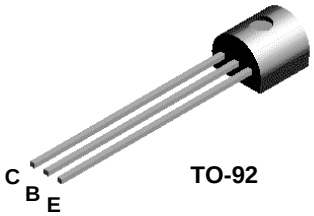
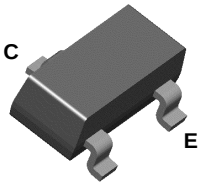
FAIRCHILD
SEMICONDUCTOR TM

# 2N4401




TO-92

# MMBT4401




SOT-23
Mark: 2X

## NPN General Pupose Amplifier

This device is designed for use as a medium power amplifier and switch requiring collector currents up to 500 mA.

### Absolute Maximum Ratings* TA = 25°C unless otherwise noted

| Symbol | Parameter | Value | Units |
|---|---|---|---|
| $V_{CEO}$ | Collector-Emitter Voltage | 40 | V |
| $V_{CBO}$ | Collector-Base Voltage | 60 | V |
| $V_{EBO}$ | Emitter-Base Voltage | 6.0 | V |
| $I_C$ | Collector Current - Continuous | 600 | mA |
| $T_J$, $T_{stg}$ | Operating and Storage Junction Temperature Range | -55 to +150 | °C |

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

**NOTES**:
**1)** These ratings are based on a maximum junction temperature of 150 degrees C.
**2)** These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

### Thermal Characteristics TA = 25°C unless otherwise noted

| Symbol | Characteristic | Max | | Units |
|---|---|---|---|---|
| | | 2N4401 | *MMBT4401 | |
| $P_D$ | Total Device Dissipation<br>Derate above 25°C | 625<br>5.0 | 350<br>2.8 | mW<br>mW/°C |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 83.3 | | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | 200 | 357 | °C/W |

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

## NPN General Purpose Amplifier
(continued)

### Electrical Characteristics
TA = 25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Max | Units |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{(BR)CEO}$ | Collector-Emitter Breakdown Voltage* | $I_C$ = 1.0 mA, $I_B$ = 0 | 40 | | V |
| $V_{(BR)CBO}$ | Collector-Base Breakdown Voltage | $I_C$ = 0.1 mA, $I_E$ = 0 | 60 | | V |
| $V_{(BR)EBO}$ | Emitter-Base Breakdown Voltage | $I_E$ = 0.1 mA, $I_C$ = 0 | 6.0 | | V |
| $I_{BL}$ | Base Cutoff Current | $V_{CE}$ = 35 V, $V_{EB}$ = 0.4 V | | 0.1 | µA |
| $I_{CEX}$ | Collector Cutoff Current | $V_{CE}$ = 35 V, $V_{EB}$ = 0.4 V | | 0.1 | µA |
| **ON CHARACTERISTICS*** | | | | | |
| $h_{FE}$ | DC Current Gain | $I_C$ = 0.1 mA, $V_{CE}$ = 1.0 V<br>$I_C$ = 1.0 mA, $V_{CE}$ = 1.0 V<br>$I_C$ = 10 mA, $V_{CE}$ = 1.0 V<br>$I_C$ = 150 mA, $V_{CE}$ = 1.0 V<br>$I_C$ = 500 mA, $V_{CE}$ = 2.0 V | 20<br>40<br>80<br>100<br>40 | <br><br><br>300<br> | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 500 mA, $I_B$ = 50 mA | | 0.4<br>0.75 | V<br>V |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage | $I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 500 mA, $I_B$ = 50 mA | 0.75 | 0.95<br>1.2 | V<br>V |
| **SMALL SIGNAL CHARACTERISTICS** | | | | | |
| $f_T$ | Current Gain - Bandwidth Product | $I_C$ = 20 mA, $V_{CE}$ = 10 V, f = 100 MHz | 250 | | MHz |
| $C_{cb}$ | Collector-Base Capacitance | $V_{CB}$ = 5.0 V, $I_E$ = 0, f = 140 kHz | | 6.5 | pF |
| $C_{eb}$ | Emitter-Base Capacitance | $V_{BE}$ = 0.5 V, $I_C$ = 0, f = 140 kHz | | 30 | pF |
| $h_{ie}$ | Input Impedance | $I_C$ = 1.0 mA, $V_{CE}$ = 10 V, f = 1.0 kHz | 1.0 | 15 | kΩ |
| $h_{re}$ | Voltage Feedback Ratio | $I_C$ = 1.0 mA, $V_{CE}$ = 10 V, f = 1.0 kHz | 0.1 | 8.0 | x $10^{-4}$ |
| $h_{fe}$ | Small-Signal Current Gain | $I_C$ = 1.0 mA, $V_{CE}$ = 10 V, f = 1.0 kHz | 40 | 500 | |
| $h_{oe}$ | Output Admittance | $I_C$ = 1.0 mA, $V_{CE}$ = 10 V, f = 1.0 kHz | 1.0 | 30 | µmhos |
| **SWITCHING CHARACTERISTICS** | | | | | |
| $t_d$ | Delay Time | $V_{CC}$ = 30 V, $V_{EB}$ = 2 V, | | 15 | ns |
| $t_r$ | Rise Time | $I_C$ = 150 mA, $I_{B1}$ = 15 mA | | 20 | ns |
| $t_s$ | Storage Time | $V_{CC}$ = 30 V, $I_C$ = 150 mA | | 225 | ns |
| $t_f$ | Fall Time | $I_{B1}$ = $I_{B2}$ = 15 mA | | 30 | ns |

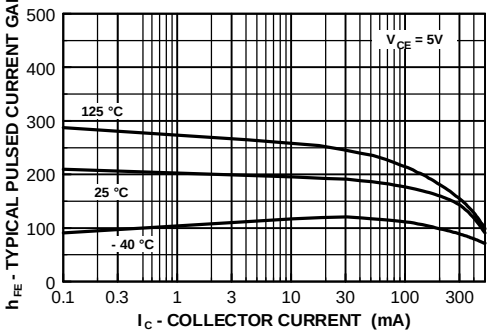
*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%

## NPN General Purpose Amplifier

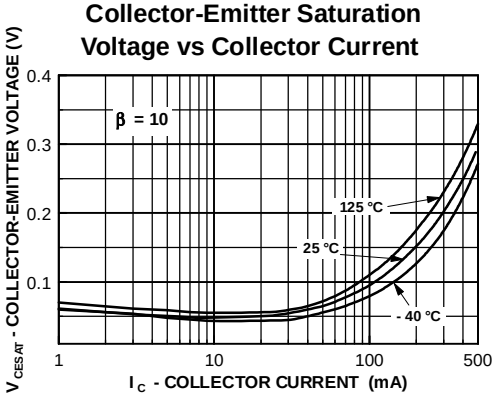
(continued)

### Typical Characteristics

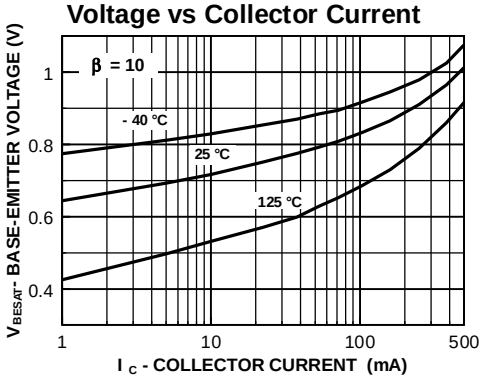
**Typical Pulsed Current Gain vs Collector Current**



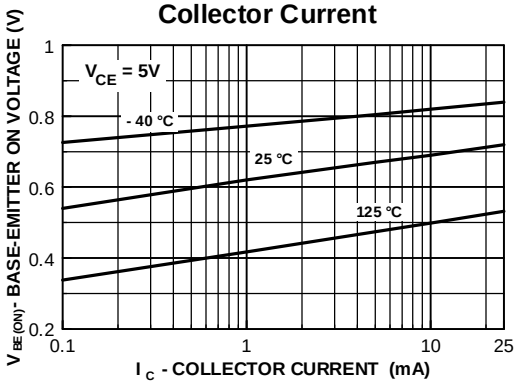

**Collector-Emitter Saturation Voltage vs Collector Current**



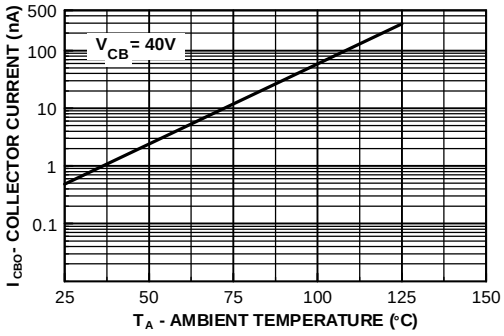

**Base-Emitter Saturation Voltage vs Collector Current**



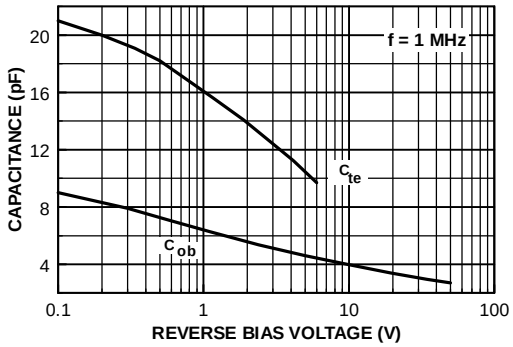

**Base-Emitter ON Voltage vs Collector Current**




**Collector-Cutoff Current vs Ambient Temperature**

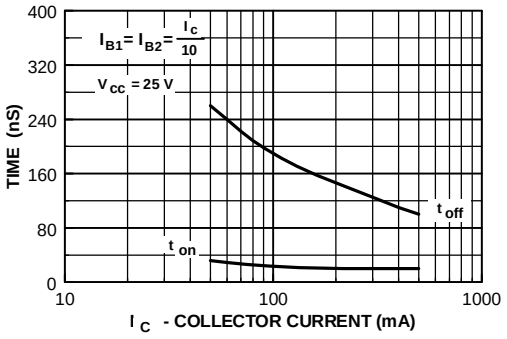



**Emitter Transition and Output Capacitance vs Reverse Bias Voltage**

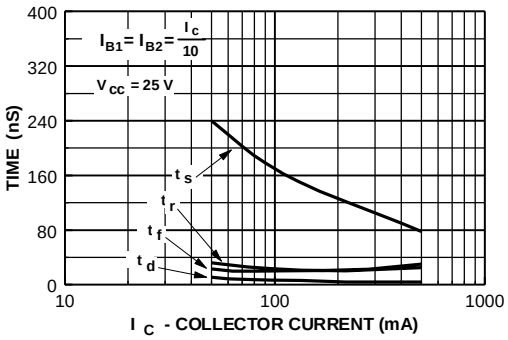


## Typical Characteristics (continued)

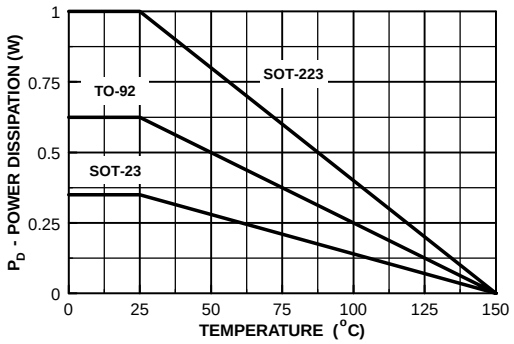
**Turn On and Turn Off Times vs Collector Current**




**Switching Times vs Collector Current**



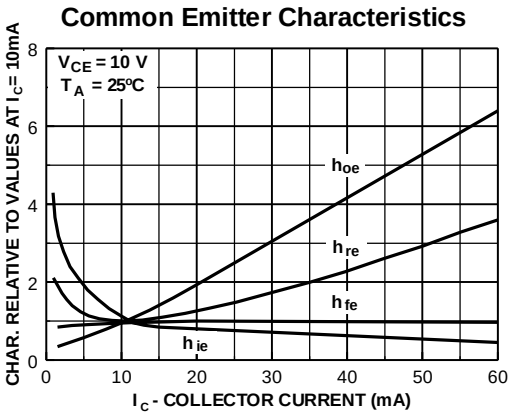

**Power Dissipation vs Ambient Temperature**

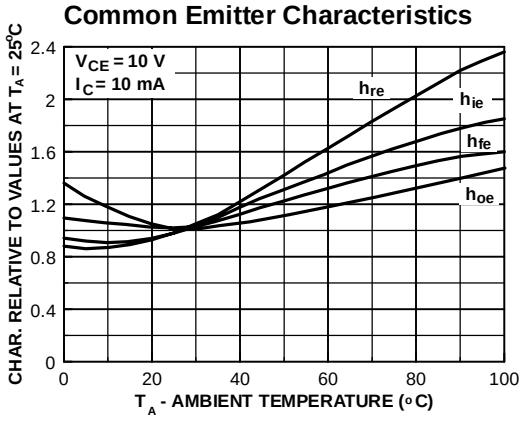


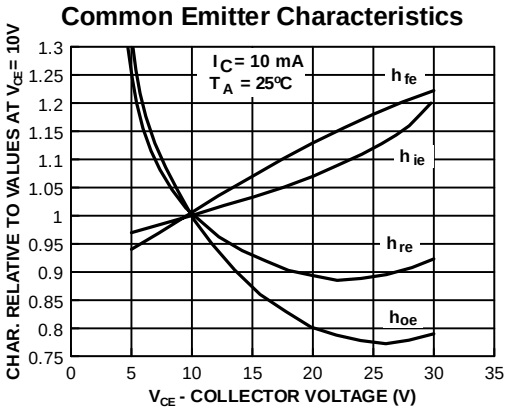
## NPN General Purpose Amplifier

(continued)

### Typical Common Emitter Characteristics (f = 1.0kHz)



## Test Circuits

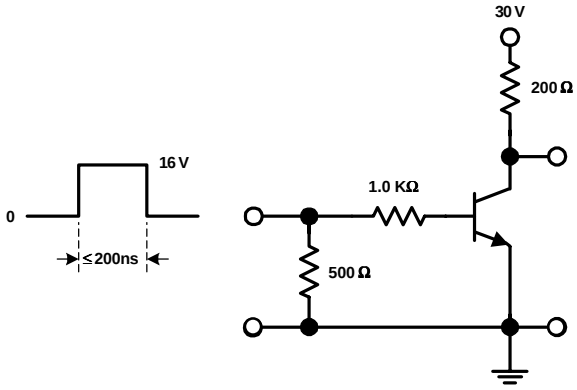



**FIGURE 1: Saturated Turn-On Switching Timer**

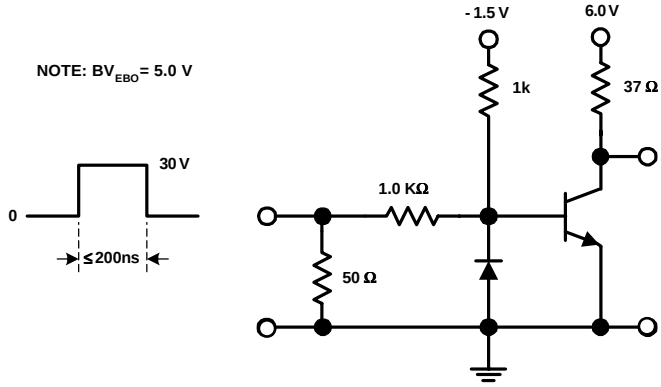


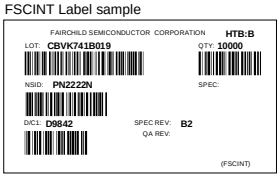

**FIGURE 2: Saturated Turn-Off Switching Time**

# TO-92 Tape and Reel Data

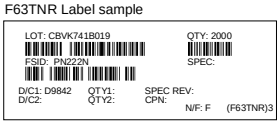
FAIRCHILD SEMICONDUCTOR TM

## TO-92 Packaging Configuration: Figure 1.0

FSCINT Label sample

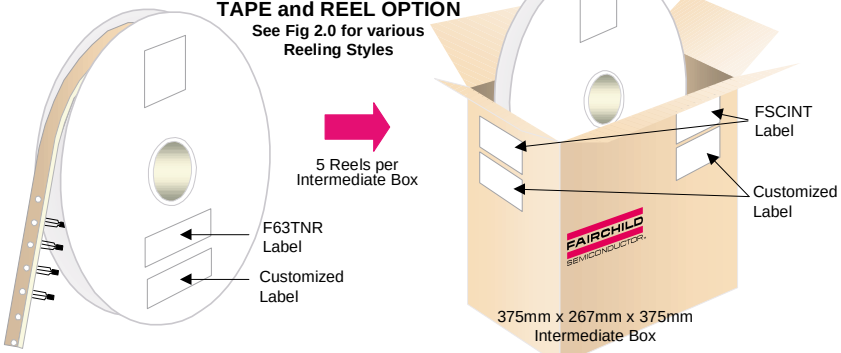



F63TNR Label sample




### TAPE and REEL OPTION

**See Fig 2.0 for various Reeling Styles**



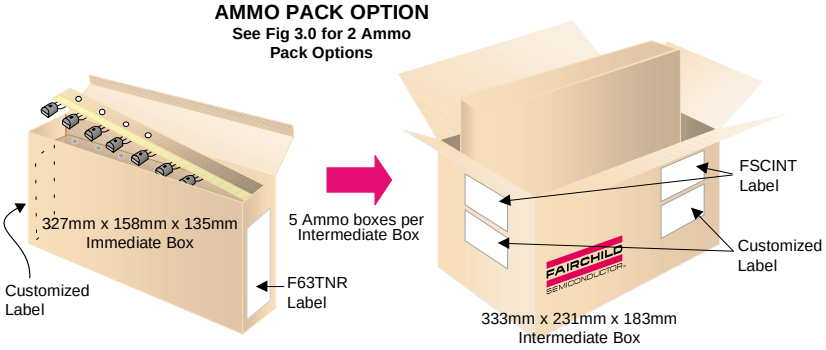

### TO-92 TNR/AMMO PACKING INFROMATION

| Packing | Style | Quantity | EOL code |
|---|---|---|---|
| Reel | A | 2,000 | D26Z |
| | E | 2,000 | D27Z |
| Ammo | M | 2,000 | D74Z |
| | P | 2,000 | D75Z |

Unit weight = 0.22 gm
Reel weight with components = 1.04 kg
Ammo weight with components = 1.02 kg
Max quantity per intermediate box = 10,000 units

### AMMO PACK OPTION

**See Fig 3.0 for 2 Ammo Pack Options**

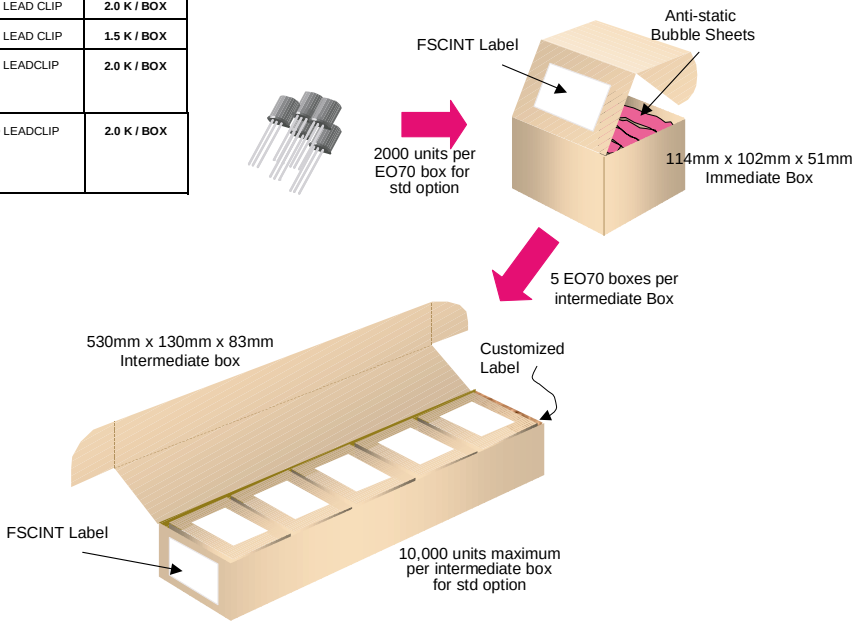



### (TO-92) BULK PACKING INFORMATION

| EOL CODE | DESCRIPTION | LEADCLIP DIMENSION | QUANTITY |
|---|---|---|---|
| J18Z | TO-18 OPTION STD | NO LEAD CLIP | 2.0 K / BOX |
| J05Z | TO-5 OPTION STD | NO LEAD CLIP | 1.5 K / BOX |
| NO EOL CODE | TO-92 STANDARD STRAIGHT FOR: PKG 92, 94 (NON PROELECTRON SERIES), 96 | NO LEADCLIP | 2.0 K / BOX |
| L34Z | TO-92 STANDARD STRAIGHT FOR: PKG 94 (PROELECTRON SERIES BCXXX, BFXXX, BSRXXX), 97, 98 | NO LEADCLIP | 2.0 K / BOX |

### BULK OPTION

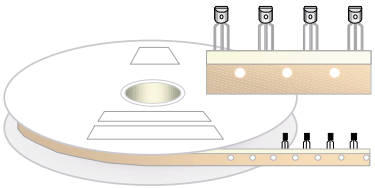
**See Bulk Packing Information table**



# TO-92 Tape and Reel Data, continued

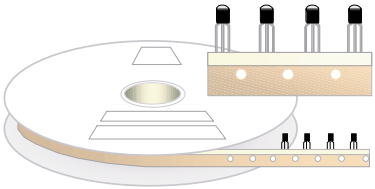
**TO-92 Reeling Style**
**Configuration:** Figure 2.0

**Machine Option “A” (H)**



**Style “A”, D26Z, D70Z (s/h)**

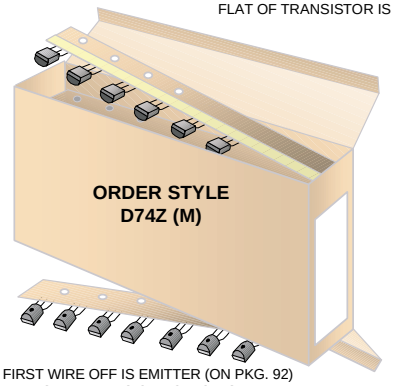
**Machine Option “E” (J)**



**Style “E”, D27Z, D71Z (s/h)**

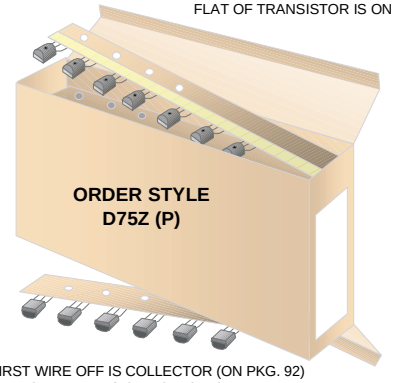
**TO-92 Radial Ammo Packaging**
**Configuration:** Figure 3.0

FIRST WIRE OFF IS COLLECTOR
ADHESIVE TAPE IS ON THE TOP SIDE
FLAT OF TRANSISTOR IS ON TOP




FIRST WIRE OFF IS EMITTER (ON PKG. 92)
ADHESIVE TAPE IS ON BOTTOM SIDE
FLAT OF TRANSISTOR IS ON BOTTOM

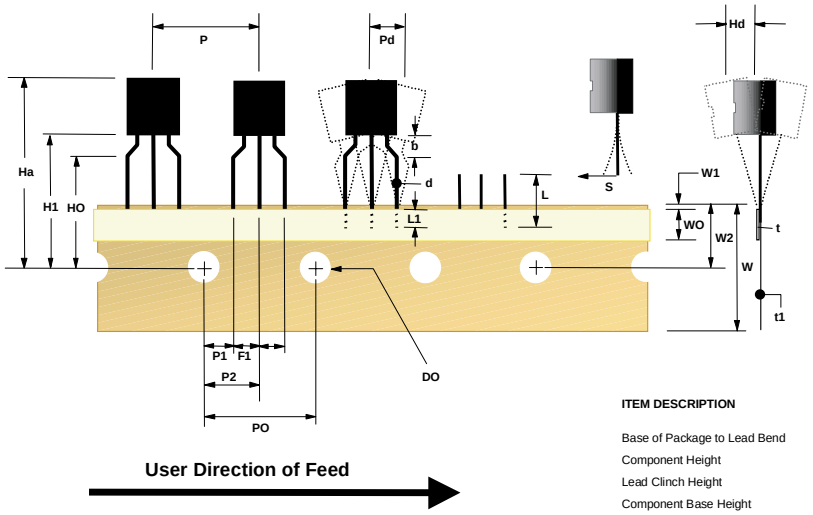
FIRST WIRE OFF IS EMITTER
ADHESIVE TAPE IS ON THE TOP SIDE
FLAT OF TRANSISTOR IS ON BOTTOM




FIRST WIRE OFF IS COLLECTOR (ON PKG. 92)
ADHESIVE TAPE IS ON BOTTOM SIDE
FLAT OF TRANSISTOR IS ON TOP

# TO-92 Tape and Reel Data, continued

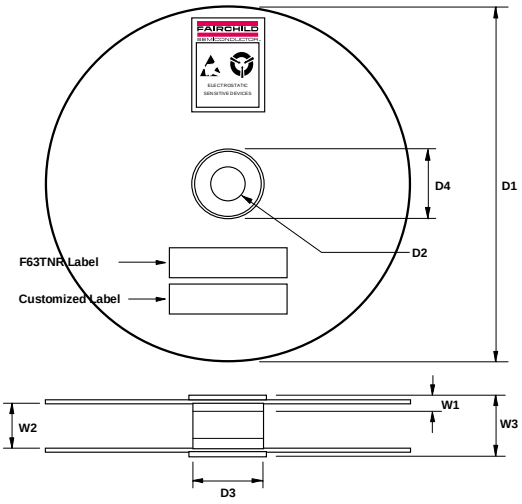
## TO-92 Tape and Reel Taping
**Dimension Configuration:** Figure 4.0




| ITEM DESCRIPTION | SYMBOL | DIMENSION |
|---|---|---|
| Base of Package to Lead Bend | b | 0.098 (max) |
| Component Height | Ha | 0.928 (+/- 0.025) |
| Lead Clinch Height | HO | 0.630 (+/- 0.020) |
| Component Base Height | H1 | 0.748 (+/- 0.020) |
| Component Alignment ( side/side ) | Pd | 0.040 (max) |
| Component Alignment ( front/back ) | Hd | 0.031 (max) |
| Component Pitch | P | 0.500 (+/- 0.020) |
| Feed Hole Pitch | PO | 0.500 (+/- 0.008) |
| Hole Center to First Lead | P1 | 0.150 (+0.009, -0.010) |
| Hole Center to Component Center | P2 | 0.247 (+/- 0.007) |
| Lead Spread | F1/F2 | 0.104 (+/- 0 .010) |
| Lead Thickness | d | 0.018 (+0.002, -0.003) |
| Cut Lead Length | L | 0.429 (max) |
| Taped Lead Length | L1 | 0.209 (+0.051, -0.052) |
| Taped Lead Thickness | t | 0.032 (+/- 0.006) |
| Carrier Tape Thickness | t1 | 0.021 (+/- 0.006) |
| Carrier Tape Width | W | 0.708 (+0.020, -0.019) |
| Hold - down Tape Width | WO | 0.236 (+/- 0.012) |
| Hold - down Tape position | W1 | 0.035 (max) |
| Feed Hole Position | W2 | 0.360 (+/- 0.025) |
| Sprocket Hole Diameter | DO | 0.157 (+0.008, -0.007) |
| Lead Spring Out | S | 0.004 (max) |

Note : All dimensions are in inches.

## TO-92 Reel
**Configuration:** Figure 5.0



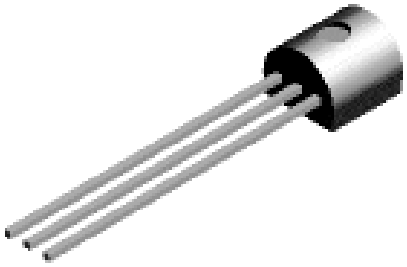

| ITEM DESCRIPTION | SYSMBOL | MINIMUM | MAXIMUM |
|---|---|---|---|
| Reel Diameter | D1 | 13.975 | 14.025 |
| Arbor Hole Diameter (Standard) | D2 | 1.160 | 1.200 |
| (Small Hole) | D2 | 0.650 | 0.700 |
| Core Diameter | D3 | 3.100 | 3.300 |
| Hub Recess Inner Diameter | D4 | 2.700 | 3.100 |
| Hub Recess Depth | W1 | 0.370 | 0.570 |
| Flange to Flange Inner Width | W2 | 1.630 | 1.690 |
| Hub to Hub Center Width | W3 | | 2.090 |

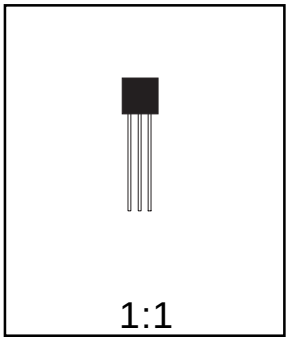
Note: All dimensions are inches

## TO-92 Package Dimensions

FAIRCHILD SEMICONDUCTOR™

# TO-92 (FS PKG Code 92, 94, 96)





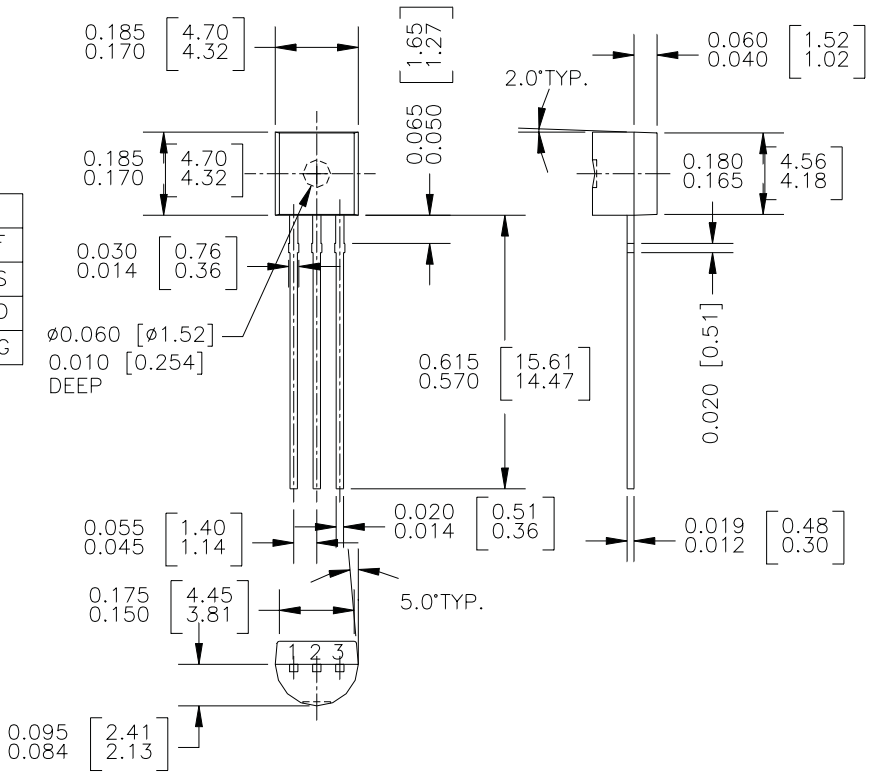

Scale 1:1 on letter size paper

Dimensions shown below are in:
inches [millimeters]

Part Weight per unit (gram): 0.1977

TO−92 (92,94,96)

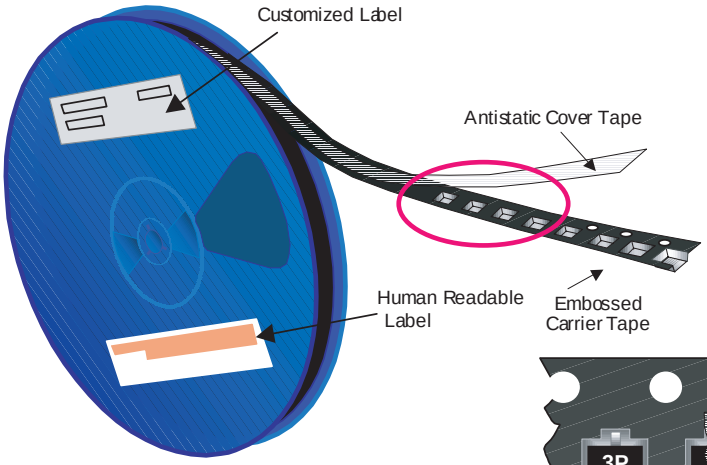
| PIN | 92 | | 94 | | 96 | |
|---|---|---|---|---|---|---|
| | B | F | B | F | B | F |
| 1 | E | D | E | D | B | S |
| 2 | B | S | C | G | E | D |
| 3 | C | G | B | S | C | G |



# SOT-23 Tape and Reel Data

FAIRCHILD SEMICONDUCTOR™

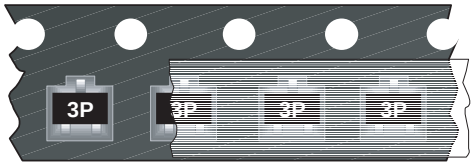
## SOT-23 Packaging Configuration: Figure 10




**Packaging Description:**

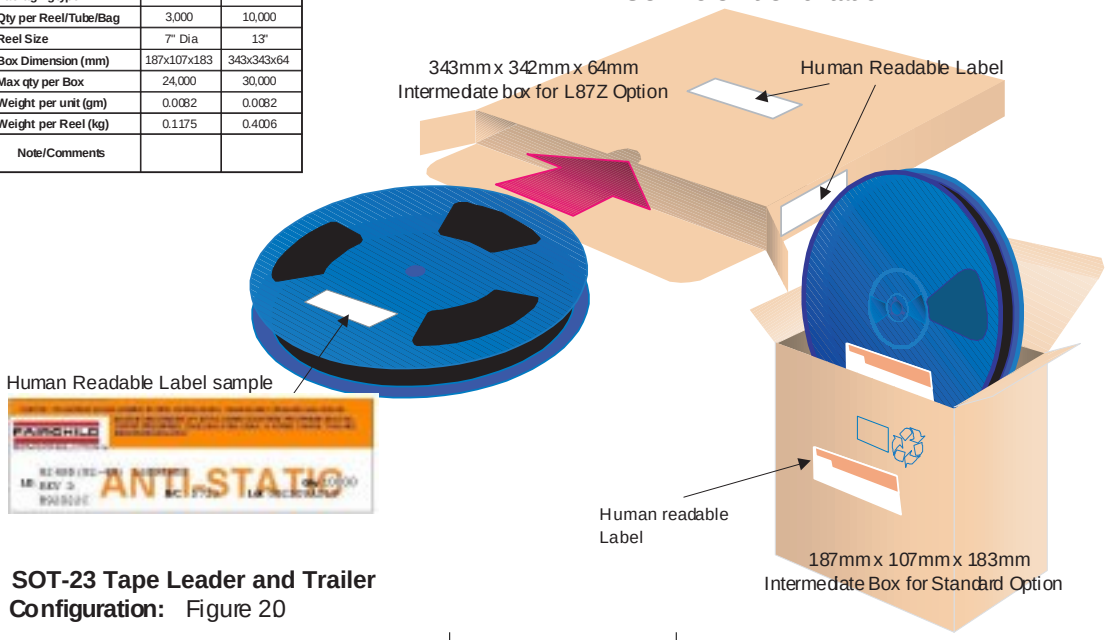
SOT-23 parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 3,000 units per 7" or 177cm diameter reel. The reels are dark blue in color and is made of polystyrene plastic (anti-static coated). Other option comes in 10,000 units per 13" or 330cm diameter reel. This and some other options are described in the Packaging Information table.

These full reels are individually labeled and placed inside a standard intermediate made of recyclable corrugated brown paper with a Fairchild logo printing. One pizza box contains eight reels maximum. And these intermediate boxes are placed inside a labeled shipping box which comes in different sizes depending on the number of parts shipped.

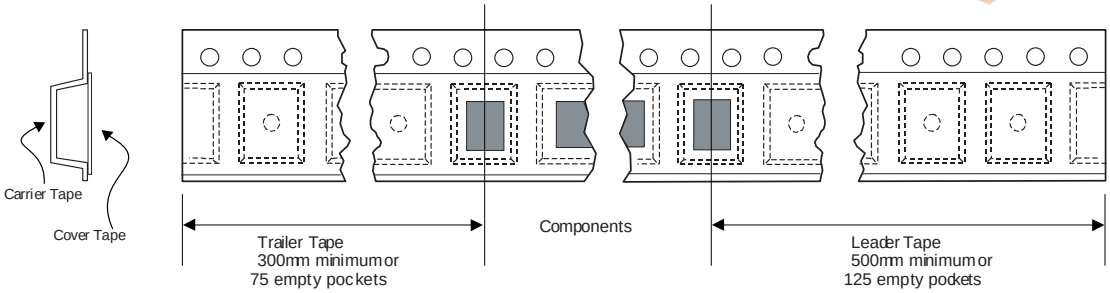



| SOT-23 Packaging Information | | |
|---|---|---|
| Packaging Option | Standard (no flow code) | D87Z |
| Packaging type | TNR | TNR |
| Qty per Reel/Tube/Bag | 3,000 | 10,000 |
| Reel Size | 7" Dia | 13" |
| Box Dimension (mm) | 187x107x183 | 343x343x64 |
| Max qty per Box | 24,000 | 30,000 |
| Weight per unit (gm) | 0.0082 | 0.0082 |
| Weight per Reel (kg) | 0.1175 | 0.4006 |
| Note/Comments | | |

## SOT-23 Unit Orientation

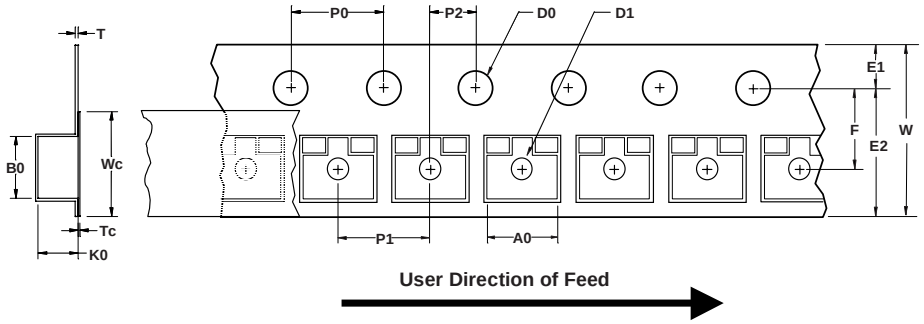



## SOT-23 Tape Leader and Trailer Configuration: Figure 20



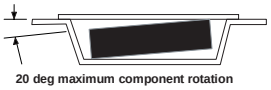
# SOT-23 Tape and Reel Data, continued

## SOT-23 Embossed Carrier Tape
**Configuration:** Figure 3.0

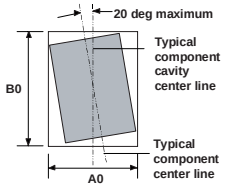



| Dimensions are in millimeter | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pkg type** | **A0** | **B0** | **W** | **D0** | **D1** | **E1** | **E2** | **F** | **P1** | **P0** | **K0** | **T** | **Wc** | **Tc** |
| **SOT-23** (8mm) | 3.15 +/-0.10 | 2.77 +/-0.10 | 8.0 +/-0.3 | 1.55 +/-0.05 | 1.125 +/-0.125 | 1.75 +/-0.10 | 6.25 min | 3.50 +/-0.05 | 4.0 +/-0.1 | 4.0 +/-0.1 | 1.30 +/-0.10 | 0.228 +/-0.013 | 5.2 +/-0.3 | 0.06 +/-0.02 |

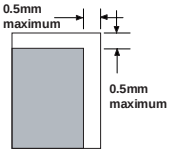
Notes: A0, B0, and K0 dimensions are determined with respect to the EIA/Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).




Sketch A (Side or Front Sectional View)
**Component Rotation**

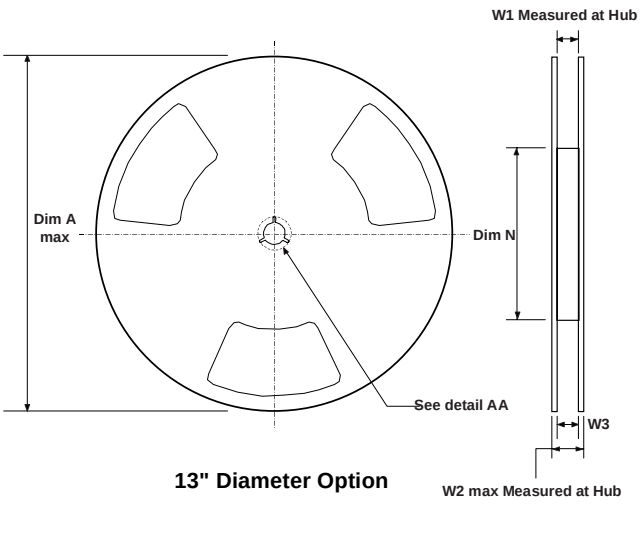



Sketch B (Top View)
**Component Rotation**

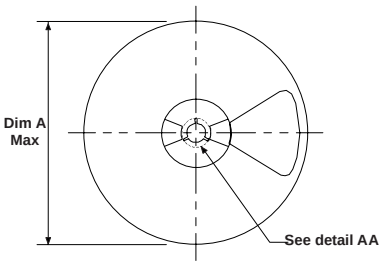



Sketch C (Top View)
**Component lateral movement**

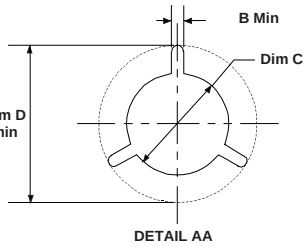
## SOT-23 Reel Configuration: Figure 4.0




**13" Diameter Option**




**7" Diameter Option**

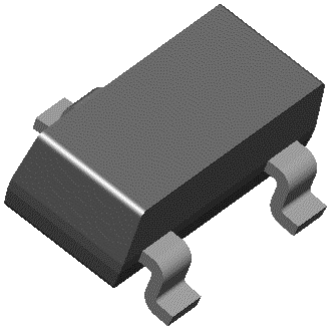


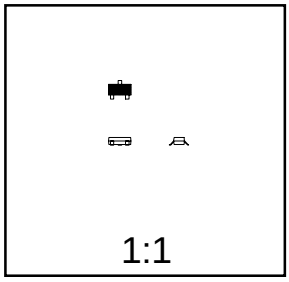

| Dimensions are in inches and millimeters | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Tape Size** | **Reel Option** | **Dim A** | **Dim B** | **Dim C** | **Dim D** | **Dim N** | **Dim W1** | **Dim W2** | **Dim W3 (LSL-USL)** |
| 8mm | 7" Dia | 7.00 177.8 | 0.059 1.5 | 512 +0.020/-0.008 13 +0.5/-0.2 | 0.795 20.2 | 2.165 55 | 0.331 +0.059/-0.000 8.4 +1.5/0 | 0.567 14.4 | 0.311 – 0.429 7.9 – 10.9 |
| 8mm | 13" Dia | 13.00 330 | 0.059 1.5 | 512 +0.020/-0.008 13 +0.5/-0.2 | 0.795 20.2 | 4.00 100 | 0.331 +0.059/-0.000 8.4 +1.5/0 | 0.567 14.4 | 0.311 – 0.429 7.9 – 10.9 |

## SOT-23 Package Dimensions

FAIRCHILD SEMICONDUCTOR™

# SOT-23 (FS PKG Code 49)

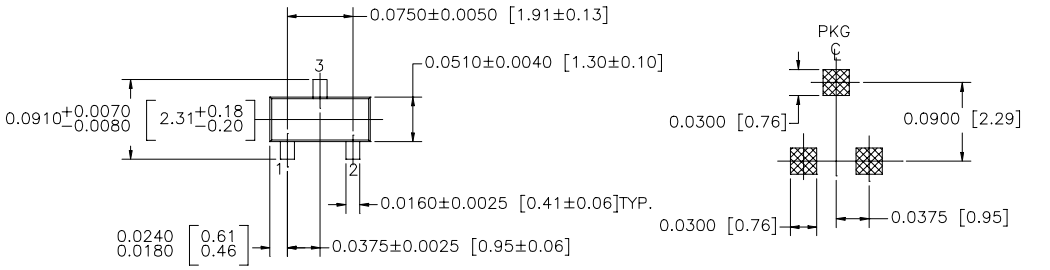


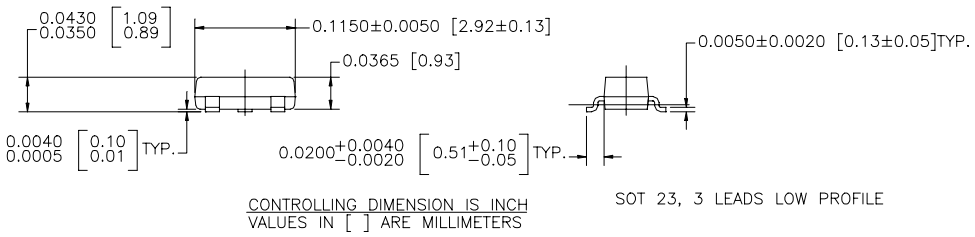



Scale 1:1 on letter size paper

Dimensions shown below are in:
inches [millimeters]

Part Weight per unit (gram): 0.0082




NOTE : UNLESS OTHERWISE SPECIFIED

1. STANDARD LEAD FINISH 150 MICROINCHES / 3.81 MICROMETERS MINIMUM TIN / LEAD (SOLDER) ON ALLOY 42
2. REFERENCE JEDEC REGISTRATION TO−236, VARIATION AB, ISSUE G, DATED JUL 1993

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