

# NDF05N50Z, NDP05N50Z, NDD05N50Z

## N-Channel Power MOSFET 500 V, 1.25 $\Omega$

### 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             | NDF             | NDP | NDD | Unit             |
|---|--------------------|-----------------|-----|-----|------------------|
| Drain-to-Source Voltage   | $V_{DSS}$          | 500             |     |     | V                |
| Continuous Drain Current $R_{\theta JC}$  | $I_D$              | 5<br>(Note 1)   | 5   | 4.7 | A                |
| Continuous Drain Current $R_{\theta JC}$ , $T_A = 100^\circ\text{C}$                                      | $I_D$              | 3.2<br>(Note 1) | 3.2 | 3   | A                |
| Pulsed Drain Current, $V_{GS} @ 10\text{ V}$  | $I_{DM}$           | 20<br>(Note 1)  | 20  | 19  | A                |
| Power Dissipation $R_{\theta JC}$   | $P_D$              | 28              | 96  | 83  | W                |
| Gate-to-Source Voltage  | $V_{GS}$           | $\pm 30$        |     |     | V                |
| Single Pulse Avalanche Energy, $I_D = 5.0\text{ A}$   | $E_{AS}$           | 130             |     |     | mJ               |
| ESD (HBM) (JESD22-A114)   | $V_{esd}$          | 3000            |     |     | V                |
| RMS Isolation Voltage ( $t = 0.3\text{ sec.}$ , R.H. $\leq 30\%$ , $T_A = 25^\circ\text{C}$ ) (Figure 15) | $V_{ISO}$          | 4500            |     |     | V                |
| Peak Diode Recovery   | $dv/dt$            | 4.5 (Note 2)    |     |     | V/ns             |
| Continuous Source Current (Body Diode)  | $I_S$              | 5               |     |     | A                |
| Maximum Temperature for Soldering Leads, 0.063" (1.6 mm) from Case for 10 s Package Body for 10 s         | $T_L$<br>$T_{PKG}$ | 300<br>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.

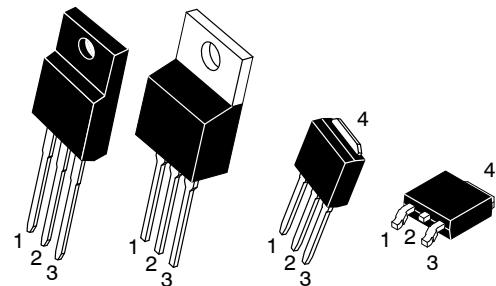
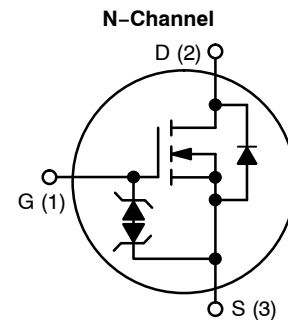
1. Limited by maximum junction temperature
2.  $I_S = 4.4\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ ,  $T_J = +150^\circ\text{C}$



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| $V_{DSS}$ | $R_{DS(on)}$ (TYP) @ 2.2 A |
|-----------|----------------------------|
| 500 V     | 1.25 $\Omega$              |



TO-220FP TO-220AB IPAK DPAK  
CASE 221D CASE 221A CASE 369D CASE 369AA  
STYLE 1 STYLE 5 STYLE 2 STYLE 2

### MARKING AND ORDERING INFORMATION

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

# NDF05N50Z, NDP05N50Z, NDD05N50Z

## THERMAL RESISTANCE

| Parameter                        | Symbol          | Value                | Unit |
|----------------------------------|-----------------|----------------------|------|
| Junction-to-Case (Drain)         | $R_{\theta JC}$ | NDP05N50Z            | 1.3  |
|                                  |                 | NDF05N50Z            | 4.4  |
|                                  |                 | NDD05N50Z            | 1.5  |
| Junction-to-Ambient Steady State | $R_{\theta JA}$ | (Note 3) NDP05N50Z   | 50   |
|                                  |                 | (Note 3) NDF05N50Z   | 50   |
|                                  |                 | (Note 4) NDD05N50Z   | 38   |
|                                  |                 | (Note 3) NDD05N50Z-1 | 80   |

3. Insertion mounted

4. Surface mounted on FR4 board using 1" sq. pad size, (Cu area = 1.127 in sq [2 oz] including traces).

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

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

### OFF CHARACTERISTICS

|   |                                |  |                      |     |          |                    |
|---|--------------------------------|--|----------------------|-----|----------|--------------------|
| Drain-to-Source Breakdown Voltage         | $BV_{DSS}$                     | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$                 | 500                  |     |          | V                  |
| Breakdown Voltage Temperature Coefficient | $\Delta BV_{DSS} / \Delta T_J$ | Reference to $25^\circ\text{C}$ ,<br>$I_D = 1\text{ mA}$ |                      | 0.6 |          | $V/^\circ\text{C}$ |
| Drain-to-Source Leakage Current           | $I_{DSS}$                      | $V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$             | 25 $^\circ\text{C}$  |     | 1        | $\mu\text{A}$      |
|   |                                |  | 150 $^\circ\text{C}$ |     | 50       |                    |
| Gate-to-Source Forward Leakage            | $I_{GSS}$                      | $V_{GS} = \pm 20\text{ V}$                               |                      |     | $\pm 10$ | $\mu\text{A}$      |

### ON CHARACTERISTICS (Note 5)

|                                      |              |  |     |      |     |          |
|--------------------------------------|--------------|--|-----|------|-----|----------|
| Static Drain-to-Source On-Resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}, I_D = 2.2\text{ A}$ |     | 1.25 | 1.5 | $\Omega$ |
| Gate Threshold Voltage               | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 50\ \mu\text{A}$   | 3.0 |      | 4.5 | V        |
| Forward Transconductance             | $g_{FS}$     | $V_{DS} = 15\text{ V}, I_D = 2.5\text{ A}$ |     | 3.5  |     | S        |

### DYNAMIC CHARACTERISTICS

|                                 |           |  |  |      |  |             |
|---------------------------------|-----------|--|--|------|--|-------------|
| Input Capacitance               | $C_{iss}$ | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ |  | 530  |  | $\text{pF}$ |
| Output Capacitance              | $C_{oss}$ |  |  | 68   |  |             |
| Reverse Transfer Capacitance    | $C_{rss}$ |  |  | 15   |  |             |
| Total Gate Charge               | $Q_g$     | $V_{DD} = 250\text{ V}, I_D = 5\text{ A},$<br>$V_{GS} = 10\text{ V}$ |  | 18.5 |  | $\text{nC}$ |
| Gate-to-Source Charge           | $Q_{gs}$  |  |  | 4    |  |             |
| Gate-to-Drain ("Miller") Charge | $Q_{gd}$  |  |  | 10   |  |             |
| Plateau Voltage                 | $V_{GP}$  |  |  | 6.5  |  |             |
| Gate Resistance                 | $R_g$     |  |  | 4.5  |  | $\Omega$    |

### RESISTIVE SWITCHING CHARACTERISTICS

|                     |              |   |  |    |  |             |
|---------------------|--------------|---|--|----|--|-------------|
| Turn-On Delay Time  | $t_{d(on)}$  | $V_{DD} = 250\text{ V}, I_D = 5\text{ A},$<br>$V_{GS} = 10\text{ V}, R_G = 5\ \Omega$ |  | 11 |  | $\text{ns}$ |
| Rise Time           | $t_r$        |   |  | 15 |  |             |
| Turn-Off Delay Time | $t_{d(off)}$ |   |  | 24 |  |             |
| Fall Time           | $t_f$        |   |  | 14 |  |             |

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

|                         |          |   |  |      |     |               |
|-------------------------|----------|---|--|------|-----|---------------|
| Diode Forward Voltage   | $V_{SD}$ | $I_S = 5\text{ A}, V_{GS} = 0\text{ V}$   |  |      | 1.6 | V             |
| Reverse Recovery Time   | $t_{rr}$ | $V_{GS} = 0\text{ V}, V_{DD} = 30\text{ V}$<br>$I_S = 5\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$ |  | 255  |     | ns            |
| Reverse Recovery Charge | $Q_{rr}$ |   |  | 1.25 |     | $\mu\text{C}$ |

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

TYPICAL CHARACTERISTICS

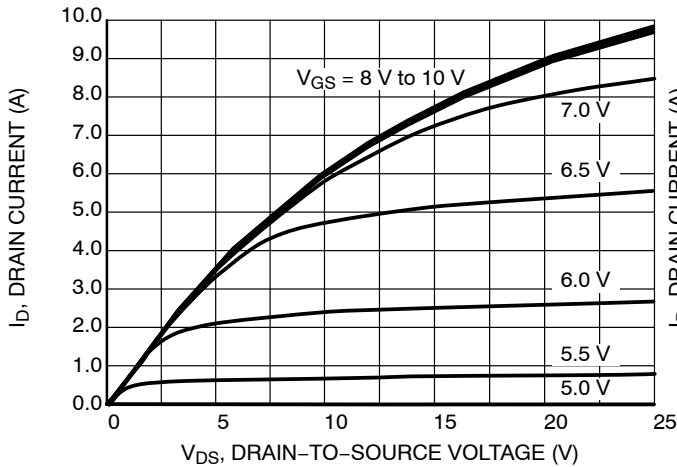


Figure 1. On-Region Characteristics

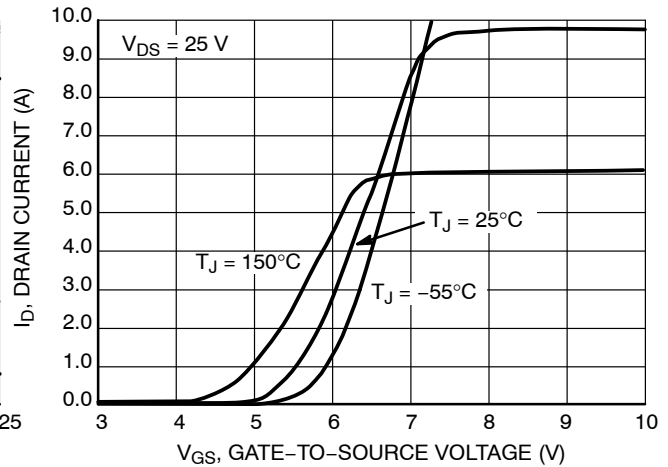


Figure 2. Transfer Characteristics

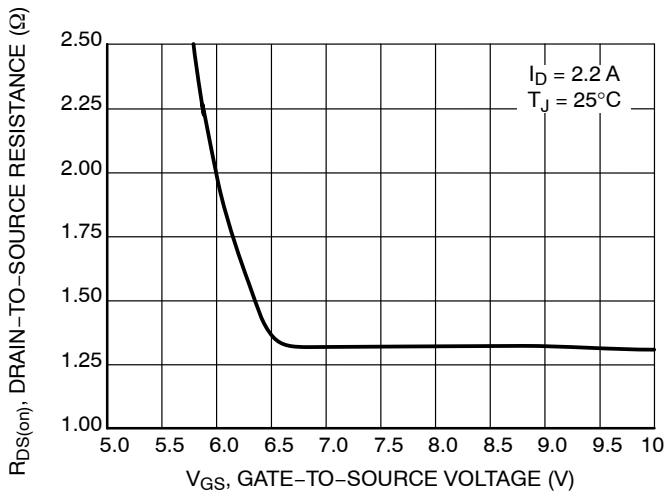


Figure 3. On-Region versus Gate-to-Source Voltage

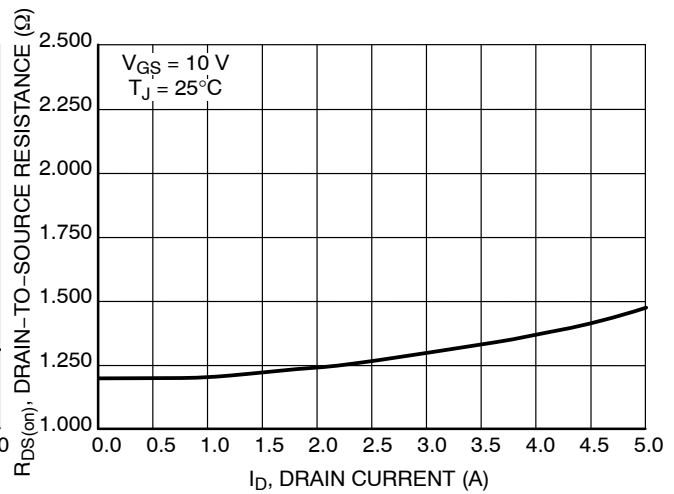


Figure 4. On-Resistance versus Drain Current and Gate Voltage

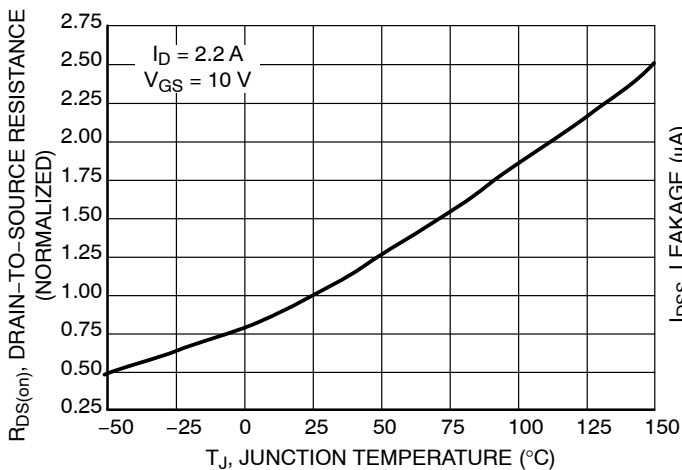


Figure 5. On-Resistance Variation with Temperature

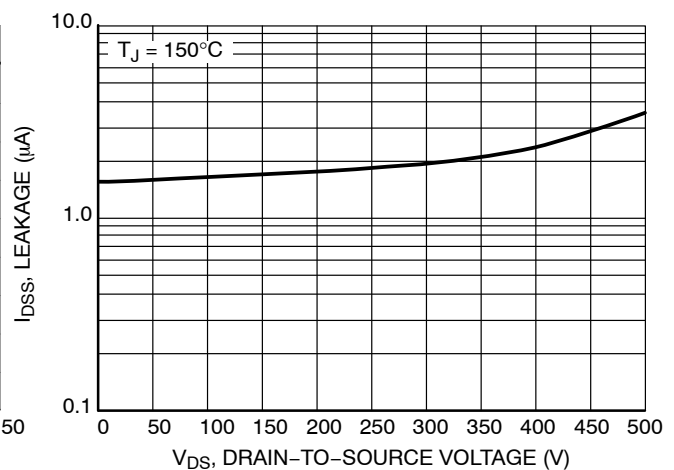


Figure 6. Drain-to-Source Leakage Current versus Voltage

# NDF05N50Z, NDP05N50Z, NDD05N50Z

## TYPICAL CHARACTERISTICS

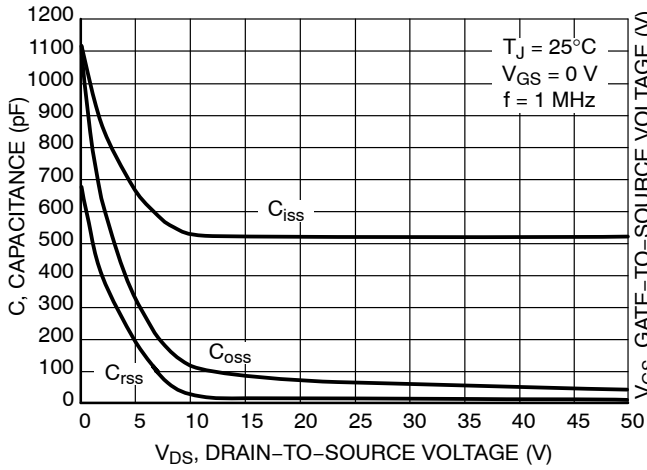


Figure 7. Capacitance Variation

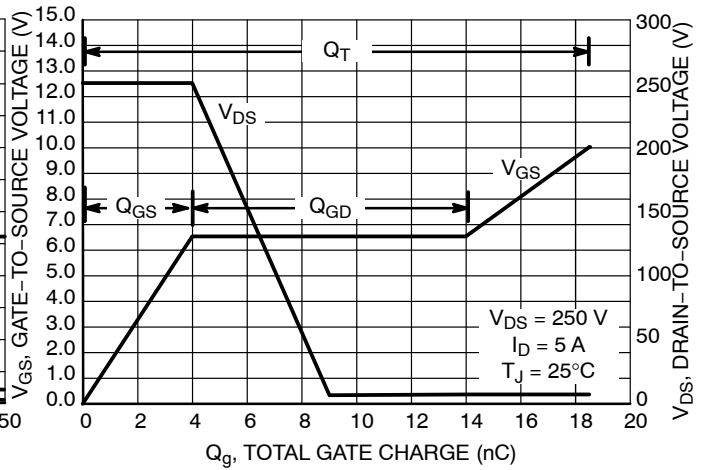


Figure 8. Gate-to-Source Voltage and Drain-to-Source Voltage versus Total Charge

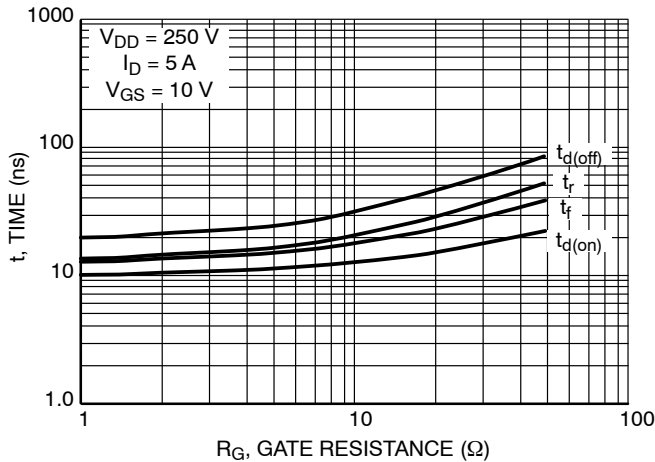


Figure 9. Resistive Switching Time Variation versus Gate Resistance

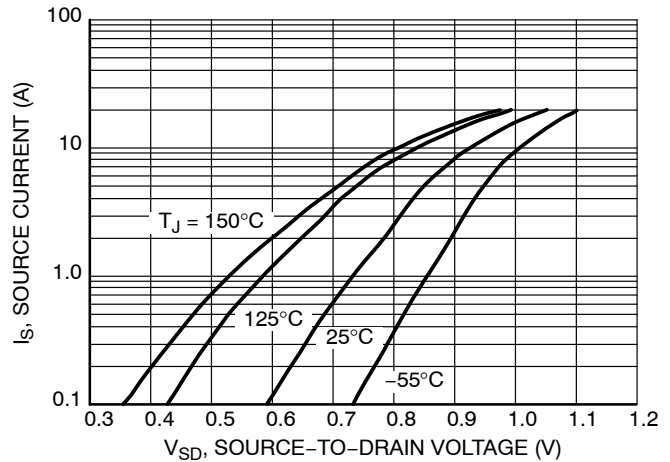


Figure 10. Diode Forward Voltage versus Current

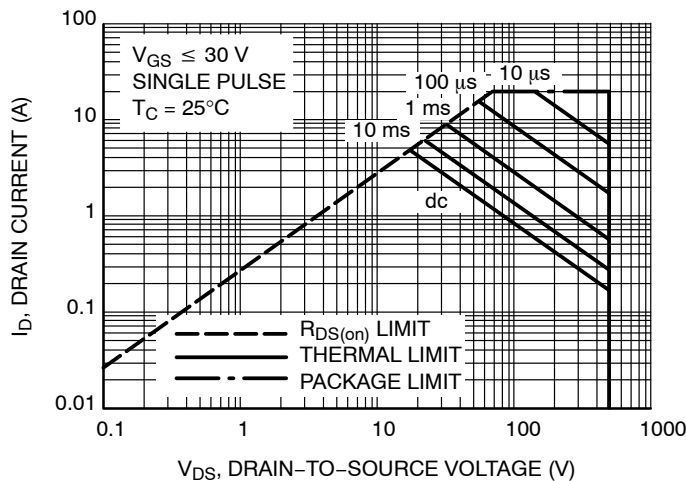


Figure 11. Maximum Rated Forward Biased Safe Operating Area NDD05N50Z

# NDF05N50Z, NDP05N50Z, NDD05N50Z

## TYPICAL CHARACTERISTICS

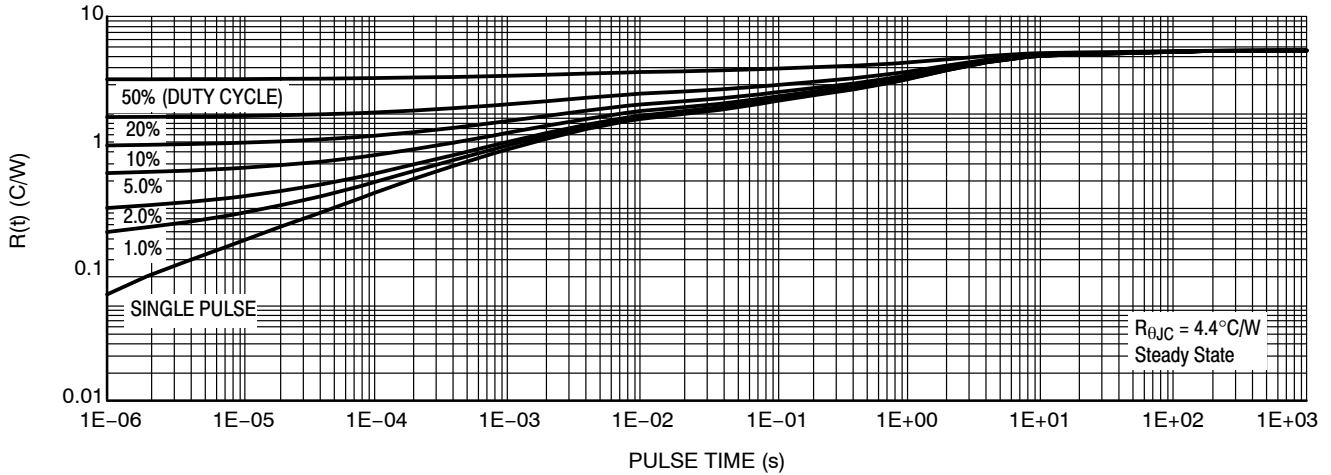


Figure 12. Thermal Impedance (Junction-to-Case) for NDF05N50Z

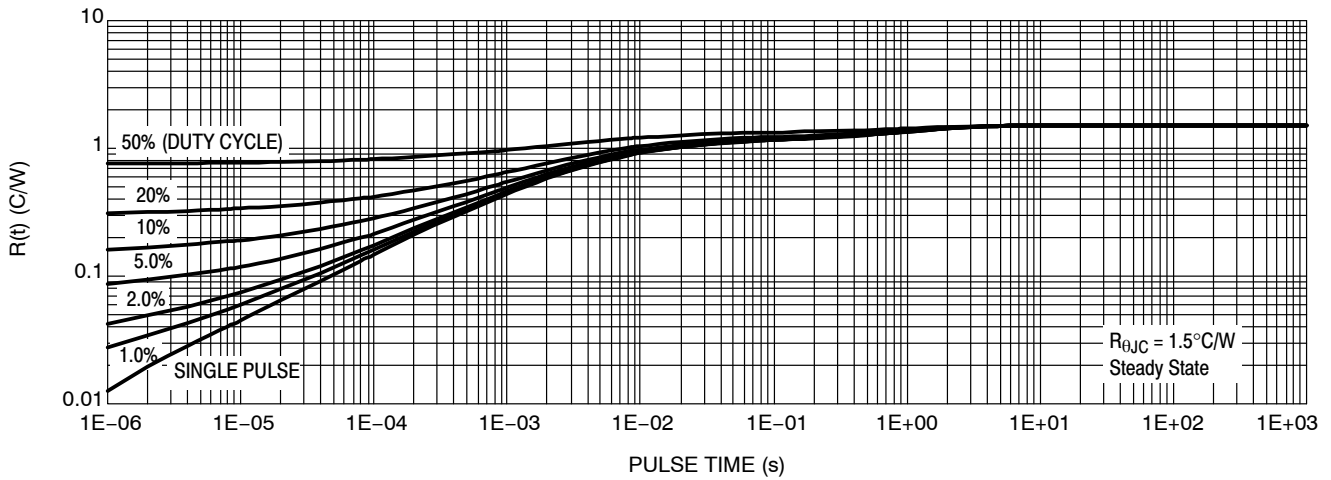


Figure 13. Thermal Impedance (Junction-to-Case) for NDD05N50Z

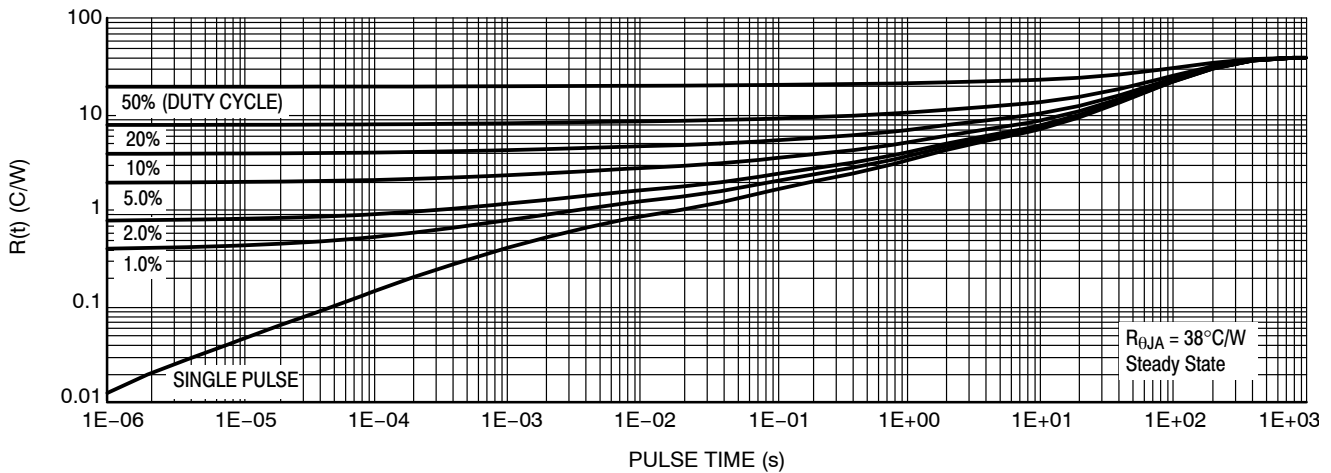
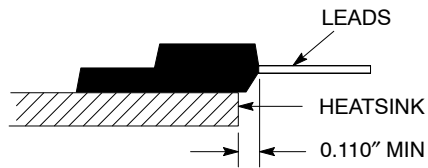


Figure 14. Thermal Impedance (Junction-to-Ambient) for NDD05N50Z

# NDF05N50Z, NDP05N50Z, NDD05N50Z



**Figure 15. Mounting Position for Isolation Test**

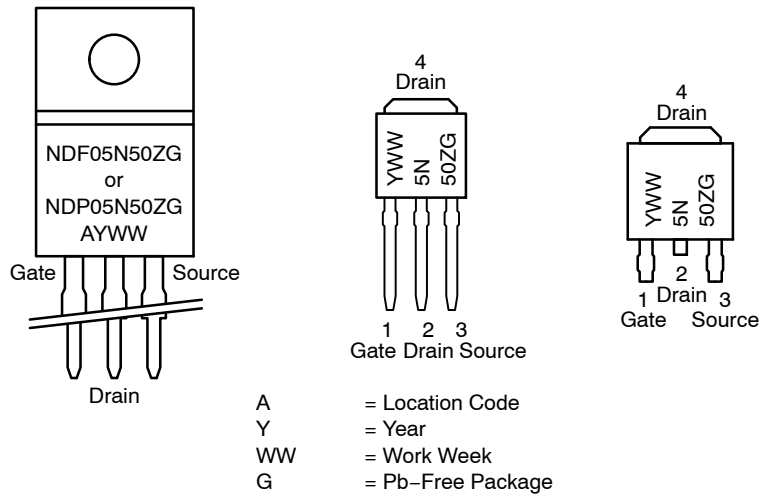
Measurement made between leads and heatsink with all leads shorted together.

## ORDERING INFORMATION

| Order Number | Package               | Shipping <sup>†</sup>               |
|--------------|-----------------------|-------------------------------------|
| NDF05N50ZG   | TO-220FP<br>(Pb-Free) | 50 Units / Rail<br>(In Development) |
| NDP05N50ZG   | TO-220AB<br>(Pb-Free) | 50 Units / Rail<br>(In Development) |
| NDD05N50Z-1G | IPAK<br>(Pb-Free)     | 75 Units / Rail                     |
| NDD05N50ZT4G | DPAK<br>(Pb-Free)     | 2500 / Tape & Reel                  |

<sup>†</sup>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.

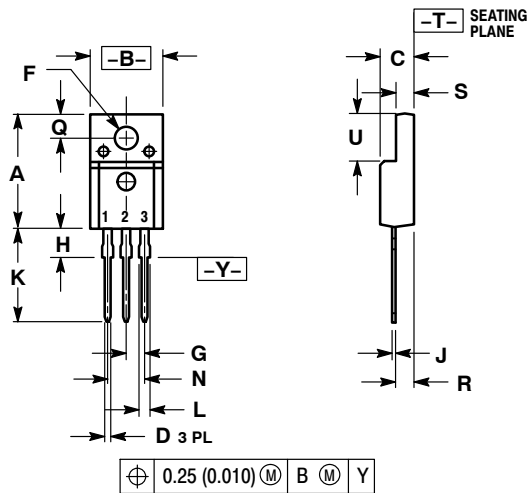
## MARKING DIAGRAMS



# NDF05N50Z, NDP05N50Z, NDD05N50Z

## PACKAGE DIMENSIONS

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

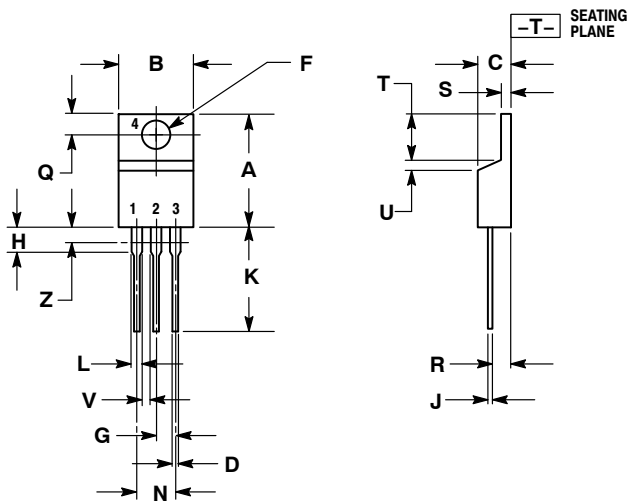


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH
  3. 221D-01 THRU 221D-02 OBSOLETE, NEW STANDARD 221D-03.

| 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:
1. GATE
  2. DRAIN
  3. 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.

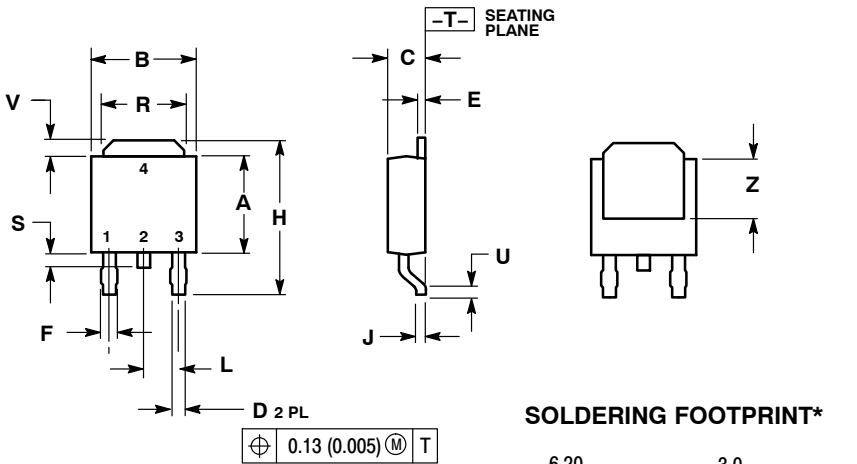
| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.570  | 0.620 | 14.48       | 15.75 |
| B   | 0.380  | 0.405 | 9.66        | 10.28 |
| C   | 0.160  | 0.190 | 4.07        | 4.82  |
| D   | 0.025  | 0.035 | 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:
1. GATE
  2. DRAIN
  3. SOURCE
  4. DRAIN

# NDF05N50Z, NDP05N50Z, NDD05N50Z

## PACKAGE DIMENSIONS

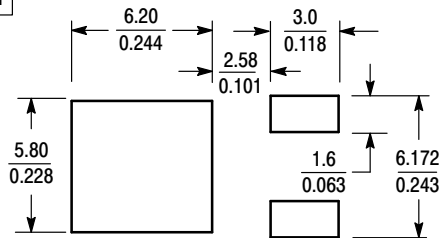
### DPAK CASE 369AA-01 ISSUE A



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.235     | 0.245 | 5.97        | 6.22  |
| B   | 0.250     | 0.265 | 6.35        | 6.73  |
| C   | 0.086     | 0.094 | 2.19        | 2.38  |
| D   | 0.025     | 0.035 | 0.63        | 0.89  |
| E   | 0.018     | 0.024 | 0.46        | 0.61  |
| F   | 0.030     | 0.045 | 0.77        | 1.14  |
| H   | 0.386     | 0.410 | 9.80        | 10.40 |
| J   | 0.018     | 0.023 | 0.46        | 0.58  |
| L   | 0.090 BSC |       | 2.29 BSC    |       |
| R   | 0.180     | 0.215 | 4.57        | 5.45  |
| S   | 0.024     | 0.040 | 0.60        | 1.01  |
| U   | 0.020     | ---   | 0.51        | ---   |
| V   | 0.035     | 0.050 | 0.89        | 1.27  |
| Z   | 0.155     | ---   | 3.93        | ---   |

### SOLDERING FOOTPRINT\*

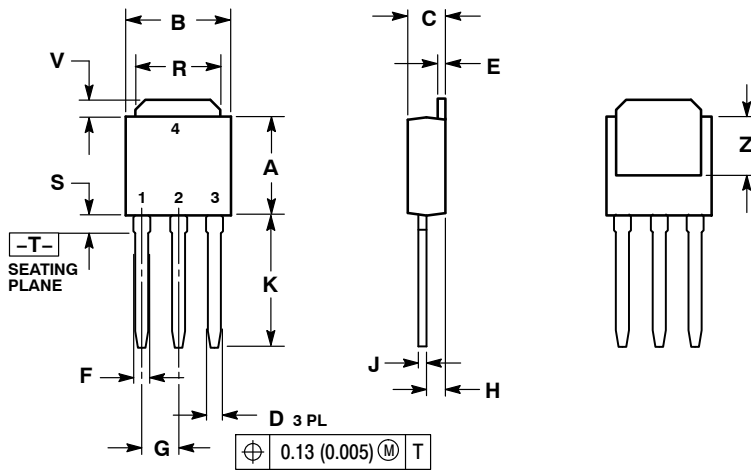


- STYLE 2:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN

SCALE 3:1  $\left(\frac{\text{mm}}{\text{inches}}\right)$

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

### IPAK CASE 369D-01 ISSUE B



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES    |       | MILLIMETERS |      |
|-----|-----------|-------|-------------|------|
|     | MIN       | MAX   | MIN         | MAX  |
| A   | 0.235     | 0.245 | 5.97        | 6.35 |
| B   | 0.250     | 0.265 | 6.35        | 6.73 |
| C   | 0.086     | 0.094 | 2.19        | 2.38 |
| D   | 0.027     | 0.035 | 0.69        | 0.88 |
| E   | 0.018     | 0.023 | 0.46        | 0.58 |
| F   | 0.037     | 0.045 | 0.94        | 1.14 |
| G   | 0.090 BSC |       | 2.29 BSC    |      |
| H   | 0.034     | 0.040 | 0.87        | 1.01 |
| J   | 0.018     | 0.023 | 0.46        | 0.58 |
| K   | 0.350     | 0.380 | 8.89        | 9.65 |
| R   | 0.180     | 0.215 | 4.45        | 5.45 |
| S   | 0.025     | 0.040 | 0.63        | 1.01 |
| V   | 0.035     | 0.050 | 0.89        | 1.27 |
| Z   | 0.155     | ---   | 3.93        | ---  |

- STYLE 2:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN



# NDF05N50Z, NDP05N50Z, NDD05N50Z

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