NDF10N60Z, NDP10N60Z

N-Channel Power MOSFET 600 V, 0.75 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)

Rating	Symbol	NDF	NDP	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°C, $R_{\theta JC}$ (Note 1)	I_D	6.0		A
Pulsed Drain Current, t_P = 10 μs	I_{DM}	40		A
Power Dissipation, $R_{\theta JC}$	P_D	39	178	W
Gate−to−Source Voltage	V_{GS}	±30		V
Single Pulse Avalanche Energy, L = 6.0 mH, I_D = 10 A	E_{AS}	300		mJ
ESD (HBM) (JESD22−A114)	V_{esd}	3900		V
RMS Isolation Voltage (t = 0.3 sec., R.H. ≤ 30%, T_A = 25°C) (Figure 13)	V_{ISO}	4500		V
Peak Diode Recovery (Note 2)	dv/dt	4.5		V/ns
Continuous Source Current (Body Diode)	I_S	10		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.

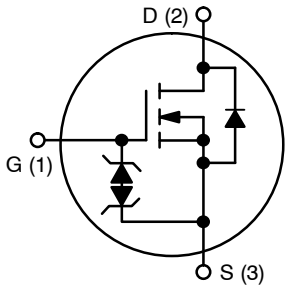
1. Limited by maximum junction temperature
2. I_S ≤ 10 A, di/dt ≤ 200 A/μs, V_{DD} = 80% BV_{DSS}

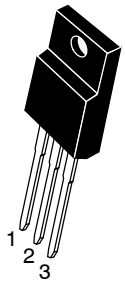
ON Semiconductor®

http://onsemi.com

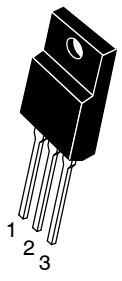
V_{DSS}	$R_{DS(ON)}$ (MAX) @ 5 A
600 V	0.75 Ω

N−Channel

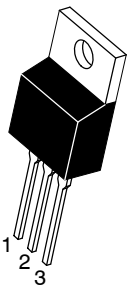




NDF10N60ZG
TO−220FP
CASE 221D



NDF10N60ZH
TO−220FP
CASE 221AH



NDP10N60ZG
TO−220AB
CASE 221A

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	NDF10N60Z	NDP10N60Z	Unit
Junction−to−Case (Drain)	$R_{\theta JC}$	3.2	0.7	°C/W
Junction−to−Ambient Steady State (Note 3)	$R_{\theta JA}$	50	50	

3. Insertion mounted

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 4)							
Static Drain−to−Source On−Resistance	V_{GS} = 10 V, I_D = 5.0 A		$R_{DS(on)}$		0.65	0.75	Ω
Gate Threshold Voltage	V_{DS} = V_{GS}, I_D = 100 μA		$V_{GS(th)}$	3.0		4.5	V
Forward Transconductance	V_{DS} = 15 V, I_D = 10 A		g_{FS}		7.9		S
DYNAMIC CHARACTERISTICS							
Input Capacitance	V_{DS} = 25 V, V_{GS} = 0 V, f = 1.0 MHz		C_{iss}		1425		pF
Output Capacitance			C_{oss}		150		
Reverse Transfer Capacitance			C_{rss}		35		
Total Gate Charge	V_{DD} = 300 V, I_D = 10 A, V_{GS} = 10 V		Q_g		47		nC
Gate−to−Source Charge			Q_{gs}		9.0		
Gate−to−Drain (“Miller”) Charge			Q_{gd}		26		
Gate Resistance			R_g		1.5		Ω
RESISTIVE SWITCHING CHARACTERISTICS							
Turn−On Delay Time	V_{DD} = 300 V, I_D = 10 A, V_{GS} = 10 V, R_G = 5 Ω		$t_{d(on)}$		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°C unless otherwise noted)

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

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

TYPICAL CHARACTERISTICS

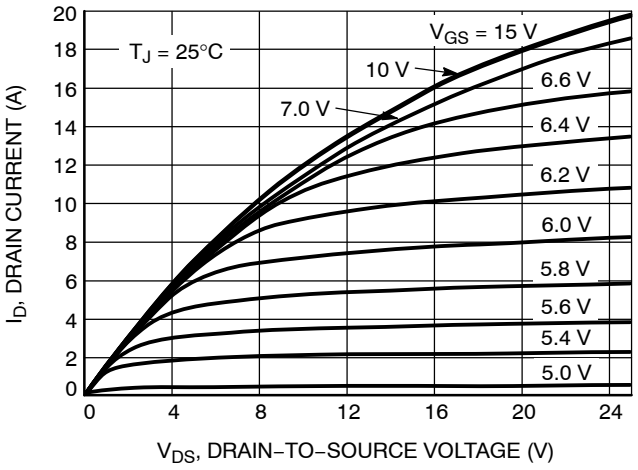


Figure 1. On−Region Characteristics

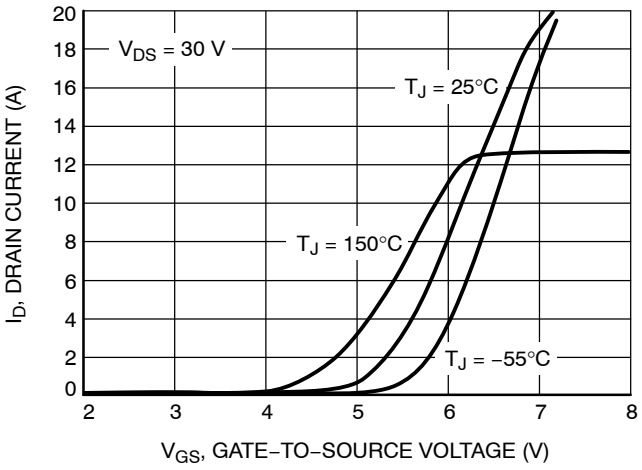


Figure 2. Transfer Characteristics

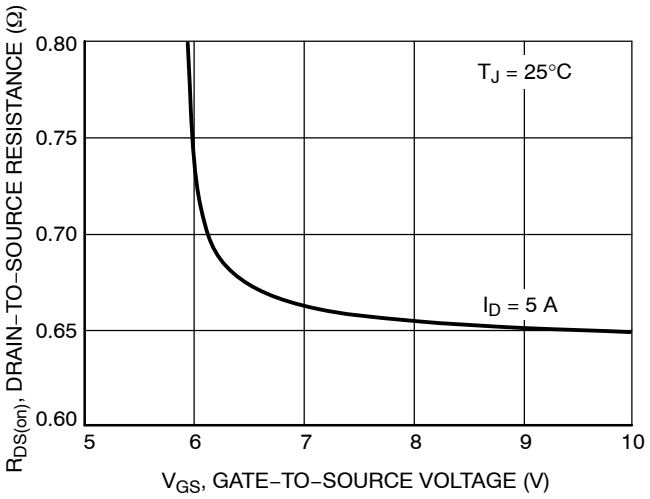


Figure 3. On−Resistance vs. Gate Voltage

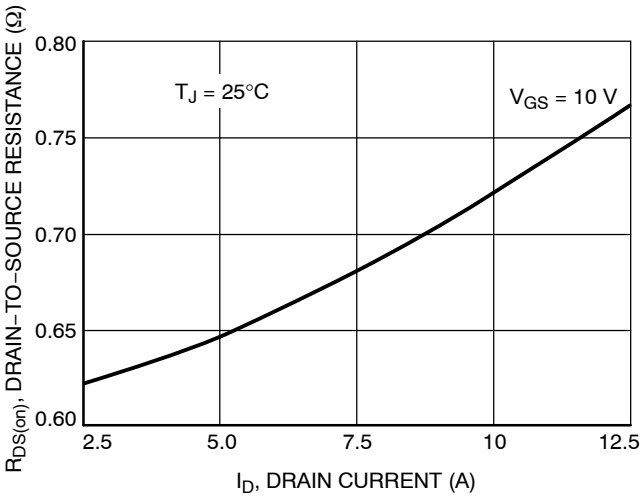


Figure 4. On−Resistance vs. Drain Current and Gate Voltage

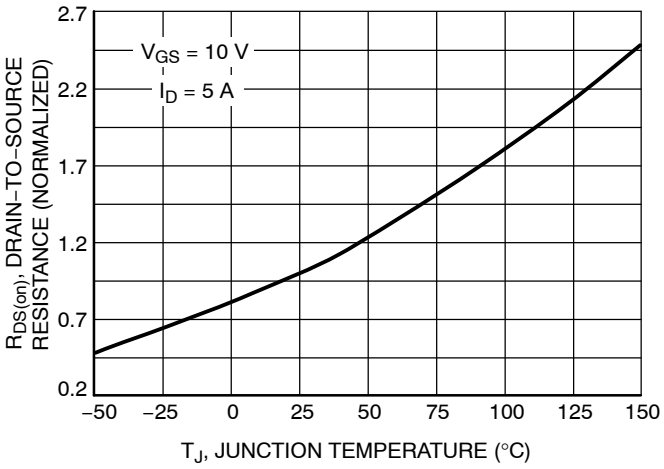


Figure 5. On−Resistance Variation with Temperature

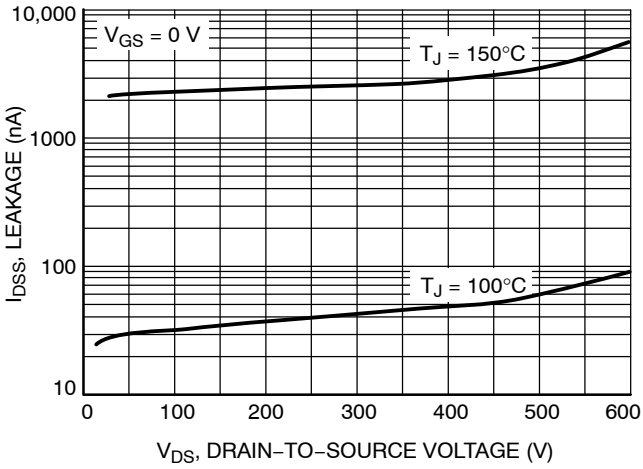


Figure 6. Drain−to−Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS

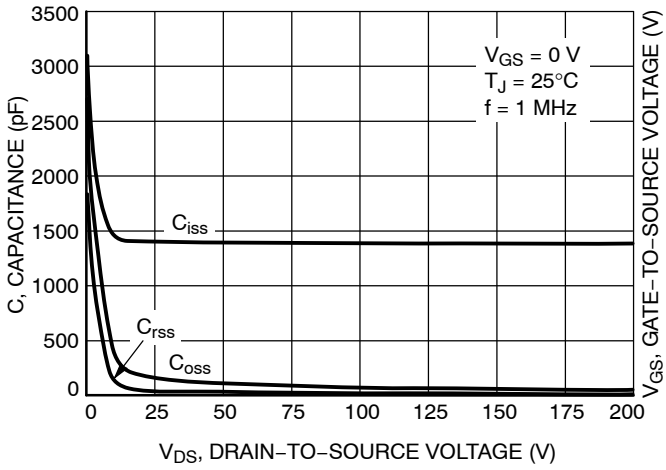


Figure 7. Capacitance Variation

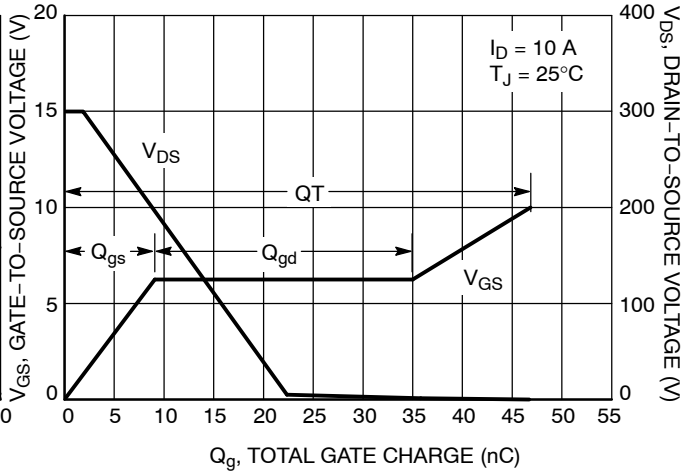


Figure 8. Gate−to−Source and Drain−to−Source Voltage vs. Total Charge

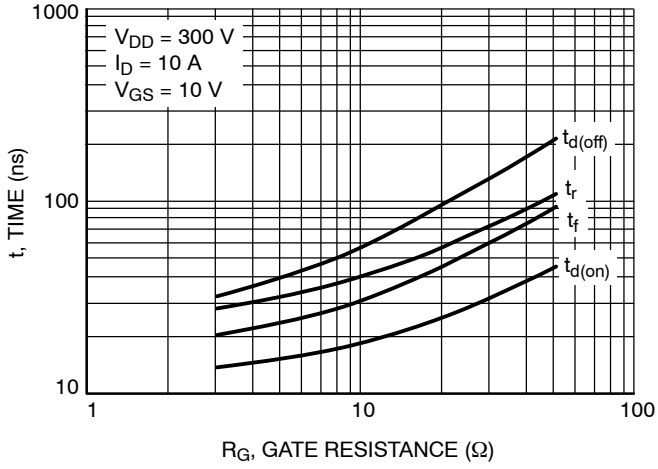


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

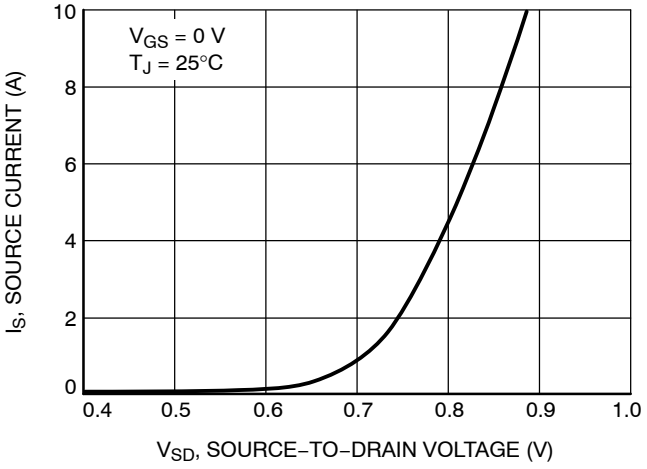


Figure 10. Diode Source Current vs. Forward Voltage

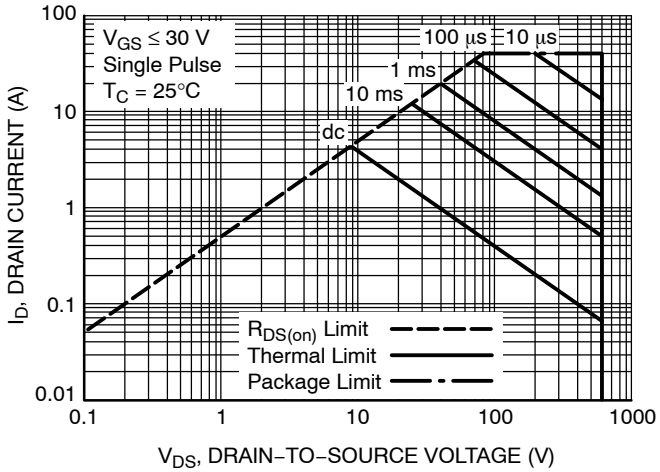


Figure 11. Maximum Rated Forward Biased Safe Operating Area for NDF10N60Z

TYPICAL CHARACTERISTICS

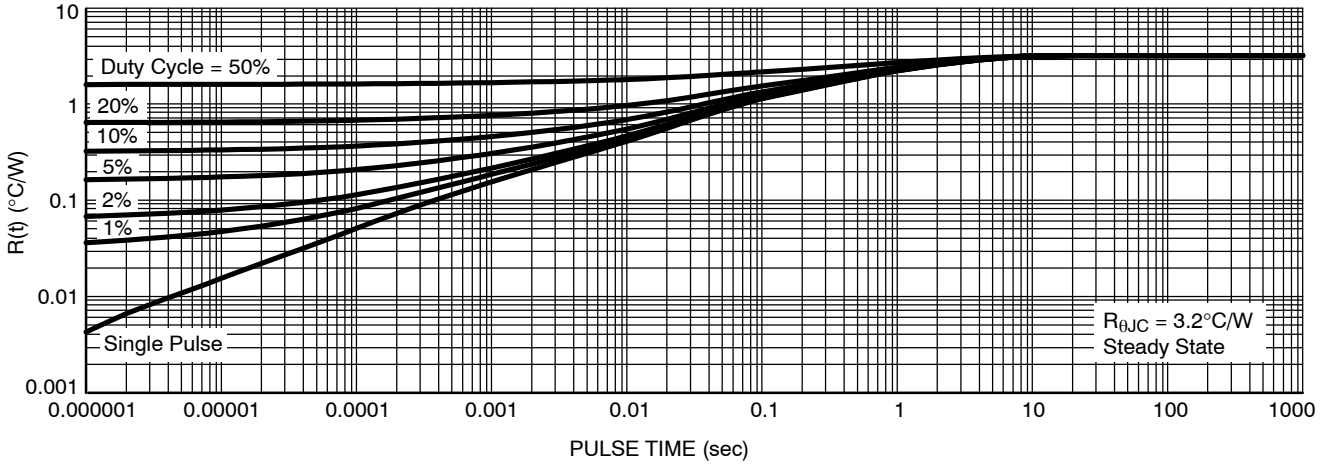


Figure 12. Thermal Impedance for NDF10N60Z

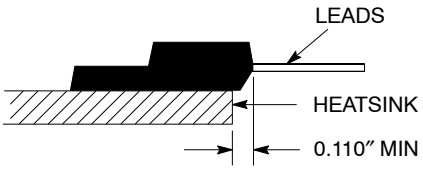


Figure 13. Mounting Position for Isolation Test

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

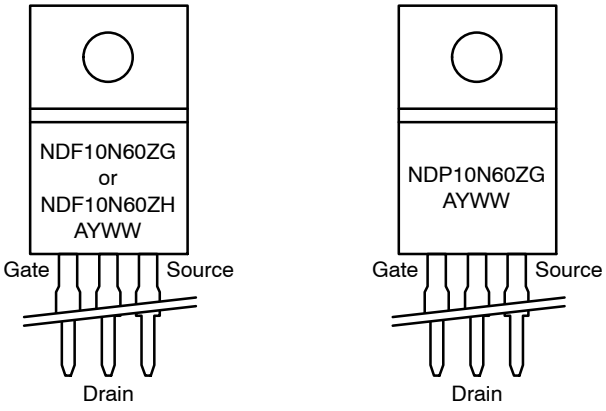
*For additional mounting information, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ORDERING INFORMATION

Order Number	Package	Shipping†
NDF10N60ZG	TO−220FP (Pb−Free, Halogen−Free)	50 Units / Rail
NDF10N60ZH	TO−220FP (Halogen−Free)	50 Units / Rail
NDP10N60ZG	TO−220AB (Pb−Free)	50 Units / Rail (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.

MARKING DIAGRAMS

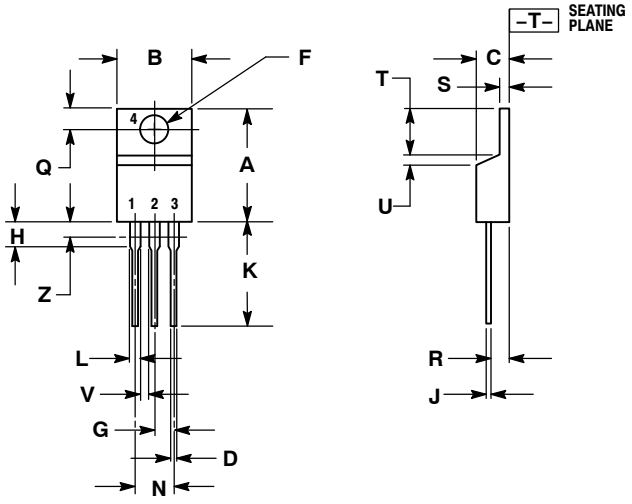


TO−220FP TO−220AB

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

PACKAGE DIMENSIONS

TO−220AB
CASE 221A−09
ISSUE AF

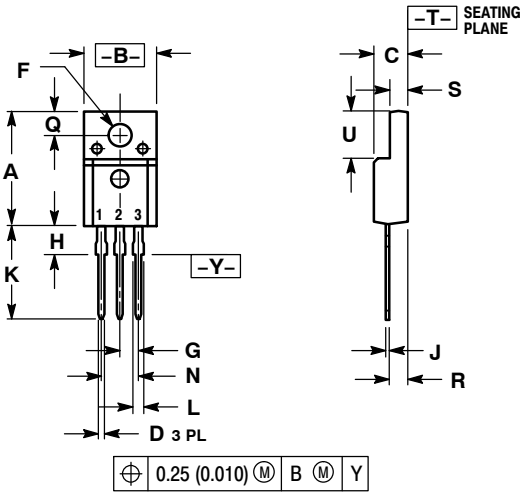


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

	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



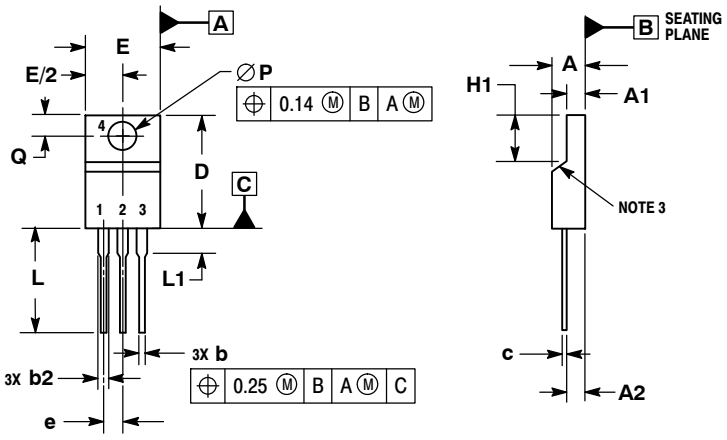
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. 221D−01 THRU 221D−02 OBSOLETE, NEW STANDARD 221D−03.

	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

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

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Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
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