



**THE DATASHEET OF  
NTP125N02RG**



# NTB125N02R, NTP125N02R

## Power MOSFET 125 A, 24 V N-Channel TO-220, D<sup>2</sup>PAK

### Features

- Planar HD3e Process for Fast Switching Performance
- Body Diode for Low  $t_{rr}$  and  $Q_{rr}$  and Optimized for Synchronous Operation
- Low  $C_{iss}$  to Minimize Driver Loss
- Optimized  $Q_{gd}$  and  $R_{DS(on)}$  for Shoot-through Protection
- Low Gate Charge
- Pb-Free Packages are Available

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

| Parameter  | Symbol          | Value      | Unit                      |
|--|-----------------|------------|---------------------------|
| Drain-to-Source Voltage  | $V_{DSS}$       | 24         | $V_{dc}$                  |
| Gate-to-Source Voltage – Continuous  | $V_{GS}$        | $\pm 20$   | $V_{dc}$                  |
| Thermal Resistance – Junction-to-Case  | $R_{\theta JC}$ | 1.1        | $^\circ\text{C}/\text{W}$ |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$   | $P_D$           | 113.6      | W                         |
| Drain Current –  |                 |            |                           |
| Continuous @ $T_C = 25^\circ\text{C}$ , Chip   | $I_D$           | 125        | A                         |
| Continuous @ $T_C = 25^\circ\text{C}$ , Limited by Package   | $I_D$           | 120.5      | A                         |
| Continuous @ $T_A = 25^\circ\text{C}$ , Limited by Wires   | $I_D$           | 95         | A                         |
| Single Pulse ( $t_p = 10 \mu\text{s}$ )  | $I_D$           | 250        | A                         |
| Thermal Resistance –   |                 |            |                           |
| Junction-to-Ambient (Note 1)   | $R_{\theta JA}$ | 46         | $^\circ\text{C}/\text{W}$ |
| Total Power Dissipation @ $T_A = 25^\circ\text{C}$   | $P_D$           | 2.72       | W                         |
| Drain Current – Continuous @ $T_A = 25^\circ\text{C}$  | $I_D$           | 18.6       | A                         |
| Thermal Resistance –   |                 |            |                           |
| Junction-to-Ambient (Note 2)   | $R_{\theta JA}$ | 63         | $^\circ\text{C}/\text{W}$ |
| Total Power Dissipation @ $T_A = 25^\circ\text{C}$   | $P_D$           | 1.98       | W                         |
| Drain Current – Continuous @ $T_A = 25^\circ\text{C}$  | $I_D$           | 15.9       | A                         |
| Operating and Storage Temperature Range  | $T_J, T_{stg}$  | -55 to 150 | $^\circ\text{C}$          |
| Single Pulse Drain-to-Source Avalanche Energy – Starting $T_J = 25^\circ\text{C}$<br>( $V_{DD} = 50 V_{dc}$ , $V_{GS} = 10 V_{dc}$ , $I_L = 15.5 A_{pk}$ ,<br>$L = 1 \text{ mH}$ , $R_G = 25 \Omega$ ) | $E_{AS}$        | 120        | 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 1 inch pad size, (Cu Area 1.127 in<sup>2</sup>).
2. When surface mounted to an FR4 board using minimum recommended pad size, (Cu Area 0.412 in<sup>2</sup>).

### PIN ASSIGNMENT

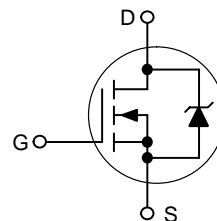
| PIN | FUNCTION |
|-----|----------|
| 1   | Gate     |
| 2   | Drain    |
| 3   | Source   |
| 4   | Drain    |



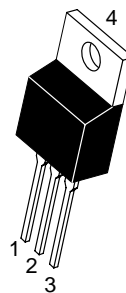
ON Semiconductor®

<http://onsemi.com>

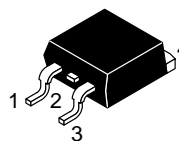
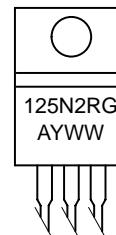
125 AMPERES, 24 VOLTS  
 $R_{DS(on)} = 3.7 \text{ m}\Omega$  (Typ)



### MARKING DIAGRAMS



TO-220AB  
CASE 221A  
STYLE 5



D<sup>2</sup>PAK  
CASE 418AA  
STYLE 2



125N2x = Device Code  
x = R  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

# NTB125N02R, NTP125N02R

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

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

### OFF CHARACTERISTICS

|   |                      |         |          |           |                          |
|---|----------------------|---------|----------|-----------|--------------------------|
| Drain-to-Source Breakdown Voltage (Note 3)<br>(V <sub>GS</sub> = 0 V <sub>dc</sub> , I <sub>D</sub> = 250 μA <sub>dc</sub> )<br>Temperature Coefficient (Positive)  | V <sub>(BR)DSS</sub> | 25<br>– | 28<br>15 | –<br>–    | V <sub>dc</sub><br>mV/°C |
| Zero Gate Voltage Drain Current<br>(V <sub>DS</sub> = 20 V <sub>dc</sub> , V <sub>GS</sub> = 0 V <sub>dc</sub> )<br>(V <sub>DS</sub> = 20 V <sub>dc</sub> , V <sub>GS</sub> = 0 V <sub>dc</sub> , T <sub>J</sub> = 125°C) | I <sub>DSS</sub>     | –<br>–  | –<br>–   | 1.5<br>10 | μA <sub>dc</sub>         |
| Gate-Body Leakage Current<br>(V <sub>GS</sub> = ±20 V <sub>dc</sub> , V <sub>DS</sub> = 0 V <sub>dc</sub> )   | I <sub>GSS</sub>     | –       | –        | ±100      | nA <sub>dc</sub>         |

### ON CHARACTERISTICS (Note 3)

|  |                     |                  |                          |                      |                          |
|--|---------------------|------------------|--------------------------|----------------------|--------------------------|
| Gate Threshold Voltage (Note 3)<br>(V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA <sub>dc</sub> )<br>Threshold Temperature Coefficient (Negative)  | V <sub>GS(th)</sub> | 1.0<br>–         | 1.5<br>5.0               | 2.0<br>–             | V <sub>dc</sub><br>mV/°C |
| Static Drain-to-Source On-Resistance (Note 3)<br>(V <sub>GS</sub> = 10 V <sub>dc</sub> , I <sub>D</sub> = 110 A <sub>dc</sub> )<br>(V <sub>GS</sub> = 4.5 V <sub>dc</sub> , I <sub>D</sub> = 55 A <sub>dc</sub> )<br>(V <sub>GS</sub> = 10 V <sub>dc</sub> , I <sub>D</sub> = 20 A <sub>dc</sub> )<br>(V <sub>GS</sub> = 4.5 V <sub>dc</sub> , I <sub>D</sub> = 20 A <sub>dc</sub> ) | R <sub>DS(on)</sub> | –<br>–<br>–<br>– | 3.7<br>4.9<br>3.7<br>4.7 | –<br>–<br>4.6<br>6.2 | mΩ                       |
| Forward Transconductance (Note 3)<br>(V <sub>DS</sub> = 10 V <sub>dc</sub> , I <sub>D</sub> = 15 A <sub>dc</sub> )   | g <sub>FS</sub>     | –                | 44                       | –                    | Mhos                     |

### DYNAMIC CHARACTERISTICS

|                      |   |                  |   |      |      |    |
|----------------------|---|------------------|---|------|------|----|
| Input Capacitance    | (V <sub>DS</sub> = 20 V <sub>dc</sub> , V <sub>GS</sub> = 0 V, f = 1 MHz) | C <sub>iss</sub> | – | 2710 | 3440 | pF |
| Output Capacitance   |   | C <sub>oss</sub> | – | 1105 | 1670 |    |
| Transfer Capacitance |   | C <sub>rss</sub> | – | 227  | 640  |    |

### SWITCHING CHARACTERISTICS (Note 4)

|                     |   |                     |   |      |    |    |
|---------------------|---|---------------------|---|------|----|----|
| Turn-On Delay Time  | (V <sub>GS</sub> = 10 V <sub>dc</sub> , V <sub>DD</sub> = 10 V <sub>dc</sub> ,<br>I <sub>D</sub> = 40 A <sub>dc</sub> , R <sub>G</sub> = 3 Ω) | t <sub>d(on)</sub>  | – | 11   | 22 | ns |
| Rise Time           |   | t <sub>r</sub>      | – | 39   | 80 |    |
| Turn-Off Delay Time |   | t <sub>d(off)</sub> | – | 27   | 40 |    |
| Fall Time           |   | t <sub>f</sub>      | – | 21   | 40 |    |
| Gate Charge         | (V <sub>GS</sub> = 4.5 V <sub>dc</sub> , I <sub>D</sub> = 40 A <sub>dc</sub> ,<br>V <sub>DS</sub> = 10 V <sub>dc</sub> ) (Note 3)             | Q <sub>T</sub>      | – | 23.6 | 28 | nC |
|                     |   | Q <sub>1</sub>      | – | 5.1  | –  |    |
|                     |   | Q <sub>2</sub>      | – | 11   | –  |    |

### SOURCE-DRAIN DIODE CHARACTERISTICS

|                                |   |                 |             |                      |               |                 |
|--------------------------------|---|-----------------|-------------|----------------------|---------------|-----------------|
| Forward On-Voltage             | (I <sub>S</sub> = 20 A <sub>dc</sub> , V <sub>GS</sub> = 0 V <sub>dc</sub> ) (Note 3)<br>(I <sub>S</sub> = 55 A <sub>dc</sub> , V <sub>GS</sub> = 0 V <sub>dc</sub> )<br>(I <sub>S</sub> = 20 A <sub>dc</sub> , V <sub>GS</sub> = 0 V <sub>dc</sub> , T <sub>J</sub> = 125°C) | V <sub>SD</sub> | –<br>–<br>– | 0.82<br>0.99<br>0.65 | 1.2<br>–<br>– | V <sub>dc</sub> |
| Reverse Recovery Time          | (I <sub>S</sub> = 30 A <sub>dc</sub> , V <sub>GS</sub> = 0 V <sub>dc</sub> ,<br>di <sub>S</sub> /dt = 100 A/μs) (Note 3)  | t <sub>rr</sub> | –           | 36.5                 | –             | ns              |
|                                |   | t <sub>a</sub>  | –           | 17.7                 | –             |                 |
|                                |   | t <sub>b</sub>  | –           | 18.8                 | –             |                 |
| Reverse Recovery Stored Charge |   | Q <sub>RR</sub> | –           | 0.024                | –             | μC              |

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

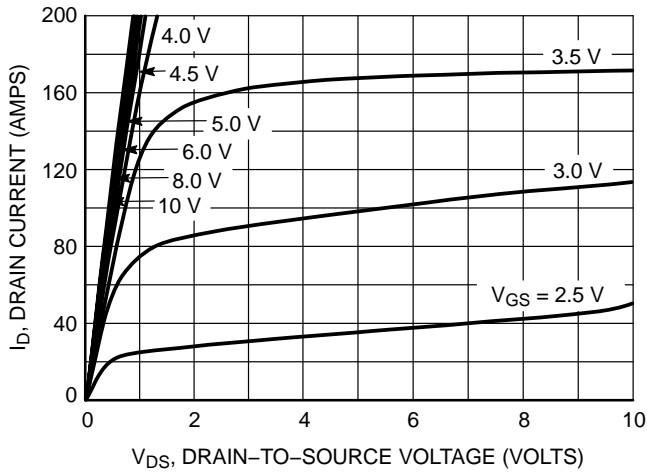
4. Switching characteristics are independent of operating junction temperatures.

### ORDERING INFORMATION

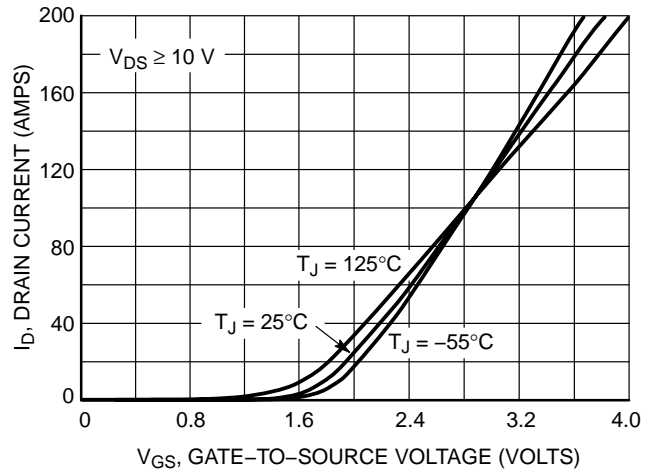
| Device        | Package                         | Shipping†               |
|---------------|---------------------------------|-------------------------|
| NTP125N02R    | TO-220AB                        | 50 Units / Rail         |
| NTP125N02RG   | TO-220AB<br>(Pb-Free)           | 50 Units / Rail         |
| NTB125N02R    | D <sup>2</sup> PAK              | 50 Units / Rail         |
| NTB125N02RG   | D <sup>2</sup> PAK<br>(Pb-Free) | 50 Units / Rail         |
| NTB125N02RT4  | D <sup>2</sup> PAK              | 800 Units / Tape & Reel |
| NTB125N02RT4G | D <sup>2</sup> PAK<br>(Pb-Free) | 800 Units / 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.

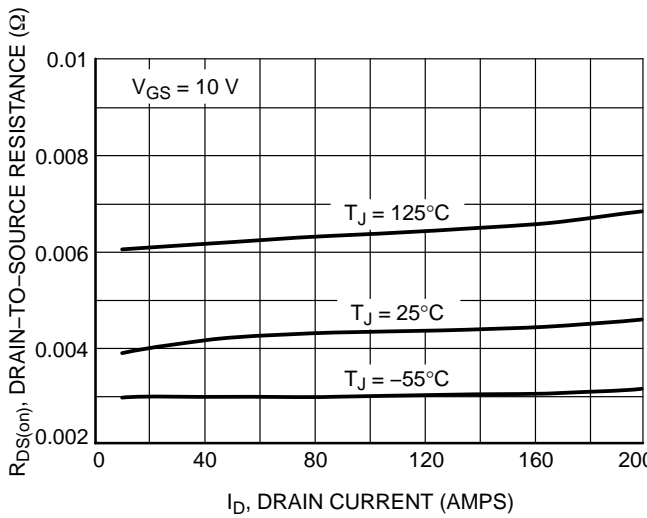
# NTB125N02R, NTP125N02R



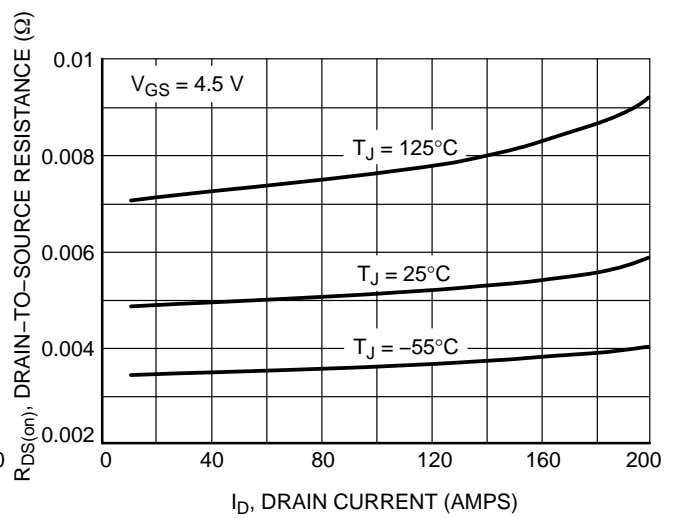
**Figure 1. On-Region Characteristics**



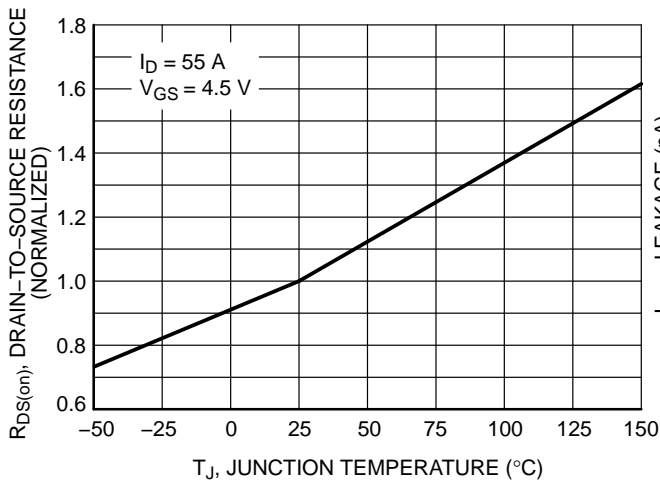
**Figure 2. Transfer Characteristics**



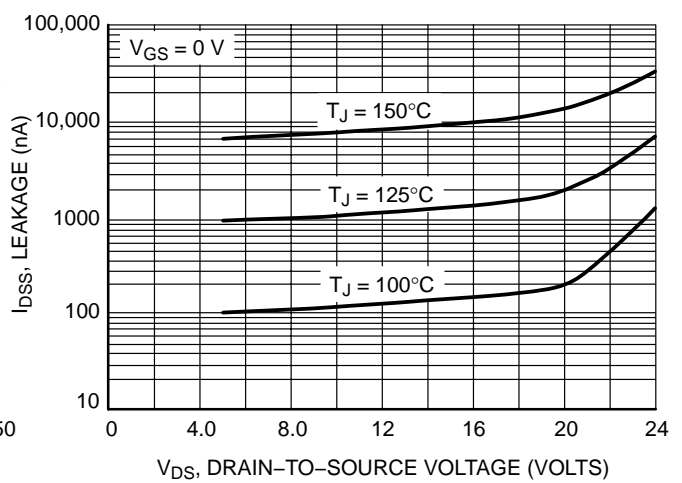
**Figure 3. On-Resistance versus Drain Current and Temperature**



**Figure 4. On-Resistance versus Drain Current and Temperature**

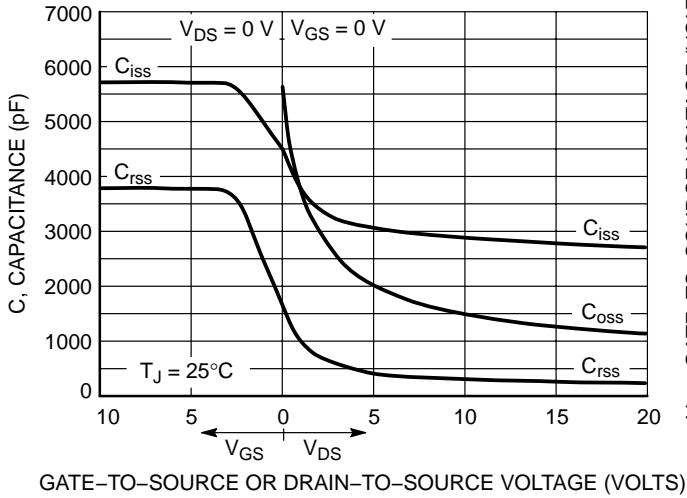


**Figure 5. On-Resistance Variation with Temperature**

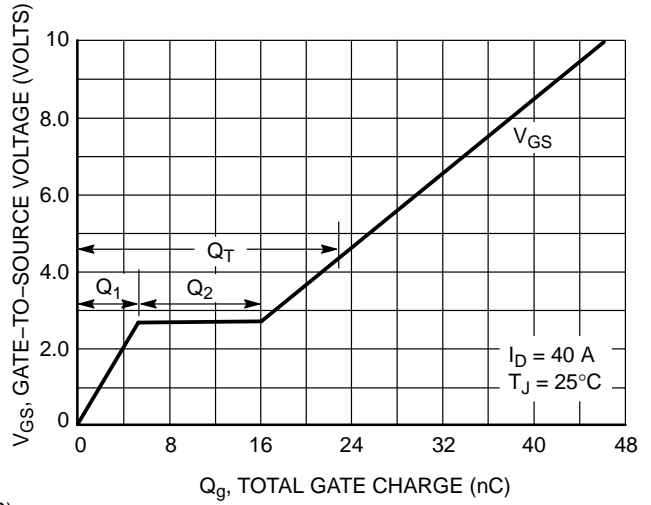


**Figure 6. Drain-to-Source Leakage Current versus Voltage**

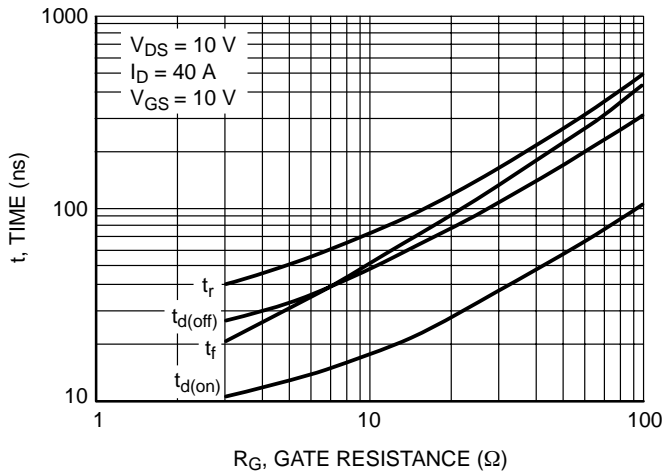
# NTB125N02R, NTP125N02R



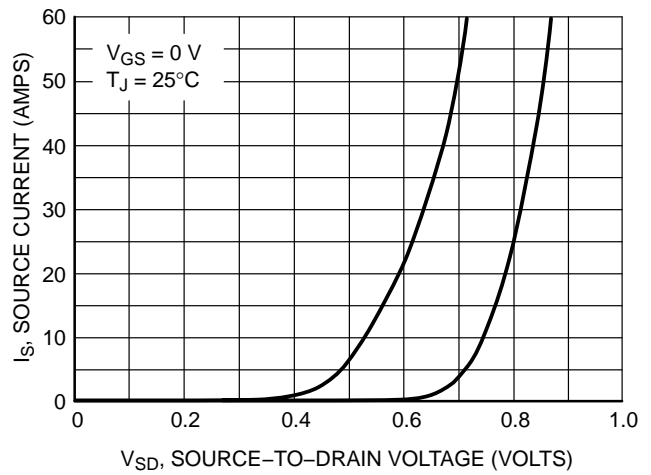
**Figure 7. Capacitance Variation**



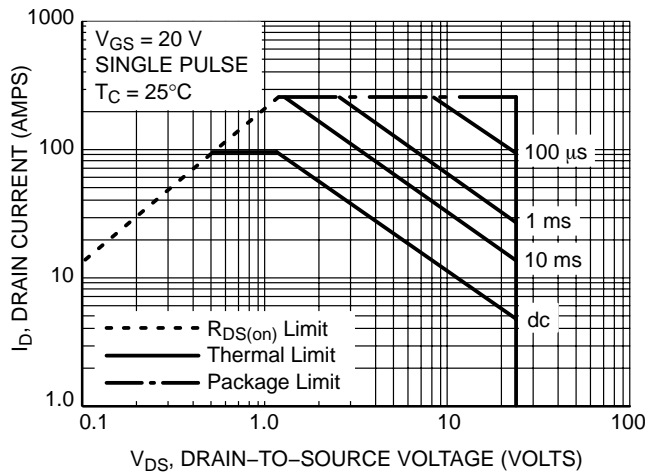
**Figure 8. Gate-to-Source and Drain-to-Source Voltage versus Total Charge**



**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**

# NTB125N02R, NTP125N02R

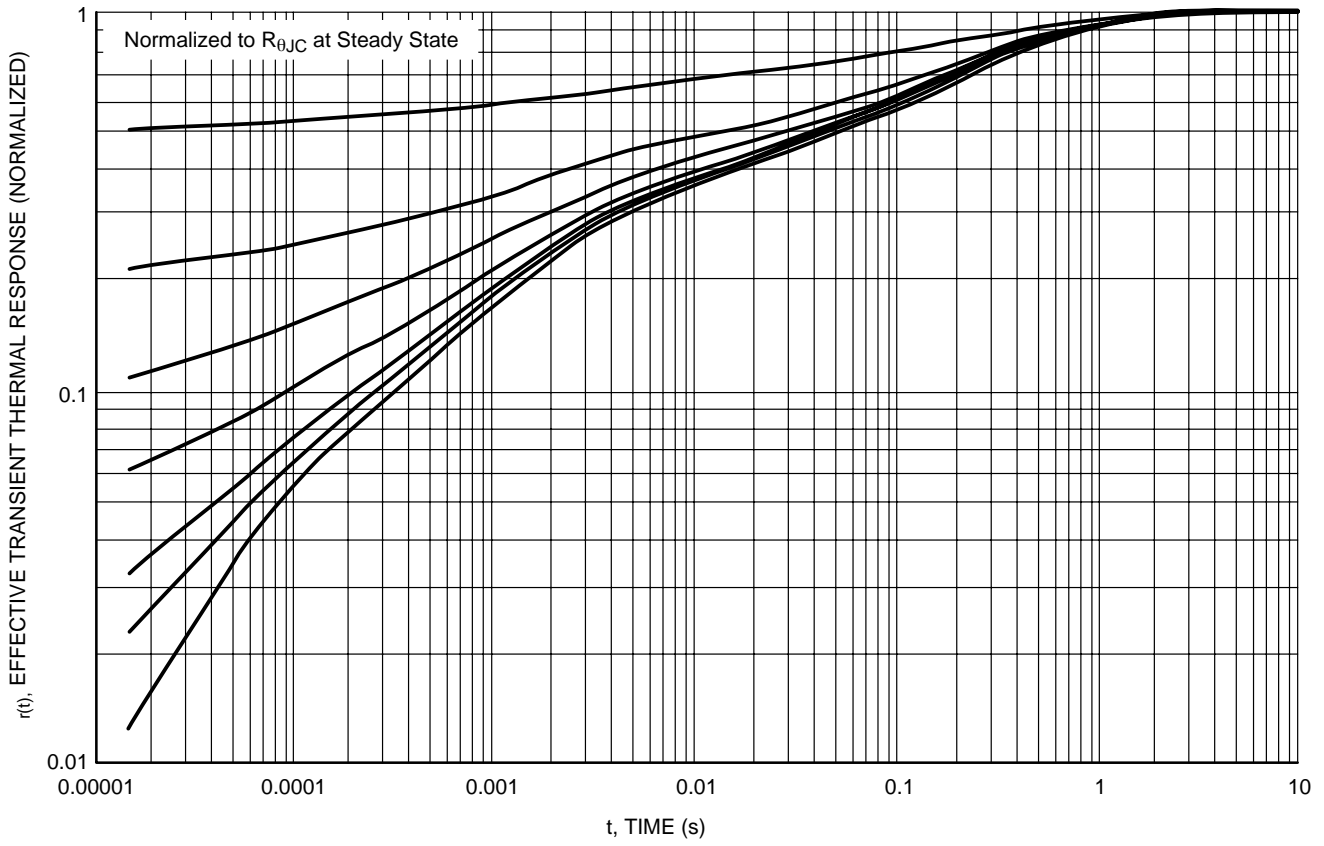
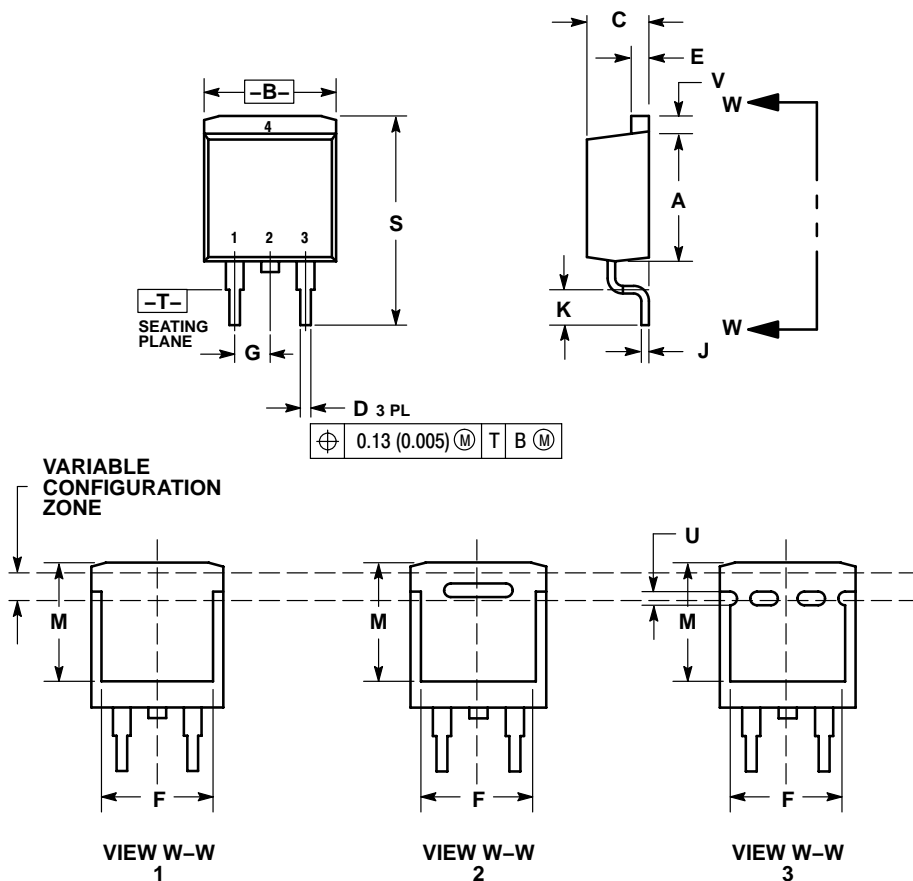


Figure 12. Thermal Response

# NTB125N02R, NTP125N02R

## PACKAGE DIMENSIONS

D<sup>2</sup>PAK  
CASE 418AA-01  
ISSUE O

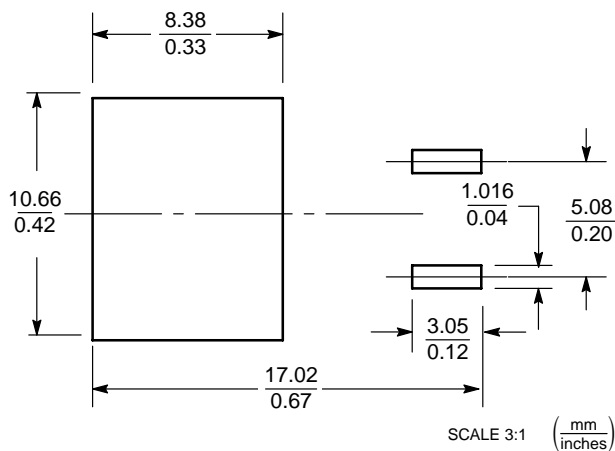


NOTES:  
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.340     | 0.380 | 8.64        | 9.65  |
| B   | 0.380     | 0.405 | 9.65        | 10.29 |
| C   | 0.160     | 0.190 | 4.06        | 4.83  |
| D   | 0.020     | 0.036 | 0.51        | 0.92  |
| E   | 0.045     | 0.055 | 1.14        | 1.40  |
| F   | 0.310     | ---   | 7.87        | ---   |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| J   | 0.018     | 0.025 | 0.46        | 0.64  |
| K   | 0.090     | 0.110 | 2.29        | 2.79  |
| M   | 0.280     | ---   | 7.11        | ---   |
| S   | 0.575     | 0.625 | 14.60       | 15.88 |
| V   | 0.045     | 0.055 | 1.14        | 1.40  |

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

### SOLDERING FOOTPRINT\*



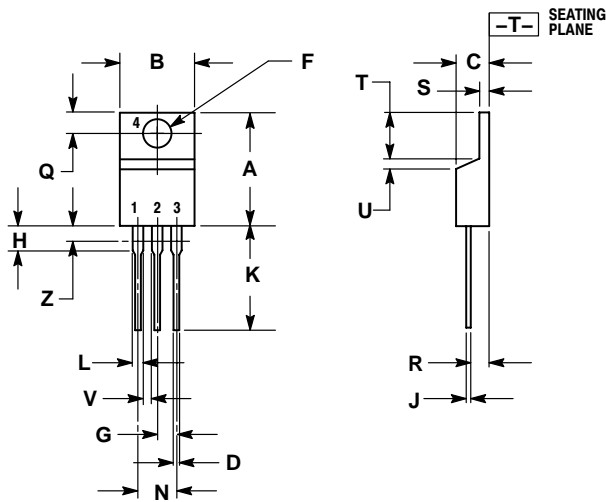
SCALE 3:1 (mm/inches)

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

# NTB125N02R, NTP125N02R

## PACKAGE DIMENSIONS

TO-220  
CASE 221A-09  
ISSUE AA



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  | 0.147 | 3.61        | 3.73  |
| G   | 0.095  | 0.105 | 2.42        | 2.66  |
| H   | 0.110  | 0.155 | 2.80        | 3.93  |
| J   | 0.018  | 0.025 | 0.46        | 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:

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

ON Semiconductor and are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

### PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT:**  
Literature Distribution Center for ON Semiconductor  
P.O. Box 61312, Phoenix, Arizona 85082-1312 USA  
**Phone:** 480-829-7710 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 480-829-7709 or 800-344-3867 Toll Free USA/Canada  
**Email:** orderlit@onsemi.com

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada

**Japan:** ON Semiconductor, Japan Customer Focus Center  
2-9-1 Kamimeguro, Meguro-ku, Tokyo, Japan 153-0051  
**Phone:** 81-3-5773-3850

**ON Semiconductor Website:** <http://onsemi.com>

**Order Literature:** <http://www.onsemi.com/litorder>

For additional information, please contact your local Sales Representative.

## Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

- ⊖ [View NTP125N02RG](#) on WIN SOURCE
- ⊖ [ON Semiconductor](#) Information

## Optimize Your Supply Chain with WIN SOURCE Solutions

- ✓ Global Sourcing Solution
- ✓ Obsolete Management
- ✓ Cost Control Management
- ✓ Shortage Management
- ✓ Alternative Solution
- ✓ Excess Inventory Management