# NTMD6N02R2

## Power MOSFET 6.0 Amps, 20 Volts

### N−Channel Enhancement Mode Dual SO−8 Package

**Features**

- Ultra Low $R_{DS(on)}$
- Higher Efficiency Extending Battery Life
- Logic Level Gate Drive
- Miniature Dual SO−8 Surface Mount Package
- Diode Exhibits High Speed, Soft Recovery
- Avalanche Energy Specified
- SO−8 Mounting Information Provided

**Applications**

- DC−DC Converters
- Low Voltage Motor Control
- Power Management in Portable and Battery−Powered Products, for example, Computers, Printers, Cellular and Cordless Telephones and PCMCIA Cards

**MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise noted)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain−to−Source Voltage | $V_{DSS}$ | 20 | V |
| Drain−to−Gate Voltage ($R_{GS}$ = 1.0 MΩ) | $V_{DGR}$ | 20 | V |
| Gate−to−Source Voltage − Continuous | $V_{GS}$ | ±12 | V |
| Thermal Resistance − Junction−to−Ambient (Note 1) | $R_{\theta JA}$ | 62.5 | °C/W |
| Total Power Dissipation @ $T_A$ = 25°C | $P_D$ | 2.0 | W |
| Continuous Drain Current @ $T_A$ = 25°C | $I_D$ | 6.5 | A |
| Continuous Drain Current @ $T_A$ = 70°C | $I_D$ | 5.5 | A |
| Pulsed Drain Current (Note 4) | $I_{DM}$ | 50 | A |
| Thermal Resistance − Junction−to−Ambient (Note 2) | $R_{\theta JA}$ | 102 | °C/W |
| Total Power Dissipation @ $T_A$ = 25°C | $P_D$ | 1.22 | W |
| Continuous Drain Current @ $T_A$ = 25°C | $I_D$ | 5.07 | A |
| Continuous Drain Current @ $T_A$ = 70°C | $I_D$ | 4.07 | A |
| Pulsed Drain Current (Note 4) | $I_{DM}$ | 40 | A |
| Thermal Resistance − Junction−to−Ambient (Note 3) | $R_{\theta JA}$ | 172 | °C/W |
| Total Power Dissipation @ $T_A$ = 25°C | $P_D$ | 0.73 | W |
| Continuous Drain Current @ $T_A$ = 25°C | $I_D$ | 3.92 | A |
| Continuous Drain Current @ $T_A$ = 70°C | $I_D$ | 3.14 | A |
| Pulsed Drain Current (Note 4) | $I_{DM}$ | 30 | A |

1. Mounted onto a 2″ square FR−4 Board (1″ sq. 2 oz. Cu 0.06″ thick single sided), t < 10 seconds.
2. Mounted onto a 2″ square FR−4 Board (1″ sq. 2 oz. Cu 0.06″ thick single sided), t = steady state.
3. Minimum FR−4 or G−10 PCB, t = steady state.
4. Pulse Test: Pulse Width = 10 μs, Duty Cycle = 2%.

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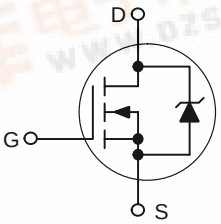
| $V_{DSS}$ | $R_{DS(ON)}$ TYP | $I_D$ MAX |
|---|---|---|
| 20 V | 35 mΩ @ $V_{GS}$ = 4.5 V | 6.0 A |

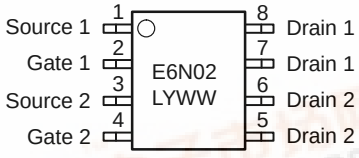
**N−Channel**





**SO−8**
**CASE 751**
**STYLE 11**

**MARKING DIAGRAM & PIN ASSIGNMENT**




(Top View)

E6N02 = Device Code
L = Assembly Location
Y = Year
WW = Work Week

**ORDERING INFORMATION**

| Device | Package | Shipping† |
|---|---|---|
| NTMD6N02R2 | SO−8 | 2500/Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

**MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise noted) (continued)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Operating and Storage Temperature Range | $T_J$, $T_{stg}$ | −55 to +150 | °C |
| Single Pulse Drain−to−Source Avalanche Energy − Starting $T_J$ = 25°C ($V_{DD}$ = 20 Vdc, $V_{GS}$ = 5.0 Vdc, Peak $I_L$ = 6.0 Apk, L = 20 mH, $R_G$ = 25 Ω) | $E_{AS}$ | 360 | mJ |
| Maximum Lead Temperature for Soldering Purposes for 10 seconds | $T_L$ | 260 | °C |

**ELECTRICAL CHARACTERISTICS** ($T_C$ = 25°C unless otherwise noted) (Note 5)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Drain−to−Source Breakdown Voltage ($V_{GS}$ = 0 Vdc, $I_D$ = 250 μAdc) | $V_{(BR)DSS}$ | 20 | – | – | Vdc |
| Temperature Coefficient (Positive) | | – | 19.2 | – | mV/°C |
| Zero Gate Voltage Drain Current ($V_{DS}$ = 20 Vdc, $V_{GS}$ = 0 Vdc, $T_J$ = 25°C) | $I_{DSS}$ | – | – | 1.0 | μAdc |
| ($V_{DS}$ = 20 Vdc, $V_{GS}$ = 0 Vdc, $T_J$ = 125°C) | | – | – | 10 | |
| Gate−Body Leakage Current ($V_{GS}$ = +12 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | – | – | 100 | nAdc |
| Gate−Body Leakage Current ($V_{GS}$ = −12 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | – | – | −100 | nAdc |
| **ON CHARACTERISTICS** | | | | | |
| Gate Threshold Voltage ($V_{DS}$ = $V_{GS}$, $I_D$ = −250 μAdc) | $V_{GS(th)}$ | 0.6 | 0.9 | 1.2 | Vdc |
| Temperature Coefficient (Negative) | | – | −3.0 | – | mV/°C |
| Static Drain−to−Source On−State Resistance | $R_{DS(on)}$ | | | | Ω |
| ($V_{GS}$ = 4.5 Vdc, $I_D$ = 6.0 Adc) | | – | 0.028 | 0.035 | |
| ($V_{GS}$ = 4.5 Vdc, $I_D$ = 4.0 Adc) | | – | 0.028 | 0.043 | |
| ($V_{GS}$ = 2.7 Vdc, $I_D$ = 2.0 Adc) | | – | 0.033 | 0.048 | |
| ($V_{GS}$ = 2.5 Vdc, $I_D$ = 3.0 Adc) | | – | 0.035 | 0.049 | |
| Forward Transconductance ($V_{DS}$ = 12 Vdc, $I_D$ = 3.0 Adc) | $g_{FS}$ | – | 10 | – | Mhos |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Input Capacitance | ($V_{DS}$ = 16 Vdc, $V_{GS}$ = 0 Vdc, f = 1.0 MHz) | $C_{iss}$ | – | 785 | 1100 | pF |
| Output Capacitance | | $C_{oss}$ | – | 260 | 450 | |
| Reverse Transfer Capacitance | | $C_{rss}$ | – | 75 | 180 | |
| **SWITCHING CHARACTERISTICS** (Notes 6 and 7) | | | | | | |
| Turn−On Delay Time | ($V_{DD}$ = 16 Vdc, $I_D$ = 6.0 Adc, $V_{GS}$ = 4.5 Vdc, $R_G$ = 6.0 Ω) | $t_{d(on)}$ | – | 12 | 20 | ns |
| Rise Time | | $t_r$ | – | 50 | 90 | |
| Turn−Off Delay Time | | $t_{d(off)}$ | – | 45 | 75 | |
| Fall Time | | $t_f$ | – | 80 | 130 | |
| Turn−On Delay Time | ($V_{DD}$ = 16 Vdc, $I_D$ = 4.0 Adc, $V_{GS}$ = 4.5 Vdc, $R_G$ = 6.0 Ω) | $t_{d(on)}$ | – | 11 | 18 | ns |
| Rise Time | | $t_r$ | – | 35 | 65 | |
| Turn−Off Delay Time | | $t_{d(off)}$ | – | 45 | 75 | |
| Fall Time | | $t_f$ | – | 60 | 110 | |
| Total Gate Charge | ($V_{DS}$ = 16 Vdc, $V_{GS}$ = 4.5 Vdc, $I_D$ = 6.0 Adc) | $Q_{tot}$ | – | 12 | 20 | nC |
| Gate−Source Charge | | $Q_{gs}$ | – | 1.5 | – | |
| Gate−Drain Charge | | $Q_{gd}$ | – | 4.0 | – | |

5. Handling precautions to protect against electrostatic discharge is mandatory
6. Indicates Pulse Test: Pulse Width = 300 μs max, Duty Cycle = 2%.
7. Switching characteristics are independent of operating junction temperature.

**ELECTRICAL CHARACTERISTICS** ($T_C$ = 25°C unless otherwise noted) (continued) (Note 8)

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **BODY−DRAIN DIODE RATINGS** (Note 9) | | | | | | |
| Diode Forward On−Voltage | ($I_S$ = 4.0 Adc, $V_{GS}$ = 0 Vdc)<br>($I_S$ = 6.0 Adc, $V_{GS}$ = 0 Vdc)<br>($I_S$ = 6.0 Adc, $V_{GS}$ = 0 Vdc, $T_J$ = 125°C) | $V_{SD}$ | −<br>−<br>− | 0.83<br>0.88<br>0.75 | 1.1<br>1.2<br>− | Vdc |
| Reverse Recovery Time | ($I_S$ = 6.0 Adc, $V_{GS}$ = 0 Vdc, $dI_S/dt$ = 100 A/μs) | $t_{rr}$ | − | 30 | − | ns |
| | | $t_a$ | − | 15 | − | |
| | | $t_b$ | − | 15 | − | |
| Reverse Recovery Stored Charge | | $Q_{RR}$ | − | 0.02 | − | μC |

8. Handling precautions to protect against electrostatic discharge is mandatory.
9. Indicates Pulse Test: Pulse Width = 300 μs max, Duty Cycle = 2%.

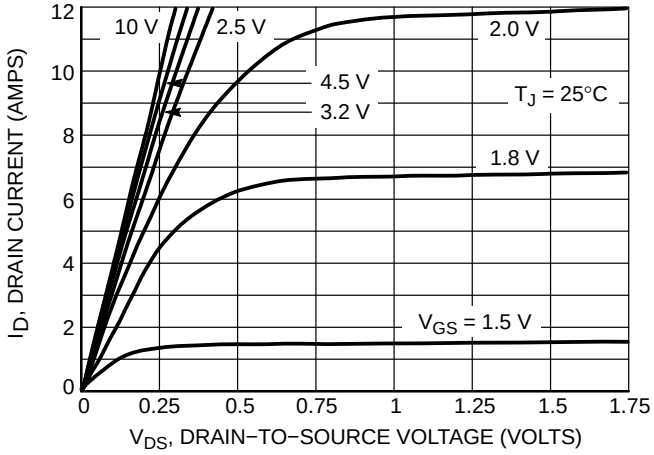



**Figure 1. On−Region Characteristics**

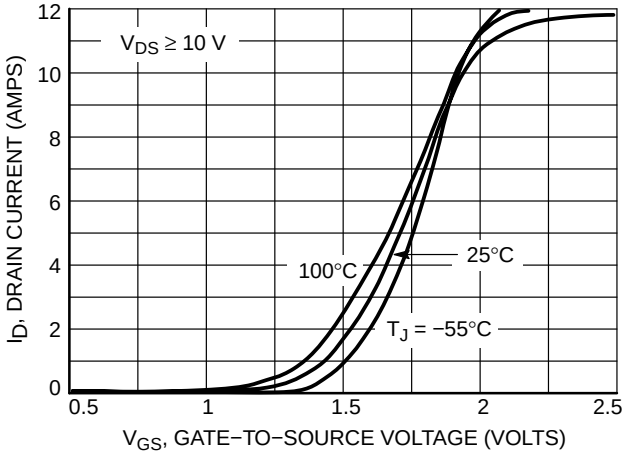



**Figure 2. Transfer Characteristics**

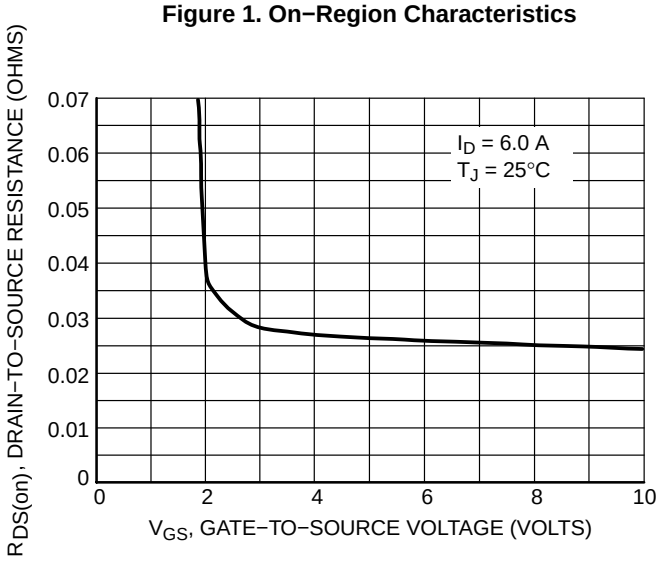



**Figure 3. On−Resistance versus Gate−To−Source Voltage**

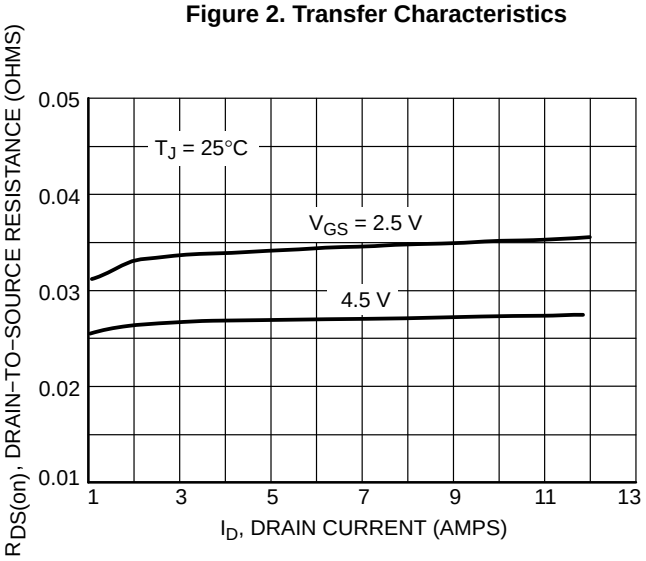



**Figure 4. On-Resistance versus Drain Current and Gate Voltage**

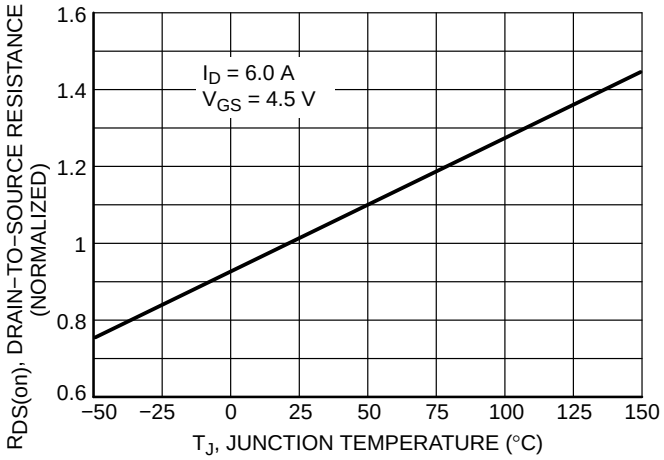



**Figure 5. On−Resistance Variation with Temperature**

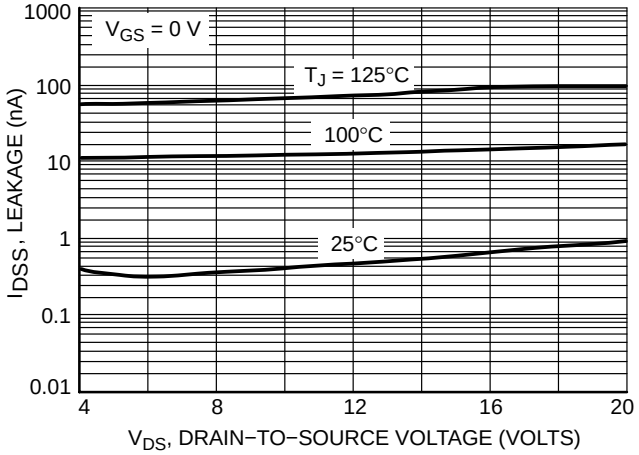



**Figure 6. Drain−To−Source Leakage Current versus Voltage**

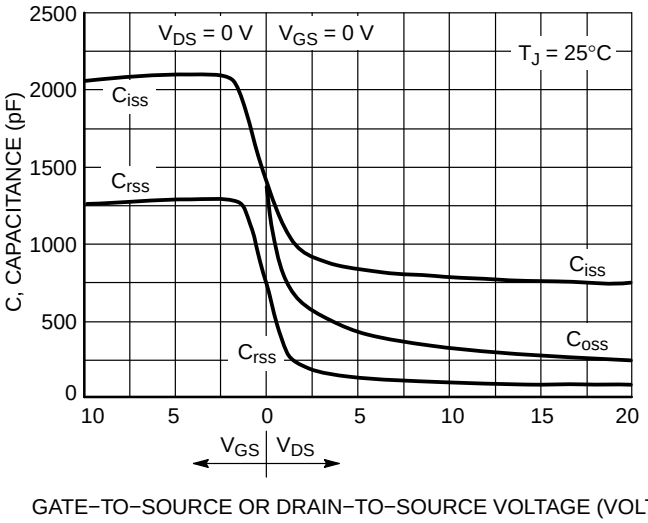



**Figure 7. Capacitance Variation**

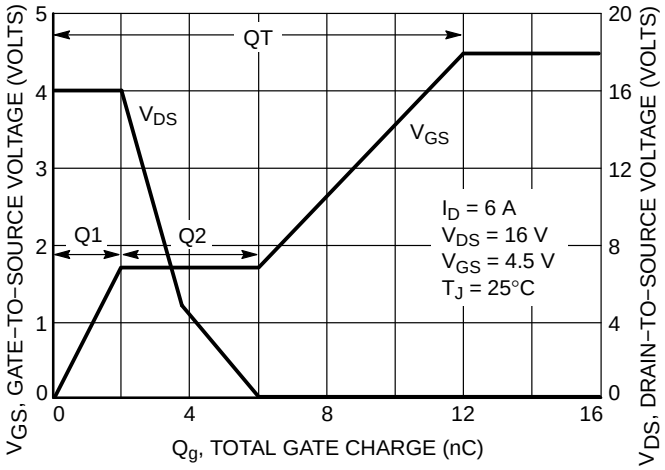



**Figure 8. Gate−To−Source and Drain−To−Source Voltage versus Total Charge**

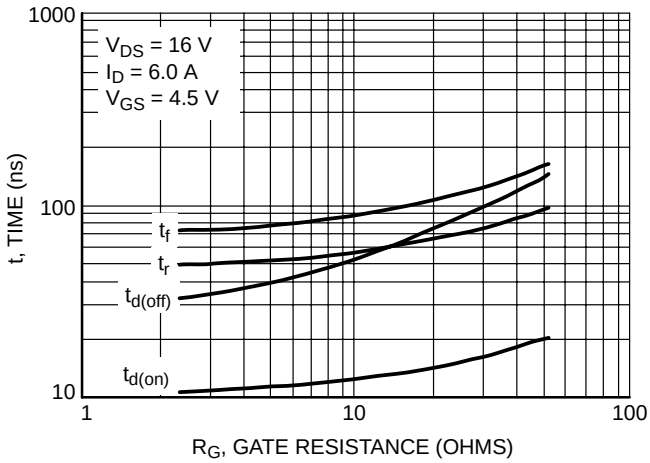



**Figure 9. Resistive Switching Time Variation versus Gate Resistance**

## DRAIN−TO−SOURCE DIODE CHARACTERISTICS

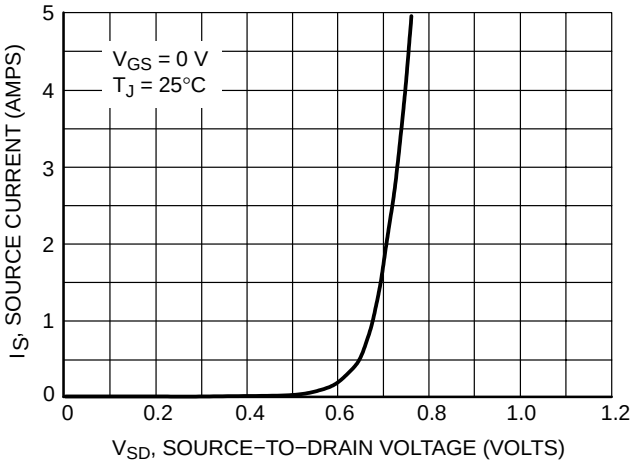



**Figure 10. Diode Forward Voltage versus Current**

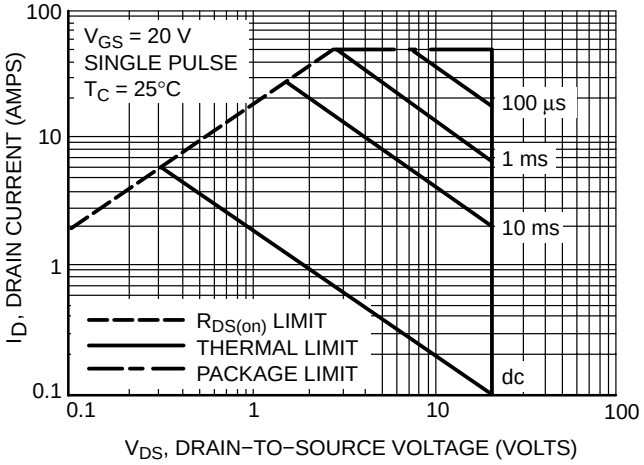



**Figure 11. Maximum Rated Forward Biased Safe Operating Area**

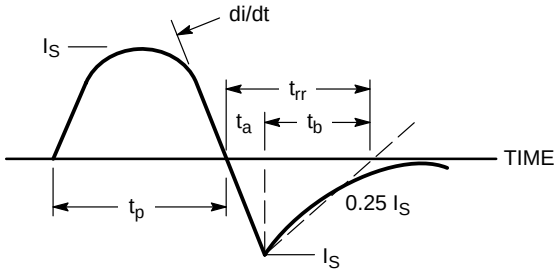



**Figure 12. Diode Reverse Recovery Waveform**

## TYPICAL ELECTRICAL CHARACTERISTICS

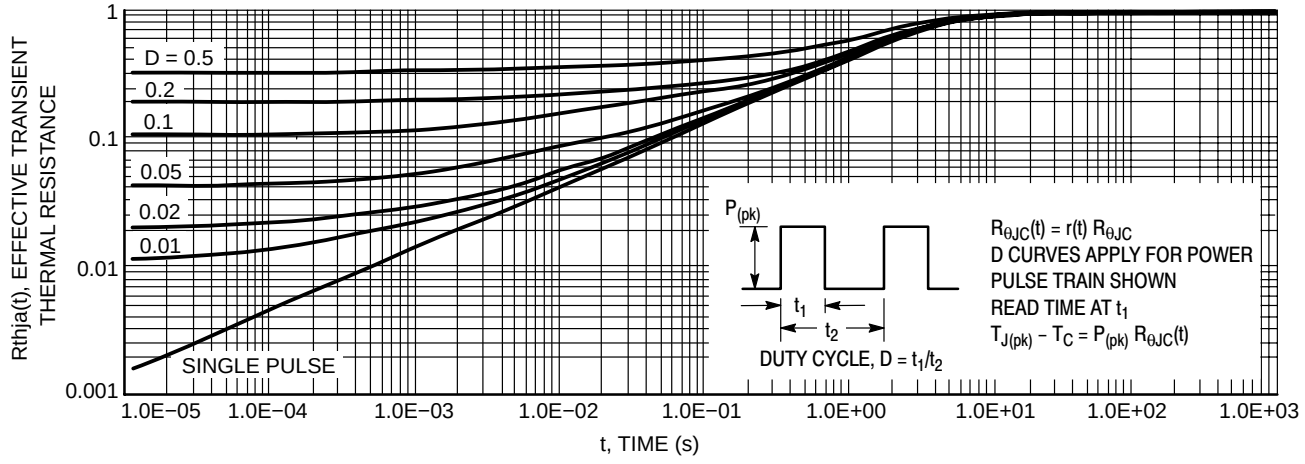
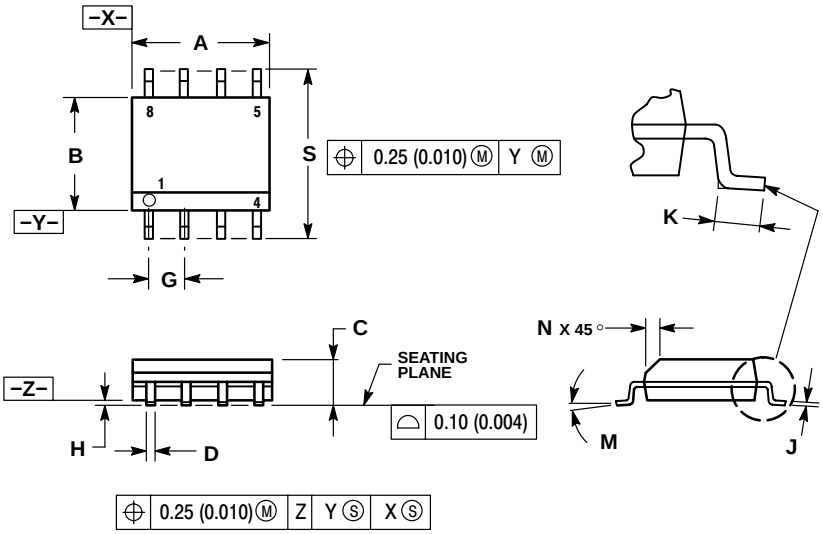



**Figure 13. Thermal Response**

# NTMD6N02R2

## PACKAGE DIMENSIONS

**SO−8**
CASE 751−07
ISSUE AB

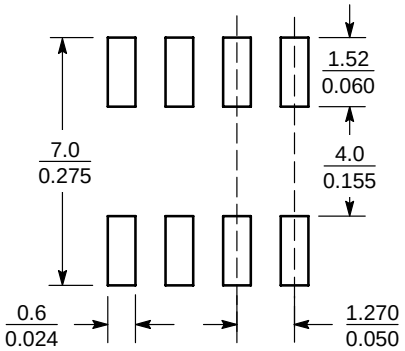



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDARD IS 751−07.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 4.80 | 5.00 | 0.189 | 0.197 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.053 | 0.069 |
| D | 0.33 | 0.51 | 0.013 | 0.020 |
| G | 1.27 BSC | | 0.050 BSC | |
| H | 0.10 | 0.25 | 0.004 | 0.010 |
| J | 0.19 | 0.25 | 0.007 | 0.010 |
| K | 0.40 | 1.27 | 0.016 | 0.050 |
| M | 0 ° | 8 ° | 0 ° | 8 ° |
| N | 0.25 | 0.50 | 0.010 | 0.020 |
| S | 5.80 | 6.20 | 0.228 | 0.244 |

STYLE 11:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

## SOLDERING FOOTPRINT*




SCALE 6:1 (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.



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