

NDF10N60Z, NDP10N60Z

N-Channel Power MOSFET 600 V, 0.75 Ω

Features

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

ABSOLUTE MAXIMUM RATINGS ($T_C = 25^\circ\text{C}$ 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 $T_A = 100^\circ\text{C}$, $R_{\theta JC}$ (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 | 36 | 125 | W |
| Gate-to-Source Voltage | V_{GS} | ± 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 | dv/dt | 4.5 (Note 2) | | 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.

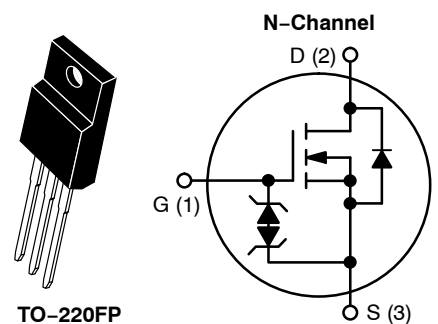
1. Limited by maximum junction temperature
2. $I_S \leq 10 \text{ A}$, $di/dt \leq 200 \text{ A}/\mu\text{s}$, $V_{DD} = 80\% BV_{DSS}$



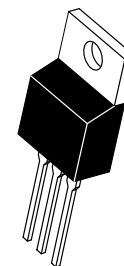
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| V_{DSS} | $R_{DS(ON)} \text{ (MAX) @ 5 A}$ |
|-----------|----------------------------------|
| 600 V | 0.75 Ω |

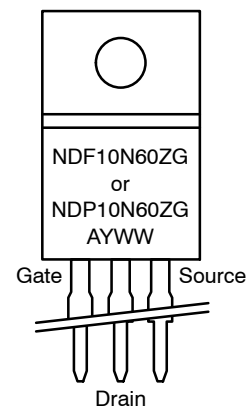


TO-220FP
CASE 221D
STYLE 1



TO-220AB
CASE 221A
STYLE 5

MARKING DIAGRAM



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

ORDERING INFORMATION

| Device | Package | Shipping |
|------------|----------|----------------|
| NDF10N60ZG | TO-220FP | 50 Units/Rail |
| NDP10N60ZG | TO-220AB | In Development |

NDF10N60Z, NDP10N60Z

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 | |

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

| Characteristic | Test Conditions | Symbol | Min | Typ | Max | Unit |
|----------------|-----------------|--------|-----|-----|-----|------|
|----------------|-----------------|--------|-----|-----|-----|------|

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°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} | | | 1 | μA |
| | | | | | 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 | $V_{DS} = V_{GS}, I_D = 100\ \mu\text{A}$ | $V_{GS(th)}$ | 3.0 | | 4.5 | V |
| Forward Transconductance | $V_{DS} = 15\text{ V}, I_D = 10\text{ A}$ | g_{FS} | | 7.9 | | S |

DYNAMIC CHARACTERISTICS

| | | | | | | |
|---------------------------------|---|-----------|--|------|--|-------------|
| Input Capacitance | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$ | C_{iss} | | 1425 | | pF |
| Output Capacitance | | C_{oss} | | 150 | | |
| Reverse Transfer Capacitance | | C_{rss} | | 35 | | |
| Total Gate Charge | $V_{DD} = 300\text{ V}, I_D = 10\text{ A},$ $V_{GS} = 10\text{ V}$ | 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 | $V_{DD} = 300\text{ V}, I_D = 10\text{ A},$ $V_{GS} = 10\text{ V}, R_G = 5\ \Omega$ | $t_{d(on)}$ | | 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 |

3. Insertion mounted

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

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TYPICAL CHARACTERISTICS

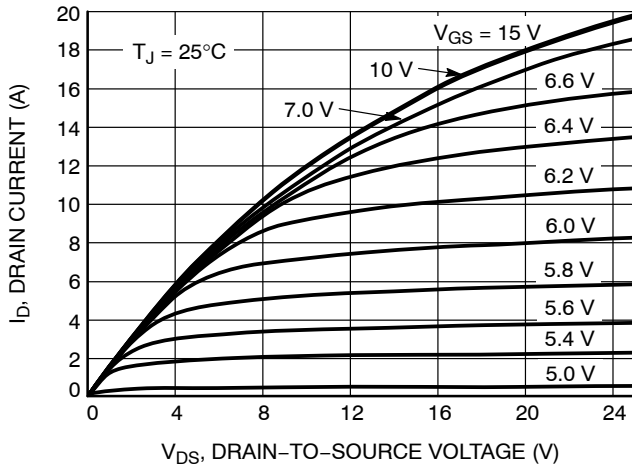


Figure 1. On-Region Characteristics

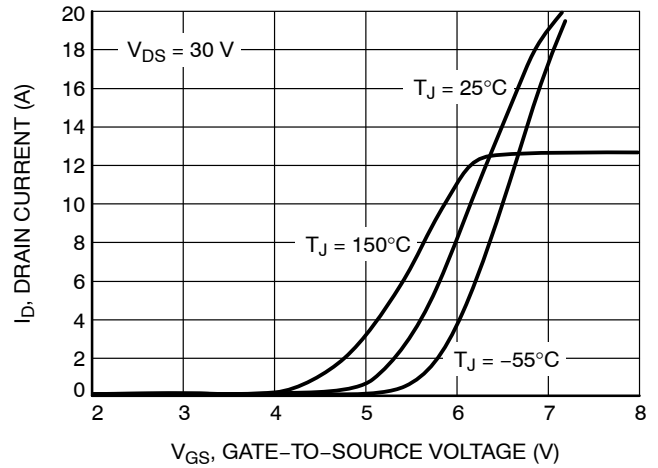


Figure 2. Transfer Characteristics

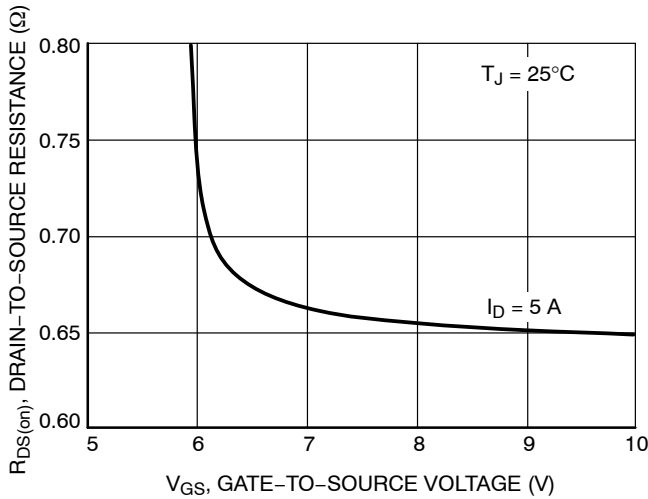


Figure 3. On-Resistance vs. Gate Voltage

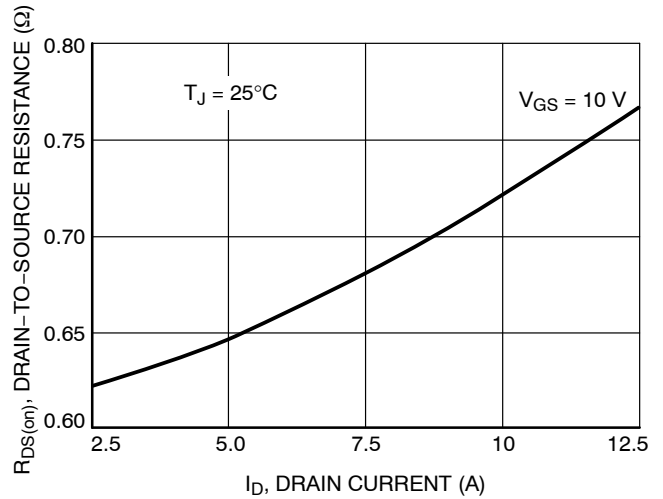


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

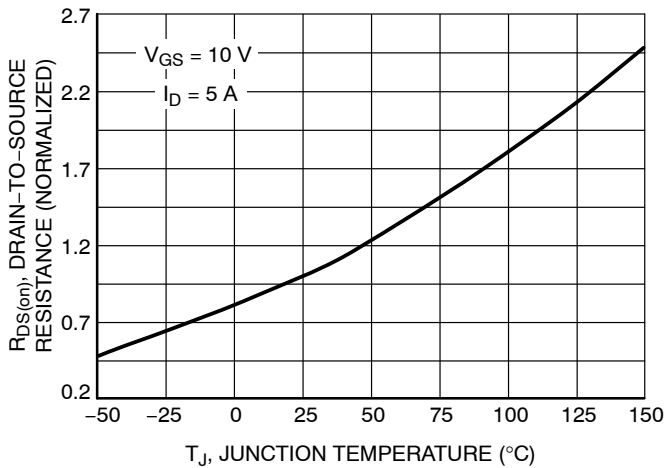


Figure 5. On-Resistance Variation with Temperature

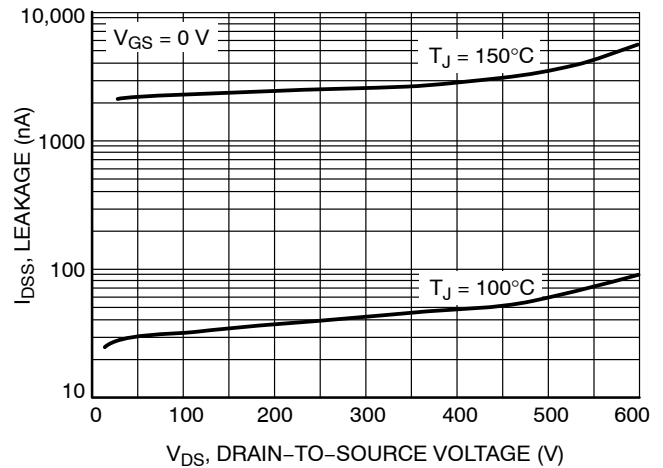


Figure 6. Drain-to-Source Leakage Current vs. Voltage

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TYPICAL CHARACTERISTICS

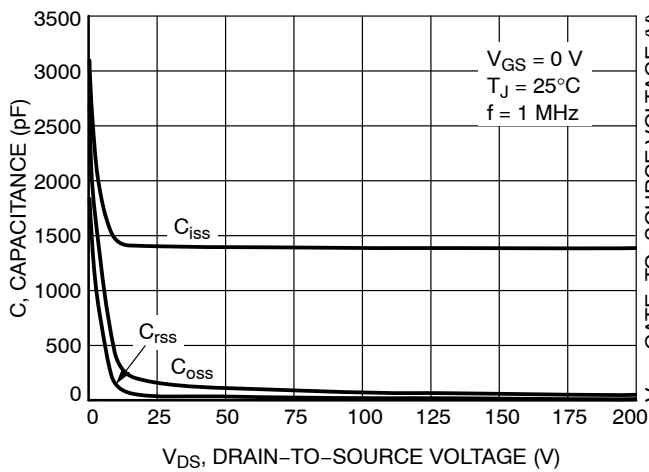


Figure 7. Capacitance Variation

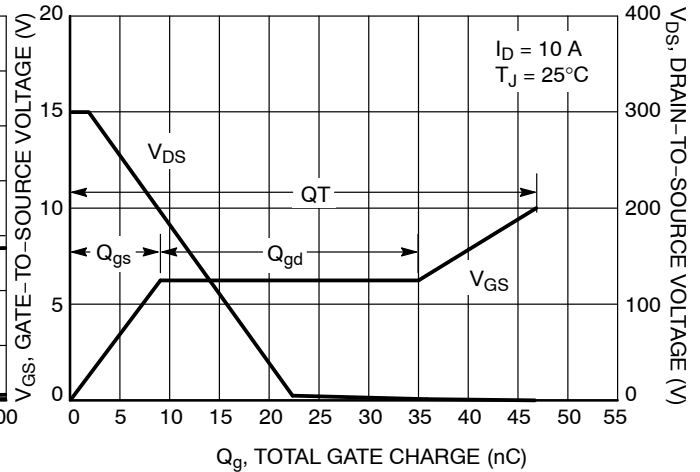


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

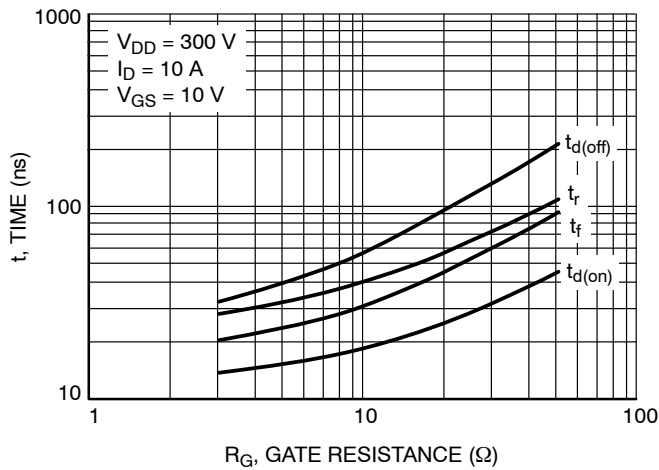


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

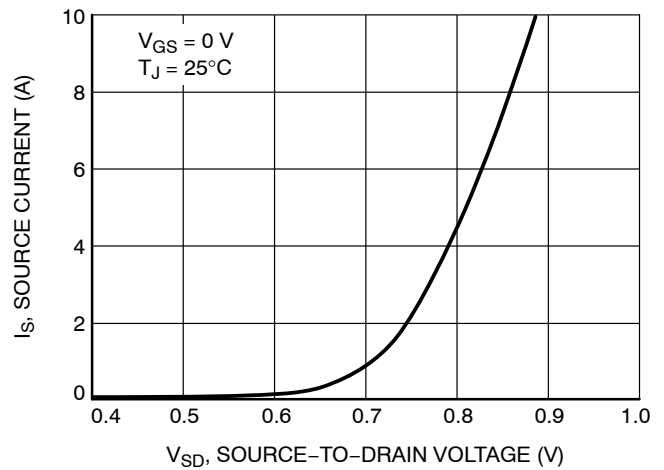


Figure 10. Diode Source Current vs. Forward Voltage

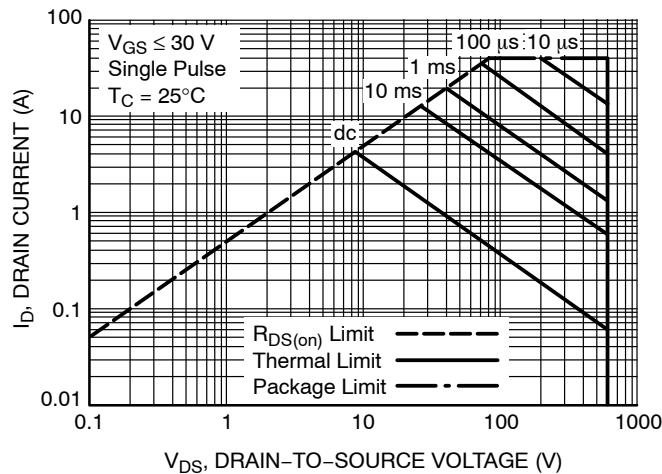


Figure 11. Maximum Rated Forward Biased Safe Operating Area for NDF10N60Z

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TYPICAL CHARACTERISTICS

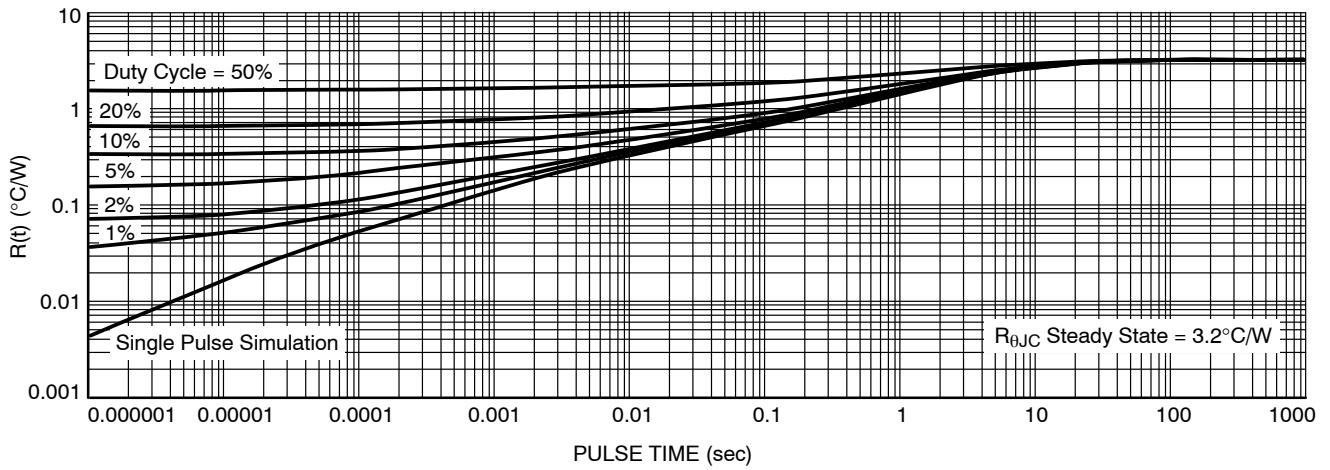


Figure 12. Thermal Impedance for NDF10N60Z

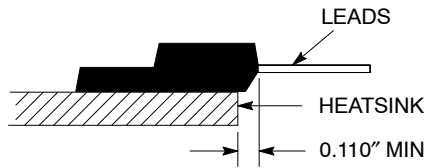


Figure 13. Mounting Position for Isolation Test

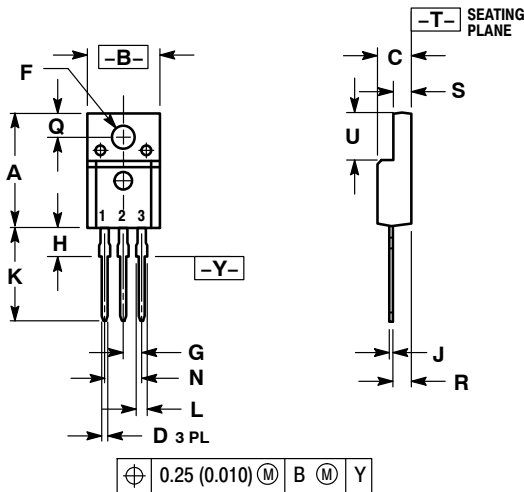
Measurement made between leads and heatsink with all leads shorted together.

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

NDF10N60Z, NDP10N60Z

PACKAGE DIMENSIONS

TO-220FP CASE 221D-03 ISSUE K

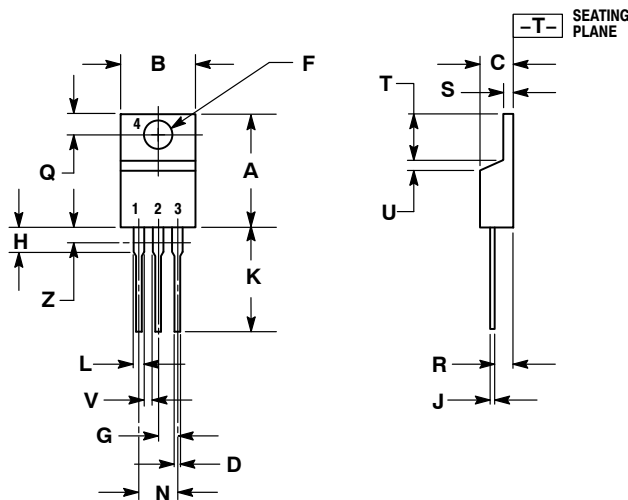


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH
 3. 221D-01 THRU 221D-02 OBSOLETE, NEW STANDARD 221D-03.

| 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
 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.

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|-------|-------------|-------|
| | 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

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