

# NTB5405N, NVB5405N

## MOSFET – Power, Single, N-Channel, D<sup>2</sup>PAK 40 V, 116 A

### Features

- Low  $R_{DS(on)}$
- High Current Capability
- Low Gate Charge
- AEC-Q101 Qualified and PPAP Capable – NVB5405N
- These Devices are Pb-Free and are RoHS Compliant

### Applications

- Electronic Brake Systems
- Electronic Power Steering
- Bridge Circuits

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

| Parameter  |                        | Symbol                    | Value      | Unit |                  |
|--|------------------------|---------------------------|------------|------|------------------|
| Drain-to-Source Voltage  |                        | $V_{DS}$                  | 40         | V    |                  |
| Gate-to-Source Voltage   |                        | $V_{GS}$                  | $\pm 20$   | V    |                  |
| Continuous Drain Current – $R_{\theta JC}$   | Steady State           | $T_C = 25^\circ\text{C}$  | $I_D$      | 116  | A                |
|  |                        | $T_C = 100^\circ\text{C}$ |            | 82   |                  |
| Power Dissipation – $R_{\theta JC}$  | Steady State           | $T_C = 25^\circ\text{C}$  | $P_D$      | 150  | W                |
| Continuous Drain Current – $R_{\theta JA}$ (Note 1)  | Steady State           | $T_A = 25^\circ\text{C}$  | $I_D$      | 16.5 | A                |
|  |                        | $T_A = 100^\circ\text{C}$ | $I_D$      | 11.6 |                  |
| Power Dissipation – $R_{\theta JA}$ (Note 1)   | Steady State           | $T_A = 25^\circ\text{C}$  | $P_D$      | 3.0  | W                |
| Pulsed Drain Current   | $t_p = 10 \mu\text{s}$ |                           | $I_{DM}$   | 280  | A                |
| Operating Junction and Storage Temperature   |                        | $T_J, T_{STG}$            | -55 to 175 |      | $^\circ\text{C}$ |
| Source Current (Body Diode) Pulsed   |                        | $I_S$                     | 75         |      | A                |
| Single Pulse Drain-to-Source Avalanche Energy – ( $V_{DD} = 50 \text{ V}, V_{GS} = 10 \text{ V}, I_{PK} = 40 \text{ A}, L = 1 \text{ mH}, R_G = 25 \Omega$ ) |                        | EAS                       | 800        |      | mJ               |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s)  |                        | $T_L$                     | 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.

### THERMAL RESISTANCE RATINGS

| Parameter                    | Symbol          | Max | Unit               |
|------------------------------|-----------------|-----|--------------------|
| Junction-to-Case (Drain)     | $R_{\theta JC}$ | 1.0 | $^\circ\text{C/W}$ |
| Junction-to-Ambient (Note 1) | $R_{\theta JA}$ | 50  | $^\circ\text{C/W}$ |

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

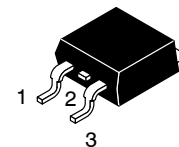
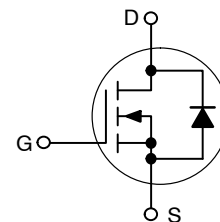


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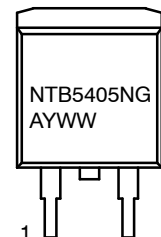
| $V_{(BR)DSS}$ | $R_{DS(ON)}$ TYP      | $I_D$ MAX (Note 1) |
|---------------|-----------------------|--------------------|
| 40 V          | 4.9 m $\Omega$ @ 10 V | 116 A              |

### N-Channel



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

### MARKING DIAGRAM



NTB5405N = Specific Device Code  
G = Pb-Free Device  
A = Assembly Location  
Y = Year  
WW = Work Week

### ORDERING INFORMATION

| Device      | Package                      | Shipping†         |
|-------------|------------------------------|-------------------|
| NTB5405NG   | D <sup>2</sup> PAK (Pb-Free) | 50 Units / Rail   |
| NTB5405NT4G | D <sup>2</sup> PAK (Pb-Free) | 800 / Tape & Reel |
| NVB5405NT4G | D <sup>2</sup> PAK (Pb-Free) | 800 / 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.

# NTB5405N, NVB5405N

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

| 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 | 40                     |     |      | V     |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | V <sub>(BR)DSS</sub> /T <sub>J</sub> |  |                        | 39  |      | mV/°C |
| Zero Gate Voltage Drain Current                           | I <sub>DSS</sub>                     | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 40 V  | T <sub>J</sub> = 25°C  |     | 1.0  | μA    |
|   |                                      |  | T <sub>J</sub> = 100°C |     | 10   |       |
| Gate-to-Source Leakage Current                            | I <sub>GSS</sub>                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±30 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 | 1.5 |      | 3.5 | V     |
| Gate Threshold Temperature Coefficient | V <sub>GS(TH)</sub> /T <sub>J</sub> |   |     | -7.0 |     | mV/°C |
| Drain-to-Source On Resistance          | R <sub>DS(on)</sub>                 | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 40 A               |     | 4.9  | 5.8 | mΩ    |
|  |                                     | V <sub>GS</sub> = 5.0 V, I <sub>D</sub> = 15 A              |     | 7.0  | 8.0 |       |
| Forward Transconductance               | g <sub>FS</sub>                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 15 A               |     | 32   |     | S     |

## CHARGES AND CAPACITANCES

|                              |                     |   |  |      |      |    |
|------------------------------|---------------------|---|--|------|------|----|
| Input Capacitance            | C <sub>ISS</sub>    | V <sub>GS</sub> = 0 V, f = 1.0 MHz, V <sub>DS</sub> = 32 V            |  | 2700 | 4000 | pF |
| Output Capacitance           | C <sub>OSS</sub>    |   |  | 700  | 1400 |    |
| Reverse Transfer Capacitance | C <sub>RSS</sub>    |   |  | 300  | 600  |    |
| Total Gate Charge            | Q <sub>G(TOT)</sub> | V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 32 V, I <sub>D</sub> = 40 A |  | 88   |      | nC |
| Threshold Gate Charge        | Q <sub>G(TH)</sub>  |   |  | 3.25 |      |    |
| Gate-to-Source Charge        | Q <sub>GS</sub>     |   |  | 9.5  |      |    |
| Gate-to-Drain Charge         | Q <sub>GD</sub>     |   |  | 37   |      |    |

## 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> = 32 V, I <sub>D</sub> = 40 A, R <sub>G</sub> = 2.5 Ω |  | 8.5 |  | ns |
| Rise Time           | t <sub>r</sub>      |   |  | 52  |  |    |
| Turn-Off Delay Time | t <sub>d(OFF)</sub> |   |  | 55  |  |    |
| Fall Time           | t <sub>f</sub>      |   |  | 70  |  |    |

## SWITCHING CHARACTERISTICS, V<sub>GS</sub> = 5 V (Note 3)

|                     |                     |  |  |     |  |    |
|---------------------|---------------------|--|--|-----|--|----|
| Turn-On Delay Time  | t <sub>d(ON)</sub>  | V <sub>GS</sub> = 5 V, V <sub>DD</sub> = 20 V, I <sub>D</sub> = 20 A, R <sub>G</sub> = 2.5 Ω |  | 19  |  | ns |
| Rise Time           | t <sub>r</sub>      |  |  | 153 |  |    |
| Turn-Off Delay Time | t <sub>d(OFF)</sub> |  |  | 32  |  |    |
| Fall Time           | t <sub>f</sub>      |  |  | 42  |  |    |

## DRAIN-SOURCE DIODE CHARACTERISTICS

|                         |                 |   |                        |  |      |     |    |
|-------------------------|-----------------|---|------------------------|--|------|-----|----|
| Forward Diode Voltage   | V <sub>SD</sub> | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 20 A                                  | T <sub>J</sub> = 25°C  |  | 0.82 | 1.1 | V  |
|                         |                 |   | T <sub>J</sub> = 100°C |  | TBD  |     |    |
| Reverse Recovery Time   | t <sub>RR</sub> | V <sub>GS</sub> = 0 V, dI <sub>SD</sub> /dt = 100 A/μs, I <sub>S</sub> = 20 A |                        |  | 66   |     | ns |
| Charge Time             | t <sub>a</sub>  |   |                        |  | 35   |     |    |
| Discharge Time          | t <sub>b</sub>  |   |                        |  | 31   |     |    |
| Reverse Recovery Charge | Q <sub>RR</sub> |   |                        |  | 113  |     |    |

- Pulse Test: pulse width ≤ 300 μs, duty cycle ≤ 2%.
- Switching characteristics are independent of operating junction temperatures.

TYPICAL PERFORMANCE CURVES

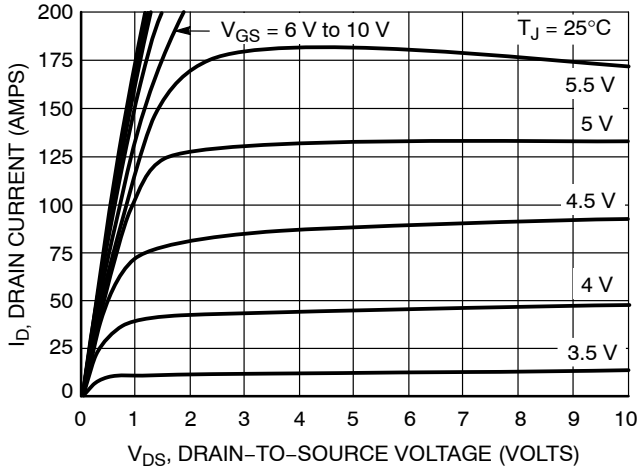


Figure 1. On-Region Characteristics

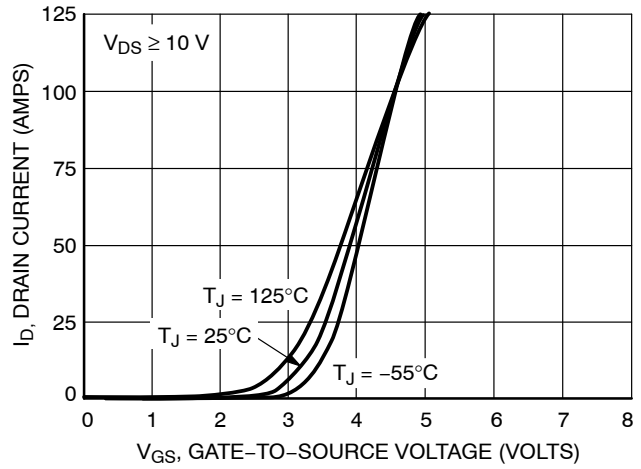


Figure 2. Transfer Characteristics

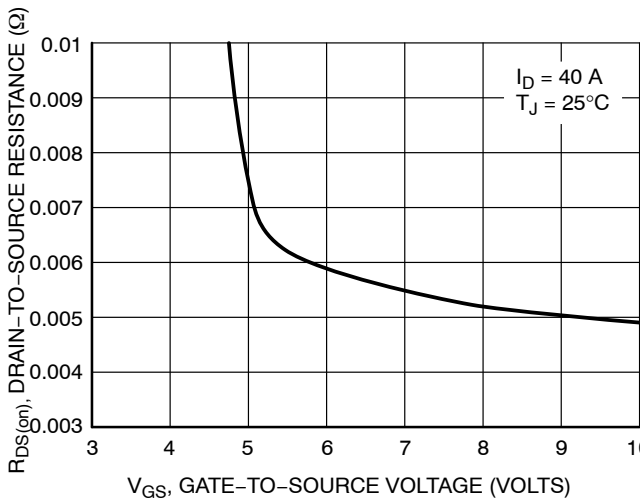


Figure 3. On-Resistance vs. Gate-to-Source Voltage

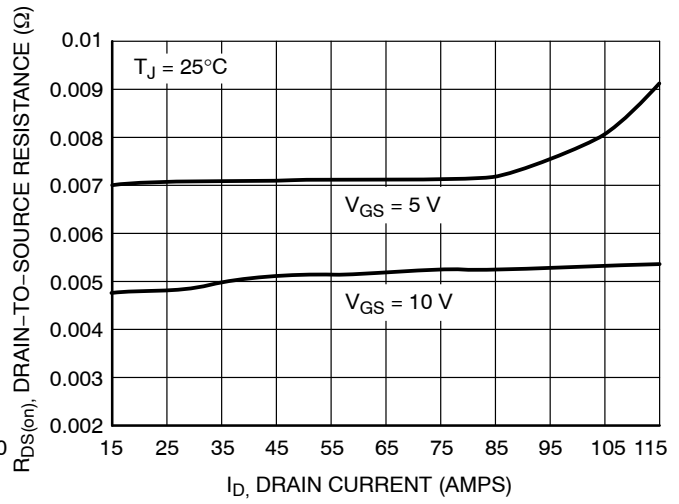


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

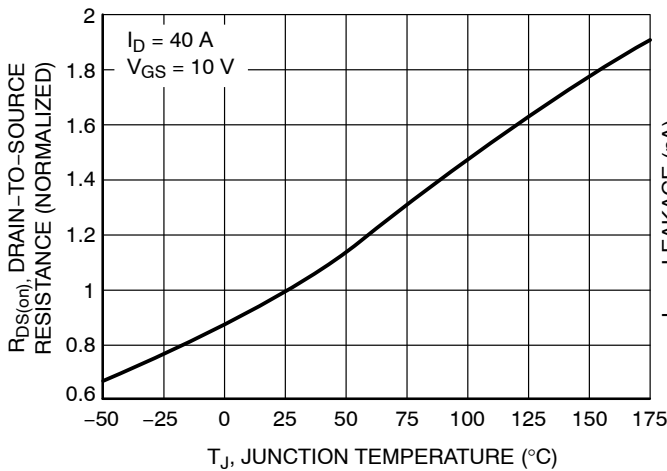


Figure 5. On-Resistance Variation with Temperature

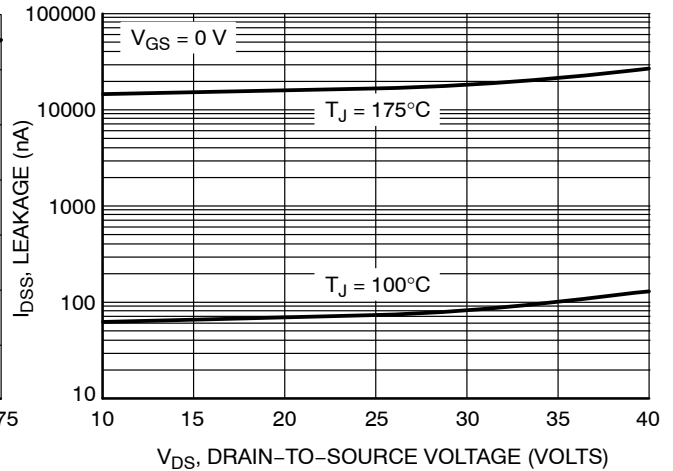


Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NTB5405N, NVB5405N

## TYPICAL PERFORMANCE CURVES

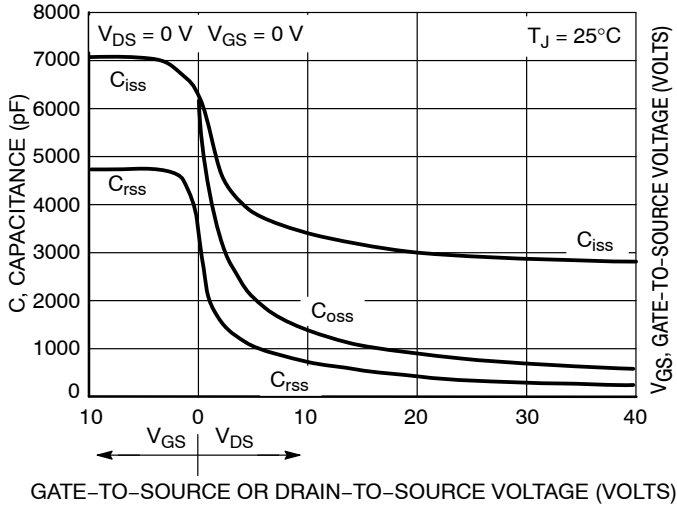


Figure 7. Capacitance Variation

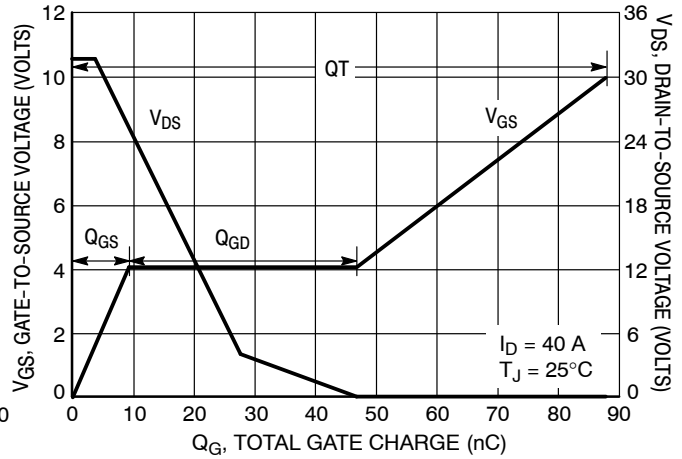


Figure 8. Gate-To-Source and Drain-To-Source Voltage vs. Total Charge

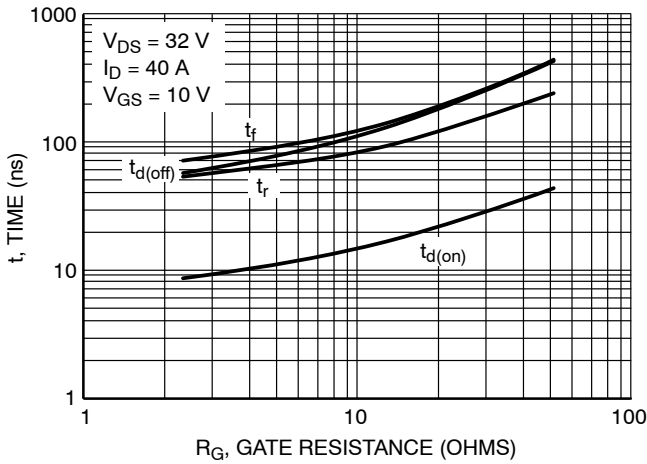


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

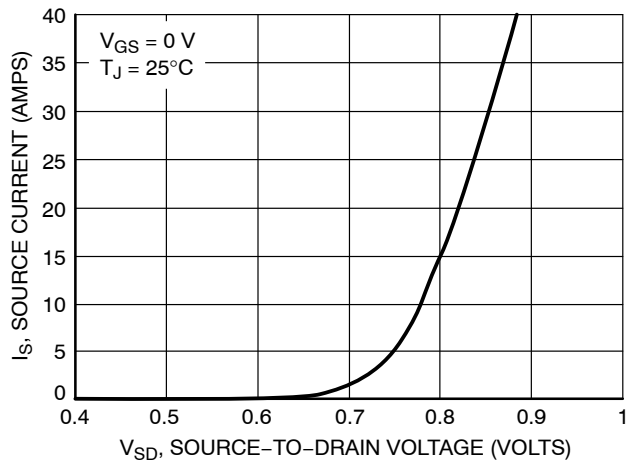


Figure 10. Diode Forward Voltage vs. Current

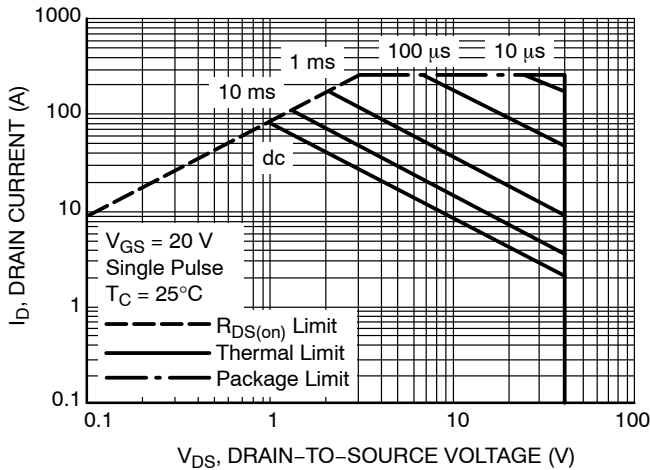


Figure 11. Maximum Rated Forward Biased Safe Operating Area

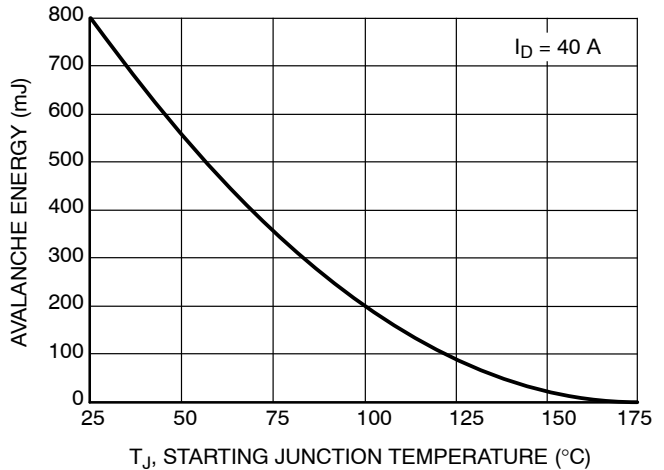


Figure 12. Maximum Avalanche Energy vs. Starting Junction Temperature

# NTB5405N, NVB5405N

## TYPICAL PERFORMANCE CURVES

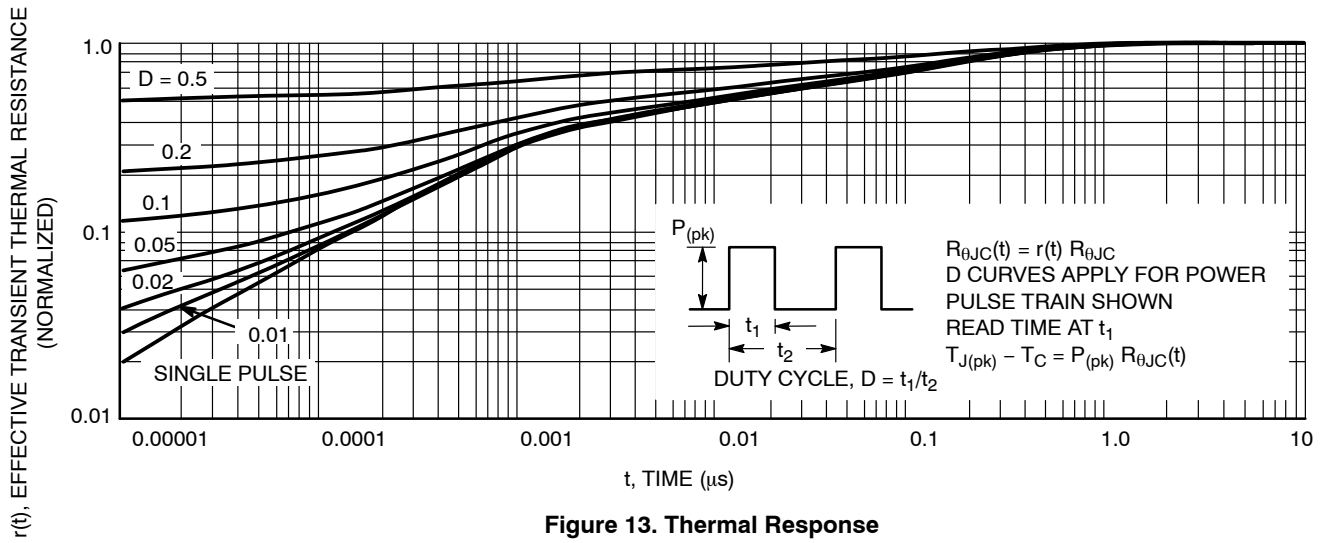
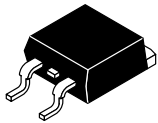


Figure 13. Thermal Response

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

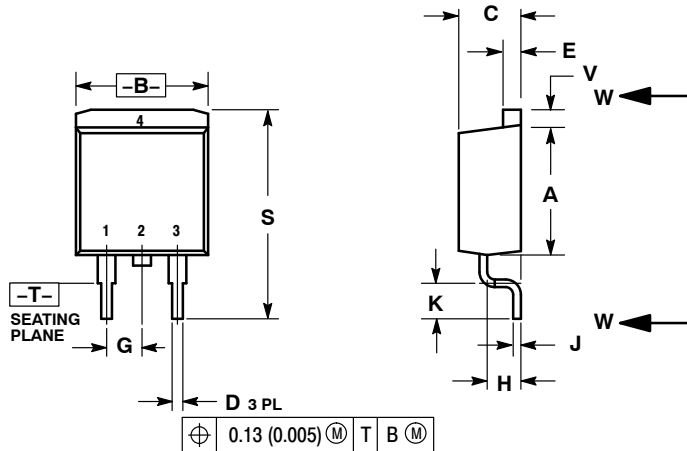
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**D<sup>2</sup>PAK 3**  
CASE 418B-04  
ISSUE L

DATE 17 FEB 2015

SCALE 1:1

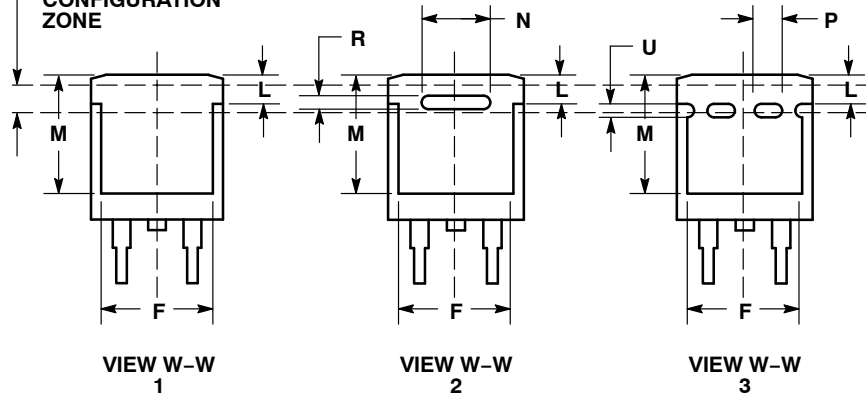


**NOTES:**

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  |

**VARIABLE CONFIGURATION ZONE**



- |  |   |   |  |   |  |
|--|---|---|--|---|--|
| <b>STYLE 1:</b><br>PIN 1. BASE<br>2. COLLECTOR<br>3. EMITTER<br>4. COLLECTOR | <b>STYLE 2:</b><br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE<br>4. DRAIN | <b>STYLE 3:</b><br>PIN 1. ANODE<br>2. CATHODE<br>3. ANODE<br>4. CATHODE | <b>STYLE 4:</b><br>PIN 1. GATE<br>2. COLLECTOR<br>3. EMITTER<br>4. COLLECTOR | <b>STYLE 5:</b><br>PIN 1. CATHODE<br>2. ANODE<br>3. CATHODE<br>4. ANODE | <b>STYLE 6:</b><br>PIN 1. NO CONNECT<br>2. CATHODE<br>3. ANODE<br>4. CATHODE |
|--|---|---|--|---|--|

**MARKING INFORMATION AND FOOTPRINT ON PAGE 2**

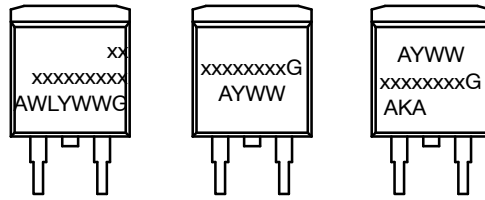
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**D<sup>2</sup>PAK 3**  
CASE 418B-04  
ISSUE L

DATE 17 FEB 2015

**GENERIC  
MARKING DIAGRAM\***

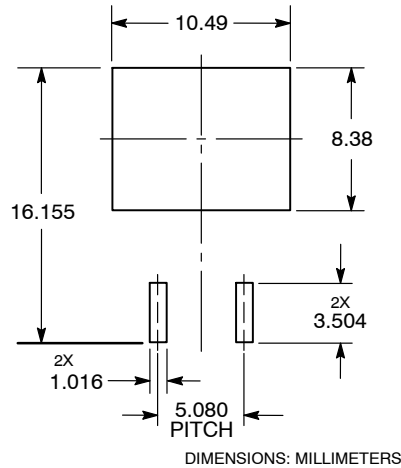


**IC                      Standard                      Rectifier**

- xx        = Specific Device Code
- A        = Assembly Location
- WL     = Wafer Lot
- Y        = Year
- WW     = Work Week
- G        = Pb-Free Package
- AKA    = Polarity Indicator

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

**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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