

# NDF11N50Z, NDP11N50Z

## N-Channel Power MOSFET 500 V, 0.52 $\Omega$

### Features

- Low ON Resistance
- Low Gate Charge
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

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

| Rating                                                                                                          | Symbol         | NDF11N50Z     | NDP11N50Z | Unit             |
|-----------------------------------------------------------------------------------------------------------------|----------------|---------------|-----------|------------------|
| Drain-to-Source Voltage                                                                                         | $V_{DS}$       | 500           |           | V                |
| Continuous Drain Current, $R_{\theta JC}$                                                                       | $I_D$          | 10.5 (Note 2) | 10.5      | A                |
| Continuous Drain Current<br>$T_A = 100^\circ\text{C}$ , $R_{\theta JC}$                                         | $I_D$          | 6.7 (Note 2)  | 6.7       | A                |
| Pulsed Drain Current,<br>$V_{GS} @ 10\text{ V}$                                                                 | $I_{DM}$       | 42 (Note 2)   | 42        | A                |
| Power Dissipation, $R_{\theta JC}$<br>(Note 1)                                                                  | $P_D$          | 36            | 145       | W                |
| Gate-to-Source Voltage                                                                                          | $V_{GS}$       | $\pm 30$      |           | V                |
| Single Pulse Avalanche<br>Energy, $I_D = 10.5\text{ A}$                                                         | $E_{AS}$       | 190           |           | mJ               |
| ESD (HBM)<br>(JESD22-A114)                                                                                      | $V_{esd}$      | 4000          |           | V                |
| RMS Isolation Voltage<br>( $t = 0.3\text{ sec.}$ , R.H. $\leq 30\%$ ,<br>$T_A = 25^\circ\text{C}$ ) (Figure 14) | $V_{ISO}$      | 4500          |           | V                |
| Peak Diode Recovery                                                                                             | $dv/dt$        | 4.5 (Note 3)  |           | V/ns             |
| Continuous Source Current<br>(Body Diode)                                                                       | $I_S$          | 10.5          |           | A                |
| Maximum Temperature for<br>Soldering Leads                                                                      | $T_L$          | 260           |           | $^\circ\text{C}$ |
| Operating Junction and<br>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.

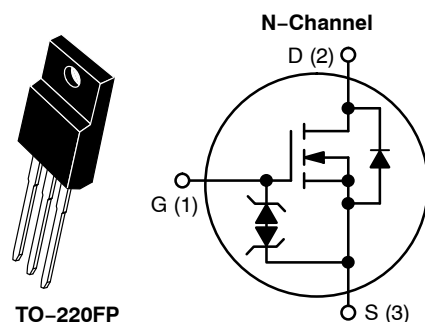
1. Surface mounted on FR4 board using 1" sq. pad size, (Cu area = 1.127 in sq [2 oz] including traces).
2. Limited by maximum junction temperature
3.  $I_d \leq 10.5\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DS}$ ,  $T_J \leq 150^\circ\text{C}$ .



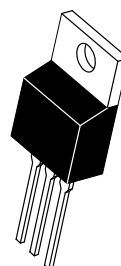
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<http://onsemi.com>

| $V_{DS}$ | $R_{DS(ON)} (MAX) @ 4.5\text{ A}$ |
|----------|-----------------------------------|
| 500 V    | 0.52 $\Omega$                     |

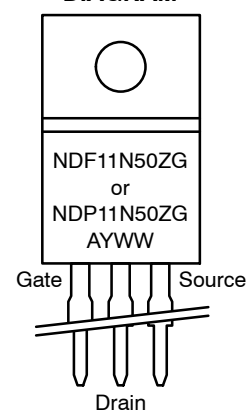


TO-220FP  
CASE 221D  
STYLE 1



TO-220  
CASE 221A  
STYLE 5

### MARKING DIAGRAM



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

### ORDERING INFORMATION

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

# NDF11N50Z, NDP11N50Z

## THERMAL RESISTANCE

| Parameter                                 | Symbol          | NDF11N50Z | NDP11N50Z | Unit |
|-------------------------------------------|-----------------|-----------|-----------|------|
| Junction-to-Case (Drain)                  | $R_{\theta JC}$ | 3.4       | 0.9       | °C/W |
| Junction-to-Ambient Steady State (Note 4) | $R_{\theta JA}$ | 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         | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$                 | $BV_{DSS}$                   | 500 |     |          | V             |
| Breakdown Voltage Temperature Coefficient | Reference to $25^\circ\text{C}$ ,<br>$I_D = 1\text{ mA}$ | $\Delta BV_{DSS}/\Delta T_J$ |     | 0.6 |          | V/°C          |
| Drain-to-Source Leakage Current           | $V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$             | $I_{DSS}$                    |     |     | 1        | $\mu\text{A}$ |
|                                           |                                                          |                              |     |     | 50       |               |
| Gate-to-Source Forward Leakage            | $V_{GS} = \pm 20\text{ V}$                               | $I_{GSS}$                    |     |     | $\pm 10$ | $\mu\text{A}$ |

### ON CHARACTERISTICS (Note 5)

|                                      |                                                 |              |     |      |      |          |
|--------------------------------------|-------------------------------------------------|--------------|-----|------|------|----------|
| Static Drain-to-Source On-Resistance | $V_{GS} = 10\text{ V}, I_D = 4.5\text{ A}$      | $R_{DS(on)}$ |     | 0.48 | 0.52 | $\Omega$ |
| Gate Threshold Voltage               | $V_{DS} = V_{GS}, I_D = 100\text{ }\mu\text{A}$ | $V_{GS(th)}$ | 3.0 |      | 4.5  | V        |
| Forward Transconductance             | $V_{DS} = 15\text{ V}, I_D = 4.5\text{ A}$      | $g_{FS}$     |     | 7.7  |      | S        |

### DYNAMIC CHARACTERISTICS

|                                 |                                                                         |           |  |      |  |          |
|---------------------------------|-------------------------------------------------------------------------|-----------|--|------|--|----------|
| Input Capacitance               | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$    | $C_{iss}$ |  | 1375 |  | pF       |
| Output Capacitance              |                                                                         | $C_{oss}$ |  | 166  |  |          |
| Reverse Transfer Capacitance    |                                                                         | $C_{rss}$ |  | 40   |  |          |
| Total Gate Charge               | $V_{DD} = 250\text{ V}, I_D = 10.5\text{ A},$<br>$V_{GS} = 10\text{ V}$ | $Q_g$     |  | 46   |  | nC       |
| Gate-to-Source Charge           |                                                                         | $Q_{gs}$  |  | 8.7  |  |          |
| Gate-to-Drain ("Miller") Charge |                                                                         | $Q_{gd}$  |  | 25   |  |          |
| Plateau Voltage                 |                                                                         | $V_{GP}$  |  | 6.2  |  | V        |
| Gate Resistance                 |                                                                         | $R_g$     |  | 1.4  |  | $\Omega$ |

### RESISTIVE SWITCHING CHARACTERISTICS

|                     |                                                                                                |              |  |    |  |    |
|---------------------|------------------------------------------------------------------------------------------------|--------------|--|----|--|----|
| Turn-On Delay Time  | $V_{DD} = 250\text{ V}, I_D = 10.5\text{ A},$<br>$V_{GS} = 10\text{ V}, R_G = 5\text{ }\Omega$ | $t_{d(on)}$  |  | 15 |  | ns |
| Rise Time           |                                                                                                | $t_r$        |  | 32 |  |    |
| 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   | $I_S = 10.5\text{ A}, V_{GS} = 0\text{ V}$                                                             | $V_{SD}$ |  |     | 1.6 | V             |
| Reverse Recovery Time   | $V_{GS} = 0\text{ V}, V_{DD} = 30\text{ V}$<br>$I_S = 10.5\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$ | $t_{rr}$ |  | 310 |     | ns            |
| Reverse Recovery Charge |                                                                                                        | $Q_{rr}$ |  | 2.5 |     | $\mu\text{C}$ |

4. Insertion mounted

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

# NDF11N50Z, NDP11N50Z

## TYPICAL CHARACTERISTICS

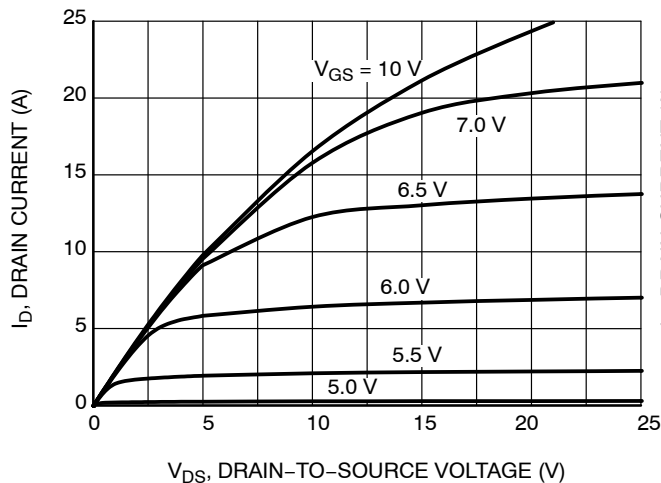


Figure 1. On-Region Characteristics

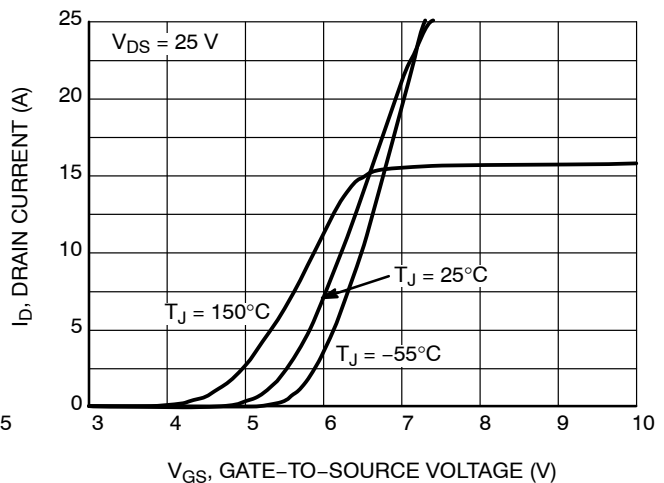


Figure 2. Transfer Characteristics

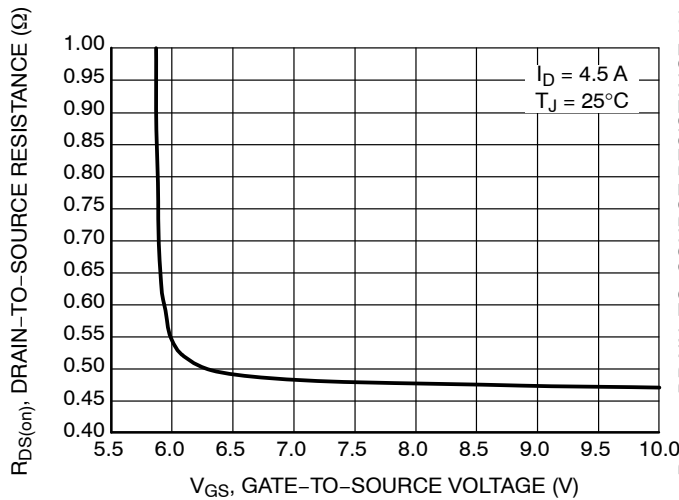


Figure 3. On-Region versus Gate-to-Source Voltage

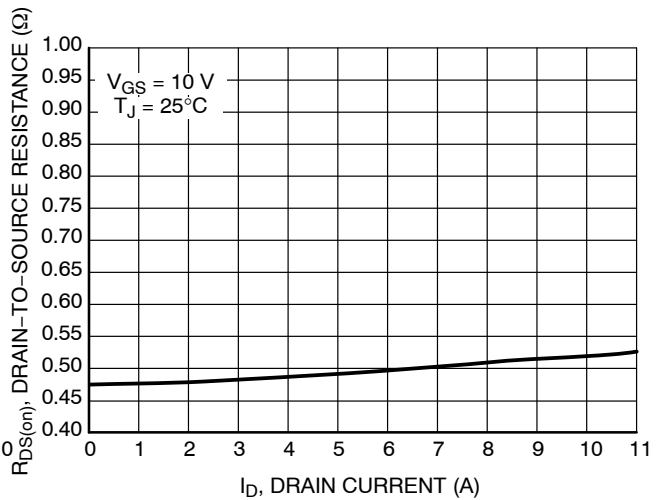


Figure 4. On-Resistance versus Drain Current and Gate Voltage

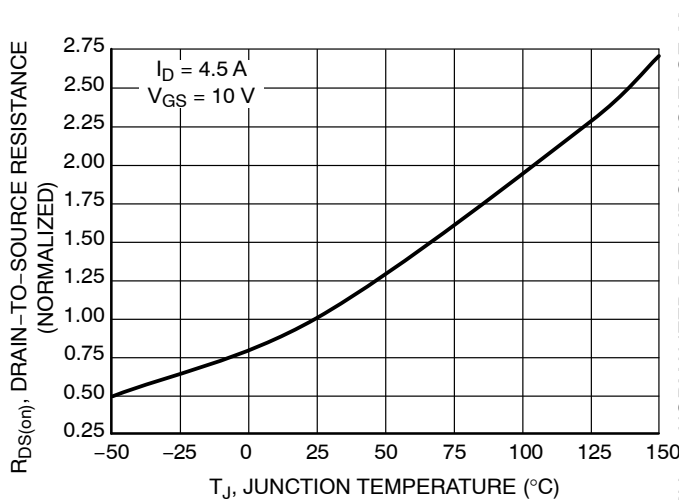


Figure 5. On-Resistance Variation with Temperature

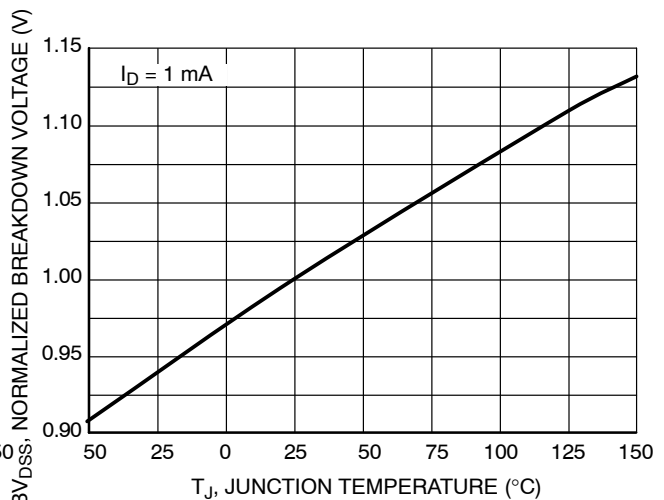
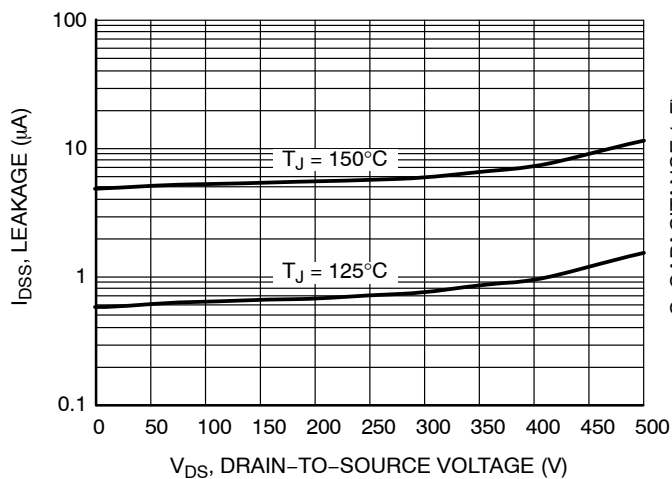


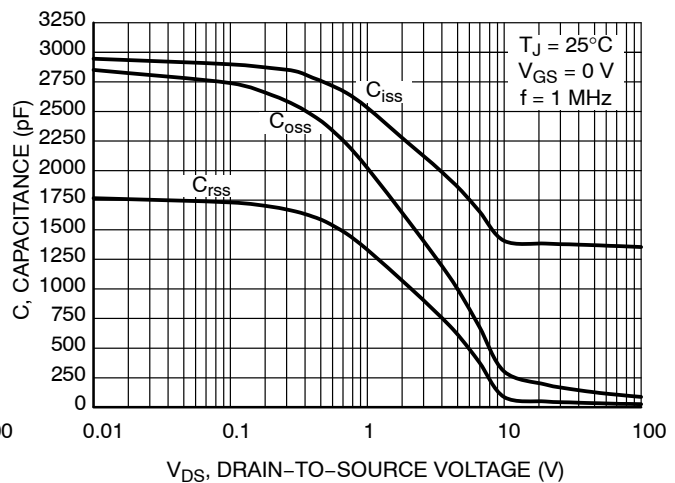
Figure 6.  $BV_{DSS}$  Variation with Temperature

# NDF11N50Z, NDP11N50Z

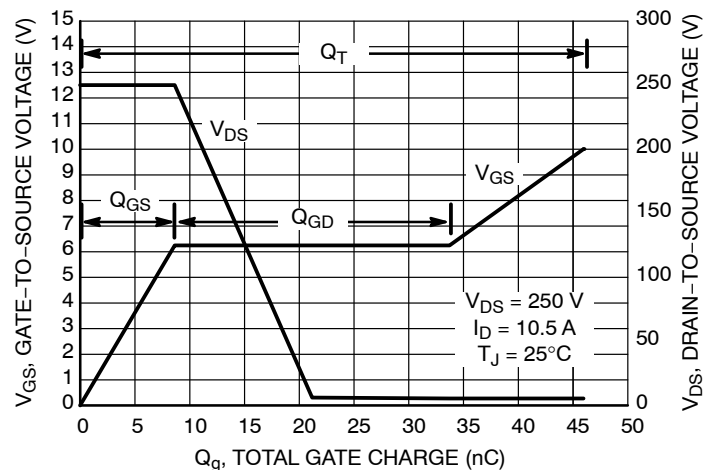
## TYPICAL CHARACTERISTICS



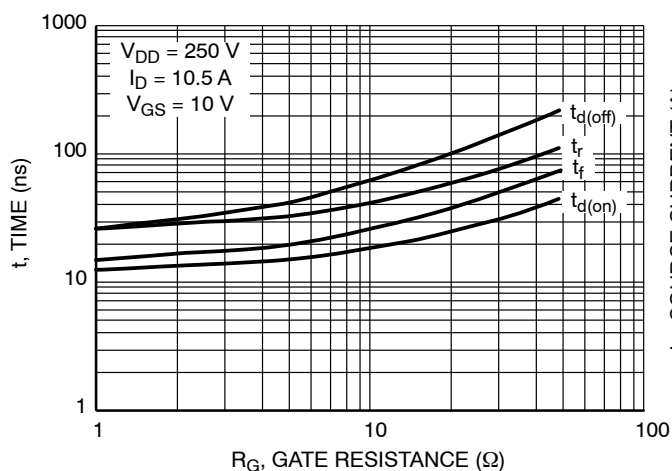
**Figure 7. Drain-to-Source Leakage Current versus Voltage**



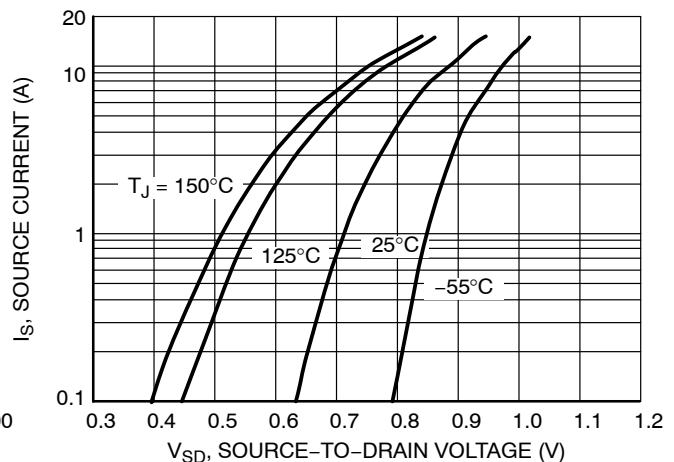
**Figure 8. Capacitance Variation**



**Figure 9. Gate-to-Source Voltage and Drain-to-Source Voltage versus Total Charge**



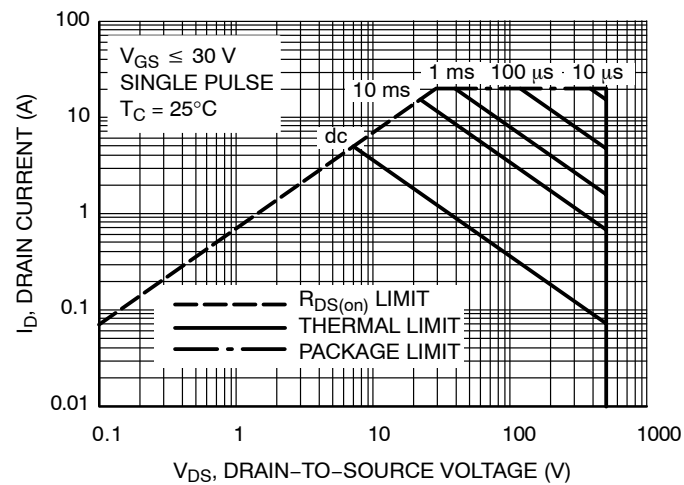
**Figure 10. Resistive Switching Time Variation versus Gate Resistance**



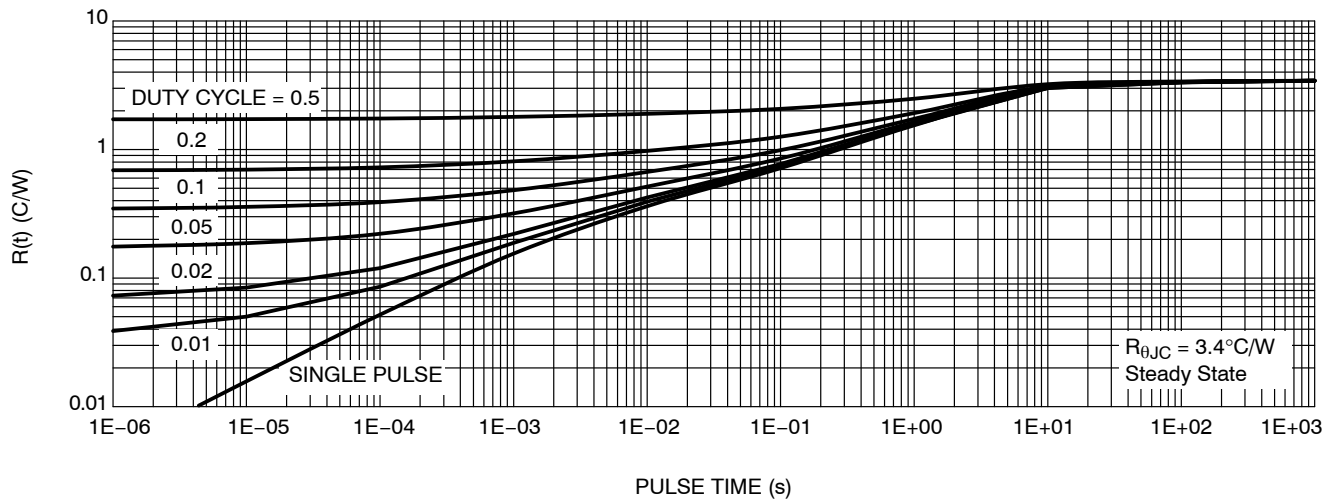
**Figure 11. Diode Forward Voltage versus Current**

# NDF11N50Z, NDP11N50Z

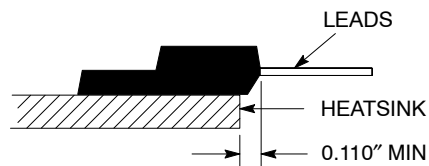
## TYPICAL CHARACTERISTICS



**Figure 12. Maximum Rated Forward Biased Safe Operating Area NDF11N50Z**



**Figure 13. Thermal Impedance (Junction-to-Case) for NDF11N50Z**



**Figure 14. Isolation Test Diagram**

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.

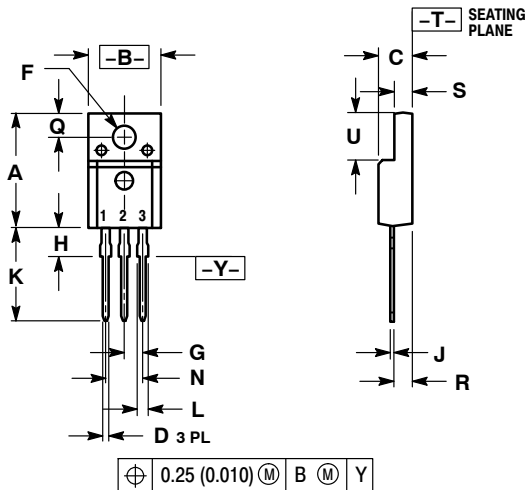
**NDF11N50Z, NDP11N50Z****ORDERING INFORMATION**

| <b>Order Number</b> | <b>Package</b>        | <b>Shipping</b>                     |
|---------------------|-----------------------|-------------------------------------|
| NDF11N50ZG          | TO-220FP<br>(Pb-Free) | 50 Units / Rail                     |
| NDP11N50ZG          | TO-220AB<br>(Pb-Free) | 50 Units / Rail<br>(In Development) |

# NDF11N50Z, NDP11N50Z

## PACKAGE DIMENSIONS

### TO-220FP CASE 221D-03 ISSUE K



#### NOTES:

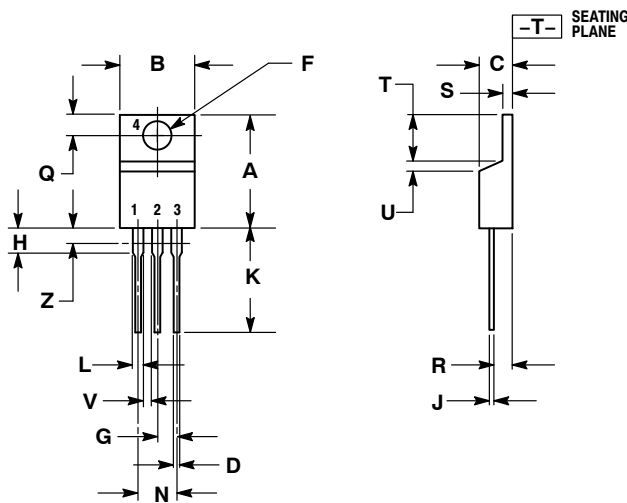
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. 221D-01 THRU 221D-02 OBSOLETE, NEW STANDARD 221D-03.

| 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
- DRAIN
- SOURCE

### TO-220 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.

| 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
- DRAIN
- SOURCE
- DRAIN

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