



**THE DATASHEET OF  
NTB65N02RT4G**



# NTB65N02R, NTP65N02R

## Power MOSFET 65 A, 24 V N-Channel TO-220, D<sup>2</sup>PAK

### 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
- Pb-Free Packages are Available\*

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

| Parameter   | Symbol              | Value      | Unit                      |
|---|---------------------|------------|---------------------------|
| Drain-to-Source Voltage   | $V_{DS}$            | 25         | $V_{dc}$                  |
| Gate-to-Source Voltage – Continuous   | $V_{GS}$            | $\pm 20$   | $V_{dc}$                  |
| Thermal Resistance – Junction-to-Case   | $R_{\theta JC}$     | 2.0        | $^\circ\text{C}/\text{W}$ |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$  | $P_D$               | 62.5       | W                         |
| Drain Current –   |                     |            |                           |
| Continuous @ $T_C = 25^\circ\text{C}$ , Chip  | $I_D$               | 65         | A                         |
| Continuous @ $T_C = 25^\circ\text{C}$ , Limited by Package  | $I_D$               | 58         | A                         |
| Single Pulse ( $t_p = 10 \mu\text{s}$ )   | $I_{DM}$            | 160        | A                         |
| Thermal Resistance –  |                     |            |                           |
| Junction-to-Ambient (Note 1)  | $R_{\theta JA}$     | 67         | $^\circ\text{C}/\text{W}$ |
| Total Power Dissipation @ $T_A = 25^\circ\text{C}$  | $P_D$               | 1.86       | W                         |
| Drain Current – Continuous @ $T_A = 25^\circ\text{C}$   | $I_D$               | 10         | A                         |
| Thermal Resistance –  |                     |            |                           |
| Junction-to-Ambient (Note 2)  | $R_{\theta JA}$     | 120        | $^\circ\text{C}/\text{W}$ |
| Total Power Dissipation @ $T_A = 25^\circ\text{C}$  | $P_D$               | 1.04       | W                         |
| Drain Current – Continuous @ $T_A = 25^\circ\text{C}$   | $I_D$               | 7.6        | A                         |
| Operating and Storage Temperature Range   | $T_J$ and $T_{stg}$ | -55 to 150 | $^\circ\text{C}$          |
| Single Pulse Drain-to-Source Avalanche Energy – Starting $T_J = 25^\circ\text{C}$<br>( $V_{DD} = 50 V_{dc}$ , $V_{GS} = 10 V_{dc}$ , $I_L = 11 A_{pk}$ , $L = 1 \text{ mH}$ , $R_G = 25 \Omega$ ) | $E_{AS}$            | 60         | mJ                        |
| Maximum Lead Temperature for Soldering Purposes, 1/8" from Case for 10 Seconds  | $T_L$               | 260        | $^\circ\text{C}$          |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. When surface mounted to an FR4 board using 1 in. 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>).

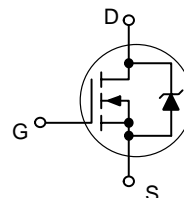
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



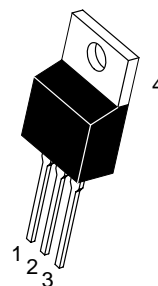
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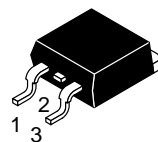
| $V_{(BR)DSS}$ | $R_{DS(on)}$ TYP      | $I_D$ MAX |
|---------------|-----------------------|-----------|
| 24 V          | 8.4 m $\Omega$ @ 10 V | 65 A      |



### MARKING DIAGRAMS



TO-220AB  
CASE 221A  
STYLE 5



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



65N02R = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### PIN ASSIGNMENT

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

### ORDERING INFORMATION

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

# NTB65N02R, NTP65N02R

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

| Characteristics   | Symbol               | Min     | Typ          | Max       | Unit                     |
|---|----------------------|---------|--------------|-----------|--------------------------|
| <b>OFF CHARACTERISTICS</b>  |                      |         |              |           |                          |
| 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> | 24<br>– | 27.5<br>25.5 | –<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> = 150°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>4.1         | 2.0<br>–          | V <sub>dc</sub><br>mV/°C |
| Static Drain-to-Source On-Resistance (Note 3)<br>(V <sub>GS</sub> = 4.5 V <sub>dc</sub> , I <sub>D</sub> = 15 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> = 10 V <sub>dc</sub> , I <sub>D</sub> = 30 A <sub>dc</sub> ) | R <sub>DS(on)</sub> | –<br>–<br>– | 11.2<br>8.4<br>8.2 | 12.5<br>10.5<br>– | 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>     | –           | 27                 | –                 | 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> | – | 948 | 1330 | pF |
| Output Capacitance   |   | C <sub>OSS</sub> | – | 456 | 640  |    |
| Transfer Capacitance |   | C <sub>rSS</sub> | – | 160 | 225  |    |

### 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> = 30 A <sub>dc</sub> , R <sub>G</sub> = 3 Ω) | t <sub>d(on)</sub>  | – | 7.0 | – | ns |
| Rise Time           |   | t <sub>r</sub>      | – | 53  | – |    |
| Turn-Off Delay Time |   | t <sub>d(off)</sub> | – | 14  | – |    |
| Fall Time           |   | t <sub>f</sub>      | – | 10  | – |    |
| Gate Charge         | (V <sub>GS</sub> = 4.5 V <sub>dc</sub> , I <sub>D</sub> = 30 A <sub>dc</sub> ,<br>V <sub>DS</sub> = 10 V <sub>dc</sub> ) (Note 3)             | Q <sub>T</sub>      | – | 9.5 | – | nC |
|                     |   | Q <sub>1</sub>      | – | 3.0 | – |    |
|                     |   | Q <sub>2</sub>      | – | 4.4 | – |    |

### 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> = 30 A <sub>dc</sub> , V <sub>GS</sub> = 0 V <sub>dc</sub> )<br>(I <sub>S</sub> = 15 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>– | 0.88<br>1.10<br>0.80 | 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> | –           | 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.

# NTB65N02R, NTP65N02R

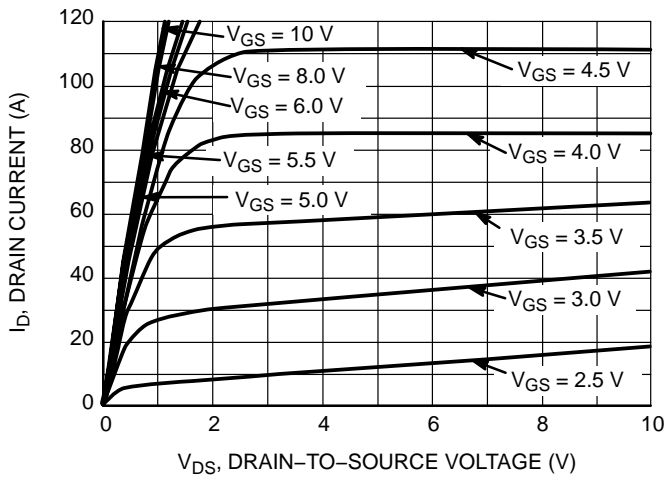


Figure 1. On-Region Characteristics

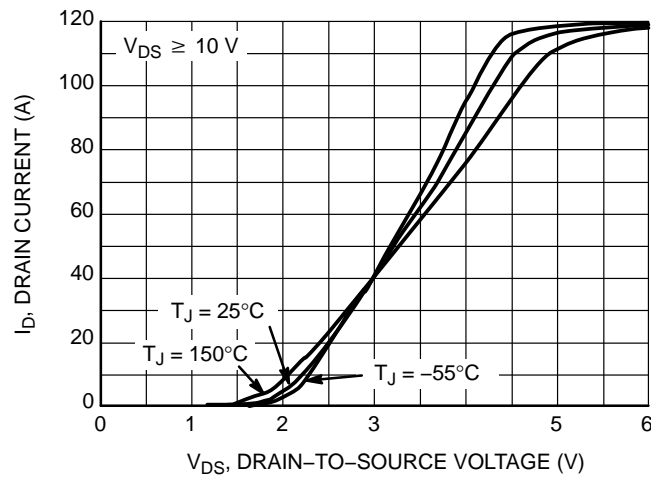


Figure 2. Transfer Characteristics

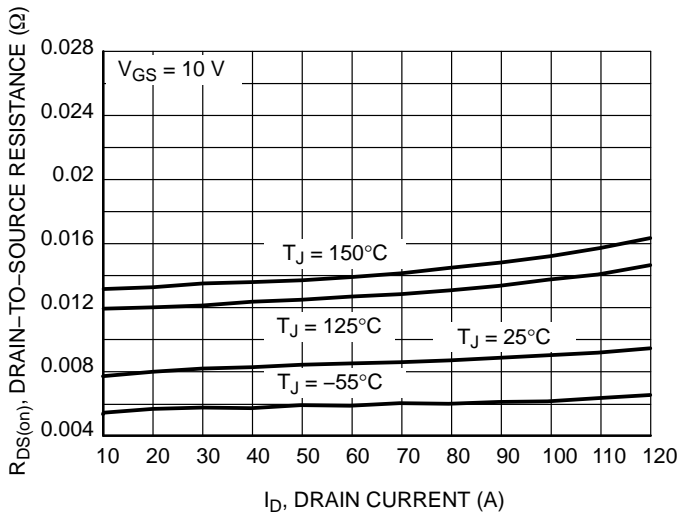


Figure 3. On-Resistance versus Drain Current and Temperature

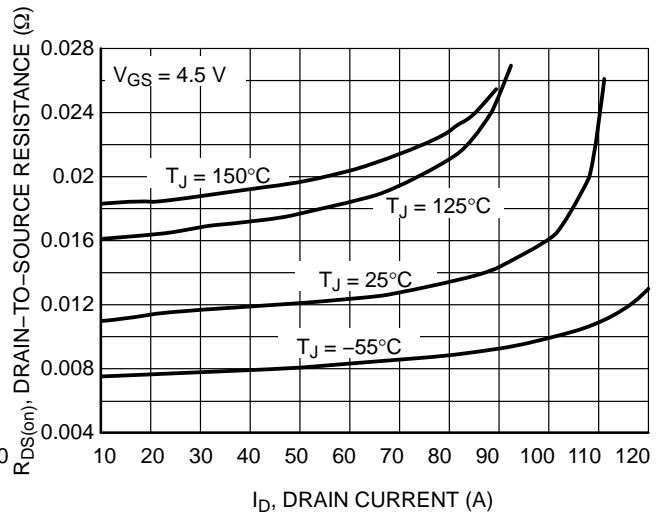


Figure 4. On-Resistance versus Drain Current and Temperature

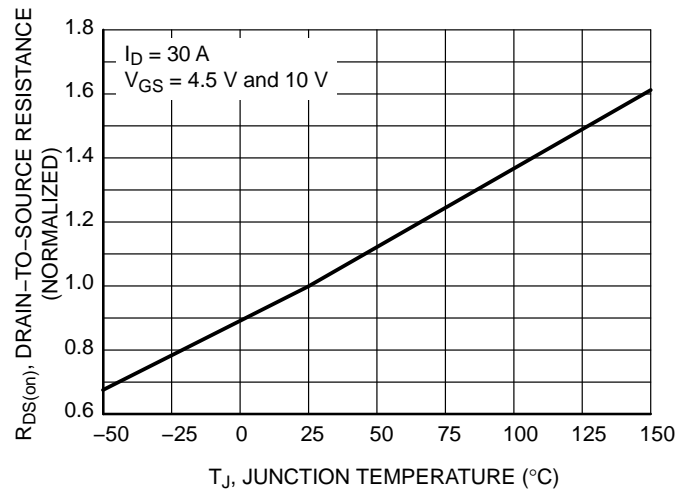


Figure 5. On-Resistance Variation with Temperature

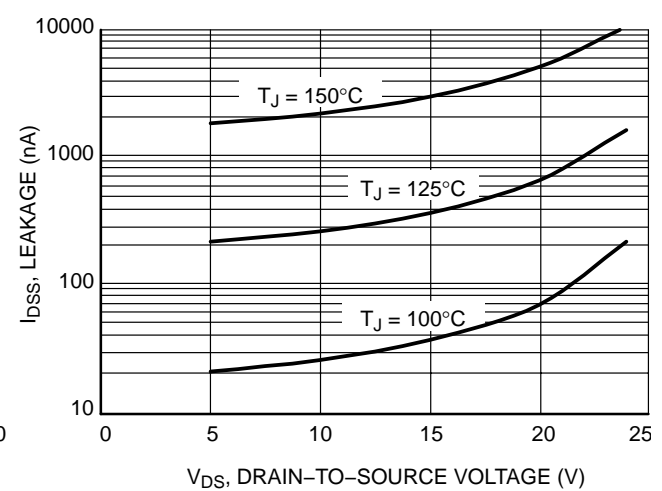


Figure 6. Drain-to-Source Leakage Current versus Voltage

# NTB65N02R, NTP65N02R

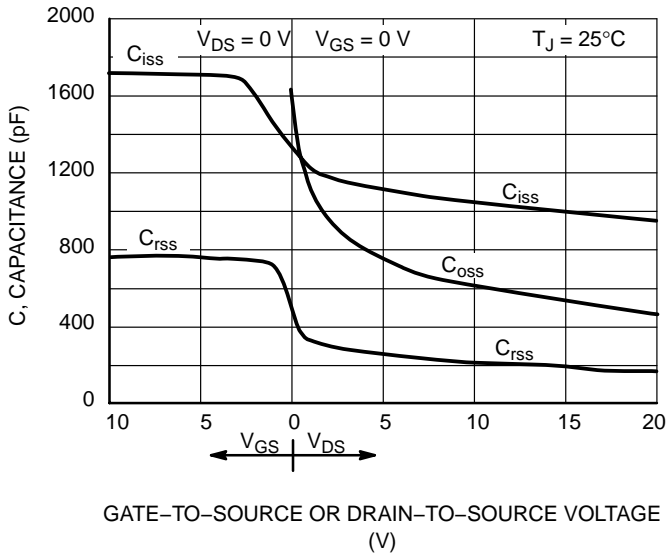


Figure 7. Capacitance Variation

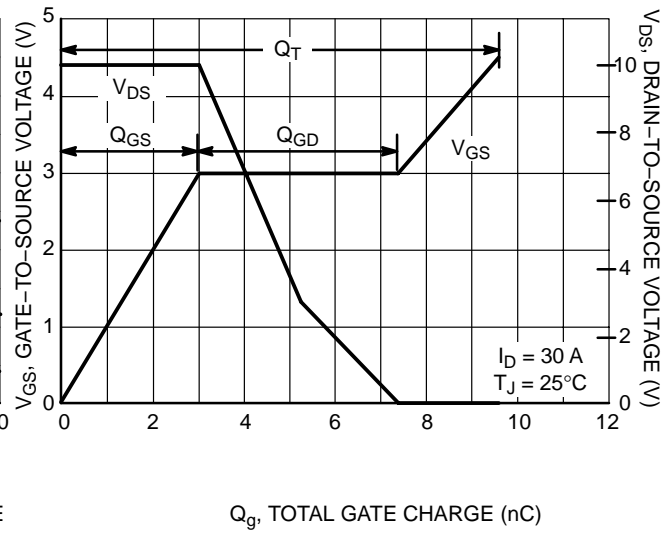


Figure 8. Gate-to-Source and Drain-to-Source Voltage versus Total Charge

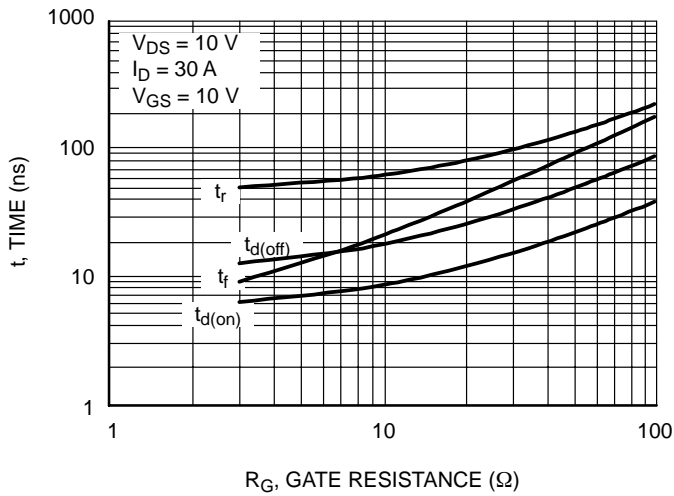


Figure 9. Resistive Switching Time Variation versus Gate Resistance

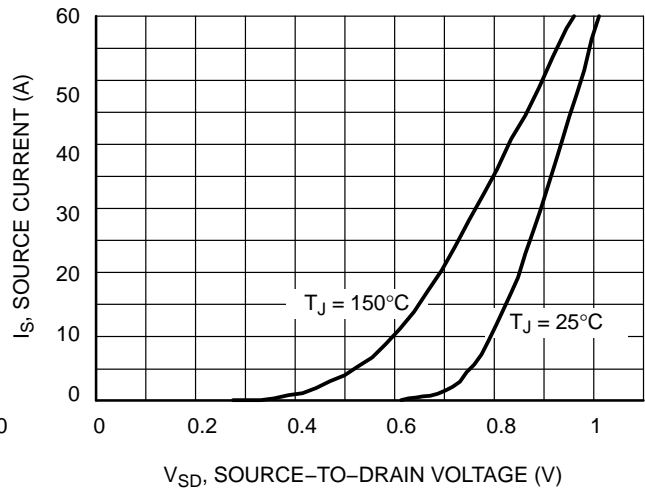


Figure 10. Diode Forward Voltage versus Current

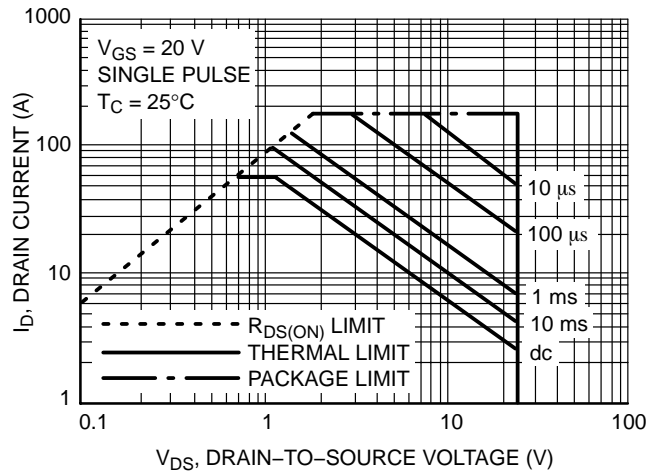
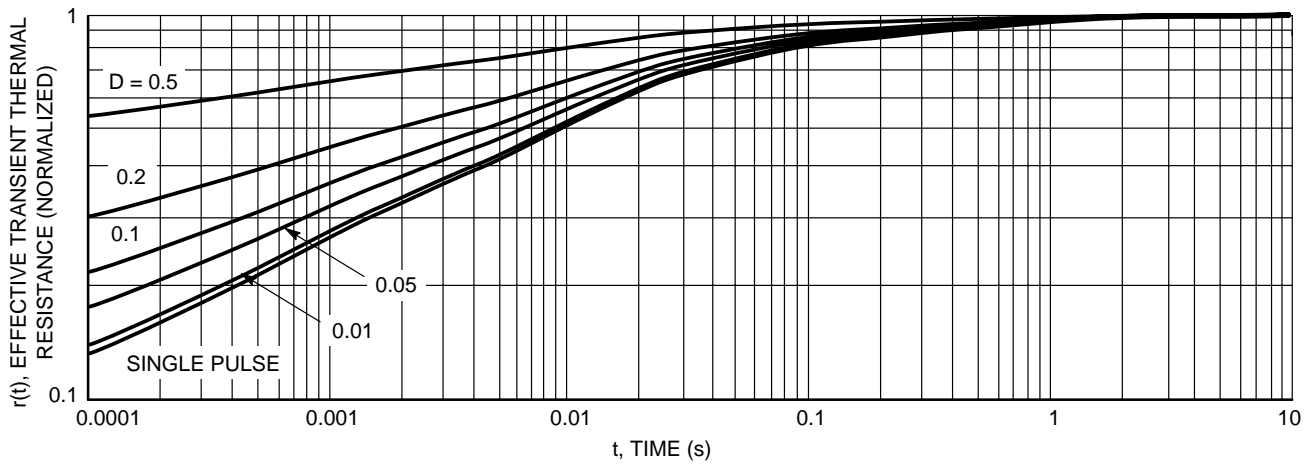


Figure 11. Maximum Rated Forward Biased Safe Operating Area

## NTB65N02R, NTP65N02R



**Figure 12. Thermal Response**

### ORDERING INFORMATION

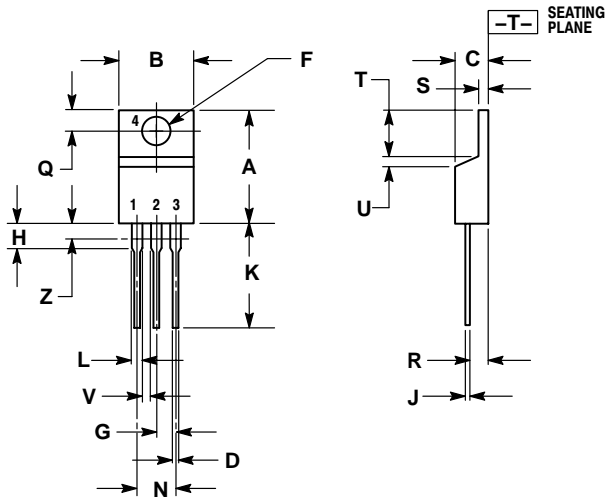
| Device       | Package                         | Shipping†         |
|--------------|---------------------------------|-------------------|
| NTB65N02R    | D <sup>2</sup> PAK              | 50 Units / Rail   |
| NTB65N02RG   | D <sup>2</sup> PAK<br>(Pb-Free) | 50 Units / Rail   |
| NTB65N02RT4  | D <sup>2</sup> PAK              | 800 / Tape & Reel |
| NTB65N02RT4G | D <sup>2</sup> PAK<br>(Pb-Free) | 800 / Tape & Reel |
| NTP65N02R    | TO-220AB                        | 50 Units / Rail   |
| NTP65N02RG   | TO-220AB<br>(Pb-Free)           | 50 Units / Rail   |

†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.

# NTB65N02R, NTP65N02R

## PACKAGE DIMENSIONS

TO-220AB  
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.

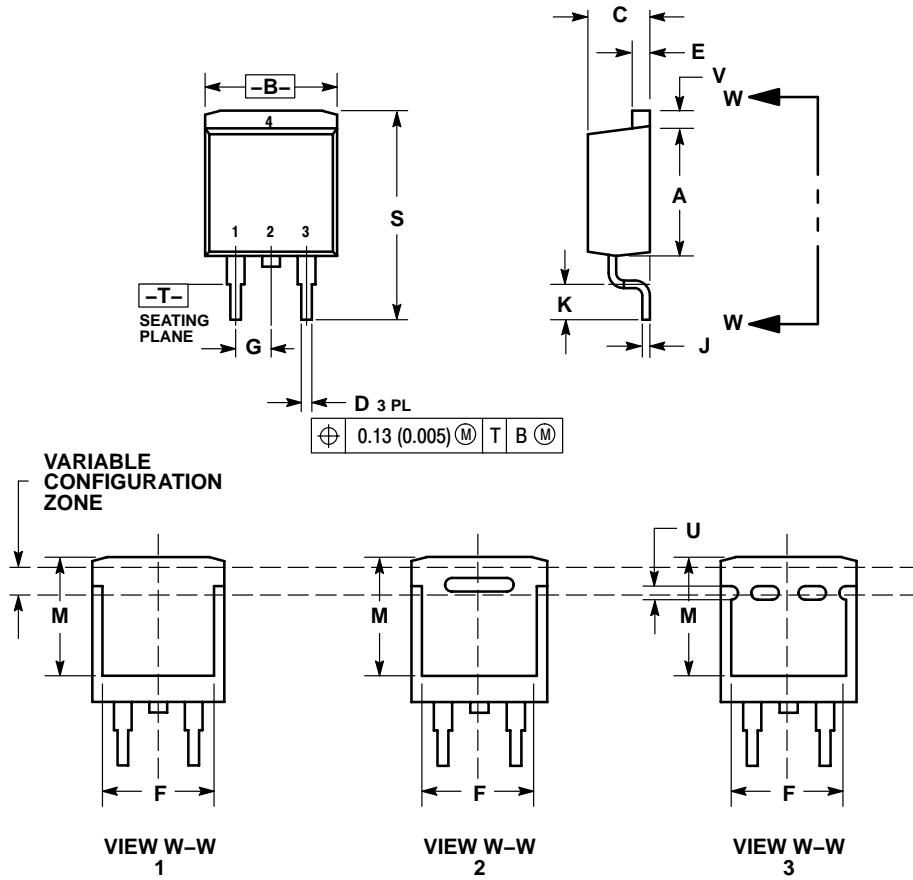
| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.570  | 0.620 | 14.48       | 15.75 |
| B   | 0.380  | 0.405 | 9.66        | 10.28 |
| C   | 0.160  | 0.190 | 4.07        | 4.82  |
| D   | 0.025  | 0.035 | 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

# NTB65N02R, NTP65N02R

## PACKAGE DIMENSIONS

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

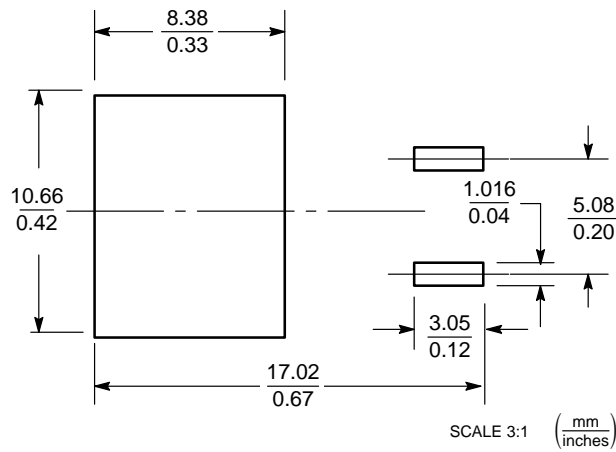


- NOTES:  
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
2. CONTROLLING DIMENSION: INCH.

| 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\*



\*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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