

# NTHS4166N

## MOSFET – Power, Single, N-Channel, ChipFET Package

30 V, 8.2 A

### Features

- Trench Technology
- Low  $R_{DS(on)}$  to Minimize Conduction Losses
- Leadless ChipFET Package has 40% Smaller Footprint than TSOP-6
- Excellent Thermal Capabilities

This is a Pb-Free Device

### Applications

- Load Switching
- DC-DC Converters
- Low Side Switching

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

| Parameter                                                                                                                                                                                              |                                                               |                            | Symbol               | Value      | Unit               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|----------------------------|----------------------|------------|--------------------|
| Drain-to-Source Voltage                                                                                                                                                                                |                                                               |                            | $V_{DSS}$            | 30         | V                  |
| Gate-to-Source Voltage                                                                                                                                                                                 |                                                               |                            | $V_{GS}$             | $\pm 20$   | V                  |
| Continuous Drain Current $R_{\theta JA}$ (Note 1)                                                                                                                                                      | Steady State                                                  | $T_A = 25^{\circ}\text{C}$ | $I_D$                | 6.6        | A                  |
|                                                                                                                                                                                                        |                                                               | $T_A = 85^{\circ}\text{C}$ |                      | 4.8        |                    |
| Power Dissipation $R_{\theta JA}$ (Note 1)                                                                                                                                                             |                                                               | $T_A = 25^{\circ}\text{C}$ | $P_D$                | 1.5        | W                  |
| Continuous Drain Current $R_{\theta JA}$ (Note 2)                                                                                                                                                      |                                                               | $T_A = 25^{\circ}\text{C}$ | $I_D$                | 4.9        | A                  |
|                                                                                                                                                                                                        |                                                               | $T_A = 85^{\circ}\text{C}$ |                      | 3.6        |                    |
| Power Dissipation $R_{\theta JA}$ (Note 2)                                                                                                                                                             |                                                               | $T_A = 25^{\circ}\text{C}$ | $P_D$                | 0.8        | W                  |
| Continuous Drain Current $R_{\theta JA}$ , $t \leq 5$ s (Note 1)                                                                                                                                       | Steady State                                                  | $T_A = 25^{\circ}\text{C}$ | $I_D$                | 8.2        | A                  |
|                                                                                                                                                                                                        |                                                               | $T_A = 85^{\circ}\text{C}$ |                      | 5.9        |                    |
| Power Dissipation $R_{\theta JA}$ (Note 1)                                                                                                                                                             |                                                               | $T_A = 25^{\circ}\text{C}$ | $P_D$                | 2.2        | W                  |
| Pulsed Drain Current                                                                                                                                                                                   | $T_A = 25^{\circ}\text{C}$ ,<br>$t_p = 10\text{ }\mu\text{s}$ |                            | $I_{DM}$             | 32         | A                  |
| Operating Junction and Storage Temperature                                                                                                                                                             |                                                               |                            | $T_J$ ,<br>$T_{STG}$ | -55 to 150 | $^{\circ}\text{C}$ |
| Source Current (Body Diode) $R_{\theta JF}$                                                                                                                                                            |                                                               |                            | $I_S$                | 2.6        | A                  |
| Single Pulse Drain-to-Source Avalanche Energy $T_J = 25^{\circ}\text{C}$ , $V_{DD} = 50\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_L = 20\text{ A}_{pk}$ , $L = 0.1\text{ mH}$ , $R_G = 25\text{ }\Omega$ |                                                               |                            | EAS                  | 20         | mJ                 |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s)                                                                                                                                      |                                                               |                            | $T_L$                | 260        | $^{\circ}\text{C}$ |

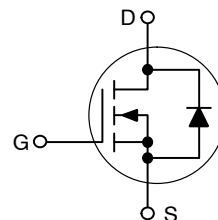
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.



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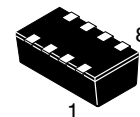
<http://onsemi.com>

| $V_{(BR)DSS}$ | $R_{DS(on)}$ Max      | $I_D$ Max |
|---------------|-----------------------|-----------|
| 30 V          | 22 m $\Omega$ @ 10 V  | 8.2 A     |
|               | 27 m $\Omega$ @ 4.5 V |           |

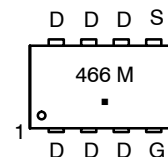


N-Channel MOSFET

### MARKING DIAGRAM AND PIN ASSIGNMENT



ChipFET  
CASE 1206A  
STYLE 1



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

### ORDERING INFORMATION

| Device       | Package           | Shipping†        |
|--------------|-------------------|------------------|
| NTHS4166NT1G | 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 Specification Brochure, BRD8011/D.

# NTHS4166N

1. Surface Mounted on FR4 Board using 1 in sq. pad, 1 oz Cu.
2. Surface Mounted on FR4 Board using the minimum recommended pad size.

## THERMAL RESISTANCE RATINGS

| Parameter                                      | Symbol          | Max | Unit |
|------------------------------------------------|-----------------|-----|------|
| Junction-to-Ambient – Steady State (Note 3)    | $R_{\theta JA}$ | 86  | °C/W |
| Junction-to-Ambient – $t \leq 5$ s (Note 3)    | $R_{\theta JA}$ | 57  |      |
| Junction-to-Ambient – $t \leq 5$ s (Note 4)    | $R_{\theta JA}$ | 155 |      |
| Junction-to-Foot (Drain) Steady State (Note 3) | $R_{\theta JF}$ | 20  |      |

3. Surface Mounted on FR4 Board using 1 in sq. pad, 1 oz Cu.
4. Surface Mounted on FR4 Board using the minimum recommended pad size.

## 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                         | $V_{(BR)DSS}$     | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | 30                        |      |           | V             |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ |                                                     |                           | 18.3 |           | mV/°C         |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$         | $V_{GS} = 0\text{ V}, V_{DS} = 30\text{ V}$         | $T_J = 25^\circ\text{C}$  |      | 1.0       | $\mu\text{A}$ |
|                                                           |                   |                                                     | $T_J = 125^\circ\text{C}$ |      | 10        |               |
| Gate-to-Source Leakage Current                            | $I_{GSS}$         | $V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$     |                           |      | $\pm 100$ | nA            |

### ON CHARACTERISTICS (Note 5)

|                                            |                  |                                                 |     |     |     |            |
|--------------------------------------------|------------------|-------------------------------------------------|-----|-----|-----|------------|
| Gate Threshold Voltage                     | $V_{GS(TH)}$     | $V_{GS} = V_{DS}, I_D = 250\text{ }\mu\text{A}$ | 1.1 |     | 2.3 | V          |
| Negative Threshold Temperature Coefficient | $V_{GS(TH)}/T_J$ |                                                 |     | 5.5 |     | mV/°C      |
| Drain-to-Source On-Resistance              | $R_{DS(on)}$     | $V_{GS} = 10\text{ V}, I_D = 4.9\text{ A}$      |     | 18  | 22  | m $\Omega$ |
|                                            |                  | $V_{GS} = 4.5\text{ V}, I_D = 3.7\text{ A}$     |     | 23  | 27  |            |
| Forward Transconductance                   | $g_{FS}$         | $V_{DS} = 5\text{ V}, I_D = 4.9\text{ A}$       |     | 9.0 |     | S          |

### CHARGES AND CAPACITANCES

|                              |              |                                                                   |  |      |  |    |
|------------------------------|--------------|-------------------------------------------------------------------|--|------|--|----|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}, V_{DS} = 15\text{ V}$   |  | 900  |  | pF |
| Output Capacitance           | $C_{OSS}$    |                                                                   |  | 210  |  |    |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                   |  | 140  |  |    |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = 4.5\text{ V}, V_{DS} = 15\text{ V}, I_D = 4.9\text{ A}$ |  | 9.2  |  | nC |
| Threshold Gate Charge        | $Q_{G(TH)}$  |                                                                   |  | 0.85 |  |    |
| Gate-to-Source Charge        | $Q_{GS}$     |                                                                   |  | 2.86 |  |    |
| Gate-to-Drain Charge         | $Q_{GD}$     |                                                                   |  | 3.84 |  |    |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = 10\text{ V}, V_{DS} = 15\text{ V}, I_D = 4.9\text{ A}$  |  | 18   |  | nC |
| Gate Resistance              | $R_G$        |                                                                   |  | 1.6  |  |    |

### SWITCHING CHARACTERISTICS (Note 6)

|                     |              |                                                                                            |  |     |  |    |
|---------------------|--------------|--------------------------------------------------------------------------------------------|--|-----|--|----|
| Turn-On Delay Time  | $t_{d(on)}$  | $V_{GS} = 4.5\text{ V}, V_{DS} = 15\text{ V}, I_D = 4.9\text{ A}, R_G = 3.0\text{ }\Omega$ |  | 12  |  | ns |
| Rise Time           | $t_r$        |                                                                                            |  | 13  |  |    |
| Turn-Off Delay Time | $t_{d(off)}$ |                                                                                            |  | 16  |  |    |
| Fall Time           | $t_f$        |                                                                                            |  | 5.0 |  |    |
| Turn-On Delay Time  | $t_{d(on)}$  | $V_{GS} = 10\text{ V}, V_{DS} = 15\text{ V}, I_D = 4.9\text{ A}, R_G = 3.0\text{ }\Omega$  |  | 8.0 |  | ns |
| Rise Time           | $t_r$        |                                                                                            |  | 11  |  |    |
| Turn-Off Delay Time | $t_{d(off)}$ |                                                                                            |  | 20  |  |    |
| Fall Time           | $t_f$        |                                                                                            |  | 4.0 |  |    |

5. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .
6. Switching characteristics are independent of operating junction temperatures.

# NTHS4166N

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

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

### **DRAIN-SOURCE DIODE CHARACTERISTICS**

|                         |          |                                                                                    |                           |  |      |     |    |
|-------------------------|----------|------------------------------------------------------------------------------------|---------------------------|--|------|-----|----|
| Forward Diode Voltage   | $V_{SD}$ | $V_{GS} = 0\text{ V}, I_S = 5.2\text{ A}$                                          | $T_J = 25^\circ\text{C}$  |  | 0.83 | 1.0 | V  |
|                         |          |                                                                                    | $T_J = 125^\circ\text{C}$ |  | 0.7  |     |    |
| Reverse Recovery Time   | $t_{RR}$ | $V_{GS} = 0\text{ V}, I_S = 5.2\text{ A},$<br>$dI_S/dt = 100\text{ A}/\mu\text{s}$ |                           |  | 16   |     | ns |
| Charge Time             | $t_a$    |                                                                                    |                           |  | 7.5  |     |    |
| Discharge Time          | $t_b$    |                                                                                    |                           |  | 8.5  |     |    |
| Reverse Recovery Charge | $Q_{RR}$ |                                                                                    |                           |  | 6.0  |     | nC |

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

6. Switching characteristics are independent of operating junction temperatures.

TYPICAL PERFORMANCE CURVES

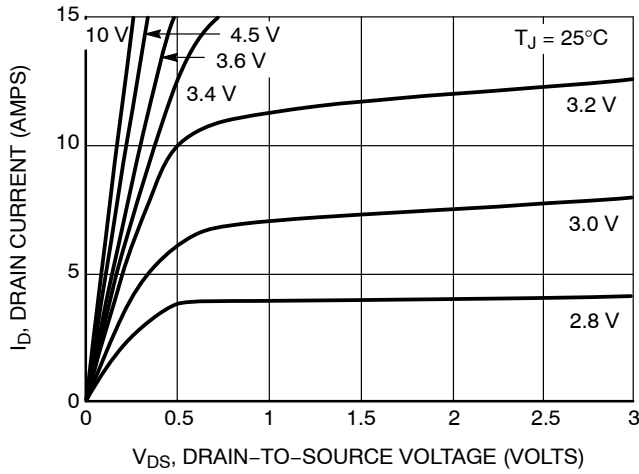


Figure 1. On-Region Characteristics

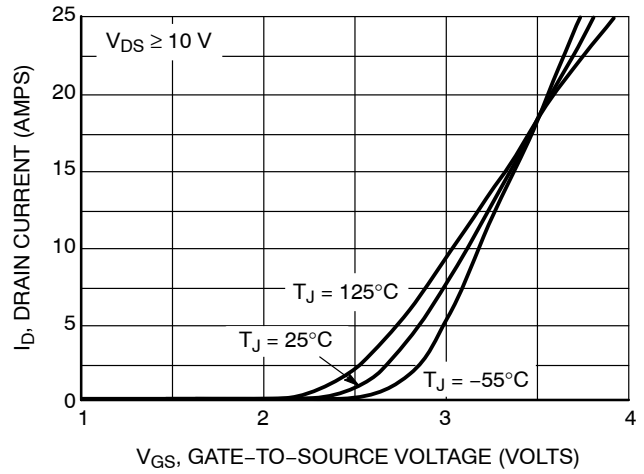


Figure 2. Transfer Characteristics

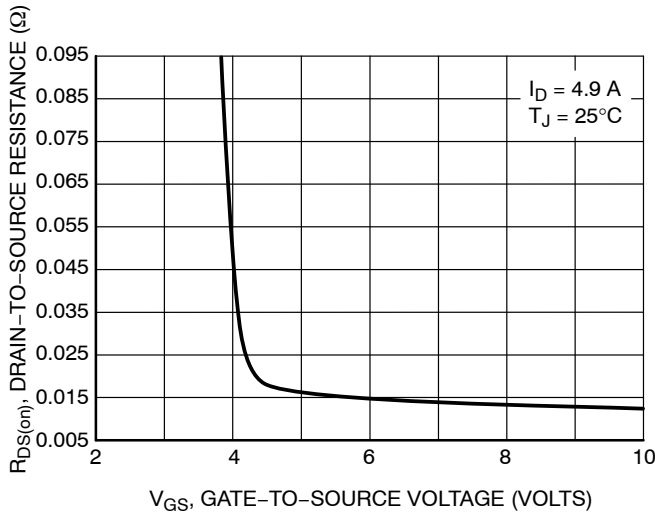


Figure 3. On-Resistance vs. Gate-to-Source Voltage

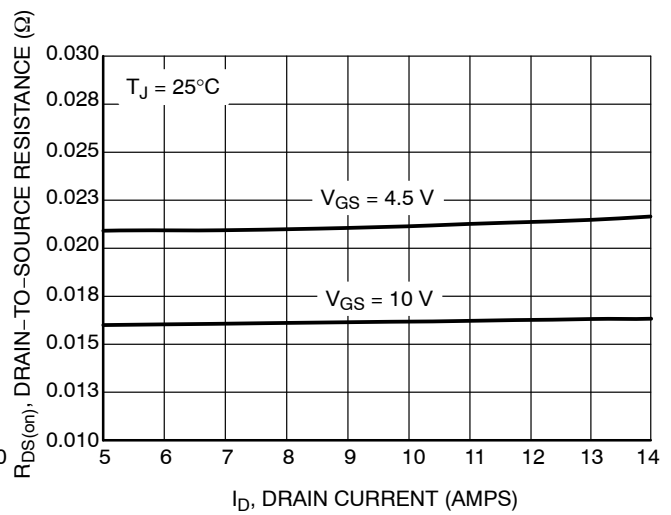


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

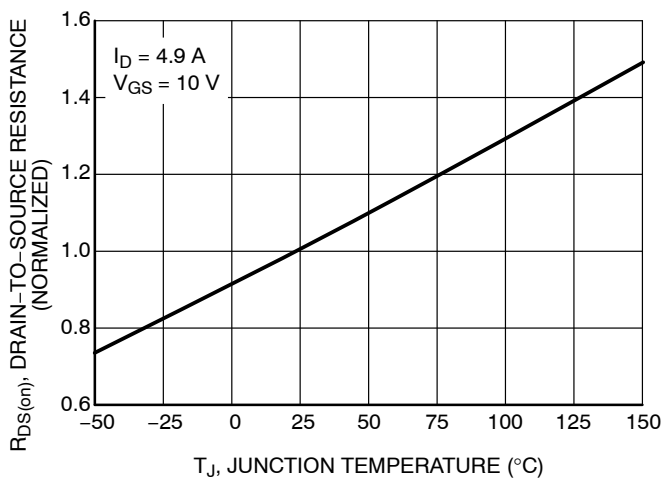


Figure 5. On-Resistance Variation with Temperature

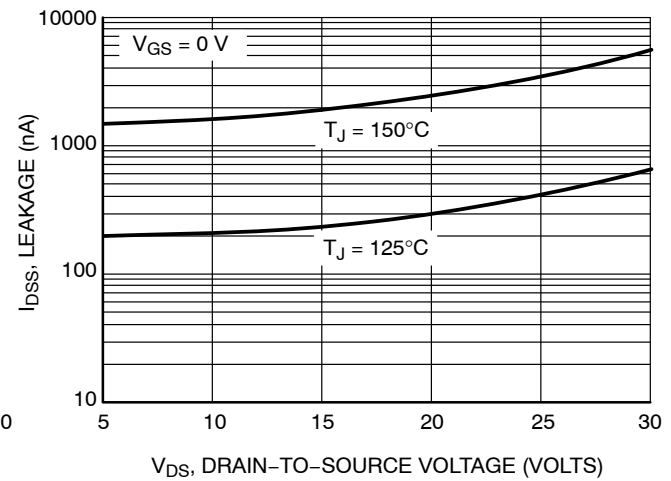


Figure 6. Drain-to-Source Leakage Current vs. Drain Voltage

TYPICAL PERFORMANCE CURVES

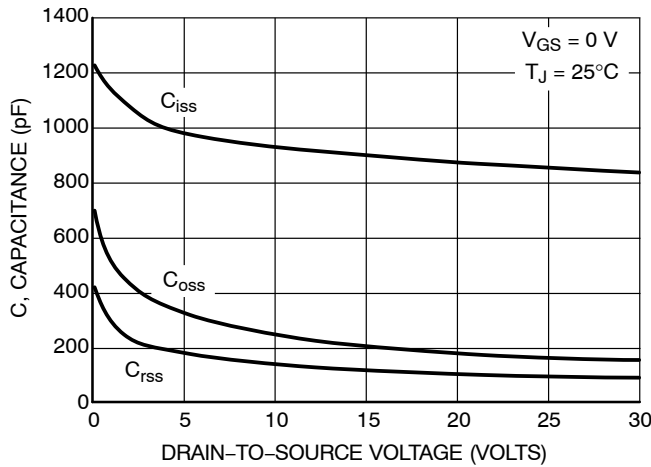


Figure 7. Capacitance Variation

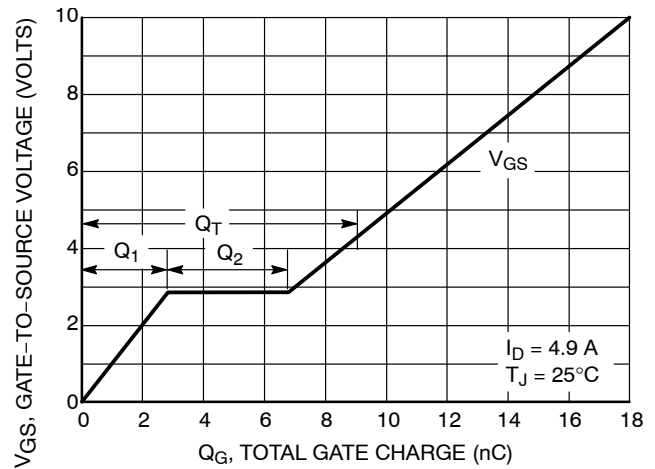


Figure 8. Gate-To-Source and Drain-To-Source Voltage vs. Total Charge

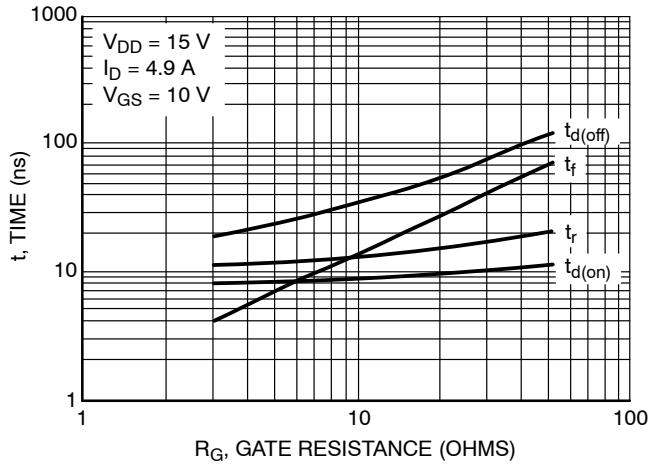


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

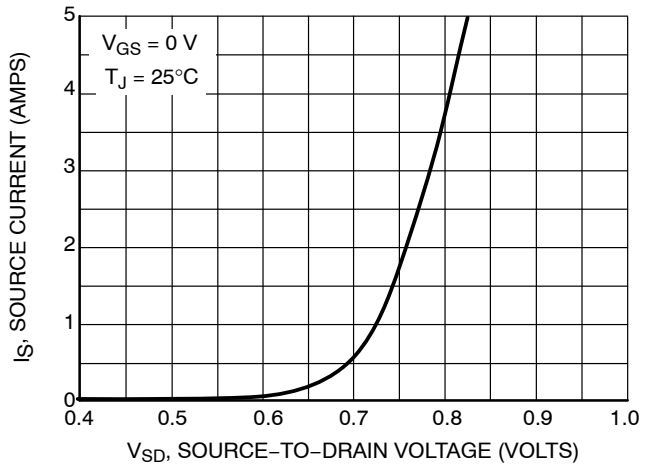


Figure 10. Diode Forward Voltage vs. Current

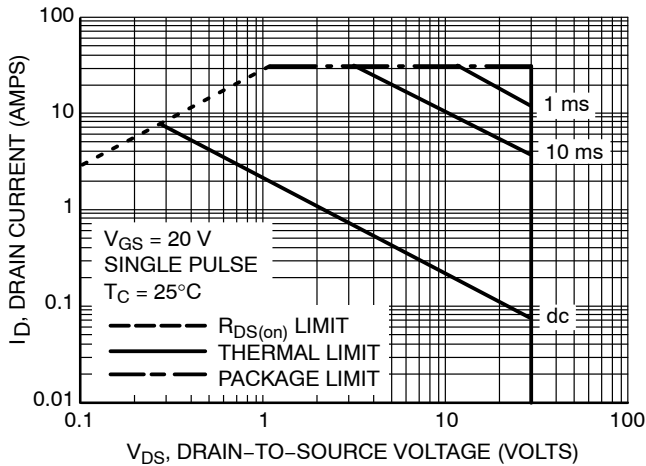


Figure 11. Maximum Rated Forward Biased Safe Operating Area

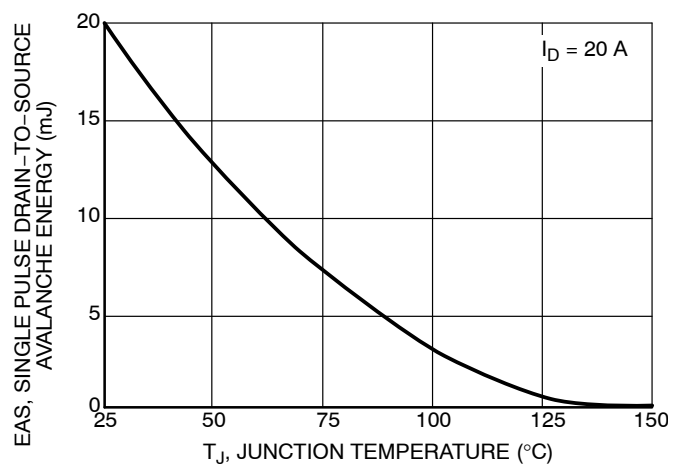


Figure 12. Maximum Avalanche Energy vs. Starting Junction Temperature

# MECHANICAL CASE OUTLINE

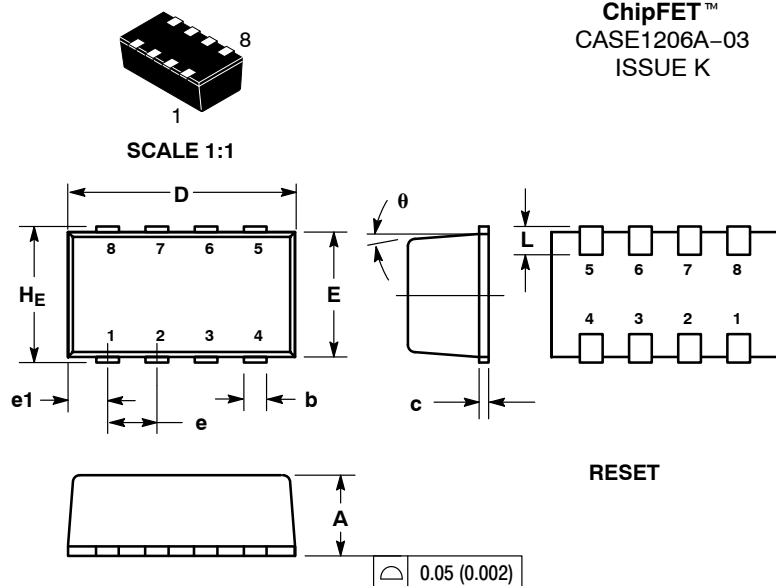
## PACKAGE DIMENSIONS

ON Semiconductor®



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 |
| He    | 1.80        | 1.90 | 2.00 | 0.071     | 0.075 | 0.079 |
| theta | 5° NOM      |      |      | 5° NOM    |       |       |

### STYLE 1:

- PIN 1. DRAIN  
2. DRAIN  
3. DRAIN  
4. GATE  
5. SOURCE  
6. DRAIN  
7. DRAIN  
8. DRAIN

### 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

### STYLE 3:

- PIN 1. ANODE  
2. ANODE  
3. SOURCE  
4. GATE  
5. DRAIN  
6. DRAIN  
7. CATHODE  
8. CATHODE

### STYLE 4:

- PIN 1. COLLECTOR  
2. COLLECTOR  
3. COLLECTOR  
4. BASE  
5. EMITTER  
6. COLLECTOR  
7. COLLECTOR  
8. COLLECTOR

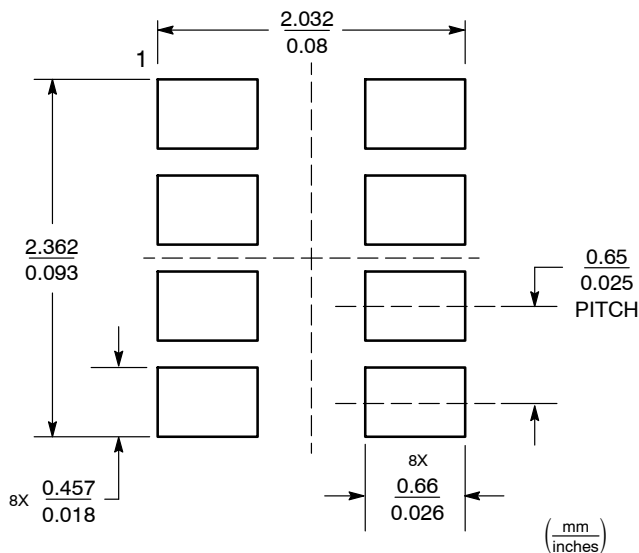
### STYLE 5:

- PIN 1. ANODE  
2. ANODE  
3. DRAIN  
4. DRAIN  
5. SOURCE  
6. GATE  
7. CATHODE  
8. CATHODE

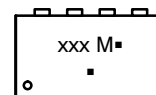
### STYLE 6:

- PIN 1. ANODE  
2. DRAIN  
3. DRAIN  
4. GATE  
5. SOURCE  
6. DRAIN  
7. DRAIN  
8. CATHODE / DRAIN

### SOLDERING FOOTPRINT



### GENERIC MARKING DIAGRAM\*



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

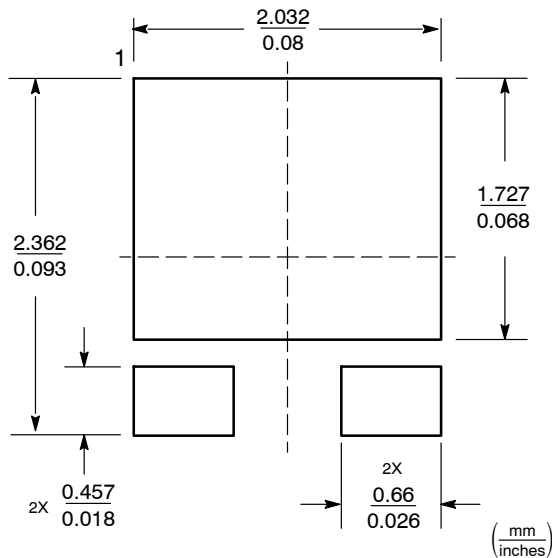
\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

### OPTIONAL SOLDERING FOOTPRINTS ON PAGE 2

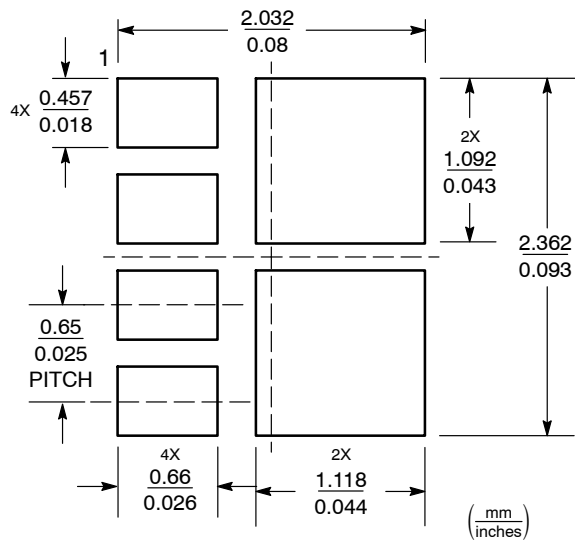
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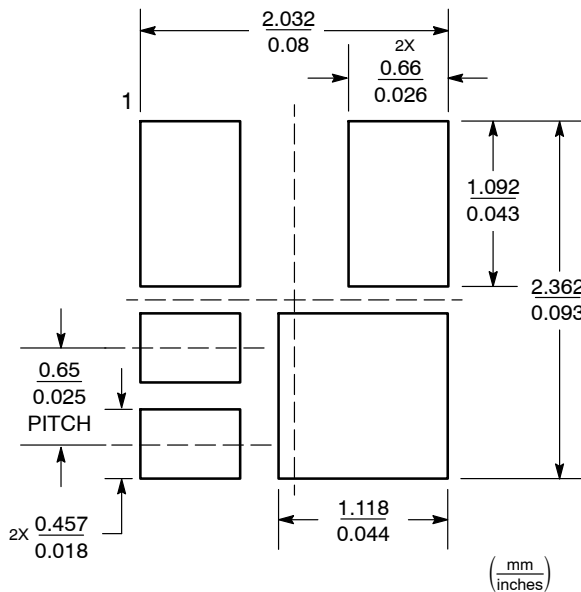
ADDITIONAL SOLDERING FOOTPRINTS\*



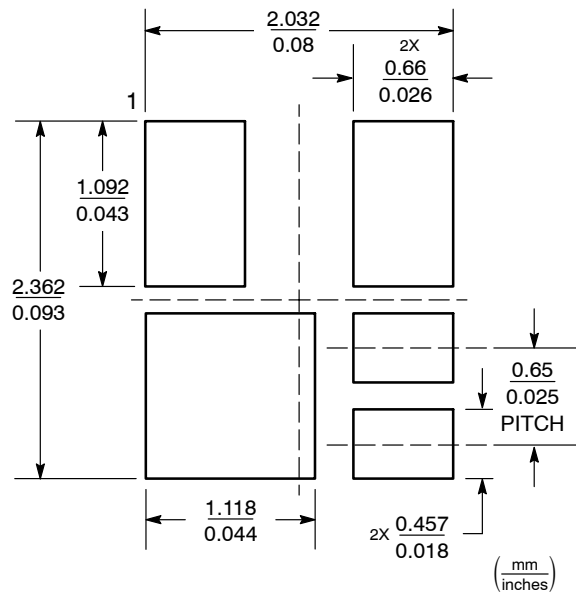
Styles 1 and 4



Style 2



Style 3



Style 5

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

|                  |             |                                                                                                                                                                                     |
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