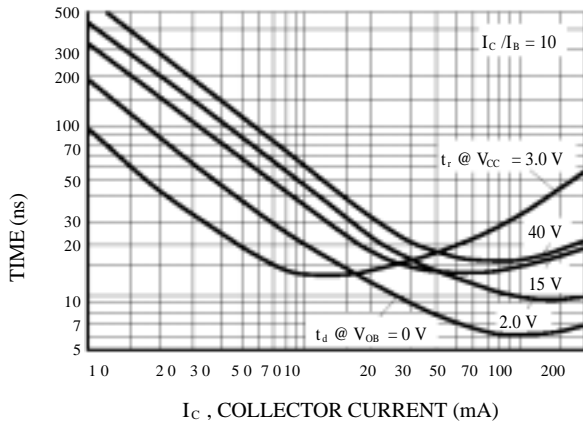


Figure 5. Turn-On Time

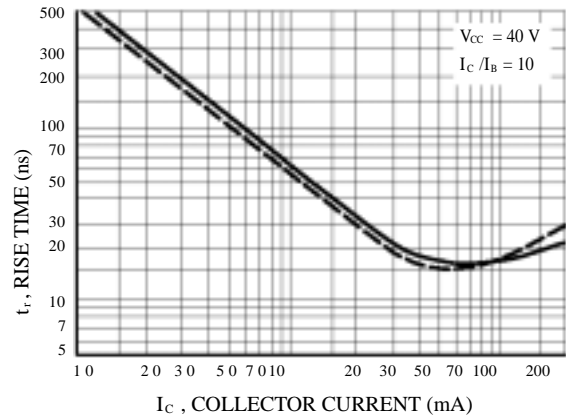


Figure 6. Rise Time

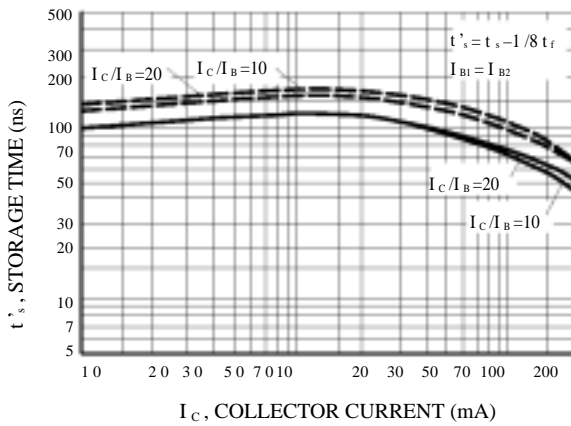


Figure 7. Storage Time

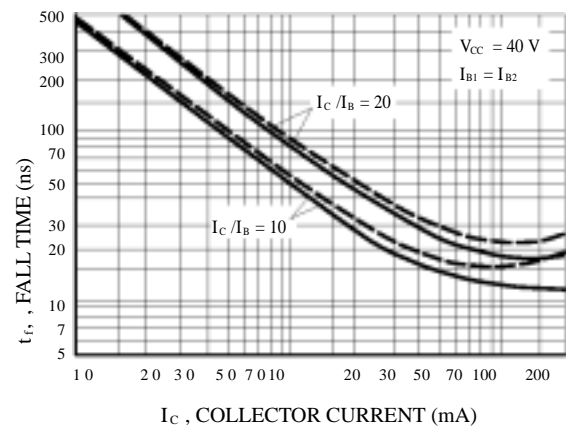


Figure 8. Fall Time

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

### NOISE FIGURE VARIATIONS

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

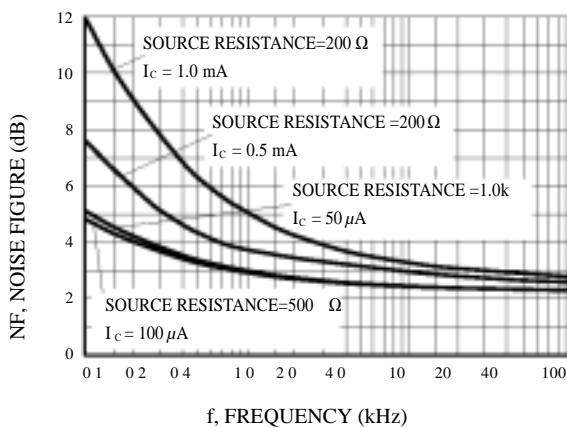


Figure 9.

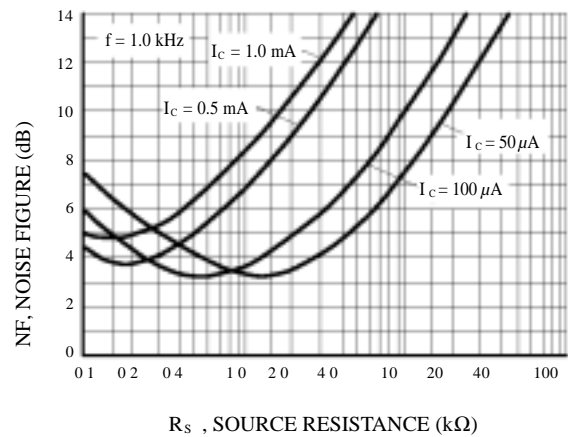


Figure 10.

## h PARAMETERS

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

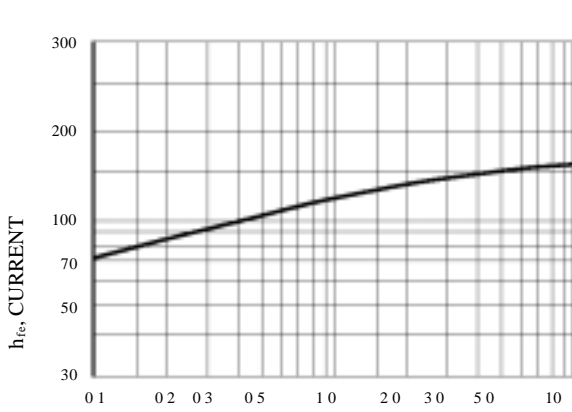


Figure 11. Current Gain

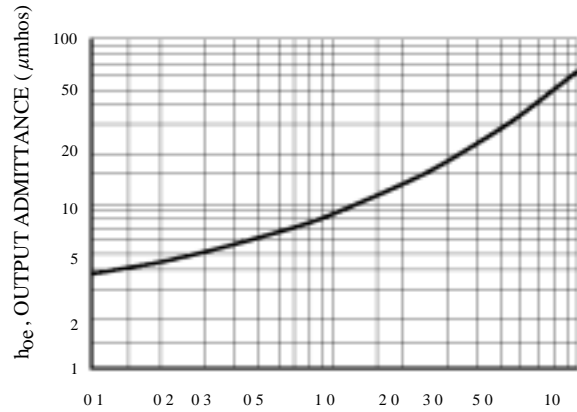


Figure 12. Output Admittance

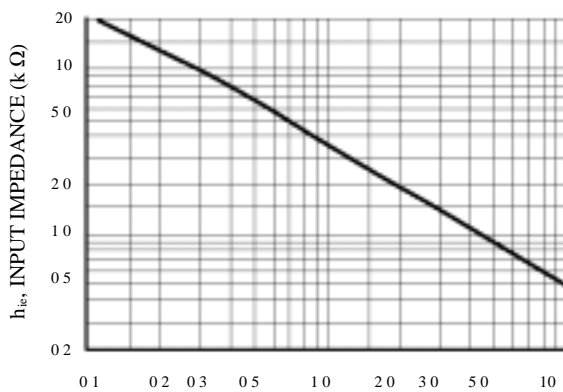


Figure 13. Input Impedance

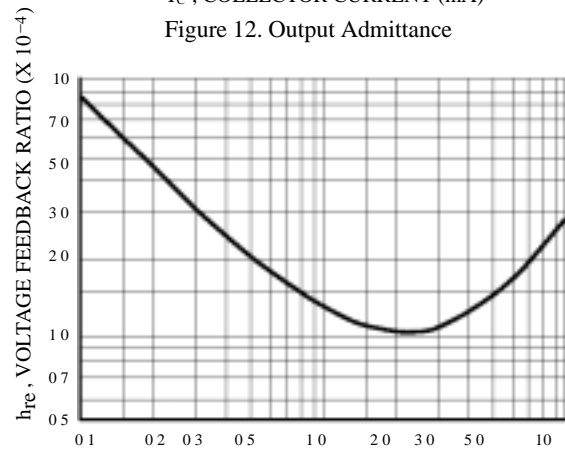


Figure 14. Voltage Feedback Ratio

## TYPICAL STATIC CHARACTERISTICS

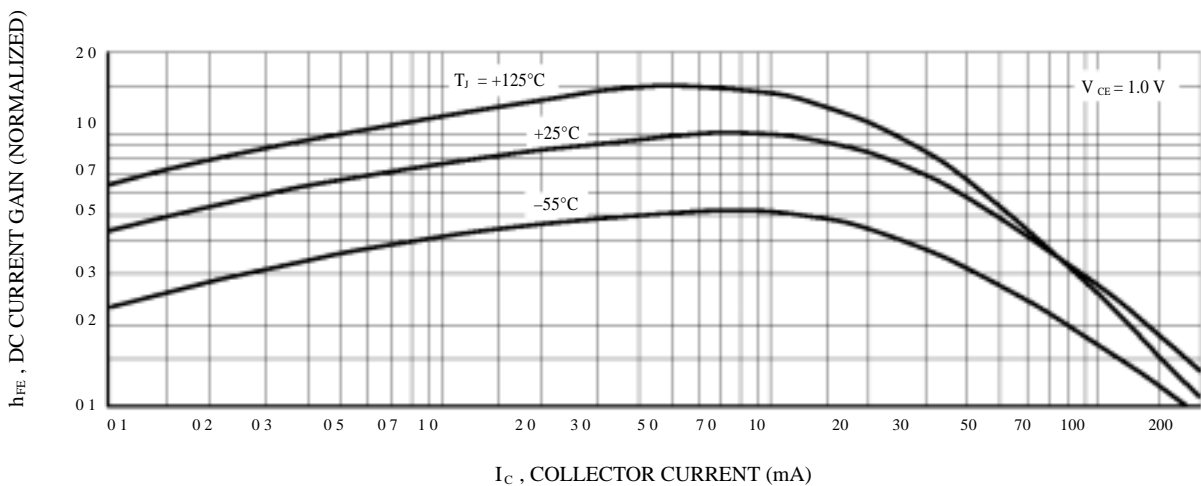


Figure 15. DC Current Gain

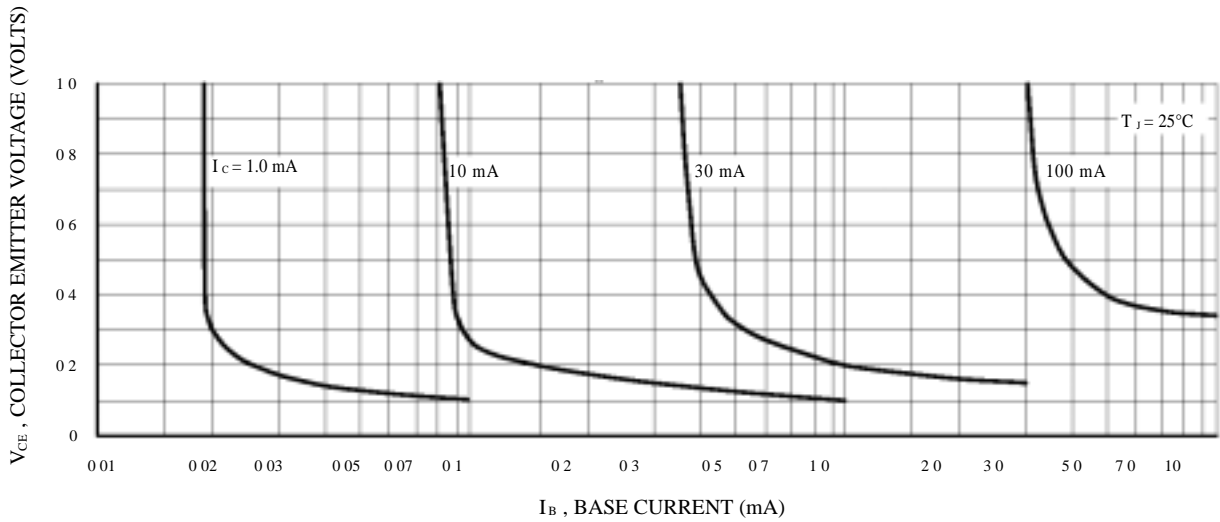


Figure 16. Collector Saturation Region

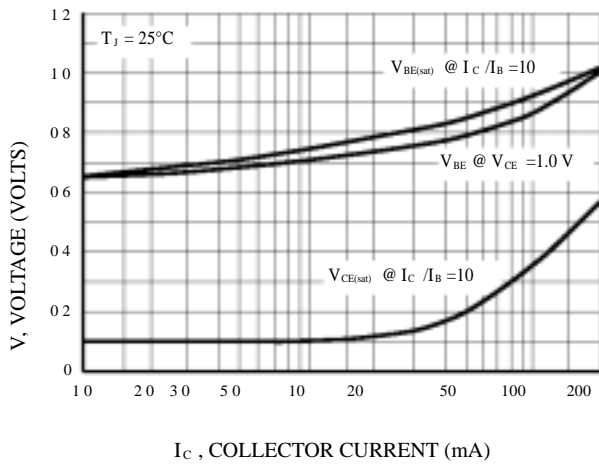


Figure 17. "ON" Voltages

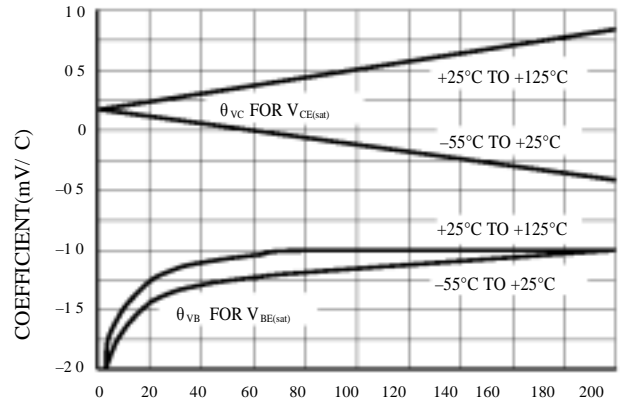
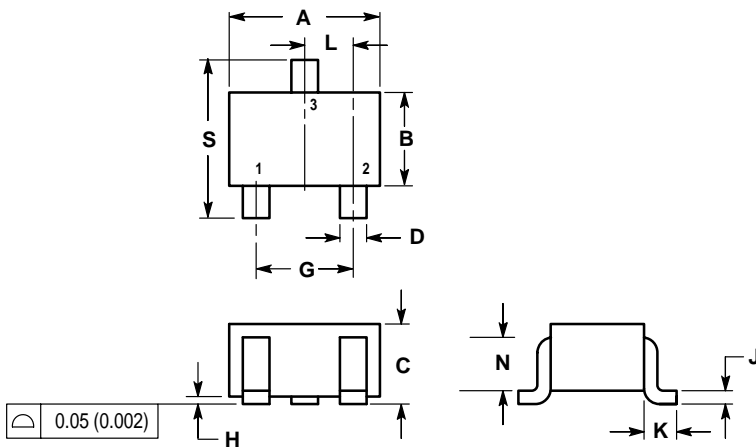


Figure 18. Temperature Coefficients

## SC-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

