

# NTP45N06L, NTB45N06L

## Power MOSFET 45 Amps, 60 Volts

### Logic Level, N-Channel TO-220 and D<sup>2</sup>PAK

Designed for low voltage, high speed switching applications in power supplies, converters and power motor controls and bridge circuits.

#### Features

- Higher Current Rating
- Lower  $R_{DS(on)}$
- Lower  $V_{DS(on)}$
- Lower Capacitances
- Lower Total Gate Charge
- Tighter  $V_{SD}$  Specification
- Lower Diode Reverse Recovery Time
- Lower Reverse Recovery Stored Charge
- Pb-Free Packages are Available

#### Typical Applications

- Power Supplies
- Converters
- Power Motor Controls
- Bridge Circuits

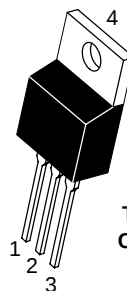
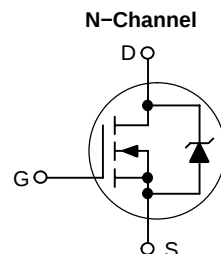


**ON Semiconductor®**

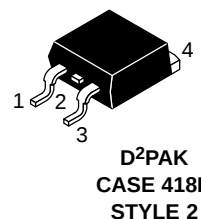
<http://onsemi.com>

**45 AMPERES, 60 VOLTS**

$R_{DS(on)} = 28 \text{ m}\Omega$

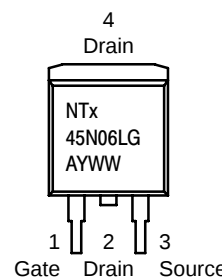
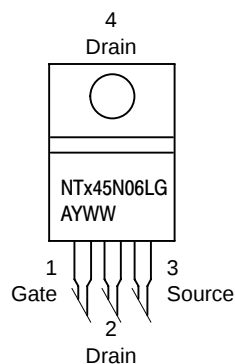


**TO-220AB  
CASE 221A  
STYLE 5**



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

#### MARKING DIAGRAMS & PIN ASSIGNMENTS



NTx45N06L = Device Code  
x = B or P  
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.

# NTP45N06L, NTB45N06L

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

| Rating                                                                                                                                                                                                                            | Symbol                                                   | Value                     | Unit                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|---------------------------|---------------------|
| Drain-to-Source Voltage                                                                                                                                                                                                           | V <sub>DSS</sub>                                         | 60                        | Vdc                 |
| Drain-to-Gate Voltage (R <sub>GS</sub> = 10 MΩ)                                                                                                                                                                                   | V <sub>DGR</sub>                                         | 60                        | Vdc                 |
| Gate-to-Source Voltage<br>– Continuous<br>– Non-Repetitive (t <sub>p</sub> ≤ 10 ms)                                                                                                                                               | V <sub>GS</sub><br>V <sub>GS</sub>                       | ± 15<br>± 20              | Vdc                 |
| Drain Current<br>– Continuous @ T <sub>A</sub> = 25°C<br>– Continuous @ T <sub>A</sub> = 100°C<br>– Single Pulse (t <sub>p</sub> ≤ 10 μs)                                                                                         | I <sub>D</sub><br>I <sub>D</sub><br>I <sub>DM</sub>      | 45<br>30<br>150           | Adc<br><br>Apk      |
| Total Power Dissipation @ T <sub>A</sub> = 25°C<br>Derate above 25°C<br>Total Power Dissipation @ T <sub>A</sub> = 25°C (Note 1)<br>Total Power Dissipation @ T <sub>A</sub> = 25°C (Note 2)                                      | P <sub>D</sub>                                           | 125<br>0.83<br>3.2<br>2.4 | W<br>W/°C<br>W<br>W |
| Operating and Storage Temperature Range                                                                                                                                                                                           | T <sub>J</sub> , T <sub>stg</sub>                        | –55 to +175               | °C                  |
| Single Pulse Drain-to-Source Avalanche Energy – Starting T <sub>J</sub> = 25°C<br>(V <sub>DD</sub> = 50 Vdc, V <sub>GS</sub> = 5.0 Vdc, L = 0.3 mH<br>I <sub>L(pk)</sub> = 40 A, V <sub>DS</sub> = 60 Vdc, R <sub>G</sub> = 25 Ω) | E <sub>AS</sub>                                          | 240                       | mJ                  |
| Thermal Resistance<br>– Junction-to-Case<br>– Junction-to-Ambient (Note 1)<br>– Junction-to-Ambient (Note 2)                                                                                                                      | R <sub>θJC</sub><br>R <sub>θJA</sub><br>R <sub>θJA</sub> | 1.2<br>46.8<br>63.2       | °C/W                |
| Maximum Lead Temperature for Soldering Purposes, 1/8 in from case for 10 seconds                                                                                                                                                  | T <sub>L</sub>                                           | 260                       | °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" pad size, (Cu Area 1.127 in<sup>2</sup>).
2. When surface mounted to an FR4 board using the minimum recommended pad size, (Cu Area 0.412 in<sup>2</sup>).

## ORDERING INFORMATION

| Device       | Package                         | Shipping <sup>†</sup> |
|--------------|---------------------------------|-----------------------|
| NTP45N06L    | TO-220                          | 50 Units / Rail       |
| NTP45N06LG   | TO-220<br>(Pb-Free)             | 50 Units / Rail       |
| NTB45N06L    | D <sup>2</sup> PAK              | 50 Units / Rail       |
| NTB45N06LG   | D <sup>2</sup> PAK<br>(Pb-Free) | 50 Units / Rail       |
| NTB45N06LT4  | D <sup>2</sup> PAK              | 800 Tape & Reel       |
| NTB45N06LT4G | 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.

# NTP45N06L, NTB45N06L

## 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 $\mu$ Adc)<br>Temperature Coefficient (Positive)                         | V <sub>(BR)DSS</sub> | 60<br>– | 67<br>67.2 | –<br>–    | Vdc<br>mV/°C |
| Zero Gate Voltage Drain Current<br>(V <sub>DS</sub> = 60 Vdc, V <sub>GS</sub> = 0 Vdc)<br>(V <sub>DS</sub> = 60 Vdc, V <sub>GS</sub> = 0 Vdc, T <sub>J</sub> = 150°C) | I <sub>DSS</sub>     | –<br>–  | –<br>–     | 1.0<br>10 | $\mu$ Adc    |
| Gate-Body Leakage Current (V <sub>GS</sub> = $\pm$ 15 Vdc, V <sub>DS</sub> = 0 Vdc)                                                                                   | I <sub>GSS</sub>     | –       | –          | $\pm$ 100 | nAdc         |

### ON CHARACTERISTICS (Note 4)

|                                                                                                                                                                                      |                     |          |              |           |              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------|--------------|-----------|--------------|
| Gate Threshold Voltage (Note 4)<br>(V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 $\mu$ Adc)<br>Threshold Temperature Coefficient (Negative)                              | V <sub>GS(th)</sub> | 1.0<br>– | 1.8<br>4.7   | 2.0<br>–  | Vdc<br>mV/°C |
| Static Drain-to-Source On-Resistance (Note 4)<br>(V <sub>GS</sub> = 5.0 Vdc, I <sub>D</sub> = 22.5 Adc)                                                                              | R <sub>DS(on)</sub> | –        | 23           | 28        | m $\Omega$   |
| Static Drain-to-Source On-Voltage (Note 4)<br>(V <sub>GS</sub> = 5.0 Vdc, I <sub>D</sub> = 45 Adc)<br>(V <sub>GS</sub> = 5.0 Vdc, I <sub>D</sub> = 22.5 Adc, T <sub>J</sub> = 150°C) | V <sub>DS(on)</sub> | –<br>–   | 1.03<br>0.93 | 1.51<br>– | Vdc          |
| Forward Transconductance (Note 4) (V <sub>DS</sub> = 8.0 Vdc, I <sub>D</sub> = 12 Adc)                                                                                               | g <sub>FS</sub>     | –        | 22.8         | –         | mhos         |

### DYNAMIC CHARACTERISTICS

|                      |                                                                     |                  |   |      |      |    |
|----------------------|---------------------------------------------------------------------|------------------|---|------|------|----|
| Input Capacitance    | (V <sub>DS</sub> = 25 Vdc, V <sub>GS</sub> = 0 Vdc,<br>f = 1.0 MHz) | C <sub>iss</sub> | – | 1212 | 1700 | pF |
| Output Capacitance   |                                                                     | C <sub>oss</sub> | – | 352  | 480  |    |
| Transfer Capacitance |                                                                     | C <sub>rss</sub> | – | 90   | 180  |    |

### SWITCHING CHARACTERISTICS (Note 5)

|                     |                                                                                                                            |                     |   |      |     |    |
|---------------------|----------------------------------------------------------------------------------------------------------------------------|---------------------|---|------|-----|----|
| Turn-On Delay Time  | (V <sub>DD</sub> = 30 Vdc, I <sub>D</sub> = 45 Adc,<br>V <sub>GS</sub> = 5.0 Vdc, R <sub>G</sub> = 9.1 $\Omega$ ) (Note 4) | t <sub>d(on)</sub>  | – | 13   | 30  | ns |
| Rise Time           |                                                                                                                            | t <sub>r</sub>      | – | 341  | 680 |    |
| Turn-Off Delay Time |                                                                                                                            | t <sub>d(off)</sub> | – | 36   | 75  |    |
| Fall Time           |                                                                                                                            | t <sub>f</sub>      | – | 158  | 320 |    |
| Gate Charge         | (V <sub>DS</sub> = 48 Vdc, I <sub>D</sub> = 45 Adc,<br>V <sub>GS</sub> = 5.0 Vdc) (Note 4)                                 | Q <sub>T</sub>      | – | 23   | 32  | nC |
|                     |                                                                                                                            | Q <sub>1</sub>      | – | 4.6  | –   |    |
|                     |                                                                                                                            | Q <sub>2</sub>      | – | 14.1 | –   |    |

### SOURCE-DRAIN DIODE CHARACTERISTICS

|                                |                                                                                                                                           |                 |        |              |           |         |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------|--------------|-----------|---------|
| Forward On-Voltage             | (I <sub>S</sub> = 45 Adc, V <sub>GS</sub> = 0 Vdc) (Note 4)<br>(I <sub>S</sub> = 45 Adc, V <sub>GS</sub> = 0 Vdc, T <sub>J</sub> = 150°C) | V <sub>SD</sub> | –<br>– | 1.01<br>0.92 | 1.15<br>– | Vdc     |
| Reverse Recovery Time          | (I <sub>S</sub> = 45 Adc, V <sub>GS</sub> = 0 Vdc,<br>dI <sub>S</sub> /dt = 100 A/ $\mu$ s) (Note 4)                                      | t <sub>rr</sub> | –      | 56           | –         | ns      |
|                                |                                                                                                                                           | t <sub>a</sub>  | –      | 30           | –         |         |
|                                |                                                                                                                                           | t <sub>b</sub>  | –      | 26           | –         |         |
| Reverse Recovery Stored Charge |                                                                                                                                           | Q <sub>RR</sub> | –      | 0.09         | –         | $\mu$ C |

3. When surface mounted to an FR4 board using the minimum recommended pad size, (Cu Area 0.412 in<sup>2</sup>).

4. Pulse Test: Pulse Width  $\leq$  300  $\mu$ s, Duty Cycle  $\leq$  2%.

5. Switching characteristics are independent of operating junction temperatures.

# NTP45N06L, NTB45N06L

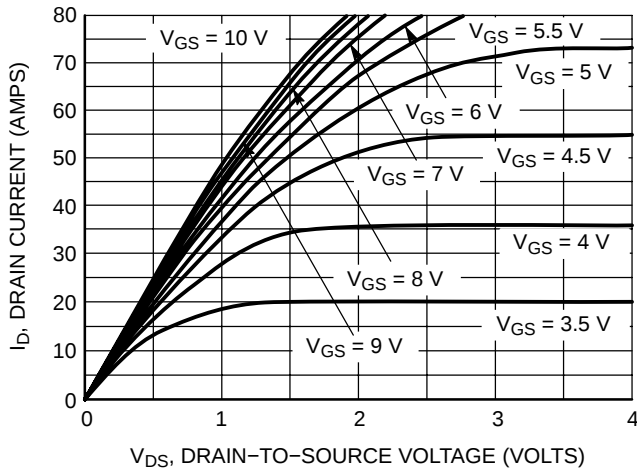


Figure 1. On-Region Characteristics

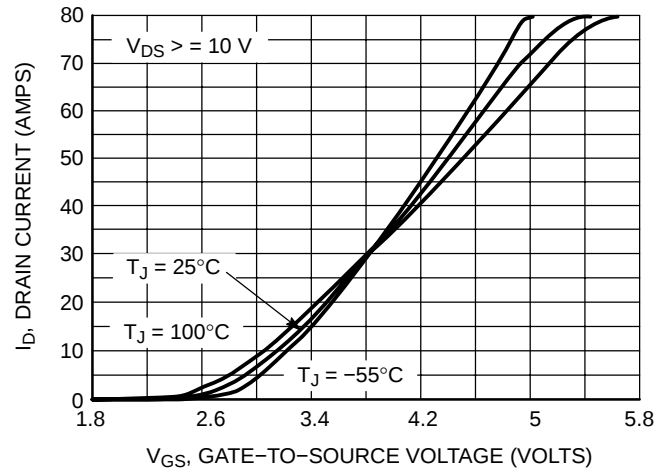


Figure 2. Transfer Characteristics

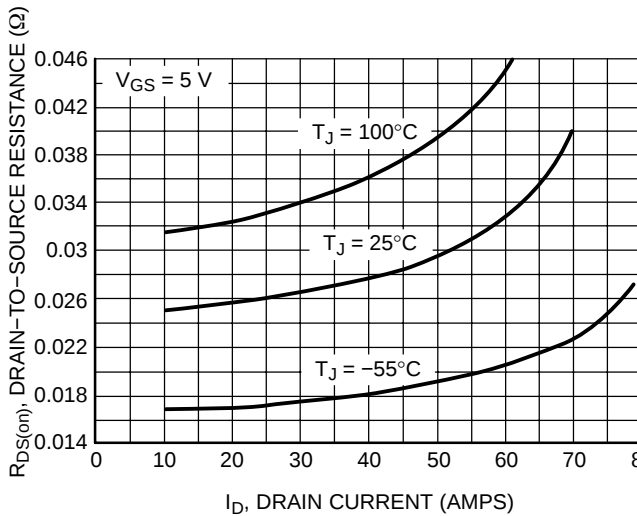


Figure 3. On-Resistance vs. Gate-to-Source Voltage

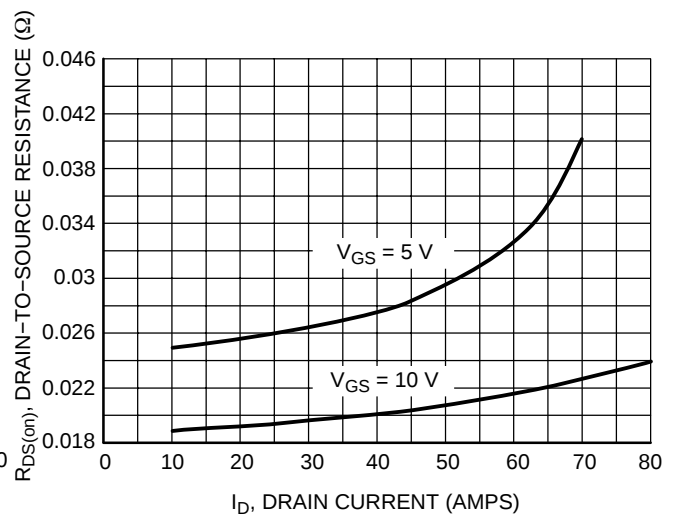


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

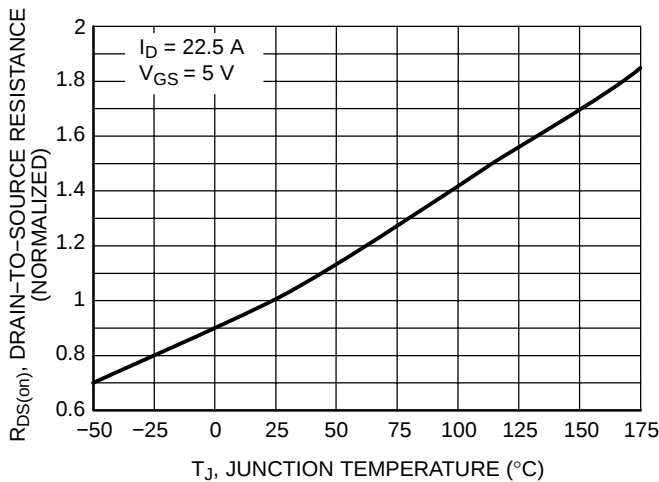


Figure 5. On-Resistance Variation with Temperature

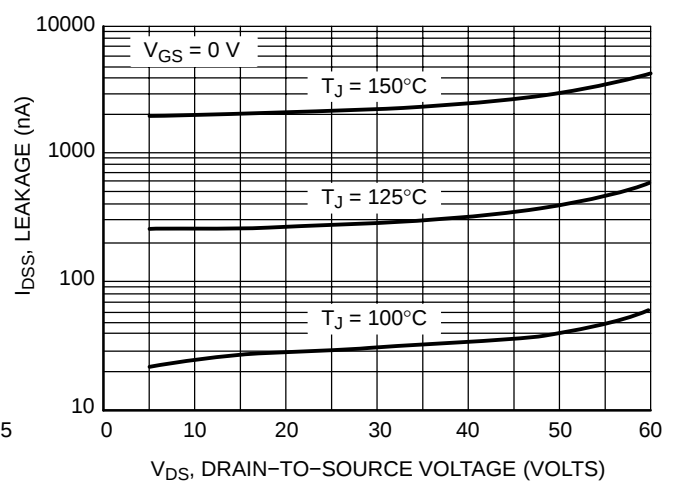


Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NTP45N06L, NTB45N06L

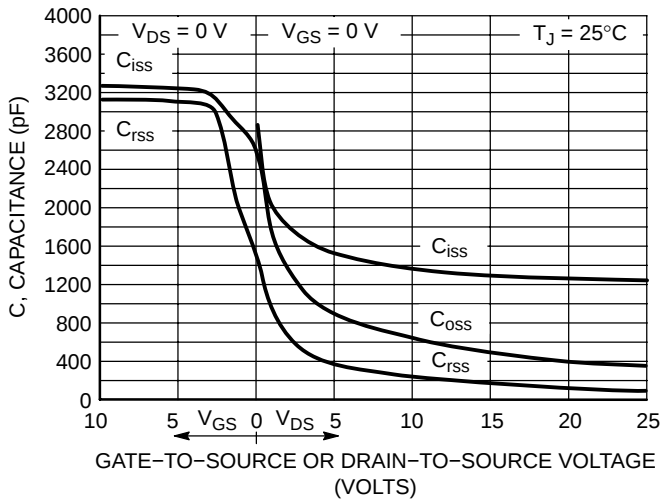


Figure 7. Capacitance Variation

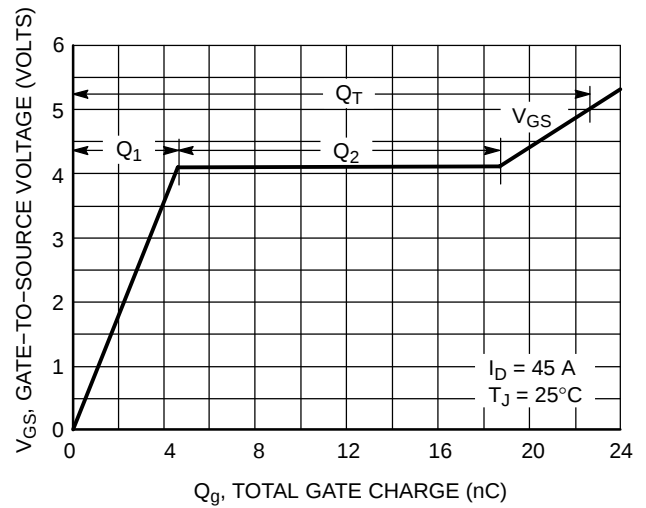


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

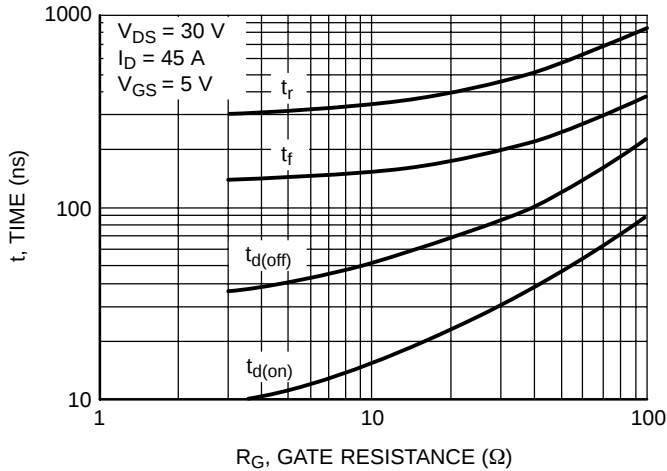


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

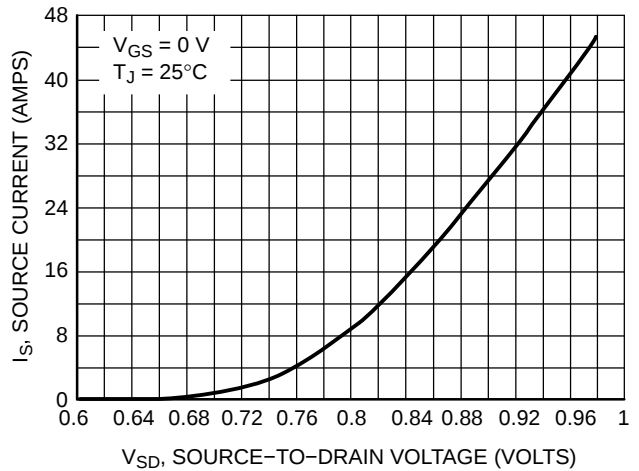


Figure 10. Diode Forward Voltage vs. Current

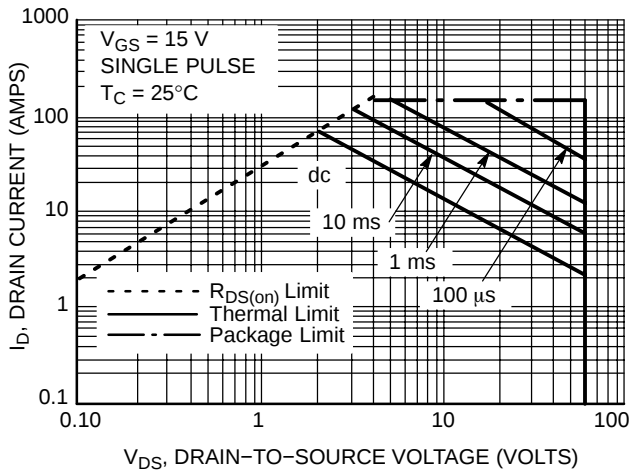


Figure 11. Maximum Rated Forward Biased Safe Operating Area

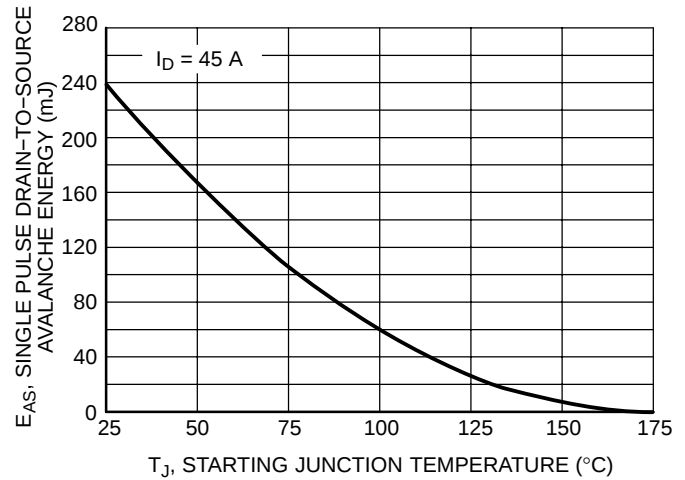


Figure 12. Maximum Avalanche Energy vs. Starting Junction Temperature

# NTP45N06L, NTB45N06L

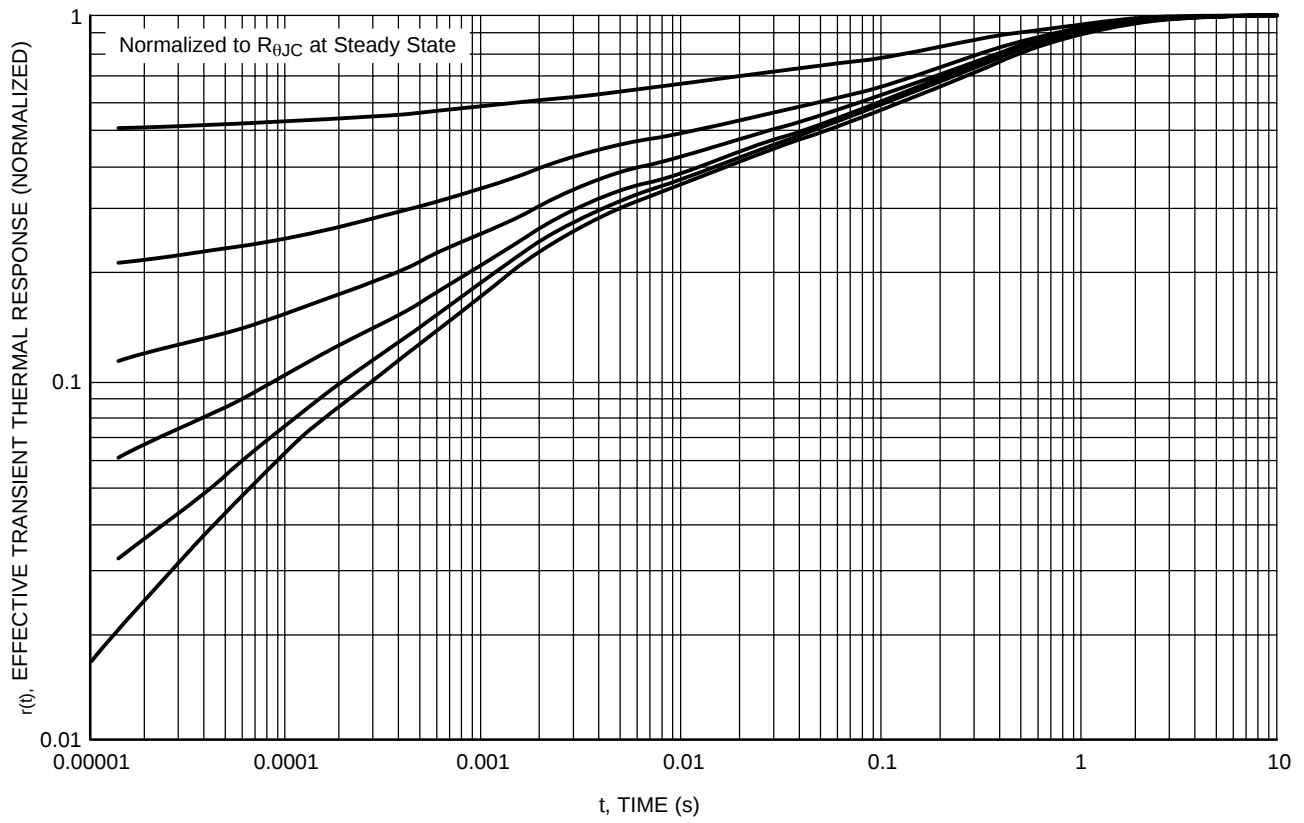


Figure 13. Thermal Response

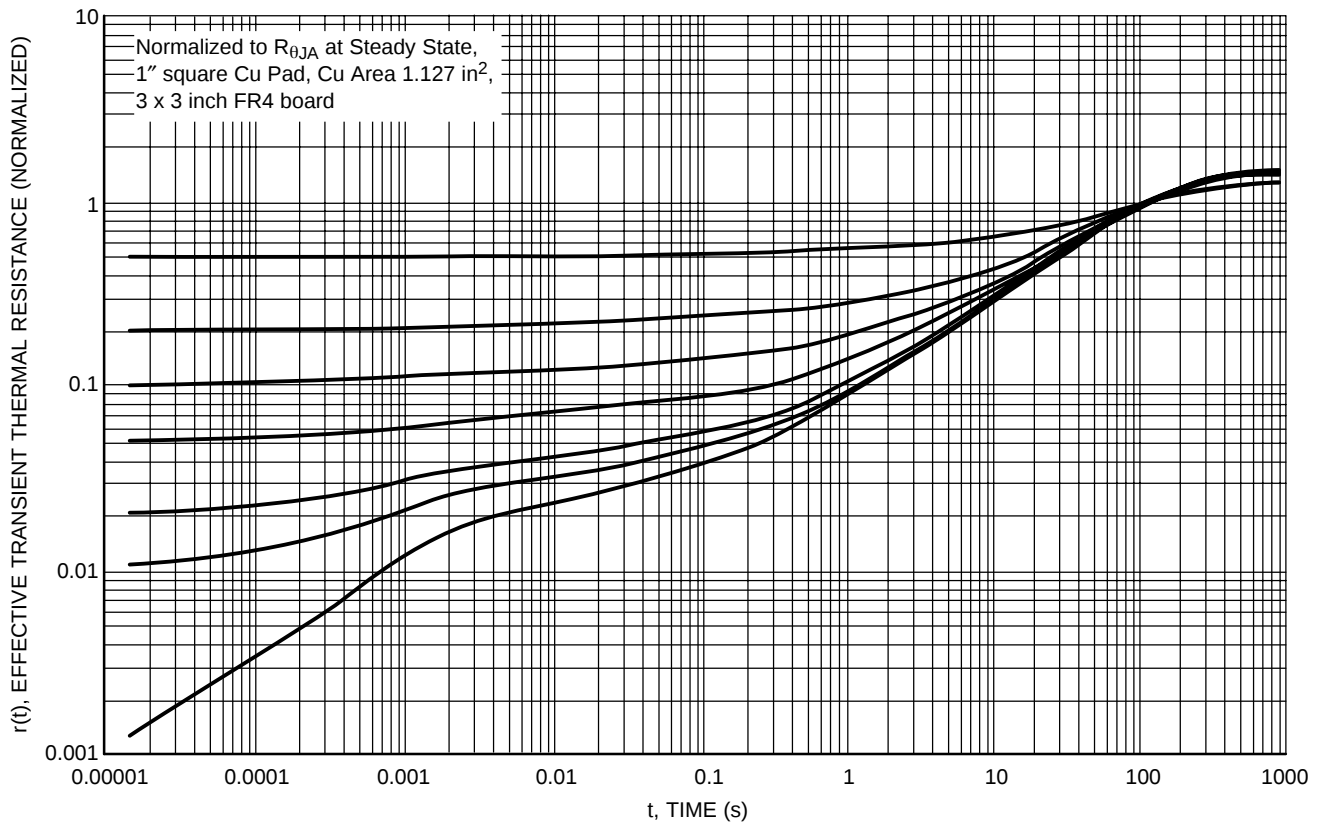
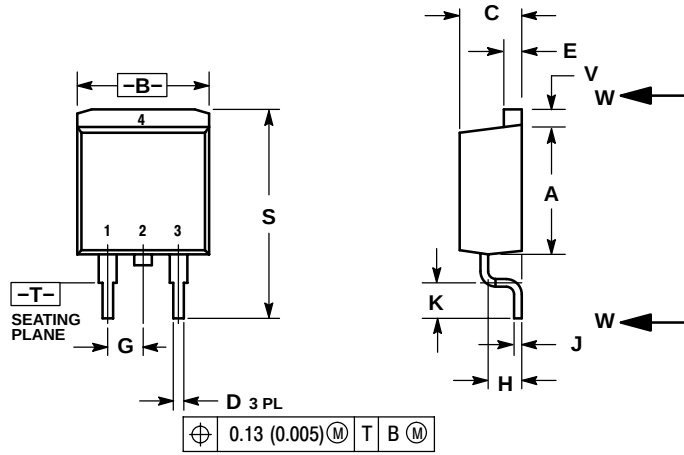


Figure 14. Thermal Response

# NTP45N06L, NTB45N06L

## PACKAGE DIMENSIONS

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



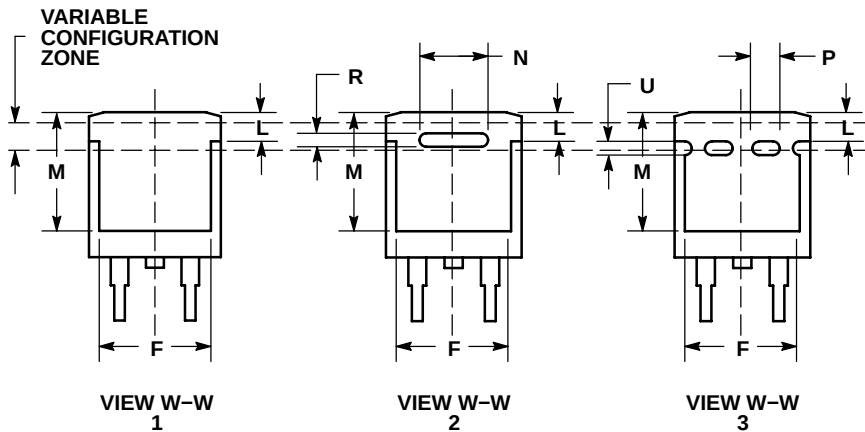
### NOTES:

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

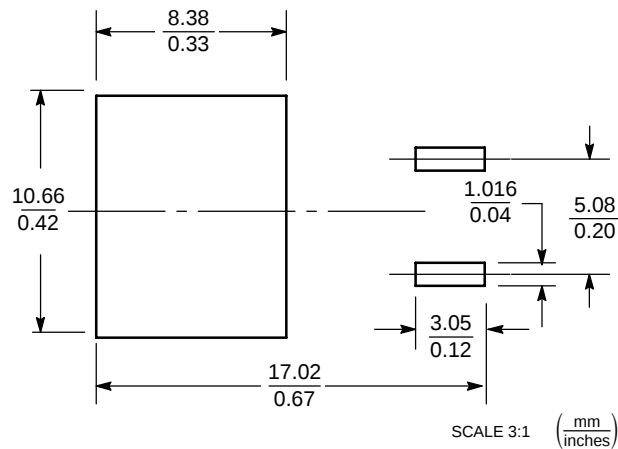
| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.340     | 0.380 | 8.64        | 9.65  |
| B   | 0.380     | 0.405 | 9.65        | 10.29 |
| C   | 0.160     | 0.190 | 4.06        | 4.83  |
| 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\*

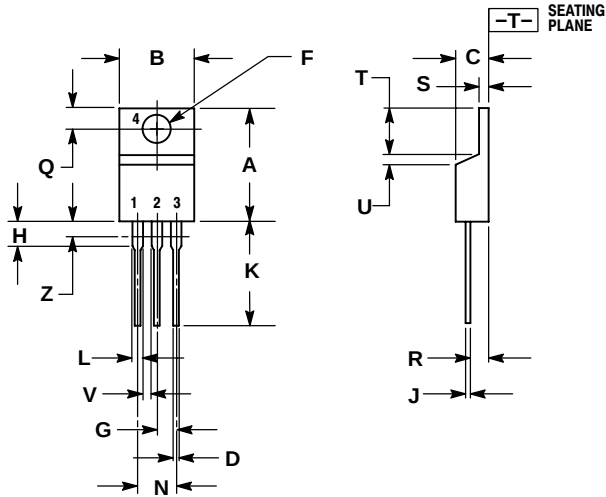


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NTP45N06L, NTB45N06L

## 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

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NTP45N06L/D



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Электрон  
Связь**

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