FAIRCHILD SEMICONDUCTOR TM

October 1996

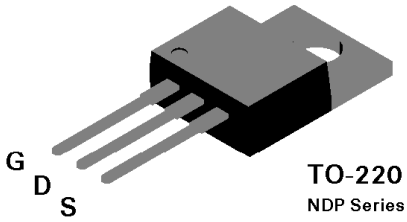
# NDP5060L / NDB5060L
# N-Channel Logic Level Enhancement Mode Field Effect Transistor

### General Description

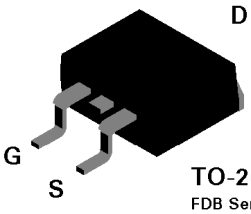
These logic level N-Channel enhancement mode power field effect transistors are produced using Fairchild's proprietary, high cell density, DMOS technology. This very high density process has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulses in the avalanche and commutation modes. These devices are particularly suited for low voltage applications such as automotive, DC/DC converters, PWM motor controls, and other battery powered circuits where fast switching, low in-line power loss, and resistance to transients are needed.

### Features

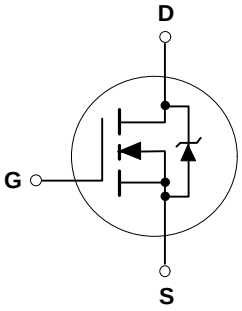
- 26 A, 60 V. $R_{DS(ON)}$ = 0.05 Ω @ $V_{GS}$= 5 V
  $R_{DS(ON)}$ = 0.035 Ω @ $V_{GS}$= 10 V.
- Critical DC electrical parameters specified at elevated temperature.
- Rugged internal source-drain diode can eliminate the need for an external Zener diode transient suppressor.
- 175°C maximum junction temperature rating.
- High density cell design for extremely low $R_{DS(ON)}$.
- TO-220 and TO-263 ($D^2$PAK) package for both through hole and surface mount applications.




TO-220
NDP Series




TO-263AB
FDB Series




## Absolute Maximum Ratings

$T_C$ = 25°C unless otherwise noted

| Symbol | Parameter | NDP5060L | NDB5060L | Units |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | 60 | | V |
| $V_{DGR}$ | Drain-Gate Voltage ($R_{GS}$ ≤ 1 MΩ) | 60 | | V |
| $V_{GSS}$ | Gate-Source Voltage - Continuous | ±16 | | V |
| | - Nonrepetitive ($t_p$ < 50 µs) | ±25 | | |
| $I_D$ | Drain Current - Continuous | 26 | | A |
| | - Pulsed | 78 | | |
| $P_D$ | Total Power Dissipation @ $T_C$ = 25°C | 68 | | W |
| | Derate above 25°C | 0.45 | | W/°C |
| $T_J$,$T_{STG}$ | Operating and Storage Temperature Range | -65 to 175 | | °C |

## Electrical Characteristics ($T_C$ = 25°C unless otherwise noted)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **DRAIN-SOURCE AVALANCHE RATINGS** (Note 1) | | | | | | |
| $W_{DSS}$ | Single Pulse Drain-Source Avalanche Energy | $V_{DD}$ = 30 V, $I_D$ = 26 A | | | 100 | mJ |
| $I_{AR}$ | Maximum Drain-Source Avalanche Current | | | | 26 | A |
| **OFF CHARACTERISTICS** | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 250 µA | 60 | | | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 60 V, $V_{GS}$ = 0 V | | | 250 | µA |
| | | $T_J$ = 125°C | | | 1 | mA |
| $I_{GSSF}$ | Gate - Body Leakage, Forward | $V_{GS}$ = 16 V, $V_{DS}$ = 0 V | | | 100 | nA |
| $I_{GSSR}$ | Gate - Body Leakage, Reverse | $V_{GS}$ = -16 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 | 1 | 1.4 | 2 | V |
| | | $T_J$ = 125°C | 0.65 | 1 | 1.5 | |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}$ = 5 V, $I_D$ = 13 A | | 0.042 | 0.05 | Ω |
| | | $T_J$ = 125°C | | 0.07 | 0.08 | |
| | | $V_{GS}$ = 10 V, $I_D$ = 13 A | | 0.031 | 0.035 | |
| $I_{D(on)}$ | On-State Drain Current | $V_{GS}$ = 5 V, $V_{DS}$ = 10 V | 26 | | | A |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 10 V, $I_D$ = 13 A | | 16 | | S |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 30 V, $V_{GS}$ = 0 V, f = 1.0 MHz | | 840 | | pF |
| $C_{oss}$ | Output Capacitance | | | 230 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 75 | | pF |
| **SWITCHING CHARACTERISTICS** (Note 1) | | | | | | |
| $t_{D(on)}$ | Turn - On Delay Time | $V_{DD}$ = 30 V, $I_D$ = 26 A, $V_{GS}$ = 5 V, $R_{GEN}$ = 30 Ω $R_{GS}$ = 30 Ω | | 13 | 20 | nS |
| $t_r$ | Turn - On Rise Time | | | 200 | 400 | nS |
| $t_{D(off)}$ | Turn - Off Delay Time | | | 45 | 80 | nS |
| $t_f$ | Turn - Off Fall Time | | | 102 | 200 | nS |
| $Q_g$ | Total Gate Charge | $V_{DS}$ = 24 V, $I_D$ = 26 A, $V_{GS}$ = 5 V | | 17 | 24 | nC |
| $Q_{gs}$ | Gate-Source Charge | | | 4 | | nC |
| $Q_{gd}$ | Gate-Drain Charge | | | 10 | | nC |

## Electrical Characteristics ($T_c$ = 25°C unless otherwise noted)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **DRAIN-SOURCE DIODE CHARACTERISTICS** | | | | | | |
| $I_S$ | Maximum Continuos Drain-Source Diode Forward Current | | | | 26 | A |
| $I_{SM}$ | Maximum Pulsed Drain-Source Diode Forward Current | | | | 78 | A |
| $V_{SD}$ | Drain-Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 13 A (Note 1) | | 0.9 | 1.3 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_F$ = 26 A, $dI_F/dt$ = 100 A/µs | | 54 | 120 | ns |
| $I_{rr}$ | Reverse Recovery Current | | | 2.1 | 8 | A |
| **THERMAL CHARACTERISTICS** | | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | | | | 2.2 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | | | | 62.5 | °C/W |

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

## Typical Electrical Characteristics

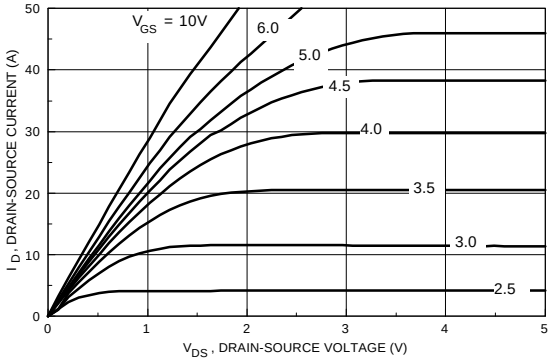



**Figure 1. On-Region Characteristics.**

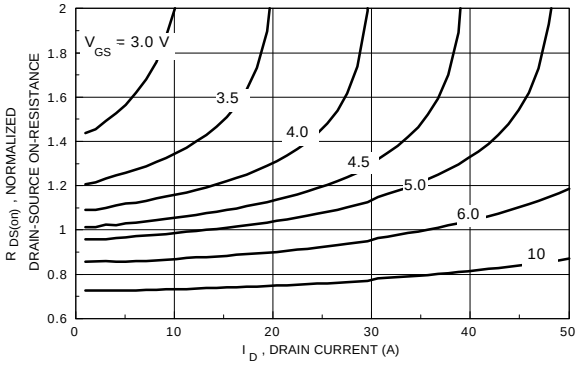



**Figure 2. On-Resistance Variation with Gate Voltage and Drain Current.**

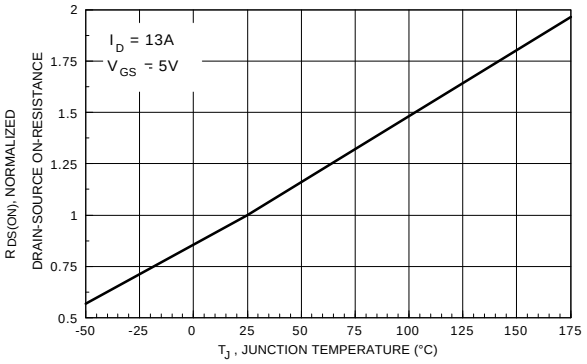



**Figure 3. On-Resistance Variation with Temperature.**

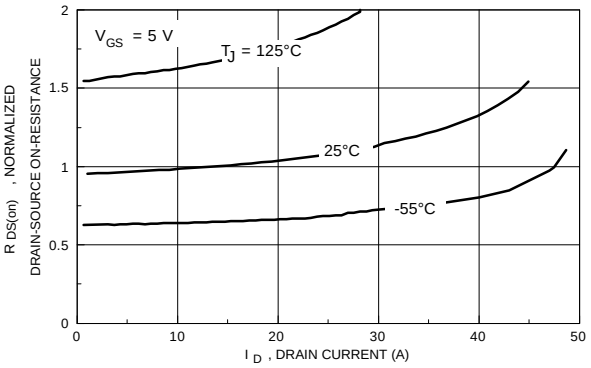



**Figure 4. On-Resistance Variation with Drain Current and Temperature.**

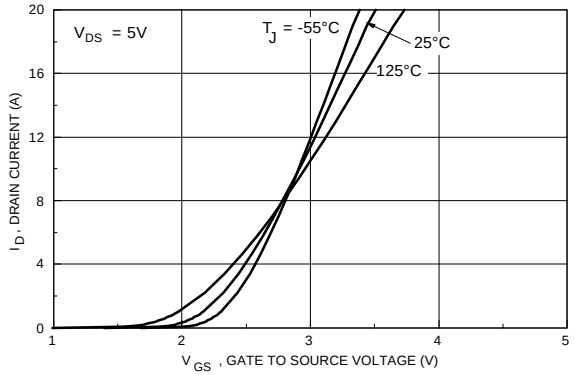



**Figure 5. Transfer Characteristics.**

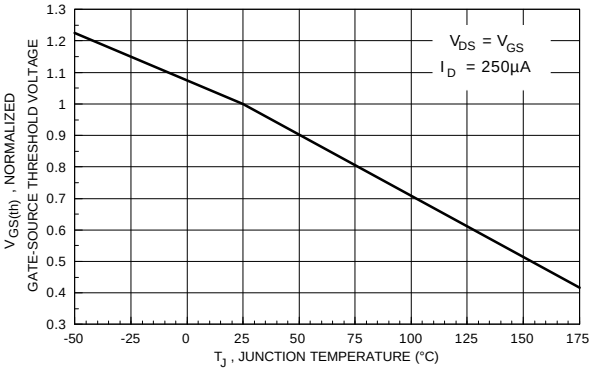



**Figure 6. Gate Threshold Variation with Temperature.**

## Typical Electrical Characteristics (continued)

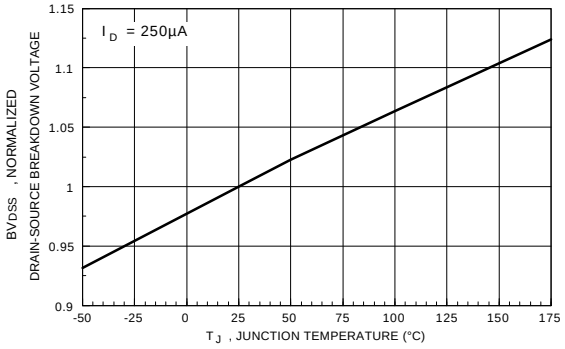



**Figure 7. Breakdown Voltage Variation with Temperature**.

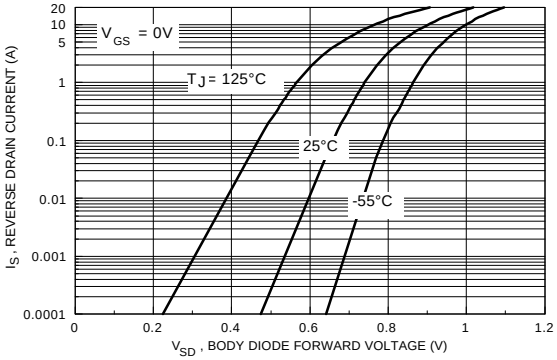



**Figure 8. Body Diode Forward Voltage Variation with Current and Temperature**.

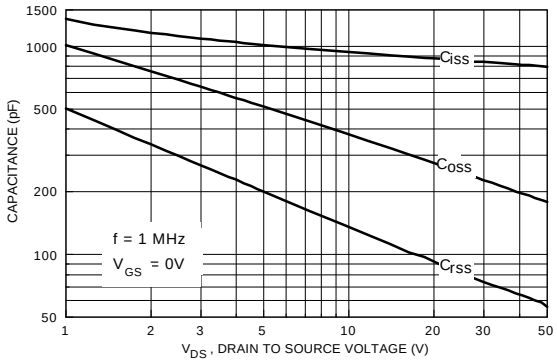



**Figure 9. Capacitance Characteristics**.

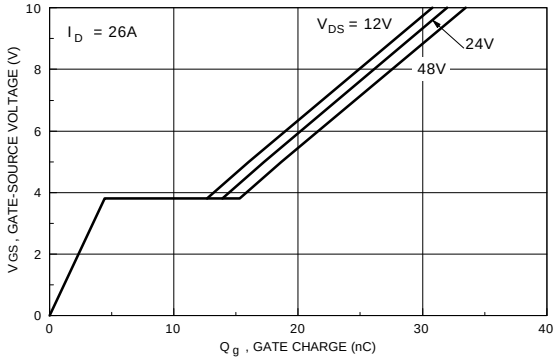



**Figure 10. Gate Charge Characteristics**.

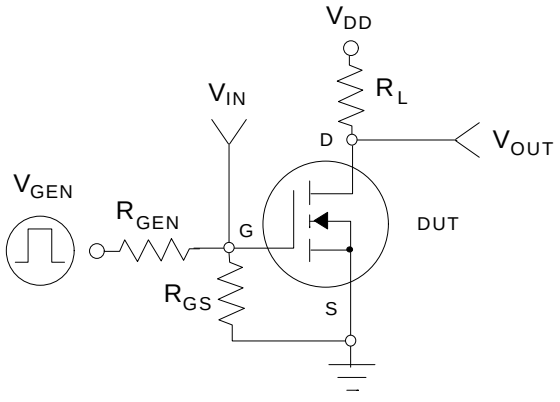



**Figure 11. Switching Test Circuit**.

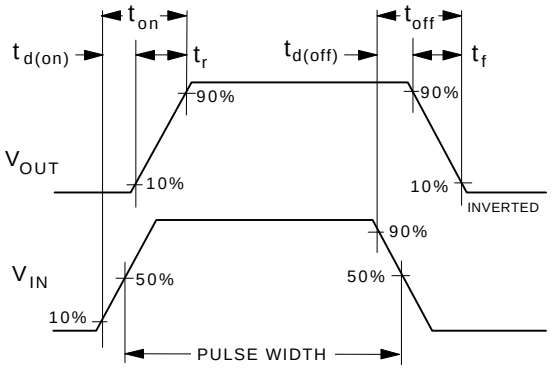



**Figure 12. Switching Waveforms**.

## Typical Electrical Characteristics (continued)

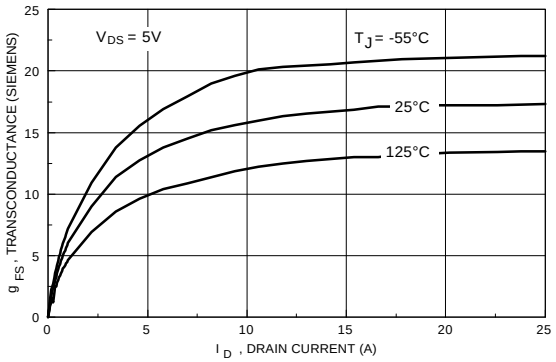



**Figure 13. Transconductance Variation with Drain Current and Temperature**.

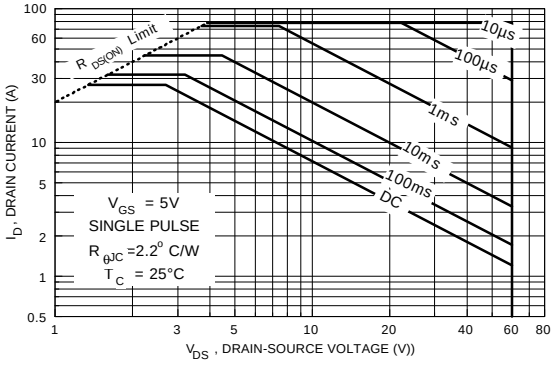



**Figure 14. Maximum Safe Operating Area**.

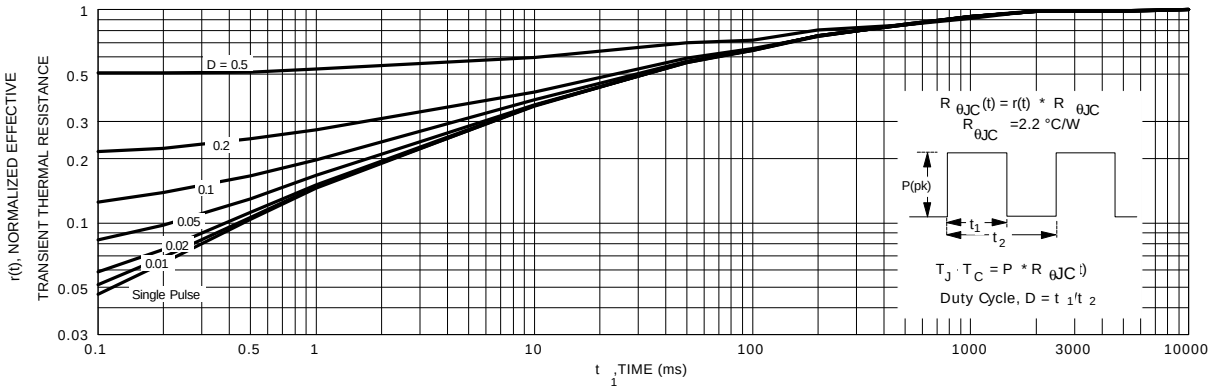



**Figure 15. Transient Thermal Response Curve.**

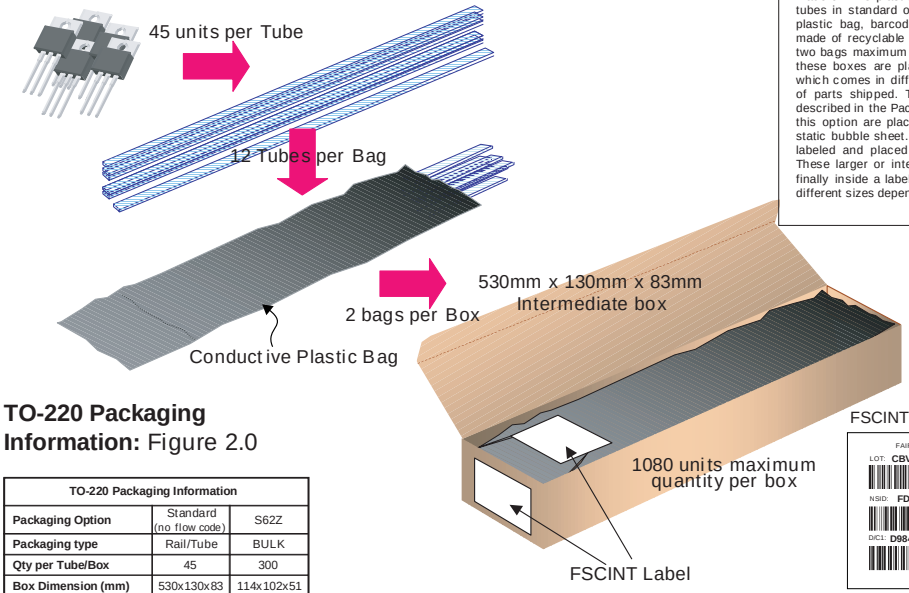
# TO-220 Tape and Reel Data and Package Dimensions

FAIRCHILD SEMICONDUCTOR™

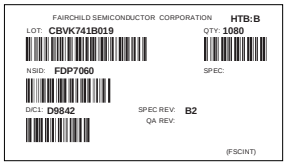
## TO-220 Tube Packing
**Configuration:** Figure 1.0

**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.



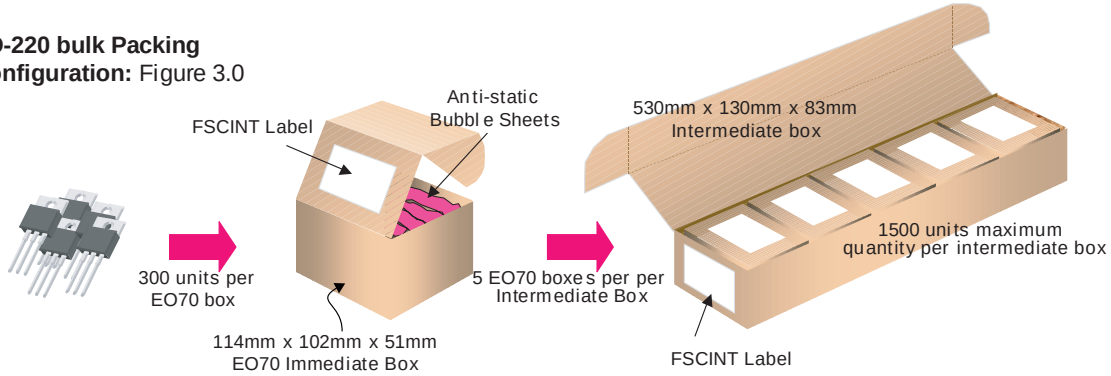

FSCINT Label sample



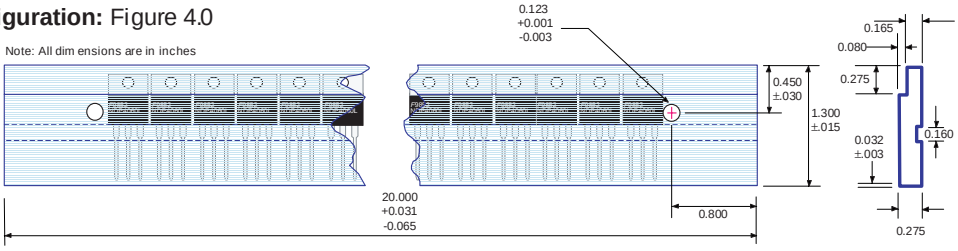

## TO-220 Packaging
**Information:** Figure 2.0

| 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

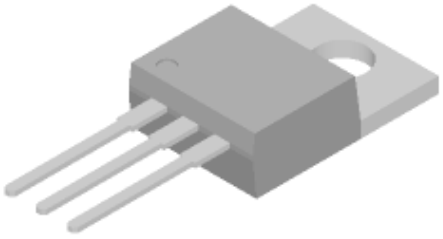


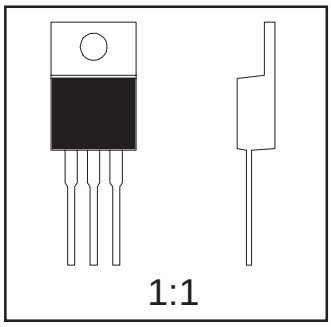

## TO-220 Tube
**Configuration:** Figure 4.0



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

# TO-220 (FS PKG Code 37)

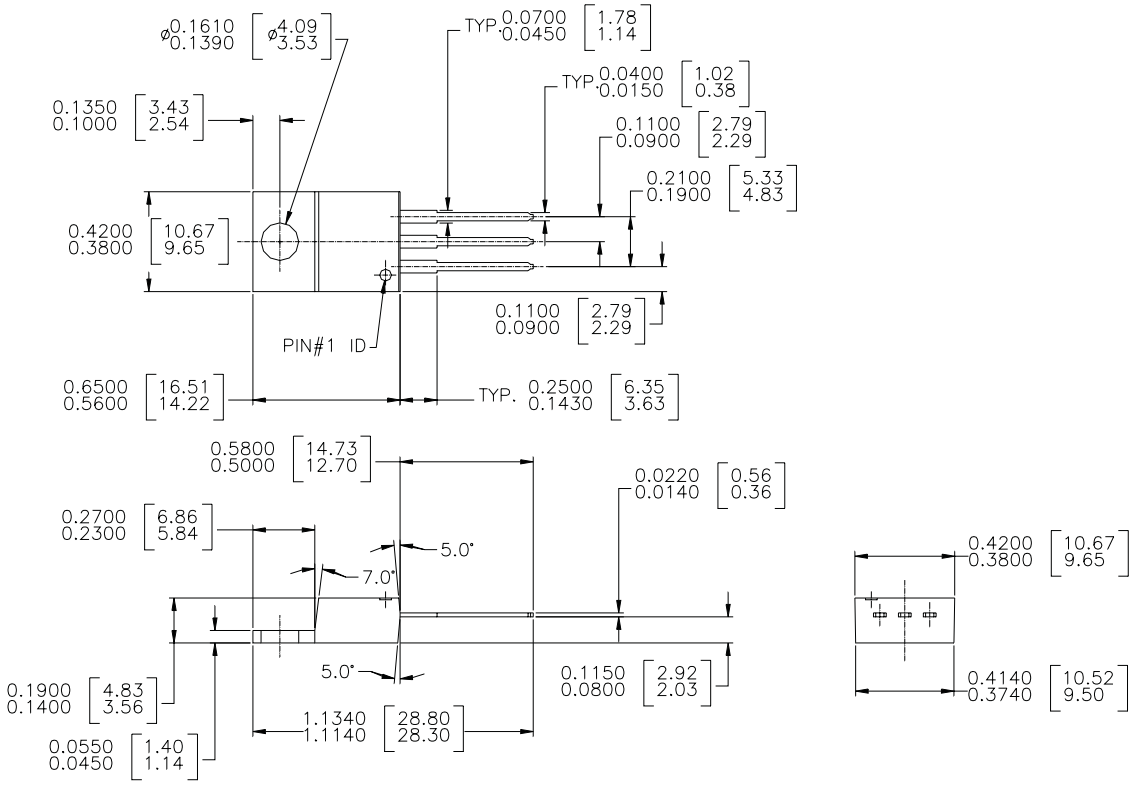





Scale 1:1 on letter size paper

Dimensions shown below are in:
inches [millimeters]

Part Weight per unit (gram): 1.4378




NOTE : UNLESS OTHERWISE SPECIFIED

TO 220 3 LEAD

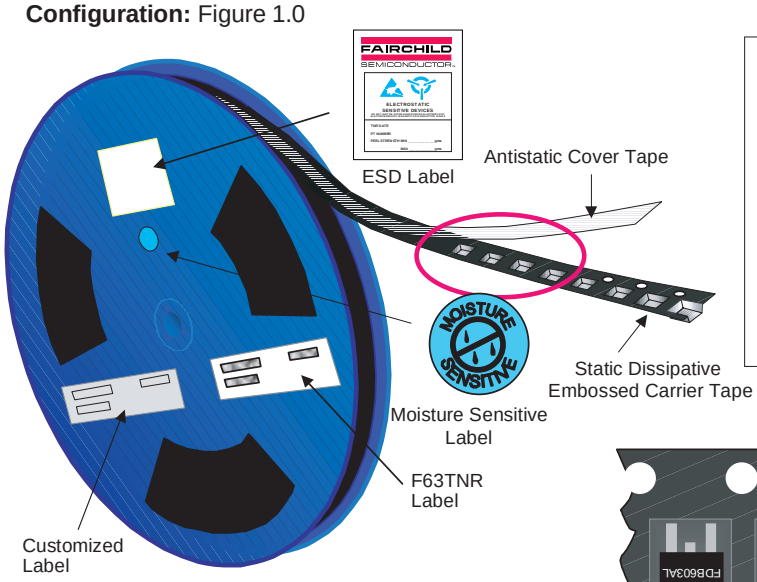
1. STANDARD LEAD FINISH :
200 MICROINCHES / 5.08 MICRON MINIMUM
LEAD / TIN 15/85 ON OLIN 194 COPPER OR EQUIVALENT

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

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

FAIRCHILD SEMICONDUCTOR™

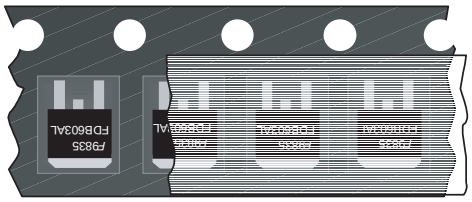
## TO-263AB/D²PAK Packaging Configuration: Figure 1.0




**Packaging Description:**

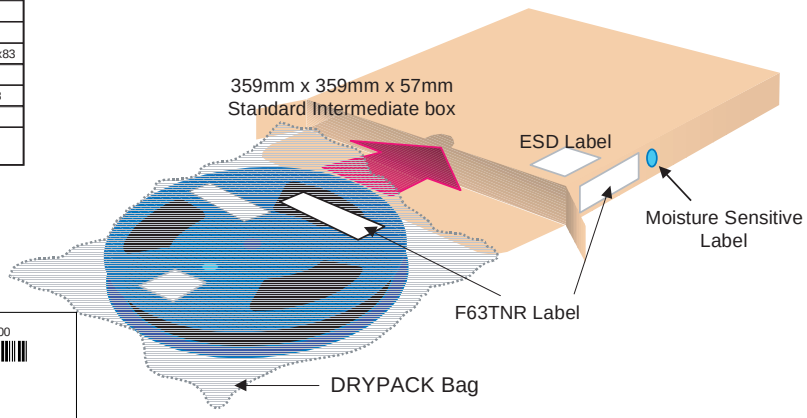
TO-263/D²PAK parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts 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.

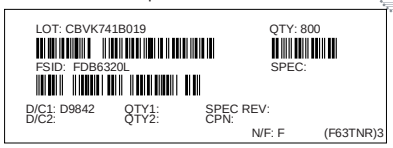


**TO-263AB/D²PAK Unit Orientation**

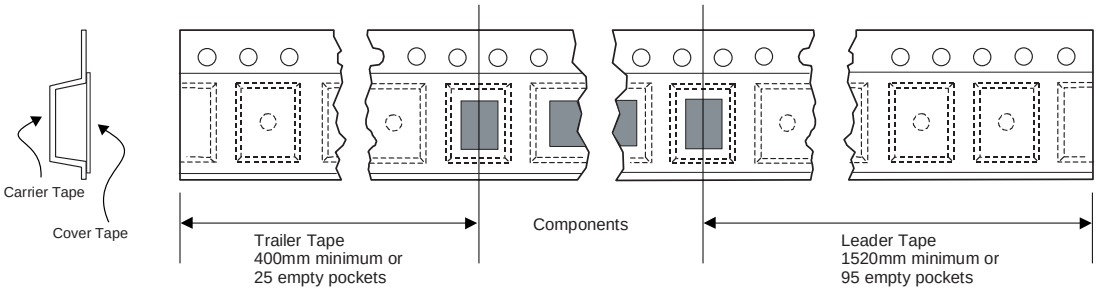
| TO-263AB/D²PAK Packaging Information | | |
|---|---|---|
| **Packaging Option** | Standard (no flow code) | L86Z |
| **Packaging type** | TNR | Rail/Tube |
| **Qty per Reel/Tube/Bag** | 800 | 45 |
| **Reel Size** | 13" Dia | - |
| **Box Dimension (mm)** | 359x359x57 | 530x130x83 |
| **Max qty per Box**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




F63TNR Label sample



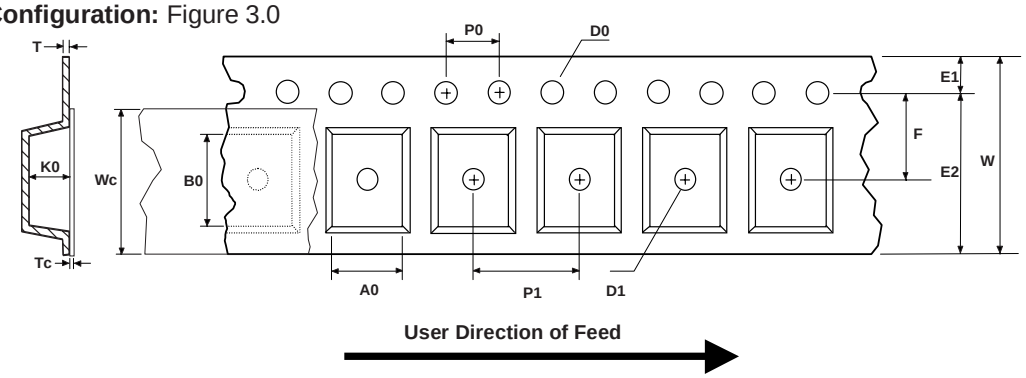

## TO-263AB/D²PAK Tape Leader and Trailer Configuration: Figure 2.0



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

## TO-263AB/D²PAK Embossed Carrier Tape

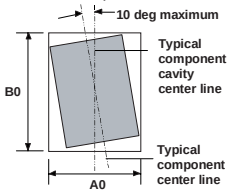
**Configuration:** Figure 3.0



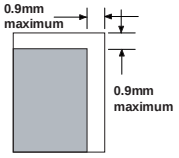

| Dimensions are in millimeter | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pkg type** | **A0** | **B0** | **W** | **D0** | **D1** | **E1** | **E2** | **F** | **P1** | **P0** | **K0** | **T** | **Wc** | **Tc** |
| **TO263AB/ D²PAK** (24mm) | 10.60 +/-0.10 | 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**



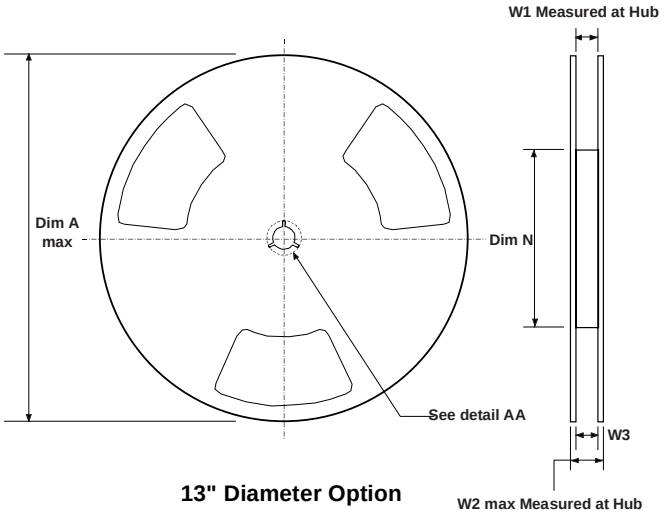

Sketch B (Top View)
**Component Rotation**




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

## TO-263AB/D²PAK Reel Configuration:

Figure 4.0

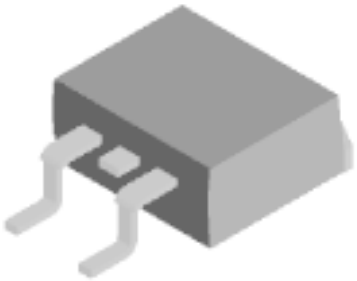


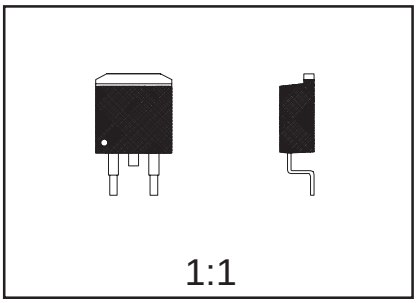

**13" Diameter Option**

| 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)

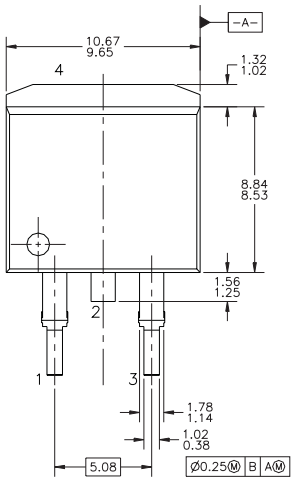


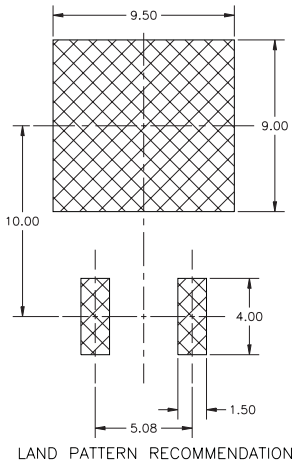



Scale 1:1 on letter size paper

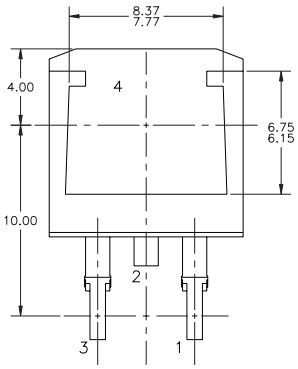
Dimensions shown below are in:
inches [millimeters]

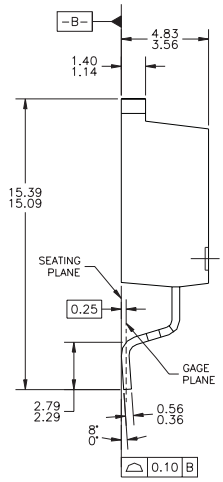
Part Weight per unit (gram): 1.4378




LAND PATTERN RECOMMENDATION




NOTES: UNLESS OTHERWISE SPECIFIED
A) ALL DIMENSIONS ARE IN MILLIMETERS.
B) STANDARD LEAD FINISH:
200 MICROINCHES / 5.08 MICROMETERS MIN.
LEAD/TIN 15/85 ON OLIN 194 COPPER OR EQUIVALENT.
C) MAXIMUM VERTICAL BURR ON HEATSINK NOT TO EXCEED 0.003 INCH / 0.05mm.
D) NO PACKAGE CHIPS, CRACKS OR SURFACE IDENTIFICATION ALLOWED AFTER FORMING.
E) REFERENCE JEDEC, TO-263, ISSUE C, VARIATION AB, DATED 2/92.

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|---|---|---|
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