**FAIRCHILD**

SEMICONDUCTOR ™

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. $R_{DS(ON)} = 0.023\ \Omega$ @ $V_{GS}= 4.5$ V
  $R_{DS(ON)} = 0.028\ \Omega$ @ $V_{GS}= 2.7$ 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^{2}PAK) package for both through hole and surface mount applications.

TO-220
NDP Series

TO-263AB
NDB Series
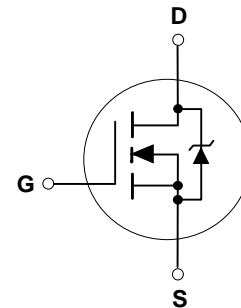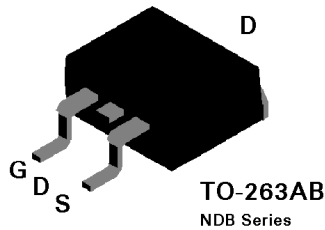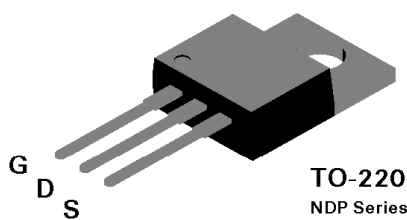
Absolute Maximum Ratings T_C = 25°C unless otherwise noted

Symbol	Parameter	NDP6020	NDB6020	Units
V_{DSS}	Drain-Source Voltage	20		V
V_{DGR}	Drain-Gate Voltage ($R_{GS} \leq 1$ 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%.

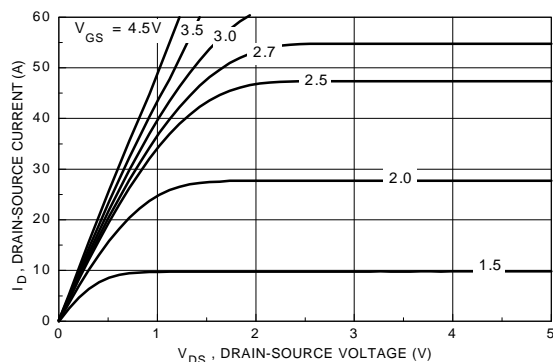# Typical Electrical Characteristics
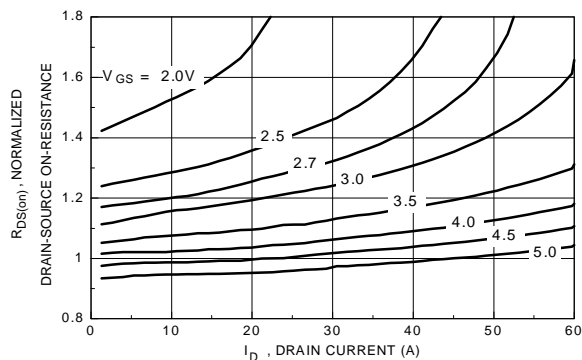

Figure 1. On-Region Characteristics.

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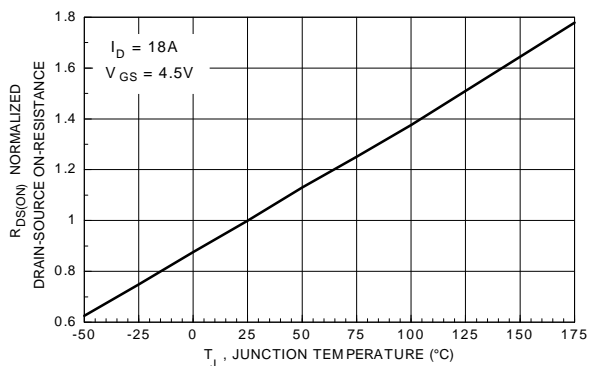

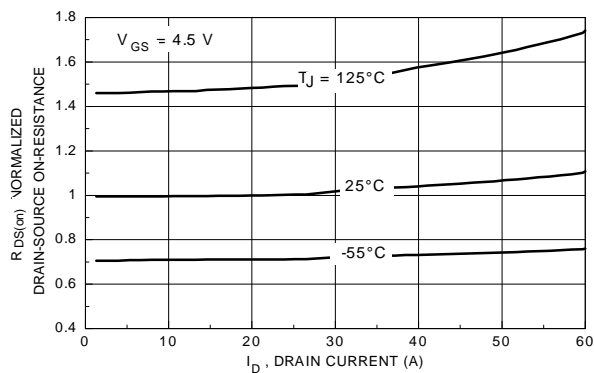Figure 3. On-Resistance Variation with Temperature.

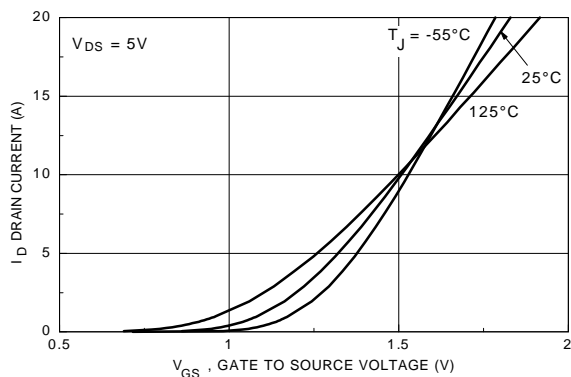Figure 4. On-Resistance Variation with Drain Current and Temperature.
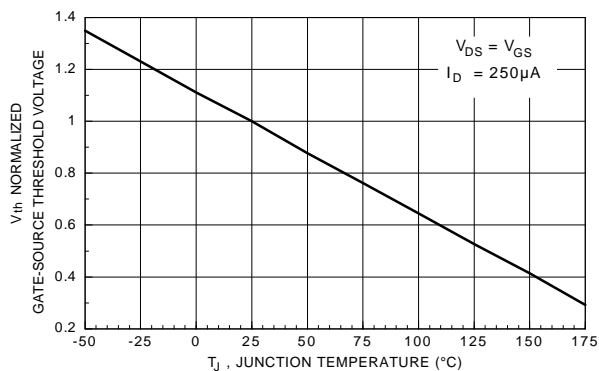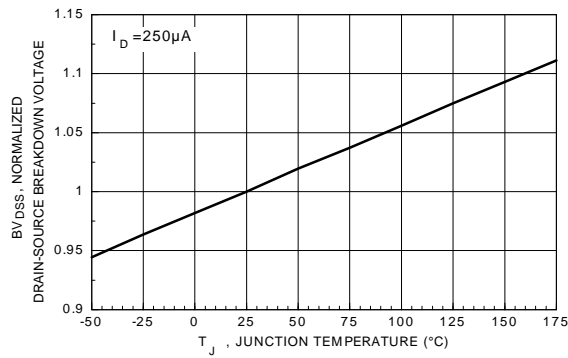

Figure 5. Transfer Characteristics.

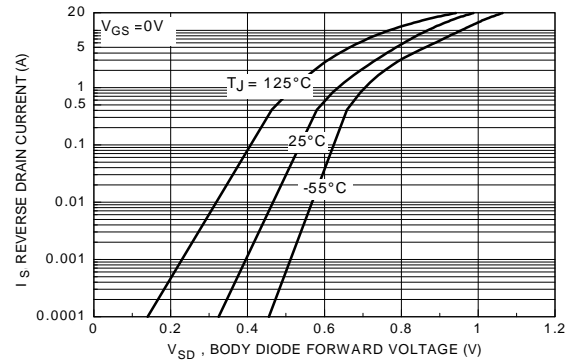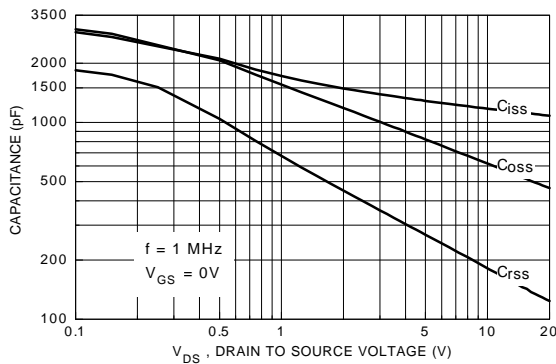Figure 6. Gate Threshold Variation with Temperature.

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.
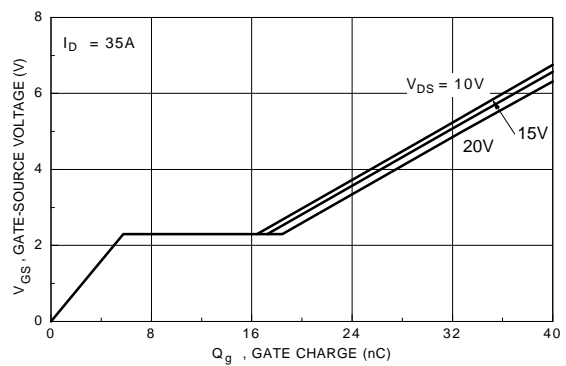
Figure 10. Gate Charge Characteristics.
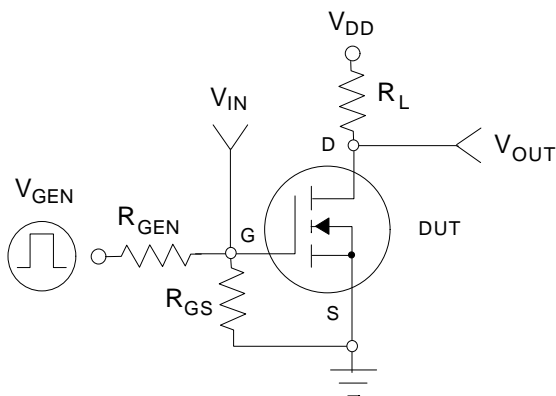
Figure 11. Switching Test Circuit.

Figure 12. Switching Waveforms.

Typical Electrical Characteristics (continued)

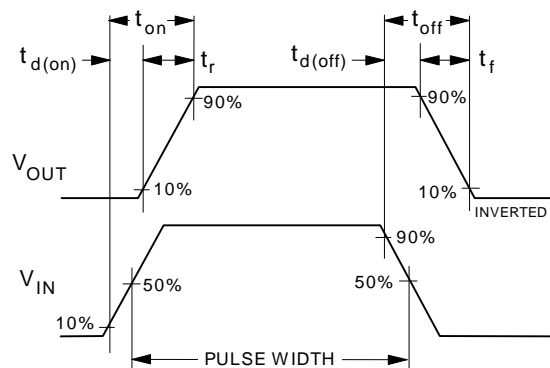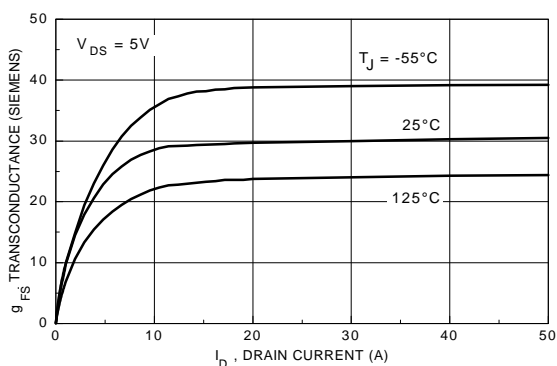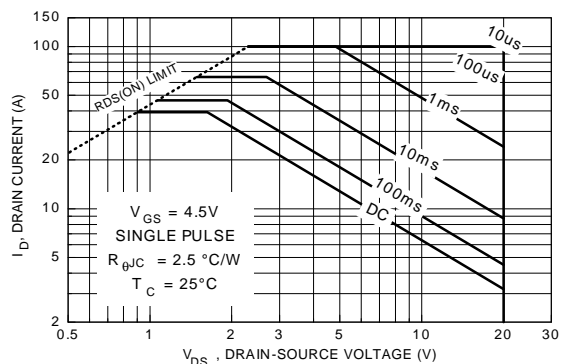**Figure 13. Transconductance Variation with Drain Current and Temperature**.
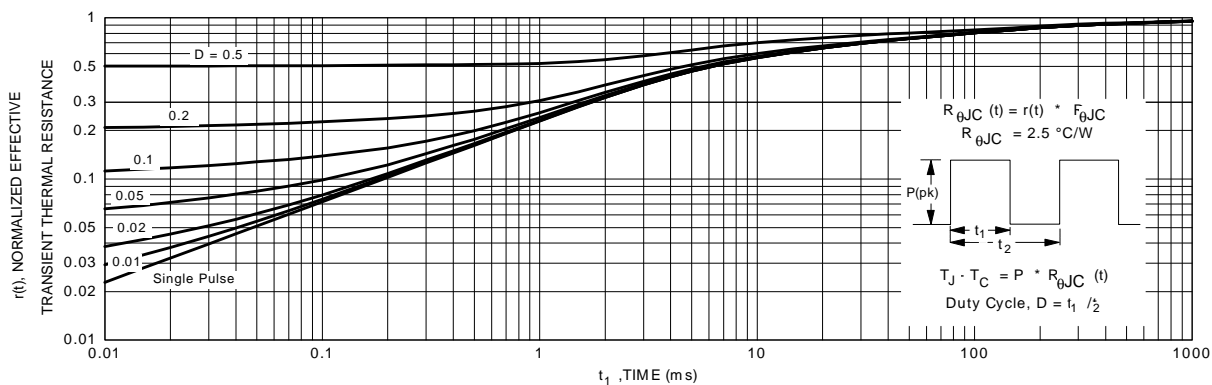
Figure 14. Maximum Safe Operating Area.

Figure 15. Transient Thermal Response Curve.

TO-220 Tape and Reel Data and Package Dimensions

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TO-220 Tube Packing
Configuration: Figure 1.0

45 units per Tube

12 Tubes per Bag

2 bags per Box

Conductive Plastic Bag

530mm x 130mm x 83mm
Intermediate box

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		

1080 units maximum quantity per box

FSCINT Label sample

FAIRCHILD SEMICONDUCTOR CORPORATION **HTB:B**
LOT: **CBVK741B019**   QTY: **1080**
NSID: **FDP7060**   SPEC:
D/C1: **D9842**   SPEC REV: **B2**
QA REV:
(FSCINT)

FSCINT Label

TO-220 bulk Packing
Configuration: Figure 3.0

FSCINT Label

Anti-static Bubble Sheets

530mm x 130mm x 83mm
Intermediate box

300 units per EO70 box

5 EO70 boxes per per Intermediate Box

1500 units maximum quantity per intermediate box

114mm x 102mm x 51mm
EO70 Immediate Box

FSCINT Label
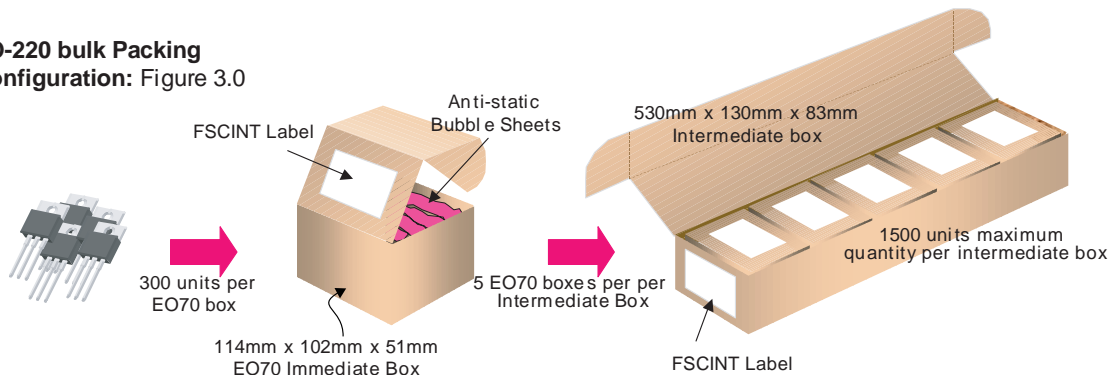
TO-220 Tube
Configuration: Figure 4.0

Note: All dimensions are in inches

0.123
+0.001
-0.003

0.450
±0.030

1.300
±0.015

20.000
+0.031
-0.065

0.800

0.165
0.080
0.275
0.032
±0.003
0.160
0.275
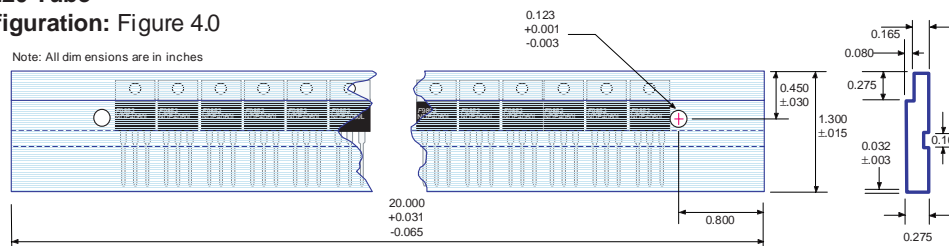
TO-220 Tape and Reel Data and Package Dimensions, continued

TO-220 (FS PKG Code 37)

1:1

Scale 1:1 on letter size paper

Dimensions shown below are in:
inches [millimeters]

Part Weight per unit (gram): 1.4378

$\phi \begin{array}{c} 0.1610 \\ 0.1390 \end{array} \left[\phi \begin{array}{c} 4.09 \\ 3.53 \end{array}\right]$

TYP. $\begin{array}{c} 0.0700 \\ 0.0450 \end{array} \left[\begin{array}{c} 1.78 \\ 1.14 \end{array}\right]$

$\begin{array}{c} 0.1350 \\ 0.1000 \end{array} \left[\begin{array}{c} 3.43 \\ 2.54 \end{array}\right]$

TYP. $\begin{array}{c} 0.0400 \\ 0.0150 \end{array} \left[\begin{array}{c} 1.02 \\ 0.38 \end{array}\right]$

$\begin{array}{c} 0.1100 \\ 0.0900 \end{array} \left[\begin{array}{c} 2.79 \\ 2.29 \end{array}\right]$

$\begin{array}{c} 0.2100 \\ 0.1900 \end{array} \left[\begin{array}{c} 5.33 \\ 4.83 \end{array}\right]$

$\begin{array}{c} 0.4200 \\ 0.3800 \end{array} \left[\begin{array}{c} 10.67 \\ 9.65 \end{array}\right]$

$\begin{array}{c} 0.1100 \\ 0.0900 \end{array} \left[\begin{array}{c} 2.79 \\ 2.29 \end{array}\right]$

PIN#1 ID

$\begin{array}{c} 0.6500 \\ 0.5600 \end{array} \left[\begin{array}{c} 16.51 \\ 14.22 \end{array}\right]$

TYP. $\begin{array}{c} 0.2500 \\ 0.1430 \end{array} \left[\begin{array}{c} 6.35 \\ 3.63 \end{array}\right]$

$\begin{array}{c} 0.5800 \\ 0.5000 \end{array} \left[\begin{array}{c} 14.73 \\ 12.70 \end{array}\right]$

$\begin{array}{c} 0.0220 \\ 0.0140 \end{array} \left[\begin{array}{c} 0.56 \\ 0.36 \end{array}\right]$

$\begin{array}{c} 0.2700 \\ 0.2300 \end{array} \left[\begin{array}{c} 6.86 \\ 5.84 \end{array}\right]$

$\begin{array}{c} 0.4200 \\ 0.3800 \end{array} \left[\begin{array}{c} 10.67 \\ 9.65 \end{array}\right]$

5.0°

7.0°

5.0°

$\begin{array}{c} 0.1150 \\ 0.0800 \end{array} \left[\begin{array}{c} 2.92 \\ 2.03 \end{array}\right]$

$\begin{array}{c} 0.4140 \\ 0.3740 \end{array} \left[\begin{array}{c} 10.52 \\ 9.50 \end{array}\right]$

$\begin{array}{c} 0.1900 \\ 0.1400 \end{array} \left[\begin{array}{c} 4.83 \\ 3.56 \end{array}\right]$

$\begin{array}{c} 0.0550 \\ 0.0450 \end{array} \left[\begin{array}{c} 1.40 \\ 1.14 \end{array}\right]$

$\begin{array}{c} 1.1340 \\ 1.1140 \end{array} \left[\begin{array}{c} 28.80 \\ 28.30 \end{array}\right]$

NOTE : UNLESS OTHERWISE SPECIFIED

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

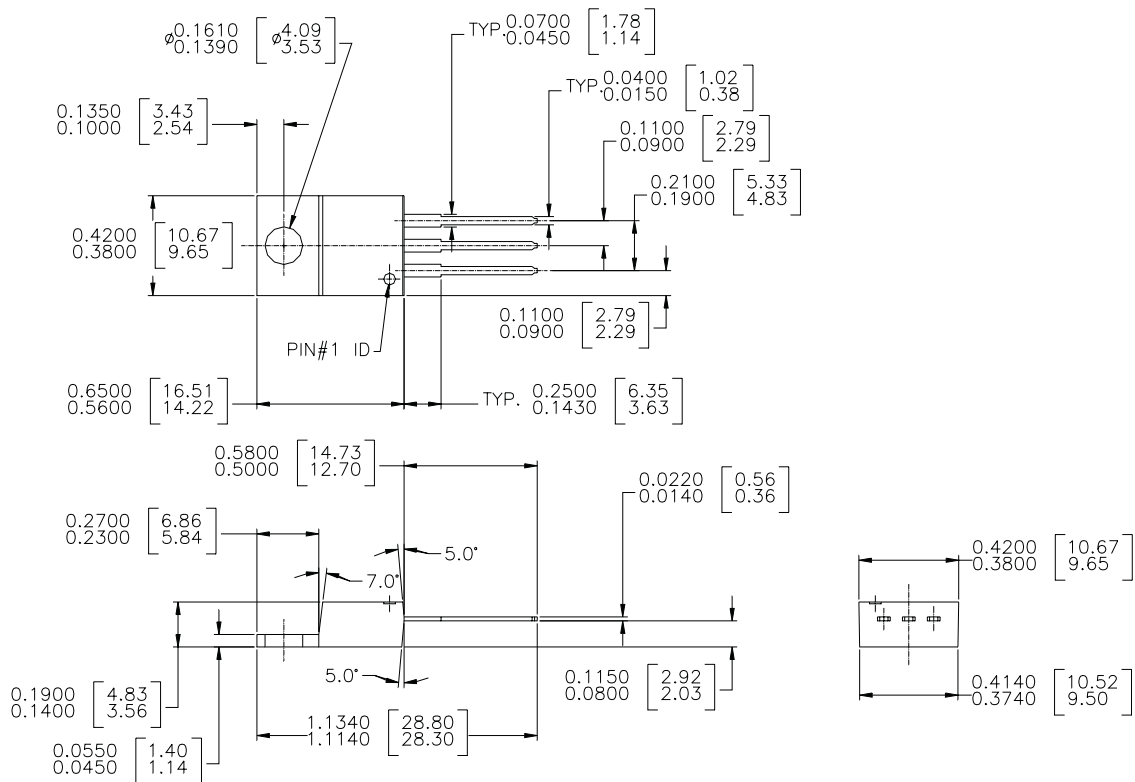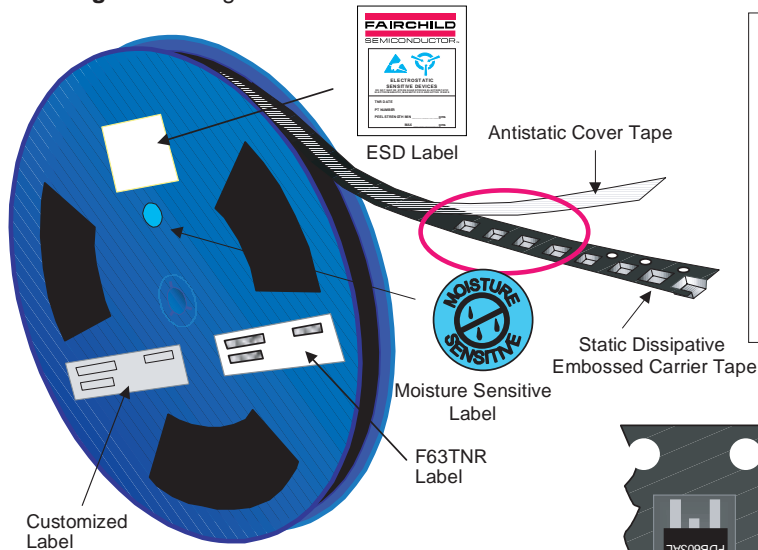2. DIMENSION BASED ON JEDEC STANDARD TO-220
VARIATION AB, ISSUE J, DATED 3/24/87

TO 220 3 LEAD

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

FAIRCHILD
SEMICONDUCTOR ™

TO-263AB/D²PAK Packaging
Configuration: Figure 1.0

ESD Label

Antistatic Cover Tape

Static Dissipative Embossed Carrier Tape

Moisture Sensitive Label
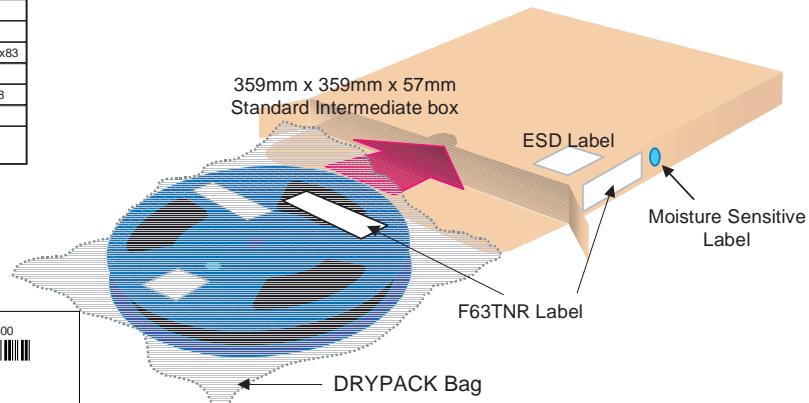
F63TNR Label

Customized Label

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.
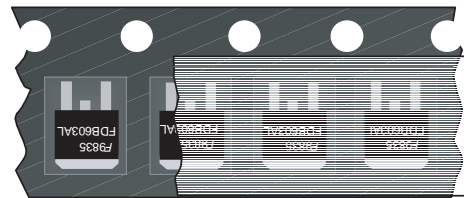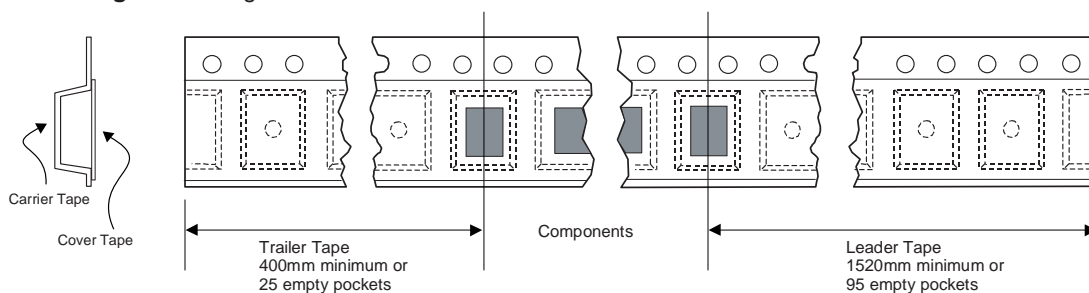
TO-263AB/D²PAK Unit Orientation

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		

359mm x 359mm x 57mm Standard Intermediate box

ESD Label

Moisture Sensitive Label

F63TNR Label

DRYPACK Bag

F63TNR Label sample

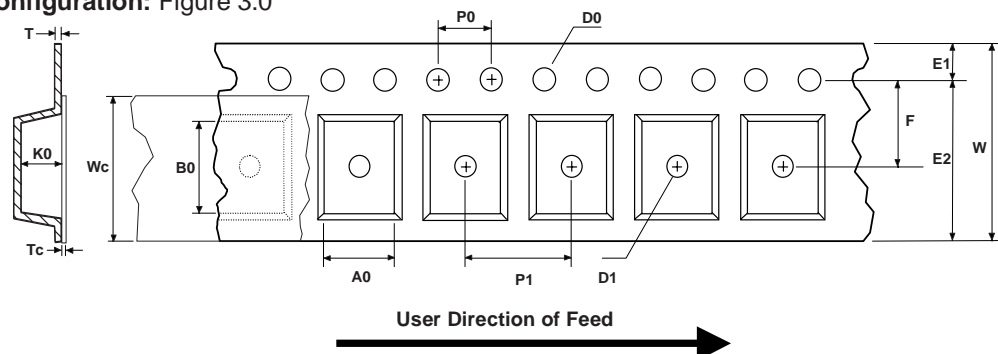LOT: CBVK741B019   QTY: 800
FSID: FDB6320L   SPEC:
D/C1: D9842   QTY1:   SPEC REV:
D/C2:   QTY2:   CPN:
                         N/F: F   (F63TNR)3

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

Carrier Tape

Cover Tape

Trailer Tape
400mm minimum or
25 empty pockets

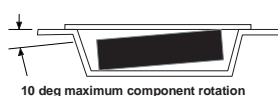Components

Leader Tape
1520mm minimum or
95 empty pockets

TO-263AB/D^{2}PAK Tape and Reel Data and Package Dimensions, continued

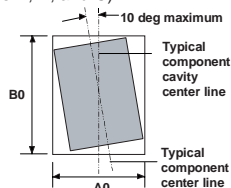## TO-263AB/D^{2}PAK Embossed Carrier Tape
Configuration: Figure 3.0

User Direction of Feed

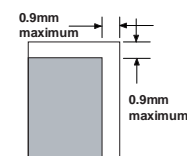|						Dimensions are in millimeter							
Pkg type	**A0**	**B0**	**W**	**D0**	**D1**	**E1**	**E2**	**F**	**P1**	**P0**	**K0**	**T**	**Wc**	**Tc**
TO263AB/ D^{2}PAK (24mm)	10.60 +/-0.10	15.80 +/-0.10	24.0 +/-0.3	1.55 +/-0.05	1.60 +/-0.10	1.75 +/-0.10	22.25 min	11.50 +/-0.10	16.0 +/-0.1	4.0 +/-0.1	4.90 +/-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).

10 deg maximum component rotation

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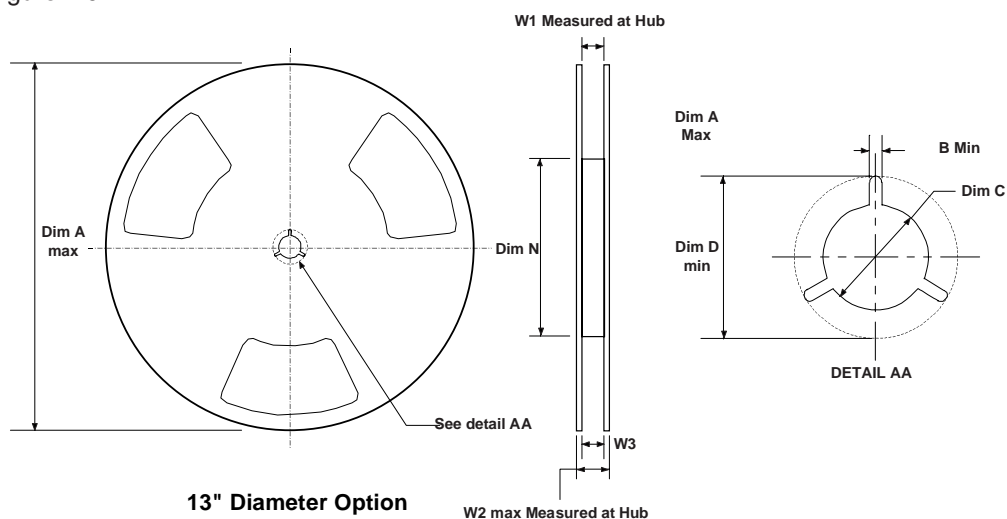**Component Rotation**

10 deg maximum

Typical component cavity center line

Typical component center line

Sketch B (Top View)
Component Rotation

0.9mm maximum

0.9mm maximum

Sketch C (Top View)
Component lateral movement

TO-263AB/D^{2}PAK Reel Configuration:
Figure 4.0

13" Diameter Option

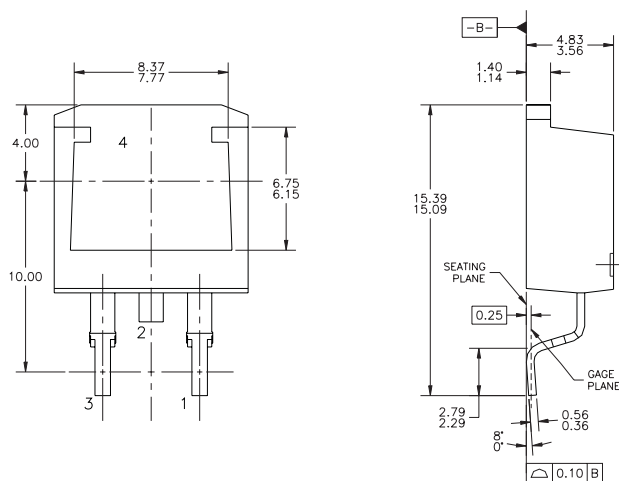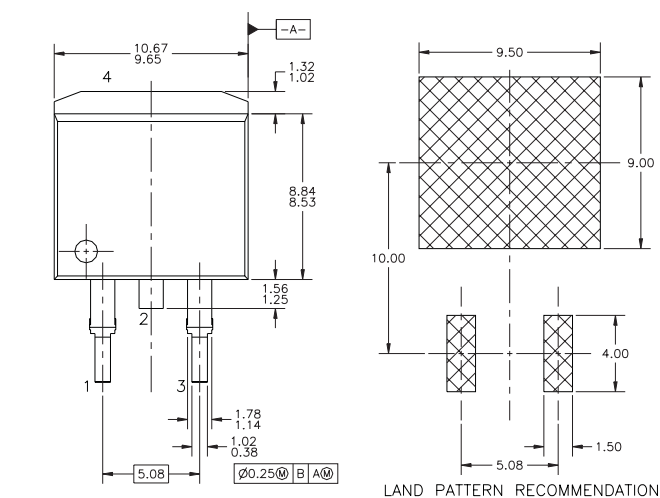|				Dimensions are in inches and millimeters				
Tape Size	**Reel Option**	**Dim A**	**Dim B**	**Dim C**	**Dim D**	**Dim N**	**Dim W1**	**Dim W2**	**Dim W3 (LSL-USL)**
24mm	13" Dia	13.00 330	0.059 1.5	512 +0.020/-0.008 13 +0.5/-0.2	0.795 20.2	4.00 100	0.961 +0.078/-0.000 24.4 +2/0	1.197 30.4	0.941 – 0.1.079 23.9 – 27.4

TO-263AB/D²PAK (FS PKG Code 45)
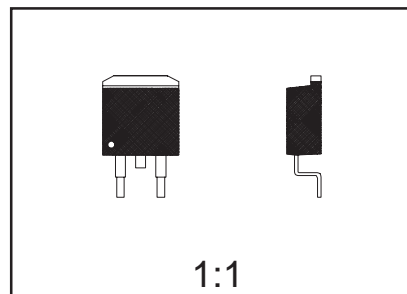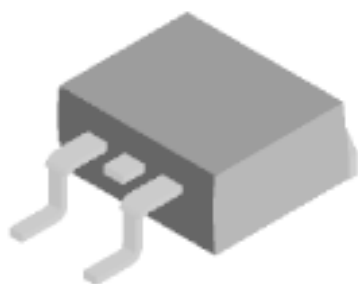
1:1

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.

TRADEMARKS

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CoolFET™	MICROWIRE™	TinyLogic™
CROSSVOLT™	POP™	UHC™
E²CMOS™	PowerTrench®	VCX™
FACT™	QFET™	
FACT Quiet Series™	QS™	
FAST®	Quiet Series™	
FASTr™	SuperSOT™-3	
GTO™	SuperSOT™-6	
HiSeC™	SuperSOT™-8	

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LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.