# NDF06N60Z

# N-Channel Power MOSFET 600 V, 1.2 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 | Value | Unit |
|---|---|---|---|
| Drain−to−Source Voltage | $V_{DSS}$ | 600 | V |
| Continuous Drain Current, $R_{\theta JC}$ (Note 1) | $I_D$ | 7.1 | A |
| Continuous Drain Current $T_A$ = 100°C, $R_{\theta JC}$ (Note 1) | $I_D$ | 4.5 | A |
| Pulsed Drain Current, $V_{GS}$ @ 10 V | $I_{DM}$ | 28 | A |
| Power Dissipation, $R_{\theta JC}$ | $P_D$ | 35 | W |
| Gate−to−Source Voltage | $V_{GS}$ | ±30 | V |
| Single Pulse Avalanche Energy, L = 6.3 mH, $I_D$ = 6.0 A | $E_{AS}$ | 113 | mJ |
| ESD (HBM) (JESD22−A114) | $V_{esd}$ | 3000 | 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) | $I_S$ | 6.0 | 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. $I_{SD}$ = 6.0 A, di/dt ≤ 100 A/μs, $V_{DD} \le BV_{DSS}$, $T_J$ = +150°C

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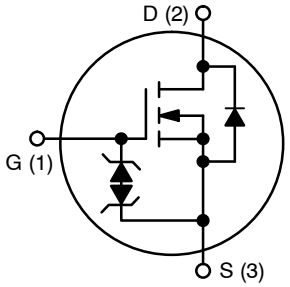
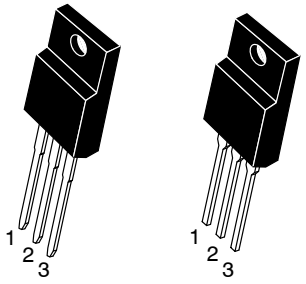
| $V_{DSS}$ (@ $T_{Jmax}$) | $R_{DS(ON)}$ (MAX) @ 3 A |
|---|---|
| 650 V | 1.2 Ω |

**N−Channel**




**NDF06N60ZG**
**TO−220FP**
**CASE 221D**

**NDF06N60ZH**
**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.

## THERMAL RESISTANCE

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Junction−to−Case (Drain) | $R_{\theta JC}$ | 3.6 | °C/W |
| Junction−to−Ambient Steady State (Note 3) | $R_{\theta JA}$ | 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, $I_D$ = 3.0 A | | $R_{DS(on)}$ | | 0.98 | 1.2 | Ω |
| Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 100 μA | | $V_{GS(th)}$ | 3.0 | 3.9 | 4.5 | V |
| Forward Transconductance | $V_{DS}$ = 15 V, $I_D$ = 3.0 A | | $g_{FS}$ | | 5.0 | | S |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| Input Capacitance (Note 5) | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1.0 MHz | | $C_{iss}$ | 738 | 923 | 1107 | pF |
| Output Capacitance (Note 5) | | | $C_{oss}$ | 90 | 106 | 125 | |
| Reverse Transfer Capacitance (Note 5) | | | $C_{rss}$ | 15 | 23 | 30 | |
| Total Gate Charge (Note 5) | $V_{DD}$ = 300 V, $I_D$ = 6.0 A, $V_{GS}$ = 10 V | | $Q_g$ | 15.5 | 31 | 47 | nC |
| Gate−to−Source Charge (Note 5) | | | $Q_{gs}$ | 3 | 6.3 | 9.5 | |
| Gate−to−Drain (“Miller”) Charge (Note 5) | | | $Q_{gd}$ | 8 | 17 | 24.5 | |
| Plateau Voltage | | | $V_{GP}$ | | 6.4 | | V |
| Gate Resistance | | | $R_g$ | | 3.2 | | Ω |
| **RESISTIVE SWITCHING CHARACTERISTICS** | | | | | | | |
| Turn−On Delay Time | $V_{DD}$ = 300 V, $I_D$ = 6.0 A, $V_{GS}$ = 10 V, $R_G$ = 5 Ω | | $t_{d(on)}$ | | 13 | | ns |
| Rise Time | | | $t_r$ | | 17 | | |
| Turn−Off Delay Time | | | $t_{d(off)}$ | | 30 | | |
| Fall Time | | | $t_f$ | | 28 | | |
| **SOURCE−DRAIN DIODE CHARACTERISTICS** ($T_C$ = 25°C unless otherwise noted) | | | | | | | |
| Diode Forward Voltage | $I_S$ = 6.0 A, $V_{GS}$ = 0 V | | $V_{SD}$ | | | 1.6 | V |
| Reverse Recovery Time | $V_{GS}$ = 0 V, $V_{DD}$ = 30 V, $I_S$ = 6.0 A, di/dt = 100 A/μs | | $t_{rr}$ | | 338 | | ns |
| Reverse Recovery Charge | | | $Q_{rr}$ | | 2.0 | | μC |

4. Pulse Width ≤ 380 μs, Duty Cycle ≤ 2%.
5. Guaranteed by design.

## TYPICAL CHARACTERISTICS

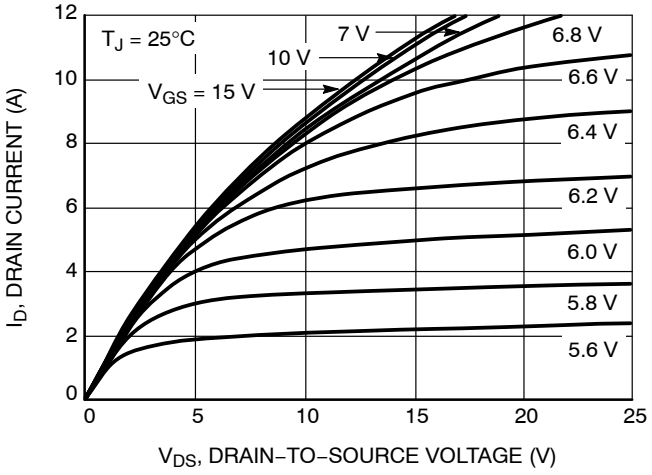



**Figure 1. On−Region Characteristics**

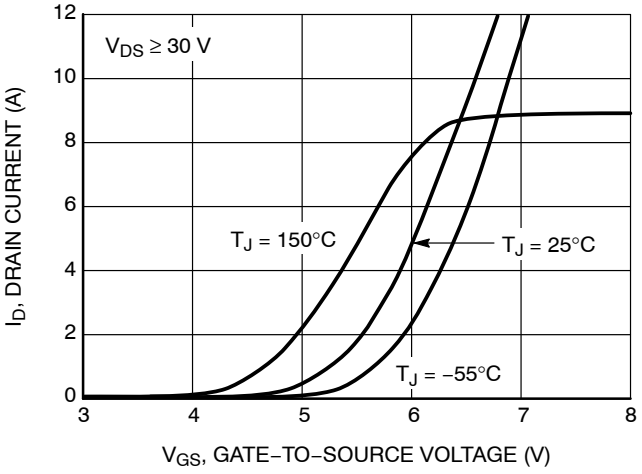



**Figure 2. Transfer Characteristics**

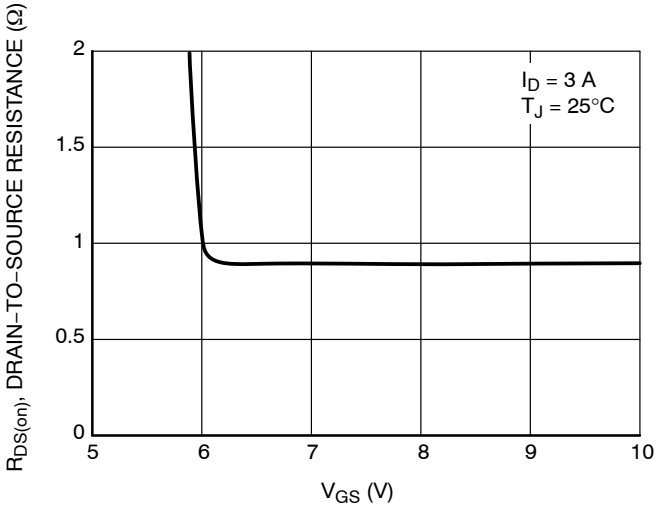



**Figure 3. On−Resistance vs. $V_{GS}$**

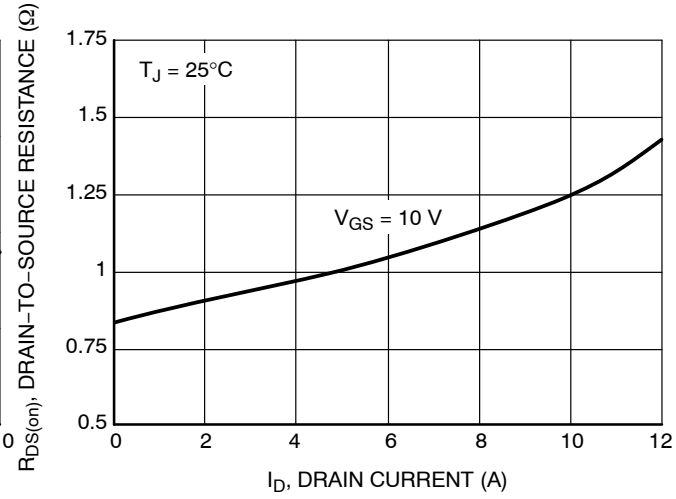



**Figure 4. On−Resistance vs. Drain Current and Gate Voltage**

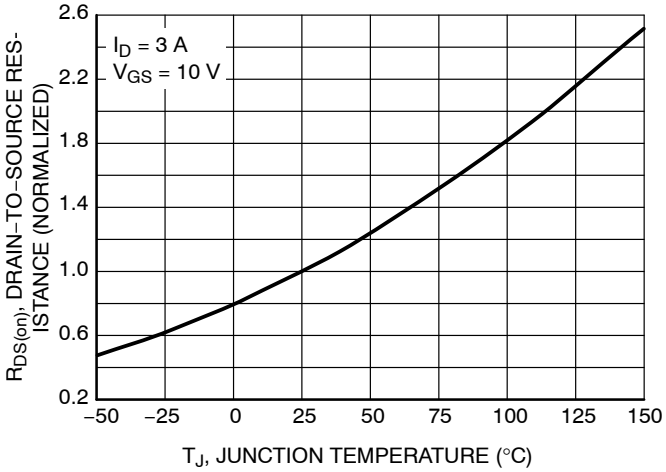



**Figure 5. On−Resistance Variation with Temperature**

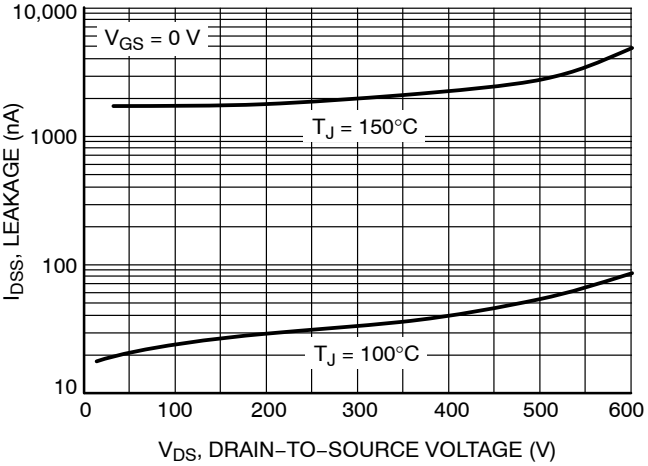



**Figure 6. Drain−to−Source Leakage Current vs. Voltage**

## TYPICAL CHARACTERISTICS

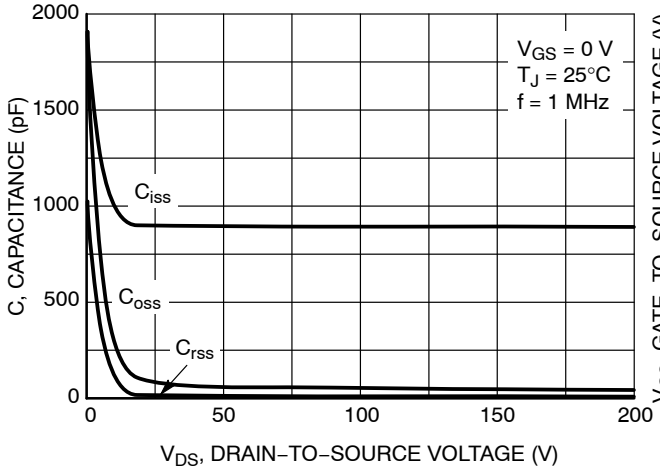



**Figure 7. Capacitance Variation**

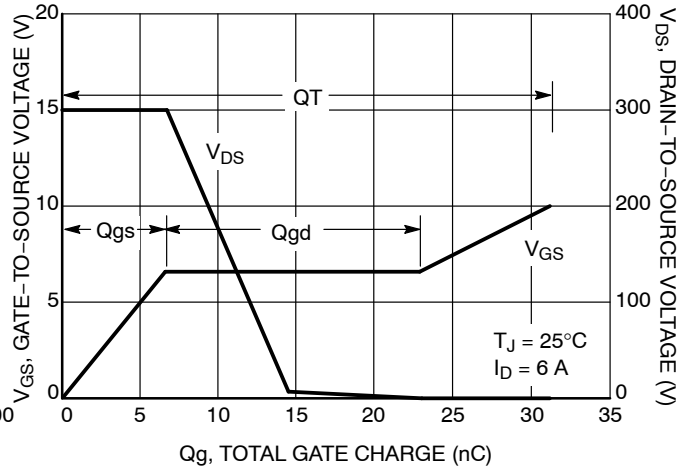



**Figure 8. Gate−to−Source and Drain−to−Source Voltage vs. Total Charge**

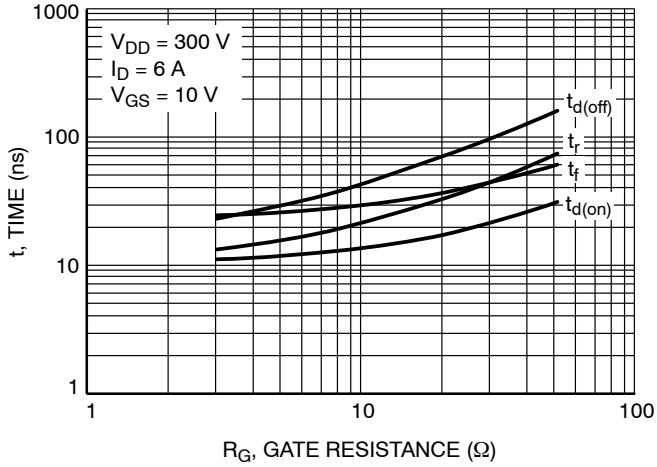



**Figure 9. Resistive Switching Time Variation vs. Gate Resistance**

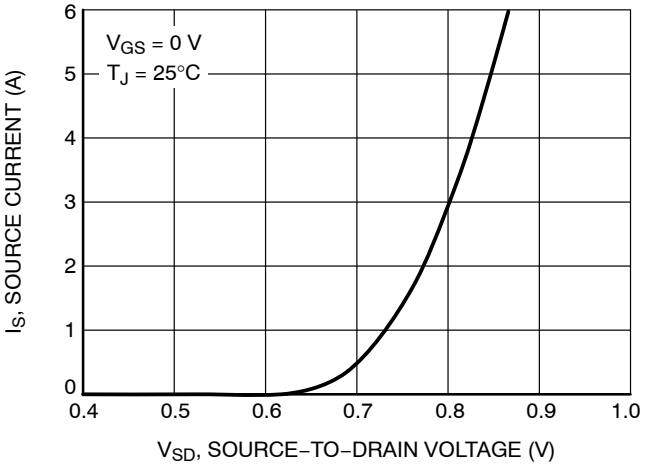



**Figure 10. Diode Forward Voltage vs. Current**

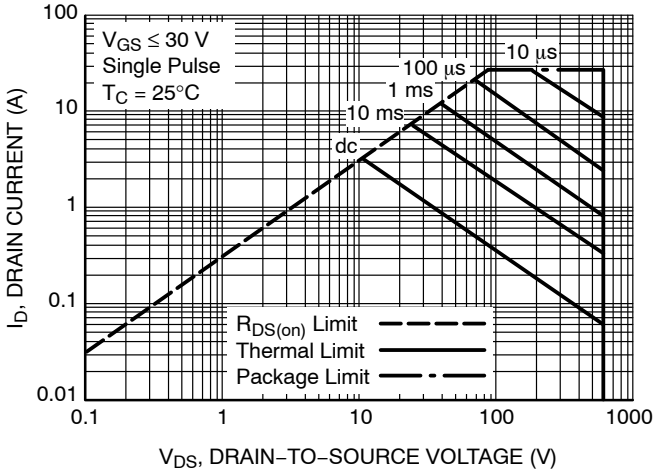



**Figure 11. Maximum Rated Forward Biased Safe Operating Area for NDF06N60Z**

## TYPICAL CHARACTERISTICS

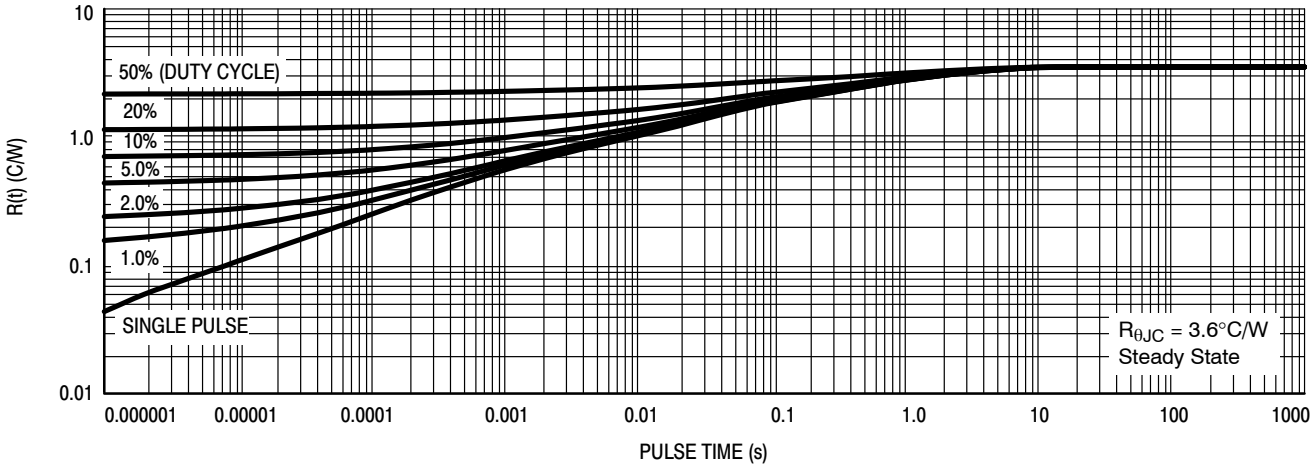



**Figure 12. Thermal Impedance for NDF06N60Z**

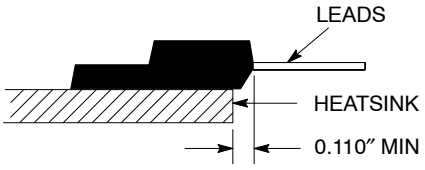



**Figure 13. Mounting Position for Isolation Test**

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

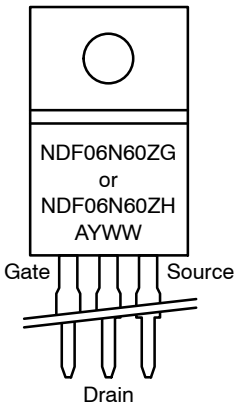
*For additional mounting information, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## ORDERING INFORMATION

| Order Number | Package | Shipping† |
|---|---|---|
| NDF06N60ZG | TO−220FP<br>(Pb−Free, Halogen−Free) | 50 Units / Rail |
| NDF06N60ZH | TO−220FP<br>(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

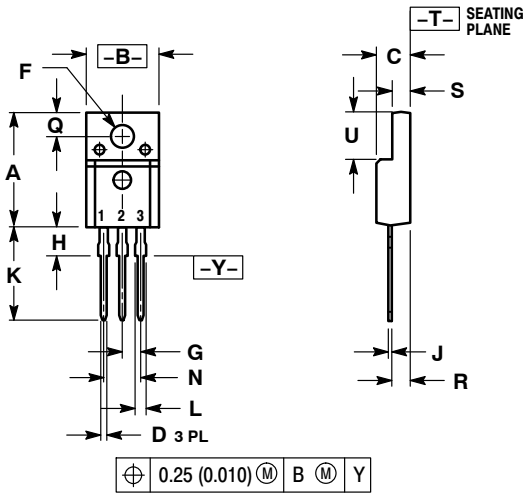



TO−220FP

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

## PACKAGE DIMENSIONS

**TO−220 FULLPAK**
CASE 221D−03
ISSUE K



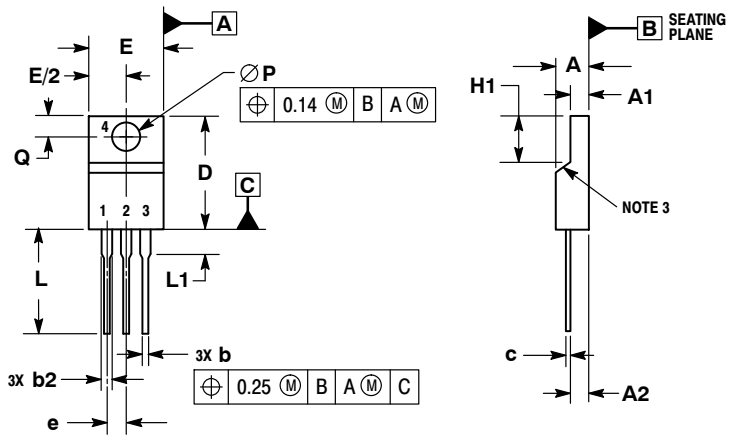

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. 221D−01 THRU 221D−02 OBSOLETE, NEW STANDARD 221D−03.

| | 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 FULLPACK, 3−LEAD**
CASE 221AH
ISSUE B




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



**PUBLICATION ORDERING INFORMATION**

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