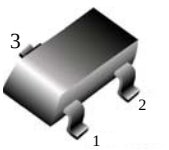
# General Purpose Transistor

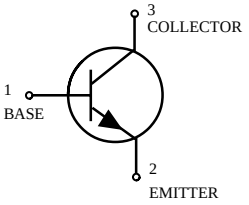
- We declare that the material of product compliance with RoHS requirements.

## ORDERING INFORMATION

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




SOT–23




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

## ELECTRICAL CHARACTERISTICS ($T_A$ = 25 C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | |
| Collector–Emitter Breakdown Voltage(3)<br>($I_C$ = 1.0 mAdc) | $V_{(BR)CEO}$ | 40 | - | Vdc |
| Collector–Base Breakdown Voltage<br>($I_C$ = 10 µAdc) | $V_{(BR)CBO}$ | 60 | - | Vdc |
| Emitter–Base Breakdown Voltage<br>($I_E$ = 10 µAdc) | $V_{(BR)EBO}$ | 6.0 | - | Vdc |
| Base Cutoff Current<br>( $V_{CE}$ = 30 Vdc, $V_{EB}$ = 3.0 Vdc, ) | $I_{BL}$ | - | 50 | nAdc |
| Collector Cutoff Current<br>( $V_{CE}$ = 30Vdc, $V_{BE}$ = 3.0Vdc ) | $I_{CEX}$ | - | 50 | nAdc |

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

**ELECTRICAL CHARACTERISTICS** ( $T_A$ 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| **ON CHARACTERISTICS (3)** | | | | |
| DC Current Gain | $h_{FE}$ | | | – |
| ($I_C$ = 0.1 mAdc, $V_{CE}$ = 1.0 Vdc) | | 40 | – | |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 1.0 Vdc) | | 70 | – | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc) | | 100 | 300 | |
| ($I_C$ = 50 mAdc, $V_{CE}$ = 1.0 Vdc) | | 60 | – | |
| ($I_C$ = 100 mAdc, $V_{CE}$ = 1.0 Vdc) | | 30 | – | |
| Collector–Emitter Saturation Voltage | $V_{CE(sat)}$ | | | Vdc |
| ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc) | | – | 0.2 | |
| ($I_C$ = 50 mAdc, $I_B$ = 5.0 mAdc) | | – | 0.3 | |
| Base–Emitter Saturation Voltage | $V_{BE(sat)}$ | | | Vdc |
| ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc) | | 0.65 | 0.85 | |
| ($I_C$ = 50 mAdc, $I_B$ = 5.0 mAdc) | | – | 0.95 | |
| **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 | kΩ |
| Voltage Feedback Ratio ($V_{CE}$ = 10 Vdc, $I_C$ = 1.0 mAdc, f = 1.0 kHz) | $h_{re}$ | 0.5 | 8.0 | X $10^{-4}$ |
| 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 ($V_{CE}$ = 5.0Vdc, $I_C$ = 100 $\mu$Adc, RS = 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 $\mu$s; Duty Cycle ≤ 2.0%.

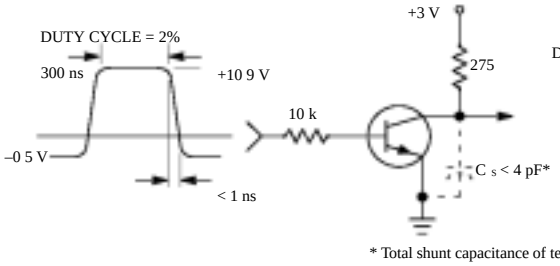
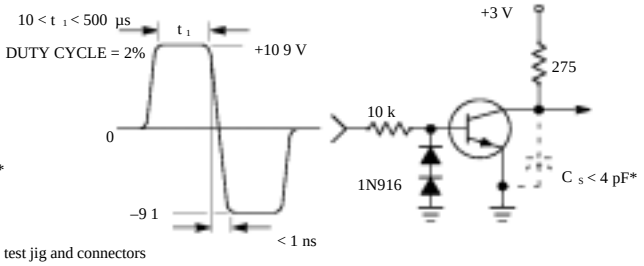


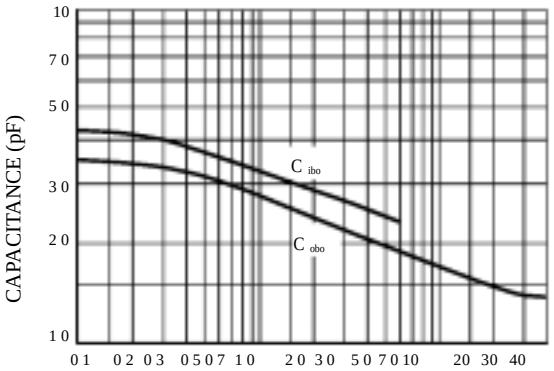

Figure 1. Delay and Rise Time
Equivalent Test Circuit



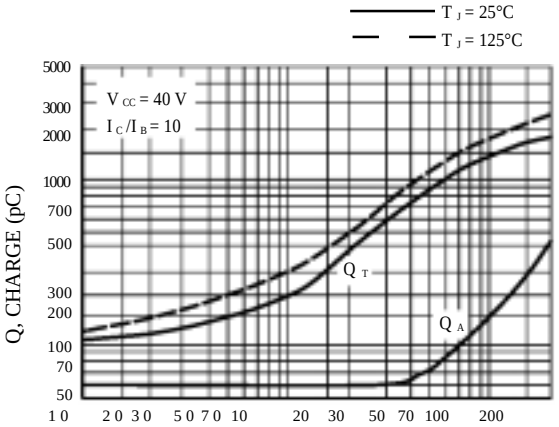

* Total shunt capacitance of test jig and connectors

Figure 2. Storage and Fall Time
Equivalent Test Circuit

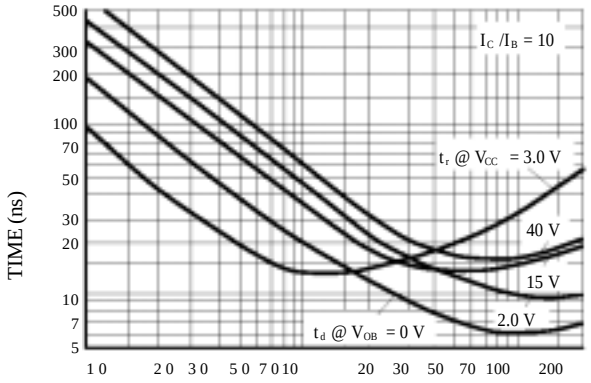
## TYPICAL TRANSIENT CHARACTERISTICS




REVERSE BIAS VOLTAGE (VOLTS)
Figure 3. Capacitance

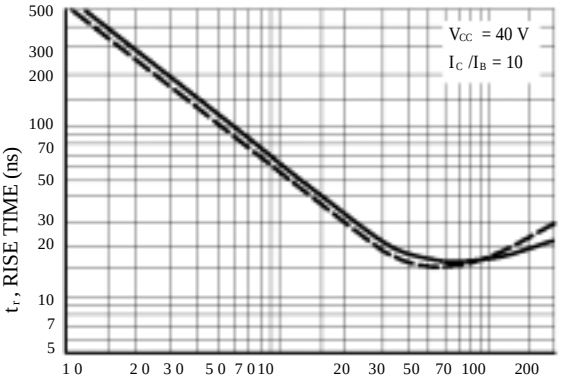



I C , COLLECTOR CURRENT (mA)
Figure 4. Charge Data



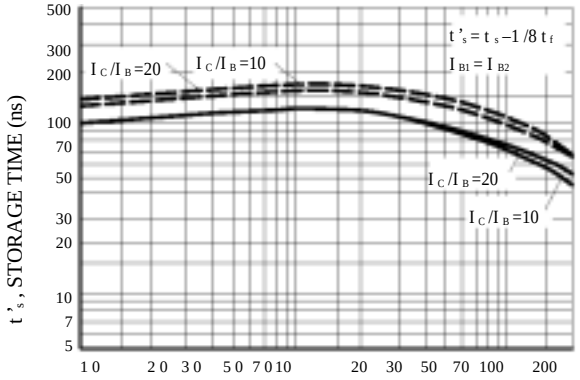

I C , COLLECTOR CURRENT (mA)

Figure 5. Turn–On Time



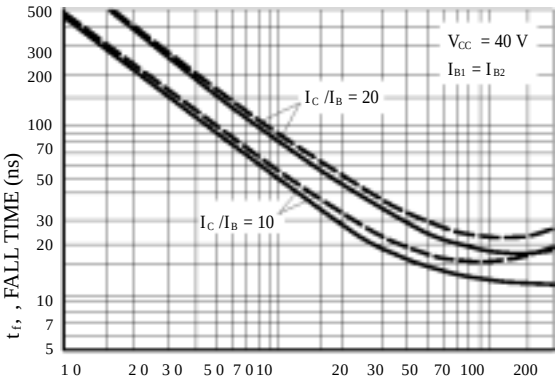

I C , COLLECTOR CURRENT (mA)

Figure 6. Rise Time




I C , COLLECTOR CURRENT (mA)

Figure 7. Storage Time



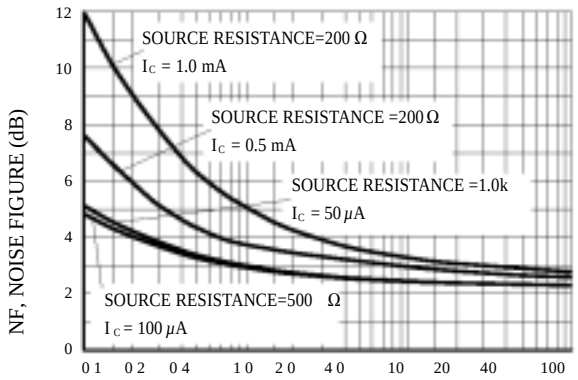

I C , COLLECTOR CURRENT (mA)

Figure 8. Fall Time

## TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS

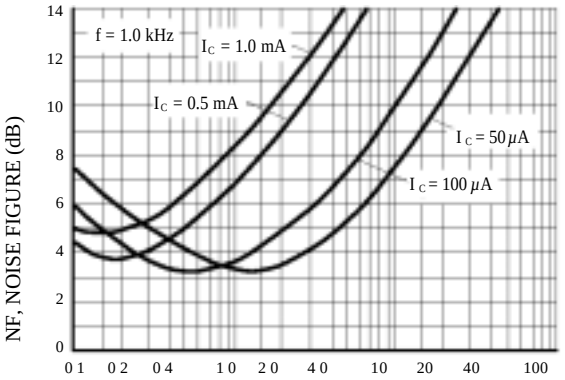
## NOISE FIGURE VARIATIONS

($V_{CE}$ = 5.0 Vdc, $T_A$ = 25°C, Bandwidth = 1.0 Hz)




f, FREQUENCY (kHz)

Figure 9.




$R_S$ , SOURCE RESISTANCE (kΩ)

Figure 10.

## h PARAMETERS

($V_{CE}$ = 10 Vdc, f = 1.0 kHz, $T_A$ = 25°C)

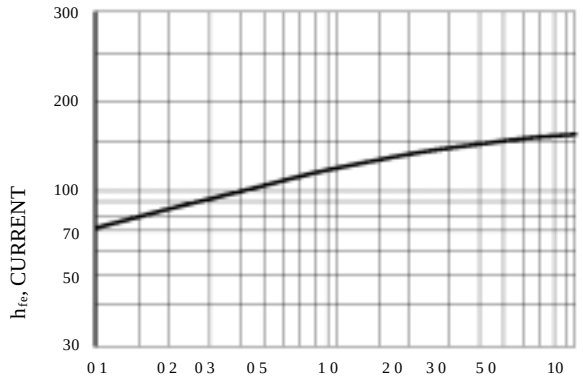



Figure 11. Current Gain

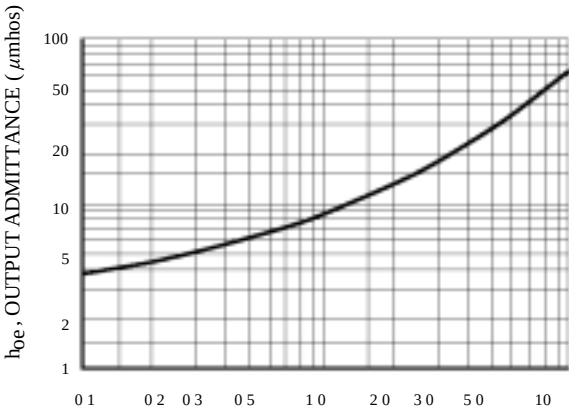



Figure 12. Output Admittance

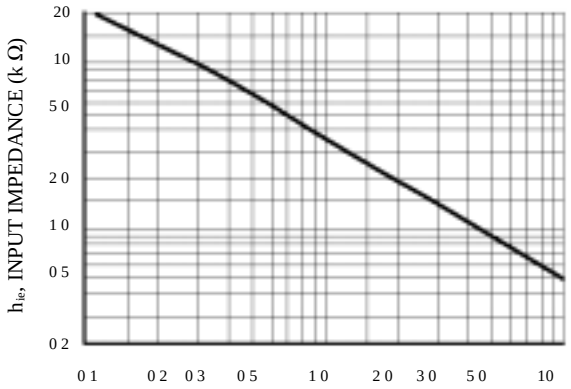



Figure 13. Input Impedance

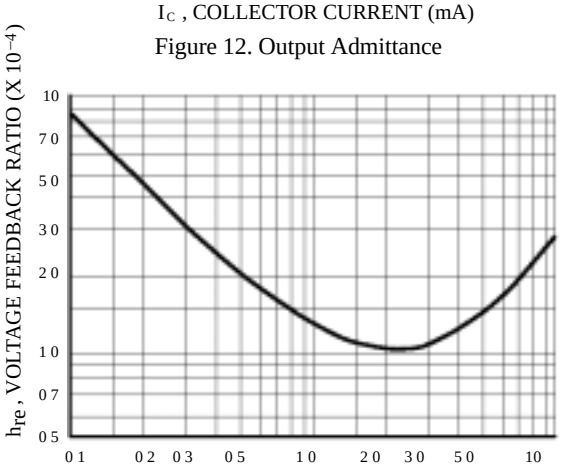



Figure 14. Voltage Feedback Ratio

## TYPICAL STATIC CHARACTERISTICS

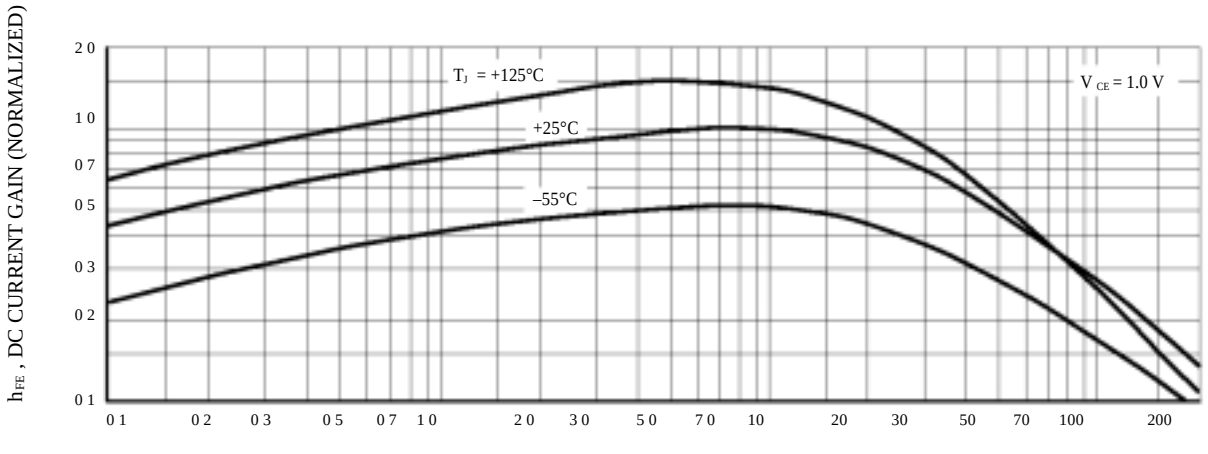



Figure 15. DC Current Gain

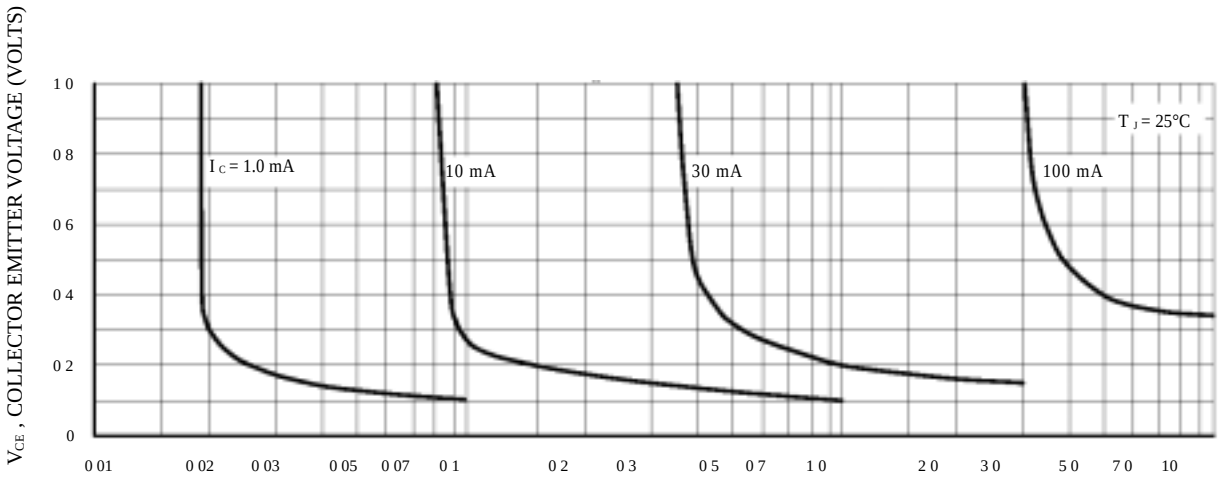



Figure 16. Collector Saturation Region

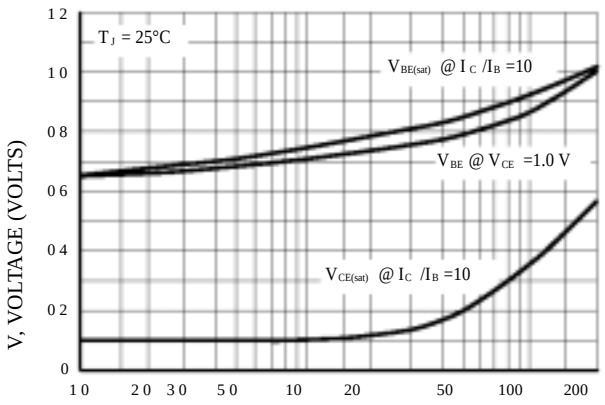



Figure 17. “ON” Voltages

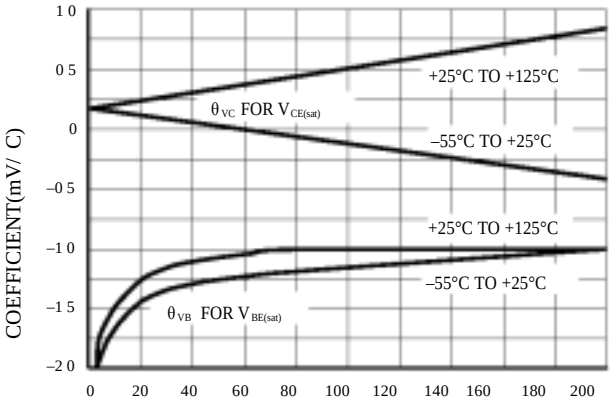
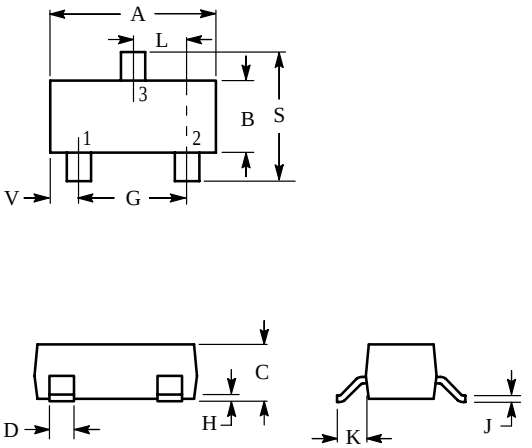



Figure 18. Temperature Coefficients

## SOT−23

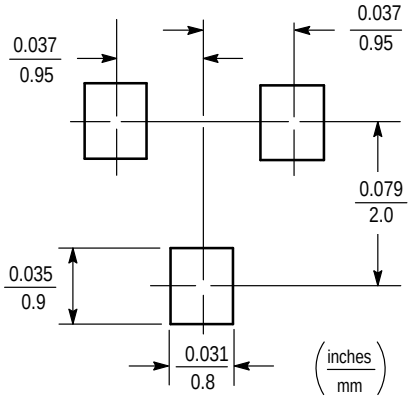



NOTES:

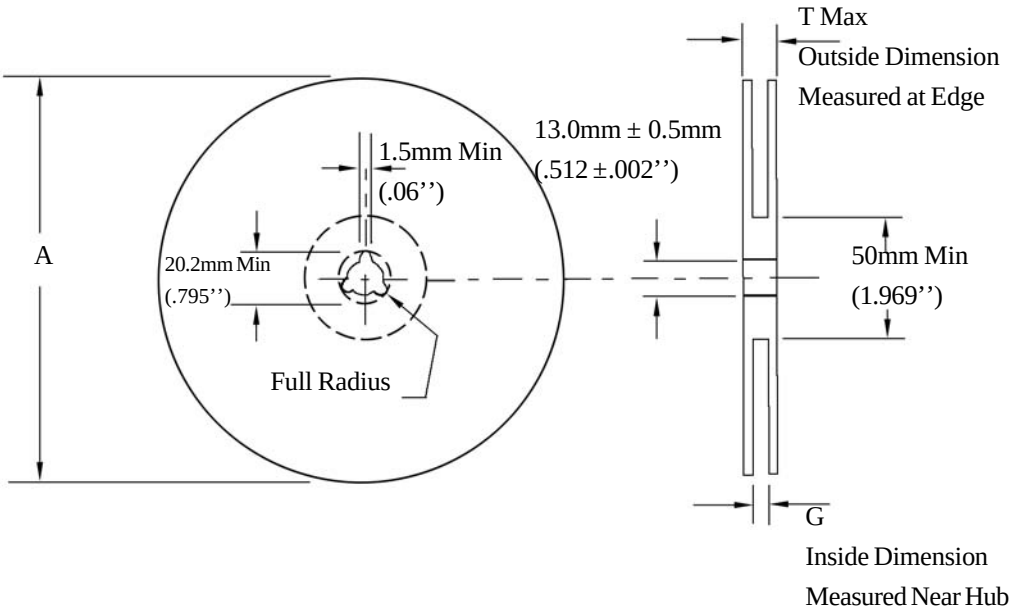
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M,1982
2. CONTROLLING DIMENSION: INCH.

| 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



# EMBOSSED 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)