

General Purpose Transistor

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

ORDERING INFORMATION

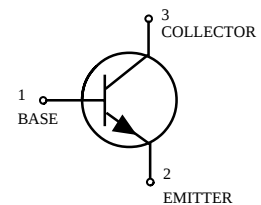
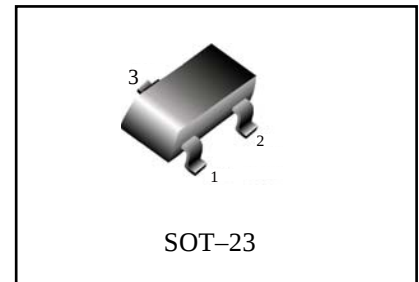
Device	Marking	Shipping
2N3904S	1AM	3000/Tape & Reel

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) $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	225	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	$^\circ\text{C/W}$
Total Device Dissipation Alumina Substrate, (2) $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	300	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	$^\circ\text{C/W}$
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
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(3) ($I_C = 1.0\text{ mAdc}$)	$V_{(BR)CEO}$	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

- 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 $\leq 300\text{ }\mu\text{s}$, Duty Cycle $\leq 2.0\%$.

ELECTRICAL CHARACTERISTICS (T_A 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS (3)				
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
SMALL–SIGNAL CHARACTERISTICS				
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 Ω
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	μ mhos
Noise Figure ($V_{CE} = 5.0$ Vdc, $I_C = 100$ μ Adc, $R_S = 1.0$ k Ω , $f = 1.0$ 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	
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	

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

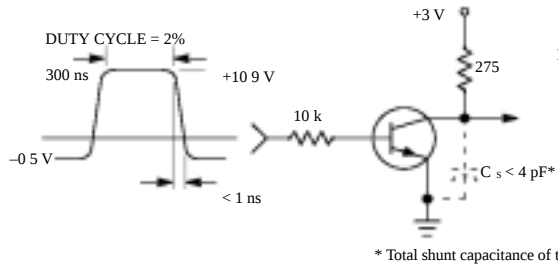


Figure 1. Delay and Rise Time
Equivalent Test Circuit

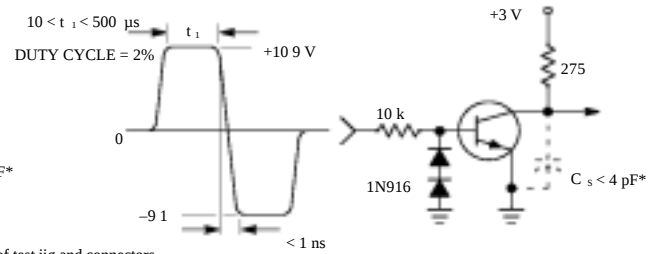


Figure 2. Storage and Fall Time
Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

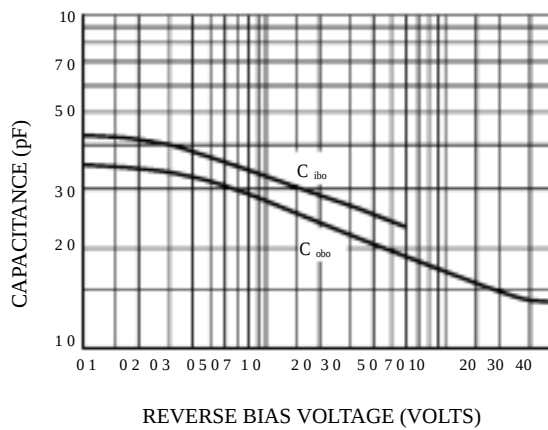


Figure 3. Capacitance

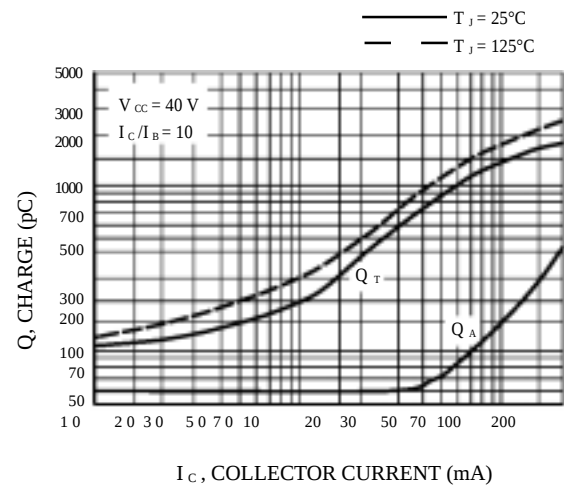
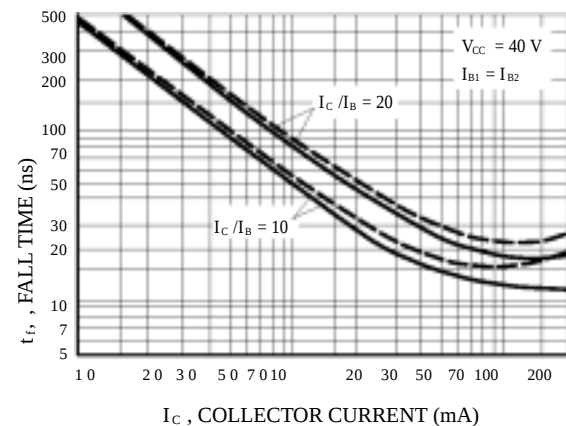
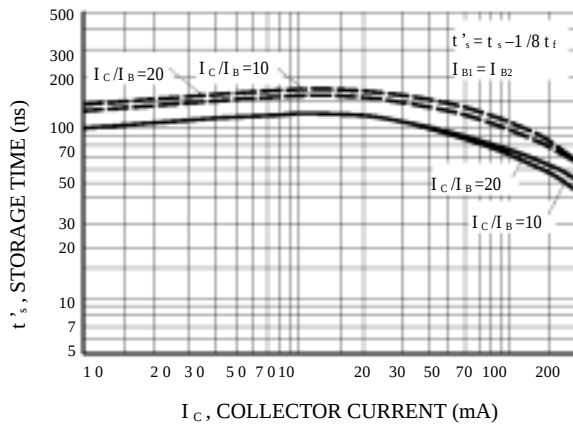
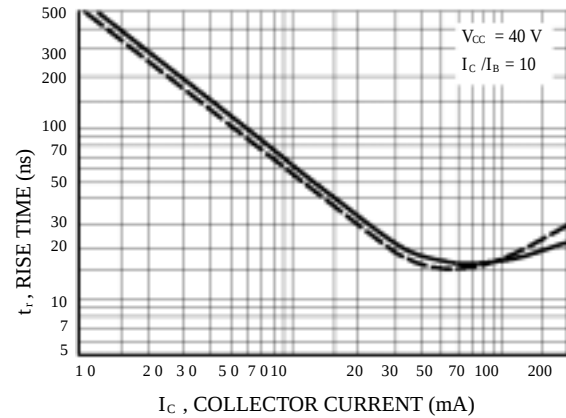
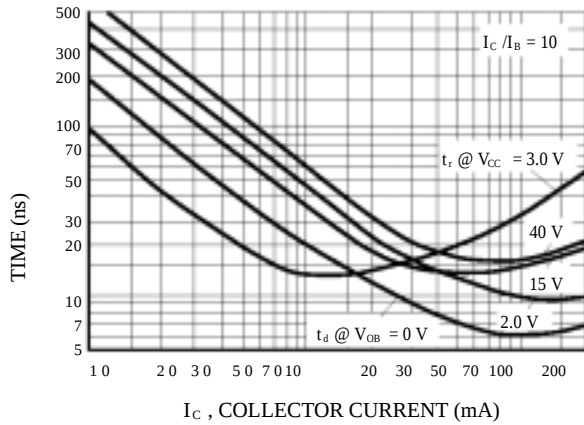


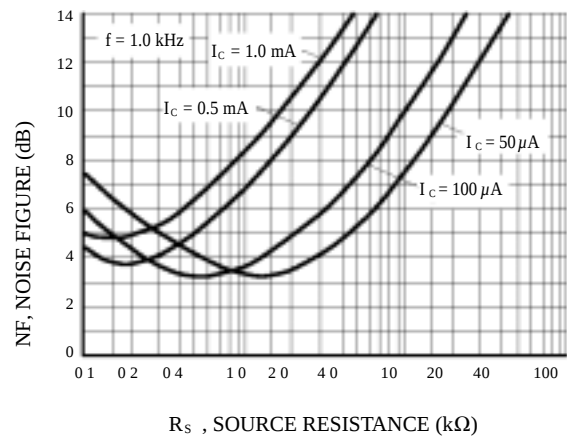
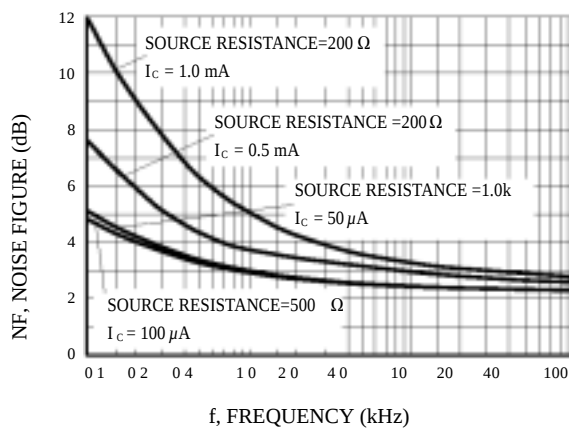
Figure 4. Charge Data



TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

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



h PARAMETERS

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

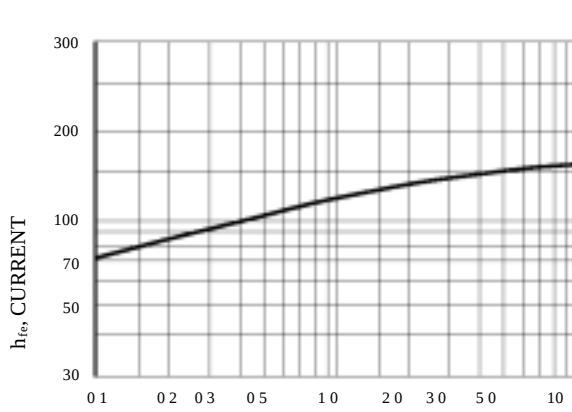


Figure 11. Current Gain

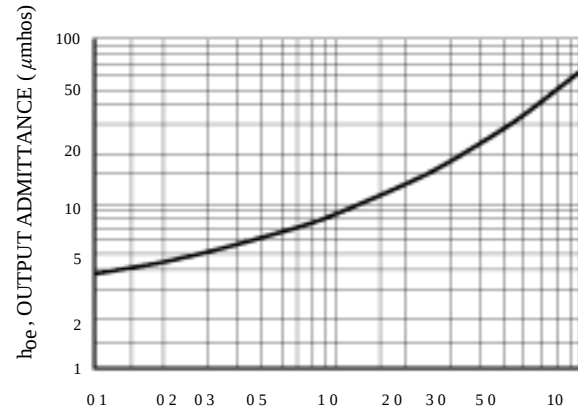


Figure 12. Output Admittance

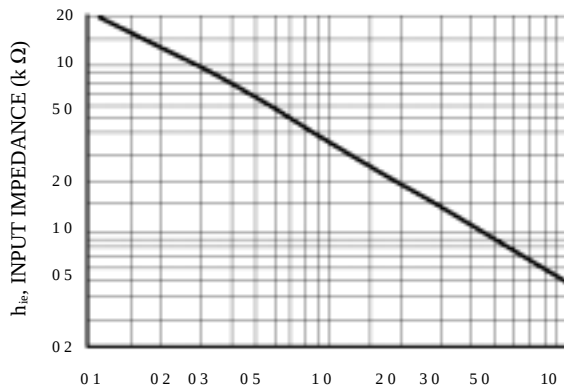


Figure 13. Input Impedance

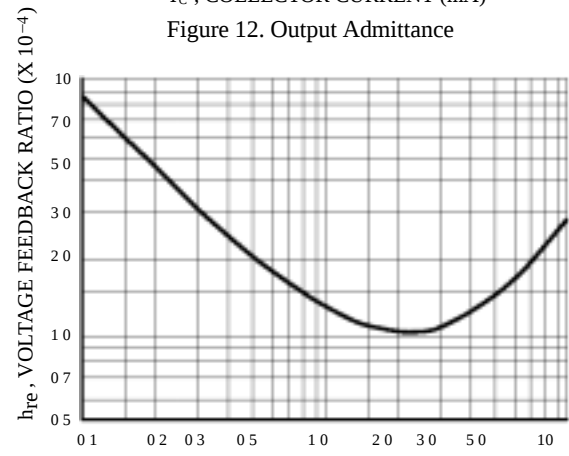


Figure 14. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

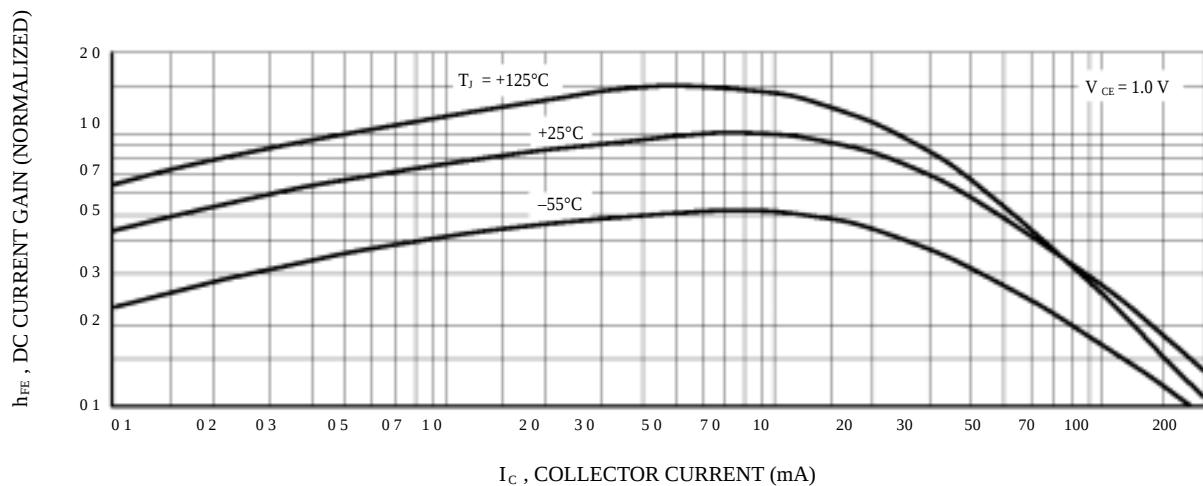
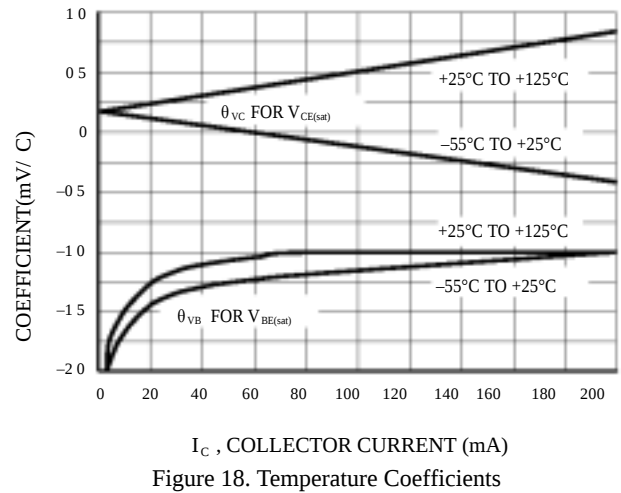
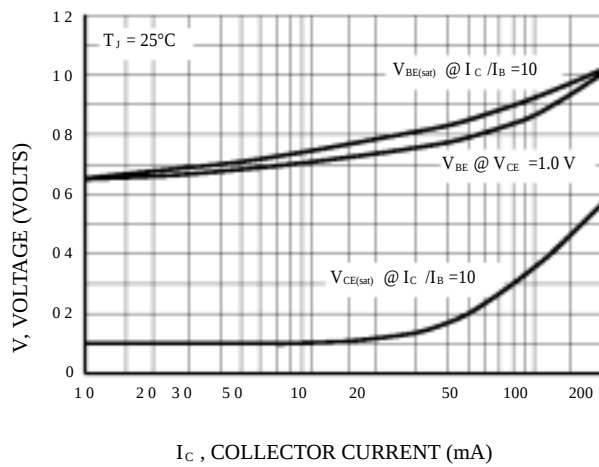
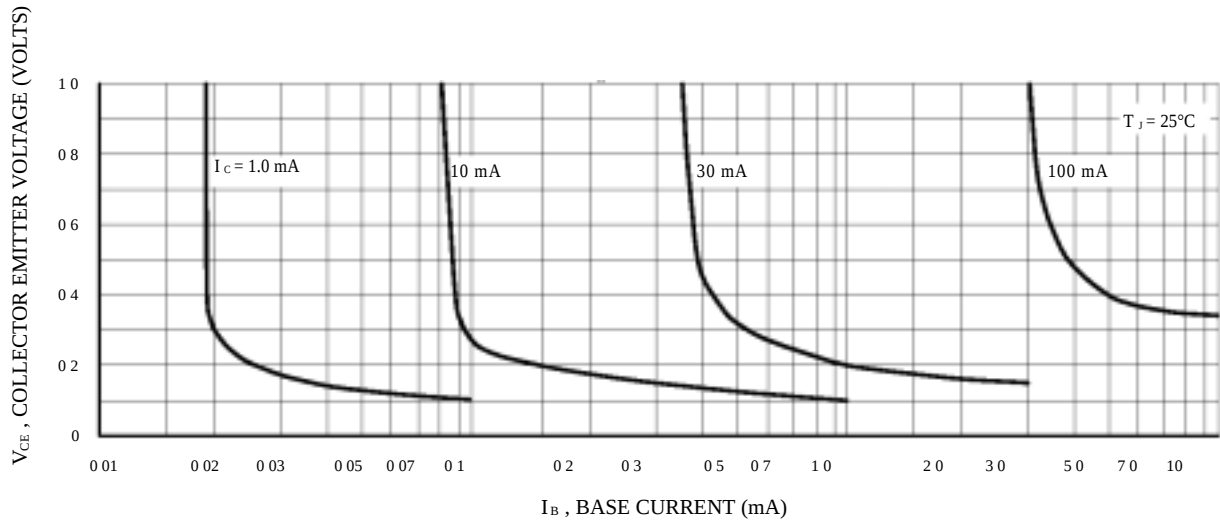


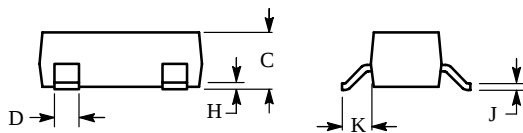
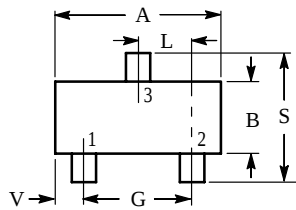
Figure 15. DC Current Gain



SOT-23

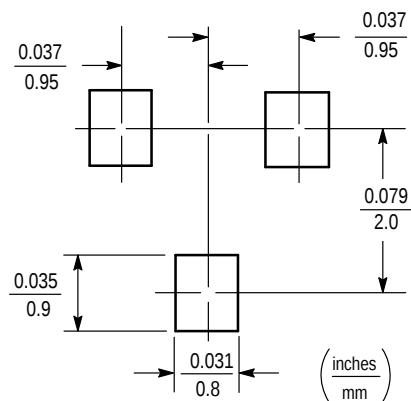
NOTES:

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

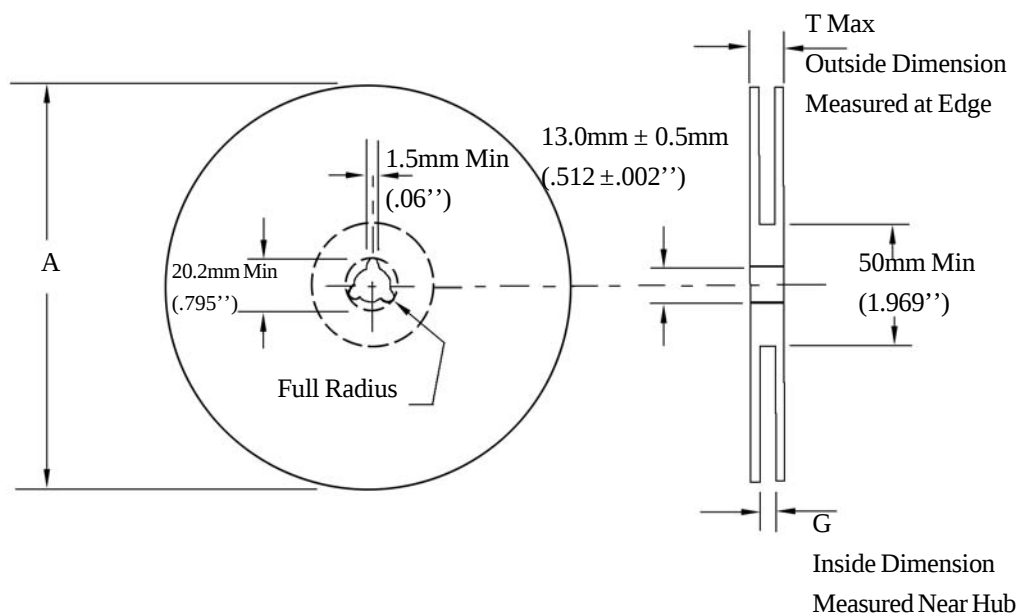


DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.1102	0.1197	2.80	3.04
B	0.0472	0.0551	1.20	1.40
C	0.0350	0.0440	0.89	1.11
D	0.0150	0.0200	0.37	0.50
G	0.0701	0.0807	1.78	2.04
H	0.0005	0.0040	0.013	0.100
J	0.0034	0.0070	0.085	0.177
K	0.0140	0.0285	0.35	0.69
L	0.0350	0.0401	0.89	1.02
S	0.0830	0.1039	2.10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

PIN 1 BASE
2 EMITTER
3 COLLECTOR



EMBOSED TAPE AND REEL DATA FOR DISCRETES



Size	A Max	G	T Max
8 mm	330mm (12.992'')	8.4mm+1.5mm, -0.0 (.33''+.059'', -0.00)	14.4mm (.56'')

Reel Dimensions

Metric Dimensions Govern — English are in parentheses for reference only

Storage Conditions

Temperature: 5 to 40 Deg.C (20 to 30 Deg. C is preferred)

Humidity: 30 to 80 RH (40 to 60 is preferred)

Recommended Period: One year after manufacturing

(This recommended period is for the soldering condition only. The characteristics and reliabilities of the products are not restricted to this limitation)