

# NDF10N60Z

## N-Channel Power MOSFET 600 V, 0.75 $\Omega$

### Features

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

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	NDF	Unit
Drain-to-Source Voltage	$V_{DSS}$	600	V
Continuous Drain Current, $R_{\theta JC}$ (Note 1)	$I_D$	10	A
Continuous Drain Current $T_A = 100^\circ\text{C}$ , $R_{\theta JC}$ (Note 1)	$I_D$	6.0	A
Pulsed Drain Current, $t_p = 10 \mu\text{s}$	$I_{DM}$	40	A
Power Dissipation, $R_{\theta JC}$	$P_D$	39	W
Gate-to-Source Voltage	$V_{GS}$	$\pm 30$	V
Single Pulse Avalanche Energy ( $L = 6.0 \text{ mH}$ , $I_D = 10 \text{ A}$ )	$E_{AS}$	300	mJ
ESD (HBM) (JESD22-A114)	$V_{esd}$	3900	V
RMS Isolation Voltage ( $t = 0.3 \text{ sec.}$ , R.H. $\leq 30\%$ , $T_A = 25^\circ\text{C}$ ) (Figure 13)	$V_{ISO}$	4500	V
Peak Diode Recovery (Note 2)	$dV/dt$	4.5	V/ns
MOSFET $dV/dt$	$dV/dt$	60	V/ns
Continuous Source Current (Body Diode)	$I_S$	10	A
Maximum Temperature for Soldering Leads	$T_L$	260	$^\circ\text{C}$
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to 150	$^\circ\text{C}$

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.

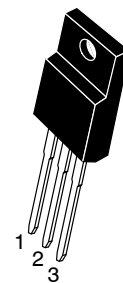
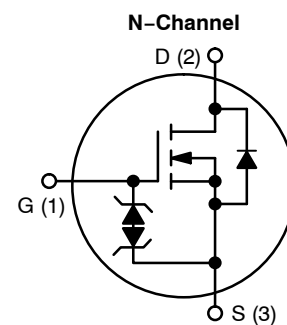
1. Limited by maximum junction temperature.
2.  $I_S \leq 10 \text{ A}$ ,  $di/dt \leq 200 \text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% \text{ BV}_{DSS}$



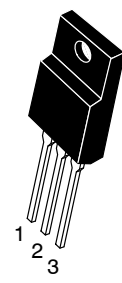
**ON Semiconductor**<sup>®</sup>

<http://onsemi.com>

$V_{DSS}$ (@ $T_{Jmax}$ )	$R_{DS(ON)}$ (MAX) @ 5 A
650 V	0.75 $\Omega$



**NDF10N60ZG**  
**TO-220FP**  
**CASE 221D**



**NDF10N60ZH**  
**TO-220FP**  
**CASE 221AH**

### ORDERING AND MARKING INFORMATION

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

# NDF10N60Z

## THERMAL RESISTANCE

Parameter	Symbol	NDF10N60Z	Unit
Junction-to-Case (Drain)	$R_{\theta JC}$	3.2	°C/W
Junction-to-Ambient Steady State (Note 3)	$R_{\theta JA}$	50	

3. Insertion mounted

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Test Conditions	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	$BV_{DSS}$	600			V
Breakdown Voltage Temperature Coefficient	Reference to $25^\circ\text{C}$ , $I_D = 1\text{ mA}$	$\Delta BV_{DSS}/\Delta T_J$		0.6		V/°C
Drain-to-Source Leakage Current	$V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$	$I_{DSS}$	25°C		1	μA
			150°C		50	
Gate-to-Source Forward Leakage	$V_{GS} = \pm 20\text{ V}$	$I_{GSS}$			±10	μA

### ON CHARACTERISTICS (Note 4)

Static Drain-to-Source On-Resistance	$V_{GS} = 10\text{ V}, I_D = 5.0\text{ A}$	$R_{DS(on)}$		0.65	0.75	Ω
Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 100\text{ }\mu\text{A}$	$V_{GS(th)}$	3.0	3.9	4.5	V
Forward Transconductance	$V_{DS} = 15\text{ V}, I_D = 10\text{ A}$	$g_{FS}$		7.9		S

### DYNAMIC CHARACTERISTICS

Input Capacitance (Note 5)	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$	$C_{iss}$	1097	1373	1645	pF
Output Capacitance (Note 5)		$C_{oss}$	118	150	178	
Reverse Transfer Capacitance (Note 5)		$C_{rss}$	20	35	50	
Total Gate Charge (Note 5)	$V_{DD} = 300\text{ V}, I_D = 10\text{ A},$ $V_{GS} = 10\text{ V}$	$Q_g$	23	47	68	nC
Gate-to-Source Charge (Note 5)		$Q_{gs}$	5.0	9.0	14	
Gate-to-Drain ("Miller") Charge (Note 5)		$Q_{gd}$	12	26	36	
Plateau Voltage		$V_{GP}$		6.4		
Gate Resistance		$R_g$	0.5	1.5	4.5	Ω

### RESISTIVE SWITCHING CHARACTERISTICS

Turn-On Delay Time	$V_{DD} = 300\text{ V}, I_D = 10\text{ A},$ $V_{GS} = 10\text{ V}, R_G = 5\text{ }\Omega$	$t_{d(on)}$		15		ns
Rise Time		$t_r$		31		
Turn-Off Delay Time		$t_{d(off)}$		40		
Fall Time		$t_f$		23		

### SOURCE-DRAIN DIODE CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Diode Forward Voltage	$I_S = 10\text{ A}, V_{GS} = 0\text{ V}$	$V_{SD}$			1.6	V
Reverse Recovery Time	$V_{GS} = 0\text{ V}, V_{DD} = 30\text{ V}$ $I_S = 10\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$	$t_{rr}$		395		ns
Reverse Recovery Charge		$Q_{rr}$		3.0		μC

4. Pulse Width  $\leq 380\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

5. Guaranteed by design.

# NDF10N60Z

## TYPICAL CHARACTERISTICS

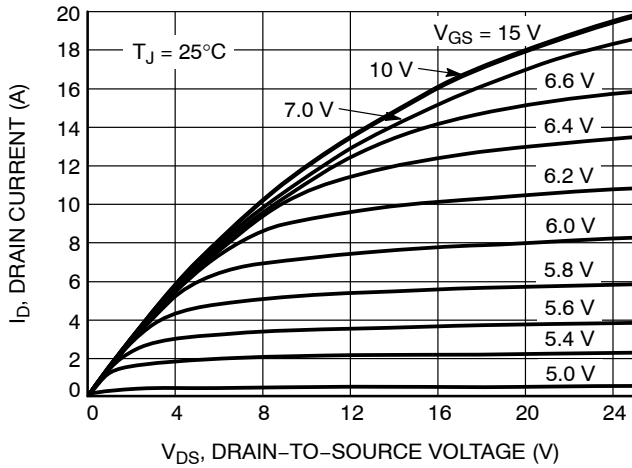


Figure 1. On-Region Characteristics

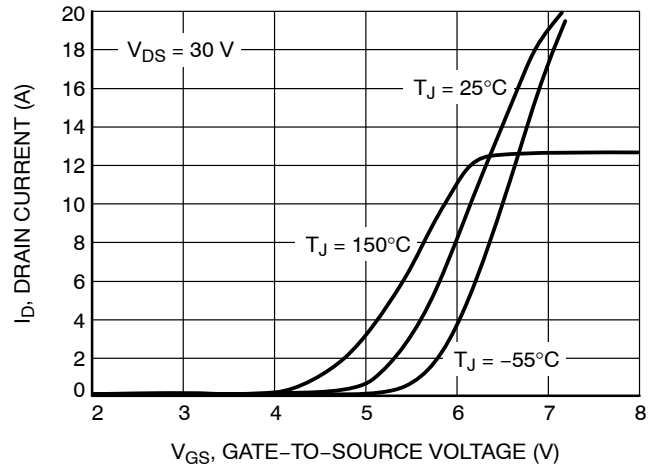


Figure 2. Transfer Characteristics

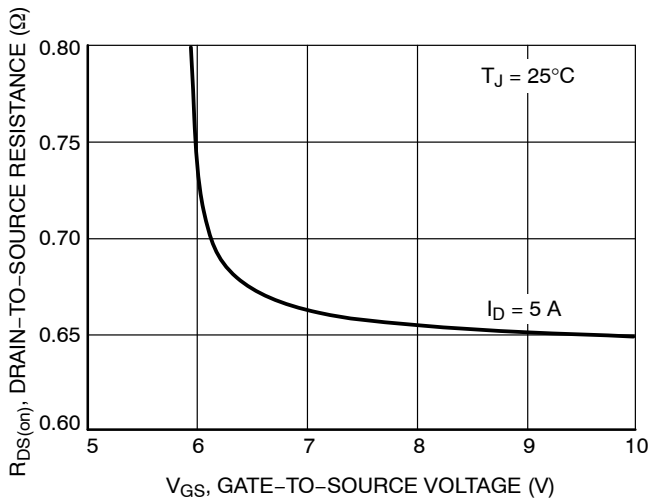


Figure 3. On-Resistance vs. Gate Voltage

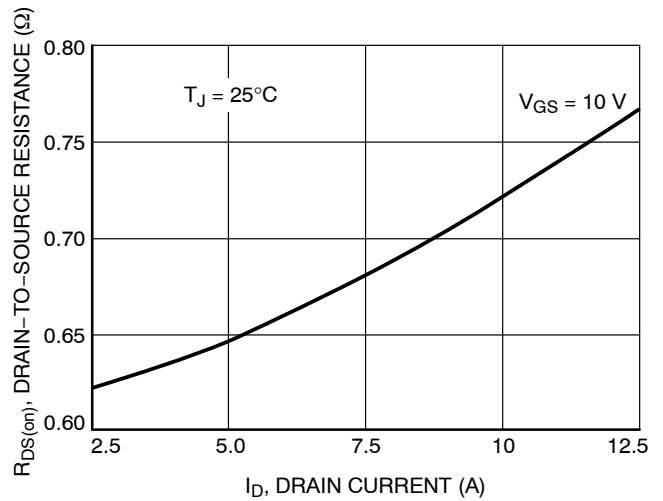


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

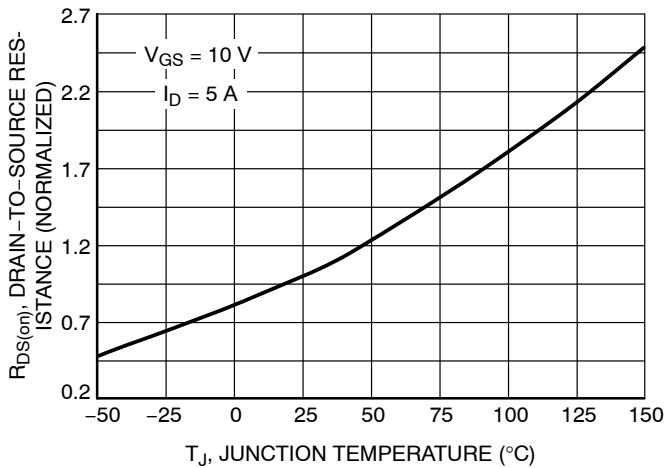


Figure 5. On-Resistance Variation with Temperature

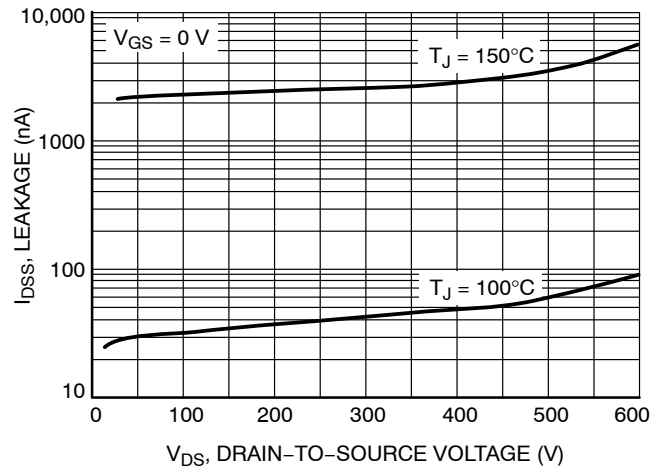


Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NDF10N60Z

## TYPICAL CHARACTERISTICS

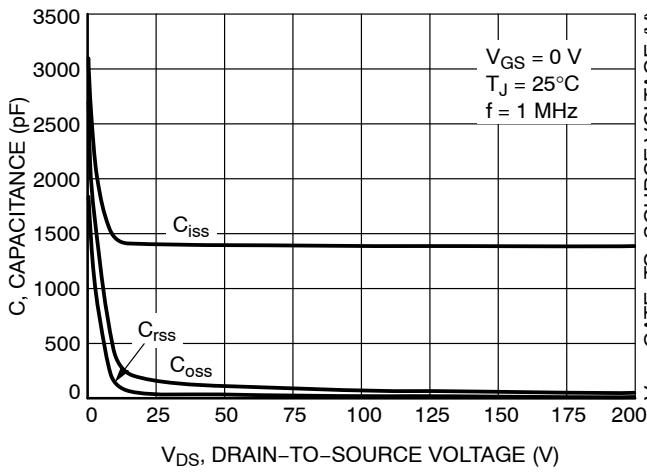


Figure 7. Capacitance Variation

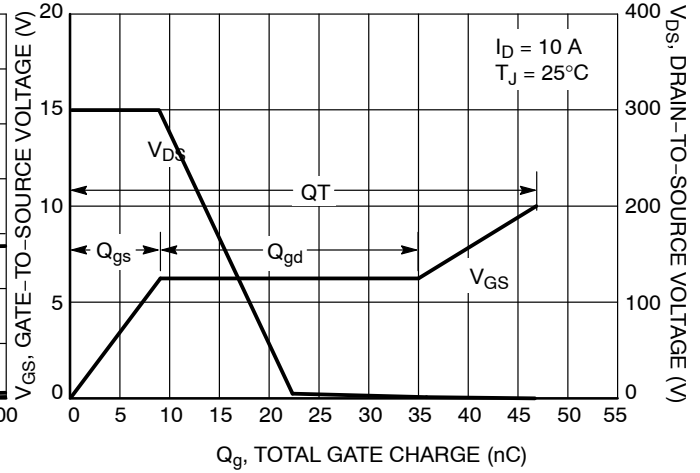


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

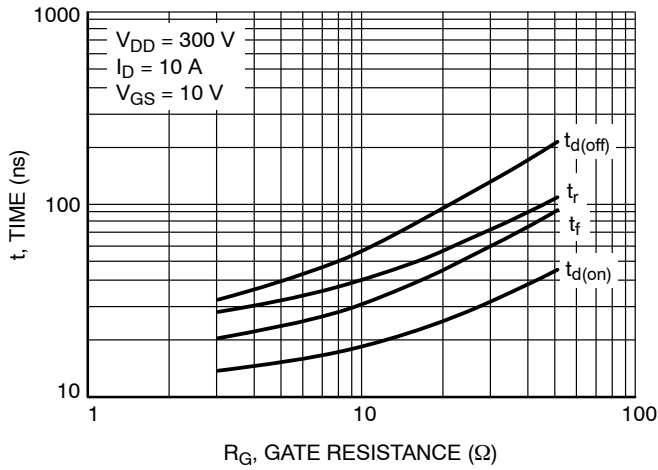


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

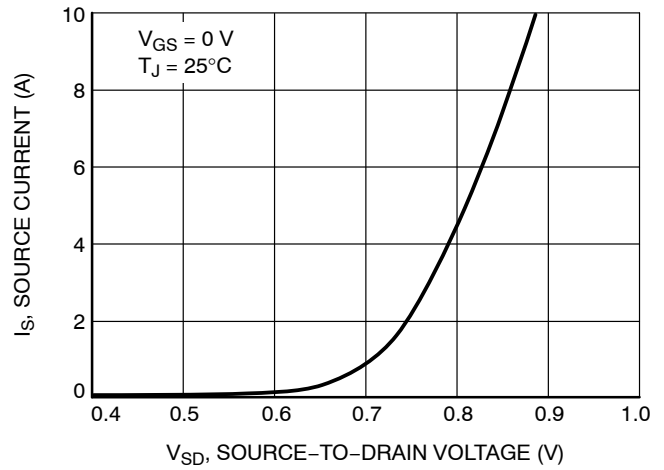


Figure 10. Diode Source Current vs. Forward Voltage

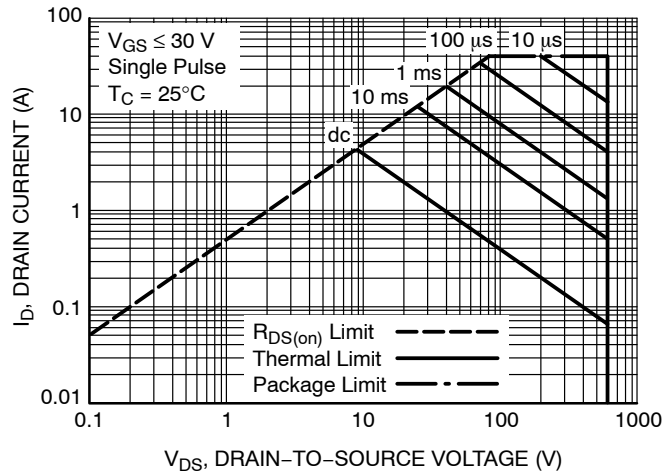


Figure 11. Maximum Rated Forward Biased Safe Operating Area for NDF10N60Z

# NDF10N60Z

## TYPICAL CHARACTERISTICS

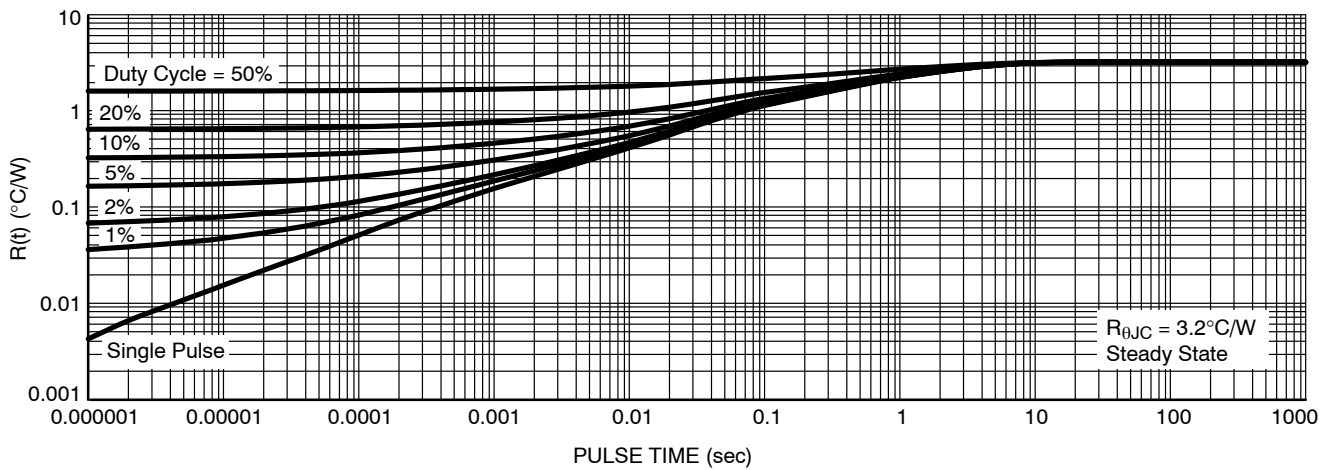


Figure 12. Thermal Impedance for NDF10N60Z

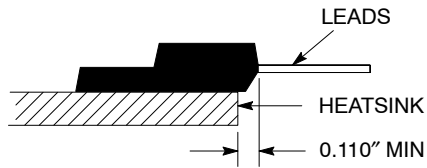


Figure 13. Mounting Position for Isolation Test

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.

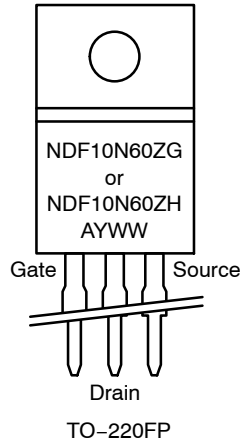
# NDF10N60Z

## ORDERING INFORMATION

Order Number	Package	Shipping†
NDF10N60ZG	TO-220FP (Pb-Free, Halogen-Free)	50 Units / Rail
NDF10N60ZH	TO-220FP (Pb-Free, Halogen-Free)	50 Units / Rail

†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

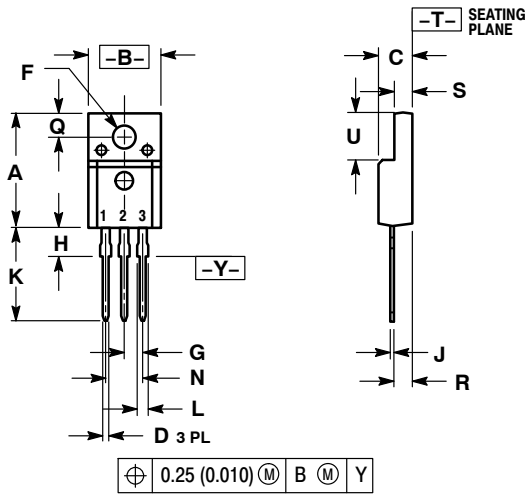


- A = Location Code
- Y = Year
- WW = Work Week
- G, H = Pb-Free, Halogen-Free Package

# NDF10N60Z

## PACKAGE DIMENSIONS

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.

DIM	INCHES		MILLIMETERS	
	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

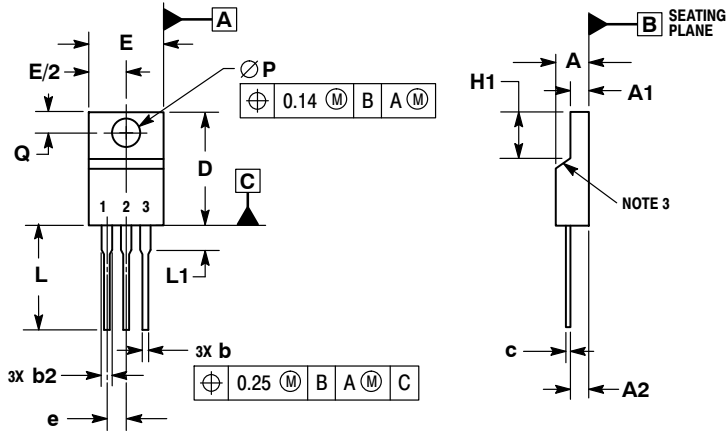
STYLE 1:

- PIN 1. GATE
- DRAIN
- SOURCE

# NDF10N60Z

## PACKAGE DIMENSIONS


### TO-220 FULLPACK, 3-LEAD CASE 221AH ISSUE D



#### 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.

DIM	MILLIMETERS	
	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	14.70	15.30
E	9.70	10.30
e	2.54 BSC	
H1	6.70	7.10
L	12.70	14.73
L1	---	2.10
P	3.00	3.40
Q	2.80	3.20

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