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## Is Now



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# NTB5860N, NTP5860N, NVB5860N

## N-Channel Power MOSFET

### 60 V, 220 A, 3.0 mΩ

#### Features

- Low  $R_{DS(on)}$
- High Current Capability
- 100% Avalanche Tested
- These Devices are Pb-Free, Halogen Free and are RoHS Compliant
- NVB Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable

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

| Parameter   |                        |                             | Symbol         | Value       | Unit               |
|---|------------------------|-----------------------------|----------------|-------------|--------------------|
| Drain-to-Source Voltage   |                        |                             | $V_{DSS}$      | 60          | V                  |
| Gate-to-Source Voltage – Continuous                                     |                        |                             | $V_{GS}$       | $\pm 20$    | V                  |
| Continuous Drain Current, $R_{\theta JC}$                               | Steady State           | $T_C = 25^{\circ}\text{C}$  | $I_D$          | 220         | A                  |
|   |                        | $T_C = 100^{\circ}\text{C}$ |                | 156         |                    |
| Power Dissipation, $R_{\theta JC}$                                      | Steady State           | $T_C = 25^{\circ}\text{C}$  | $P_D$          | 283         | W                  |
| Pulsed Drain Current  | $t_p = 10 \mu\text{s}$ |                             | $I_{DM}$       | 660         | A                  |
| Current Limited by Package  |                        |                             | $I_{DMmax}$    | 130         | A                  |
| Operating and Storage Temperature Range                                 |                        |                             | $T_J, T_{stg}$ | -55 to +175 | $^{\circ}\text{C}$ |
| Source Current (Body Diode)   |                        |                             | $I_S$          | 130         | A                  |
| Single Pulse Drain-to-Source Avalanche Energy ( $L = 0.3 \text{ mH}$ )  |                        |                             | $E_{AS}$       | 735         | mJ                 |
| Lead Temperature for Soldering Purposes (1/8" from Case for 10 Seconds) |                        |                             | $T_L$          | 260         | $^{\circ}\text{C}$ |

#### THERMAL RESISTANCE RATINGS

| Parameter                                   | Symbol          | Max  | Unit               |
|---|-----------------|------|--------------------|
| Junction-to-Case (Drain) Steady State       | $R_{\theta JC}$ | 0.53 | $^\circ\text{C/W}$ |
| Junction-to-Ambient – Steady State (Note 1) | $R_{\theta JA}$ | 28   |                    |

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.

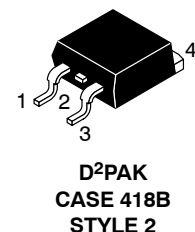
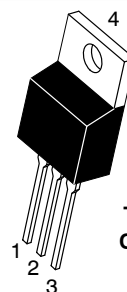
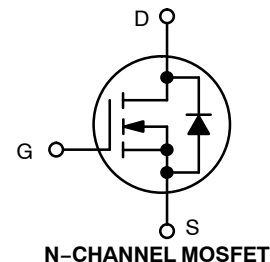
1. Surface mounted on FR4 board using 1 sq in pad size, (Cu Area 1.127 sq in [2 oz] including traces).



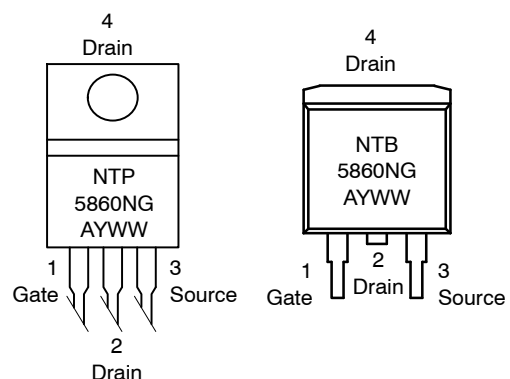
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<http://onsemi.com>

| $V_{(BR)DSS}$ | $R_{DS(on)} \text{ MAX}$ | $I_D \text{ MAX}$ |
|---------------|--------------------------|-------------------|
| 60 V          | 3.0 mΩ @ 10 V            | 220 A             |



#### MARKING DIAGRAMS & PIN ASSIGNMENTS



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

\*Could be one or two digit alpha or numeric code

#### ORDERING INFORMATION

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

# NTB5860N, NTP5860N, NVB5860N

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

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

### OFF CHARACTERISTICS

|   |                                      |   |                        |     |      |       |
|---|--------------------------------------|---|------------------------|-----|------|-------|
| Drain-to-Source Breakdown Voltage                         | V <sub>(BR)DSS</sub>                 | V <sub>DS</sub> = 0 V, I <sub>D</sub> = 250 μA  | 60                     |     |      | V     |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | V <sub>(BR)DSS</sub> /T <sub>J</sub> | I <sub>D</sub> = 250 μA                         |                        | 5.0 |      | mV/°C |
| Zero Gate Voltage Drain Current                           | I <sub>DSS</sub>                     | V <sub>GS</sub> = 0 V<br>V <sub>DS</sub> = 60 V | T <sub>J</sub> = 25°C  |     | 1.0  | μA    |
|   |                                      |   | T <sub>J</sub> = 125°C |     | 100  |       |
| Gate-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 | 2.0 |       | 4.0 | V     |
| Threshold Temperature Coefficient | V <sub>GS(th)</sub> /T <sub>J</sub> |   |     | -10.1 |     | mV/°C |
| Drain-to-Source On-Resistance     | R <sub>DS(on)</sub>                 | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 75 A               |     | 2.5   | 3.0 | mΩ    |
| Forward Transconductance          | g <sub>FS</sub>                     | V <sub>DS</sub> = 15 V, I <sub>D</sub> = 30 A               |     | 38    |     | S     |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                       |                     |  |  |       |  |    |
|-----------------------|---------------------|--|--|-------|--|----|
| Input Capacitance     | C <sub>iss</sub>    | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V,<br>f = 1 MHz              |  | 10760 |  | pF |
| Output Capacitance    | C <sub>oss</sub>    |  |  | 1125  |  |    |
| Transfer Capacitance  | C <sub>rss</sub>    |  |  | 700   |  |    |
| Total Gate Charge     | Q <sub>G(TOT)</sub> | V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 48 V,<br>I <sub>D</sub> = 65 A |  | 180   |  | nC |
| Threshold Gate Charge | Q <sub>G(TH)</sub>  |  |  | 11    |  |    |
| Gate-to-Source Charge | Q <sub>GS</sub>     |  |  | 45    |  |    |
| Gate-to-Drain Charge  | Q <sub>GD</sub>     |  |  | 57    |  |    |

### SWITCHING CHARACTERISTICS, V<sub>GS</sub> = 10 V (Note 3)

|                     |                     |  |  |     |  |    |
|---------------------|---------------------|--|--|-----|--|----|
| Turn-On Delay Time  | t <sub>d(on)</sub>  | V <sub>GS</sub> = 10 V, V <sub>DD</sub> = 48 V,<br>I <sub>D</sub> = 65 A, R <sub>G</sub> = 2.5 Ω |  | 27  |  | ns |
| Rise Time           | t <sub>r</sub>      |  |  | 117 |  |    |
| Turn-Off Delay Time | t <sub>d(off)</sub> |  |  | 66  |  |    |
| Fall Time           | t <sub>f</sub>      |  |  | 150 |  |    |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                                |                 |   |                        |  |      |     |                 |
|--------------------------------|-----------------|---|------------------------|--|------|-----|-----------------|
| Forward Diode Voltage          | V <sub>SD</sub> | V <sub>GS</sub> = 0 V<br>I <sub>S</sub> = 20 A                                  | T <sub>J</sub> = 25°C  |  | 0.76 | 1.1 | V <sub>dc</sub> |
|                                |                 |   | T <sub>J</sub> = 125°C |  | 0.63 |     |                 |
| Reverse Recovery Time          | t <sub>rr</sub> | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 65 A,<br>di <sub>S</sub> /dt = 100 A/μs |                        |  | 55   |     | ns              |
| Charge Time                    | t <sub>a</sub>  |   |                        |  | 29   |     |                 |
| Discharge Time                 | t <sub>b</sub>  |   |                        |  | 26   |     |                 |
| Reverse Recovery Stored Charge | Q <sub>RR</sub> |   |                        |  | 76   |     | nC              |

- Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
- Switching characteristics are independent of operating junction temperatures.

TYPICAL CHARACTERISTICS

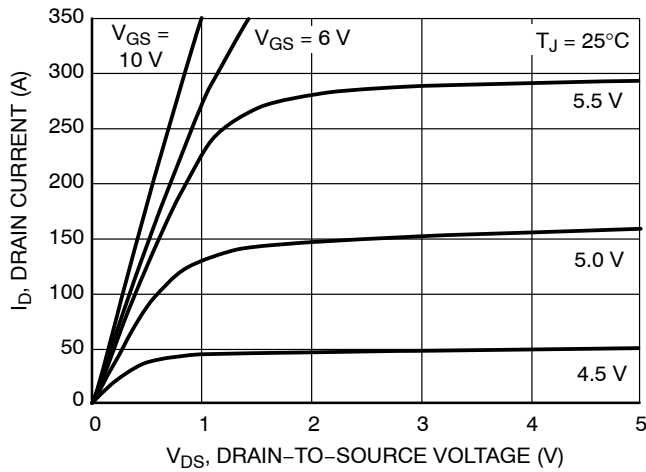


Figure 1. On-Region Characteristics

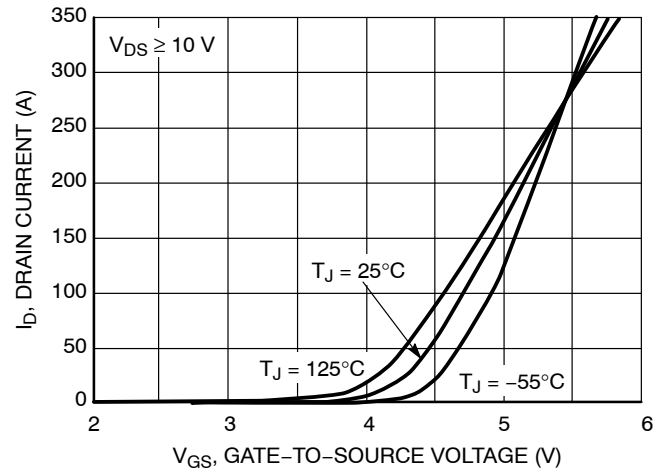


Figure 2. Transfer Characteristics

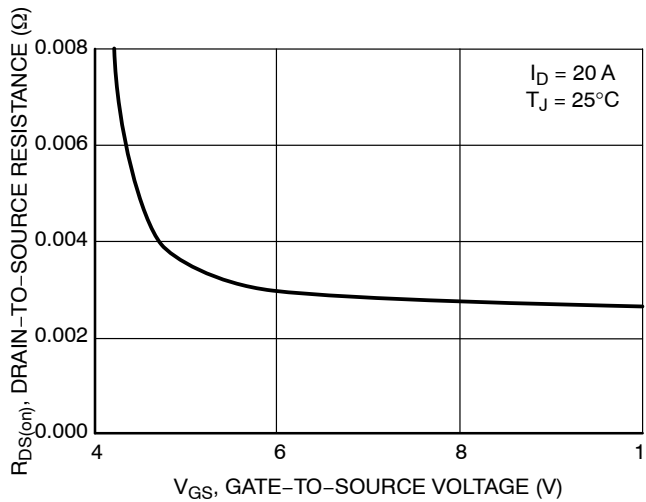


Figure 3. On-Resistance vs. Gate Voltage

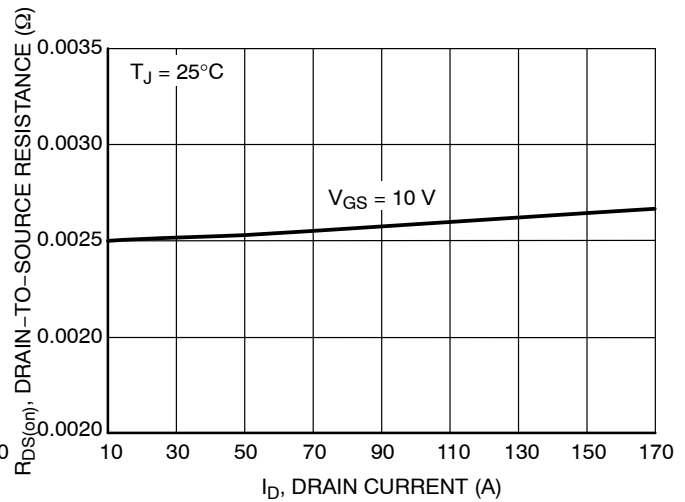


Figure 4. On-Resistance vs. Drain Current

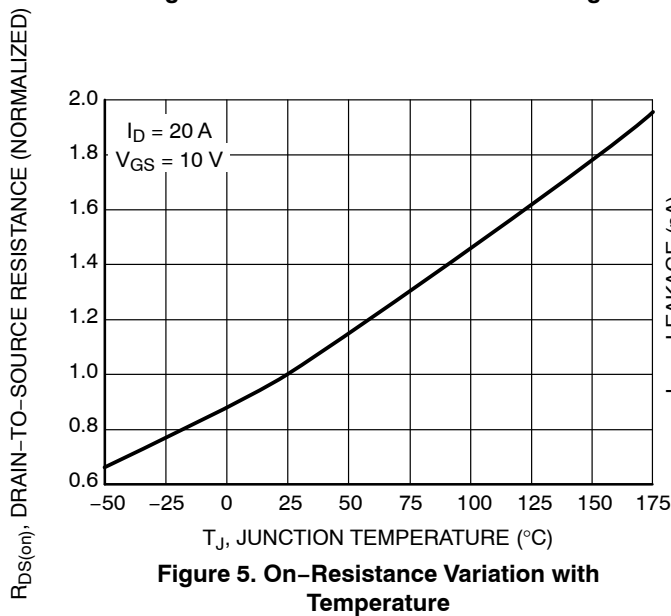


Figure 5. On-Resistance Variation with Temperature

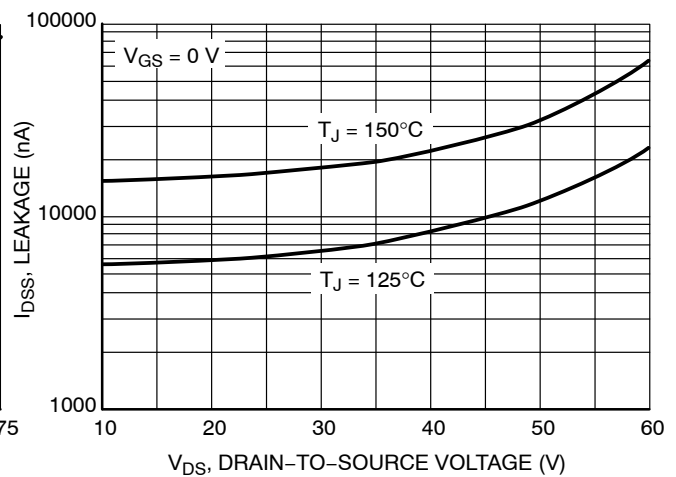


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS

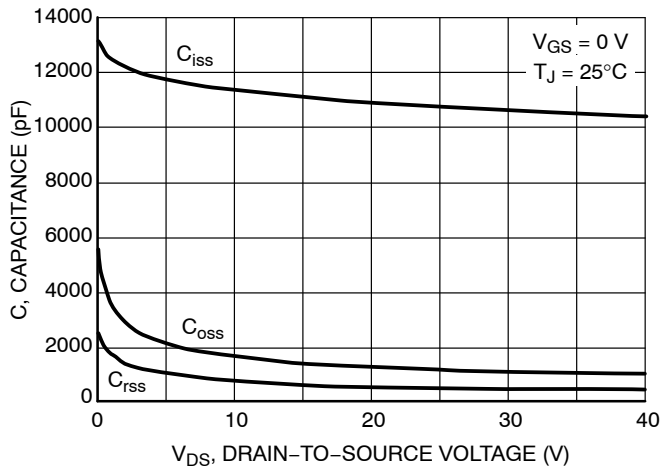


Figure 7. Capacitance Variation

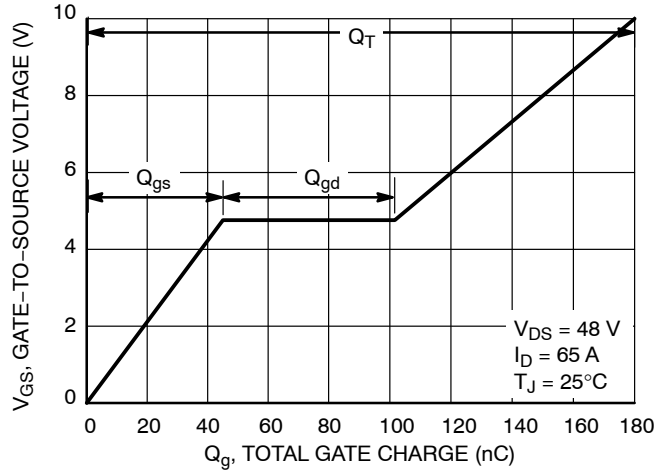


Figure 8. Gate-to-Source vs. Total Charge

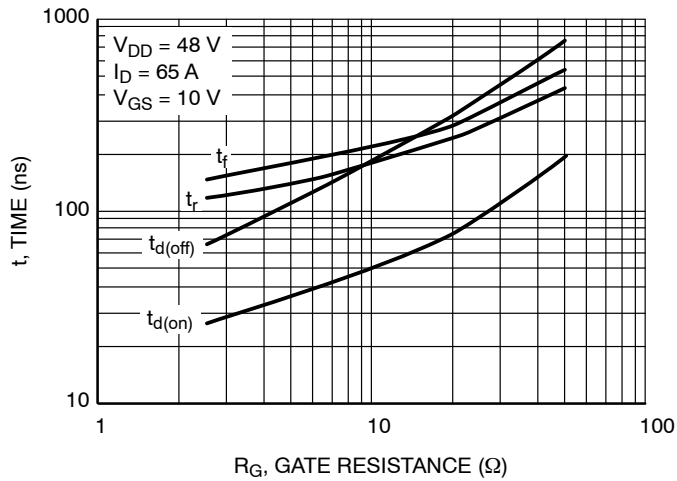


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

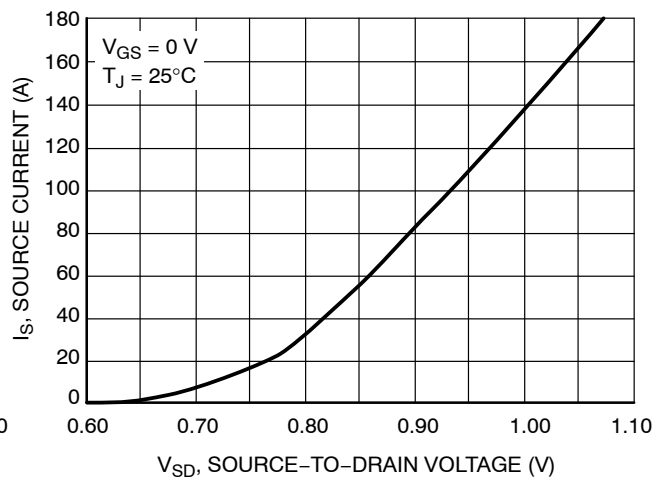


Figure 10. Diode Forward Voltage vs. Current

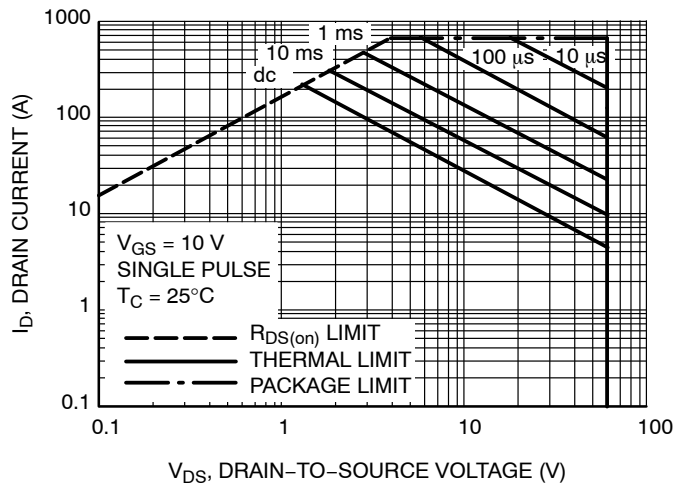


Figure 11. Maximum Rated Forward Biased Safe Operating Area

# NTB5860N, NTP5860N, NVB5860N

## TYPICAL CHARACTERISTICS

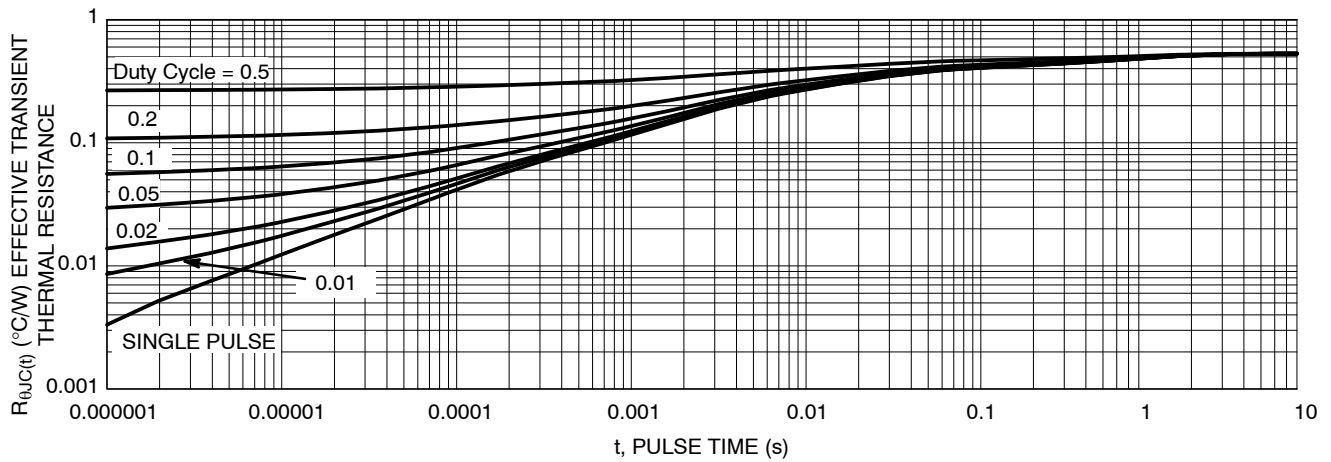


Figure 12. Thermal Response

### ORDERING INFORMATION

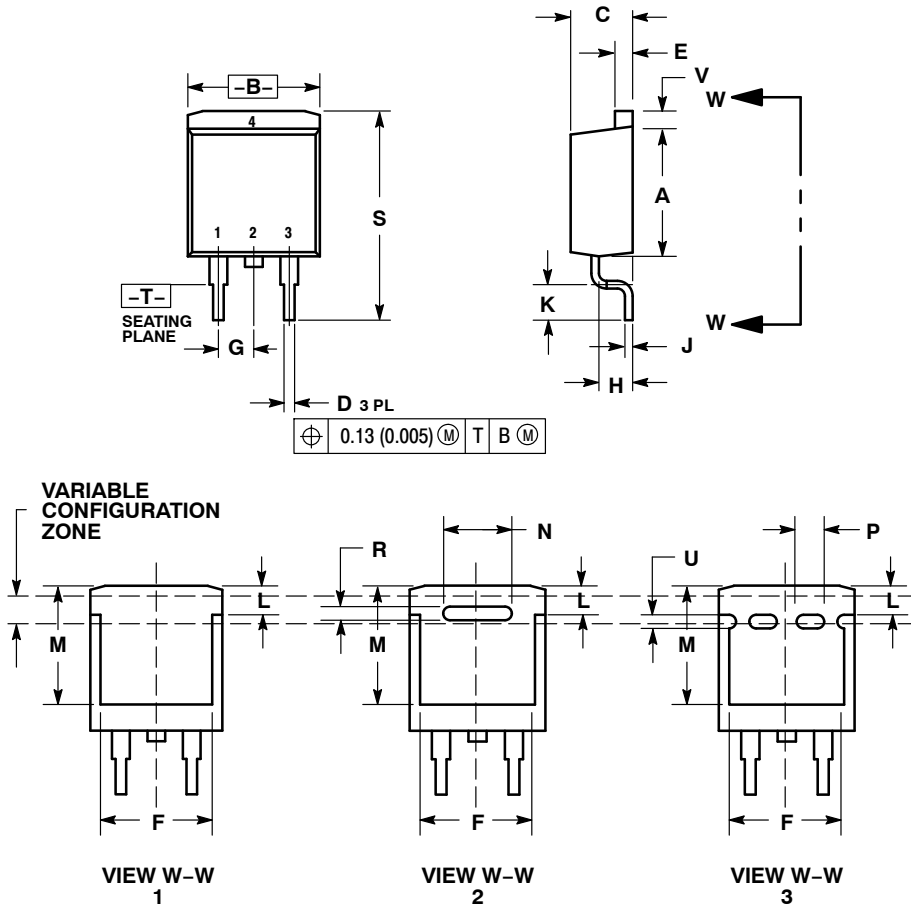
| Device       | Package                         | Shipping <sup>†</sup> |
|--------------|---------------------------------|-----------------------|
| NTP5860NG    | TO-220AB<br>(Pb-Free)           | 50 Units / Rail       |
| NTB5860NT4G  | D <sup>2</sup> PAK<br>(Pb-Free) | 800 / Tape & Reel     |
| NVB5860NT4G* | D <sup>2</sup> PAK<br>(Pb-Free) | 800 / 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.

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

PACKAGE DIMENSIONS

D<sup>2</sup>PAK  
CASE 418B-04  
ISSUE J

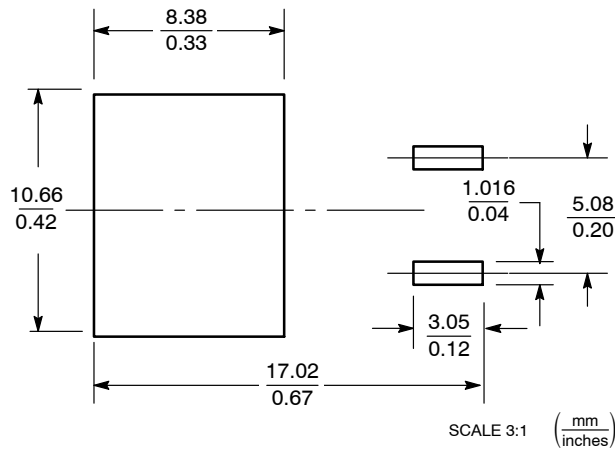


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. 418B-01 THRU 418B-03 OBSOLETE, NEW STANDARD 418B-04.

| 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     | 0.035 | 0.51        | 0.89  |
| E   | 0.045     | 0.055 | 1.14        | 1.40  |
| F   | 0.310     | 0.350 | 7.87        | 8.89  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.080     | 0.110 | 2.03        | 2.79  |
| J   | 0.018     | 0.025 | 0.46        | 0.64  |
| K   | 0.090     | 0.110 | 2.29        | 2.79  |
| L   | 0.052     | 0.072 | 1.32        | 1.83  |
| M   | 0.280     | 0.320 | 7.11        | 8.13  |
| N   | 0.197 REF |       | 5.00 REF    |       |
| P   | 0.079 REF |       | 2.00 REF    |       |
| R   | 0.039 REF |       | 0.99 REF    |       |
| 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\*

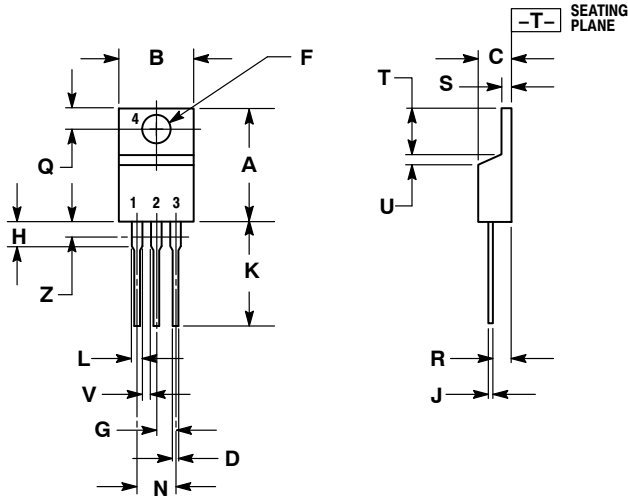


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NTB5860N, NTP5860N, NVB5860N

## PACKAGE DIMENSIONS

TO-220  
CASE 221A-09  
ISSUE AF



### 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  | 0.161 | 3.61        | 4.09  |
| G   | 0.095  | 0.105 | 2.42        | 2.66  |
| H   | 0.110  | 0.155 | 2.80        | 3.93  |
| J   | 0.014  | 0.025 | 0.36        | 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

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