

# NTD5414N, NVD5414N

## Power MOSFET

24 A, 60 V Single N-Channel DPAK

### Features

- Low  $R_{DS(on)}$
- High Current Capability
- Avalanche Energy Specified
- NVD Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free and are RoHS Compliant

### Applications

- LED Lighting and LED Backlight Drivers
- DC-DC Converters
- DC Motor Drivers
- Power Supplies Secondary Side Synchronous Rectification

### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ Unless otherwise specified)

| Parameter                                                                                                                                                                                                    |                        |                        | Symbol                            | Value       | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------|-----------------------------------|-------------|------|
| Drain-to-Source Voltage                                                                                                                                                                                      |                        |                        | V <sub>DSS</sub>                  | 60          | V    |
| Gate-to-Source Voltage – Continuous                                                                                                                                                                          |                        |                        | V <sub>GS</sub>                   | ± 20        | V    |
| Gate-to-Source Voltage – Nonrepetitive (T <sub>P</sub> < 10 μs)                                                                                                                                              |                        |                        | V <sub>GS</sub>                   | ± 30        | V    |
| Continuous Drain Current R <sub>θJC</sub> (Note 1)                                                                                                                                                           | Steady State           | T <sub>C</sub> = 25°C  | I <sub>D</sub>                    | 24          | A    |
|                                                                                                                                                                                                              |                        | T <sub>C</sub> = 100°C |                                   | 16          |      |
| Power Dissipation R <sub>θJC</sub> (Note 1)                                                                                                                                                                  | Steady State           | T <sub>C</sub> = 25°C  | P <sub>D</sub>                    | 55          | W    |
| Pulsed Drain Current                                                                                                                                                                                         | t <sub>p</sub> = 10 μs |                        | I <sub>DM</sub>                   | 75          | A    |
| Operating and Storage Temperature Range                                                                                                                                                                      |                        |                        | T <sub>J</sub> , T <sub>stg</sub> | –55 to +175 | °C   |
| Source Current (Body Diode)                                                                                                                                                                                  |                        |                        | I <sub>S</sub>                    | 24          | A    |
| Single Pulse Drain-to-Source Avalanche Energy – Starting T <sub>J</sub> = 25°C (V <sub>DD</sub> = 50 V <sub>dc</sub> , V <sub>GS</sub> = 10 V, I <sub>L(pk)</sub> = 24 A, L = 0.3 mH, R <sub>G</sub> = 25 Ω) |                        |                        | E <sub>AS</sub>                   | 86.4        | mJ   |
| Lead Temperature for Soldering Purposes, 1/8" from Case for 10 Seconds                                                                                                                                       |                        |                        | T <sub>L</sub>                    | 260         | °C   |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL RESISTANCE RATINGS

| Parameter                                      | Symbol          | Max  | Unit               |
|------------------------------------------------|-----------------|------|--------------------|
| Junction-to-Case (Drain) Steady State (Note 1) | $R_{\theta JC}$ | 2.7  | $^\circ\text{C/W}$ |
|                                                | $R_{\theta JA}$ | 58.6 |                    |

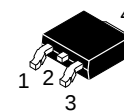
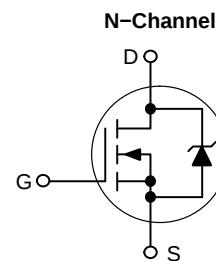
1. Surface mounted on FR4 board using 1 sq in pad size, (Cu Area 1.127 sq in [1 oz] including traces).



ON Semiconductor®

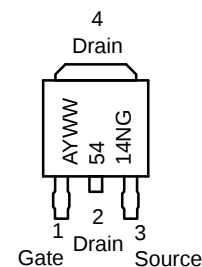
<http://onsemi.com>

| $V_{(BR)DS}$ | $R_{DS(ON)} \text{ MAX}$ | $I_D \text{ MAX}$ (Note 1) |
|--------------|--------------------------|----------------------------|
| 60 V         | 37 m $\Omega$ @ 10 V     | 24 A                       |



DPAK  
CASE 369AA  
STYLE 2

### MARKING DIAGRAMS & PIN ASSIGNMENT



A = Assembly Location\*  
Y = Year  
WW = Work Week  
5414N = Specific Device Code  
G = Pb-Free Device

\* The Assembly Location code (A) is front side optional. In cases where the Assembly Location is stamped in the package, the front side assembly code may be blank.

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 5 of this data sheet.

# NTD5414N, NVD5414N

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

| Characteristics | Symbol | Test Condition | Min | Typ | Max | Unit |
|-----------------|--------|----------------|-----|-----|-----|------|
|-----------------|--------|----------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                           |                   |                                                     |                           |      |           |               |
|-----------------------------------------------------------|-------------------|-----------------------------------------------------|---------------------------|------|-----------|---------------|
| Drain-to-Source Breakdown Voltage                         | $V_{(BR)DSS}$     | $V_{DS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | 60                        |      |           | V             |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ |                                                     |                           | 67.3 |           | mV/°C         |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$         | $V_{GS} = 0\text{ V}$<br>$V_{DS} = 60\text{ V}$     | $T_J = 25^\circ\text{C}$  |      | 1.0       | $\mu\text{A}$ |
|                                                           |                   |                                                     | $T_J = 150^\circ\text{C}$ |      | 50        |               |
| Gate-Body Leakage Current                                 | $I_{GSS}$         | $V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$     |                           |      | $\pm 100$ | nA            |

### ON CHARACTERISTICS (Note 2)

|                                            |                  |                                                              |     |      |      |            |
|--------------------------------------------|------------------|--------------------------------------------------------------|-----|------|------|------------|
| Gate Threshold Voltage                     | $V_{GS(th)}$     | $V_{GS} = V_{DS}, I_D = 250\text{ }\mu\text{A}$              | 2.0 | 3.2  | 4.0  | V          |
| Negative Threshold Temperature Coefficient | $V_{GS(th)}/T_J$ |                                                              |     | 0.74 |      | mV/°C      |
| Drain-to-Source On-Voltage                 | $V_{DS(on)}$     | $V_{GS} = 10\text{ V}, I_D = 24\text{ A}$                    |     | 0.7  | 1.16 | V          |
|                                            |                  | $V_{GS} = 10\text{ V}, I_D = 12\text{ A}, 150^\circ\text{C}$ |     | 0.7  |      |            |
| Drain-to-Source On-Resistance              | $R_{DS(on)}$     | $V_{GS} = 10\text{ V}, I_D = 24\text{ A}$                    |     | 28.4 | 37   | m $\Omega$ |
| Forward Transconductance                   | $g_{FS}$         | $V_{DS} = 15\text{ V}, I_D = 20\text{ A}$                    |     | 24   |      | S          |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                       |              |                                                                      |  |      |      |    |
|-----------------------|--------------|----------------------------------------------------------------------|--|------|------|----|
| Input Capacitance     | $C_{iss}$    | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1\text{ MHz}$   |  | 800  | 1200 | pF |
| Output Capacitance    | $C_{oss}$    |                                                                      |  | 165  |      |    |
| Transfer Capacitance  | $C_{rss}$    |                                                                      |  | 75   |      |    |
| Total Gate Charge     | $Q_{G(TOT)}$ | $V_{GS} = 10\text{ V}, V_{DS} = 48\text{ V},$<br>$I_D = 24\text{ A}$ |  | 25   | 48   | nC |
| Threshold Gate Charge | $Q_{G(TH)}$  |                                                                      |  | 1.1  |      |    |
| Gate-to-Source Charge | $Q_{GS}$     |                                                                      |  | 4.8  |      |    |
| Gate-to-Drain Charge  | $Q_{GD}$     |                                                                      |  | 11.3 |      |    |

### SWITCHING CHARACTERISTICS, $V_{GS} = 10\text{ V}$ (Note 3)

|                     |              |                                                                                               |  |    |  |    |
|---------------------|--------------|-----------------------------------------------------------------------------------------------|--|----|--|----|
| Turn-On Delay Time  | $t_{d(on)}$  | $V_{GS} = 10\text{ V}, V_{DD} = 48\text{ V},$<br>$I_D = 24\text{ A}, R_G = 9.1\text{ }\Omega$ |  | 12 |  | ns |
| Rise Time           | $t_r$        |                                                                                               |  | 58 |  |    |
| Turn-Off Delay Time | $t_{d(off)}$ |                                                                                               |  | 47 |  |    |
| Fall Time           | $t_f$        |                                                                                               |  | 69 |  |    |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                                |          |                                                                                             |                           |  |      |      |    |
|--------------------------------|----------|---------------------------------------------------------------------------------------------|---------------------------|--|------|------|----|
| Forward Diode Voltage (Note 2) | $V_{SD}$ | $V_{GS} = 0\text{ V}$<br>$I_S = 24\text{ A}$                                                | $T_J = 25^\circ\text{C}$  |  | 0.92 | 1.15 | V  |
|                                |          |                                                                                             | $T_J = 125^\circ\text{C}$ |  | 0.8  |      |    |
| Reverse Recovery Time          | $t_{rr}$ | $I_S = 24\text{ A}_{dc}, V_{GS} = 0\text{ V}_{dc},$<br>$dI_S/dt = 100\text{ A}/\mu\text{s}$ |                           |  | 45.7 |      | ns |
| Charge Time                    | $t_a$    |                                                                                             |                           |  | 31.7 |      |    |
| Discharge Time                 | $t_b$    |                                                                                             |                           |  | 14   |      |    |
| Reverse Recovery Stored Charge | $Q_{RR}$ |                                                                                             |                           |  | 76   |      | nC |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

3. Switching characteristics are independent of operating junction temperatures.

TYPICAL PERFORMANCE CURVES

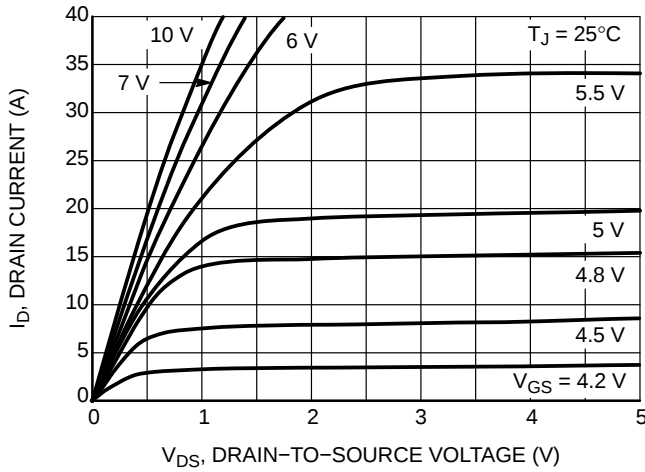


Figure 1. On-Region Characteristics

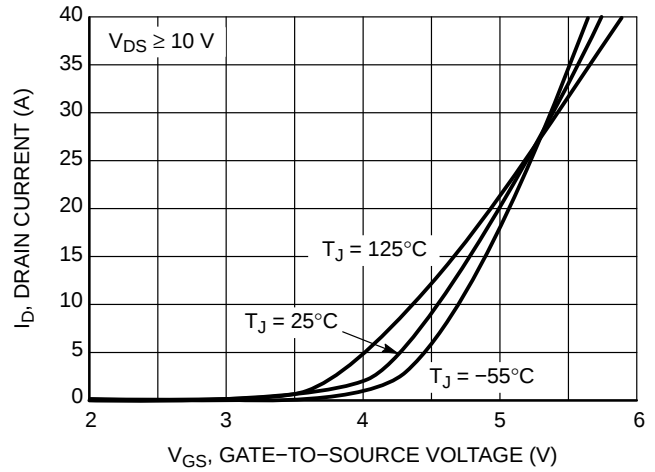


Figure 2. Transfer Characteristics

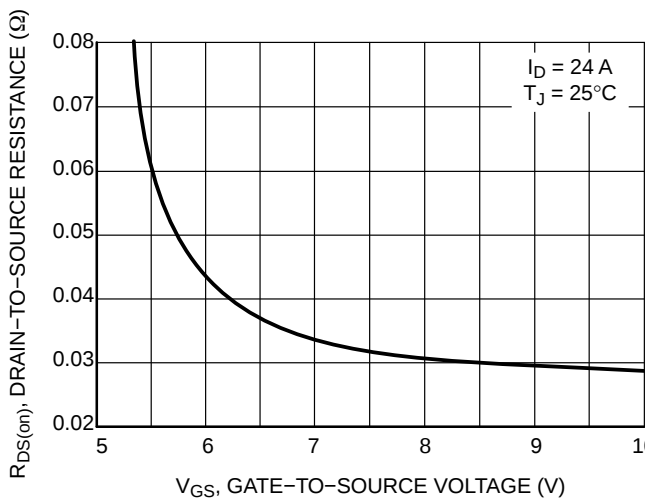


Figure 3. On-Resistance vs. Gate-to-Source Voltage

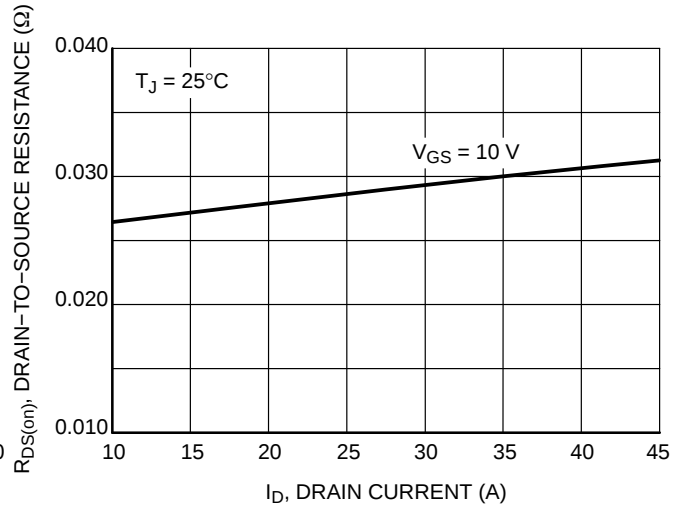


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

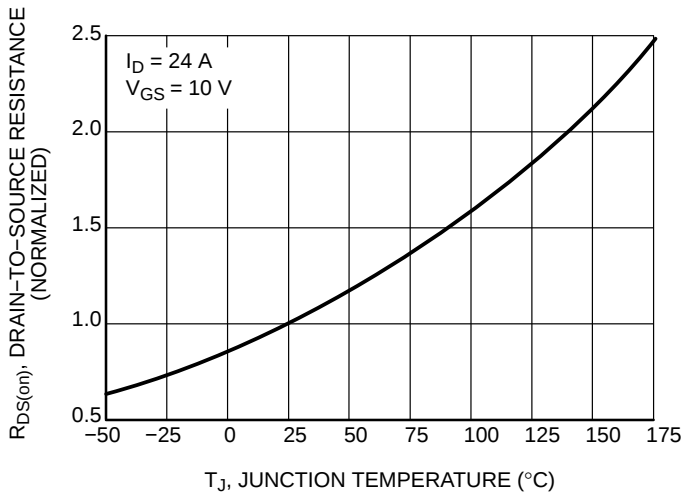


Figure 5. On-Resistance Variation with Temperature

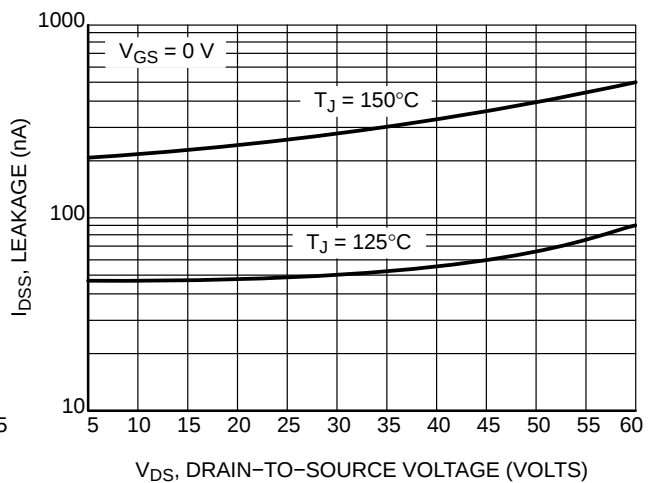


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL PERFORMANCE CURVES

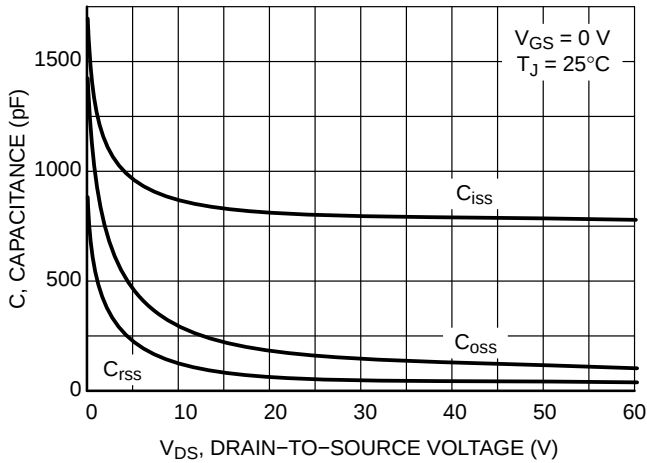


Figure 7. Capacitance Variation

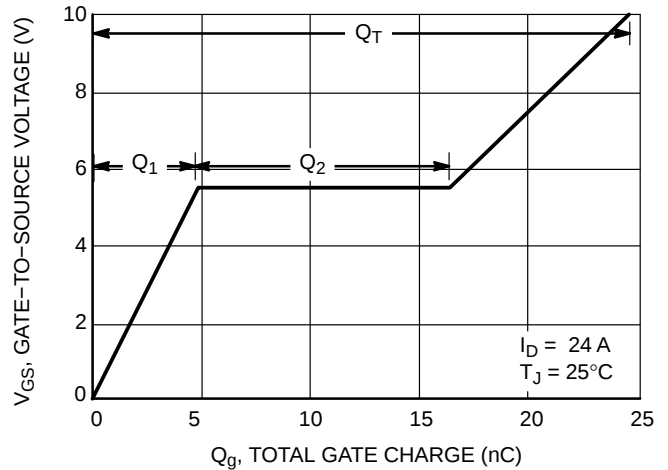


Figure 8. Gate-to-Source Voltage vs. Total Charge

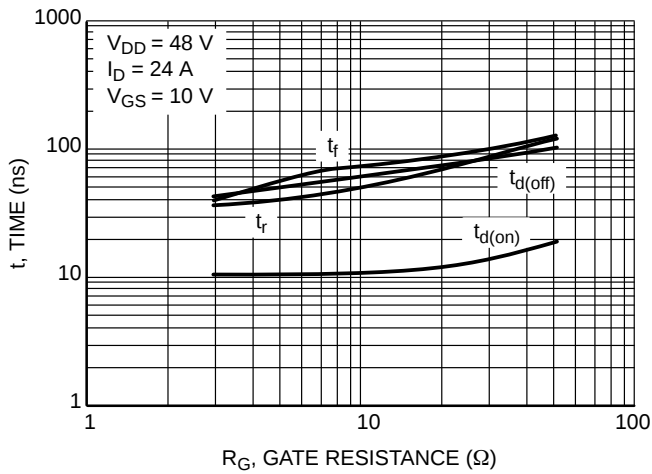


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

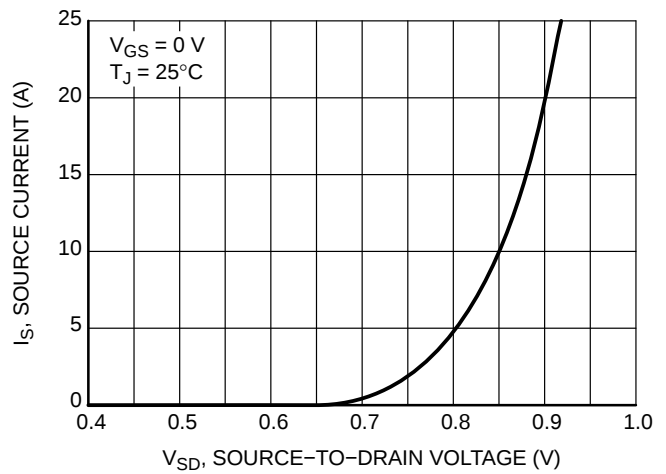


Figure 10. Diode Forward Voltage vs. Current

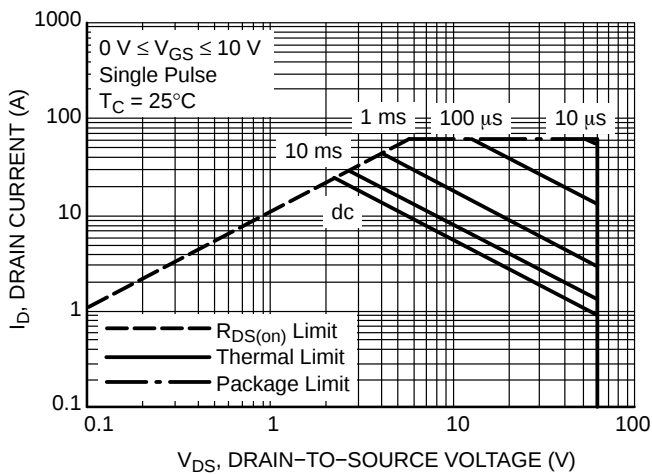


Figure 11. Maximum Rated Forward Biased Safe Operating Area

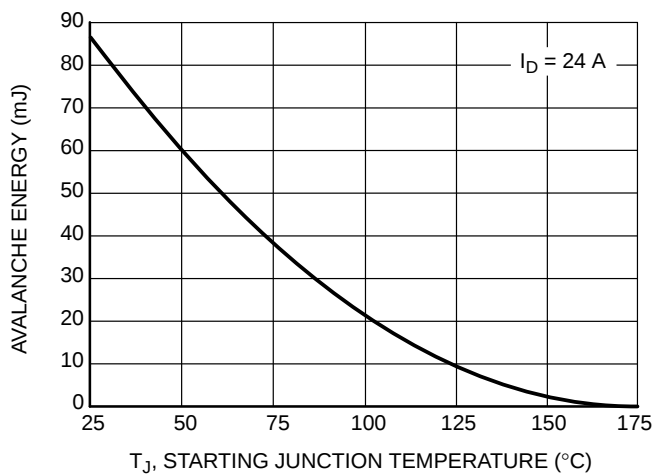


Figure 12. Maximum Avalanche Energy vs. Starting Junction Temperature

# NTD5414N, NVD5414N

## TYPICAL PERFORMANCE CURVES

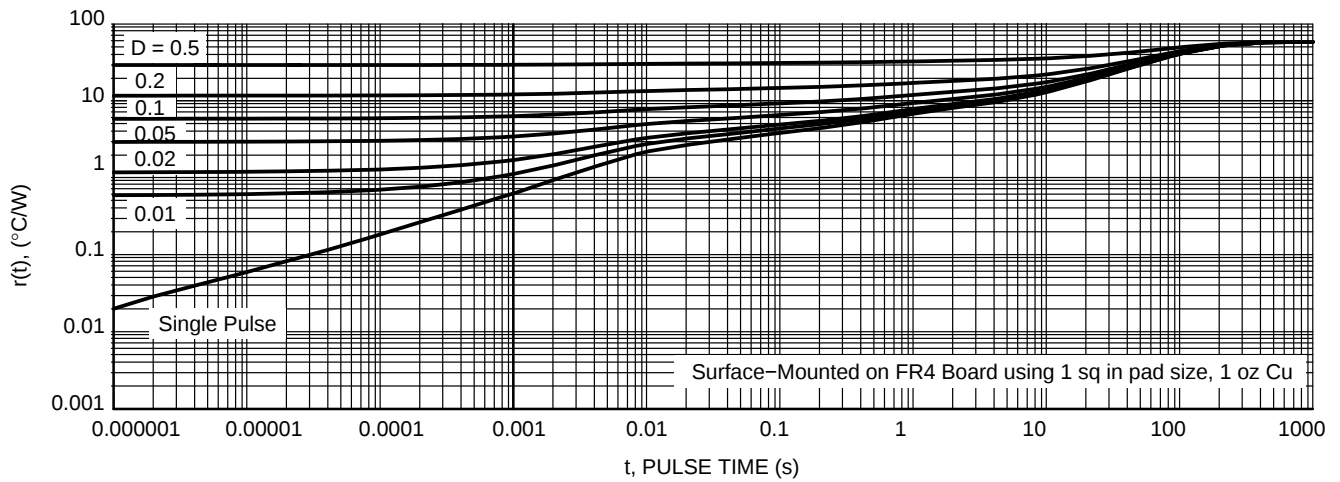


Figure 13. Thermal Response

### ORDERING INFORMATION

| Device       | Package           | Shipping <sup>†</sup> |
|--------------|-------------------|-----------------------|
| NTD5414NT4G  | DPAK<br>(Pb-Free) | 2500 / Tape & Reel    |
| NVD5414NT4G* | DPAK<br>(Pb-Free) | 2500 / Tape & Reel    |

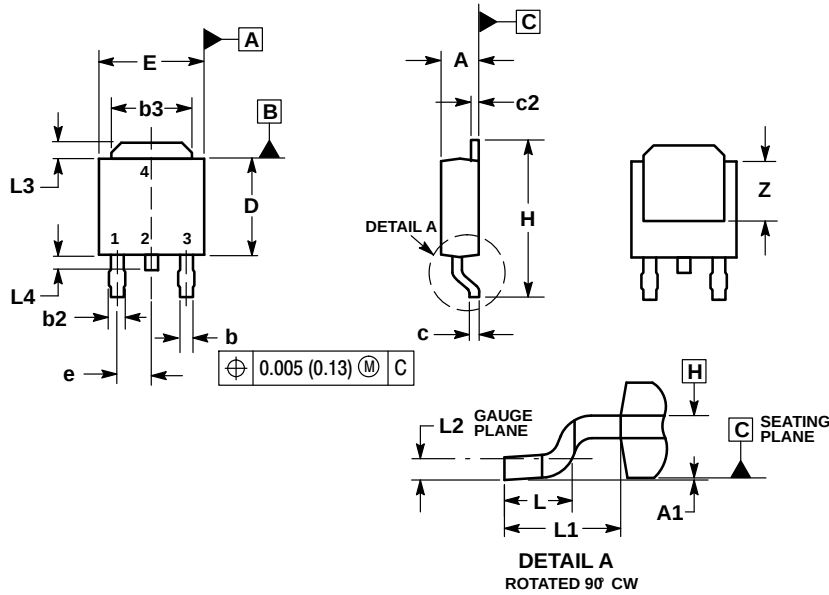
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*NVD Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable.

# NTD5414N, NVD5414N

## PACKAGE DIMENSIONS

### DPAK (SINGLE GAUGE) CASE 369AA ISSUE B



#### NOTES:

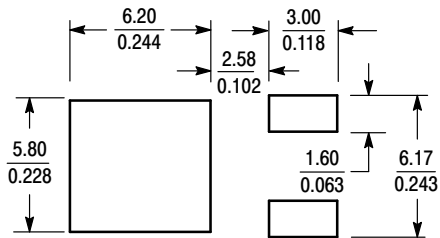
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
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        | ---   |

#### STYLE 2:

- PIN 1. GATE
- DRAIN
- SOURCE
- DRAIN

### SOLDERING FOOTPRINT\*



SCALE 3:1 (mm/inches)

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

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