July 2000

# FDP5680/FDB5680

## 60V N-Channel PowerTrench™ MOSFET

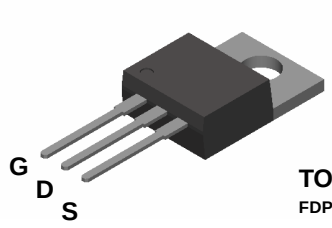
### General Description

This N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers.

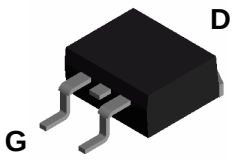
These MOSFETs feature faster switching and lower gate charge than other MOSFETs with comparable $R_{DS(on)}$ specifications resulting in DC/DC power supply designs with higher overall efficiency.

### Features

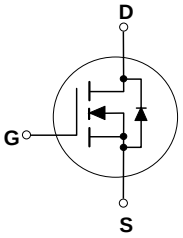
- 40 A, 60 V. $R_{DS(ON)}$ = 0.020 Ω @ $V_{GS}$ = 10 V
  $R_{DS(ON)}$ = 0.023 Ω @ $V_{GS}$ = 6 V.
- Critical DC electrical parameters specified at evevated temperature.
- Rugged internal source-drain diode can eliminate the need for an external Zener diode transient suppressor.
- High performance trend technology for extremely low $R_{DS(ON)}$.
- 175°C maximum junction temperature rating.




**TO-220**
**FDP Series**




**TO-263AB**
**FDB Series**




## Absolute Maximum Ratings $T_C$ = 25°C unless otherwise noted

| Symbol | Parameter | FDP5680 | FDB5680 | Units |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | 60 | | V |
| $V_{GSS}$ | Gate-Source Voltage | ±20 | | V |
| $I_D$ | Maximum Drain Current - Continuous | 40 | | A |
| | - Pulsed | 120 | | |
| $P_D$ | Total Power Dissipation @ $T_C$ = 25°C | 65 | | W |
| | Derate above 25°C | 0.43 | | W/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Junction Temperature Range | -65 to +175 | | °C |

## Thermal Characteristics

| | | | |
|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | 2.3 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 62.5 | °C/W |

## Package Marking and Ordering Information

| Device Marking | Device | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|
| FDB5680 | FDB5680 | 13” | 24mm | 800 |
| FDP5680 | FDP5680 | Tube | N/A | 45 |

## Electrical Characteristics

$T_c$ = 25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Drain-Source Avalanche Ratings** (Note1) | | | | | | |
| $W_{DSS}$ | Single Pulse Drain-Source Avalanche Energy | $V_{DD}$ = 30 V, $I_D$ = 40A | | | 90 | mJ |
| $I_{AR}$ | Maximum Drain-Source Avalanche Current | | | | 40 | A |
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = -250 μA | 60 | | | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = -250 μA, Referenced to 25°C | | 60 | | mV/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 48 V, $V_{GS}$ = 0 V | | | 1 | μA |
| $I_{GSSF}$ | Gate-Body Leakage Current, Forward | $V_{GS}$ = 20 V, $V_{DS}$ = 0 V | | | 100 | nA |
| $I_{GSSR}$ | Gate-Body Leakage Current, Reverse | $V_{GS}$ = -20 V, $V_{DS}$ = 0 V | | | -100 | nA |
| **On Characteristics** (Note 1) | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | 2 | 2.5 | 4 | V |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D$ = -250 μA, Referenced to 25°C | | -6.4 | | mV/°C |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS}$ = 10 V, $I_D$ = 20 A,<br>$V_{GS}$ = 10 V, $I_D$ = 20 A, $T_J$ = 125°C<br>$V_{GS}$ = 6 V, $I_D$ = 19 A | | 0.016<br>0.022<br>0.018 | 0.020<br>0.035<br>0.023 | Ω |
| $I_{D(on)}$ | On-State Drain Current | $V_{GS}$ = 10 V, $V_{DS}$ = 5 V | 20 | | | A |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 5 V, $I_D$ = 20 A | | 43 | | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V,<br>f = 1.0 MHz | | 1850 | | pF |
| $C_{oss}$ | Output Capacitance | | | 230 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 95 | | pF |
| **Switching Characteristics** (Note 1) | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 30 V, $I_D$ = 1 A,<br>$V_{GS}$ = 10 V, $R_{GEN}$ = 6 Ω | | 15 | 27 | ns |
| $t_r$ | Turn-On Rise Time | | | 9 | 18 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 35 | 56 | ns |
| $t_f$ | Turn-Off Fall Time | | | 16 | 26 | ns |
| $Q_g$ | Total Gate Charge | $V_{DS}$ = 30 V, $I_D$ = 20 A<br>$V_{GS}$ = 10 V | | 33 | 46 | nC |
| $Q_{gs}$ | Gate-Source Charge | | | 6.5 | | nC |
| $Q_{gd}$ | Gate-Drain Charge | | | 7.5 | | nC |
| **Drain-Source Diode Characteristics and Maximum Ratings** | | | | | | |
| $I_S$ | Maximum Continuous Drain-Source Diode Forward Current (Note 1) | | | | 40 | A |
| $V_{SD}$ | Drain-Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 20 A (Note 1) | | 0.9 | 1.2 | V |

**Note:**

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

## Typical Characteristics

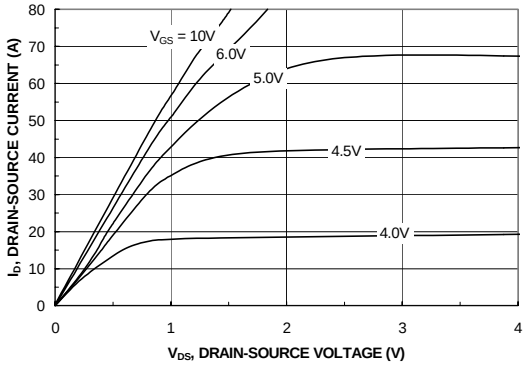



**Figure 1. On-Region Characteristics.**

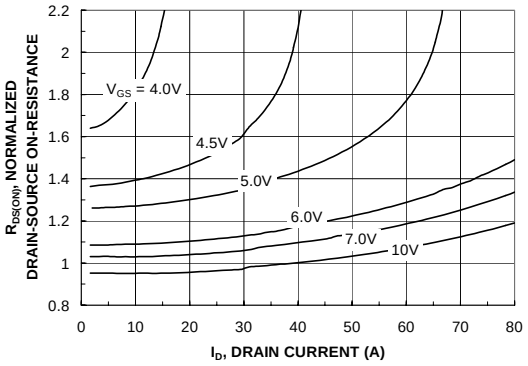



**Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.**

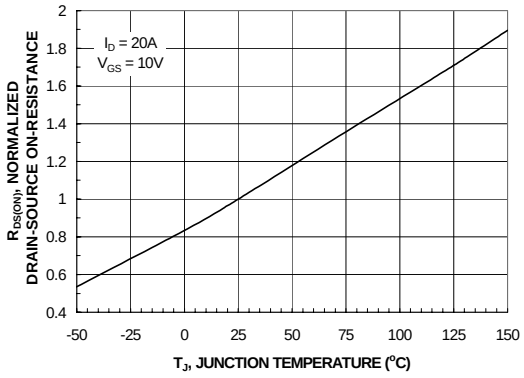



**Figure 3. On-Resistance Variation with Temperature.**

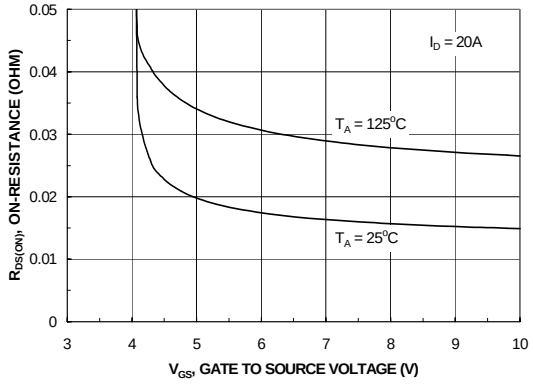



**Figure 4. On-Resistance Variation with Gate-to-Source Voltage.**

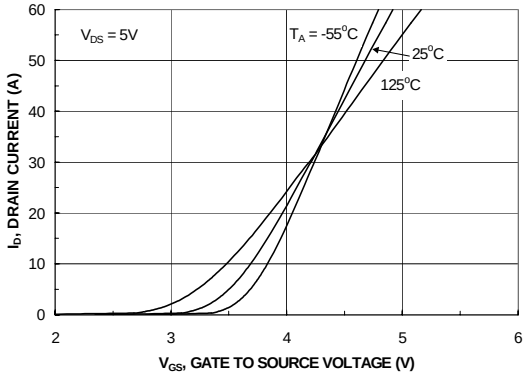



**Figure 5. Transfer Characteristics.**

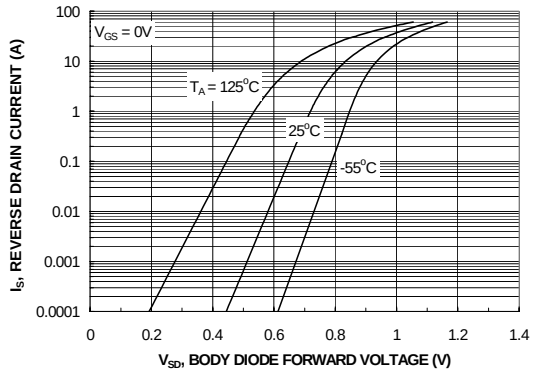



**Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.**

## Typical Characteristics (continued)

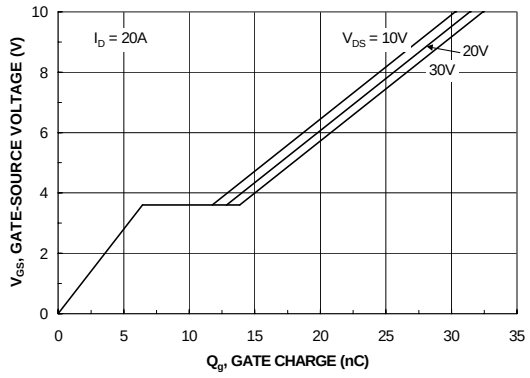



**Figure 7. Gate-Charge Characteristics.**

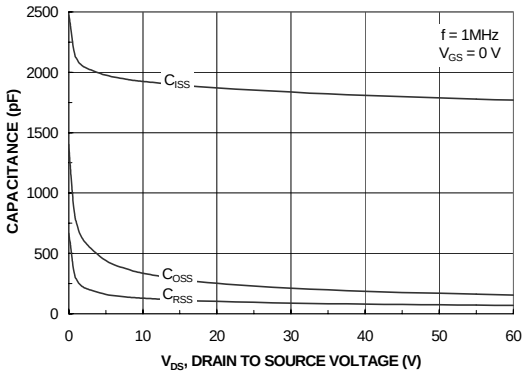



**Figure 8. Capacitance Characteristics.**

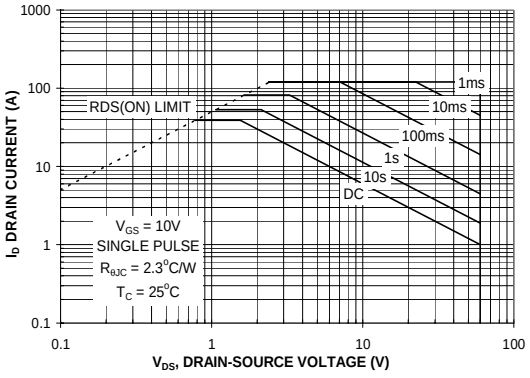



**Figure 9. Maximum Safe Operating Area.**

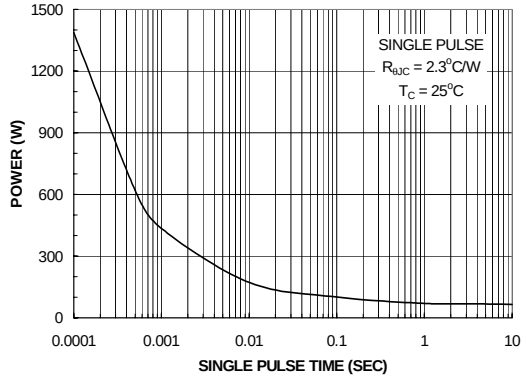



**Figure 10. Single Pulse Maximum Power Dissipation.**

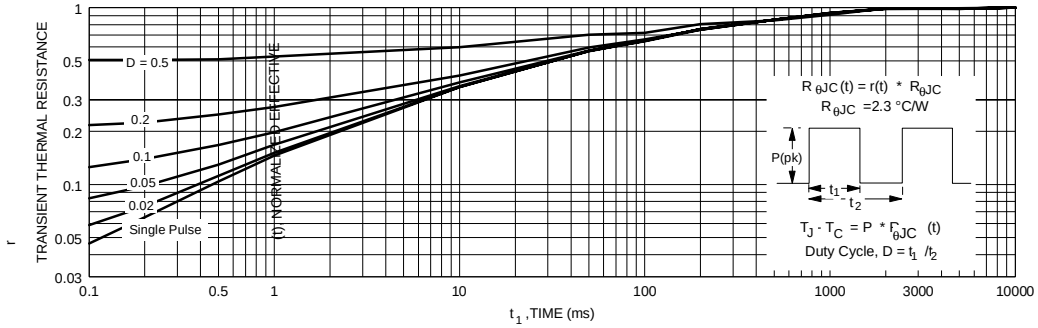



**Figure 11. Transient Thermal Response Curve.**

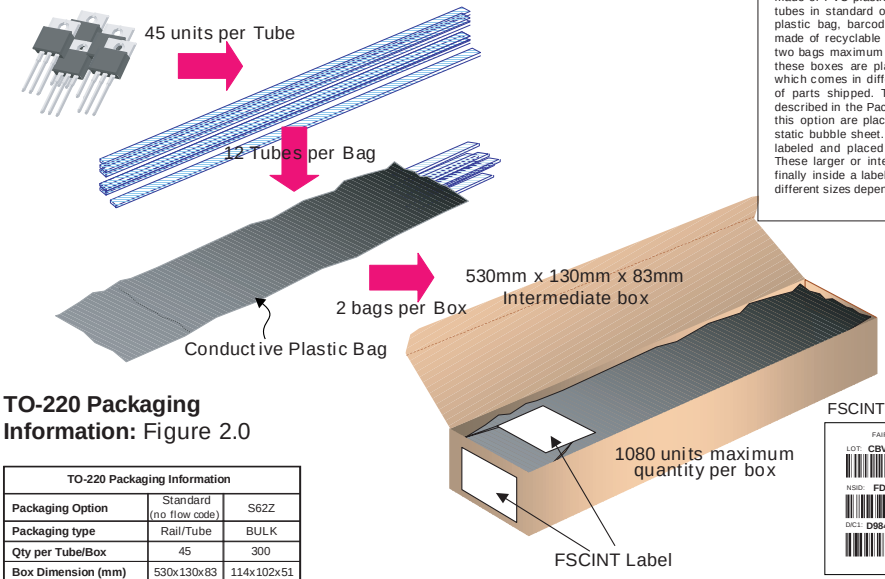
# TO-220 Tape and Reel Data and Package Dimensions

FAIRCHILD SEMICONDUCTOR TM

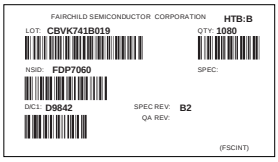
## TO-220 Tube Packing
**Configuration:** Figure 1.0

**Packaging Description:**

TO-220 parts are shipped normally in tube. The tube is made of PVC plastic treated with anti-static agent.These tubes in standard option are placed inside a dissipative plastic bag, barcode labeled, and placed inside a box made of recyclable corrugated paper. One box contains two bags maximum (see fig. 1.0). And one or several of these boxes are placed inside a labeled shipping box which comes in different sizes depending on the number of parts shipped. The other option comes in bulk as described in the Packaging Information table. The units in this option are placed inside a small box laid with anti-static bubble sheet. These smaller boxes are individually labeled and placed inside a larger box (see fig. 3.0). These larger or intermediate boxes then will be placed finally inside a labeled shipping box which still comes in different sizes depending on the number of units shipped.



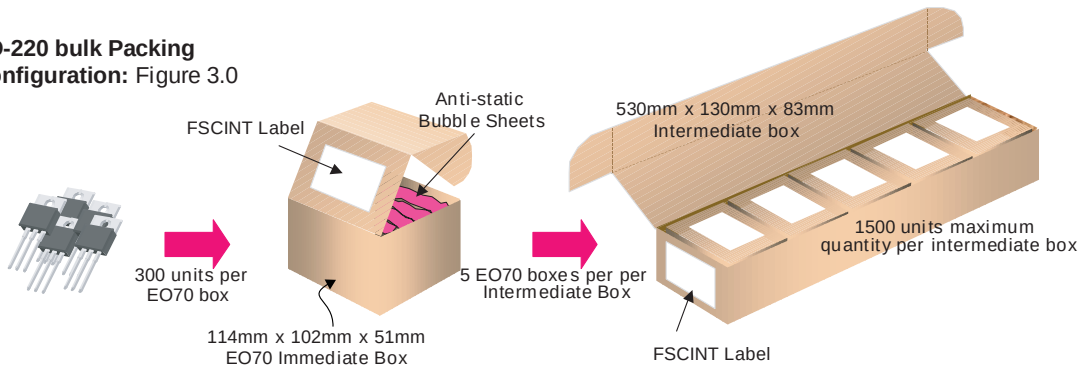

FSCINT Label sample




## TO-220 Packaging
**Information:** Figure 2.0

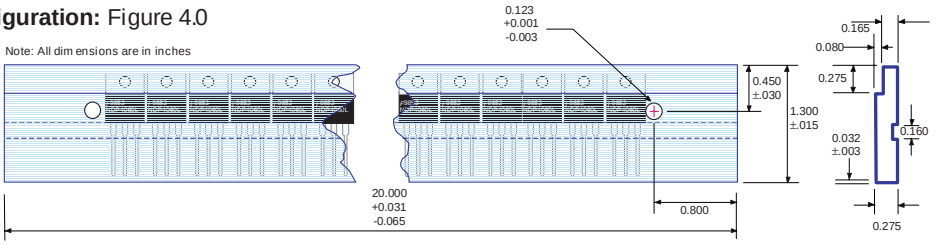
| TO-220 Packaging Information | | |
|---|---|---|
| **Packaging Option** | Standard (no flow code) | S62Z |
| **Packaging type** | Rail/Tube | BULK |
| **Qty per Tube/Box** | 45 | 300 |
| **Box Dimension (mm)** | 530x130x83 | 114x102x51 |
| **Max qty per Box** | 1,080 | 1,500 |
| **Weight per unit (gm)** | 1.4378 | 1.4378 |
| **Note/Comments** | | |

## TO-220 bulk Packing
**Configuration:** Figure 3.0



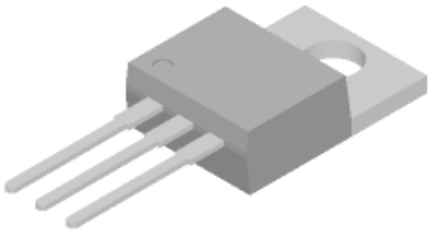

## TO-220 Tube
**Configuration:** Figure 4.0

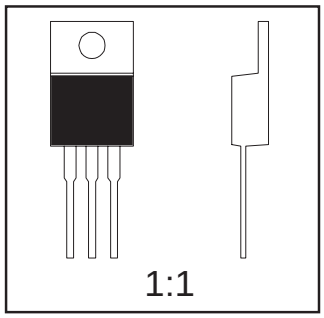
Note: All dimensions are in inches



## TO-220 Tape and Reel Data and Package Dimensions, continued

# TO-220 (FS PKG Code 37)

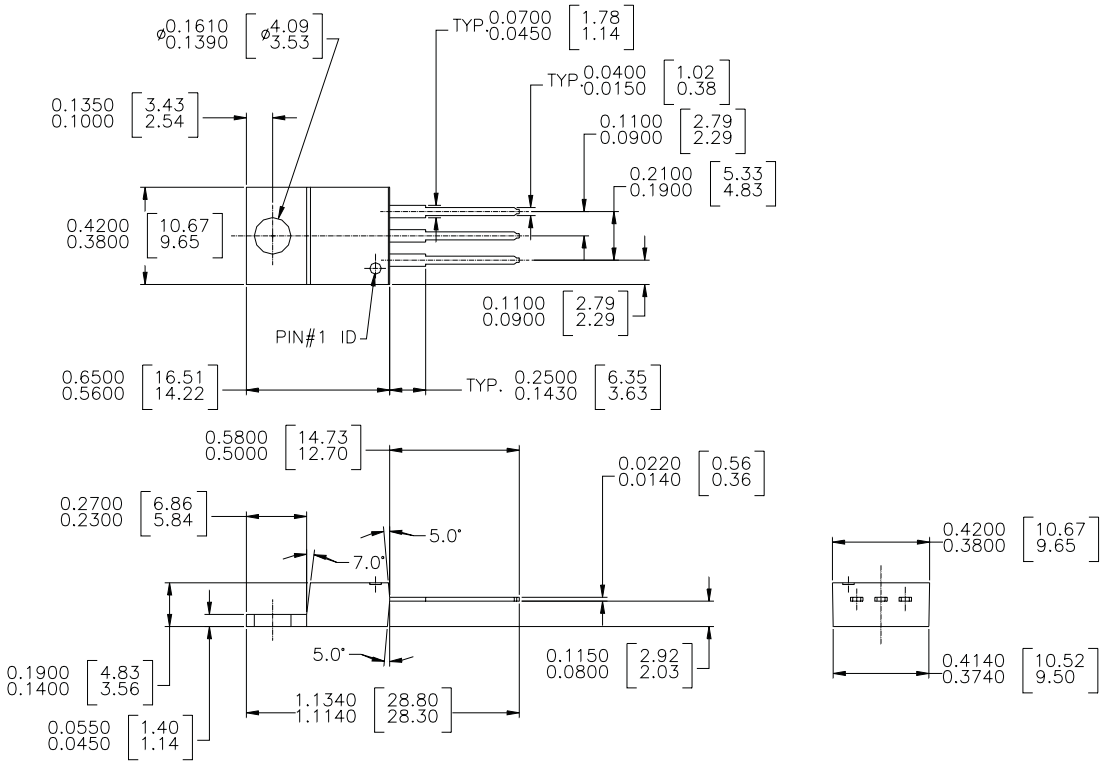





Scale 1:1 on letter size paper

Dimensions shown below are in:
inches [millimeters]

Part Weight per unit (gram): 1.4378




NOTE : UNLESS OTHERWISE SPECIFIED

1. STANDARD LEAD FINISH :
200 MICROINCHES / 5.08 MICRON MINIMUM
LEAD / TIN 15/85 ON OLIN 194 COPPER OR EQUIVALENT

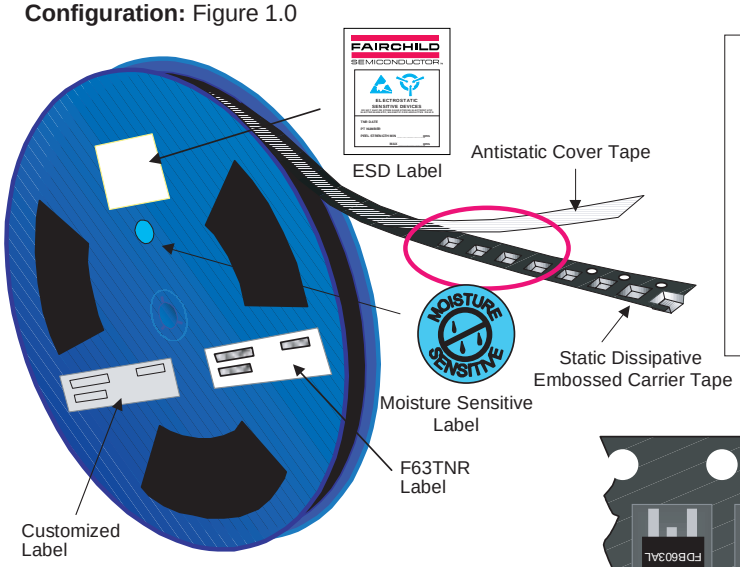
2. DIMENSION BASED ON JEDEC STANDARD TO-220
VARIATION AB, ISSUE J, DATED 3/24/87

TO 220 3 LEAD

# TO-263AB/D²PAK Tape and Reel Data and Package Dimensions

FAIRCHILD SEMICONDUCTOR TM

## TO-263AB/D²PAK Packaging Configuration: Figure 1.0

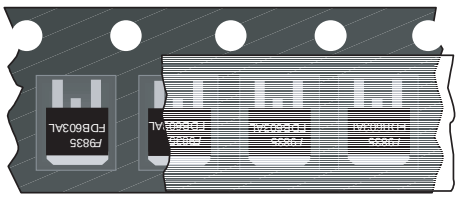



**Packaging Description:**

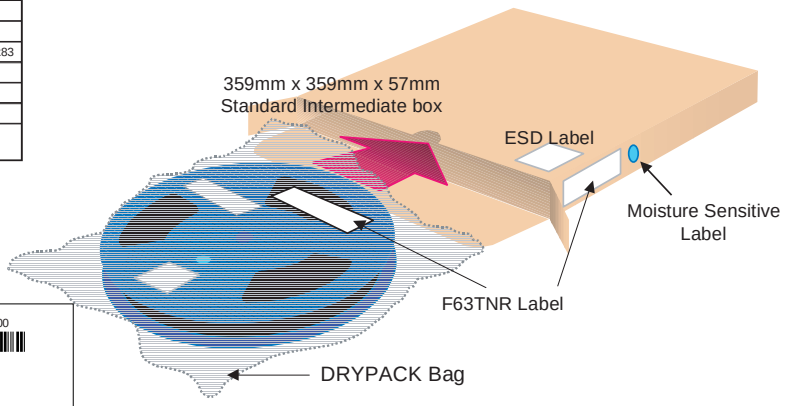
TO-263/D²PAK parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 800 units per 13" or 330cm diameter reel. The reels are dark blue in color and is made of polystyrene plastic (anti-static coated). This and some other options are further described in the Packaging Information table.

These full reels are individually barcode labeled, dry packed, and placed inside a standard intermediate box (illustrated in figure 1.0) made of recyclable corrugated brown paper. One box contains one reel maximum. And these boxes are placed inside a barcode labeled shipping box which comes in different sizes depending on the number of parts shipped.

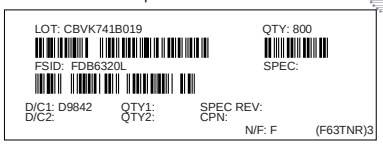
| TO-263AB/D²PAK Packaging Information | | |
|---|---|---|
| **Packaging Option** | Standard (no flow code) | L86Z |
| **Packaging type** | TNR | Rail/Tube |
| **Qty per Reel/Tube/Bag** | 800 | 45 |
| **Reel Size** | 13" Dia | - |
| **Box Dimension (mm)** | 359x359x57 | 530x130x83 |
| **Max qty per Box** | 800 | 1,080 |
| **Weight per unit (gm)** | 1.4378 | 1.4378 |
| **Weight per Reel** | 1.6050 | - |
| **Note/Comments** | | |



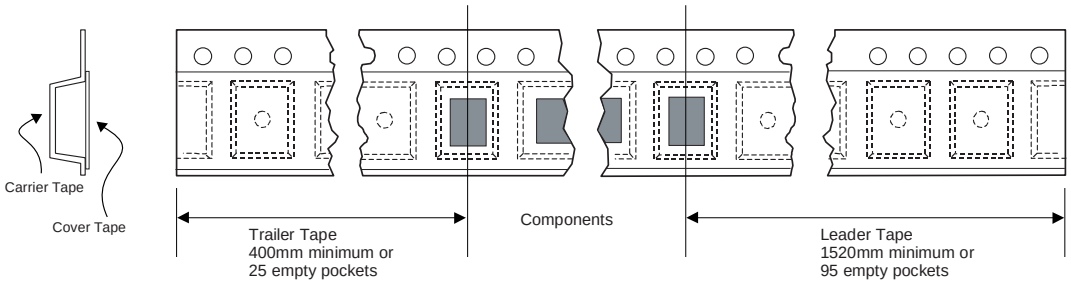
**TO-263AB/D²PAK Unit Orientation**




F63TNR Label sample



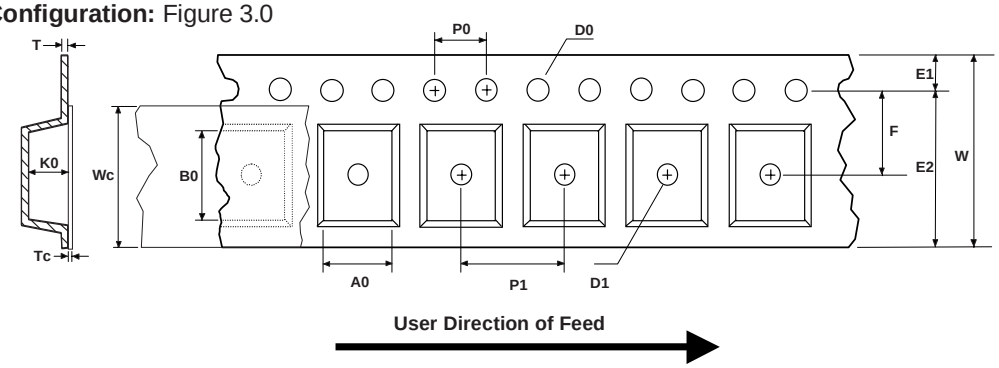

## TO-263AB/D²PAK Tape Leader and Trailer Configuration: Figure 2.0



# TO-263AB/D²PAK Tape and Reel Data and Package Dimensions, continued

## TO-263AB/D²PAK Embossed Carrier Tape

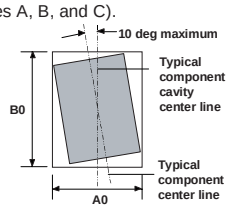
**Configuration:** Figure 3.0



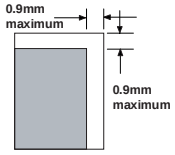

| Dimensions are in millimeter | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pkg type** | **A0** | **B0** | **W** | **D0** | **D1** | **E1** | **E2** | **F** | **P1** | **P0** | **K0** | **T** | **Wc** | **Tc** |
| **TO263AB/ D²PAK** (24mm) | 10.60 +/-0.10 | 15.80 +/-0.10 | 24.0 +/-0.3 | 1.55 +/-0.05 | 1.60 +/-0.10 | 1.75 +/-0.10 | 22.25 min | 11.50 +/-0.10 | 16.0 +/-0.1 | 4.0 +/-0.1 | 4.90 +/-0.10 | 0.450 +/-0.150 | 21.0 +/-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**



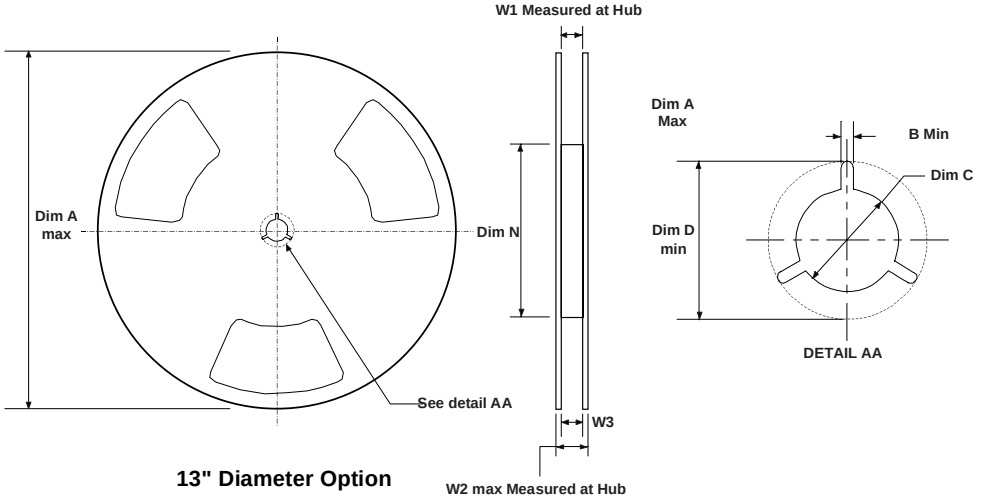

Sketch B (Top View)
**Component Rotation**




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

## TO-263AB/D²PAK Reel Configuration:

Figure 4.0

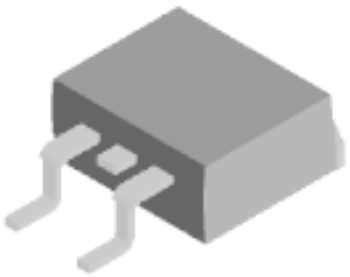


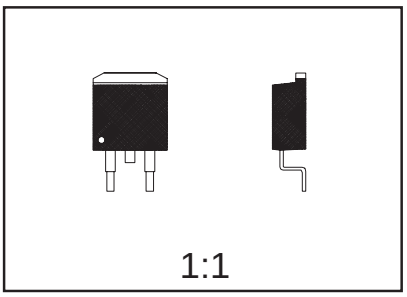

**13" Diameter Option**

| 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)** |
| 24mm | 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 | 0.961 +0.078/-0.000 24.4 +2/0 | 1.197 30.4 | 0.941 – 0.1.079 23.9 – 27.4 |

## TO-263AB/D²PAK Tape and Reel Data and Package Dimensions, continued

# TO-263AB/D²PAK (FS PKG Code 45)

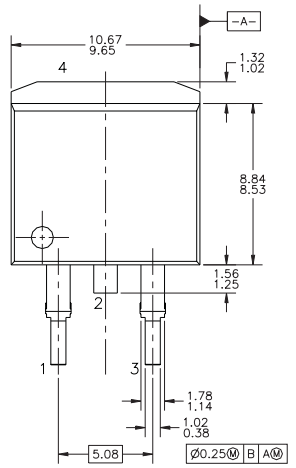


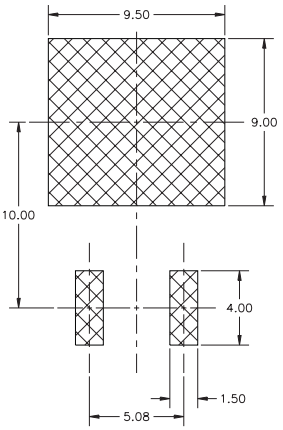



Scale 1:1 on letter size paper

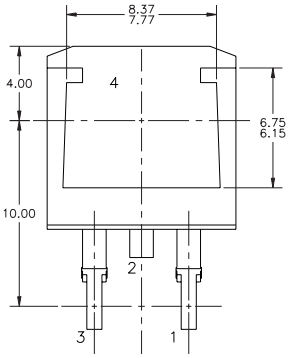
Dimensions shown below are in:
inches [millimeters]

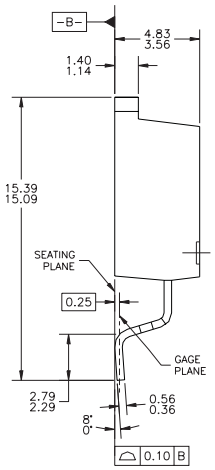
Part Weight per unit (gram): 1.4378




LAND PATTERN RECOMMENDATION

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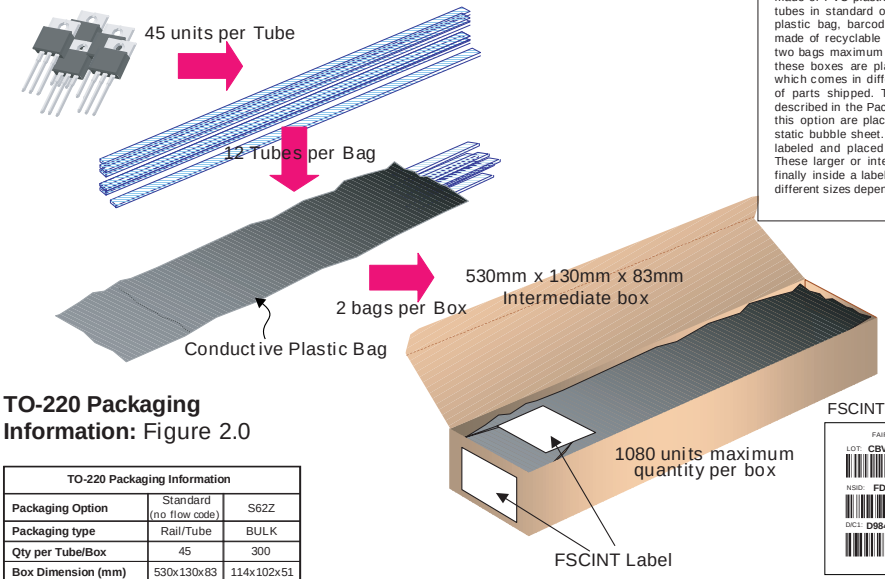
# TO-220 Tape and Reel Data and Package Dimensions

FAIRCHILD SEMICONDUCTOR TM

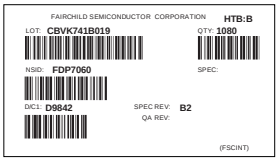
## TO-220 Tube Packing
**Configuration:** Figure 1.0

**Packaging Description:**

TO-220 parts are shipped normally in tube. The tube is made of PVC plastic treated with anti-static agent.These tubes in standard option are placed inside a dissipative plastic bag, barcode labeled, and placed inside a box made of recyclable corrugated paper. One box contains two bags maximum (see fig. 1.0). And one or several of these boxes are placed inside a labeled shipping box which comes in different sizes depending on the number of parts shipped. The other option comes in bulk as described in the Packaging Information table. The units in this option are placed inside a small box laid with anti-static bubble sheet. These smaller boxes are individually labeled and placed inside a larger box (see fig. 3.0). These larger or intermediate boxes then will be placed finally inside a labeled shipping box which still comes in different sizes depending on the number of units shipped.



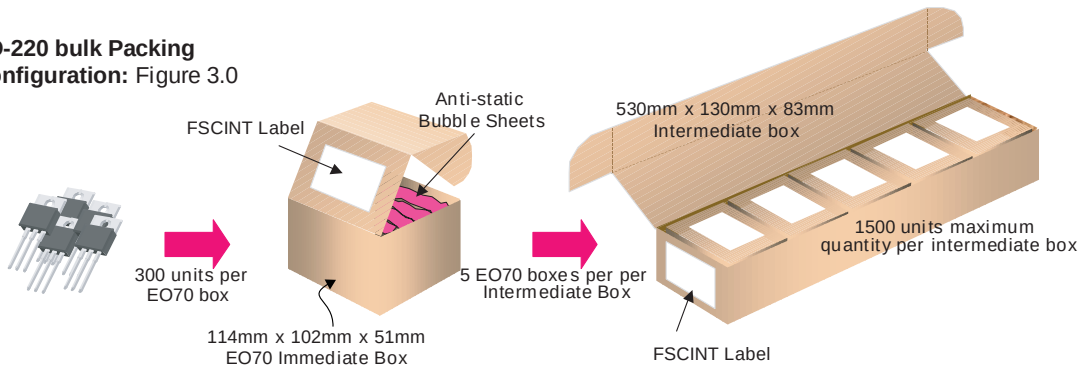

FSCINT Label sample




## TO-220 Packaging
**Information:** Figure 2.0

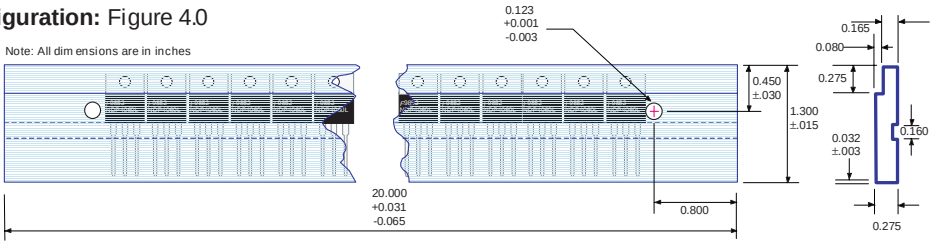
| TO-220 Packaging Information | | |
|---|---|---|
| **Packaging Option** | Standard (no flow code) | S62Z |
| **Packaging type** | Rail/Tube | BULK |
| **Qty per Tube/Box** | 45 | 300 |
| **Box Dimension (mm)** | 530x130x83 | 114x102x51 |
| **Max qty per Box** | 1,080 | 1,500 |
| **Weight per unit (gm)** | 1.4378 | 1.4378 |
| **Note/Comments** | | |

## TO-220 bulk Packing
**Configuration:** Figure 3.0



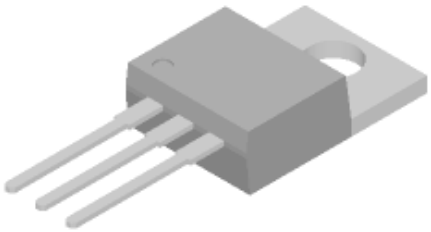

## TO-220 Tube
**Configuration:** Figure 4.0

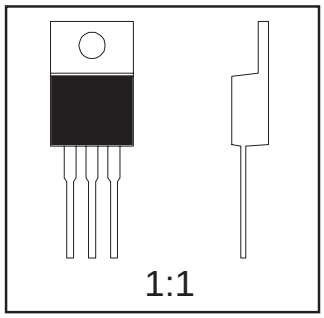
Note: All dimensions are in inches



## TO-220 Tape and Reel Data and Package Dimensions, continued

# TO-220 (FS PKG Code 37)

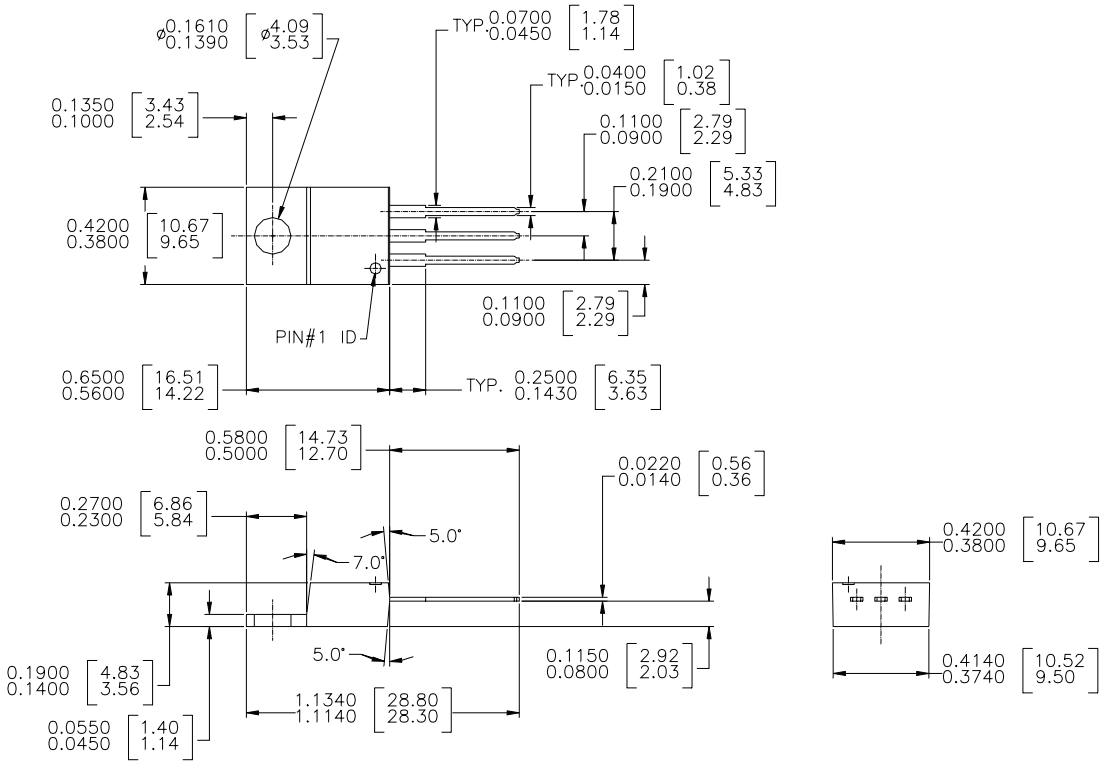





Scale 1:1 on letter size paper

Dimensions shown below are in:
inches [millimeters]

Part Weight per unit (gram): 1.4378

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LEAD / TIN 15/85 ON OLIN 194 COPPER OR EQUIVALENT

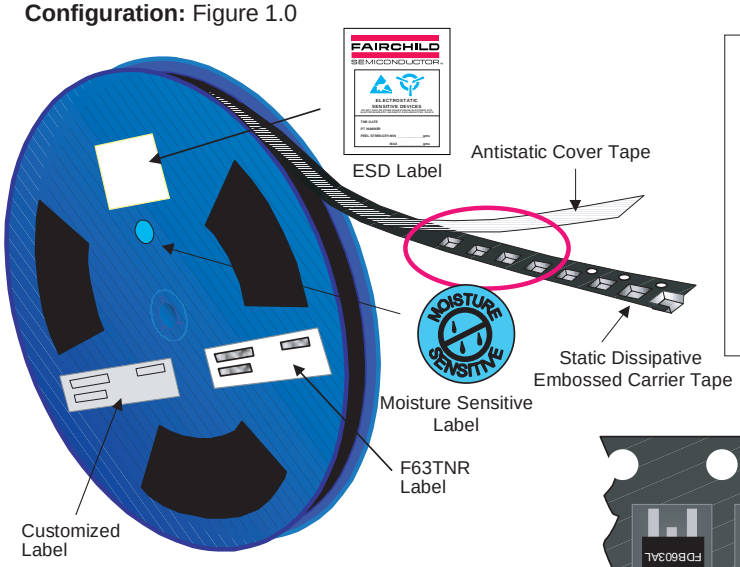
2. DIMENSION BASED ON JEDEC STANDARD TO-220
VARIATION AB, ISSUE J, DATED 3/24/87

TO 220 3 LEAD

# TO-263AB/D²PAK Tape and Reel Data and Package Dimensions

FAIRCHILD SEMICONDUCTOR TM

## TO-263AB/D²PAK Packaging Configuration: Figure 1.0

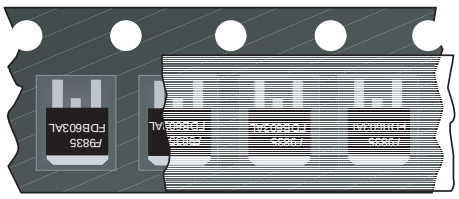



**Packaging Description:**

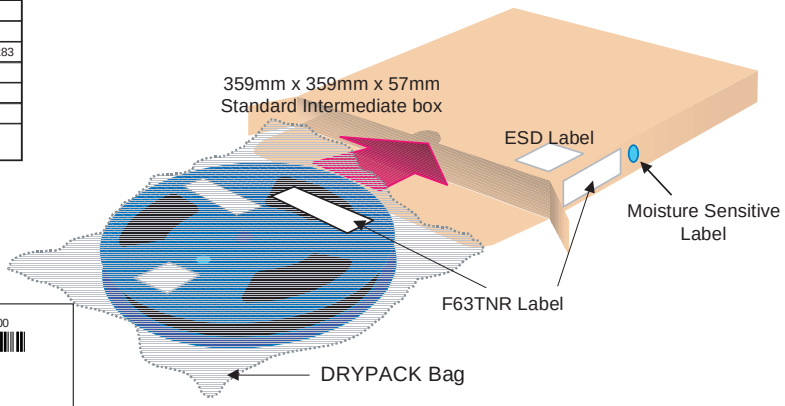
TO-263/D²PAK parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 800 units per 13" or 330cm diameter reel. The reels are dark blue in color and is made of polystyrene plastic (anti-static coated). This and some other options are further described in the Packaging Information table.

These full reels are individually barcode labeled, dry packed, and placed inside a standard intermediate box (illustrated in figure 1.0) made of recyclable corrugated brown paper. One box contains one reel maximum. And these boxes are placed inside a barcode labeled shipping box which comes in different sizes depending on the number of parts shipped.

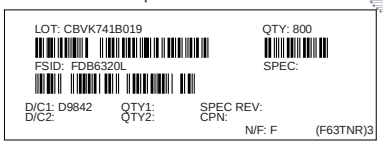
| TO-263AB/D²PAK Packaging Information | | |
|---|---|---|
| **Packaging Option** | Standard (no flow code) | L86Z |
| **Packaging type** | TNR | Rail/Tube |
| **Qty per Reel/Tube/Bag** | 800 | 45 |
| **Reel Size** | 13" Dia | - |
| **Box Dimension (mm)** | 359x359x57 | 530x130x83 |
| **Max qty per Box** | 800 | 1,080 |
| **Weight per unit (gm)** | 1.4378 | 1.4378 |
| **Weight per Reel** | 1.6050 | - |
| **Note/Comments** | | |



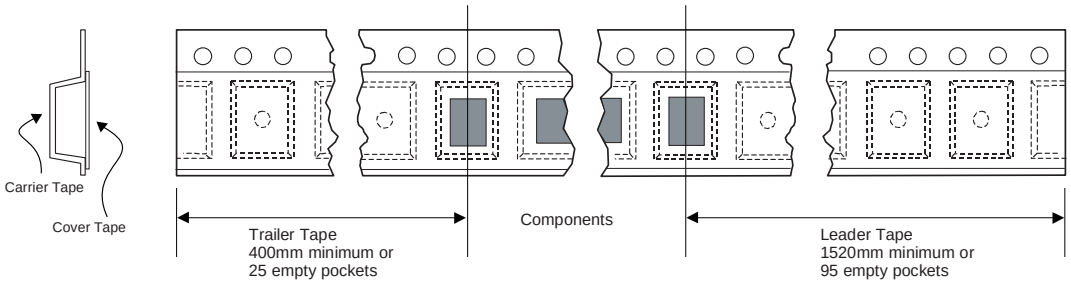
**TO-263AB/D²PAK Unit Orientation**




F63TNR Label sample



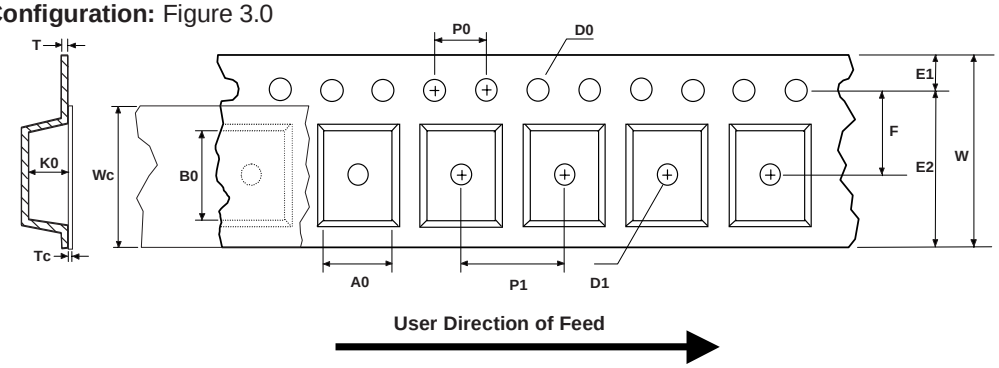

## TO-263AB/D²PAK Tape Leader and Trailer Configuration: Figure 2.0



# TO-263AB/D²PAK Tape and Reel Data and Package Dimensions, continued

## TO-263AB/D²PAK Embossed Carrier Tape

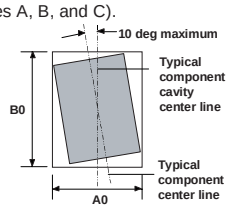
**Configuration:** Figure 3.0



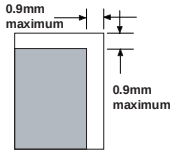

| Dimensions are in millimeter | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pkg type** | **A0** | **B0** | **W** | **D0** | **D1** | **E1** | **E2** | **F** | **P1** | **P0** | **K0** | **T** | **Wc** | **Tc** |
| **TO263AB/ D²PAK** (24mm) | 10.60 +/-0.10 | 15.80 +/-0.10 | 24.0 +/-0.3 | 1.55 +/-0.05 | 1.60 +/-0.10 | 1.75 +/-0.10 | 22.25 min | 11.50 +/-0.10 | 16.0 +/-0.1 | 4.0 +/-0.1 | 4.90 +/-0.10 | 0.450 +/-0.150 | 21.0 +/-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**



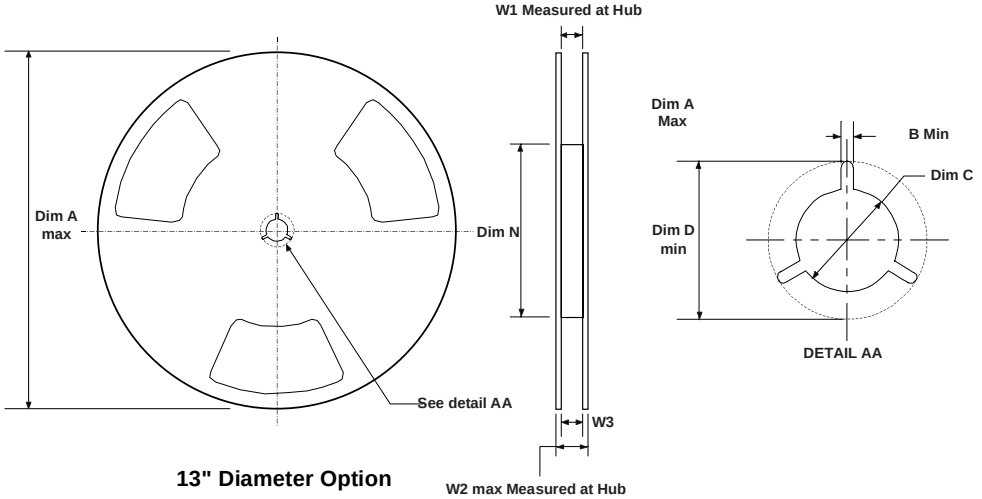

Sketch B (Top View)
**Component Rotation**




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

## TO-263AB/D²PAK Reel Configuration:

Figure 4.0

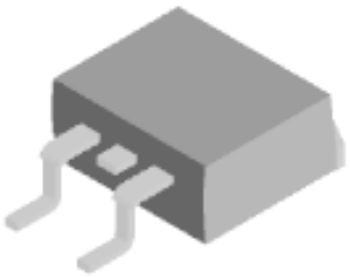


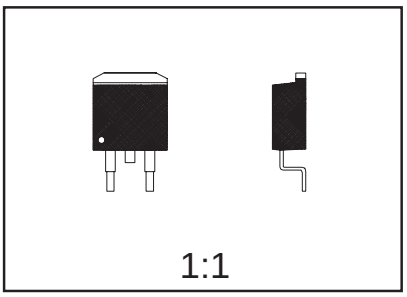

**13" Diameter Option**

| 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)** |
| 24mm | 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 | 0.961 +0.078/-0.000 24.4 +2/0 | 1.197 30.4 | 0.941 – 0.1.079 23.9 – 27.4 |

## TO-263AB/D²PAK Tape and Reel Data and Package Dimensions, continued

# TO-263AB/D²PAK (FS PKG Code 45)

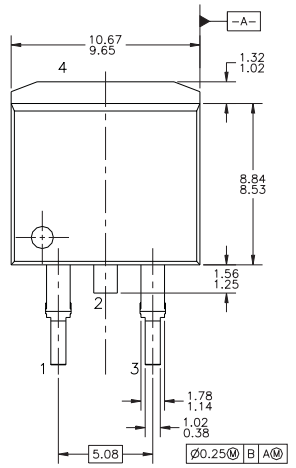


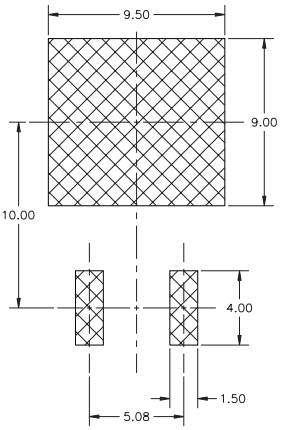



Scale 1:1 on letter size paper

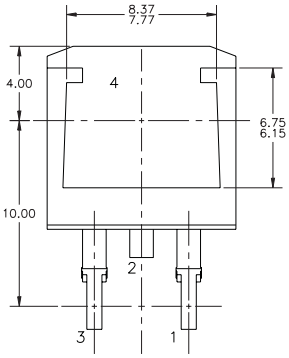
Dimensions shown below are in:
inches [millimeters]

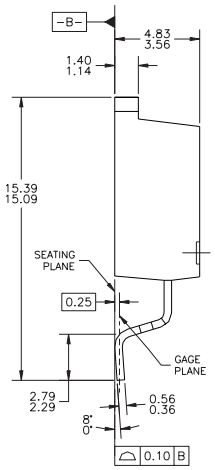
Part Weight per unit (gram): 1.4378




LAND PATTERN RECOMMENDATION

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POP™
PowerTrench®
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QS™
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