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## Is Now



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# NTD60N02R

## Power MOSFET

62 A, 25 V, N-Channel, DPAK

### Features

- Planar HD3e Process for Fast Switching Performance
- Low  $R_{DS(on)}$  to Minimize Conduction Loss
- Low  $C_{iss}$  to Minimize Driver Loss
- Low Gate Charge
- Optimized for High Side Switching Requirements in High-Efficiency DC-DC Converters
- Pb-Free Packages are Available

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

| Rating                                                                                                                                                                             | Symbol                | Value          | Unit               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------|--------------------|
| Drain-to-Source Voltage                                                                                                                                                            | $V_{DS}$              | 25             | Vdc                |
| Gate-to-Source Voltage – Continuous                                                                                                                                                | $V_{GS}$              | $\pm 20$       | Vdc                |
| Thermal Resistance<br>Junction-to-Case                                                                                                                                             | $R_{\theta JC}$       | 2.6            | $^\circ\text{C/W}$ |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$                                                                                                                                 | $P_D$                 | 58             | W                  |
| Drain Current                                                                                                                                                                      |                       |                |                    |
| Continuous @ $T_C = 25^\circ\text{C}$ , Chip                                                                                                                                       | $I_D$                 | 62             | A                  |
| Continuous @ $T_C = 25^\circ\text{C}$ , Limited by Package                                                                                                                         | $I_D$                 | 50             | A                  |
| Continuous @ $T_A = 25^\circ\text{C}$ , Limited by Wires                                                                                                                           | $I_D$                 | 32             | A                  |
| Thermal Resistance<br>Junction-to-Ambient (Note 1)                                                                                                                                 | $R_{\theta JA}$       | 80             | $^\circ\text{C/W}$ |
| Total Power Dissipation @ $T_A = 25^\circ\text{C}$                                                                                                                                 | $P_D$                 | 1.87           | W                  |
| Drain Current – Continuous @ $T_A = 25^\circ\text{C}$                                                                                                                              | $I_D$                 | 10.5           | A                  |
| Thermal Resistance<br>Junction-to-Ambient (Note 2)                                                                                                                                 | $R_{\theta JA}$       | 120            | $^\circ\text{C/W}$ |
| Total Power Dissipation @ $T_A = 25^\circ\text{C}$                                                                                                                                 | $P_D$                 | 1.25           | W                  |
| Drain Current – Continuous @ $T_A = 25^\circ\text{C}$                                                                                                                              | $I_D$                 | 8.5            | A                  |
| Operating and Storage Temperature                                                                                                                                                  | $T_J$ , and $T_{stg}$ | $-55$ to $175$ | $^\circ\text{C}$   |
| Single Pulse Drain-to-Source Avalanche Energy – Starting $T_J = 25^\circ\text{C}$<br>( $V_{DD} = 50$ Vdc, $V_{GS} = 10.0$ Vdc, $I_L = 11$ Apk, $L = 1.0$ mH, $R_G = 25$ $\Omega$ ) | $E_{AS}$              | 60             | mJ                 |
| Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 10 seconds                                                                                                     | $T_L$                 | 260            | $^\circ\text{C}$   |

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.

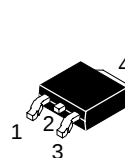
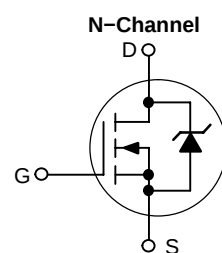
1. When surface mounted to an FR4 board using 0.5 in sq drain pad size.
2. When surface mounted to an FR4 board using the minimum recommended pad size.



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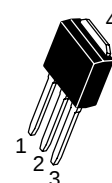
| $V_{(BR)DSS}$ | $R_{DS(on)}$ TYP      | $I_D$ MAX |
|---------------|-----------------------|-----------|
| 25 V          | 8.4 m $\Omega$ @ 10 V | 62 A      |



CASE 369AA  
DPAK  
(Surface Mount)  
STYLE 2

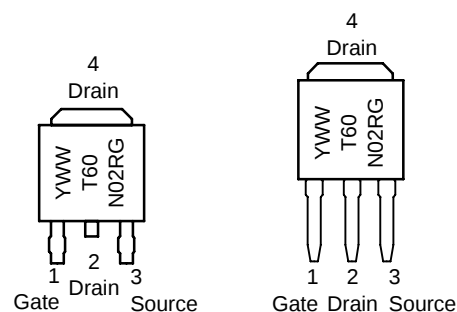


CASE 369AC  
3 IPAK  
(Straight Lead)  
STYLE 2



CASE 369D  
DPAK  
(Straight Lead)  
STYLE 2

### MARKING DIAGRAM & PIN ASSIGNMENTS



Y = Year  
WW = Work Week  
T60N02R = Device Code  
G = Pb-Free Package

### ORDERING INFORMATION

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

# NTD60N02R

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

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

### OFF CHARACTERISTICS

|                                                                                                                                                                       |                      |         |              |           |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------|--------------|-----------|--------------|
| Drain-to-Source Breakdown Voltage (Note 3)<br>(V <sub>GS</sub> = 0 Vdc, I <sub>D</sub> = 250 μAdc)<br>Temperature Coefficient (Positive)                              | V <sub>(BR)DSS</sub> | 25<br>– | 27.5<br>25.5 | –<br>–    | Vdc<br>mV/°C |
| Zero Gate Voltage Drain Current<br>(V <sub>DS</sub> = 20 Vdc, V <sub>GS</sub> = 0 Vdc)<br>(V <sub>DS</sub> = 20 Vdc, V <sub>GS</sub> = 0 Vdc, T <sub>J</sub> = 150°C) | I <sub>DSS</sub>     | –<br>–  | –<br>–       | 1.5<br>10 | μAdc         |
| Gate-Body Leakage Current (V <sub>GS</sub> = ±20 Vdc, V <sub>DS</sub> = 0 Vdc)                                                                                        | I <sub>GSS</sub>     | –       | –            | ±100      | nAdc         |

### ON CHARACTERISTICS (Note 3)

|                                                                                                                                                                                                                     |                     |             |                    |                   |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------|--------------------|-------------------|--------------|
| Gate Threshold Voltage (Note 3)<br>(V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μAdc)<br>Threshold Temperature Coefficient (Negative)                                                                  | V <sub>GS(th)</sub> | 1.0<br>–    | 1.5<br>4.1         | 2.0<br>–          | Vdc<br>mV/°C |
| Static Drain-to-Source On-Resistance (Note 3)<br>(V <sub>GS</sub> = 4.5 Vdc, I <sub>D</sub> = 15 Adc)<br>(V <sub>GS</sub> = 10 Vdc, I <sub>D</sub> = 20 Adc)<br>(V <sub>GS</sub> = 10 Vdc, I <sub>D</sub> = 31 Adc) | R <sub>DS(on)</sub> | –<br>–<br>– | 11.2<br>8.4<br>8.2 | 12.5<br>10.5<br>– | mΩ           |
| Forward Transconductance (V <sub>DS</sub> = 10 Vdc, I <sub>D</sub> = 15 Adc) (Note 3)                                                                                                                               | g <sub>FS</sub>     | –           | 27                 | –                 | Mhos         |

### DYNAMIC CHARACTERISTICS

|                      |                                                                     |                  |   |      |      |    |
|----------------------|---------------------------------------------------------------------|------------------|---|------|------|----|
| Input Capacitance    | (V <sub>DS</sub> = 20 Vdc, V <sub>GS</sub> = 0 Vdc,<br>f = 1.0 MHz) | C <sub>iss</sub> | – | 1000 | 1330 | pF |
| Output Capacitance   |                                                                     | C <sub>oss</sub> | – | 480  | 640  |    |
| Transfer Capacitance |                                                                     | C <sub>rss</sub> | – | 180  | 225  |    |

### SWITCHING CHARACTERISTICS (Note 4)

|                     |                                                                                                          |                     |   |     |    |    |
|---------------------|----------------------------------------------------------------------------------------------------------|---------------------|---|-----|----|----|
| Turn-On Delay Time  | (V <sub>GS</sub> = 10 Vdc, V <sub>DD</sub> = 10 Vdc,<br>I <sub>D</sub> = 31 Adc, R <sub>G</sub> = 3.0 Ω) | t <sub>d(on)</sub>  | – | 7.0 | –  | ns |
| Rise Time           |                                                                                                          | t <sub>r</sub>      | – | 33  | –  |    |
| Turn-Off Delay Time |                                                                                                          | t <sub>d(off)</sub> | – | 19  | –  |    |
| Fall Time           |                                                                                                          | t <sub>f</sub>      | – | 9.0 | –  |    |
| Gate Charge         | (V <sub>GS</sub> = 4.5 Vdc, I <sub>D</sub> = 31 Adc,<br>V <sub>DS</sub> = 10 Vdc) (Note 3)               | Q <sub>T</sub>      | – | 9.5 | 14 | nC |
|                     |                                                                                                          | Q <sub>GS</sub>     | – | 2.2 | –  |    |
|                     |                                                                                                          | Q <sub>GD</sub>     | – | 5.0 | –  |    |

### SOURCE-DRAIN DIODE CHARACTERISTICS

|                                |                                                                                                                                                                                                 |                 |             |                      |               |     |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------|----------------------|---------------|-----|
| Forward On-Voltage             | (I <sub>S</sub> = 20 Adc, V <sub>GS</sub> = 0 Vdc) (Note 3)<br>(I <sub>S</sub> = 31 Adc, V <sub>GS</sub> = 0 Vdc)<br>(I <sub>S</sub> = 15 Adc, V <sub>GS</sub> = 0 Vdc, T <sub>J</sub> = 125°C) | V <sub>SD</sub> | –<br>–<br>– | 0.88<br>1.15<br>0.80 | 1.2<br>–<br>– | Vdc |
| Reverse Recovery Time          | (I <sub>S</sub> = 31 Adc, V <sub>GS</sub> = 0 Vdc,<br>di <sub>S</sub> /dt = 100 A/μs) (Note 3)                                                                                                  | t <sub>rr</sub> | –           | 29.1                 | –             | ns  |
|                                |                                                                                                                                                                                                 | t <sub>a</sub>  | –           | 13.6                 | –             |     |
|                                |                                                                                                                                                                                                 | t <sub>b</sub>  | –           | 15.5                 | –             |     |
| Reverse Recovery Stored Charge |                                                                                                                                                                                                 | Q <sub>rr</sub> | –           | 0.02                 | –             | μC  |

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

4. Switching characteristics are independent of operating junction temperatures.

TYPICAL CHARACTERISTICS

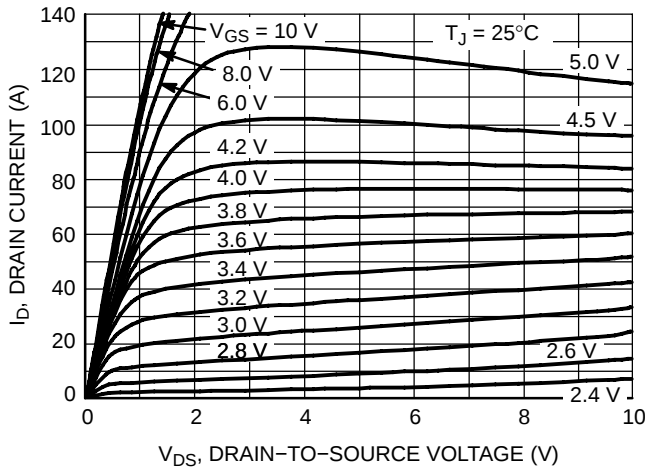


Figure 1. On-Region Characteristics

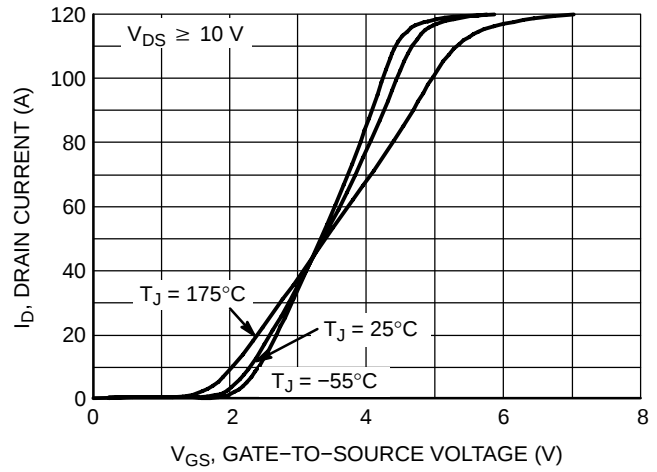


Figure 2. Transfer Characteristics

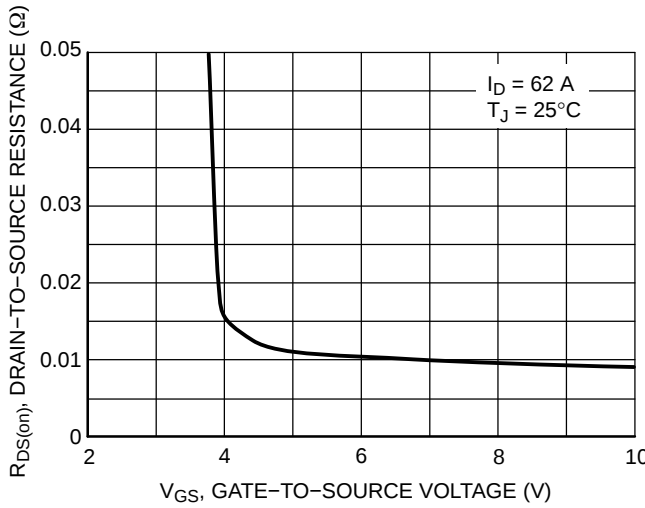


Figure 3. On-Resistance versus Gate-to-Source Voltage

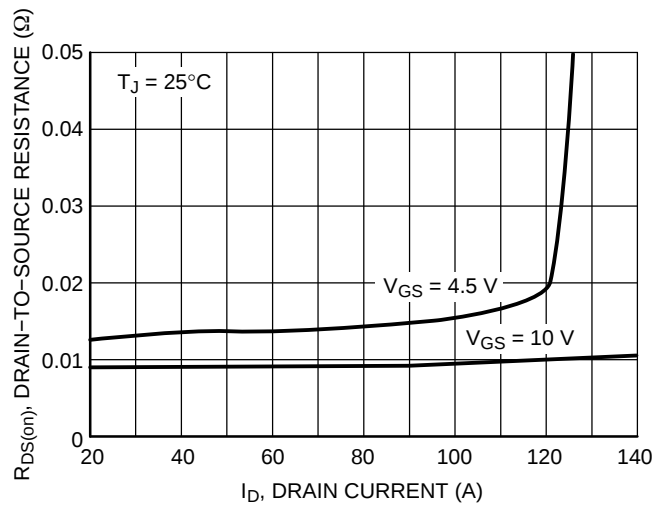


Figure 4. On-Resistance versus Drain Current and Gate Voltage

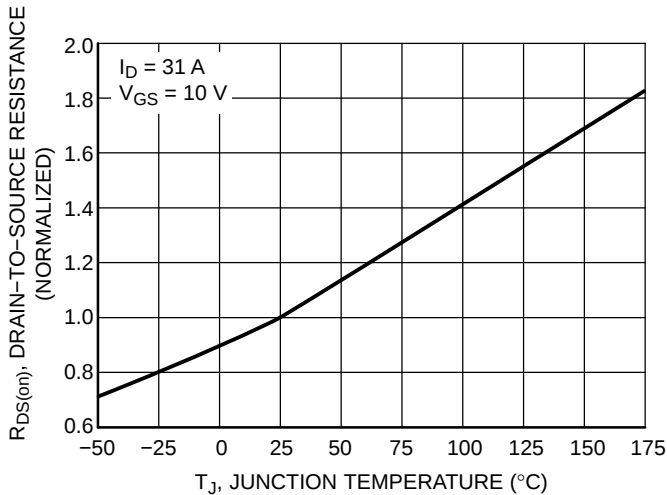


Figure 5. On-Resistance Variation with Temperature

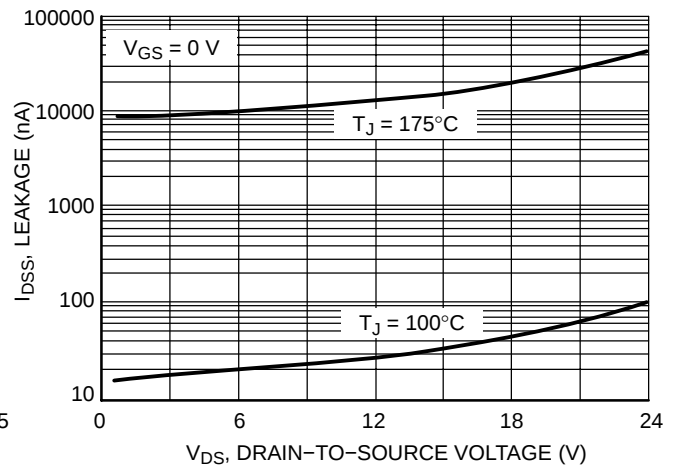


Figure 6. Drain-to-Source Leakage Current versus Voltage

# NTD60N02R

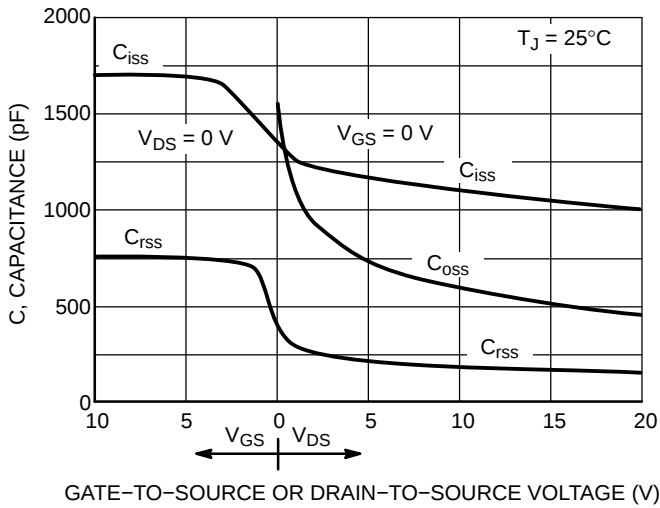


Figure 7. Capacitance Variation

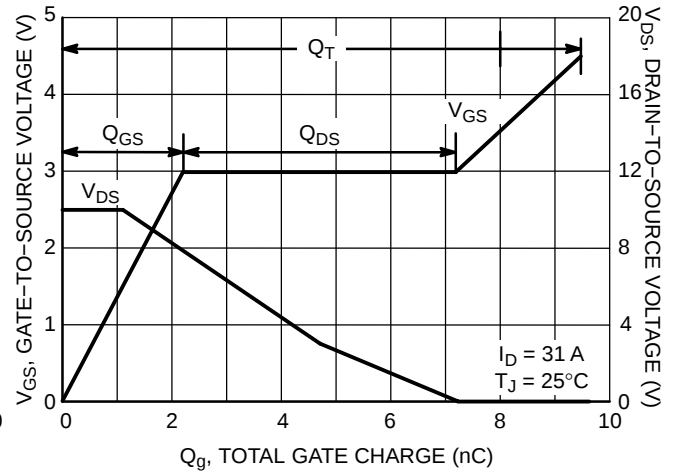


Figure 8. Gate-to-Source and Drain-to-Source Voltage versus Total Charge

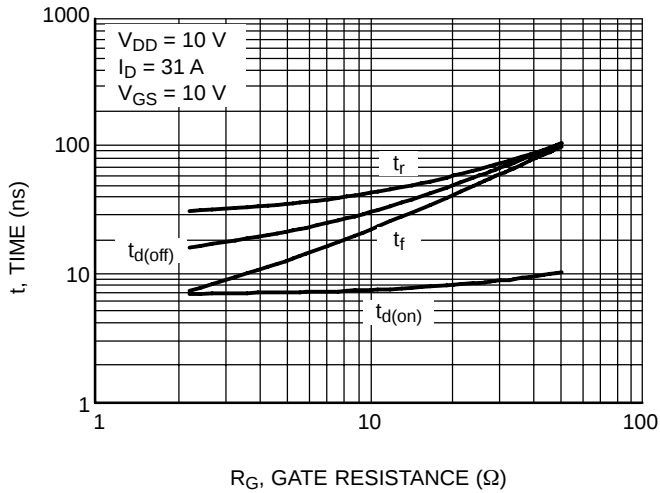


Figure 9. Resistive Switching Time Variation versus Gate Resistance

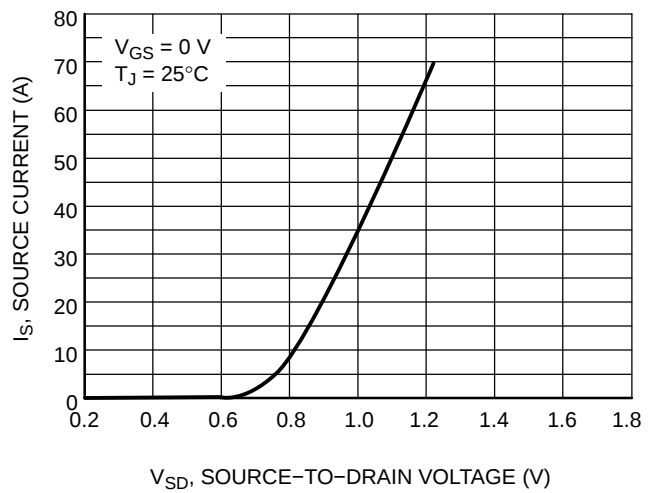


Figure 10. Diode Forward Voltage versus Current

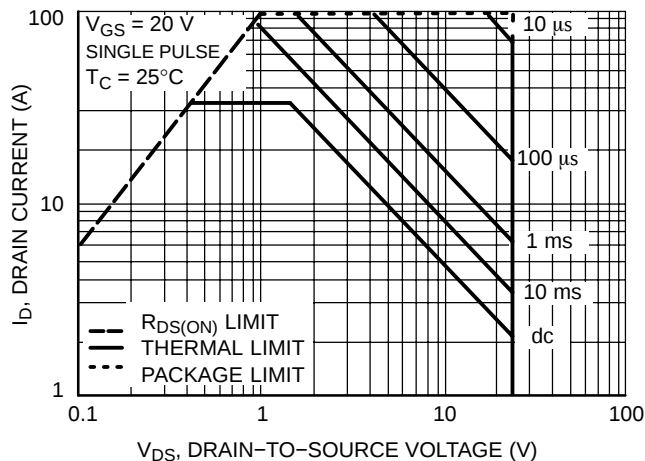
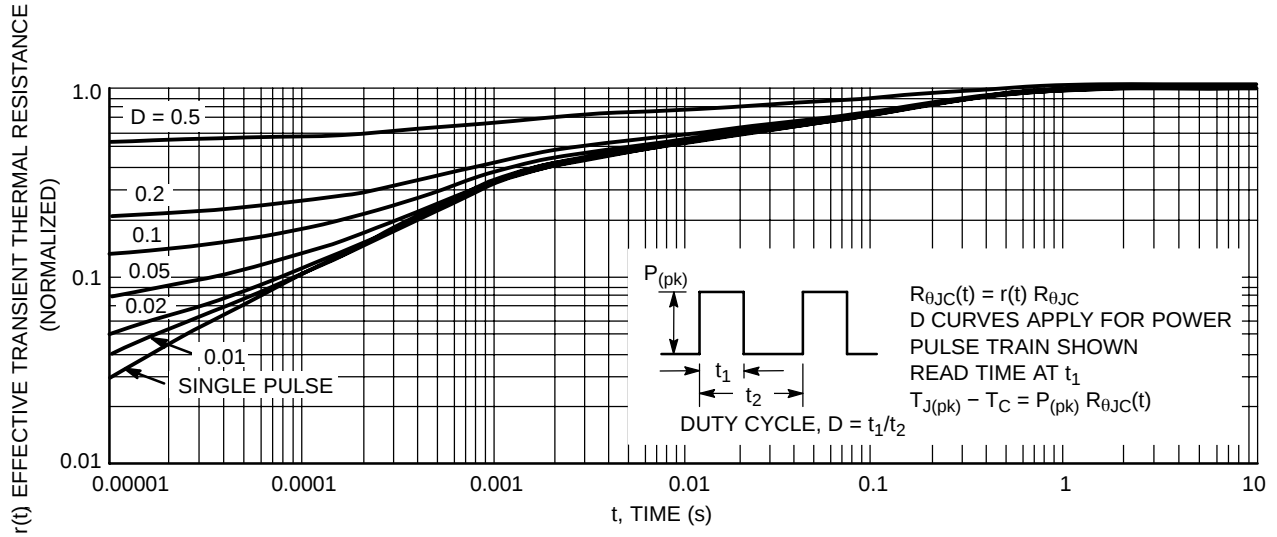


Figure 11. Maximum Rated Forward Biased Safe Operating Area

## NTD60N02R



### ORDERING INFORMATION

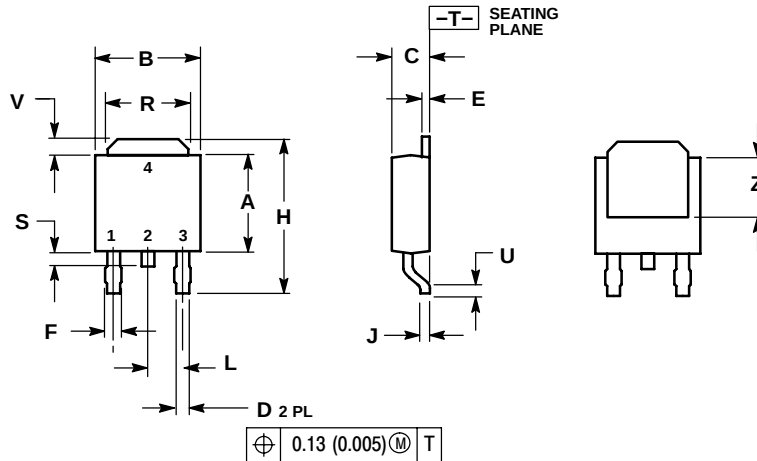
| Order Number  | Package                                              | Shipping <sup>†</sup> |
|---------------|------------------------------------------------------|-----------------------|
| NTD60N02R     | DPAK-3                                               | 75 Units / Rail       |
| NTD60N02RG    | DPAK-3<br>(Pb-Free)                                  | 75 Units / Rail       |
| NTD60N02RT4   | DPAK-3                                               | 2500 / Tape & Reel    |
| NTD60N02RT4G  | DPAK-3<br>(Pb-Free)                                  | 2500 / Tape & Reel    |
| NTD60N02R-1   | DPAK-3 Straight Lead                                 | 75 Units / Rail       |
| NTD60N02R-1G  | DPAK-3 Straight Lead<br>(Pb-Free)                    | 75 Units / Rail       |
| NTD60N02R-35  | DPAK-3 Straight Lead<br>(3.5 ± 0.15 mm)              | 75 Units / Rail       |
| NTD60N02R-35G | DPAK-3 Straight Lead<br>(3.5 ± 0.15 mm)<br>(Pb-Free) | 75 Units / Rail       |

<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.

# NTD60N02R

## PACKAGE DIMENSIONS

**DPAK**  
CASE 369AA-01  
ISSUE A

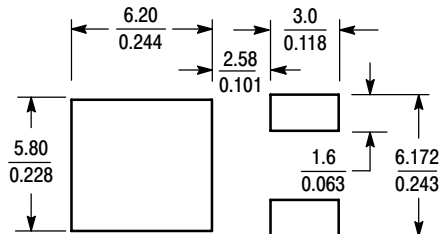


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

| 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        | ---   |

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

## SOLDERING FOOTPRINT\*



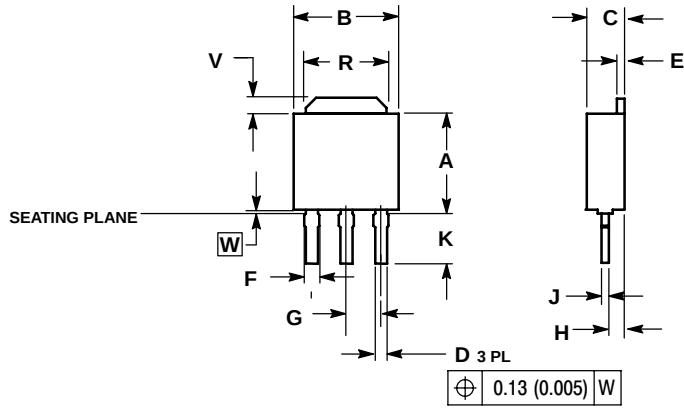
SCALE 3:1  $\left( \frac{\text{mm}}{\text{inches}} \right)$

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

# NTD60N02R

## PACKAGE DIMENSIONS

### 3 IPAK, STRAIGHT LEAD CASE 369AC-01 ISSUE O



#### NOTES:

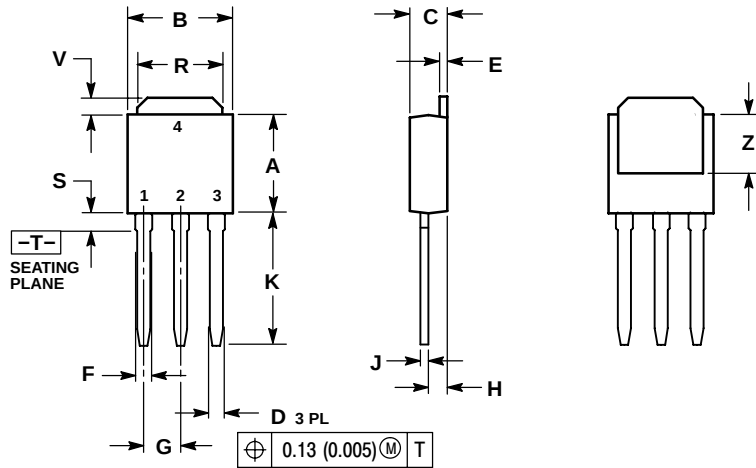
- 1.. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- 2.. CONTROLLING DIMENSION: INCH.
3. SEATING PLANE IS ON TOP OF DAMBAR POSITION.
4. DIMENSION A DOES NOT INCLUDE DAMBAR POSITION OR MOLD GATE.

| 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   | 0.027     | 0.035 | 0.69        | 0.88 |
| E   | 0.018     | 0.023 | 0.46        | 0.58 |
| F   | 0.037     | 0.043 | 0.94        | 1.09 |
| 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   | 0.134     | 0.142 | 3.40        | 3.60 |
| R   | 0.180     | 0.215 | 4.57        | 5.46 |
| V   | 0.035     | 0.050 | 0.89        | 1.27 |
| W   | 0.000     | 0.010 | 0.000       | 0.25 |

# NTD60N02R

## PACKAGE DIMENSIONS

### DPAK 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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