NDF04N60Z, NDP04N60Z, NDD04N60Z

N-Channel Power MOSFET 600 V, 2.0 Ω

Features

- Low ON Resistance
- Low Gate Charge
- ESD Diode−Protected Gate
- 100% Avalanche Tested
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

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

Parameter	Symbol	NDF	NDP	NDD	Unit
Drain−to−Source Voltage	V_{DSS}	600			V
Continuous Drain Current $R_{\theta JC}$ (Note 1)	I_D	4.8		4.1	A
Continuous Drain Current $R_{\theta JC}$, T_A = 100°C (Note 1)	I_D	3.0		2.6	A
Pulsed Drain Current, V_{GS} @ 10V	I_{DM}	20		20	A
Power Dissipation $R_{\theta JC}$	P_D	30	117	83	W
Gate−to−Source Voltage	V_{GS}	±30			V
Single Pulse Avalanche Energy, I_D = 4.0 A	E_{AS}	120			mJ
ESD (HBM) (JESD22−A114)	V_{esd}	3000			V
RMS Isolation Voltage (t = 0.3 sec., R.H. ≤ 30%, T_A = 25°C) (Figure 15)	V_{ISO}	4500	–	–	V
Peak Diode Recovery (Note 2)	dv/dt	4.5			V/ns
Continuous Source Current (Body Diode)	I_S	4.0			A
Maximum Temperature for Soldering Leads	T_L	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.

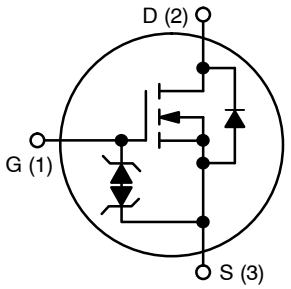
1. Limited by maximum junction temperature
2. I_{SD} = 4.0 A, di/dt ≤ 100 A/μs, $V_{DD} \le BV_{DSS}$, T_J = +150°C

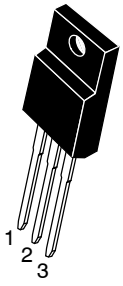
ON Semiconductor®

http://onsemi.com

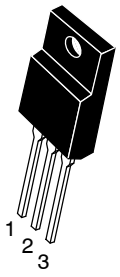
V_{DSS}	$R_{DS(on)}$ (MAX) @ 2 A
600 V	2.0 Ω

N−Channel

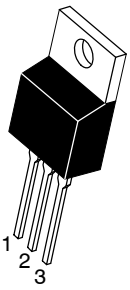




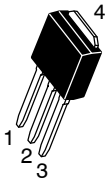
NDF04N60ZG
TO−220FP
CASE 221D



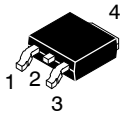
NDF04N60ZH
TO−220FP
CASE 221AH



NDP04N60ZG
TO−220AB
CASE 221A



NDD04N60Z−1G
IPAK
CASE 369D



NDD04N60ZT4G
DPAK
CASE 369AA

ORDERING AND MARKING INFORMATION

See detailed ordering, marking and shipping information in the package dimensions section on page 6 of this data sheet.

THERMAL RESISTANCE

Parameter		Symbol	Value	Unit
Junction−to−Case (Drain)	NDP04N60Z NDF04N60Z NDD04N60Z	$R_{\theta JC}$	1.1 4.2 1.5	°C/W
Junction−to−Ambient Steady State	(Note 3) NDP04N60Z (Note 3) NDF04N60Z (Note 4) NDD04N60Z (Note 3) NDD04N60Z−1	$R_{\theta JA}$	50 50 38 80	

3. Insertion mounted
4. Surface mounted on FR4 board using 1″ sq. pad size (Cu area = 1.127 in sq [2 oz] including traces).

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 = 50 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

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

TYPICAL CHARACTERISTICS

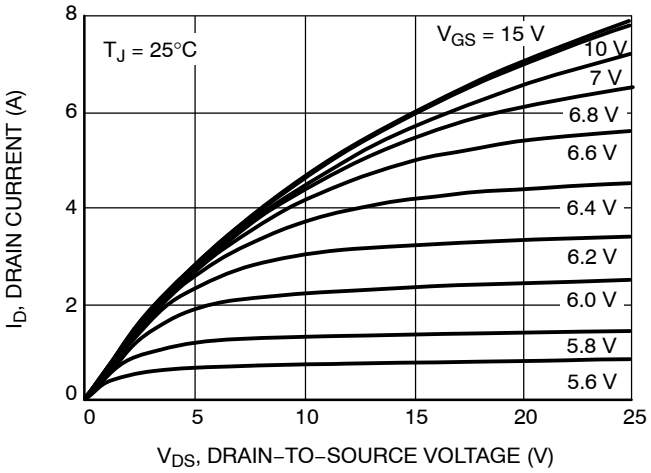


Figure 1. On−Region Characteristics

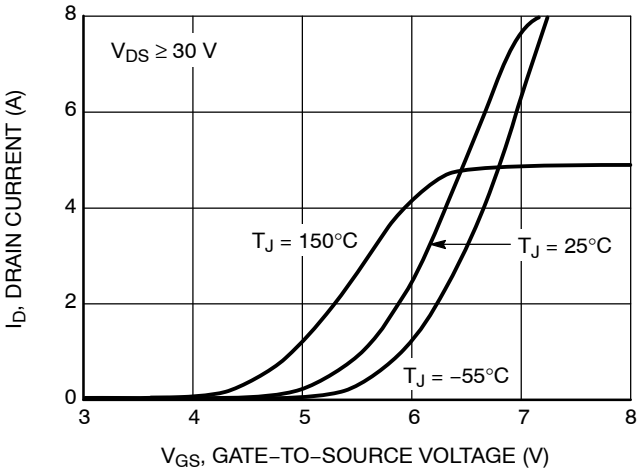


Figure 2. Transfer Characteristics

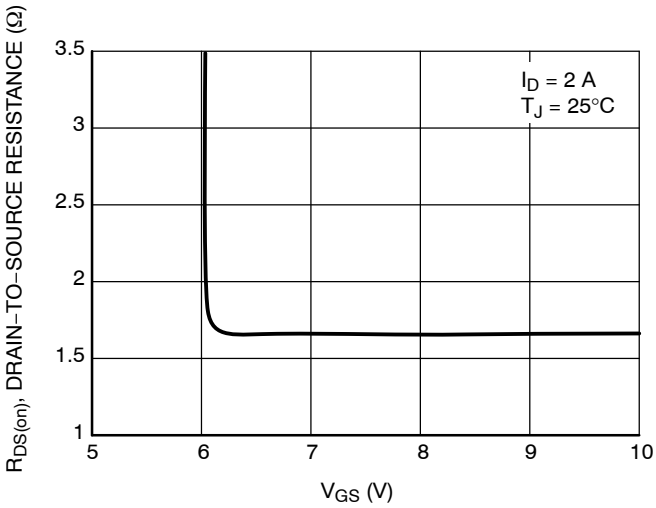


Figure 3. On−Resistance vs. Gate Voltage

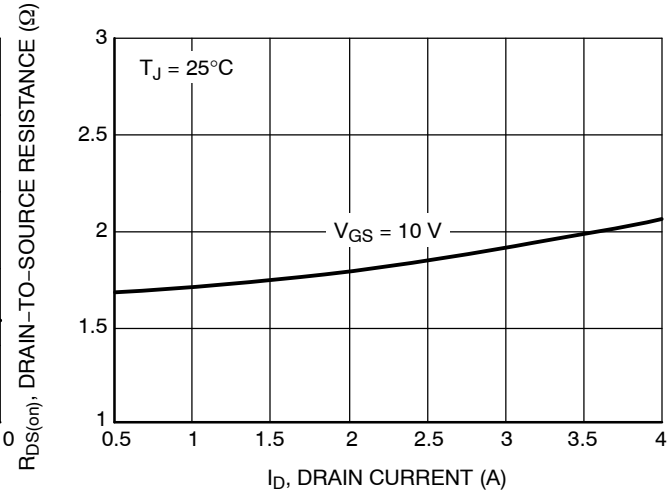


Figure 4. On−Resistance vs. Drain Current and Gate Voltage

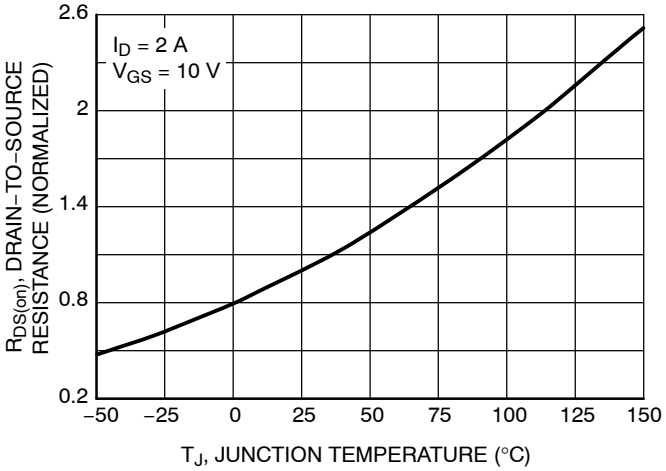


Figure 5. On−Resistance Variation with Temperature

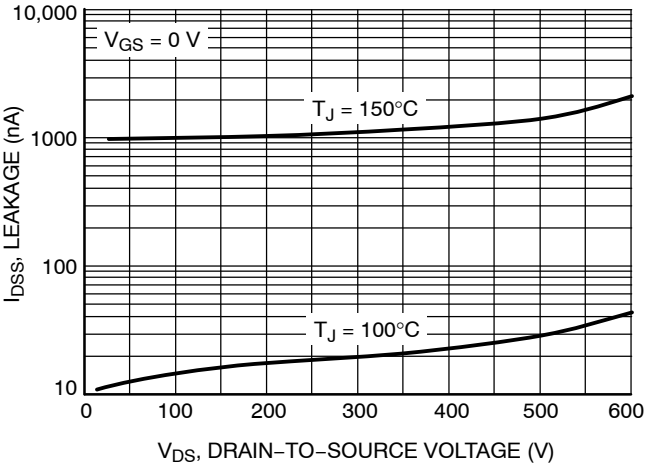


Figure 6. Drain−to−Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS

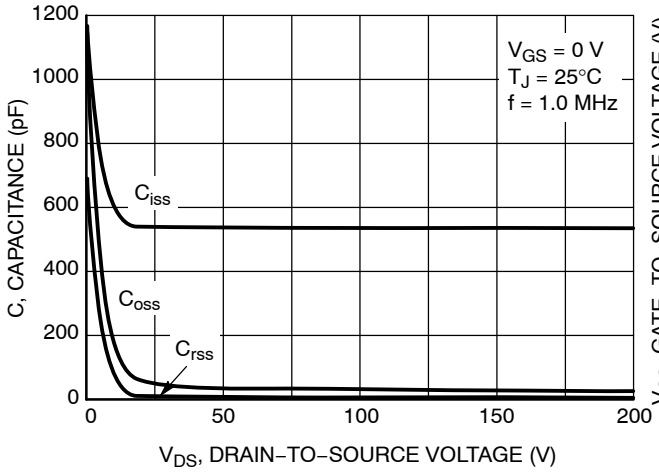


Figure 7. Capacitance Variation

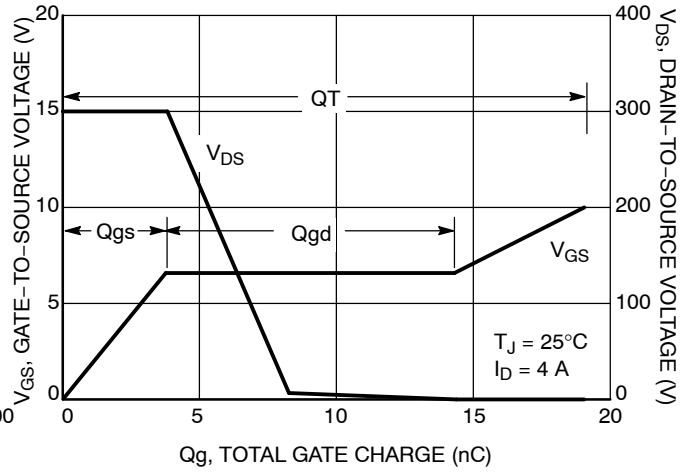


Figure 8. Gate−to−Source and Drain−to−Source Voltage vs. Total Charge

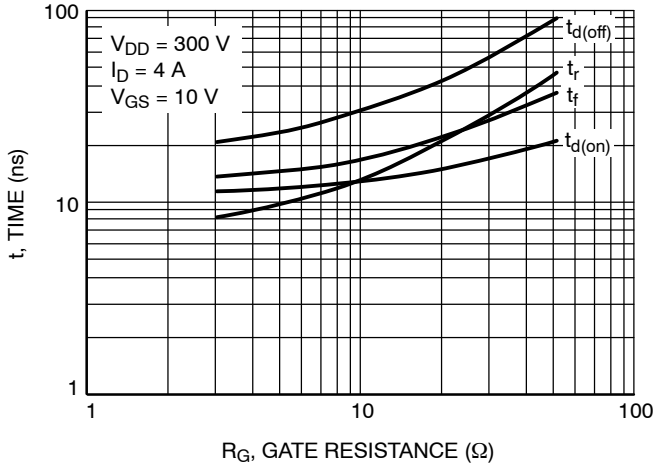


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

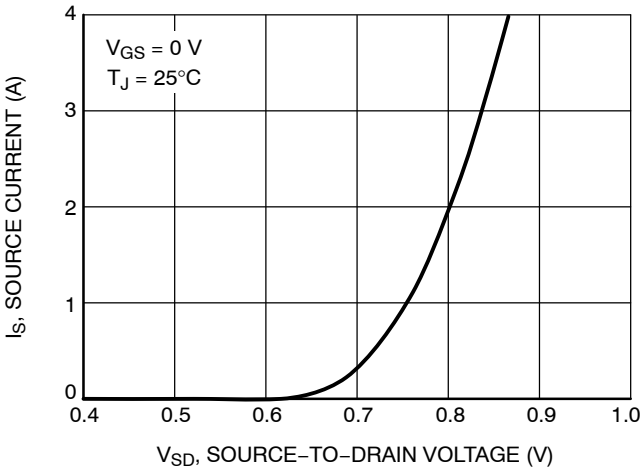


Figure 10. Diode Forward Voltage vs. Current

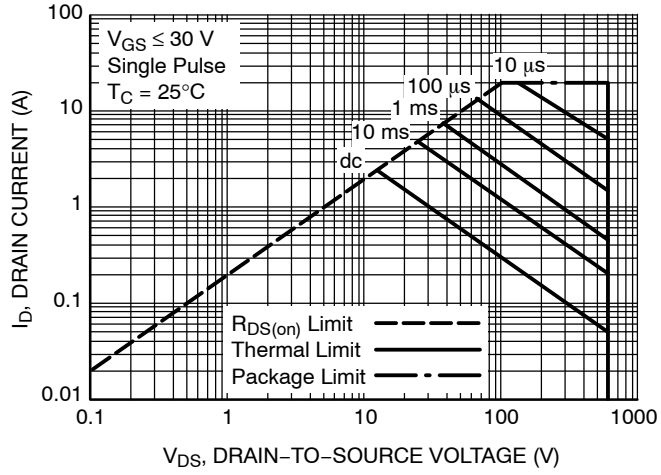


Figure 11. Maximum Rated Forward Biased Safe Operating Area for NDF04N60Z

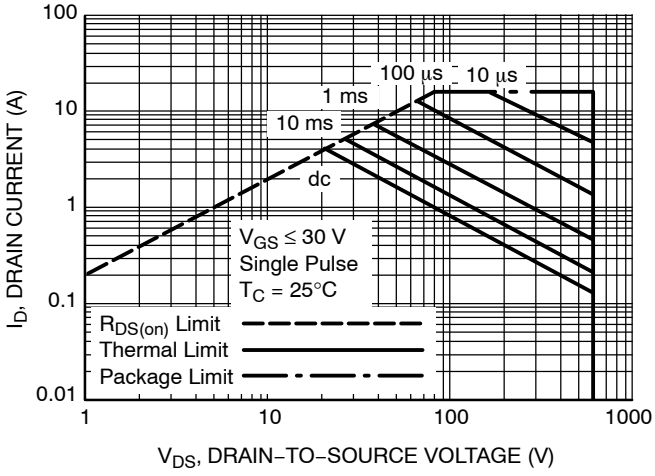


Figure 12. Maximum Rated Forward Biased Safe Operating Area for NDD04N60Z

TYPICAL CHARACTERISTICS

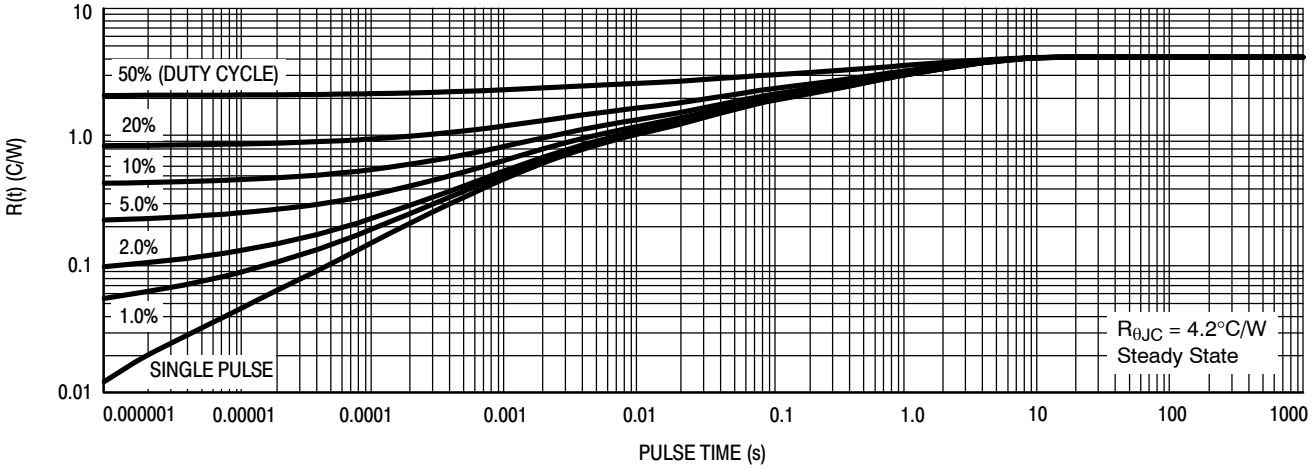


Figure 13. Thermal Impedance for NDF04N60Z

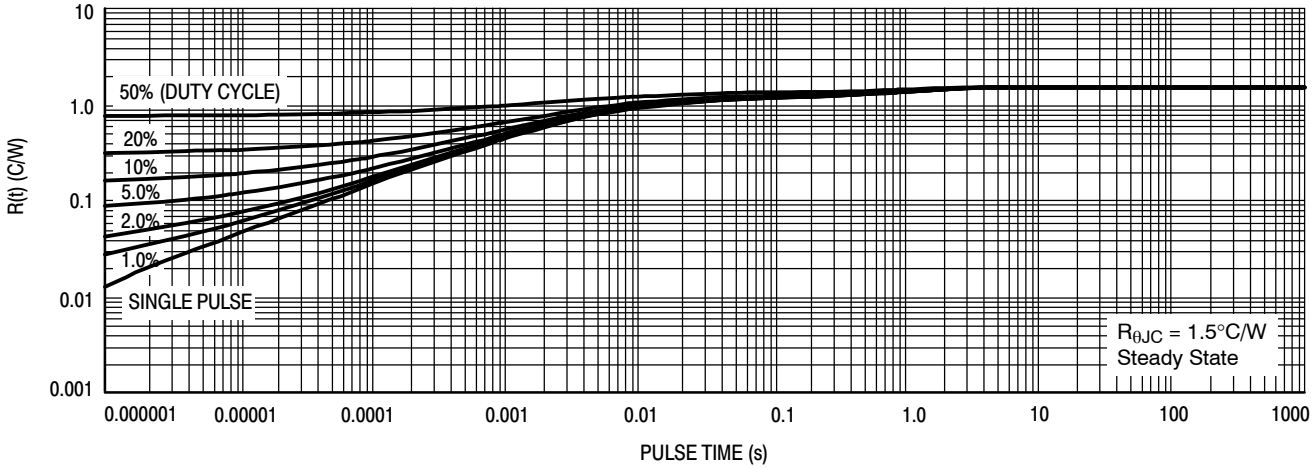


Figure 14. Thermal Impedance for NDD04N60Z

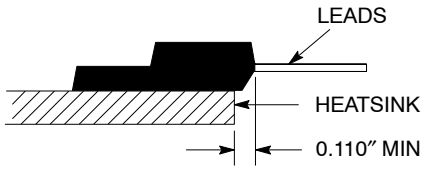


Figure 15. Mounting Position for Isolation Test

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

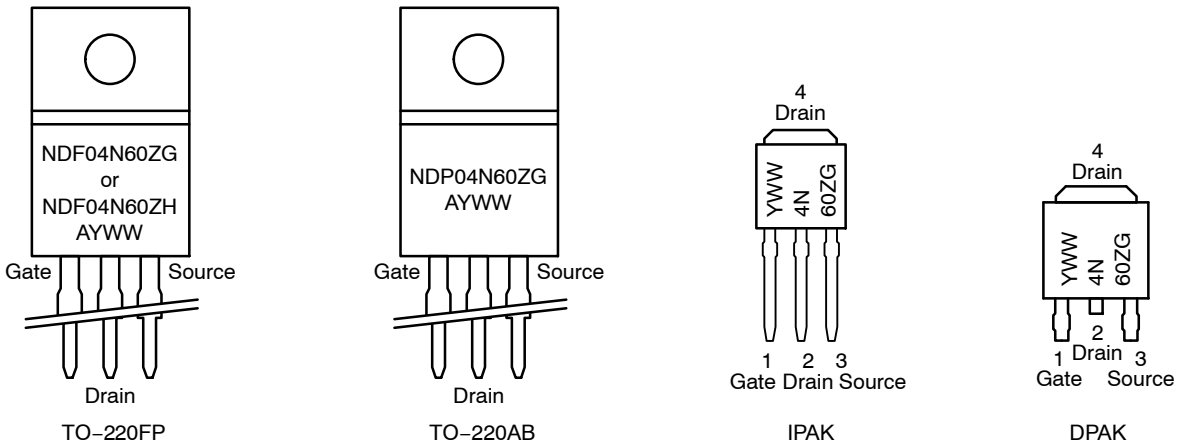
*For additional mounting information, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ORDERING INFORMATION

Order Number	Package	Shipping†
NDF04N60ZG	TO−220FP (Pb−Free, Halogen−Free)	50 Units / Rail
NDF04N60ZH	TO−220FP (Halogen−Free)	50 Units / Rail
NDP04N60ZG	TO−220AB (Pb−Free)	50 Units / Rail (In Development)
NDD04N60Z−1G	IPAK (Pb−Free, Halogen−Free)	75 Units / Rail
NDD04N60ZT4G	DPAK (Pb−Free, Halogen−Free)	2500 / Tape and Reel

†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.

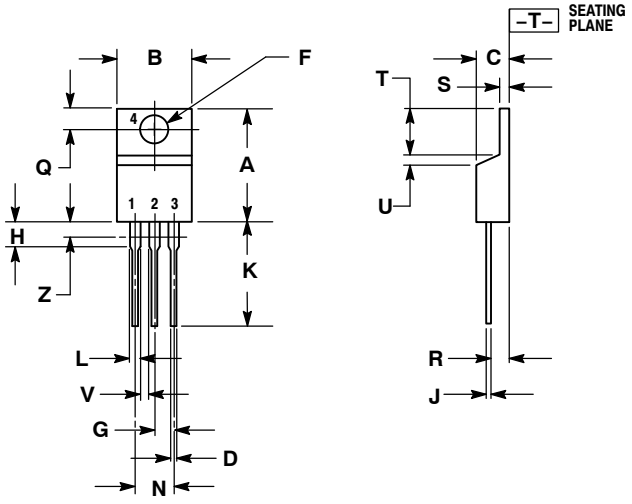
MARKING DIAGRAMS



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

PACKAGE DIMENSIONS

TO−220AB
CASE 221A−09
ISSUE AF

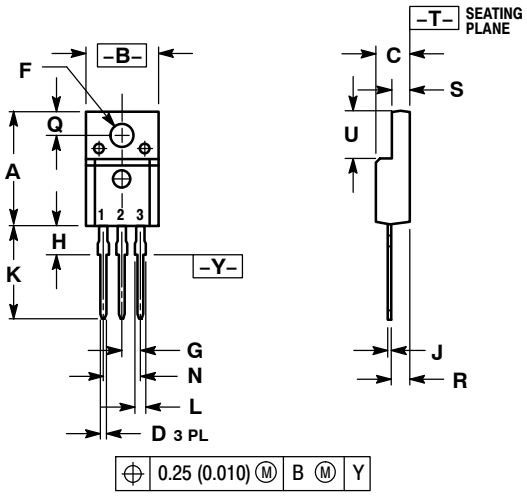


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

	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

TO−220 FULLPAK
CASE 221D−03
ISSUE K



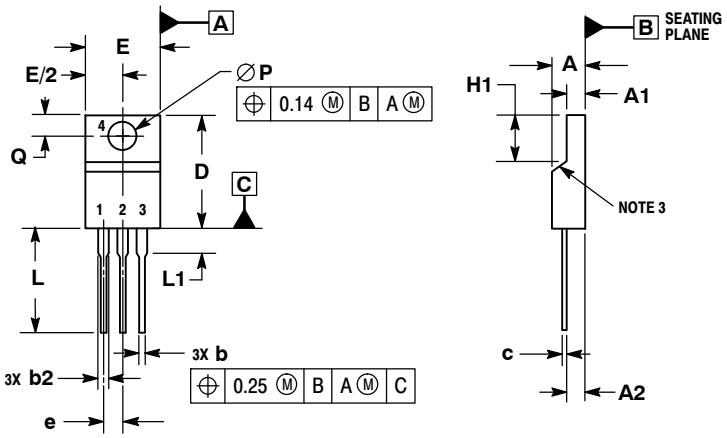
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. 221D−01 THRU 221D−02 OBSOLETE, NEW STANDARD 221D−03.

	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

PACKAGE DIMENSIONS

TO−220 FULLPAK, 3−LEAD
CASE 221AH−01
ISSUE O

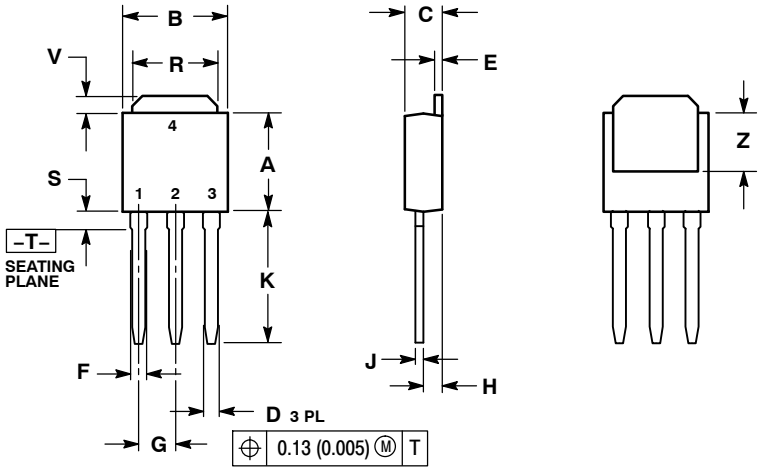


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR UNCONTROLLED IN THIS AREA.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH AND GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.13 PER SIDE. THESE DIMENSIONS ARE TO BE MEASURED AT OUTERMOST EXTREME OF THE PLASTIC BODY.
5. DIMENSION b2 DOES NOT INCLUDE DAMBAR PROTRUSION. LEAD WIDTH INCLUDING PROTRUSION SHALL NOT EXCEED 2.00.

	MILLIMETERS	
DIM	MIN	MAX
A	4.30	4.70
A1	2.50	2.90
A2	2.50	2.70
b	0.54	0.84
b2	1.10	1.40
c	0.49	0.79
D	14.22	15.88
E	9.65	10.67
e	2.54 BSC	
H1	5.97	6.48
L	12.70	14.73
L1	---	2.80
P	3.00	3.40
Q	2.80	3.20

PACKAGE DIMENSIONS

IPAK
CASE 369D−01
ISSUE C



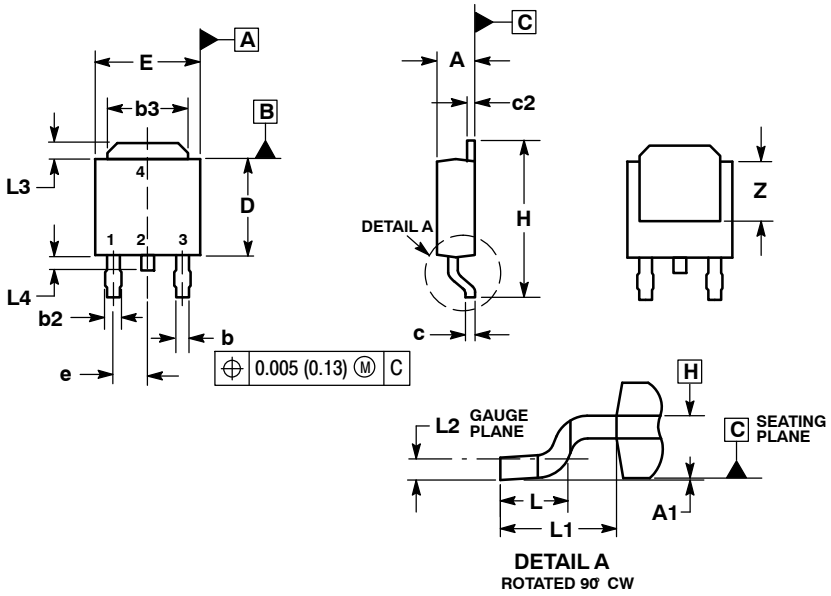
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	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 (SINGLE GAUGE)
CASE 369AA−01
ISSUE B

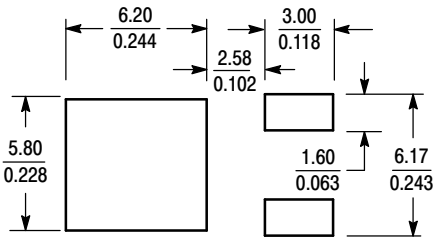


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.086	0.094	2.18	2.38
A1	0.000	0.005	0.00	0.13
b	0.025	0.035	0.63	0.89
b2	0.030	0.045	0.76	1.14
b3	0.180	0.215	4.57	5.46
c	0.018	0.024	0.46	0.61
c2	0.018	0.024	0.46	0.61
D	0.235	0.245	5.97	6.22
E	0.250	0.265	6.35	6.73
e	0.090 BSC		2.29 BSC	
H	0.370	0.410	9.40	10.41
L	0.055	0.070	1.40	1.78
L1	0.108 REF		2.74 REF	
L2	0.020 BSC		0.51 BSC	
L3	0.035	0.050	0.89	1.27
L4	−−−	0.040	−−−	1.01
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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