

# NDP04N50Z, NDD04N50Z

## N-Channel Power MOSFET 500 V, 2.7 Ω

### Features

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

### ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25°C unless otherwise noted)

| Rating   | Symbol                            | NDP          | NDD | Unit |
|--|-----------------------------------|--------------|-----|------|
| Drain-to-Source Voltage  | V <sub>DSS</sub>                  | 500          |     | V    |
| Continuous Drain Current R <sub>θJC</sub>                          | I <sub>D</sub>                    | 3.4          | 3.0 | A    |
| Continuous Drain Current R <sub>θJC</sub> ; T <sub>A</sub> = 100°C | I <sub>D</sub>                    | 2.1          | 1.9 | A    |
| Pulsed Drain Current, V <sub>GS</sub> @ 10 V                       | I <sub>DM</sub>                   | 14           | 12  | A    |
| Power Dissipation R <sub>θJC</sub>                                 | P <sub>D</sub>                    | 75           | 61  | W    |
| Gate-to-Source Voltage   | V <sub>GS</sub>                   | ±30          |     | V    |
| Single Pulse Avalanche Energy, I <sub>D</sub> = 3.4 A              | E <sub>AS</sub>                   | 120          |     | mJ   |
| ESD (HBM) (JESD22-A114)  | V <sub>esd</sub>                  | 2800         |     | V    |
| Peak Diode Recovery  | dv/dt                             | 4.5 (Note 1) |     | V/ns |
| Continuous Source Current (Body Diode)                             | I <sub>S</sub>                    | 3.4          |     | A    |
| Maximum Temperature for Soldering Leads                            | T <sub>L</sub>                    | 260          |     | °C   |
| Operating Junction and Storage Temperature Range                   | T <sub>J</sub> , T <sub>stg</sub> | -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.

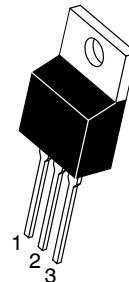
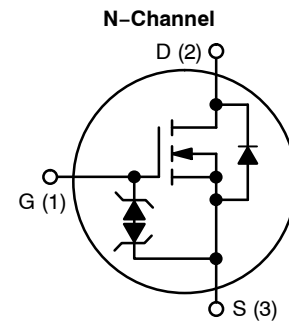
1. I<sub>D</sub> ≤ 3.4 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, T<sub>J</sub> ≤ 150°C.



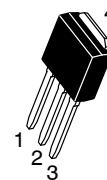
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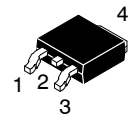
| V <sub>DSS</sub> | R <sub>DS(on)</sub> (MAX) @ 1.5 A |
|------------------|-----------------------------------|
| 500 V            | 2.7 Ω                             |



TO-220AB  
CASE 221A  
STYLE 5



IPAK  
CASE 369D  
STYLE 2



DPAK  
CASE 369AA  
STYLE 2

### MARKING AND ORDERING INFORMATION

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

# NDP04N50Z, NDD04N50Z

## THERMAL RESISTANCE

| Parameter                        | Symbol          | Value  | Unit           |
|----------------------------------|-----------------|--|----------------|
| Junction-to-Case (Drain)         | $R_{\theta JC}$ | NDP04N50Z<br>NDD04N50Z   | 1.6<br>2.0     |
| Junction-to-Ambient Steady State |                 | (Note 2) NDP04N50Z<br>(Note 3) NDD04N50Z<br>(Note 2) NDD04N50Z-1 | 51<br>40<br>80 |

2. Insertion mounted

3. 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 4)

|                                      |              |  |     |     |     |          |
|--------------------------------------|--------------|--|-----|-----|-----|----------|
| Static Drain-to-Source On-Resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}, I_D = 1.5\text{ A}$     |     | 2.3 | 2.7 | $\Omega$ |
| Gate Threshold Voltage               | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 50\text{ }\mu\text{A}$ | 3.0 |     | 4.5 | V        |
| Forward Transconductance             | $g_{FS}$     | $V_{DS} = 15\text{ V}, I_D = 1.5\text{ A}$     |     | 2.1 |     | S        |

### DYNAMIC CHARACTERISTICS

|                                 |           |  |  |     |  |          |
|---------------------------------|-----------|--|--|-----|--|----------|
| Input Capacitance               | $C_{iss}$ | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$   |  | 308 |  | pF       |
| Output Capacitance              | $C_{oss}$ |  |  | 43  |  |          |
| Reverse Transfer Capacitance    | $C_{rss}$ |  |  | 9   |  |          |
| Total Gate Charge               | $Q_g$     | $V_{DD} = 250\text{ V}, I_D = 3.4\text{ A},$<br>$V_{GS} = 10\text{ V}$ |  | 12  |  | nC       |
| Gate-to-Source Charge           | $Q_{gs}$  |  |  | 2.6 |  |          |
| Gate-to-Drain ("Miller") Charge | $Q_{gd}$  |  |  | 6.1 |  |          |
| Plateau Voltage                 | $V_{GP}$  |  |  | 6.6 |  |          |
| Gate Resistance                 | $R_g$     |  |  | 5.4 |  | $\Omega$ |

### RESISTIVE SWITCHING CHARACTERISTICS

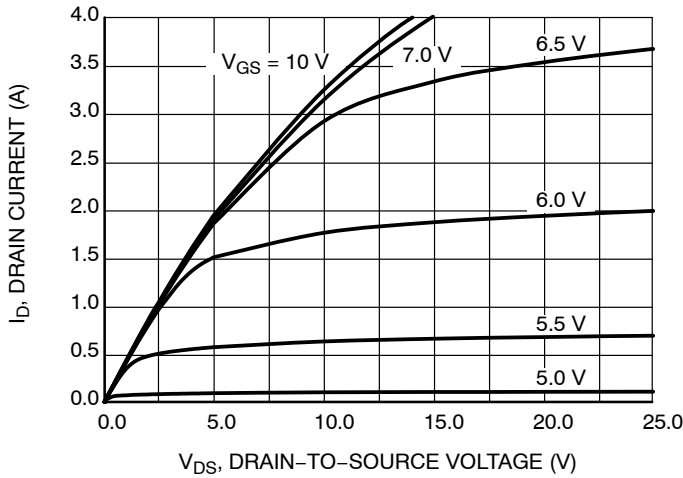
|                     |              |   |  |    |  |    |
|---------------------|--------------|---|--|----|--|----|
| Turn-On Delay Time  | $t_{d(on)}$  | $V_{DD} = 250\text{ V}, I_D = 3.4\text{ A},$<br>$V_{GS} = 10\text{ V}, R_G = 5\text{ }\Omega$ |  | 9  |  | ns |
| Rise Time           | $t_r$        |   |  | 9  |  |    |
| Turn-Off Delay Time | $t_{d(off)}$ |   |  | 16 |  |    |
| Fall Time           | $t_f$        |   |  | 10 |  |    |

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

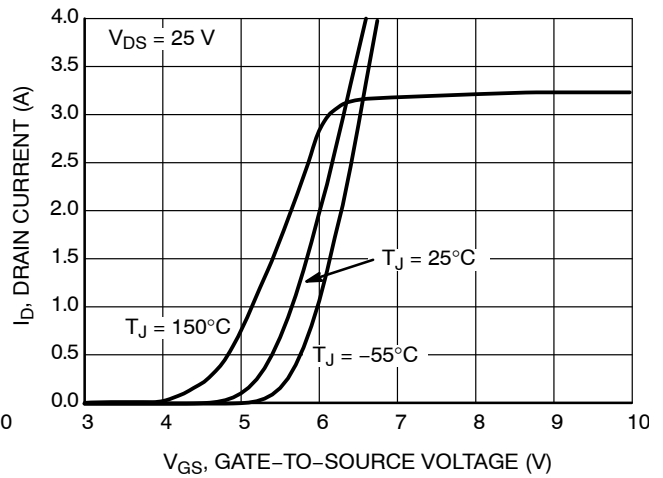
|                         |          |   |  |     |     |               |
|-------------------------|----------|---|--|-----|-----|---------------|
| Diode Forward Voltage   | $V_{SD}$ | $I_S = 3.4\text{ A}, V_{GS} = 0\text{ V}$   |  |     | 1.6 | V             |
| Reverse Recovery Time   | $t_{rr}$ | $V_{GS} = 0\text{ V}, V_{DD} = 30\text{ V}$<br>$I_S = 3.4\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$ |  | 240 |     | ns            |
| Reverse Recovery Charge | $Q_{rr}$ |   |  | 0.9 |     | $\mu\text{C}$ |

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

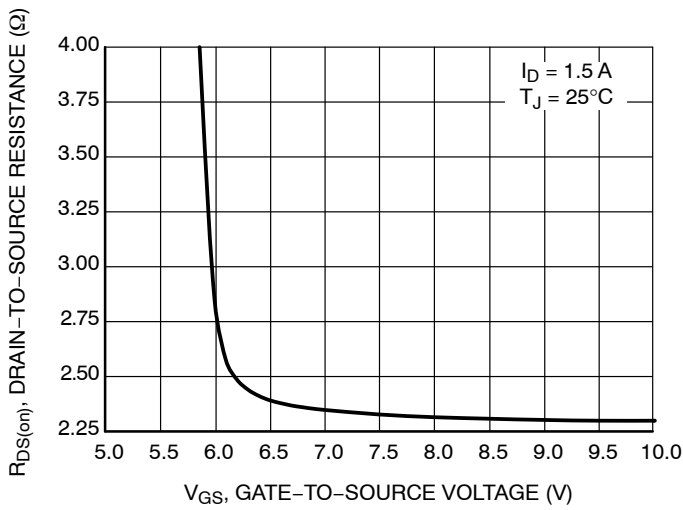
# NDP04N50Z, NDD04N50Z



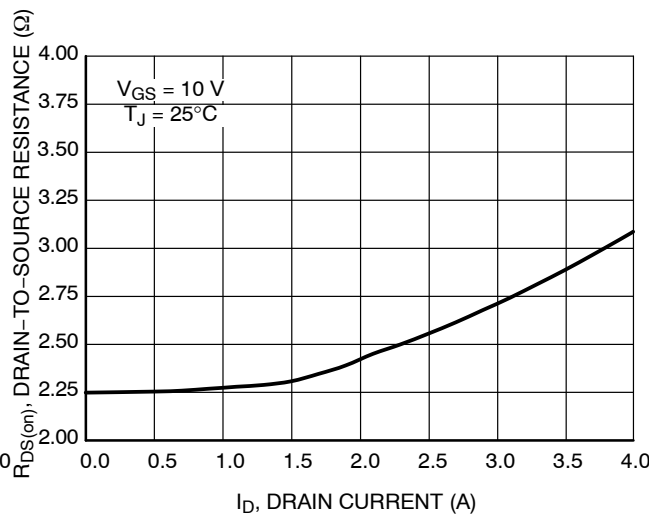
**Figure 1. On-Region Characteristics**



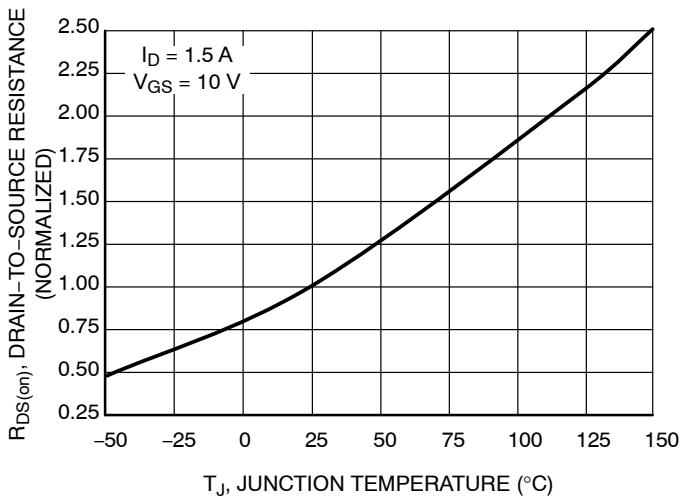
**Figure 2. Transfer Characteristics**



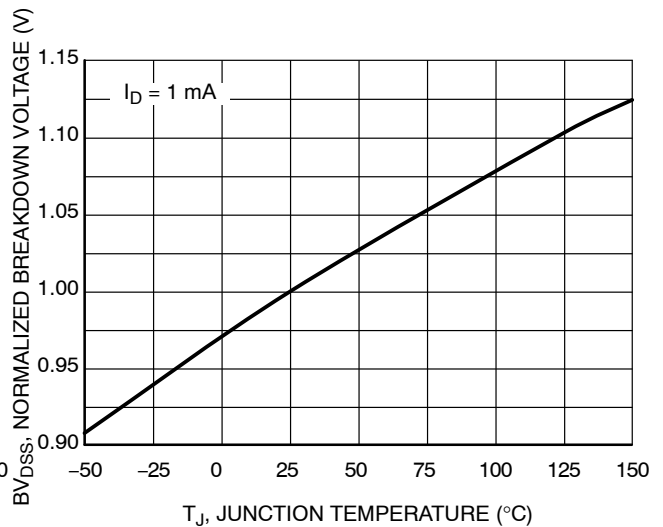
**Figure 3. On-Region versus Gate-to-Source Voltage**



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

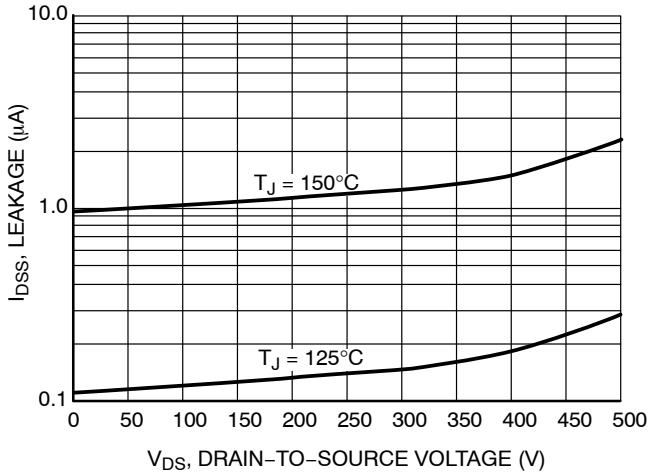


**Figure 5. On-Resistance Variation with Temperature**

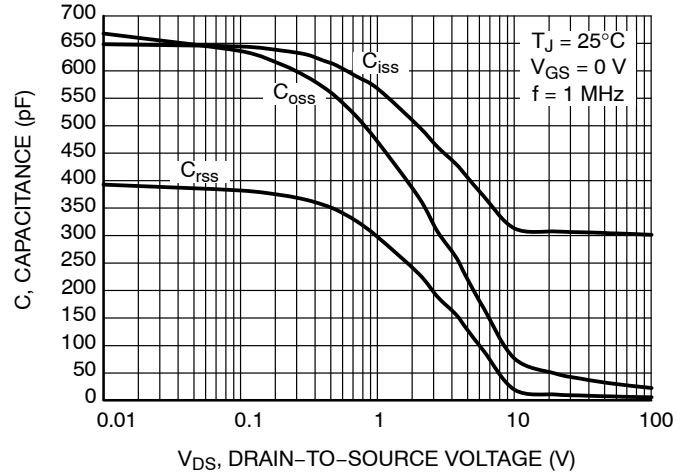


**Figure 6. BV<sub>DSS</sub> Variation with Temperature**

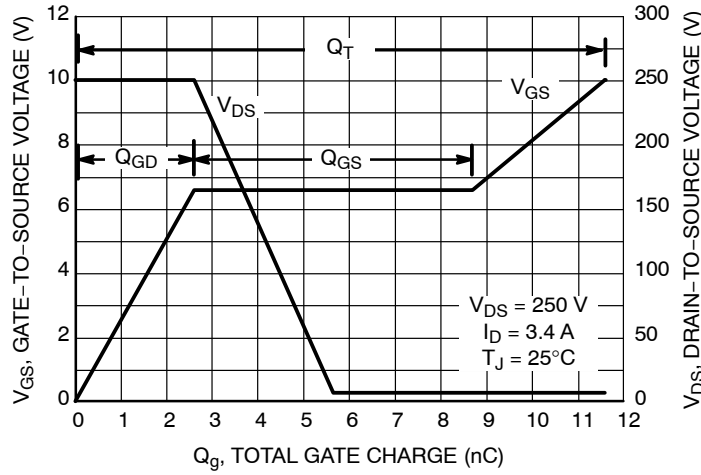
# NDP04N50Z, NDD04N50Z



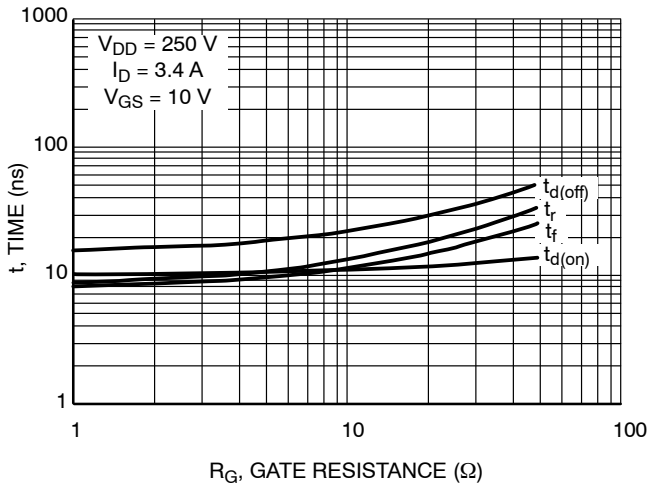
**Figure 7. Drain-to-Source Leakage Current versus Voltage**



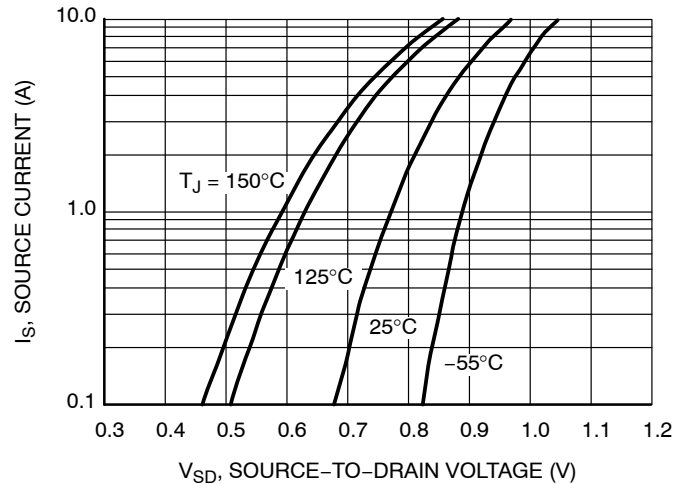
**Figure 8. Capacitance Variation**



**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**

# NDP04N50Z, NDD04N50Z

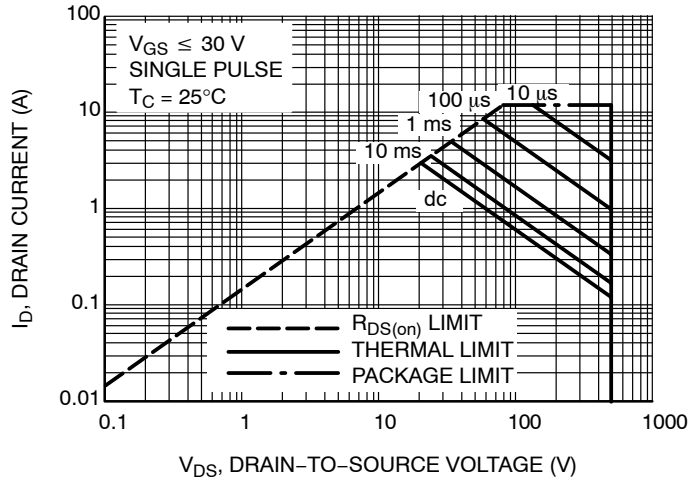


Figure 12. Maximum Rated Forward Biased Safe Operating Area NDD04N50Z

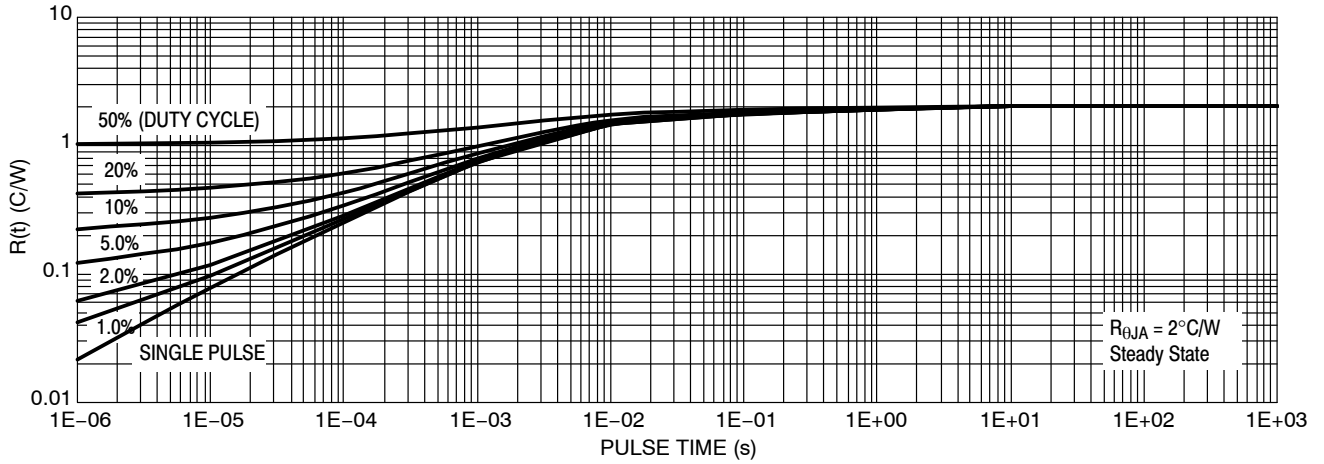


Figure 13. Thermal Impedance (Junction-to-Case) for NDD04N50Z

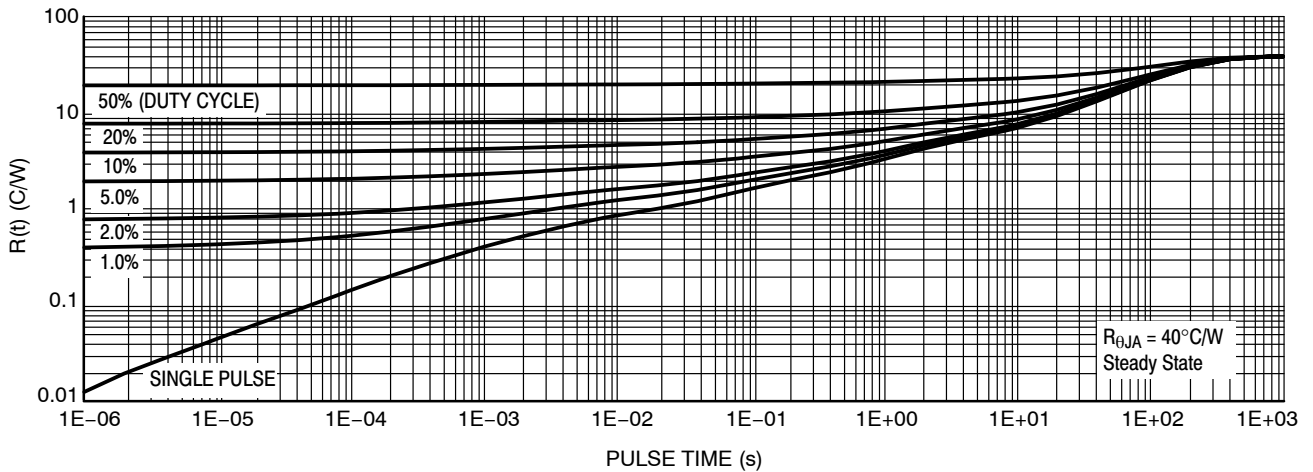


Figure 14. Thermal Impedance (Junction-to-Ambient) for NDD04N50Z

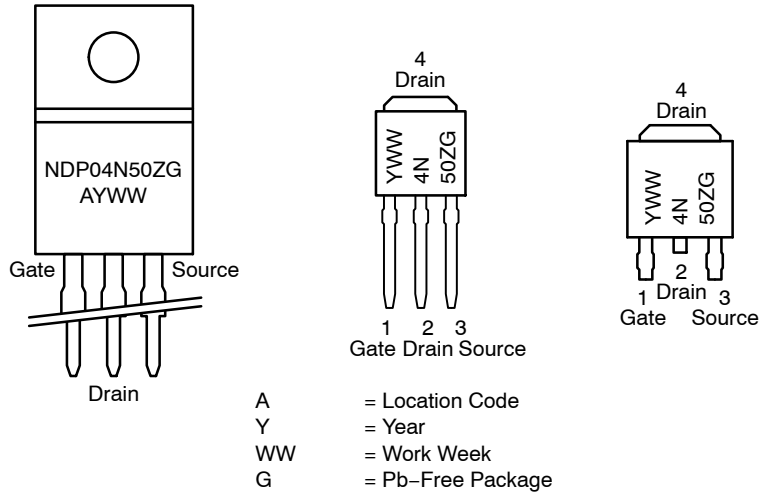
# NDP04N50Z, NDD04N50Z

## ORDERING INFORMATION

| Order Number | Package               | Shipping†                           |
|--------------|-----------------------|-------------------------------------|
| NDP04N50ZG   | TO-220AB<br>(Pb-Free) | 50 Units / Rail<br>(In Development) |
| NDD04N50Z-1G | IPAK<br>(Pb-Free)     | 75 Units / Rail                     |
| NDD04N50ZT4G | DPAK<br>(Pb-Free)     | 2500 / Tape & Reel                  |

†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.

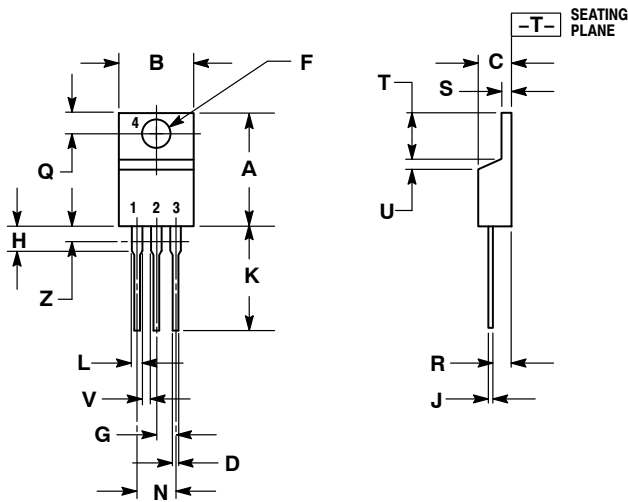
## MARKING DIAGRAMS



# NDP04N50Z, NDD04N50Z

## PACKAGE DIMENSIONS

### 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  |

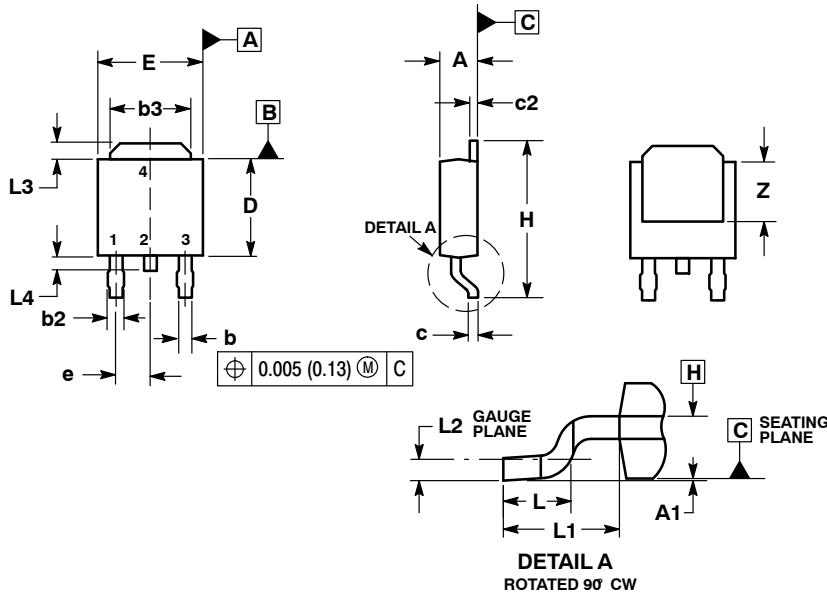
STYLE 5:

1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

# NDP04N50Z, NDD04N50Z

## PACKAGE DIMENSIONS

### DPAK (SINGLE GUAGE) CASE 369AA-01 ISSUE B

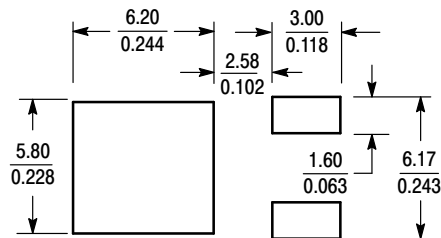


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.086  | 0.094 | 2.18        | 2.38  |
| A1  | 0.000  | 0.005 | 0.00        | 0.13  |
| b   | 0.025  | 0.035 | 0.63        | 0.89  |
| b2  | 0.030  | 0.045 | 0.76        | 1.14  |
| b3  | 0.180  | 0.215 | 4.57        | 5.46  |
| c   | 0.018  | 0.024 | 0.46        | 0.61  |
| c2  | 0.018  | 0.024 | 0.46        | 0.61  |
| D   | 0.235  | 0.245 | 5.97        | 6.22  |
| E   | 0.250  | 0.265 | 6.35        | 6.73  |
| e   | 0.090  | BSC   | 2.29        | BSC   |
| H   | 0.370  | 0.410 | 9.40        | 10.41 |
| L   | 0.055  | 0.070 | 1.40        | 1.78  |
| L1  | 0.108  | REF   | 2.74        | REF   |
| L2  | 0.020  | BSC   | 0.51        | BSC   |
| L3  | 0.035  | 0.050 | 0.89        | 1.27  |
| L4  | ---    | 0.040 | ---         | 1.01  |
| Z   | 0.155  | ---   | 3.93        | ---   |

### SOLDERING FOOTPRINT\*



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

**STYLE 2:**

- PIN 1. GATE
- DRAIN
- SOURCE
- DRAIN

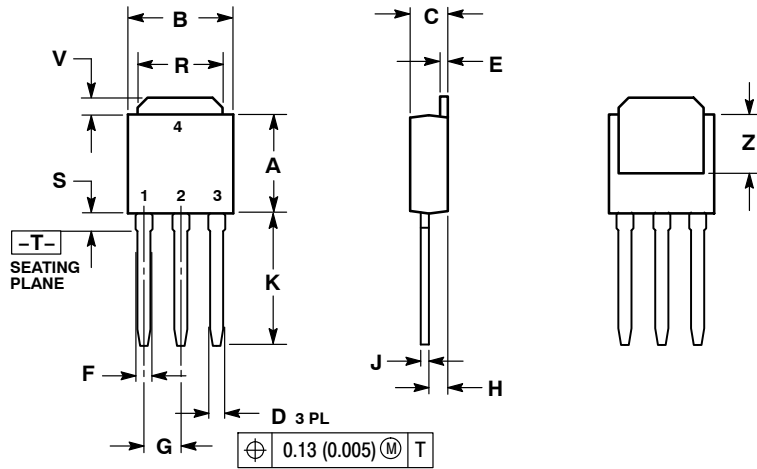
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



# NDP04N50Z, NDD04N50Z

## PACKAGE DIMENSIONS

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

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