

# NTHD4N02F

## Power MOSFET and Schottky Diode

20 V, 3.9 A, N-Channel, with 3.7 A Schottky Barrier Diode, ChipFET™

### Features

- Leadless SMD Package Featuring a MOSFET and Schottky Diode
- 40% Smaller than TSOP-6 Package with Better Thermals
- Super Low Gate Charge MOSFET
- Ultra Low  $V_F$  Schottky
- Pb-Free Package is Available

### Applications

- Fast Switching, low Gate Charge for DC-to-DC Buck and Boost Converters
- Li-Ion Battery Applications in Cell Phones, PDAs, DSCs, and Media Players
- Load Side Switching

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

| Parameter                                                         |                        | Symbol         | Value                    | Unit             |
|-------------------------------------------------------------------|------------------------|----------------|--------------------------|------------------|
| Drain-to-Source Voltage                                           |                        | $V_{DS}$       | 20                       | V                |
| Gate-to-Source Voltage                                            |                        | $V_{GS}$       | $\pm 12$                 | V                |
| Continuous Drain Current                                          | Steady State           | $I_D$          | $T_J = 25^\circ\text{C}$ | A                |
|                                                                   |                        |                | $T_J = 85^\circ\text{C}$ |                  |
|                                                                   | $t \leq 5 \text{ s}$   |                | $T_J = 25^\circ\text{C}$ |                  |
| Pulsed Drain Current                                              | $t_p = 10 \mu\text{s}$ | $I_{DM}$       | 12                       | A                |
| Power Dissipation                                                 | Steady State           | $P_D$          | $T_J = 25^\circ\text{C}$ | W                |
|                                                                   |                        |                | $T_J = 85^\circ\text{C}$ |                  |
|                                                                   | $t \leq 5 \text{ s}$   |                | $T_J = 25^\circ\text{C}$ |                  |
| Continuous Source Current (Body Diode)                            |                        | $I_S$          | 2.6                      | A                |
| Operating Junction and Storage Temperature                        |                        | $T_J, T_{STG}$ | -55 to 150               | $^\circ\text{C}$ |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s) |                        | $T_L$          | 260                      | $^\circ\text{C}$ |

### SCHOTTKY DIODE MAXIMUM RATINGS

( $T_J = 25^\circ\text{C}$  unless otherwise noted)

| Parameter                         |                      | Symbol    | Value                    | Unit |
|-----------------------------------|----------------------|-----------|--------------------------|------|
| Peak Repetitive Reverse Voltage   |                      | $V_{RRM}$ | 20                       | V    |
| DC Blocking Voltage               |                      | $V_R$     | 20                       | V    |
| Average Rectified Forward Current | Steady State         | $I_F$     | $T_J = 25^\circ\text{C}$ | A    |
|                                   | $t \leq 5 \text{ s}$ |           |                          | A    |

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.



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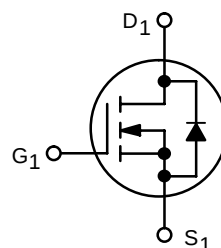
<http://onsemi.com>

### MOSFET

| $V_{(BR)DS}$ | $R_{DS(on)}$ TYP      | $I_D$ MAX |
|--------------|-----------------------|-----------|
| 20 V         | 60 m $\Omega$ @ 4.5 V | 3.9 A     |
|              | 80 m $\Omega$ @ 2.5 V |           |

### SCHOTTKY DIODE

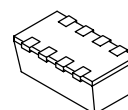
| $V_R$ MAX | $V_F$ TYP | $I_F$ MAX |
|-----------|-----------|-----------|
| 20 V      | 0.35 V    | 3.7 A     |



N-Channel MOSFET

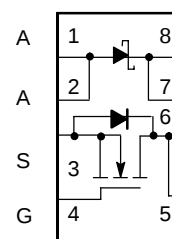


SCHOTTKY DIODE

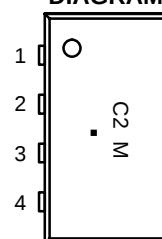


ChipFET™  
CASE 1206A  
STYLE 3

### PIN CONNECTIONS



### MARKING DIAGRAM



C2 = Specific Device Code  
M = Month Code  
■ = Pb-Free Package

### ORDERING INFORMATION

| Device       | Package           | Shipping†        |
|--------------|-------------------|------------------|
| NTHD4N02FT1  | ChipFET           | 3000/Tape & Reel |
| NTHD4N02FT1G | ChipFET (Pb-Free) | 3000/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.

# NTHD4N02F

## THERMAL RESISTANCE RATINGS

| Parameter                                   | Symbol          | Max | Unit                 |
|---------------------------------------------|-----------------|-----|----------------------|
| Junction-to-Ambient – Steady State (Note 1) | $R_{\theta JA}$ | 110 | $^{\circ}\text{C/W}$ |
| Junction-to-Ambient – $t \leq 5$ s          | $R_{\theta JA}$ | 60  | $^{\circ}\text{C/W}$ |

1. Surface Mounted on FR4 Board using 1 in sq. pad size (Cu area = 1.27 in sq. [1 oz] including traces).

## MOSFET ELECTRICAL CHARACTERISTICS ( $T_J = 25^{\circ}\text{C}$ unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|-----------|--------|-----------------|-----|-----|-----|-------|
|-----------|--------|-----------------|-----|-----|-----|-------|

### OFF CHARACTERISTICS

|                                   |               |                                                     |                            |    |           |               |
|-----------------------------------|---------------|-----------------------------------------------------|----------------------------|----|-----------|---------------|
| Drain-to-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | 20                         | 28 |           | V             |
| Zero Gate Voltage Drain Current   | $I_{DSS}$     | $V_{GS} = 0\text{ V}$<br>$V_{DS} = 16\text{ V}$     | $T_J = 25^{\circ}\text{C}$ |    | 1.0       | $\mu\text{A}$ |
|                                   |               |                                                     | $T_J = 85^{\circ}\text{C}$ |    | 5.0       |               |
| Gate-to-Source Leakage Current    | $I_{GSS}$     | $V_{DS} = 0\text{ V}, V_{GS} = \pm 12\text{ V}$     |                            |    | $\pm 100$ | nA            |

### ON CHARACTERISTICS (Note 2)

|                               |              |                                                 |     |       |       |          |
|-------------------------------|--------------|-------------------------------------------------|-----|-------|-------|----------|
| Gate Threshold Voltage        | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_D = 250\text{ }\mu\text{A}$ | 0.6 |       | 1.2   | V        |
| Drain-to-Source On-Resistance | $R_{DS(on)}$ | $V_{GS} = 4.5\text{ V}, I_D = 2.9\text{ A}$     |     | 0.058 | 0.080 | $\Omega$ |
|                               |              | $V_{GS} = 2.5\text{ V}, I_D = 2.3\text{ A}$     |     | 0.077 | 0.115 |          |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 10\text{ V}, I_D = 2.9\text{ A}$      |     | 6.0   |       | S        |

### CHARGES AND CAPACITANCES

|                              |              |                                                                        |  |     |     |    |
|------------------------------|--------------|------------------------------------------------------------------------|--|-----|-----|----|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1.0\text{ MHz},$<br>$V_{DS} = 10\text{ V}$   |  | 180 | 300 | pF |
| Output Capacitance           | $C_{OSS}$    |                                                                        |  | 80  | 130 |    |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                        |  | 30  | 50  |    |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V},$<br>$I_D = 2.9\text{ A}$ |  | 2.6 | 4.0 | nC |
| Gate-to-Source Charge        | $Q_{GS}$     |                                                                        |  | 0.6 |     |    |
| Gate-to-Drain Charge         | $Q_{GD}$     |                                                                        |  | 0.7 |     |    |

### SWITCHING CHARACTERISTICS (Note 3)

|                     |              |                                                                                                 |  |     |     |    |
|---------------------|--------------|-------------------------------------------------------------------------------------------------|--|-----|-----|----|
| Turn-On Delay Time  | $t_{d(ON)}$  | $V_{GS} = 4.5\text{ V}, V_{DD} = 16\text{ V},$<br>$I_D = 2.9\text{ A}, R_G = 2.5\text{ }\Omega$ |  | 5.0 | 10  | ns |
| Rise Time           | $t_r$        |                                                                                                 |  | 9.0 | 18  |    |
| Turn-Off Delay Time | $t_{d(OFF)}$ |                                                                                                 |  | 10  | 20  |    |
| Fall Time           | $t_f$        |                                                                                                 |  | 3.0 | 6.0 |    |

### DRAIN-SOURCE DIODE CHARACTERISTICS (Note 2)

|                         |          |                                                                                    |  |      |      |    |
|-------------------------|----------|------------------------------------------------------------------------------------|--|------|------|----|
| Forward Diode Voltage   | $V_{SD}$ | $V_{GS} = 0\text{ V}, I_S = 2.6\text{ A}$                                          |  | 0.8  | 1.15 | V  |
| Reverse Recovery Time   | $t_{RR}$ | $V_{GS} = 0\text{ V}, I_S = 2.6\text{ A},$<br>$di_S/dt = 100\text{ A}/\mu\text{s}$ |  | 12.5 |      | ns |
| Charge Time             | $t_a$    |                                                                                    |  | 9.0  |      |    |
| Discharge Time          | $t_b$    |                                                                                    |  | 3.5  |      |    |
| Reverse Recovery Charge | $Q_{RR}$ |                                                                                    |  | 6.0  |      | nC |

### SCHOTTKY DIODE ELECTRICAL CHARACTERISTICS ( $T_J = 25^{\circ}\text{C}$ unless otherwise noted)

| Parameter                             | Symbol    | Test Conditions               | Min | Typ | Max   | Units |
|---------------------------------------|-----------|-------------------------------|-----|-----|-------|-------|
| Maximum Instantaneous Forward Voltage | $V_F$     | $I_F = 0.1\text{ A}$          |     |     | 0.31  | V     |
|                                       |           | $I_F = 1.0\text{ A}$          |     |     | 0.365 |       |
| Maximum Instantaneous Reverse Current | $I_R$     | $V_R = 10\text{ V}$           |     |     | 0.75  | mA    |
|                                       |           | $V_R = 20\text{ V}$           |     |     | 2.5   |       |
| Non-Repetitive Peak Surge Current     | $I_{FSM}$ | Halfwave, Single Pulse, 60 Hz |     |     | 23    | A     |

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

3. Switching characteristics are independent of operating junction temperatures.

TYPICAL MOSFET PERFORMANCE CURVES ( $T_J = 25^\circ\text{C}$  unless otherwise noted)

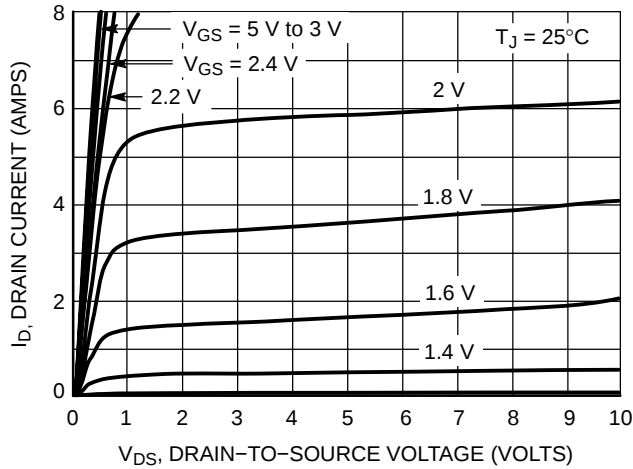


Figure 1. On-Region Characteristics

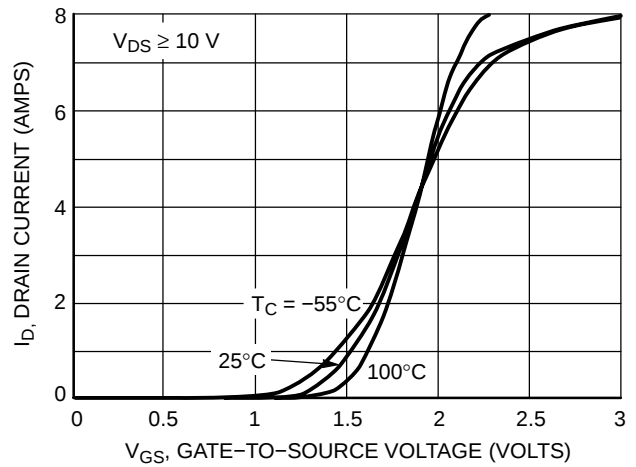


Figure 2. Transfer Characteristics

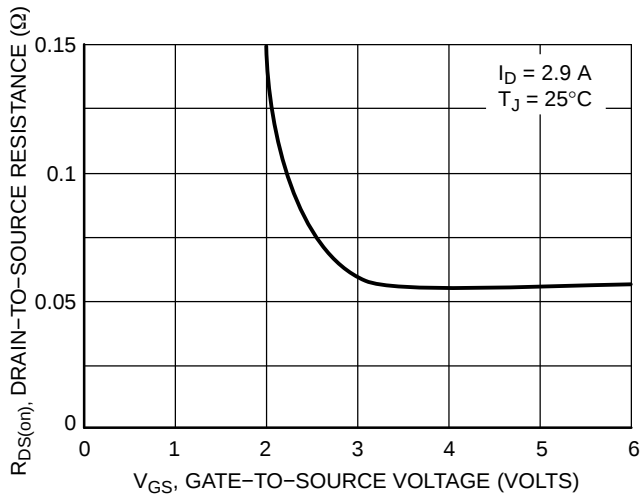


Figure 3. On-Resistance vs. Gate-to-Source Voltage

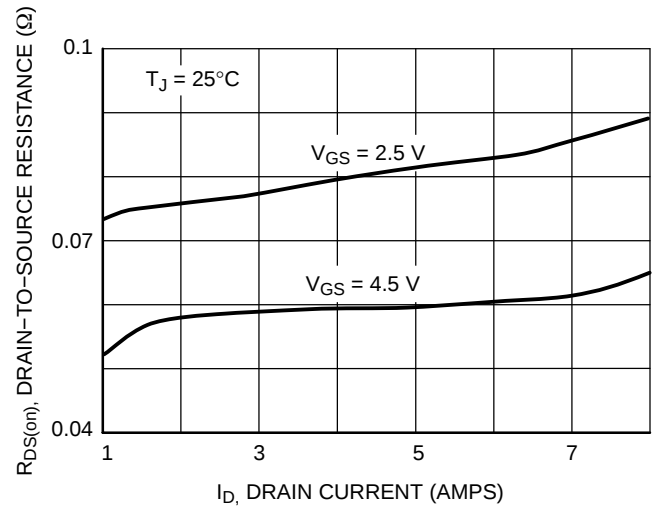


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

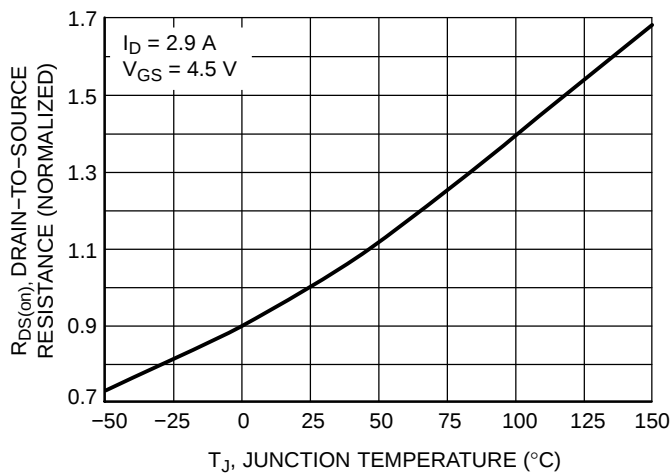


Figure 5. On-Resistance Variation with Temperature

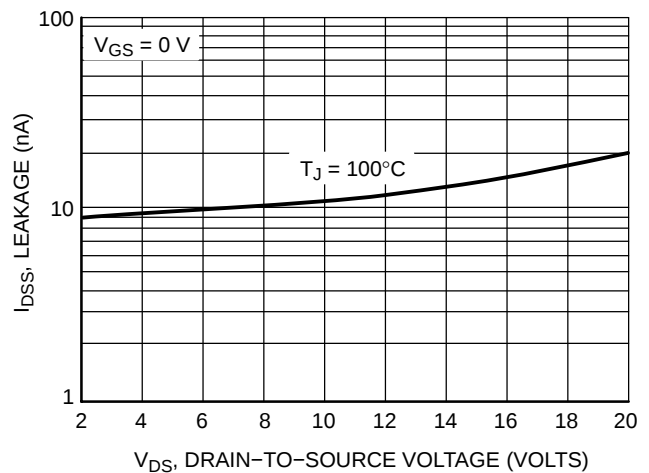


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL MOSFET PERFORMANCE CURVES ( $T_J = 25^\circ\text{C}$  unless otherwise noted)

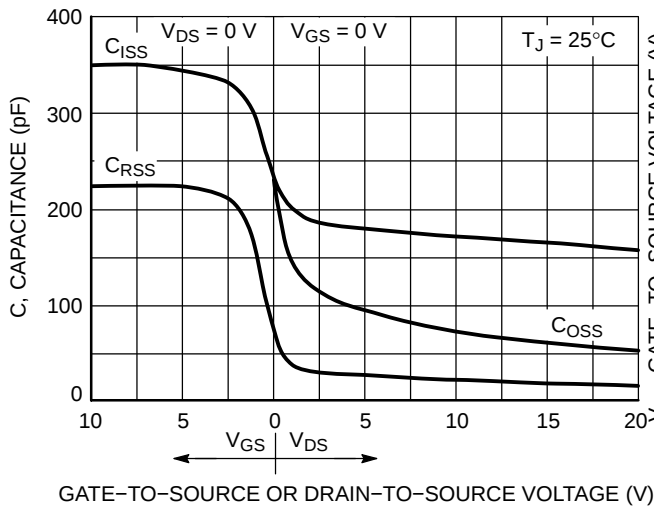


Figure 7. Capacitance Variation

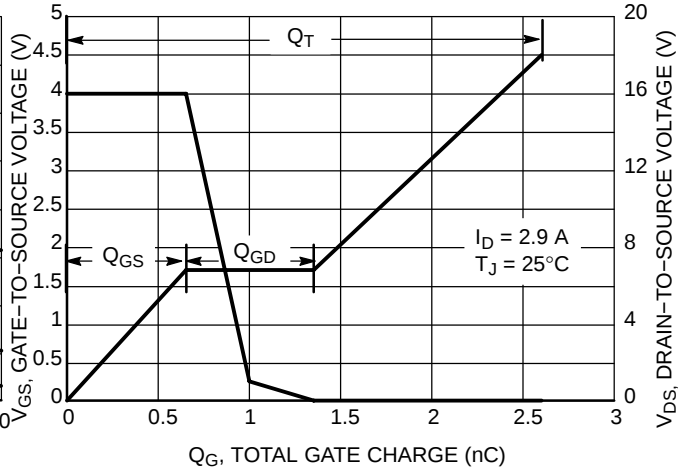


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

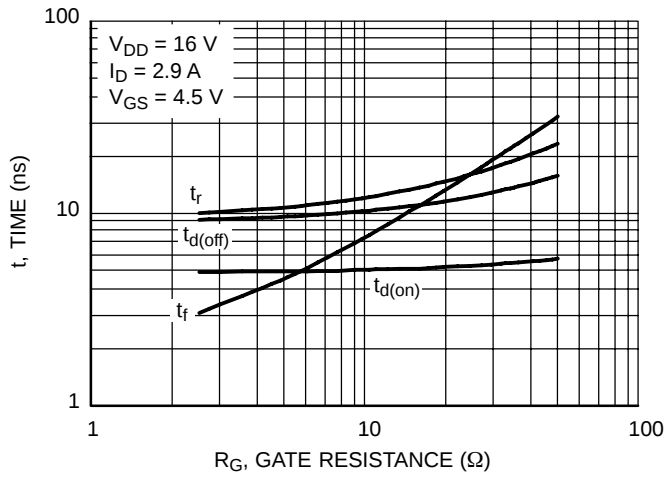


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

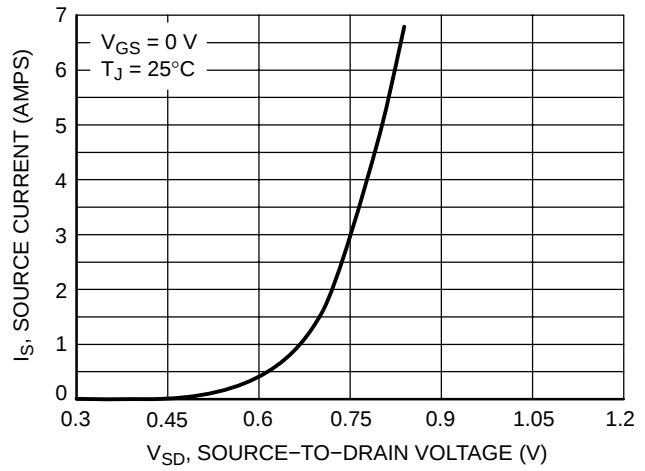


Figure 10. Diode Forward Voltage vs. Current

TYPICAL SCHOTTKY PERFORMANCE CURVES ( $T_J = 25^\circ\text{C}$  unless otherwise noted)

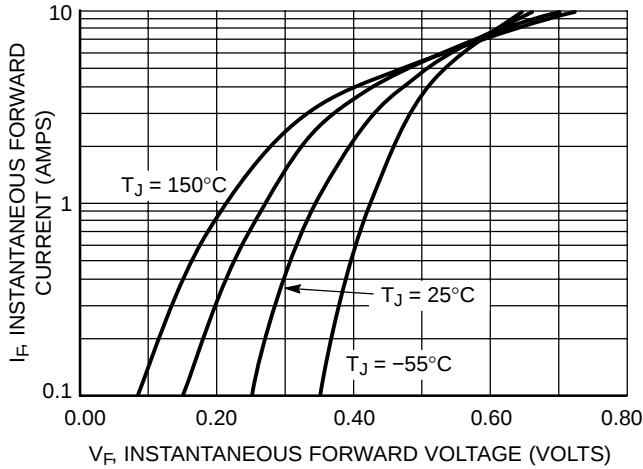


Figure 11. Typical Forward Voltage

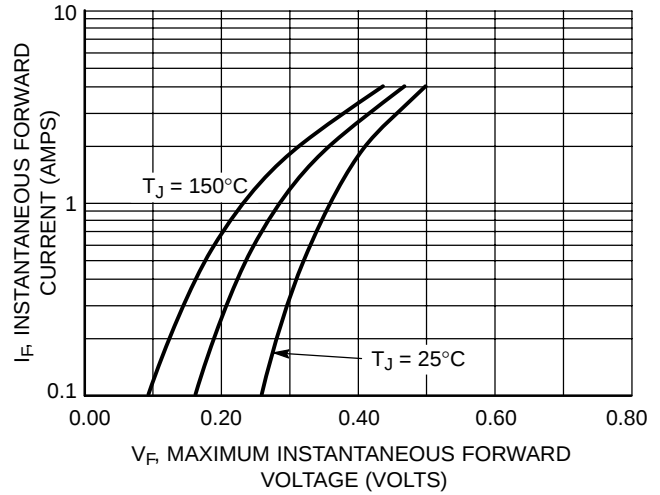


Figure 12. Maximum Forward Voltage

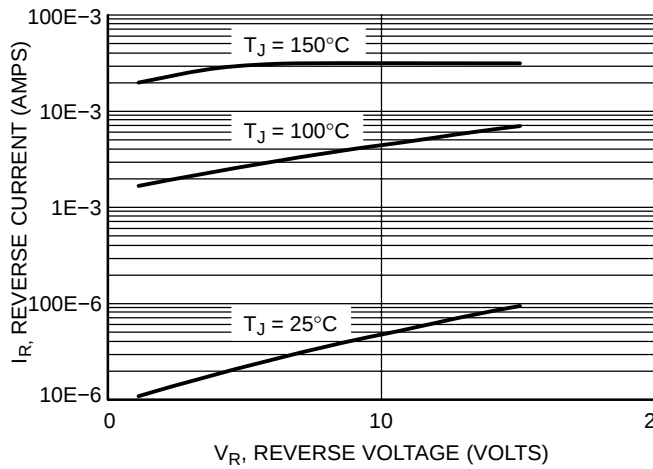


Figure 13. Typical Reverse Current

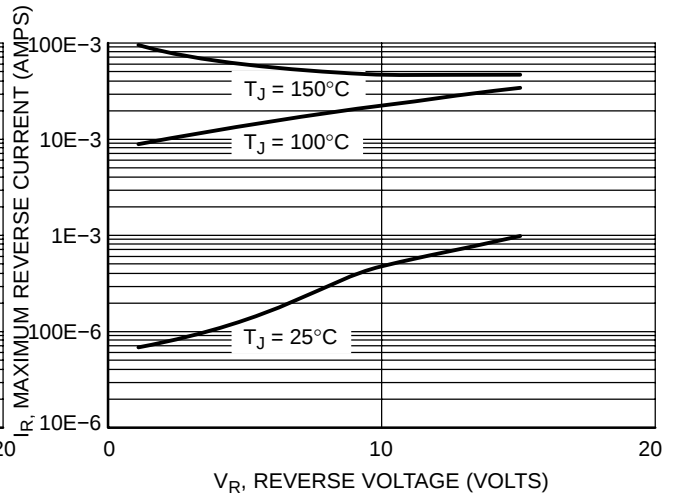


Figure 14. Maximum Reverse Current

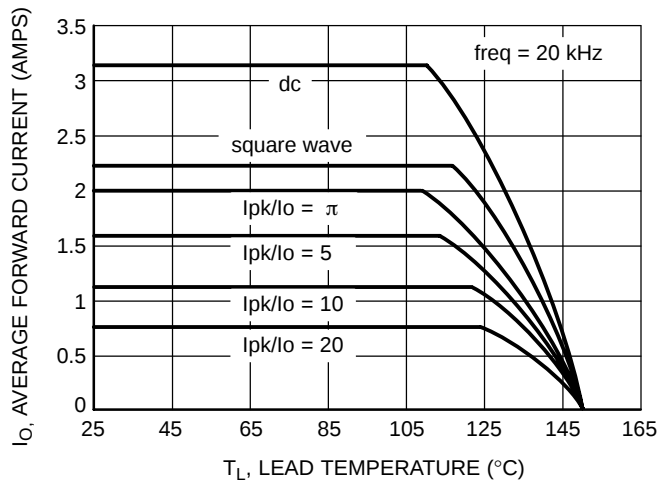


Figure 15. Current Derating

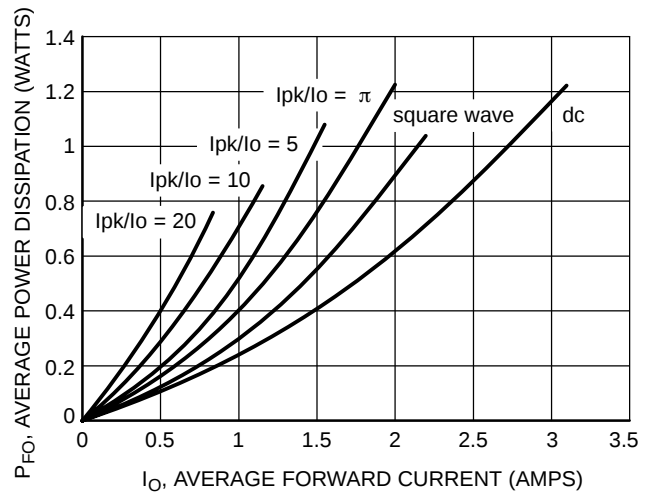
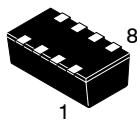
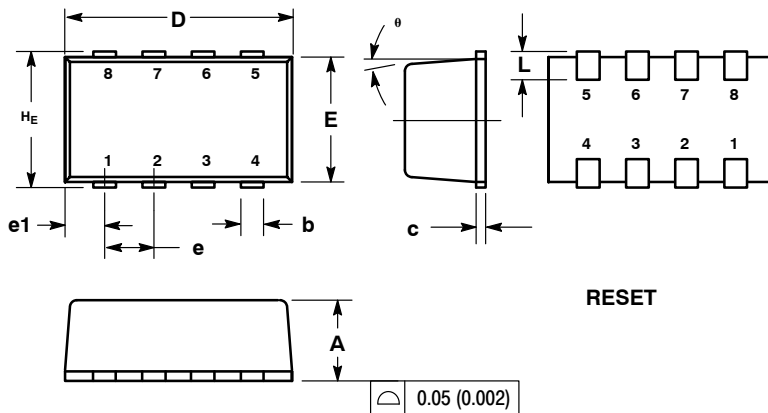


Figure 16. Forward Power Dissipation



SCALE 1:1



**ChipFET™**  
**CASE1206A-03**  
**ISSUE K**

DATE 19 MAY 2009

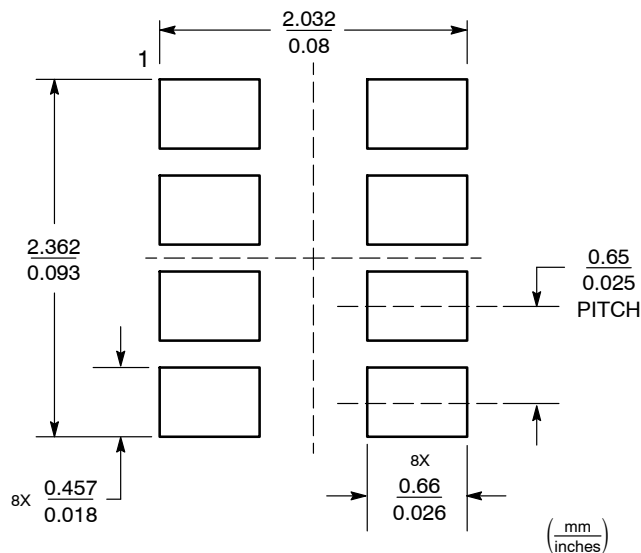
**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MOLD GATE BURRS SHALL NOT EXCEED 0.13 MM PER SIDE.
4. LEADFRAME TO MOLDED BODY OFFSET IN HORIZONTAL AND VERTICAL SHALL NOT EXCEED 0.08 MM.
5. DIMENSIONS A AND B EXCLUSIVE OF MOLD GATE BURRS.
6. NO MOLD FLASH ALLOWED ON THE TOP AND BOTTOM LEAD SURFACE.

| DIM | MILLIMETERS |      |      | INCHES    |       |       |
|-----|-------------|------|------|-----------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN       | NOM   | MAX   |
| A   | 1.00        | 1.05 | 1.10 | 0.039     | 0.041 | 0.043 |
| b   | 0.25        | 0.30 | 0.35 | 0.010     | 0.012 | 0.014 |
| c   | 0.10        | 0.15 | 0.20 | 0.004     | 0.006 | 0.008 |
| D   | 2.95        | 3.05 | 3.10 | 0.116     | 0.120 | 0.122 |
| E   | 1.55        | 1.65 | 1.70 | 0.061     | 0.065 | 0.067 |
| e   | 0.65 BSC    |      |      | 0.025 BSC |       |       |
| e1  | 0.55 BSC    |      |      | 0.022 BSC |       |       |
| L   | 0.28        | 0.35 | 0.42 | 0.011     | 0.014 | 0.017 |
| H_E | 1.80        | 1.90 | 2.00 | 0.071     | 0.075 | 0.079 |
| θ   | 5° NOM      |      |      | 5° NOM    |       |       |

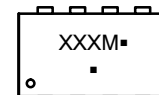
|                                                                                                                     |                                                                                                                                     |                                                                                                                         |                                                                                                                                              |                                                                                                                         |                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>STYLE 1:</b><br>PIN 1. DRAIN<br>2. DRAIN<br>3. DRAIN<br>4. GATE<br>5. SOURCE<br>6. DRAIN<br>7. DRAIN<br>8. DRAIN | <b>STYLE 2:</b><br>PIN 1. SOURCE 1<br>2. GATE 1<br>3. SOURCE 2<br>4. GATE 2<br>5. DRAIN 2<br>6. DRAIN 2<br>7. DRAIN 1<br>8. DRAIN 1 | <b>STYLE 3:</b><br>PIN 1. ANODE<br>2. ANODE<br>3. SOURCE<br>4. GATE<br>5. DRAIN<br>6. DRAIN<br>7. CATHODE<br>8. CATHODE | <b>STYLE 4:</b><br>PIN 1. COLLECTOR<br>2. COLLECTOR<br>3. COLLECTOR<br>4. BASE<br>5. EMITTER<br>6. COLLECTOR<br>7. COLLECTOR<br>8. COLLECTOR | <b>STYLE 5:</b><br>PIN 1. ANODE<br>2. ANODE<br>3. DRAIN<br>4. DRAIN<br>5. SOURCE<br>6. GATE<br>7. CATHODE<br>8. CATHODE | <b>STYLE 6:</b><br>PIN 1. ANODE<br>2. DRAIN<br>3. DRAIN<br>4. GATE<br>5. SOURCE<br>6. DRAIN<br>7. DRAIN<br>8. CATHODE / DRAIN |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|

**SOLDERING FOOTPRINT**



**Basic Style**

**GENERIC MARKING DIAGRAM\***



XXX = Specific Device Code  
M = Month Code  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

\*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. Some products may not follow the Generic Marking.

**OPTIONAL SOLDERING FOOTPRINTS ON PAGE 2**

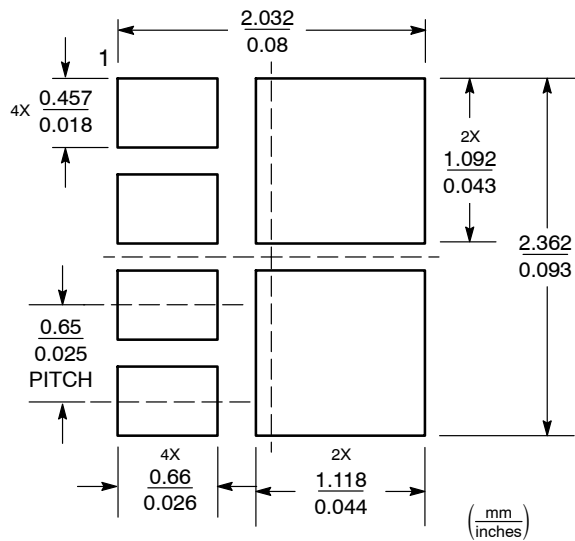
|                         |                    |                                                                                                                                                                                     |
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| <b>DESCRIPTION:</b>     | <b>ChipFET</b>     | <b>PAGE 1 OF 2</b>                                                                                                                                                                  |

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ADDITIONAL SOLDERING FOOTPRINTS\*



Styles 1 and 4



Style 2



Style 3



Style 5

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

|                  |             |                                                                                                                                                                                     |
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