

# NTD6416ANL, NVD6416ANL

## MOSFET – Power, N-Channel

100 V, 19 A, 74 mΩ

### Features

- Low  $R_{DS(on)}$
- High Current Capability
- 100% Avalanche Tested
- 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

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

| Parameter   | Symbol       | Value                     | Unit        |
|---|--------------|---------------------------|-------------|
| Drain-to-Source Voltage   | $V_{DSS}$    | 100                       | V           |
| Gate-to-Source Voltage – Continuous   | $V_{GS}$     | $\pm 20$                  | V           |
| Continuous Drain Current  | $I_D$        | $T_C = 25^\circ\text{C}$  | 19          |
|   |              | $T_C = 100^\circ\text{C}$ | 13          |
| Power Dissipation   | Steady State | $T_C = 25^\circ\text{C}$  | 71          |
|   |              | $t_p = 10 \mu\text{s}$    | $I_{DM}$    |
| Operating and Storage Temperature Range   |              | $T_J, T_{stg}$            | -55 to +175 |
| Source Current (Body Diode)   |              | $I_S$                     | 19          |
| Single Pulse Drain-to-Source Avalanche Energy ( $V_{DD} = 50 \text{ Vdc}$ , $V_{GS} = 10 \text{ Vdc}$ , $I_{L(pk)} = 18.2 \text{ A}$ , $L = 0.3 \text{ mH}$ , $R_G = 25 \Omega$ ) |              | $E_{AS}$                  | 50          |
| Lead Temperature for Soldering Purposes, 1/8" from Case for 10 Seconds  |              | $T_L$                     | 260         |

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     | $R_{\theta JC}$ | 2.1 | $^\circ\text{C/W}$ |
| Junction-to-Ambient – Steady State (Note 1) | $R_{\theta JA}$ | 47  |                    |

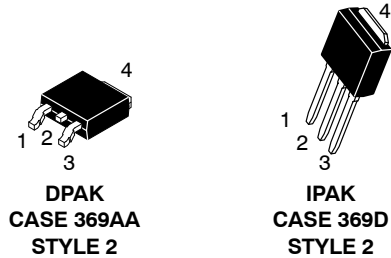
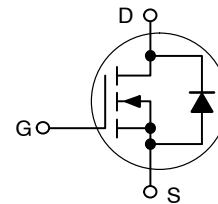
1. Surface mounted on FR4 board using 1 sq in pad size, (Cu Area 1.127 sq in [2 oz] including traces).



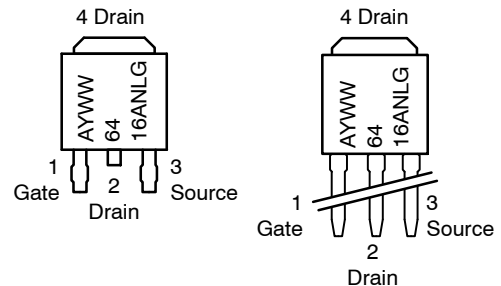
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| $V_{(BR)DSS}$ | $R_{DS(on)}$ MAX | $I_D$ MAX |
|---------------|------------------|-----------|
| 100 V         | 74 mΩ @ 10 V     | 19 A      |



### MARKING DIAGRAM & PIN ASSIGNMENTS



A = Assembly Location\*  
 Y = Year  
 WW = Work Week  
 6416ANL = Device Code  
 G = Pb-Free Package

\* 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 on page 5 of this data sheet.

# NTD6416ANL, NVD6416ANL

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted)

| Parameter   | Symbol                               | Test Condition                                    | Min                    | Typ | Max  | Unit  |
|---|--------------------------------------|---|------------------------|-----|------|-------|
| <b>OFF CHARACTERISTICS</b>                                |                                      |   |                        |     |      |       |
| Drain-to-Source Breakdown Voltage                         | V <sub>(BR)DSS</sub>                 | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA    | 100                    |     |      | V     |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | V <sub>(BR)DSS</sub> /T <sub>J</sub> |   |                        | 120 |      | mV/°C |
| Zero Gate Voltage Drain Current                           | I <sub>DSS</sub>                     | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 100 V | T <sub>J</sub> = 25°C  |     | 1.0  | μA    |
|   |                                      |   | T <sub>J</sub> = 125°C |     | 10   |       |
| Gate-to-Source Leakage Current                            | I <sub>GSS</sub>                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±20 V    |                        |     | ±100 | nA    |

## ON CHARACTERISTICS (Note 2)

|  |                                     |   |     |     |     |       |
|--|-------------------------------------|---|-----|-----|-----|-------|
| Gate Threshold Voltage                     | V <sub>GS(TH)</sub>                 | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 μA | 1.0 |     | 2.2 | V     |
| Negative Threshold Temperature Coefficient | V <sub>GS(TH)</sub> /T <sub>J</sub> |   |     | 5.4 |     | mV/°C |
| Drain-to-Source On-Resistance              | R <sub>DS(on)</sub>                 | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 10 A              |     | 70  | 80  | mΩ    |
|  |                                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 10 A               |     | 62  | 74  |       |
|  |                                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 19 A               |     | 68  | 74  |       |
| Forward Transconductance                   | g <sub>FS</sub>                     | V <sub>DS</sub> = 5 V, I <sub>D</sub> = 10 A                |     | 18  |     | S     |

## CHARGES, CAPACITANCES AND GATE RESISTANCE

|                              |                     |   |  |     |      |    |   |
|------------------------------|---------------------|---|--|-----|------|----|---|
| Input Capacitance            | C <sub>ISS</sub>    | V <sub>GS</sub> = 0 V, f = 1.0 MHz, V <sub>DS</sub> = 25 V            |  | 700 | 1000 | pF |   |
| Output Capacitance           | C <sub>OSS</sub>    |   |  | 110 |      |    |   |
| Reverse Transfer Capacitance | C <sub>RSS</sub>    |   |  | 50  |      |    |   |
| Total Gate Charge            | Q <sub>G(TOT)</sub> | V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 80 V, I <sub>D</sub> = 19 A |  | 25  | 40   | nC |   |
| Threshold Gate Charge        | Q <sub>G(TH)</sub>  |   |  | 0.7 |      |    |   |
| Gate-to-Source Charge        | Q <sub>GS</sub>     |   |  | 2.4 |      |    |   |
| Gate-to-Drain Charge         | Q <sub>GD</sub>     |   |  | 9.6 |      |    |   |
| Plateau Voltage              | V <sub>GP</sub>     |   |  | 3.2 |      |    | V |
| Gate Resistance              | R <sub>G</sub>      |   |  | 2.4 |      |    | Ω |

## SWITCHING CHARACTERISTICS (Note 3)

|                     |                     |  |  |     |  |    |
|---------------------|---------------------|--|--|-----|--|----|
| Turn-On Delay Time  | t <sub>d(on)</sub>  | V <sub>GS</sub> = 10 V, V <sub>DD</sub> = 80 V,<br>I <sub>D</sub> = 19 A, R <sub>G</sub> = 6.1 Ω |  | 7.0 |  | ns |
| Rise Time           | t <sub>r</sub>      |  |  | 16  |  |    |
| Turn-Off Delay Time | t <sub>d(off)</sub> |  |  | 35  |  |    |
| Fall Time           | t <sub>f</sub>      |  |  | 40  |  |    |

## DRAIN-SOURCE DIODE CHARACTERISTICS

|                         |                 |   |                        |      |     |    |
|-------------------------|-----------------|---|------------------------|------|-----|----|
| Forward Diode Voltage   | V <sub>SD</sub> | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 19 A                                    | T <sub>J</sub> = 25°C  | 0.9  | 1.2 | V  |
|                         |                 |   | T <sub>J</sub> = 125°C | 0.72 |     |    |
| Reverse Recovery Time   | t <sub>RR</sub> | V <sub>GS</sub> = 0 V, dI <sub>S</sub> /dt = 100 A/μs,<br>I <sub>S</sub> = 19 A |                        | 50   |     | ns |
| Charge Time             | T <sub>a</sub>  |   |                        | 38   |     |    |
| Discharge Time          | T <sub>b</sub>  |   |                        | 14   |     |    |
| Reverse Recovery Charge | Q <sub>RR</sub> |   |                        | 112  |     |    |

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 ≤ 300 μs, Duty Cycle ≤ 2%.

3. Switching characteristics are independent of operating junction temperatures.

# NTD6416ANL, NVD6416ANL

## TYPICAL CHARACTERISTICS

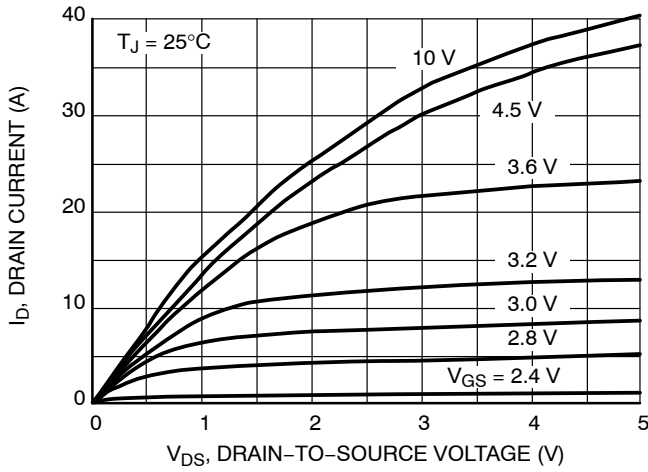


Figure 1. On-Region Characteristics

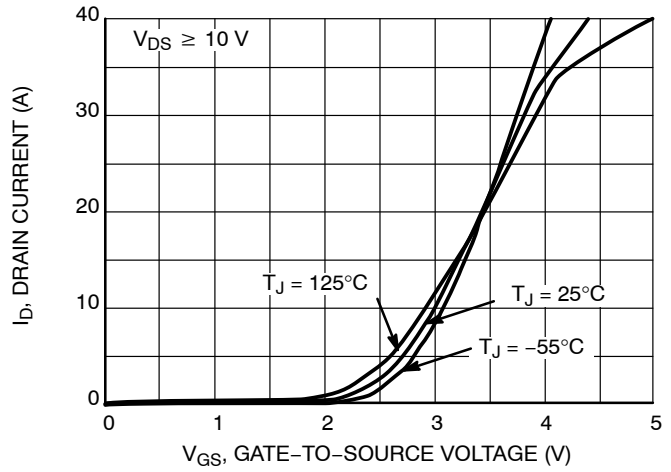


Figure 2. Transfer Characteristics

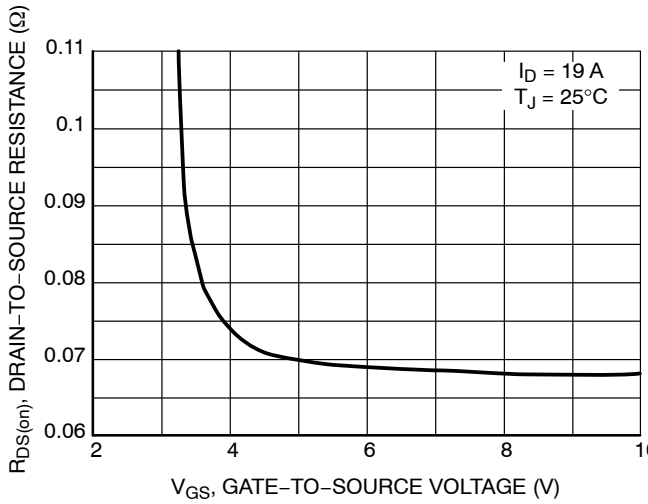


Figure 3. On-Region versus Gate-to-Source Voltage

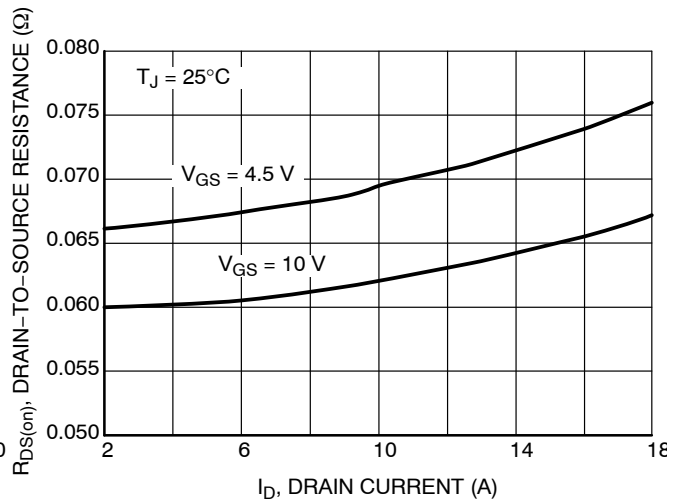


Figure 4. On-Region versus Drain Current and Gate-to-Source Voltage

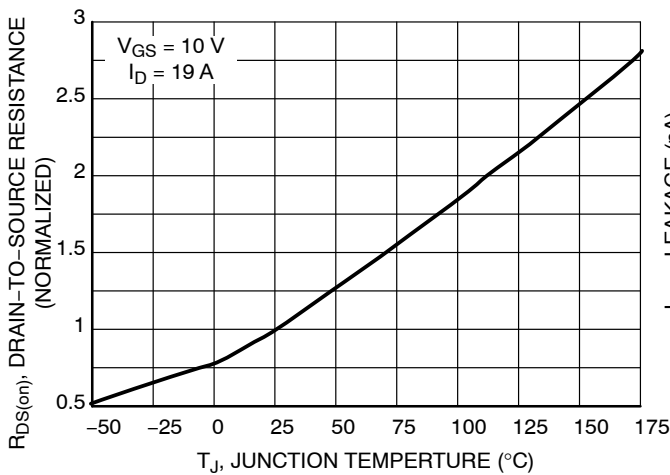


Figure 5. On-Resistance Variation with Temperature

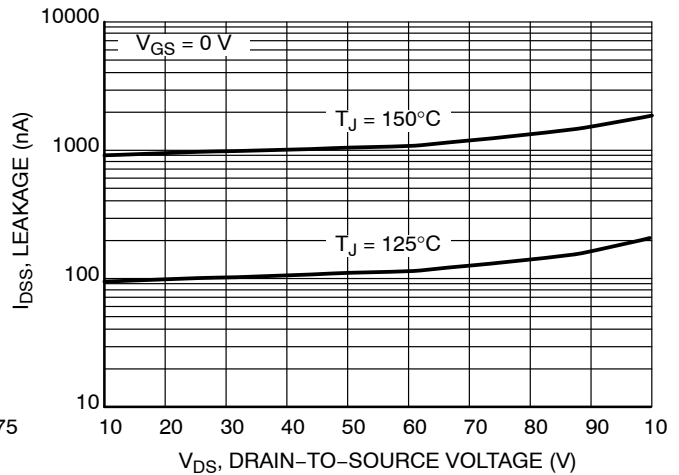


Figure 6. Drain-to-Source Leakage Current versus Voltage

# NTD6416ANL, NVD6416ANL

## TYPICAL CHARACTERISTICS

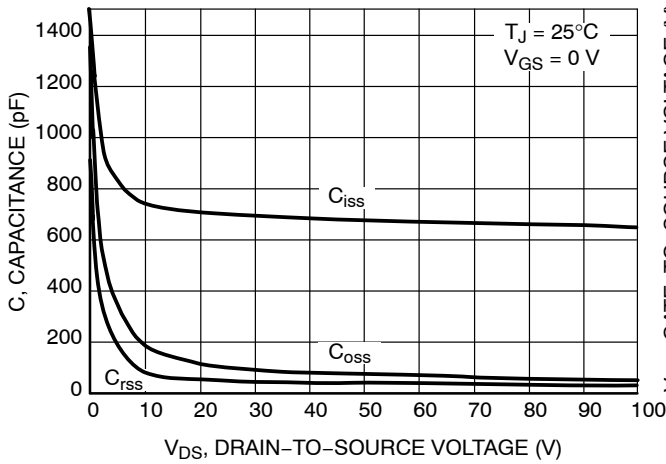


Figure 7. Capacitance Variation

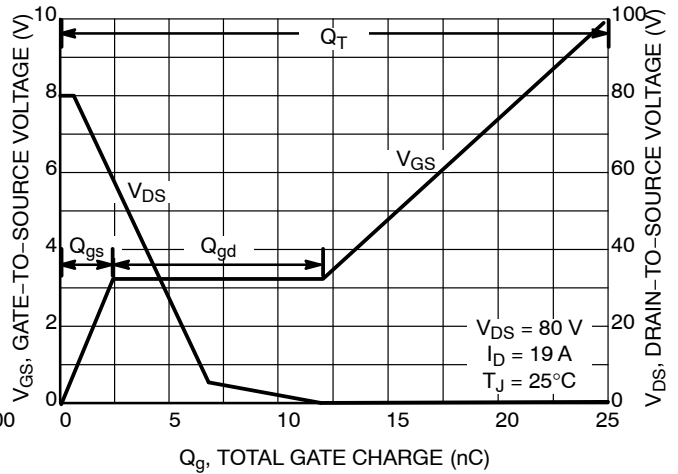


Figure 8. Gate-to-Source Voltage and Drain-to-Source Voltage versus Total Charge

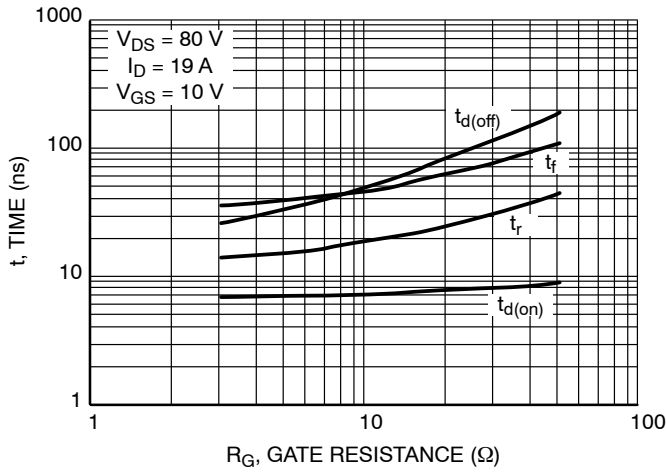


Figure 9. Resistive Switching Time Variation versus Gate Resistance

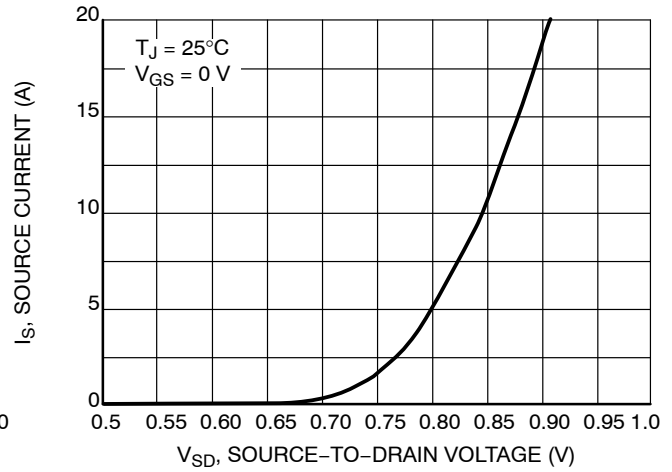


Figure 10. Diode Forward Voltage versus Current

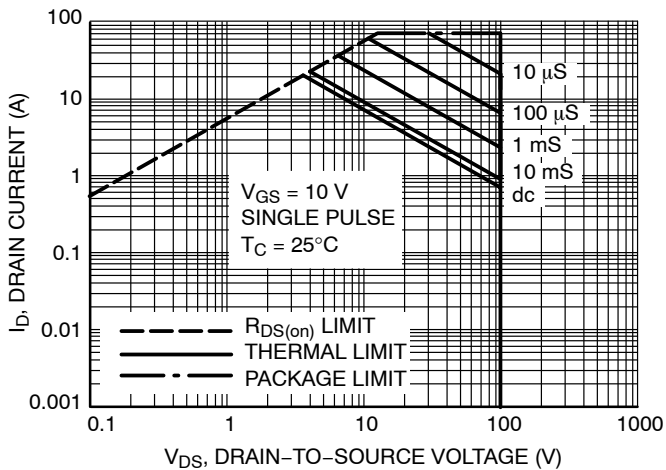


Figure 11. Maximum Rated Forward Biased Safe Operating Area

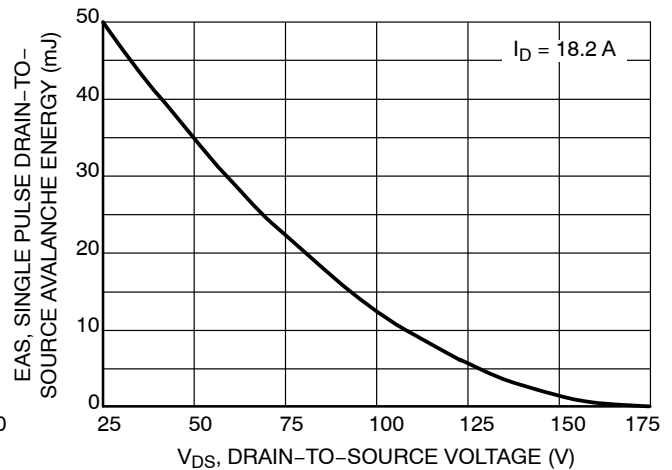


Figure 12. Resistive Switching Time Variation versus Gate Resistance

# NTD6416ANL, NVD6416ANL

## TYPICAL CHARACTERISTICS

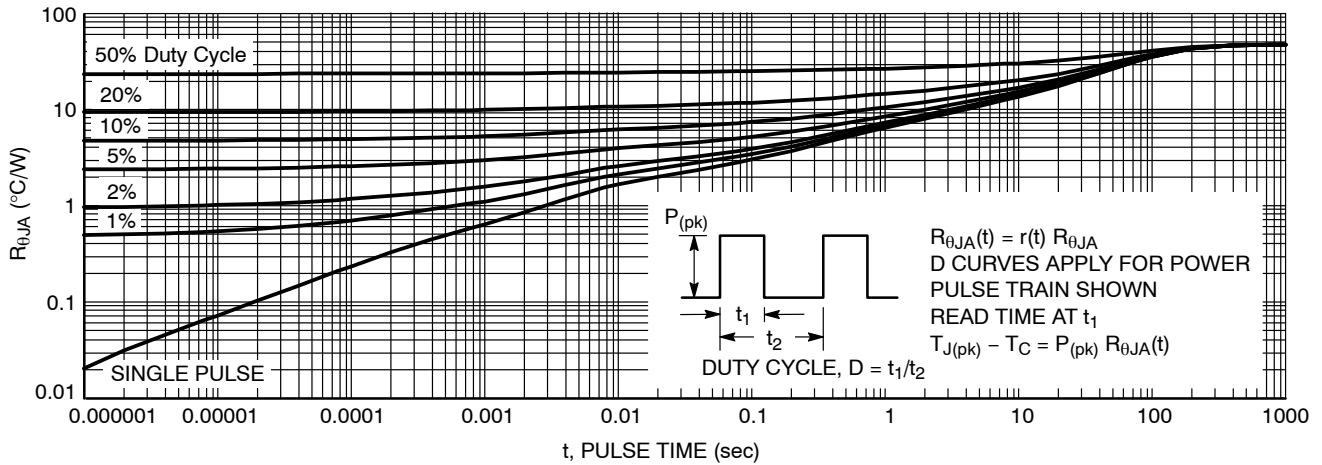


Figure 13. Thermal Response (NTD6416ANL DPAK PCB Cu Area 720 mm<sup>2</sup> PCB Cu thk 2 oz)

### ORDERING INFORMATION

| Device              | Package           | Shipping <sup>†</sup> |
|---------------------|-------------------|-----------------------|
| NTD6416ANLT4G       | DPAK<br>(Pb-Free) | 2500 / Tape & Reel    |
| NTD6416ANL-1G       | IPAK<br>(Pb-Free) | 75 Units / Rail       |
| NVD6416ANLT4G*      | DPAK<br>(Pb-Free) | 2500 / Tape & Reel    |
| NVD6416ANLT4G-VF01* | 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 Specification Brochure, BRD8011/D.

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

# MECHANICAL CASE OUTLINE

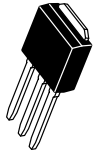
## PACKAGE DIMENSIONS

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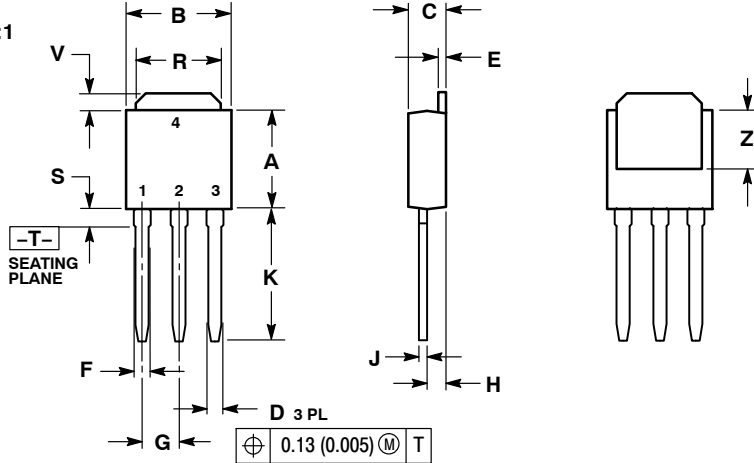


### IPAK CASE 369D-01 ISSUE C

DATE 15 DEC 2010



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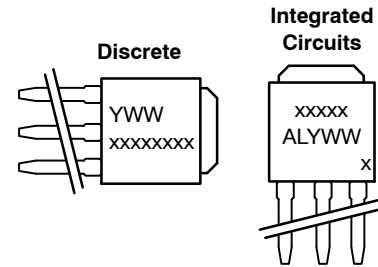


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

| 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        | ---  |

- |  |   |  |  |
|--|---|--|--|
| <p>STYLE 1:<br/>PIN 1. BASE<br/>2. COLLECTOR<br/>3. EMITTER<br/>4. COLLECTOR</p> | <p>STYLE 2:<br/>PIN 1. GATE<br/>2. DRAIN<br/>3. SOURCE<br/>4. DRAIN</p> | <p>STYLE 3:<br/>PIN 1. ANODE<br/>2. CATHODE<br/>3. ANODE<br/>4. CATHODE</p>      | <p>STYLE 4:<br/>PIN 1. CATHODE<br/>2. ANODE<br/>3. GATE<br/>4. ANODE</p> |
| <p>STYLE 5:<br/>PIN 1. GATE<br/>2. ANODE<br/>3. CATHODE<br/>4. ANODE</p>         | <p>STYLE 6:<br/>PIN 1. MT1<br/>2. MT2<br/>3. GATE<br/>4. MT2</p>        | <p>STYLE 7:<br/>PIN 1. GATE<br/>2. COLLECTOR<br/>3. EMITTER<br/>4. COLLECTOR</p> |  |

### MARKING DIAGRAMS



- xxxxxxxx = Device Code  
A = Assembly Location  
IL = Wafer Lot  
Y = Year  
WW = Work Week

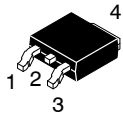
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| <b>DESCRIPTION:</b>     | <b>IPAK (DPAK INSERTION MOUNT)</b> | <b>PAGE 1 OF 1</b>   |

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# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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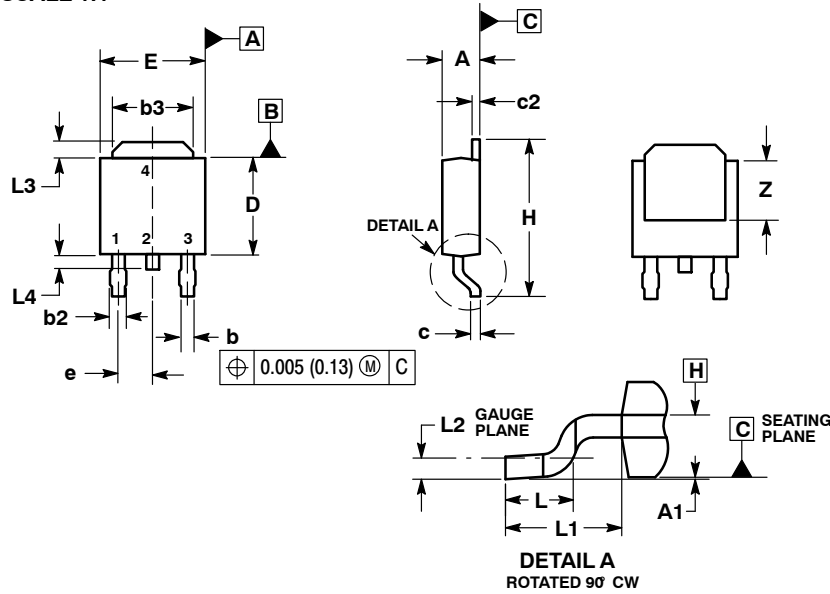
SCALE 1:1

### DPAK (SINGLE GAUGE)

#### CASE 369AA-01

#### ISSUE B

DATE 03 JUN 2010



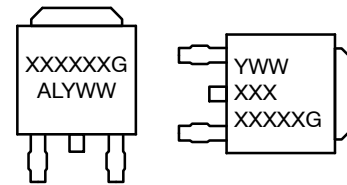
NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- CONTROLLING DIMENSION: INCHES.
- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
- 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.
- DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 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        | ---   |

- |  |   |  |  |
|--|---|--|--|
| <p>STYLE 1:<br/>PIN 1. BASE<br/>2. COLLECTOR<br/>3. EMITTER<br/>4. COLLECTOR</p> | <p>STYLE 2:<br/>PIN 1. GATE<br/>2. DRAIN<br/>3. SOURCE<br/>4. DRAIN</p> | <p>STYLE 3:<br/>PIN 1. ANODE<br/>2. CATHODE<br/>3. ANODE<br/>4. CATHODE</p>      | <p>STYLE 4:<br/>PIN 1. CATHODE<br/>2. ANODE<br/>3. GATE<br/>4. ANODE</p> |
| <p>STYLE 5:<br/>PIN 1. GATE<br/>2. ANODE<br/>3. CATHODE<br/>4. ANODE</p>         | <p>STYLE 6:<br/>PIN 1. MT1<br/>2. MT2<br/>3. GATE<br/>4. MT2</p>        | <p>STYLE 7:<br/>PIN 1. GATE<br/>2. COLLECTOR<br/>3. EMITTER<br/>4. COLLECTOR</p> |  |

### GENERIC MARKING DIAGRAM\*

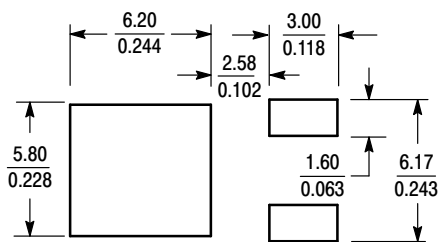


IC Discrete

- XXXXXX = Device Code
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- WW = Work Week
- G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking.

### 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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| DESCRIPTION:     | DPAK (SINGLE GAUGE) | PAGE 1 OF 1  |

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