November 1996

FAIRCHILD SEMICONDUCTOR TM

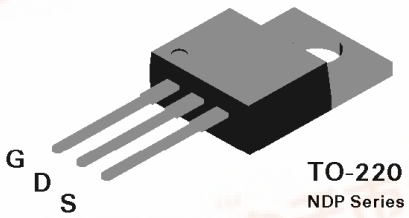
NDP6020 / NDB6020
N-Channel Logic Level Enhancement Mode Field Effect Transistor

General Description

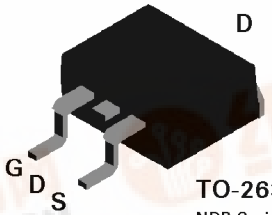
These logic level N-Channel enhancement mode power field effect transistors are produced using National's proprietary, high cell density, DMOS technology. This very high density process has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand 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

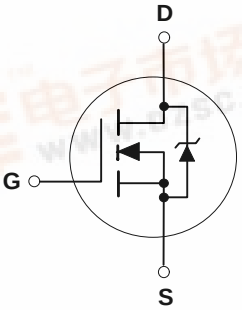
- 35 A, 20 V. $R_{DS(ON)}$ = 0.023 Ω @ V_{GS}= 4.5 V
  $R_{DS(ON)}$ = 0.028 Ω @ V_{GS}= 2.7 V.
- Critical DC electrical parameters specified at elevated temperature.
- Rugged internal source-drain diode can eliminate the need for an external Zener diode transient suppressor.
- 175°C maximum junction temperature rating.
- High density cell design for extremely low $R_{DS(ON)}$.
- TO-220 and TO-263 (D^2PAK) package for both through hole and surface mount applications.



TO-220
NDP Series



TO-263AB
NDB Series



Absolute Maximum Ratings T_C = 25°C unless otherwise noted

Symbol	Parameter	NDP6020	NDB6020	Units
V_{DSS}	Drain-Source Voltage	20		V
V_{DGR}	Drain-Gate Voltage (R_{GS} ≤ 1 MΩ)	20		V
V_{GSS}	Gate-Source Voltage - Continuous	±8		V
I_D	Drain Current - Continuous	35		A
	- Pulsed	100		
P_D	Total Power Dissipation @ T_C = 25°C	60		W
	Derate above 25°C	0.4		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
OFF CHARACTERISTICS						
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS} = 0 V, I_D = 250 µA	20			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 16 V, V_{GS} = 0 V			1	µA
		T_J = 55°C			10	mA
I_{GSSF}	Gate - Body Leakage, Forward	V_{GS} = 8 V, V_{DS} = 0 V			100	nA
I_{GSSR}	Gate - Body Leakage, Reverse	V_{GS} = -8 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	0.4	0.62	1	V
		T_J = 125°C	0.2	0.35	0.7	
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS} = 4.5 V, I_D = 18 A		0.019	0.023	Ω
		T_J = 125°C		0.024	0.032	
		V_{GS} = 2.7 V, I_D = 16 A		0.024	0.028	
$I_{D(on)}$	On-State Drain Current	V_{GS} = 4.5 V, V_{DS} = 5 V	60			A
g_{FS}	Forward Transconductance	V_{DS} = 5 V, I_D = 18 A		29		S
DYNAMIC CHARACTERISTICS						
C_{iss}	Input Capacitance	V_{DS} = 10 V, V_{GS} = 0 V, f = 1.0 MHz		1170		pF
C_{oss}	Output Capacitance			610		pF
C_{rss}	Reverse Transfer Capacitance			180		pF
SWITCHING CHARACTERISTICS (Note 1)						
$t_{D(on)}$	Turn - On Delay Time	V_{DD} = 20 V, I_D = 35 A, V_{GS} = 5 V, R_{GEN} = 10 Ω R_L = 0.5 Ω		7	20	nS
t_r	Turn - On Rise Time			148	300	nS
$t_{D(off)}$	Turn - Off Delay Time			98	200	nS
t_f	Turn - Off Fall Time			233	450	nS
Q_g	Total Gate Charge	V_{DS} = 15 V, I_D = 35 A, V_{GS} = 5 V		32	45	nC
Q_{gs}	Gate-Source Charge			6		nC
Q_{gd}	Gate-Drain Charge			11		nC

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
DRAIN-SOURCE DIODE CHARACTERISTICS						
I_S	Maximum Continuous Drain-Source Diode Forward Current				35	A
I_{SM}	Maximum Pulsed Drain-Source Diode Forward Current				100	A
V_{SD}	Drain-Source Diode Forward Voltage	V_{GS} = 0 V, I_S = 35 A (Note 1)		1.1	1.3	V
t_{rr}	Reverse Recovery Time	V_{GS} = 0 V, I_F = 35 A, dI_F/dt = 100 A/µs		43	90	ns
I_{rr}	Reverse Recovery Current			1.1	3	A
THERMAL CHARACTERISTICS						
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case				2.5	°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

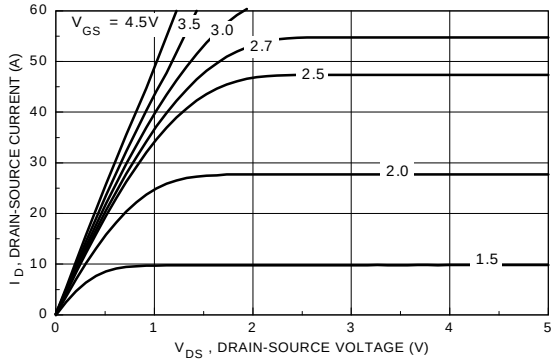


Figure 1. On-Region Characteristics.

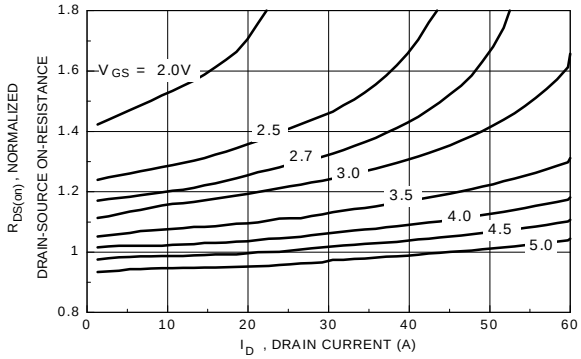


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current.

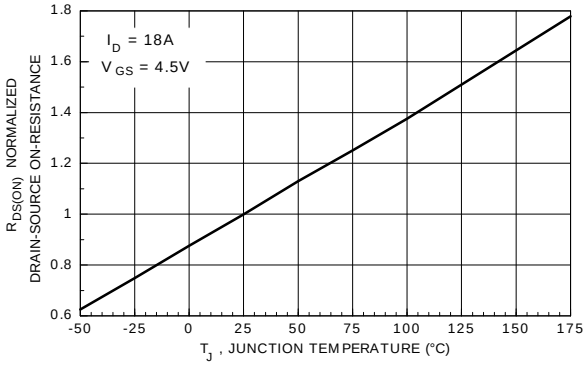


Figure 3. On-Resistance Variation with Temperature.

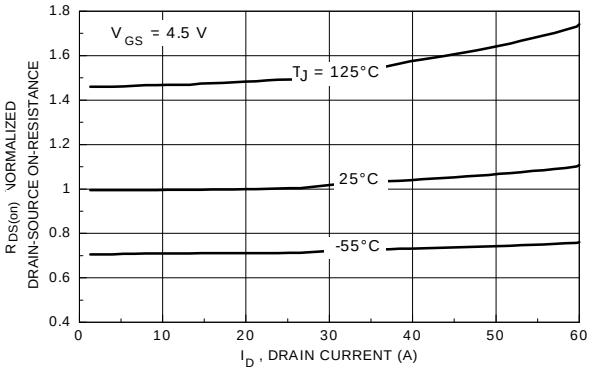


Figure 4. On-Resistance Variation with Drain Current and Temperature.

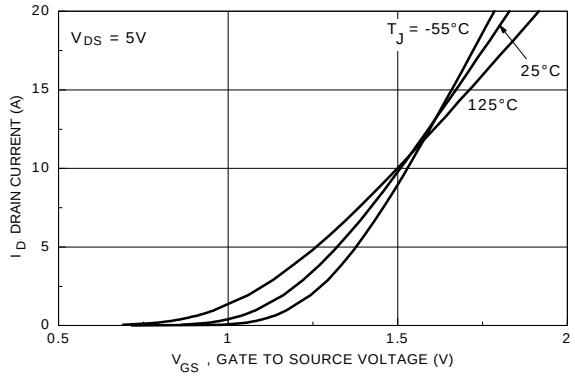


Figure 5. Transfer Characteristics.

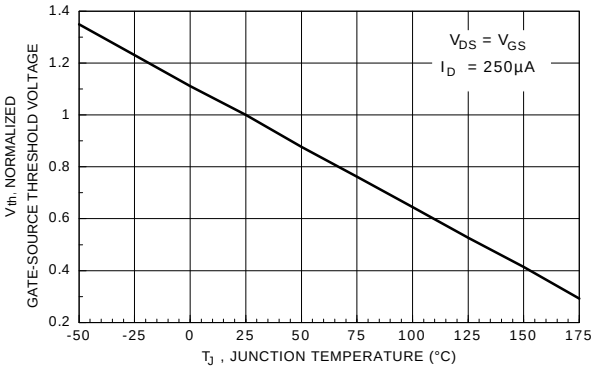


Figure 6. Gate Threshold Variation with Temperature.

Typical Electrical Characteristics (continued)

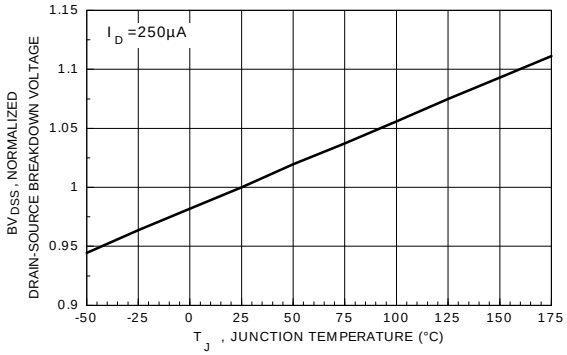


Figure 7. Breakdown Voltage Variation with Temperature.

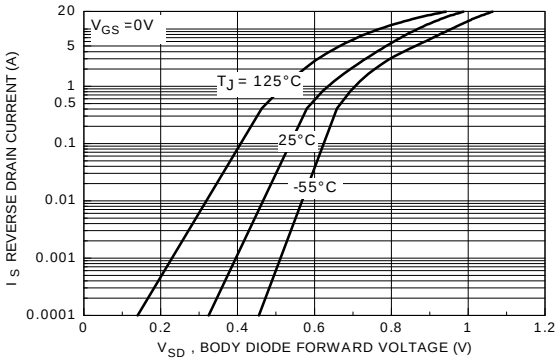


Figure 8. Body Diode Forward Voltage Variation with Current and Temperature.

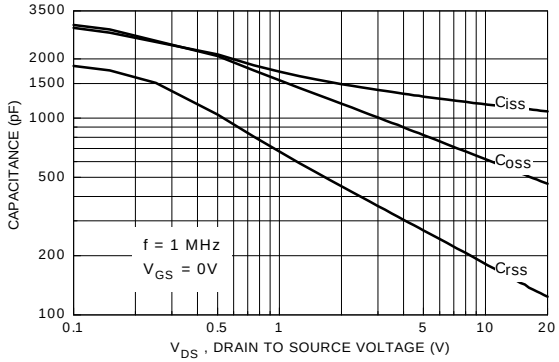


Figure 9. Capacitance Characteristics.

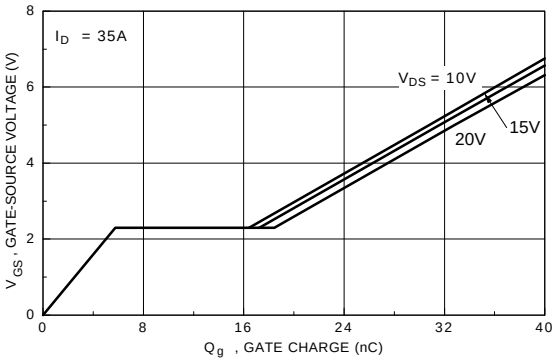


Figure 10. Gate Charge Characteristics.

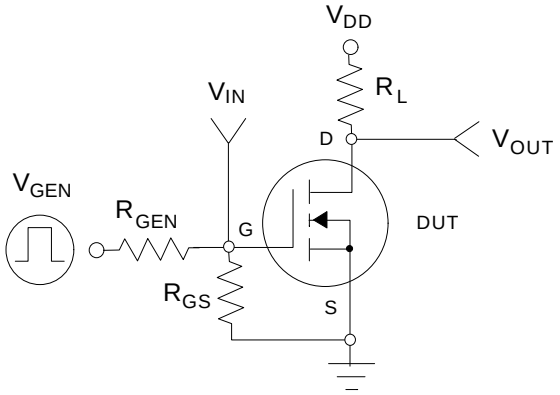


Figure 11. Switching Test Circuit.

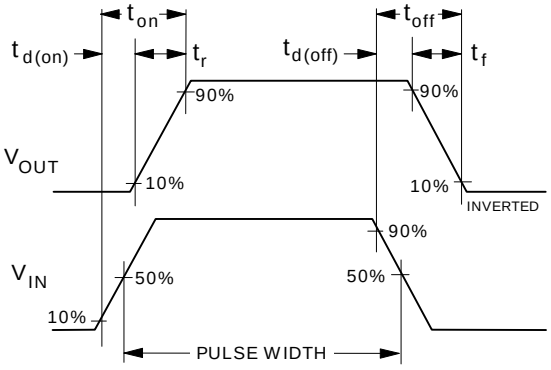


Figure 12. Switching Waveforms.

Typical Electrical Characteristics (continued)

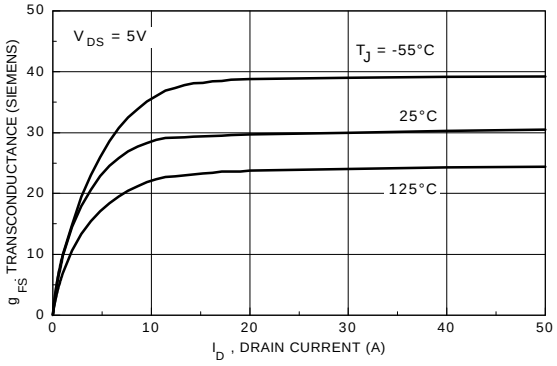


Figure 13. Transconductance Variation with Drain Current and Temperature.

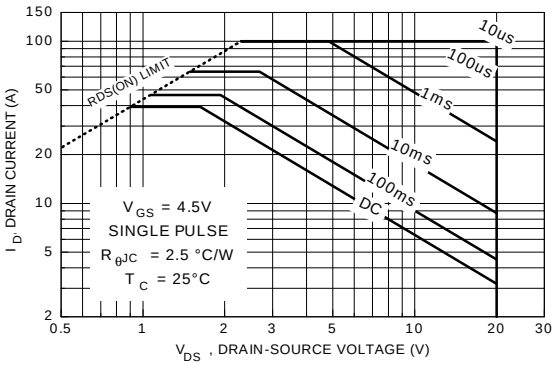


Figure 14. Maximum Safe Operating Area.

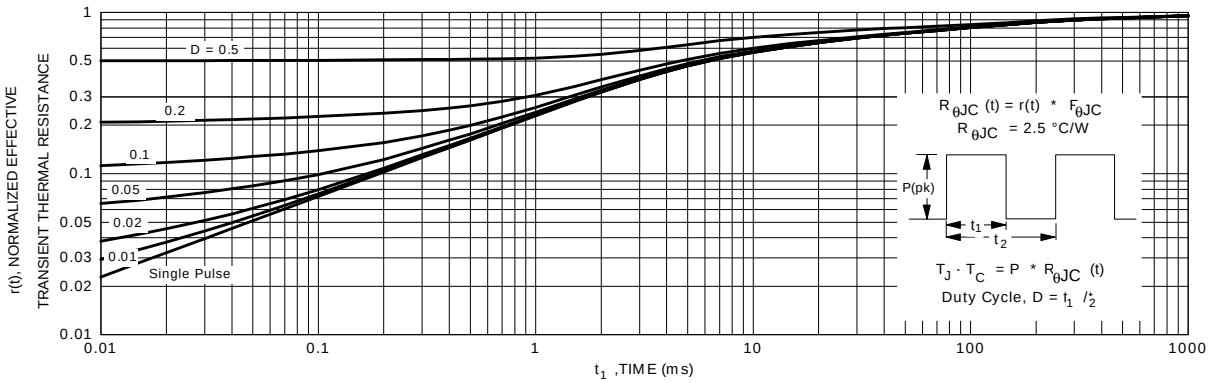


Figure 15. Transient Thermal Response Curve.

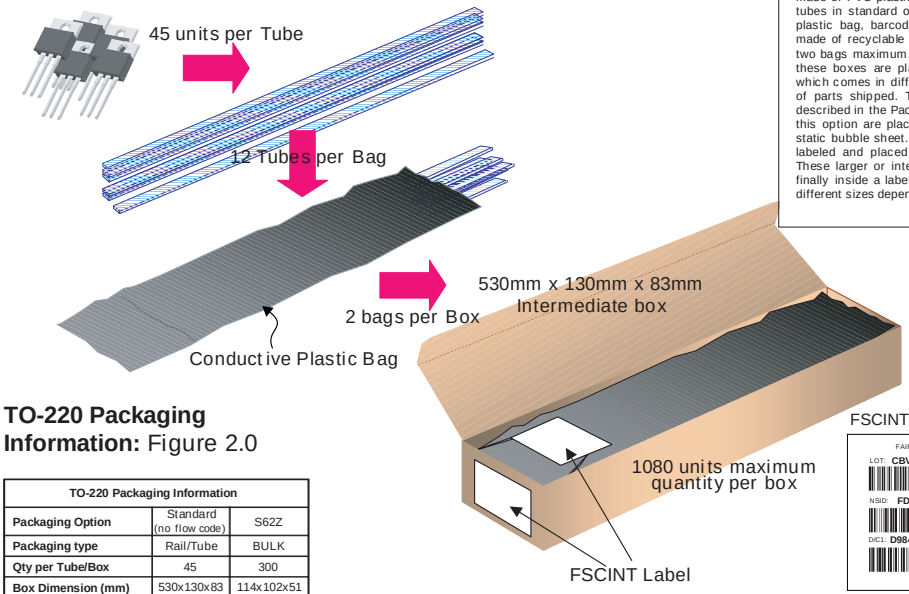
TO-220 Tape and Reel Data and Package Dimensions

FAIRCHILD SEMICONDUCTOR™

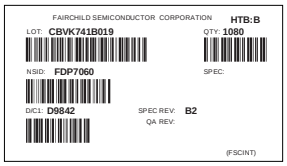
TO-220 Tube Packing
Configuration: Figure 1.0

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.



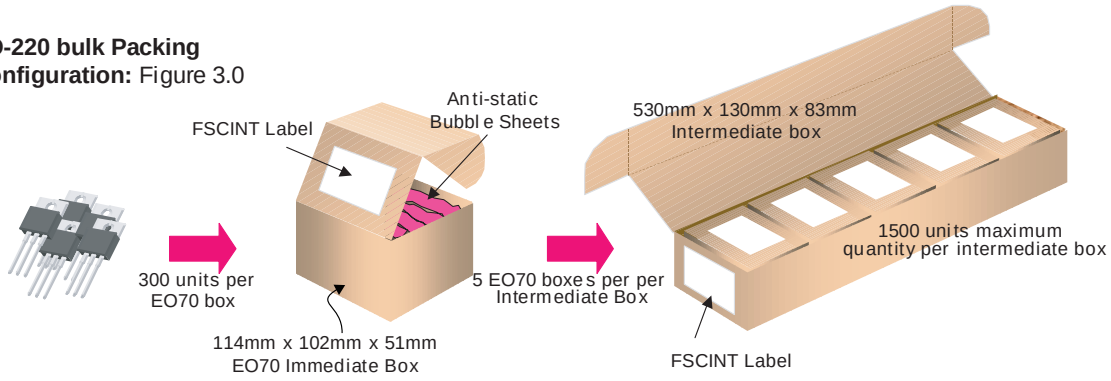
FSCINT Label sample



TO-220 Packaging
Information: Figure 2.0

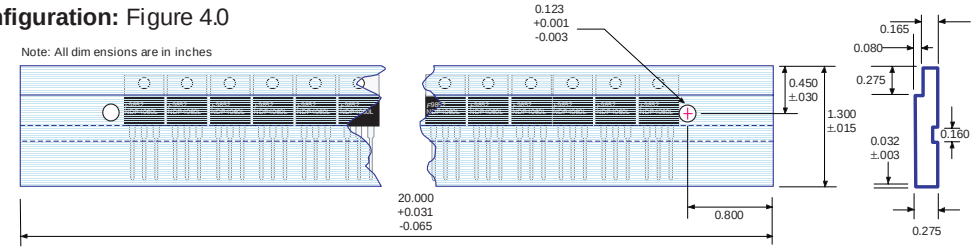
TO-220 Packaging Information		
Packaging Option	Standard (no flow code)	S62Z
Packaging type	Rail/Tube	BULK
Qty per Tube/Box	45	300
Box Dimension (mm)	530x130x83	114x102x51
Max qty per Box	1,080	1,500
Weight per unit (gm)	1.4378	1.4378
Note/Comments		

TO-220 bulk Packing
Configuration: Figure 3.0



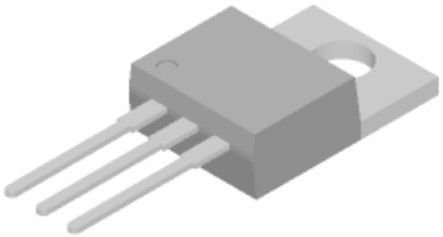
TO-220 Tube
Configuration: Figure 4.0

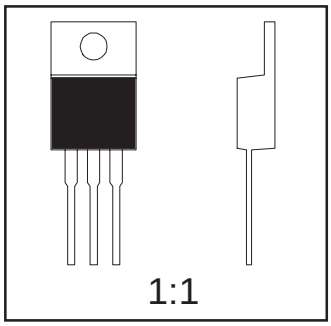
Note: All dimensions are in inches



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

TO-220 (FS PKG Code 37)

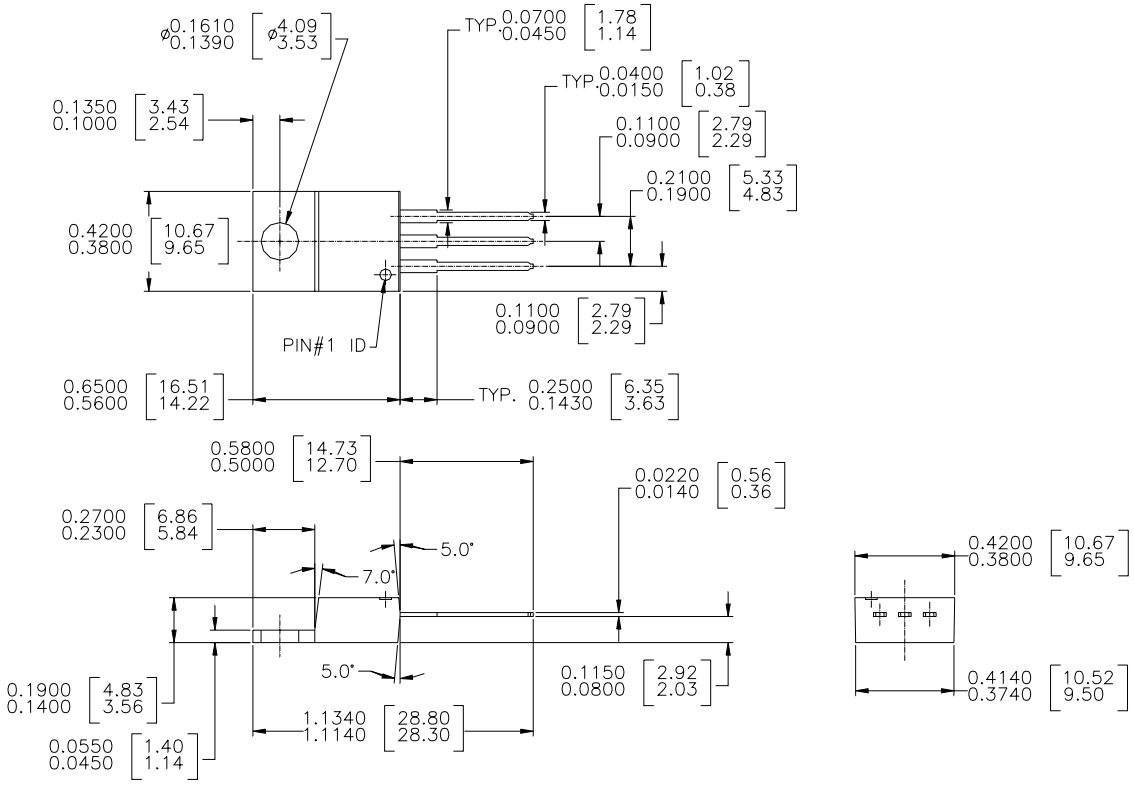




Scale 1:1 on letter size paper

Dimensions shown below are in:
inches [millimeters]

Part Weight per unit (gram): 1.4378



TO 220 3 LEAD

NOTE : UNLESS OTHERWISE SPECIFIED

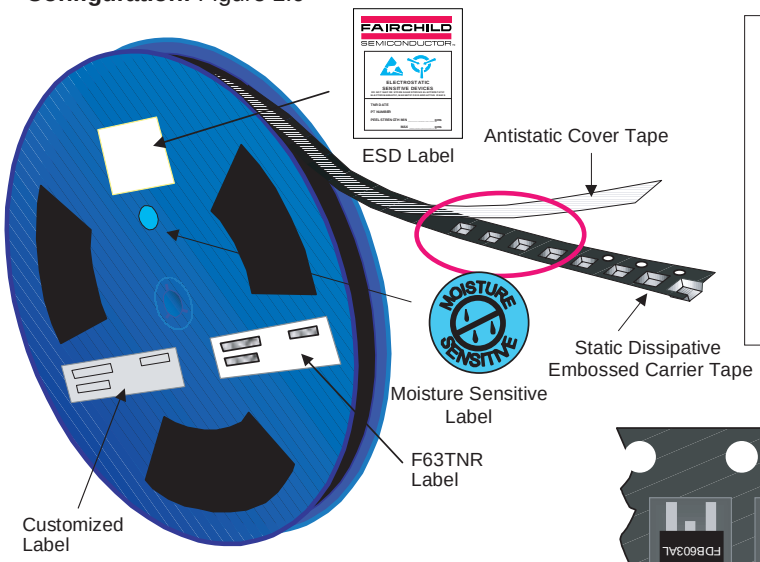
1. STANDARD LEAD FINISH :
200 MICROINCHES / 5.08 MICRON MINIMUM
LEAD / TIN 15/85 ON OLIN 194 COPPER OR EQUIVALENT

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

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

FAIRCHILD SEMICONDUCTOR™

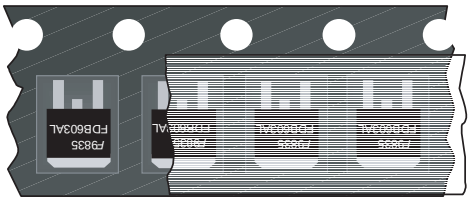
TO-263AB/D²PAK Packaging Configuration: Figure 1.0



Packaging Description:

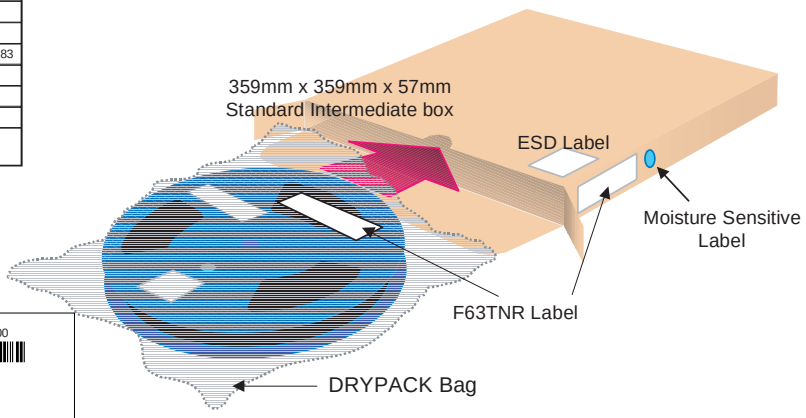
TO-263/D²PAK parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts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

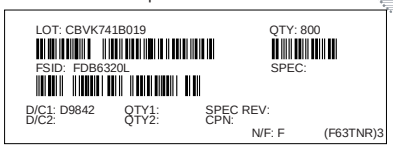


TO-263AB/D²PAK Unit Orientation

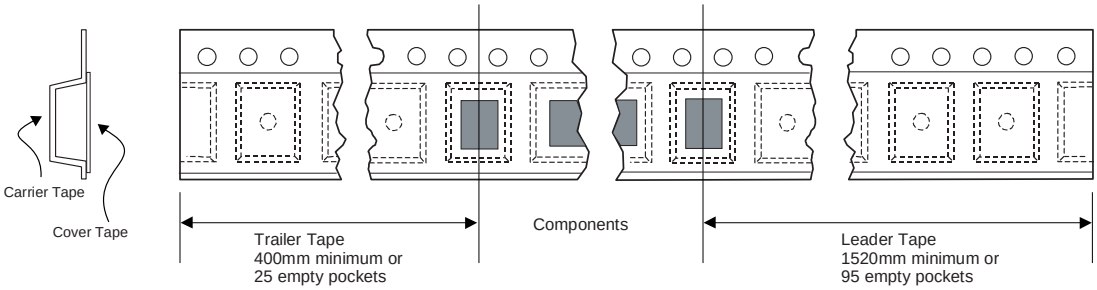
TO-263AB/D²PAK Packaging Information		
Packaging Option	Standard (no flow code)	L86Z
Packaging type	TNR	Rail/Tube
Qty per Reel/Tube/Bag	800	45
Reel Size	13" Dia	-
Box Dimension (mm)	359x359x57	530x130x83
Max qty per Box	800	1,080
Weight per unit (gm)	1.4378	1.4378
Weight per Reel	1.6050	-
Note/Comments		



F63TNR Label sample

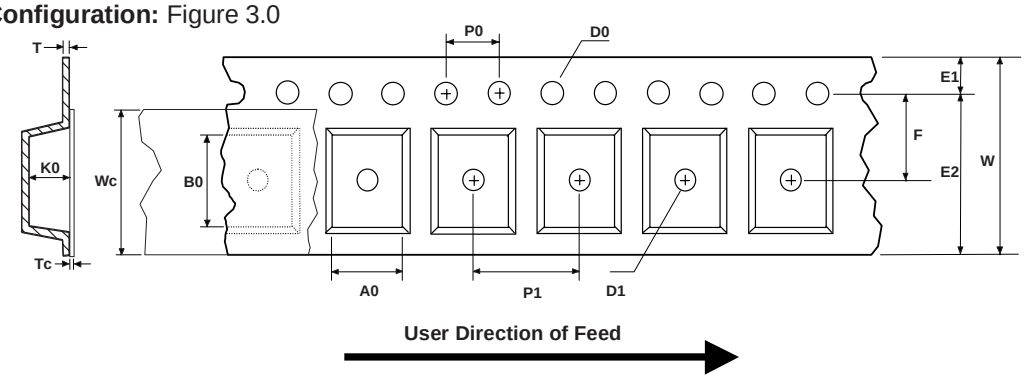


TO-263AB/D²PAK Tape Leader and Trailer Configuration: Figure 2.0



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

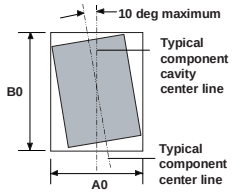
TO-263AB/D²PAK Embossed Carrier Tape
Configuration: Figure 3.0



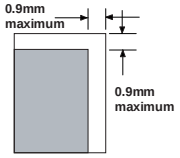
Dimensions are in millimeter														
Pkg type	**A0**	**B0**	**W**	**D0**	**D1**	**E1**	**E2**	**F**	**P1**	**P0**	**K0**	**T**	**Wc**	**Tc**
TO263AB/ D²PAK (24mm)	10.60 +/-0.10	15.80 +/-0.10	24.0 +/-0.3	1.55 +/-0.05	1.60 +/-0.10	1.75 +/-0.10	22.25 min	11.50 +/-0.10	16.0 +/-0.1	4.0 +/-0.1	4.90 +/-0.10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

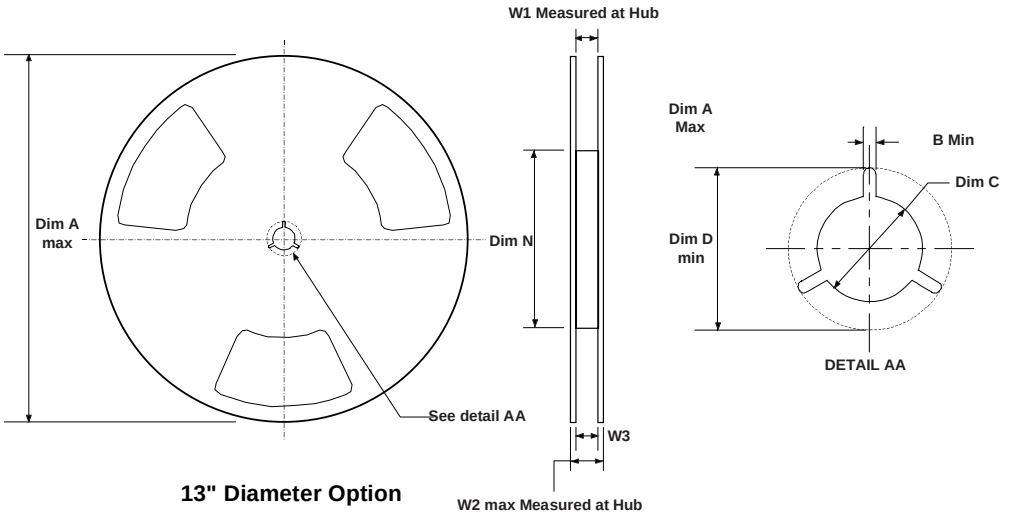


Sketch B (Top View)
Component Rotation



Sketch C (Top View)
Component lateral movement

TO-263AB/D²PAK Reel Configuration:
Figure 4.0

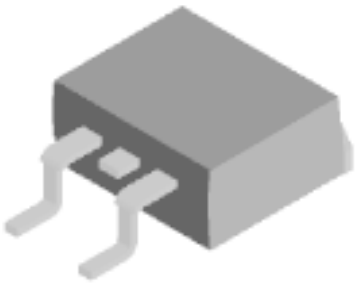


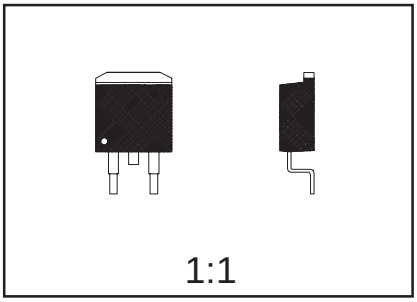
13" Diameter Option

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)

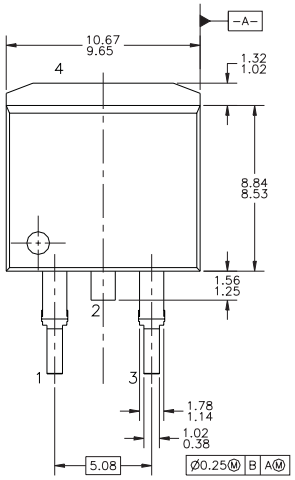


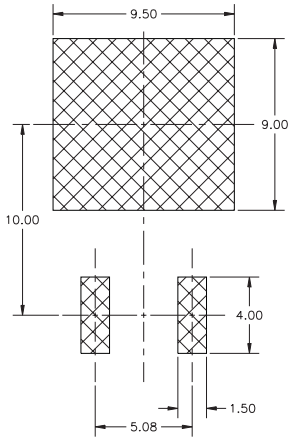


Scale 1:1 on letter size paper

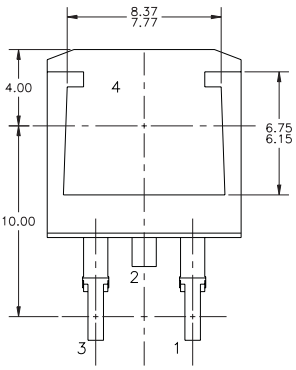
Dimensions shown below are in:
inches [millimeters]

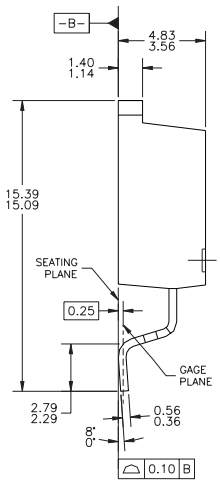
Part Weight per unit (gram): 1.4378





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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PRODUCT STATUS DEFINITIONS

Definition of Terms

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