

# MOSFET – Power, Single N-Channel, STD Gate, SO8FL

40 V, 3.1 mΩ, 94 A

## NVMFWS2D9N04XM

### Features

- Low  $R_{DS(on)}$  to Minimize Conduction Losses
- Low Capacitance to Minimize Driver Losses
- Small Footprint (5 x 6 mm) with Compact Design
- AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

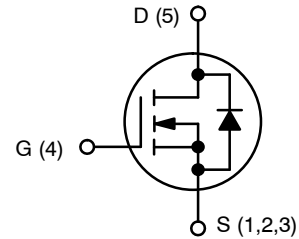
- Motor Drive
- Battery Protection
- Synchronous Rectification

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

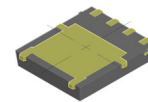
| Parameter                                                                          |              |                                                               | Symbol         | Value      | Unit               |
|------------------------------------------------------------------------------------|--------------|---------------------------------------------------------------|----------------|------------|--------------------|
| Drain-to-Source Voltage                                                            |              |                                                               | $V_{DSS}$      | 40         | V                  |
| Gate-to-Source Voltage                                                             |              | DC                                                            | $V_{GS}$       | $\pm 20$   | V                  |
| Continuous Drain Current                                                           | Steady State | $T_C = 25^{\circ}\text{C}$                                    | $I_D$          | 94         | A                  |
|                                                                                    |              | $T_C = 100^{\circ}\text{C}$                                   |                | 66         |                    |
| Power Dissipation                                                                  |              | $T_C = 25^{\circ}\text{C}$                                    | $P_D$          | 50         | W                  |
| Continuous Drain Current $R_{\theta JA}$                                           | Steady State | $T_A = 25^{\circ}\text{C}$                                    | $I_D$          | 25         | A                  |
|                                                                                    |              | $T_A = 100^{\circ}\text{C}$                                   |                | 18         |                    |
| Pulsed Drain Current                                                               |              | $T_A = 25^{\circ}\text{C}$ ,<br>$t_p = 10\text{ }\mu\text{s}$ | $I_{DM}$       | 440        | A                  |
| Operating Junction and Storage Temperature Range                                   |              |                                                               | $T_J, T_{stg}$ | -55 to 175 | $^{\circ}\text{C}$ |
| Source Current (Body Diode)                                                        |              |                                                               | $I_S$          | 42         | A                  |
| Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 4.6\text{ A}$ )       |              |                                                               | $E_{AS}$       | 133        | mJ                 |
| Lead Temperature Soldering Reflow for Soldering Purposes (1/8" from case for 10 s) |              |                                                               | $T_L$          | 260        | $^{\circ}\text{C}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

| $V_{(BR)DSS}$ | $R_{DS(ON)} \text{ MAX}$ | $I_D \text{ MAX}$ |
|---------------|--------------------------|-------------------|
| 40 V          | 3.1 mΩ @ 10 V            | 94 A              |

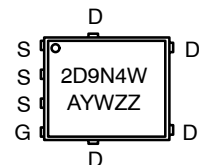


N-CHANNEL MOSFET



DFN5  
(SO8FL WF)  
CASE 507BA

### MARKING DIAGRAM



2D9N4W = Specific Device code  
A = Assembly Location  
Y = Year  
W = Work Week  
ZZ = Lot Traceability

### ORDERING INFORMATION

See detailed ordering, marking and shipping information on page 5 of this data sheet.

# NVMFWS2D9N04XM

## THERMAL RESISTANCE RATINGS

| Parameter                                            | Symbol          | Value | Unit |
|------------------------------------------------------|-----------------|-------|------|
| Thermal Resistance, Junction-to-Case (Note 2)        | $R_{\theta JC}$ | 3     | °C/W |
| Thermal Resistance, Junction-to-Ambient (Notes 1, 2) | $R_{\theta JA}$ | 41.6  |      |

- Surface-mounted on FR4 board using 650 mm<sup>2</sup>, 2 oz Cu pad.
- The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.

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

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|-----------|--------|----------------|-----|-----|-----|------|
|-----------|--------|----------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                           |                                   |                                                                  |    |    |     |               |
|-----------------------------------------------------------|-----------------------------------|------------------------------------------------------------------|----|----|-----|---------------|
| Drain-to-Source Breakdown Voltage                         | $V_{(BR)DSS}$                     | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 25^\circ\text{C}$ | 40 |    |     | V             |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $\Delta V_{(BR)DSS} / \Delta T_J$ | $I_D = 1\text{ mA}$ , Referenced to $25^\circ\text{C}$           |    | 15 |     | mV/°C         |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$                         | $V_{DS} = 40\text{ V}, T_J = 25^\circ\text{C}$                   |    |    | 10  | $\mu\text{A}$ |
|                                                           |                                   | $V_{DS} = 40\text{ V}, T_J = 125^\circ\text{C}$                  |    |    | 100 |               |
| Gate-to-Source Leakage Current                            | $I_{GSS}$                         | $V_{DS} = 0\text{ V}, V_{GS} = 20\text{ V}$                      |    |    | 100 | nA            |

### ON CHARACTERISTICS

|                                                |                                  |                                                                        |     |      |     |            |
|------------------------------------------------|----------------------------------|------------------------------------------------------------------------|-----|------|-----|------------|
| Drain-to-Source On Resistance                  | $R_{DS(on)}$                     | $V_{GS} = 10\text{ V}, I_D = 20\text{ A}, T_J = 25^\circ\text{C}$      |     | 2.7  | 3.1 | m $\Omega$ |
| Gate Threshold Voltage                         | $V_{GS(TH)}$                     | $V_{GS} = V_{DS}, I_D = 40\text{ }\mu\text{A}, T_J = 25^\circ\text{C}$ | 2.5 |      | 3.5 | V          |
| Gate Threshold Voltage Temperature Coefficient | $\Delta V_{GS(TH)} / \Delta T_J$ | $V_{GS} = V_{DS}, I_D = 40\text{ }\mu\text{A}$                         |     | -7.2 |     | mV/°C      |
| Forward Transconductance                       | $g_{FS}$                         | $V_{DS} = 5\text{ V}, I_D = 20\text{ A}$                               |     | 79.6 |     | S          |

### CHARGES & CAPACITANCES

|                              |              |                                                                 |  |      |  |          |
|------------------------------|--------------|-----------------------------------------------------------------|--|------|--|----------|
| Input Capacitance            | $C_{ISS}$    | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$   |  | 1000 |  | pF       |
| Output Capacitance           | $C_{OSS}$    |                                                                 |  | 645  |  |          |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                 |  | 12.3 |  |          |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{DD} = 32\text{ V}, I_D = 50\text{ A}, V_{GS} = 10\text{ V}$ |  | 15.7 |  | nC       |
| Threshold Gate Charge        | $Q_{G(TH)}$  |                                                                 |  | 2.9  |  |          |
| Gate-to-Source Charge        | $Q_{GS}$     |                                                                 |  | 4.8  |  |          |
| Gate-to-Drain Charge         | $Q_{GD}$     |                                                                 |  | 3    |  |          |
| Gate Resistance              | $R_G$        |                                                                 |  | 1    |  |          |
|                              |              | $f = 1\text{ MHz}$                                              |  |      |  | $\Omega$ |

### SWITCHING CHARACTERISTICS (Note 3)

|                     |              |                                                                                                                |  |      |  |    |
|---------------------|--------------|----------------------------------------------------------------------------------------------------------------|--|------|--|----|
| Turn-On Delay Time  | $t_{d(ON)}$  | Resistive Load, $V_{GS} = 0/10\text{ V}$ ,<br>$V_{DD} = 32\text{ V}, I_D = 50\text{ A}, R_G = 0\text{ }\Omega$ |  | 13.1 |  | ns |
| Rise Time           | $t_r$        |                                                                                                                |  | 4.5  |  |    |
| Turn-Off Delay Time | $t_{d(OFF)}$ |                                                                                                                |  | 19.8 |  |    |
| Fall Time           | $t_f$        |                                                                                                                |  | 3.8  |  |    |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                       |          |                                                                                                        |  |      |     |    |
|-----------------------|----------|--------------------------------------------------------------------------------------------------------|--|------|-----|----|
| Forward Diode Voltage | $V_{SD}$ | $V_{GS} = 0\text{ V}, I_S = 20\text{ A}, T_J = 25^\circ\text{C}$                                       |  | 0.84 | 1.2 | V  |
|                       |          | $V_{GS} = 0\text{ V}, I_S = 20\text{ A}, T_J = 125^\circ\text{C}$                                      |  | 0.7  |     |    |
| Reverse Recovery Time | $t_{RR}$ | $V_{GS} = 0\text{ V}, I_S = 50\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}, V_{DD} = 32\text{ V}$ |  | 107  |     | ns |
| Charge Time           | $t_a$    |                                                                                                        |  | 38   |     | ns |
| Discharge Time        | $t_b$    |                                                                                                        |  | 69   |     | ns |
| Reverse Recovery Time | $Q_{RR}$ |                                                                                                        |  | 391  |     | nC |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

- Switching characteristics are independent of operating junction temperatures

TYPICAL CHARACTERISTICS

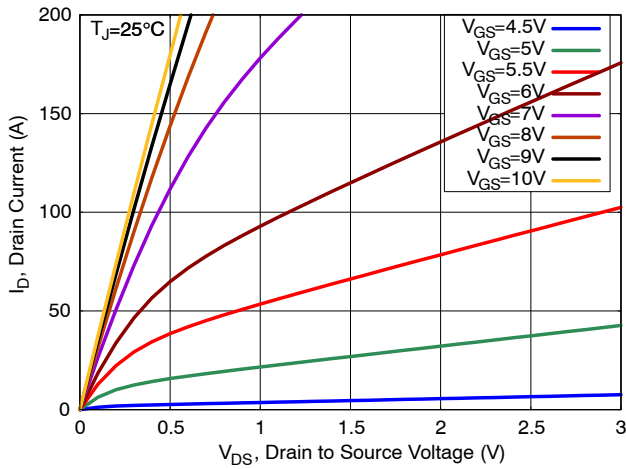


Figure 1. On-Region Characteristics

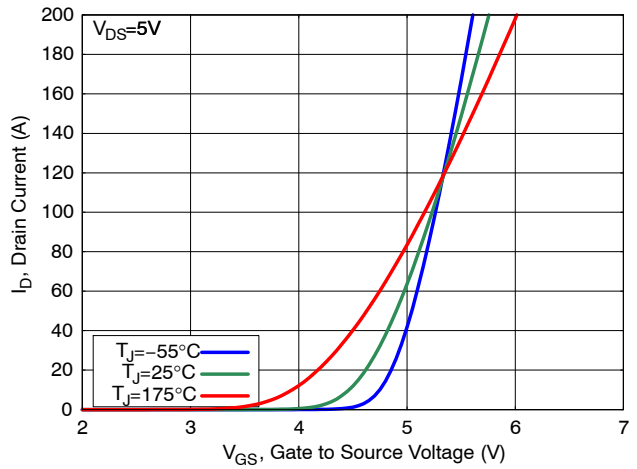


Figure 2. Transfer Characteristics

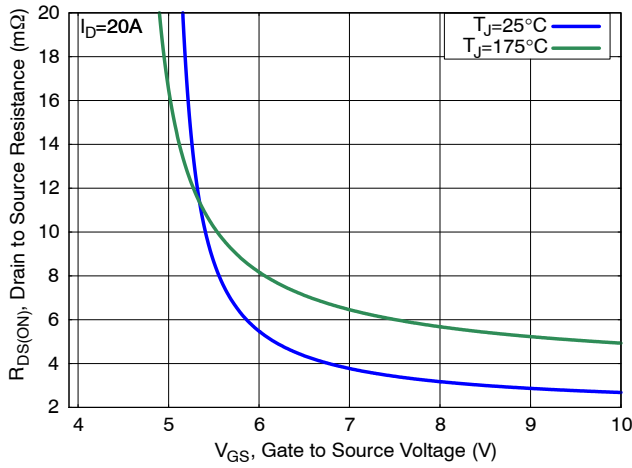


Figure 3. On-Resistance vs. Gate Voltage

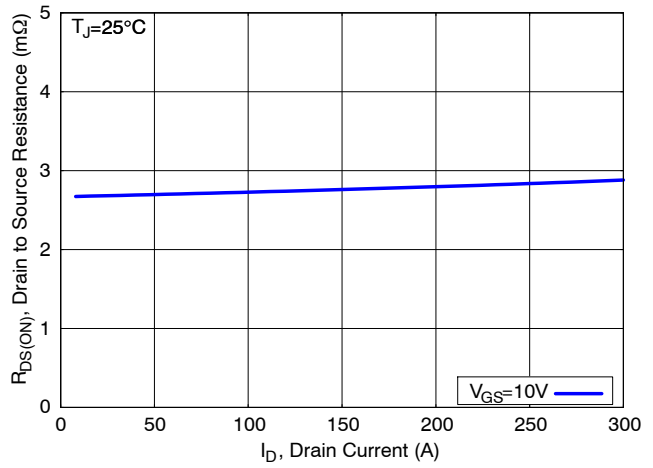


Figure 4. On-Resistance vs. Drain Current

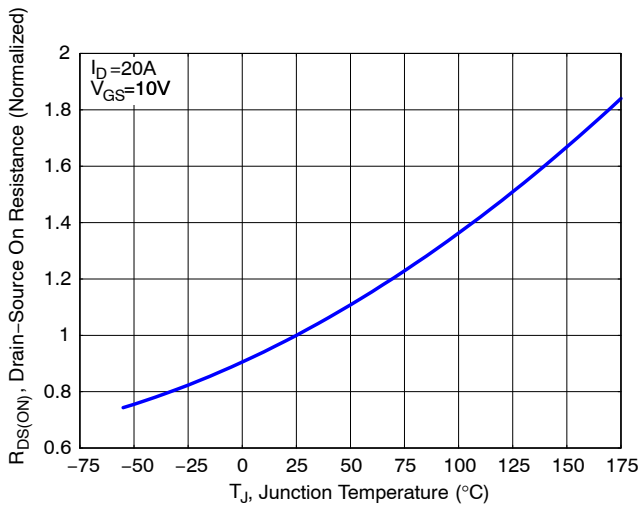


Figure 5. Normalized ON Resistance vs. Junction Temperature

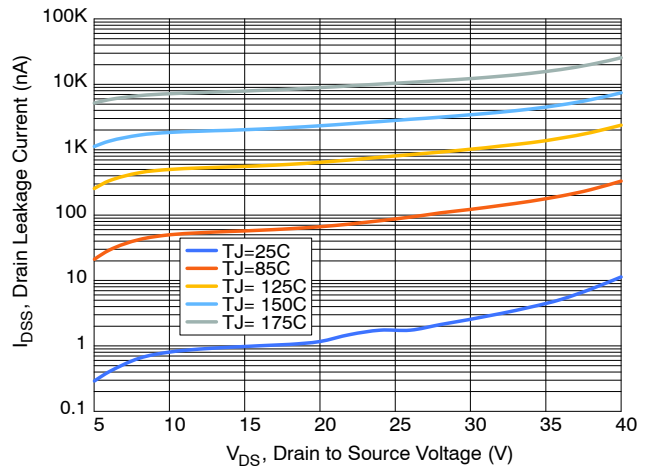


Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NVMFWS2D9N04XM

## TYPICAL CHARACTERISTICS

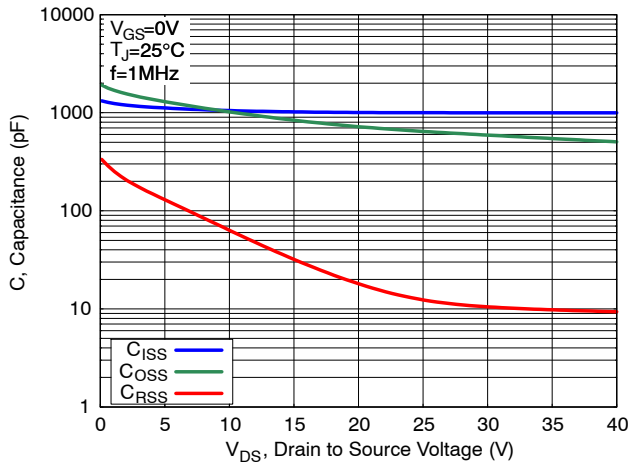


Figure 7. Capacitance Characteristics

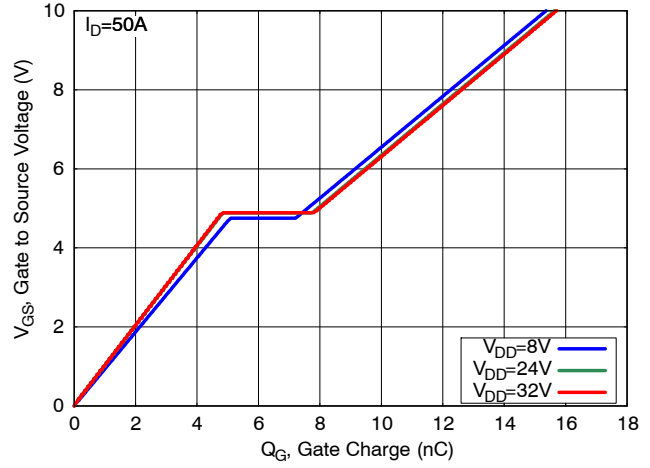


Figure 8. Gate Charge Characteristics

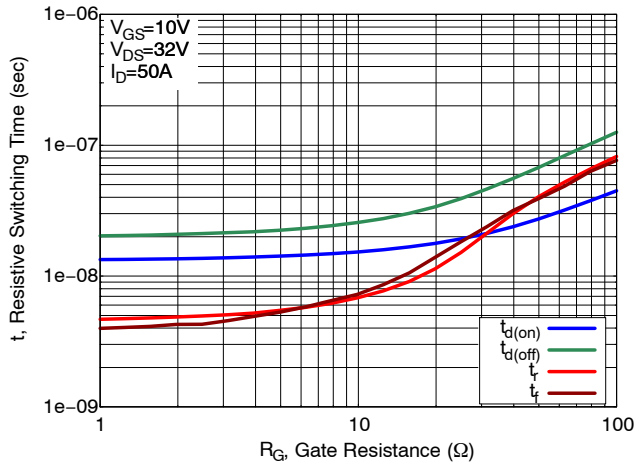


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

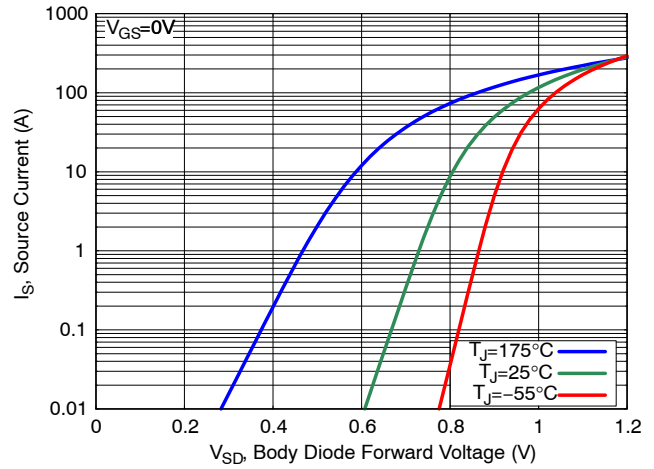


Figure 10. Diode Forward Characteristics

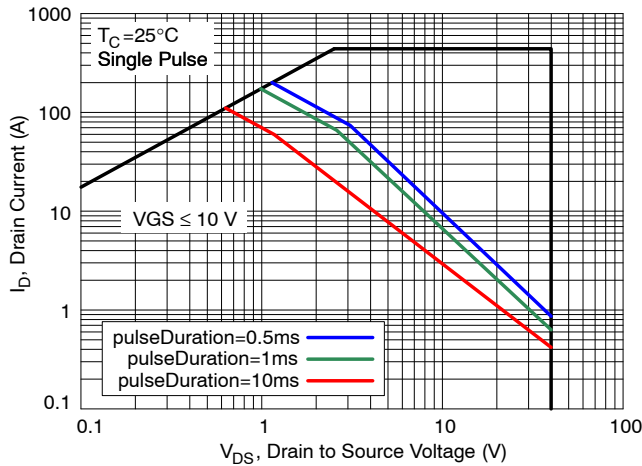


Figure 11. Safe Operating Area (SOA)

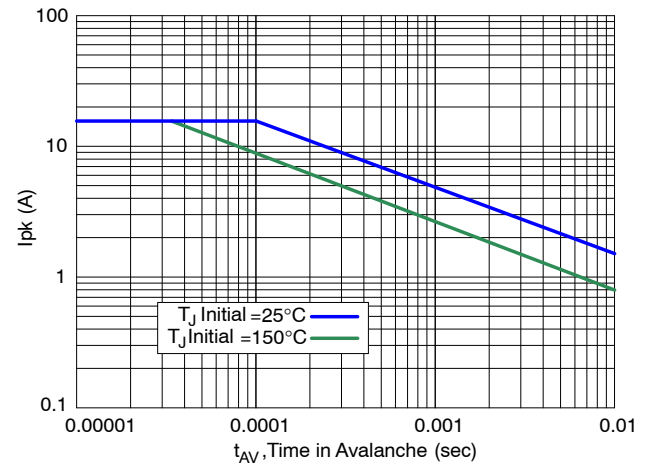


Figure 12. Ipeak vs. Time in Avalanche

# NVMFWS2D9N04XM

## TYPICAL CHARACTERISTICS

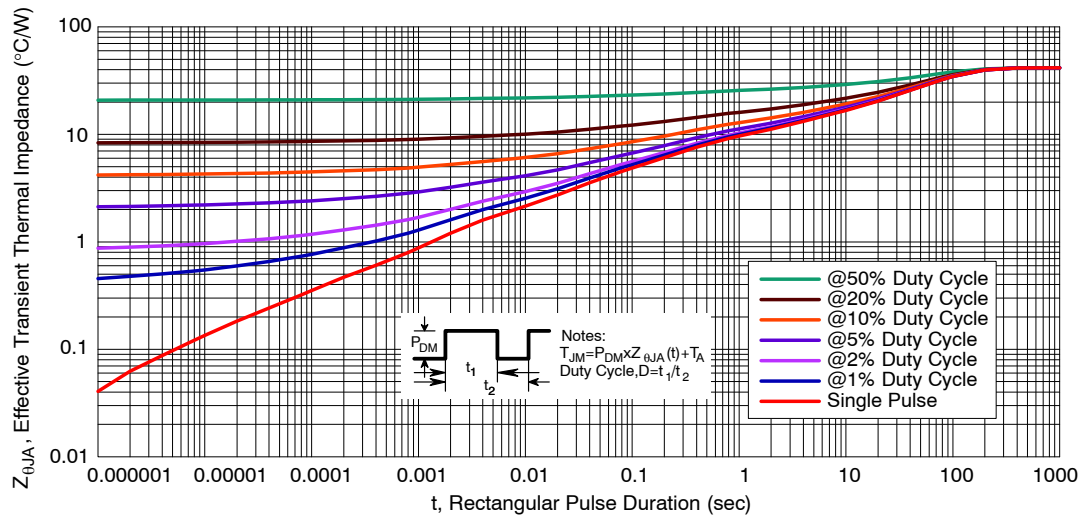
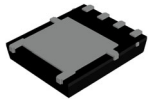


Figure 13. Transient Thermal Response

## DEVICE ORDERING INFORMATION

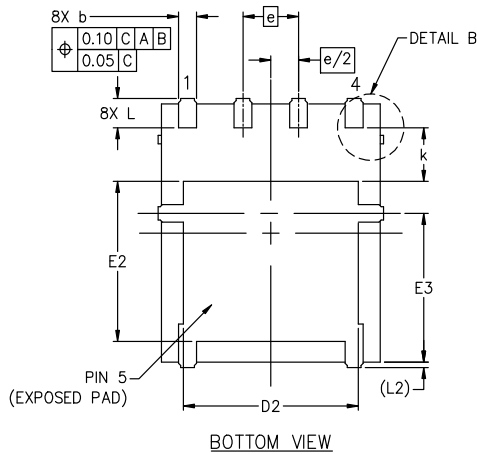
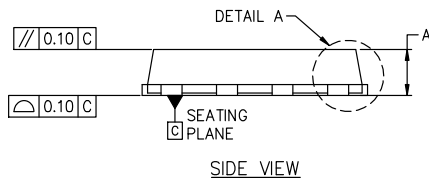
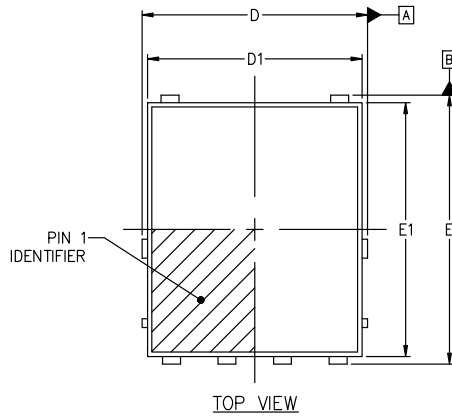
| Device            | Marking | Package            | Shipping <sup>†</sup> |
|-------------------|---------|--------------------|-----------------------|
| NVMFWS2D9N04XMT1G | 2D9N4W  | DFNW5<br>(Pb-Free) | 1500 / Tape & Reel    |

<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.



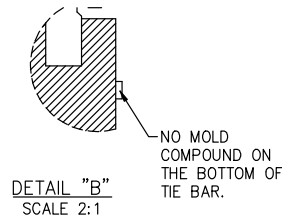
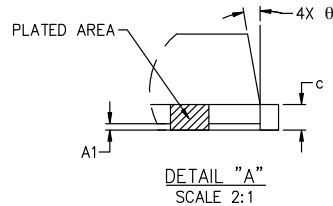
**DFNW5 4.90x5.90x1.00, 1.27P**  
**CASE 507BA**  
**ISSUE C**

DATE 19 SEP 2024

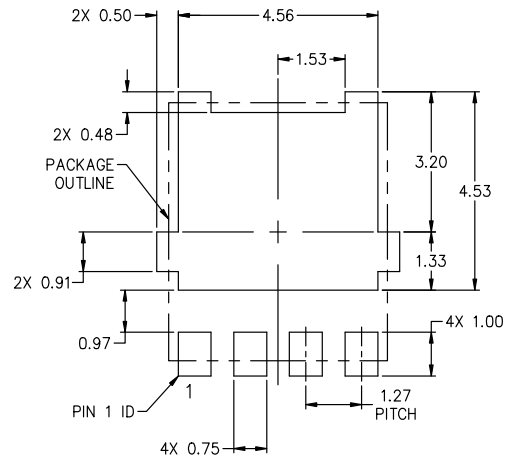


**NOTES:**

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M-2018.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
4. THIS PACKAGE CONTAINS WETTABLE FLANK DESIGN FEATURES TO AID IN FILLET FORMATION ON THE LEADS DURING MOUNTING.



| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN         | NOM  | MAX  |
| A   | 0.90        | 1.00 | 1.10 |
| A1  | 0.00        | ---  | 0.05 |
| b   | 0.33        | 0.41 | 0.51 |
| c   | 0.23        | 0.28 | 0.33 |
| D   | 5.00        | 5.15 | 5.30 |
| D1  | 4.70        | 4.90 | 5.10 |
| D2  | 3.80        | 4.00 | 4.20 |
| E   | 6.00        | 6.15 | 6.30 |
| E1  | 5.70        | 5.90 | 6.10 |
| E2  | 3.45        | 3.65 | 3.85 |
| E3  | 3.00        | 3.40 | 3.80 |
| e   | 1.27 BSC    |      |      |
| k   | 1.20        | 1.35 | 1.50 |
| L   | 0.51        | 0.57 | 0.71 |
| L2  | 0.15 REF.   |      |      |
| θ   | 0°          | 6°   | 12°  |



RECOMMENDED MOUNTING FOOTPRINT\*  
 \*FOR ADDITIONAL INFORMATION ON OUR Pb-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ONSEMI SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERM/D.

**GENERIC MARKING DIAGRAM\***



XXXXXX = Specific Device Code  
 A = Assembly Location  
 Y = Year  
 W = Work Week  
 ZZ = Lot Traceability

\*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.

|                         |                                    |                                                                                                                                                                                  |
|-------------------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <b>DESCRIPTION:</b>     | <b>DFNW5 4.90x5.90x1.00, 1.27P</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                               |

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