NDF04N60Z, NDP04N60Z, NDD04N60Z

N-Channel Power MOSFET 1.8 Ω, 600 Volts

ON Semiconductor®

http://onsemi.com

V_{DSS}	$R_{DS(ON)}$ (TYP) @ 2 A
600 V	1.8 Ω

Features

- Low ON Resistance
- Low Gate Charge
- 100% Avalanche Tested
- These Devices are Pb−Free and are RoHS Compliant

Applications

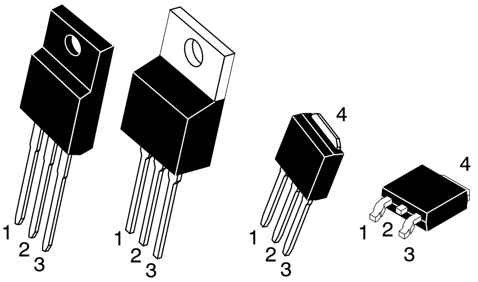
- Adapter (Notebook, Printer, Gaming)
- LCD Panel Power
- Lighting Ballasts

ABSOLUTE MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	NDF	NDD/NDP	Unit
Drain−to−Source Voltage	V_{DSS}	600 (Note 1)		V
Continuous Drain Current	I_D	4.0 (Note 2)		A
Continuous Drain Current T_A = 100°C	I_D	2.7 (Note 2)		A
Pulsed Drain Current, V_{GS} @ 10V	I_{DM}	14 (Note 2)		A
Power Dissipation (Note 1)	P_D	28	95	W
Gate−to−Source Voltage	V_{GS}	±30		V
Single Pulse Avalanche Energy, L = 6.4 mH, I_D = 4.0 A	E_{AS}	51		mJ
ESD (HBM) (JESD 22−114−B)	V_{esd}	2500		V
RMS Isolation Voltage (t = 0.3 sec., R.H. ≤ 30%, T_A = 25°C) (Figure 13)	V_{ISO}	4500	−	V
Peak Diode Recovery	dv/dt	4.5 (Note 3)		V/ns
Continuous Source Current (Body Diode)	I_S	4.0		A
Maximum Temperature for Soldering Leads, 0.063″ (1.6 mm) from Case for 10 s Package Body for 10 s	T_L T_{PKG}	300 260		°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	−55 to 150		°C

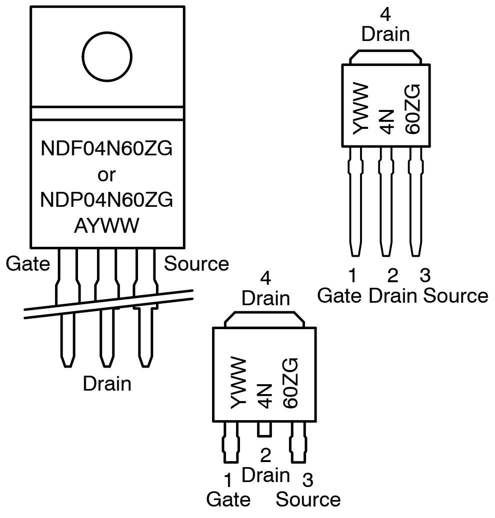
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Surface mounted on FR4 board using 1″ sq. pad size, 1 oz cu
2. Limited by maximum junction temperature
3. I_{SD} = 4.0 A, di/dt ≤ 100 A/μs, V_{DD} ≤ BV_{DSS}, T_J = +150°C



TO−220FP CASE 221D STYLE 1 **TO−220AB CASE 221A STYLE 5** **IPAK CASE 369D STYLE 2** **DPAK CASE 369AA STYLE 2**

MARKING DIAGRAMS



A = Location Code
Y = Year
WW = Work Week
G = Pb−Free Package

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 5 of this data sheet.

THERMAL RESISTANCE

Parameter	Symbol	NDF04N60Z	NDD/NDP	Unit
Junction−to−Case (Drain)	$R_{\theta JC}$	4.4	1.3	°C/W
Junction−to−Ambient Steady State (Note 4)	$R_{\theta JA}$	50	50	

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted)

Characteristic	Test Conditions		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS							
Drain−to−Source Breakdown Voltage	V_{GS} = 0 V, I_D = 1 mA		BV_{DSS}	600			V
Breakdown Voltage Temperature Coefficient	Reference to 25°C, I_D = 1 mA		$\Delta BV_{DSS}/\Delta T_J$		0.6		V/°C
Drain−to−Source Leakage Current	V_{DS} = 600 V, V_{GS} = 0 V	25°C	I_{DSS}			1	μA
		150°C				50	
Gate−to−Source Forward Leakage	V_{GS} = ±20 V		I_{GSS}			±10	μA
ON CHARACTERISTICS (Note 5)							
Static Drain−to−Source On−Resistance	V_{GS} = 10 V, I_D = 2.0 A		$R_{DS(on)}$		1.8	2.0	Ω
Gate Threshold Voltage	V_{DS} = V_{GS}, I_D = 250 μA		$V_{GS(th)}$	3.0		4.5	V
Forward Transconductance	V_{DS} = 15 V, I_D = 2.0 A		g_{FS}		3.3		S
DYNAMIC CHARACTERISTICS							
Input Capacitance	V_{DS} = 25 V, V_{GS} = 0 V, f = 1.0 MHz		C_{iss}		535		pF
Output Capacitance			C_{oss}		62		
Reverse Transfer Capacitance			C_{rss}		14		
Total Gate Charge	V_{DD} = 300 V, I_D = 4.0 A, V_{GS} = 10 V		Q_g		19		nC
Gate−to−Source Charge			Q_{gs}		3.9		
Gate−to−Drain (“Miller”) Charge			Q_{gd}		10		
Gate Resistance			R_g		4.7		Ω
RESISTIVE SWITCHING CHARACTERISTICS							
Turn−On Delay Time	V_{DD} = 300 V, I_D = 4.0 A, V_{GS} = 10 V, R_G = 5 Ω		$t_{d(on)}$		13		ns
Rise Time			t_r		9.0		
Turn−Off Delay Time			$t_{d(off)}$		24		
Fall Time			t_f		15		
SOURCE−DRAIN DIODE CHARACTERISTICS (T_C = 25°C unless otherwise noted)							
Diode Forward Voltage	I_S = 4.0 A, V_{GS} = 0 V		V_{SD}			1.6	V
Reverse Recovery Time	V_{GS} = 0 V, V_{DD} = 30 V I_S = 4.0 A, di/dt = 100 A/μs		t_{rr}		285		ns
Reverse Recovery Charge			Q_{rr}		1.3		μC

4. Insertion mounted
5. Pulse Width ≤ 380 μs, Duty Cycle ≤ 2%.

TYPICAL CHARACTERISTICS

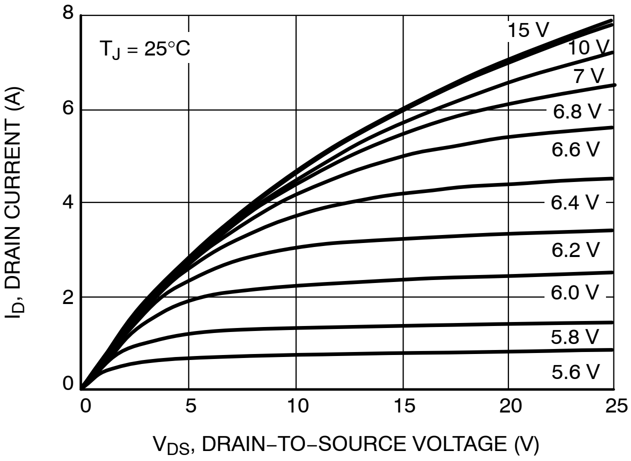


Figure 1. On−Region Characteristics

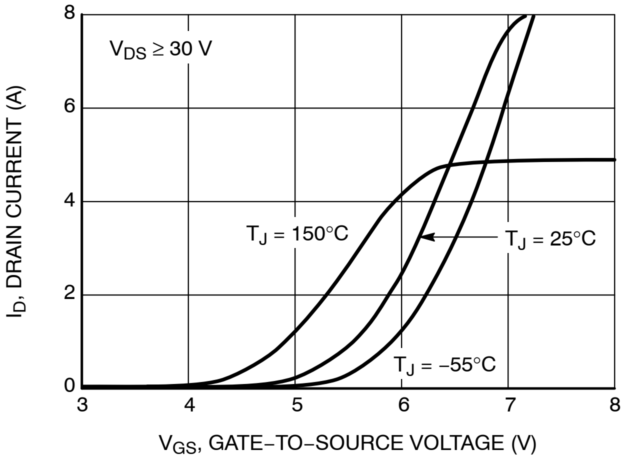


Figure 2. Transfer Characteristics

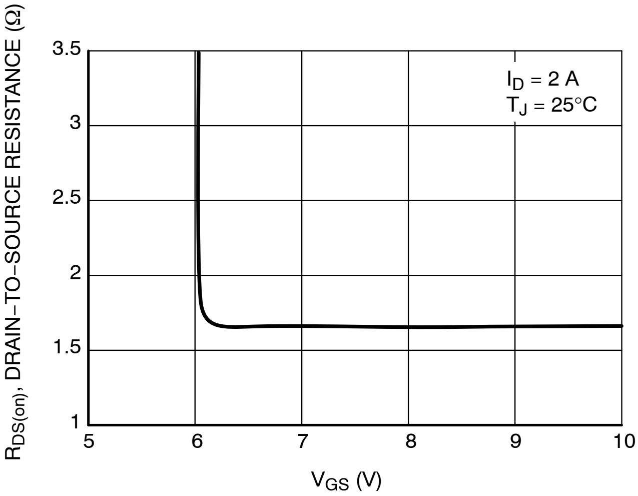


Figure 3. On−Resistance vs. Gate Voltage

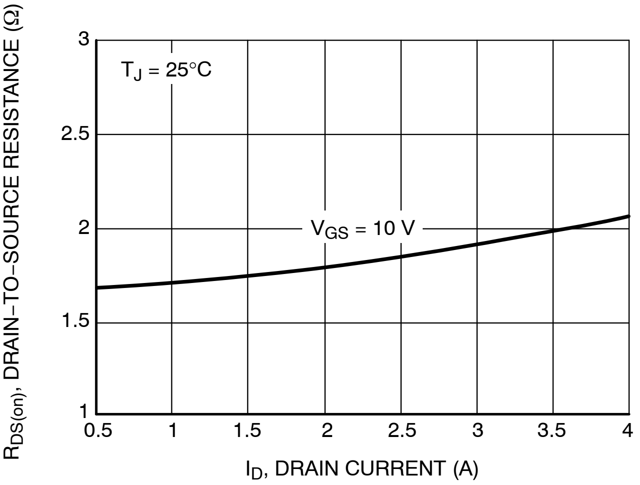


Figure 4. On−Resistance vs. Drain Current and Gate Voltage

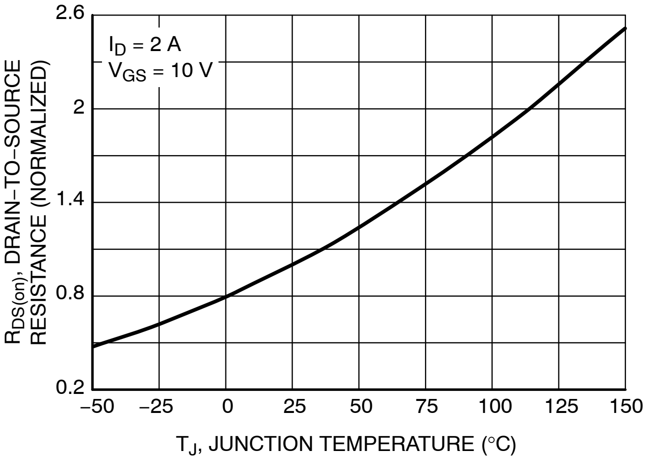


Figure 5. On−Resistance Variation with Temperature

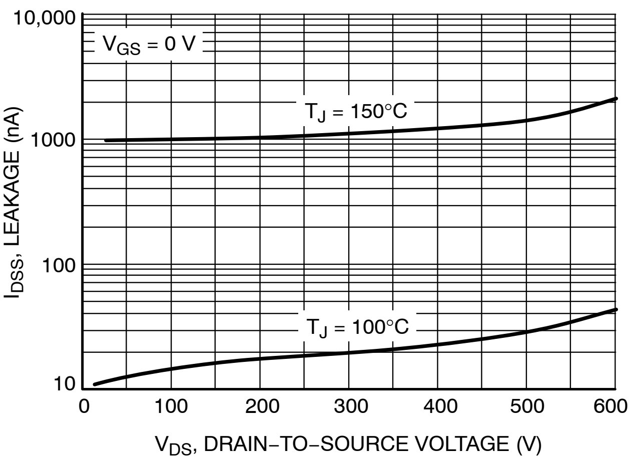


Figure 6. Drain−to−Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS

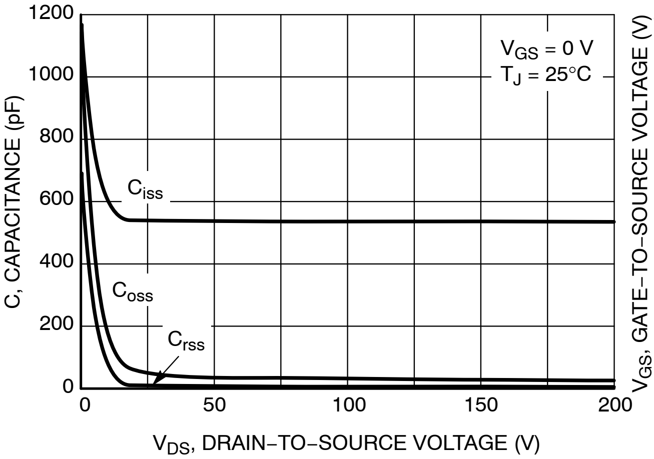


Figure 7. Capacitance Variation

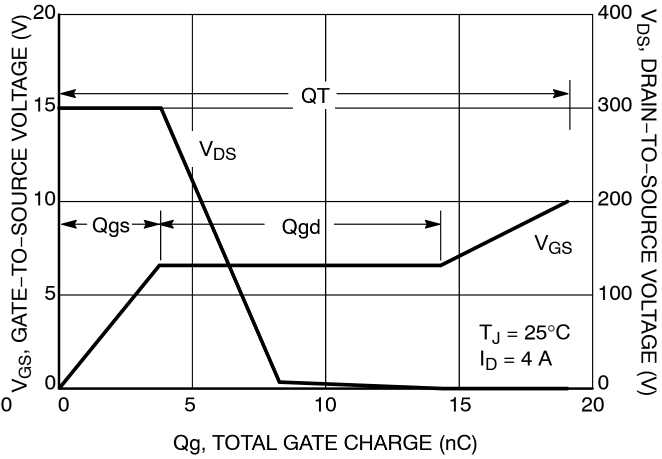


Figure 8. Gate−to−Source and Drain−to−Source Voltage vs. Total Charge

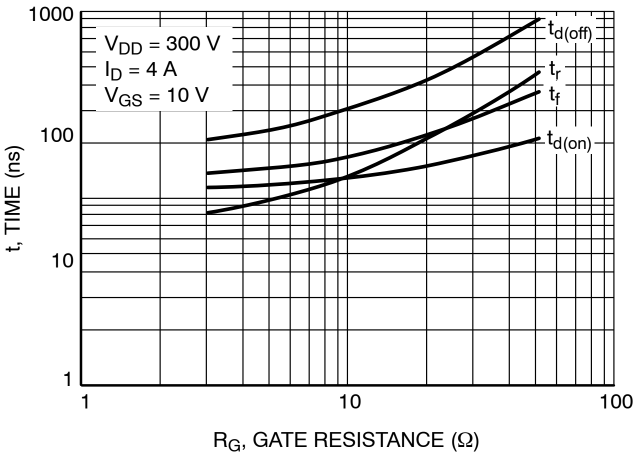


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

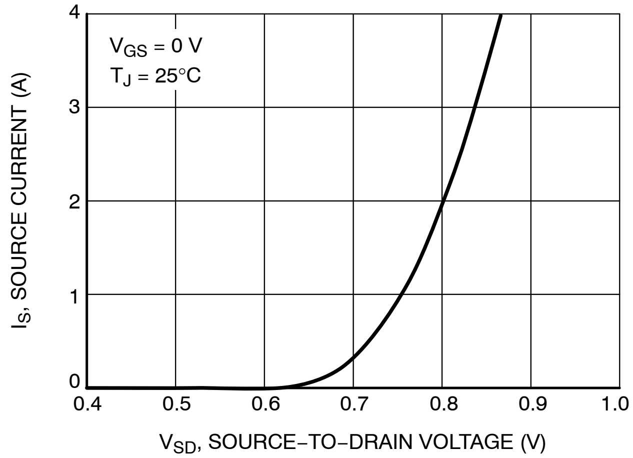


Figure 10. Diode Forward Voltage vs. Current

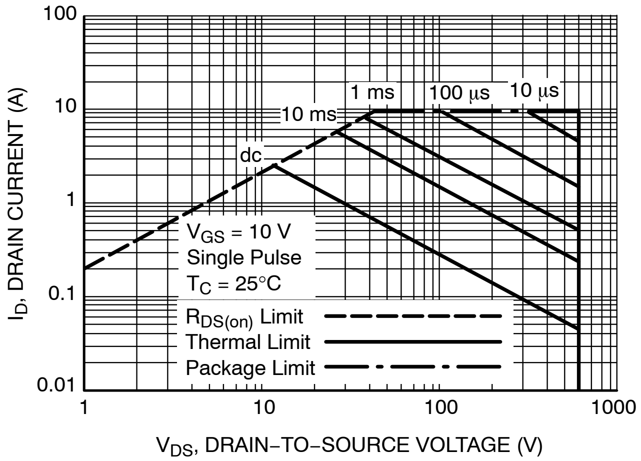


Figure 11. Maximum Rated Forward Biased Safe Operating Area for NDF04N60Z

TYPICAL CHARACTERISTICS

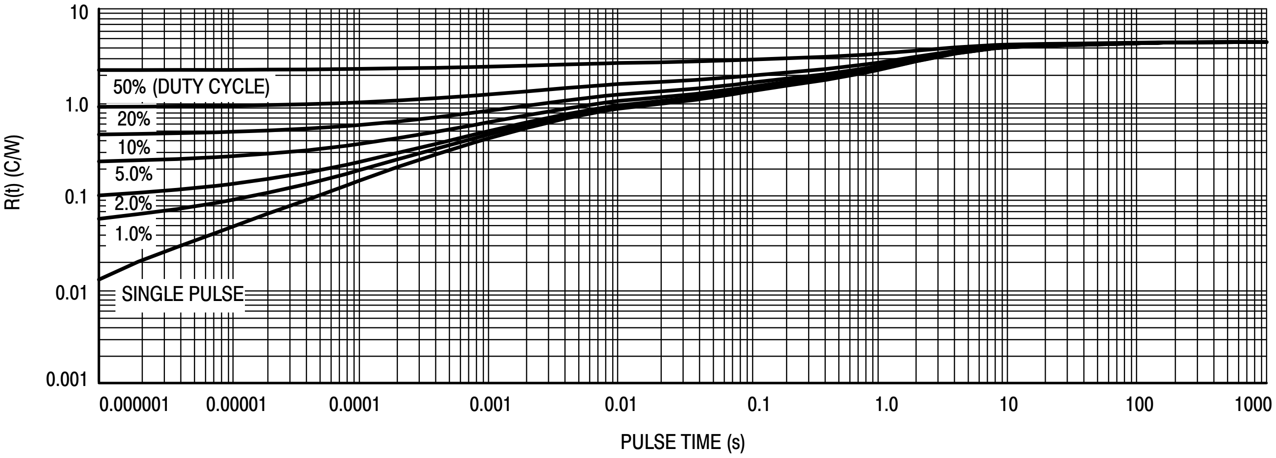


Figure 12. Thermal Impedance for NDF04N60Z

ORDERING INFORMATION

Order Number	Package	Shipping†
NDF04N60ZG	TO−220FP (Pb−Free)	50 Units / Rail
NDP04N60ZG	TO−220AB (Pb−Free)	In Development
NDD04N60Z−1G	IPAK (Pb−Free)	In Development
NDD04N60ZG	DPAK (Pb−Free)	In Development

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

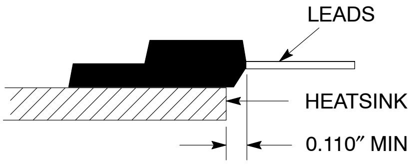


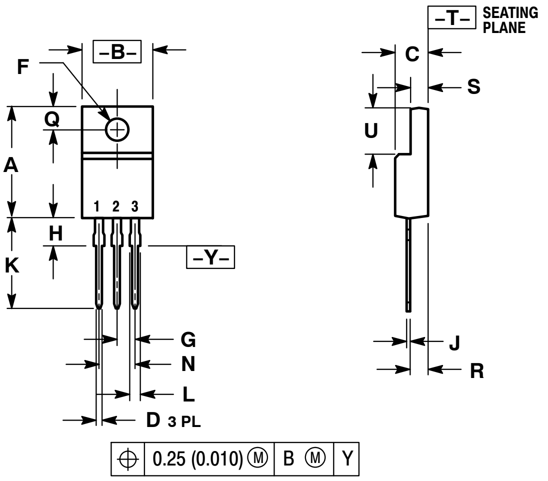
Figure 13. Mounting Position for Isolation Test

Measurement made between leads and heatsink with all leads shorted together.

PACKAGE DIMENSIONS

TO−220 FULLPAK

CASE 221D−03
ISSUE J



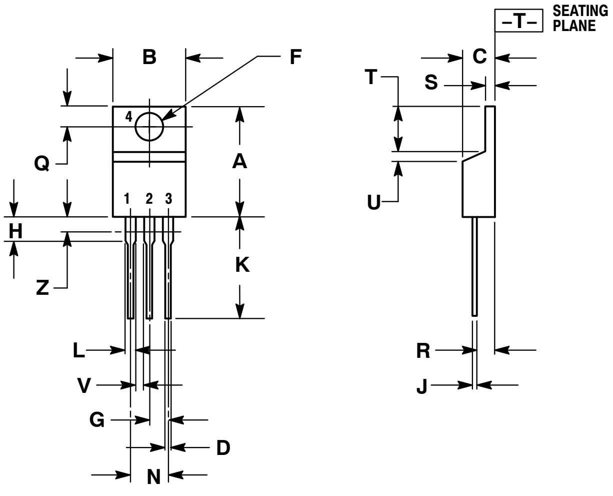
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. 221D−01 THRU 221D−02 OBSOLETE, NEW STANDARD 221D−03.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.617	0.635	15.67	16.12
B	0.392	0.419	9.96	10.63
C	0.177	0.193	4.50	4.90
D	0.024	0.039	0.60	1.00
F	0.116	0.129	2.95	3.28
G	0.100 BSC		2.54 BSC	
H	0.118	0.135	3.00	3.43
J	0.018	0.025	0.45	0.63
K	0.503	0.541	12.78	13.73
L	0.048	0.058	1.23	1.47
N	0.200 BSC		5.08 BSC	
Q	0.122	0.138	3.10	3.50
R	0.099	0.117	2.51	2.96
S	0.092	0.113	2.34	2.87
U	0.239	0.271	6.06	6.88

STYLE 1:
PIN 1. GATE
2. DRAIN
3. SOURCE

TO−220AB

CASE 221A−09
ISSUE AE



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

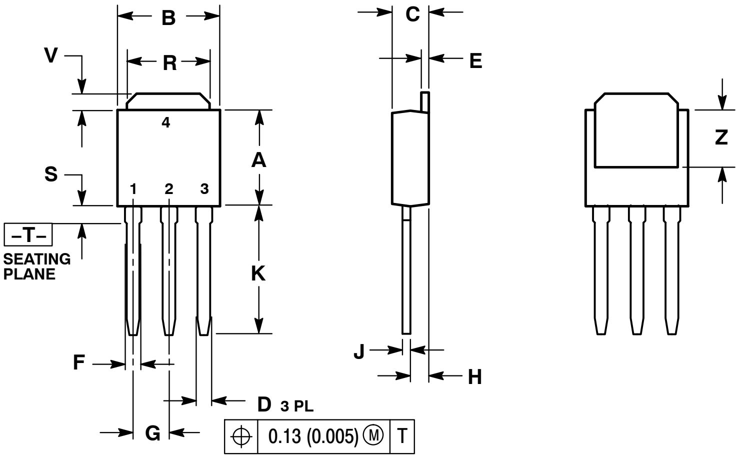
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.035	0.64	0.88
F	0.142	0.161	3.61	4.09
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.014	0.025	0.36	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	---	1.15	---
Z	---	0.080	---	2.04

STYLE 5:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

PACKAGE DIMENSIONS

IPAK

CASE 369D−01
ISSUE B



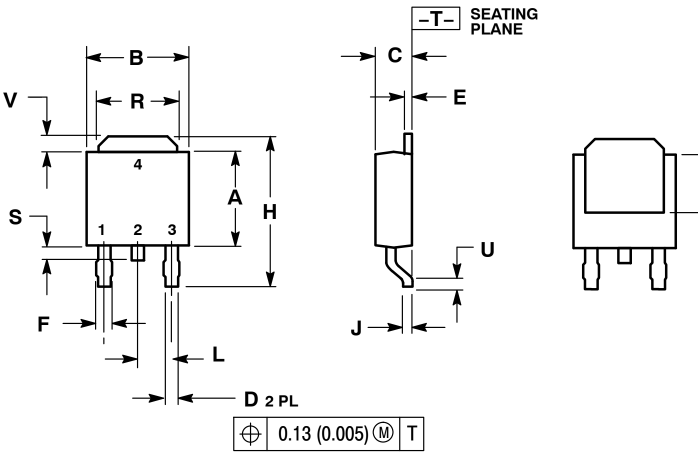
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.235	0.245	5.97	6.35
B	0.250	0.265	6.35	6.73
C	0.086	0.094	2.19	2.38
D	0.027	0.035	0.69	0.88
E	0.018	0.023	0.46	0.58
F	0.037	0.045	0.94	1.14
G	0.090 BSC		2.29 BSC	
H	0.034	0.040	0.87	1.01
J	0.018	0.023	0.46	0.58
K	0.350	0.380	8.89	9.65
R	0.180	0.215	4.45	5.45
S	0.025	0.040	0.63	1.01
V	0.035	0.050	0.89	1.27
Z	0.155	−−−	3.93	−−−

STYLE 2:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

PACKAGE DIMENSIONS

DPAK
CASE 369AA−01
ISSUE A



NOTES:
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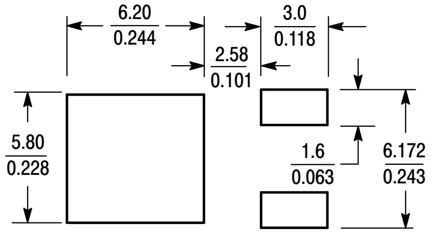
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.235	0.245	5.97	6.22
B	0.250	0.265	6.35	6.73
C	0.086	0.094	2.19	2.38
D	0.025	0.035	0.63	0.89
E	0.018	0.024	0.46	0.61
F	0.030	0.045	0.77	1.14
H	0.386	0.410	9.80	10.40
J	0.018	0.023	0.46	0.58
L	0.090 BSC		2.29 BSC	
R	0.180	0.215	4.57	5.45
S	0.024	0.040	0.60	1.01
U	0.020	−−−	0.51	−−−
V	0.035	0.050	0.89	1.27
Z	0.155	−−−	3.93	−−−

STYLE 2:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

SOLDERING FOOTPRINT*



SCALE 3:1 $\left(\frac{\text{mm}}{\text{inches}}\right)$

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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