# NTTD2P02R2

# Power MOSFET
# -2.4 Amps, -20 Volts
## Dual P−Channel Micro8

**Features**

- Ultra Low $R_{DS(on)}$
- Higher Efficiency Extending Battery Life
- Logic Level Gate Drive
- Miniature Micro−8 Surface Mount Package
- Diode Exhibits High Speed, Soft Recovery
- Micro8 Mounting Information Provided

**Applications**

- Power Management in Portable and Battery−Powered Products, i.e.: 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 |
| Gate−to−Source Voltage − Continuous | $V_{GS}$ | ±8.0 | V |
| Thermal Resistance − Junction−to−Ambient (Note 1.)<br>Total Power Dissipation @ $T_A$ = 25°C<br>Continuous Drain Current @ $T_A$ = 25°C<br>Continuous Drain Current @ $T_A$ = 70°C<br>Pulsed Drain Current (Note 3.) | $R_{\theta JA}$<br>$P_D$<br>$I_D$<br>$I_D$<br>$I_{DM}$ | 160<br>0.78<br>−2.4<br>−1.92<br>−20 | °C/W<br>W<br>A<br>A<br>A |
| Thermal Resistance − Junction−to−Ambient (Note 2.)<br>Total Power Dissipation @ $T_A$ = 25°C<br>Continuous Drain Current @ $T_A$ = 25°C<br>Continuous Drain Current @ $T_A$ = 70°C<br>Pulsed Drain Current (Note 3.) | $R_{\theta JA}$<br>$P_D$<br>$I_D$<br>$I_D$<br>$I_{DM}$ | 88<br>1.42<br>−3.25<br>−2.6<br>−30 | °C/W<br>W<br>A<br>A<br>A |
| 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, $V_{GS}$ = −4.5 Vdc, Peak $I_L$ = −5.0 Apk, L = 28 mH, $R_G$ = 25 Ω) | $E_{AS}$ | 350 | mJ |
| Maximum Lead Temperature for Soldering Purposes for 10 seconds | $T_L$ | 260 | °C |

1. Minimum FR−4 or G−10 PCB, Steady State.
2. Mounted onto a 2″ square FR−4 Board (1″ sq. 2 oz Cu 0.06″ thick single sided), Steady State.
3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.



**ON Semiconductor™**

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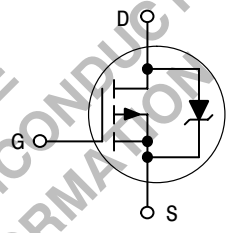
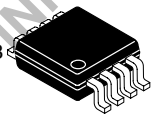
**−2.4 AMPERES**
**−20 VOLTS**
**$R_{DS(on)}$ = 90 mΩ**

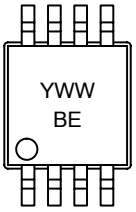
**P−Channel**



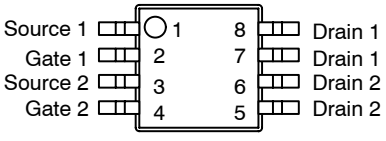

**Micro8**
**CASE 846A**
**STYLE 2**

**MARKING DIAGRAM**




Y = Year
WW = Work Week
BE = Device Code

**PIN ASSIGNMENT**




Top View

**ORDERING INFORMATION**

| Device | Package | Shipping |
|---|---|---|
| NTTD2P02R2 | Micro8 | 4000/Tape & Reel |

**ELECTRICAL CHARACTERISTICS** ($T_C$ = 25°C unless otherwise noted) (Note 1)

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| Drain−to−Source Breakdown Voltage<br>($V_{GS}$ = 0 Vdc, $I_D$ = −250 μAdc)<br>Temperature Coefficient (Positive) | | $V_{(BR)DSS}$ | <br>−20<br>− | <br>−<br>−12.7 | <br>−<br>− | Vdc<br><br>mV/°C |
| Zero Gate Voltage Drain Current<br>($V_{GS}$ = 0 Vdc, $V_{DS}$ = −16 Vdc, $T_J$ = 25°C)<br>($V_{GS}$ = 0 Vdc, $V_{DS}$ = −16 Vdc, $T_J$ = 125°C) | | $I_{DSS}$ | <br>−<br>− | <br>−<br>− | <br>−1.0<br>−25 | μAdc |
| Zero Gate Voltage Drain Current<br>($V_{GS}$ = 0 Vdc, $V_{DS}$ = −20 Vdc, $T_J$ = 25°C) | | $I_{DSS}$ | − | − | −5.0 | μAdc |
| Gate−Body Leakage Current<br>($V_{GS}$ = −8 Vdc, $V_{DS}$ = 0 Vdc) | | $I_{GSS}$ | − | − | −100 | nAdc |
| Gate−Body Leakage Current<br>($V_{GS}$ = +8 Vdc, $V_{DS}$ = 0 Vdc) | | $I_{GSS}$ | − | − | 100 | nAdc |
| **ON CHARACTERISTICS** | | | | | | |
| Gate Threshold Voltage<br>($V_{DS}$ = $V_{GS}$, $I_D$ = −250 μAdc)<br>Temperature Coefficient (Negative) | | $V_{GS(th)}$ | <br>−0.5<br>− | <br>−0.90<br>2.5 | <br>−1.4<br>− | Vdc<br><br>mV/°C |
| Static Drain−to−Source On−State Resistance<br>($V_{GS}$ = −4.5 Vdc, $I_D$ = −2.4 Adc)<br>($V_{GS}$ = −2.7 Vdc, $I_D$ = −1.2 Adc)<br>($V_{GS}$ = −2.5 Vdc, $I_D$ = −1.2 Adc) | | $R_{DS(on)}$ | <br>−<br>−<br>− | <br>0.070<br>0.100<br>0.110 | <br>0.090<br>0.130<br>− | Ω |
| Forward Transconductance ($V_{DS}$ = −10 Vdc, $I_D$ = −1.2 Adc) | | $g_{FS}$ | 2.0 | 4.2 | − | Mhos |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| Input Capacitance | ($V_{DS}$ = −16 Vdc, $V_{GS}$ = 0 Vdc, f = 1.0 MHz) | $C_{iss}$ | − | 550 | − | pF |
| Output Capacitance | | $C_{oss}$ | − | 200 | − | |
| Reverse Transfer Capacitance | | $C_{rss}$ | − | 100 | − | |
| **SWITCHING CHARACTERISTICS** (Notes 2 & 3) | | | | | | |
| Turn−On Delay Time | ($V_{DD}$ = −10 Vdc, $I_D$ = −2.4 Adc, $V_{GS}$ = −4.5 Vdc, $R_G$ = 6.0 Ω) | $t_{d(on)}$ | − | 10 | − | ns |
| Rise Time | | $t_r$ | − | 31 | − | |
| Turn−Off Delay Time | | $t_{d(off)}$ | − | 33 | − | |
| Fall Time | | $t_f$ | − | 29 | − | |
| Turn−On Delay Time | ($V_{DD}$ = −10 Vdc, $I_D$ = −1.2 Adc, $V_{GS}$ = −2.7 Vdc, $R_G$ = 6.0 Ω) | $t_{d(on)}$ | − | 15 | − | ns |
| Rise Time | | $t_r$ | − | 40 | − | |
| Turn−Off Delay Time | | $t_{d(off)}$ | − | 35 | − | |
| Fall Time | | $t_f$ | − | 35 | − | |
| Total Gate Charge | ($V_{DS}$ = −16 Vdc, $V_{GS}$ = −4.5 Vdc, $I_D$ = −2.4 Adc) | $Q_{tot}$ | − | 10 | 18 | nC |
| Gate−Source Charge | | $Q_{gs}$ | − | 1.5 | − | |
| Gate−Drain Charge | | $Q_{gd}$ | − | 5.0 | − | |
| **BODY−DRAIN DIODE RATINGS** (Note 2) | | | | | | |
| Diode Forward On−Voltage | ($I_S$ = −2.4 Adc, $V_{GS}$ = 0 Vdc)<br>($I_S$ = −2.4 Adc, $V_{GS}$ = 0 Vdc, $T_J$ = 125°C) | $V_{SD}$ | <br>− | <br>−0.88<br>−0.75 | <br>−1.0<br>− | Vdc |
| Reverse Recovery Time | ($I_S$ = −2.4 Adc, $V_{GS}$ = 0 Vdc, $dI_S/dt$ = 100 A/μs) | $t_{rr}$ | − | 37 | − | ns |
| | | $t_a$ | − | 16 | − | |
| | | $t_b$ | − | 21 | − | |
| Reverse Recovery Stored Charge | | $Q_{RR}$ | − | 0.025 | − | μC |

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

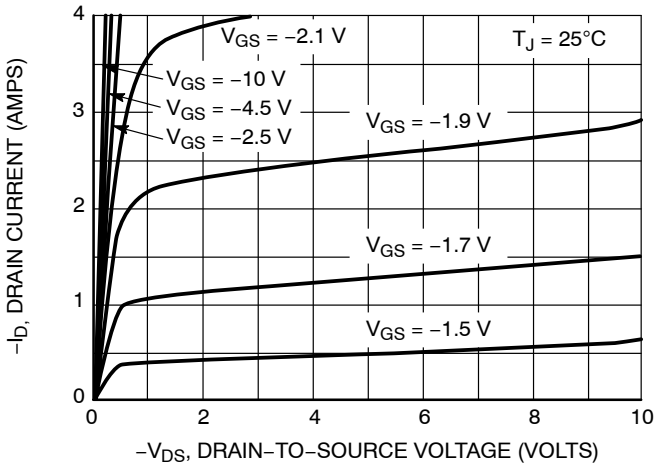



**Figure 1. On−Region Characteristics.**

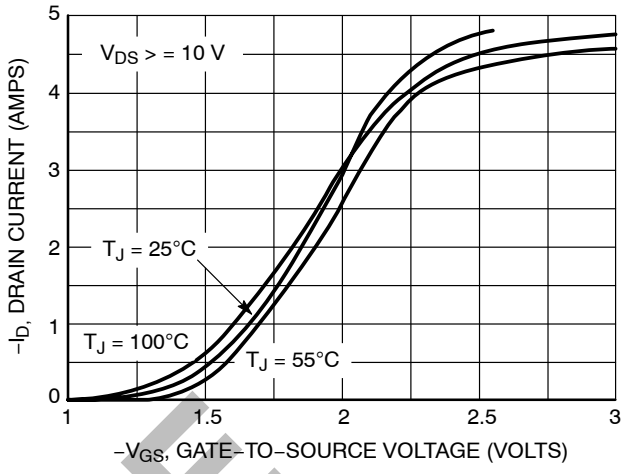



**Figure 2. Transfer Characteristics.**

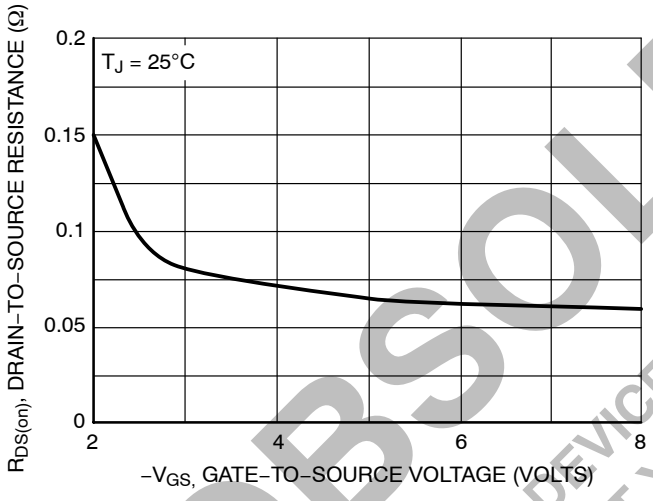



**Figure 3. On−Resistance vs. Gate−to−Source Voltage.**

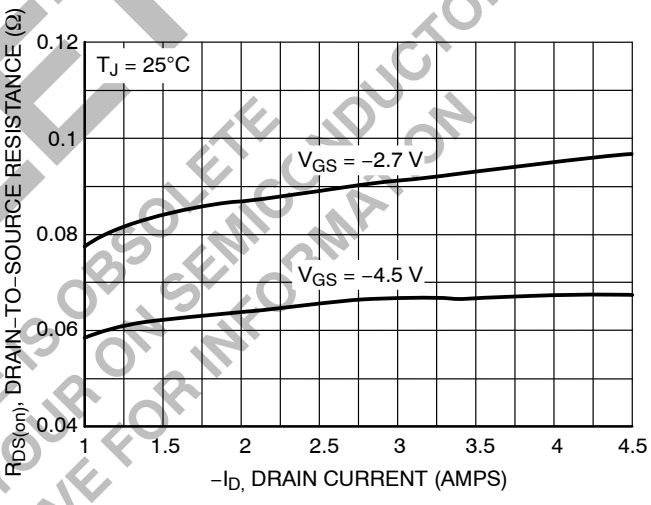



**Figure 4. On−Resistance vs. Drain Current and Gate Voltage.**

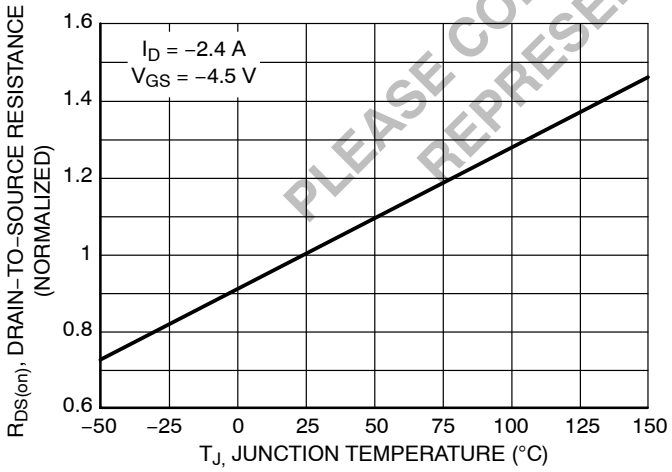



**Figure 5. On−Resistance Variation with Temperature.**

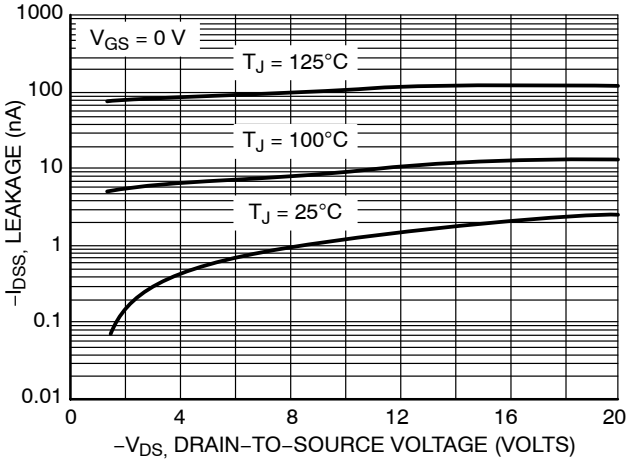



**Figure 6. Drain−to−Source Leakage Current vs. Voltage.**

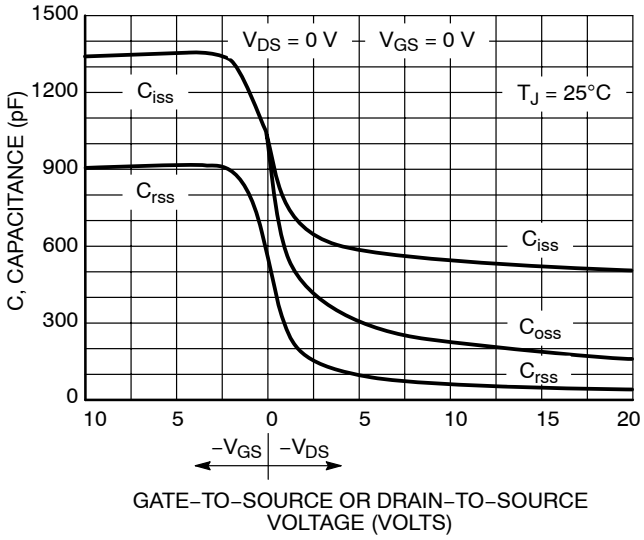



**Figure 7. Capacitance Variation**

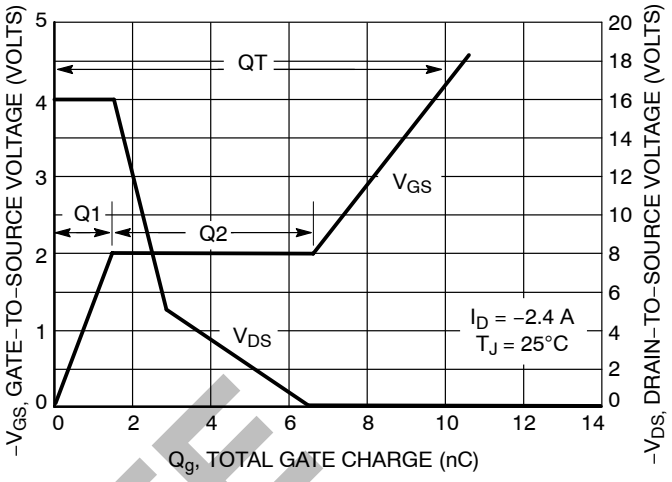



**Figure 8. Gate−to−Source and Drain−to−Source Voltage versus Total Charge**

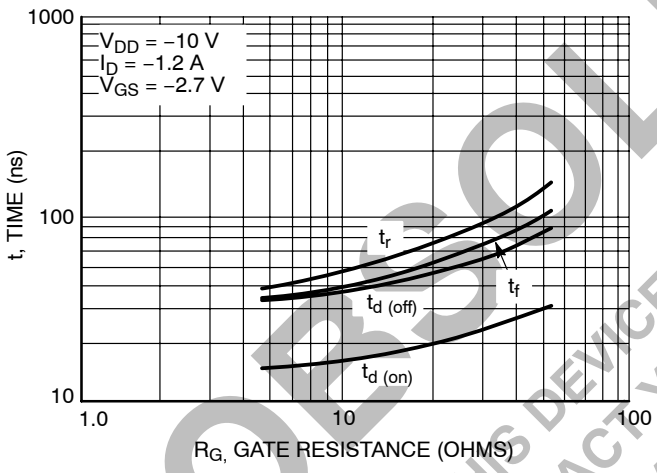



**Figure 9. Resistive Switching Time Variation versus Gate Resistance**

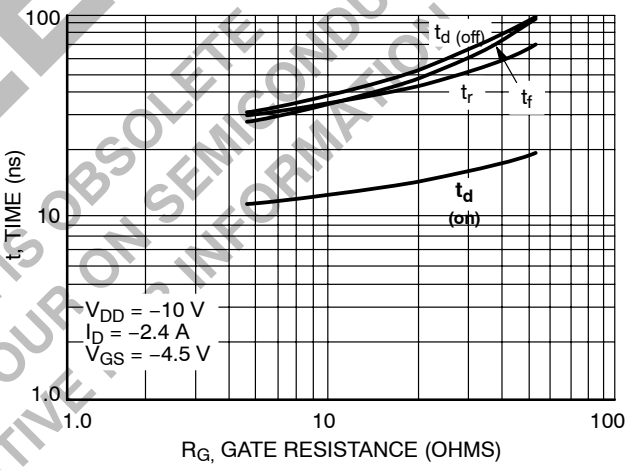



**Figure 10. Resistive Switching Time Variation versus Gate Resistance**

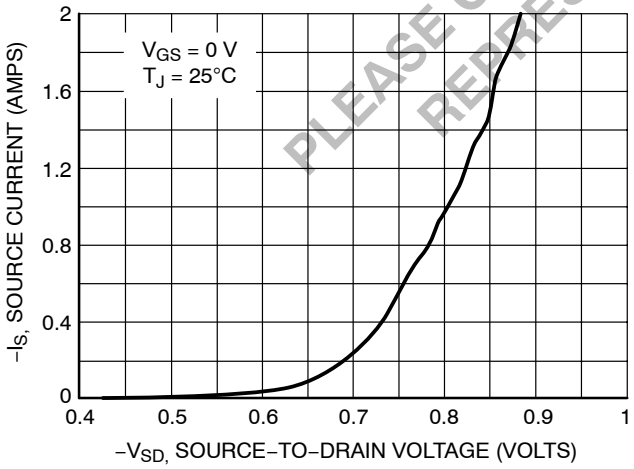



**Figure 11. Diode Forward Voltage versus Current**

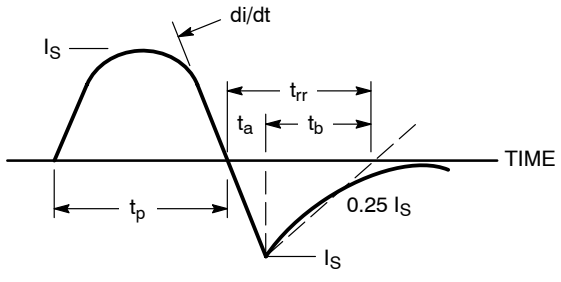



**Figure 12. Diode Reverse Recovery Waveform**

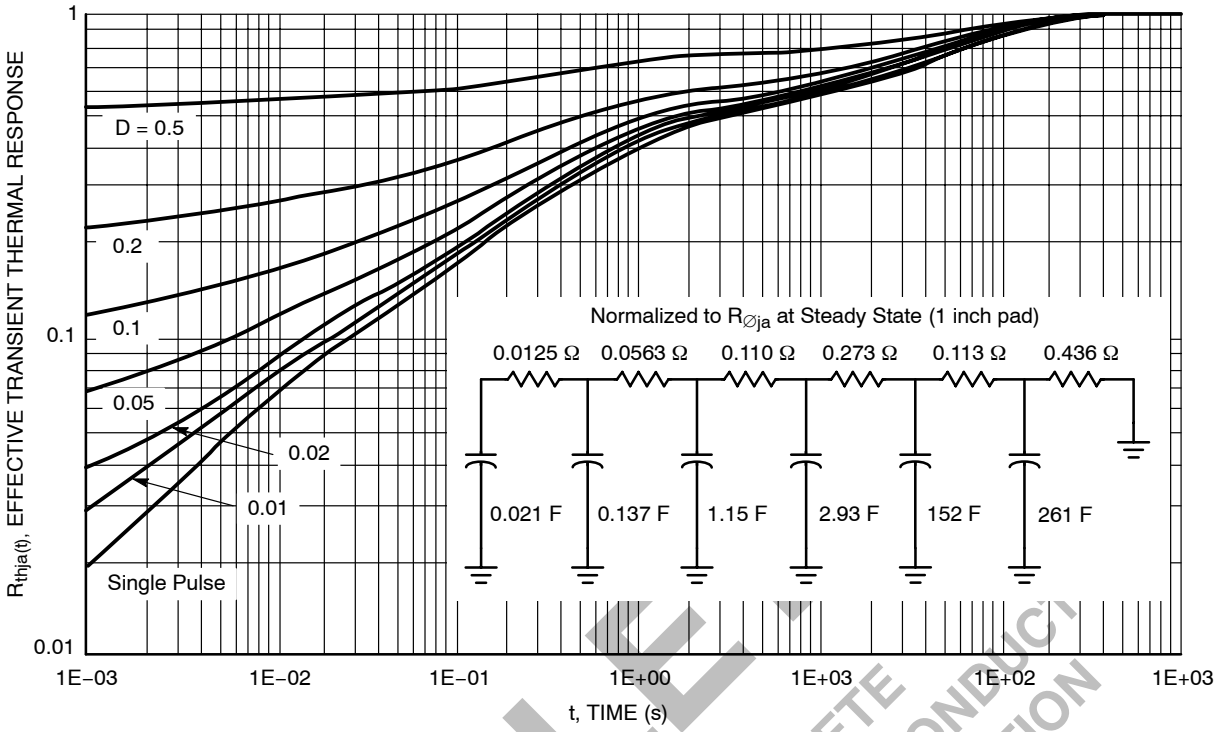
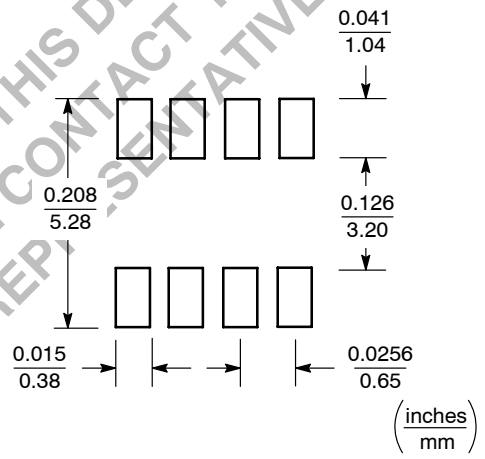



**Figure 13. FET Thermal Response.**

## INFORMATION FOR USING THE Micro−8 SURFACE MOUNT PACKAGE

### MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to ensure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self−align when subjected to a solder reflow process.



## SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

* * Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

## TYPICAL SOLDER HEATING PROFILE

For any given circuit board, there will be a group of control settings that will give the desired heat pattern. The operator must set temperatures for several heating zones and a figure for belt speed. Taken together, these control settings make up a heating “profile” for that particular circuit board. On machines controlled by a computer, the computer remembers these profiles from one operating session to the next. Figure 14 shows a typical heating profile for use when soldering a surface mount device to a printed circuit board. This profile will vary among soldering systems, but it is a good starting point. Factors that can affect the profile include the type of soldering system in use, density and types of components on the board, type of solder used, and the type of board or substrate material being used. This profile shows temperature versus time. The line on the graph shows the actual temperature that might be experienced on the surface of a test board at or near a central solder joint. The two profiles are based on a high density and a low density board. The Vitronics SMD310 convection/infrared reflow soldering system was used to generate this profile. The type of solder used was 62/36/2 Tin Lead Silver with a melting point between 177−189°C. When this type of furnace is used for solder reflow work, the circuit boards and solder joints tend to heat first. The components on the board are then heated by conduction. The circuit board, because it has a large surface area, absorbs the thermal energy more efficiently, then distributes this energy to the components. Because of this effect, the main body of a component may be up to 30 degrees cooler than the adjacent solder joints.



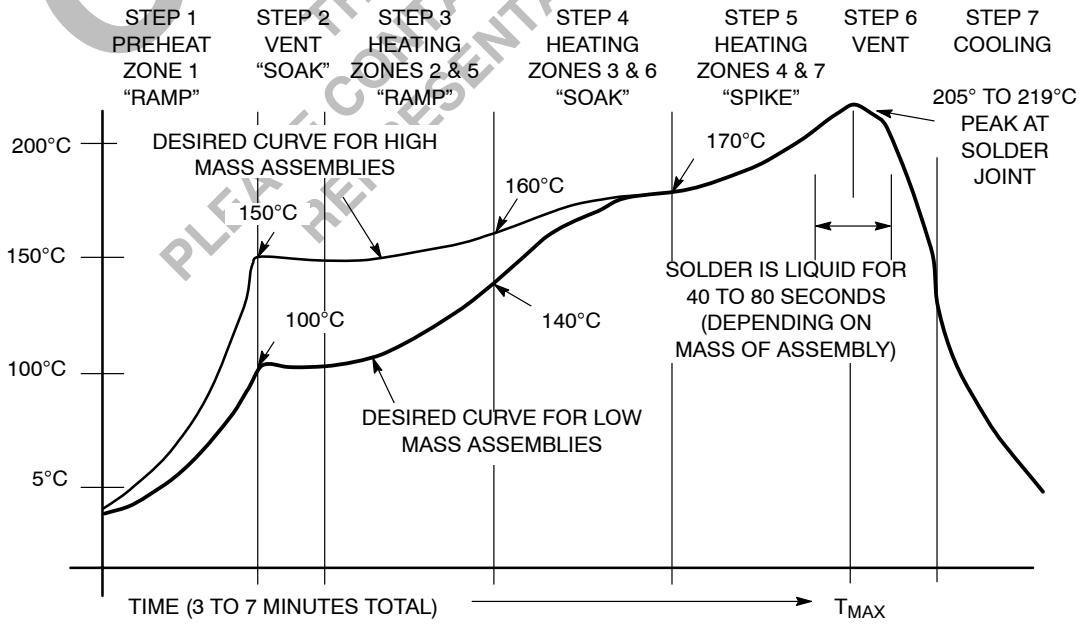
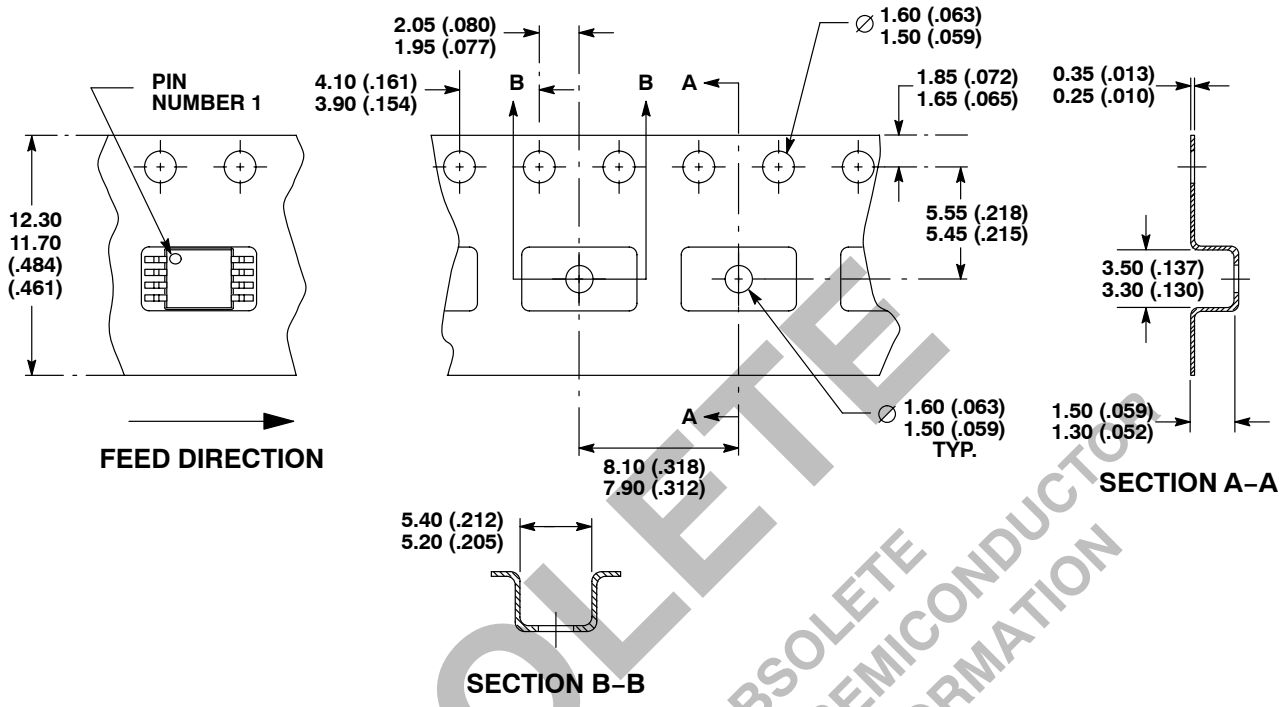



**Figure 14. Typical Solder Heating Profile**

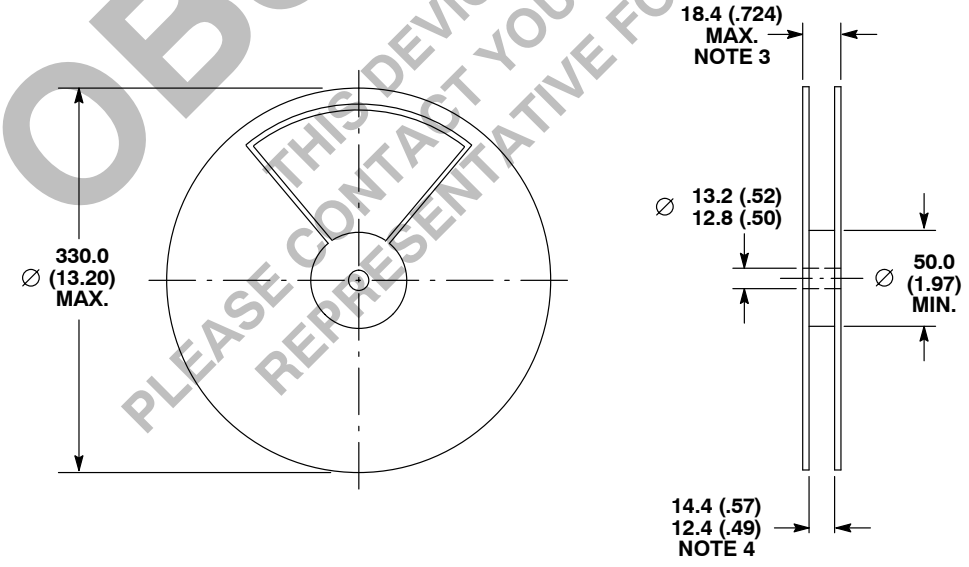
## TAPE & REEL INFORMATION

**Micro−8**

Dimensions are shown in millimeters (inches)



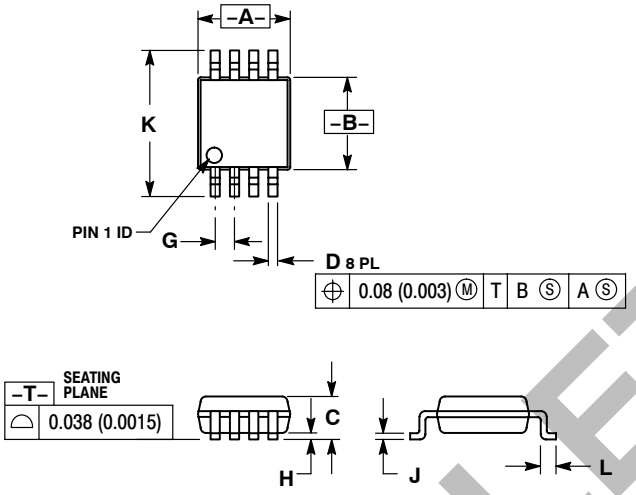

**NOTES:**
1. **CONFORMS TO EIA−481−1.**
2. **CONTROLLING DIMENSION: MILLIMETER.**




**NOTES:**
1. **CONFORMS TO EIA−481−1.**
2. **CONTROLLING DIMENSION: MILLIMETER.**
3. **INCLUDES FLANGE DISTORTION AT OUTER EDGE.**
4. **DIMENSION MEASURED AT INNER HUB.**

## PACKAGE DIMENSIONS

**Micro8**
CASE 846A–02
ISSUE E




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 2.90 | 3.10 | 0.114 | 0.122 |
| B | 2.90 | 3.10 | 0.114 | 0.122 |
| C | --- | 1.10 | --- | 0.043 |
| D | 0.25 | 0.40 | 0.010 | 0.016 |
| G | 0.65 BSC | | 0.026 BSC | |
| H | 0.05 | 0.15 | 0.002 | 0.006 |
| J | 0.13 | 0.23 | 0.005 | 0.009 |
| K | 4.75 | 5.05 | 0.187 | 0.199 |
| L | 0.40 | 0.70 | 0.016 | 0.028 |

STYLE 2:
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





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