

# MOSFET - Power, Single N-Channel, DFN5/DFNW5 60 V, 4.7 mΩ, 93 A

## NVMFS5C646NL

### Features

- Small Footprint (5x6 mm) for Compact Design
- Low  $R_{DS(on)}$  to Minimize Conduction Losses
- Low  $Q_G$  and Capacitance to Minimize Driver Losses
- NVMFS5C646NLWF – Wettable Flank Option for Enhanced Optical Inspection
- AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

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

| Parameter                                                                   | Symbol                                         | Value                     | Unit             |
|-----------------------------------------------------------------------------|------------------------------------------------|---------------------------|------------------|
| Drain-to-Source Voltage                                                     | $V_{DS}$                                       | 60                        | V                |
| Gate-to-Source Voltage                                                      | $V_{GS}$                                       | $\pm 20$                  | V                |
| Continuous Drain Current $R_{\theta JC}$ (Notes 1, 3)                       | Steady State                                   | $T_C = 25^\circ\text{C}$  | $I_D$ 93 A       |
|                                                                             |                                                | $T_C = 100^\circ\text{C}$ |                  |
| Power Dissipation $R_{\theta JC}$ (Note 1)                                  | Steady State                                   | $T_C = 25^\circ\text{C}$  | $P_D$ 79 W       |
|                                                                             |                                                | $T_C = 100^\circ\text{C}$ |                  |
| Continuous Drain Current $R_{\theta JA}$ (Notes 1, 2, 3)                    | Steady State                                   | $T_A = 25^\circ\text{C}$  | $I_D$ 20 A       |
|                                                                             |                                                | $T_A = 100^\circ\text{C}$ |                  |
| Power Dissipation $R_{\theta JA}$ (Notes 1 & 2)                             | Steady State                                   | $T_A = 25^\circ\text{C}$  | $P_D$ 3.7 W      |
|                                                                             |                                                | $T_A = 100^\circ\text{C}$ |                  |
| Pulsed Drain Current                                                        | $T_A = 25^\circ\text{C}, t_p = 10 \mu\text{s}$ | $I_{DM}$ 750              | A                |
| Operating Junction and Storage Temperature                                  | $T_J, T_{stg}$                                 | -55 to +175               | $^\circ\text{C}$ |
| Source Current (Body Diode)                                                 | $I_S$                                          | 100                       | A                |
| Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 5 \text{ A}$ ) | $E_{AS}$                                       | 185                       | mJ               |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s)           | $T_L$                                          | 260                       | $^\circ\text{C}$ |

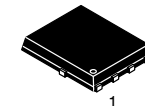
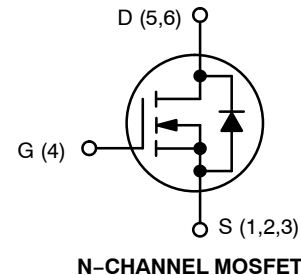
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL RESISTANCE MAXIMUM RATINGS

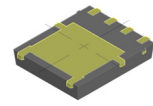
| Parameter                                   | Symbol          | Value | Unit                      |
|---------------------------------------------|-----------------|-------|---------------------------|
| Junction-to-Case – Steady State             | $R_{\theta JC}$ | 1.9   | $^\circ\text{C}/\text{W}$ |
| Junction-to-Ambient – Steady State (Note 2) | $R_{\theta JA}$ | 41    |                           |

1. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
2. Surface-mounted on FR4 board using a 650 mm<sup>2</sup>, 2 oz. Cu pad.
3. Maximum current for pulses as long as 1 second is higher but is dependent on pulse duration and duty cycle.

| $V_{(BR)DSS}$ | $R_{DS(ON)} \text{ MAX}$ | $I_D \text{ MAX}$ |
|---------------|--------------------------|-------------------|
| 60 V          | 4.7 mΩ @ 10 V            | 93 A              |
|               | 6.3 mΩ @ 4.5 V           |                   |

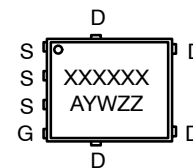


DFN5 (SO-8FL)  
CASE 488AA



DFNW5  
(FULL-CUT SO8FL WF)  
CASE 507BA

### MARKING DIAGRAM



XXXXXX = 5C646L  
(NVMFS5C646NL) or  
646LWF  
(NVMFS5C646NLWF)  
A = Assembly Location  
Y = Year  
W = Work Week  
ZZ = Lot Traceability

### ORDERING INFORMATION

See detailed ordering, marking and shipping information in the package dimensions section on page 5 of this data sheet.

NOTE: Some of the device on this data sheet have been **DISCONTINUED**. Please refer to the table on page 5

# NVMFS5C646NL

## 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                         | $V_{(BR)DSS}$     | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | 60                        |      |           | V                    |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ |                                                     |                           | 15.5 |           | mV/ $^\circ\text{C}$ |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$         | $V_{GS} = 0\text{ V}, V_{DS} = 60\text{ V}$         | $T_J = 25^\circ\text{C}$  |      | 10        | $\mu\text{A}$        |
|                                                           |                   |                                                     | $T_J = 125^\circ\text{C}$ |      | 250       |                      |
| Gate-to-Source Leakage Current                            | $I_{GSS}$         | $V_{DS} = 0\text{ V}, V_{GS} = \pm 16\text{ V}$     |                           |      | $\pm 100$ | nA                   |

### ON CHARACTERISTICS (Note 4)

|                                   |                  |                                                |     |      |     |                      |
|-----------------------------------|------------------|------------------------------------------------|-----|------|-----|----------------------|
| Gate Threshold Voltage            | $V_{GS(TH)}$     | $V_{GS} = V_{DS}, I_D = 80\text{ }\mu\text{A}$ | 1.2 |      | 2.0 | V                    |
| Threshold Temperature Coefficient | $V_{GS(TH)}/T_J$ |                                                |     | -4.9 |     | mV/ $^\circ\text{C}$ |
| Drain-to-Source On Resistance     | $R_{DS(on)}$     | $V_{GS} = 10\text{ V}, I_D = 50\text{ A}$      |     | 3.8  | 4.7 | m $\Omega$           |
|                                   |                  | $V_{GS} = 4.5\text{ V}, I_D = 50\text{ A}$     |     | 5.0  | 6.3 |                      |
| Forward Transconductance          | $g_{FS}$         | $V_{DS} = 15\text{ V}, I_D = 50\text{ A}$      |     | 105  |     | S                    |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                              |              |                                                                  |  |      |  |    |
|------------------------------|--------------|------------------------------------------------------------------|--|------|--|----|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 25\text{ V}$    |  | 2164 |  | pF |
| Output Capacitance           | $C_{OSS}$    |                                                                  |  | 900  |  |    |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                  |  | 17   |  |    |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = 4.5\text{ V}, V_{DS} = 30\text{ V}; I_D = 25\text{ A}$ |  | 15.7 |  | nC |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = 10\text{ V}, V_{DS} = 30\text{ V}; I_D = 25\text{ A}$  |  | 33.7 |  |    |
| Threshold Gate Charge        | $Q_{G(TH)}$  | $V_{GS} = 4.5\text{ V}, V_{DS} = 30\text{ V}; I_D = 25\text{ A}$ |  | 1.5  |  |    |
| Gate-to-Source Charge        | $Q_{GS}$     |                                                                  |  | 5.6  |  |    |
| Gate-to-Drain Charge         | $Q_{GD}$     |                                                                  |  | 5.1  |  |    |
| Plateau Voltage              | $V_{GP}$     |                                                                  |  | 2.8  |  | V  |

### SWITCHING CHARACTERISTICS (Note 5)

|                     |              |                                                                                           |  |      |  |    |
|---------------------|--------------|-------------------------------------------------------------------------------------------|--|------|--|----|
| Turn-On Delay Time  | $t_{d(ON)}$  | $V_{GS} = 4.5\text{ V}, V_{DS} = 30\text{ V}, I_D = 25\text{ A}, R_G = 2.5\text{ }\Omega$ |  | 10.4 |  | ns |
| Rise Time           | $t_r$        |                                                                                           |  | 14.9 |  |    |
| Turn-Off Delay Time | $t_{d(OFF)}$ |                                                                                           |  | 23.6 |  |    |
| Fall Time           | $t_f$        |                                                                                           |  | 5.1  |  |    |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                         |          |                                                                              |                           |  |      |     |    |
|-------------------------|----------|------------------------------------------------------------------------------|---------------------------|--|------|-----|----|
| Forward Diode Voltage   | $V_{SD}$ | $V_{GS} = 0\text{ V}, I_S = 50\text{ A}$                                     | $T_J = 25^\circ\text{C}$  |  | 0.88 | 1.2 | V  |
|                         |          |                                                                              | $T_J = 125^\circ\text{C}$ |  | 0.78 |     |    |
| Reverse Recovery Time   | $t_{RR}$ | $V_{GS} = 0\text{ V}, dI_S/dt = 100\text{ A}/\mu\text{s}, I_S = 50\text{ A}$ |                           |  | 40.9 |     | ns |
| Charge Time             | $t_a$    |                                                                              |                           |  | 20.8 |     |    |
| Discharge Time          | $t_b$    |                                                                              |                           |  | 20.1 |     |    |
| Reverse Recovery Charge | $Q_{RR}$ |                                                                              |                           |  | 32   |     | nC |

4. Pulse Test: pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

5. Switching characteristics are independent of operating junction temperatures.

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.

TYPICAL CHARACTERISTICS

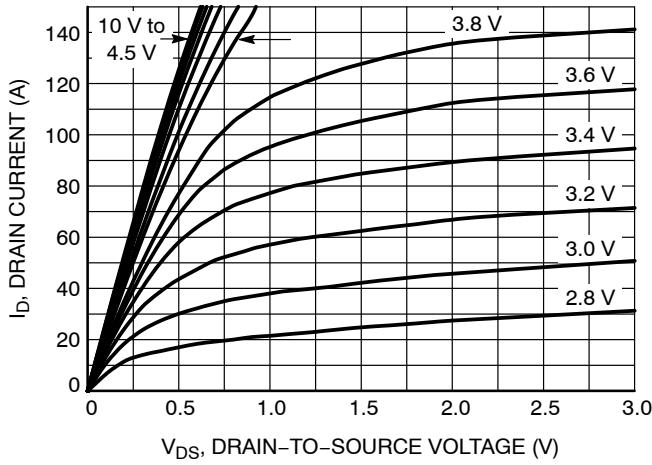


Figure 1. On-Region Characteristics

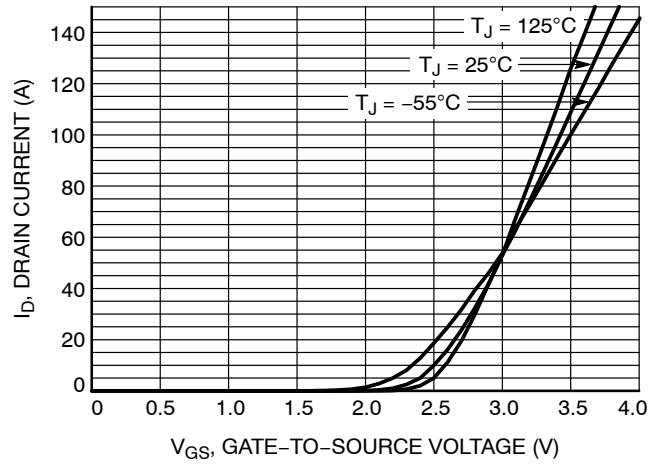


Figure 2. Transfer Characteristics

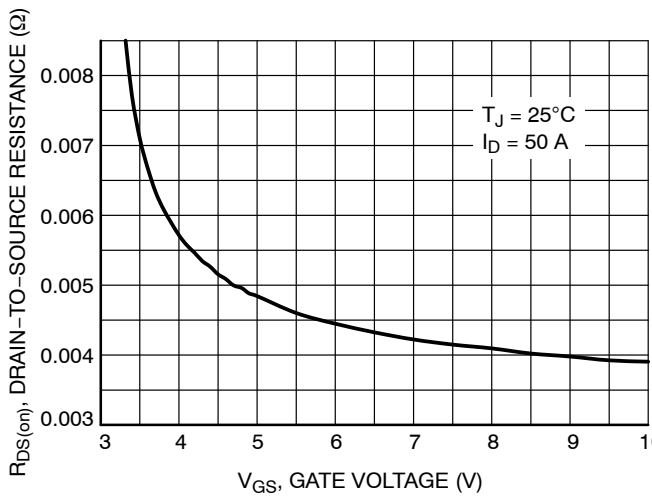


Figure 3. On-Resistance vs. Gate-to-Source Voltage

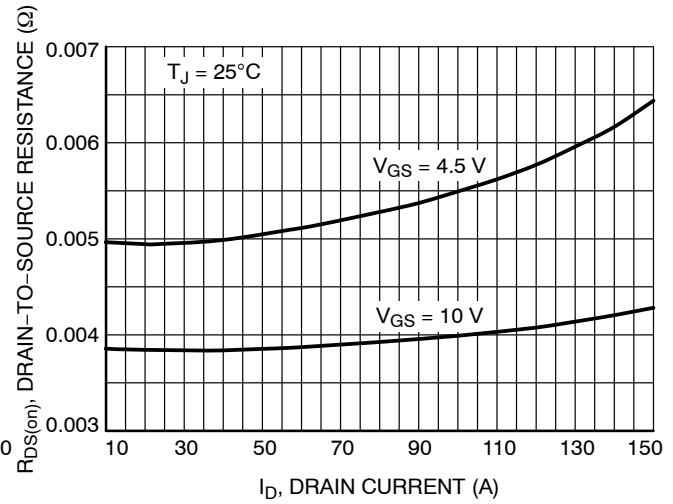


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

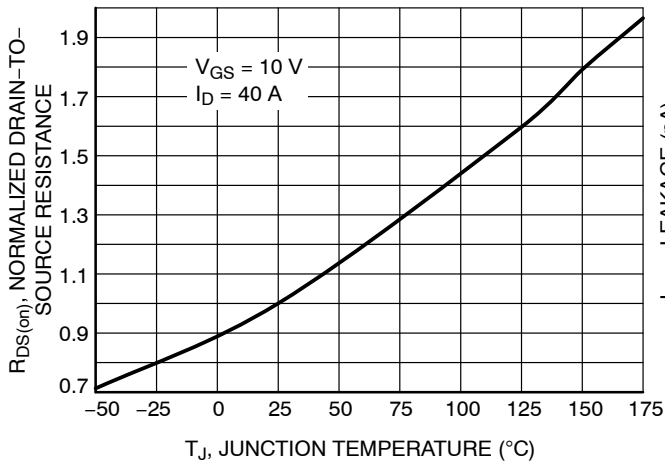


Figure 5. On-Resistance Variation with Temperature

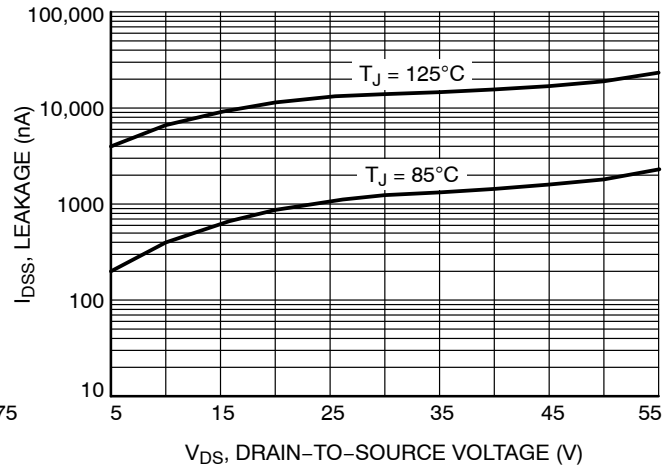
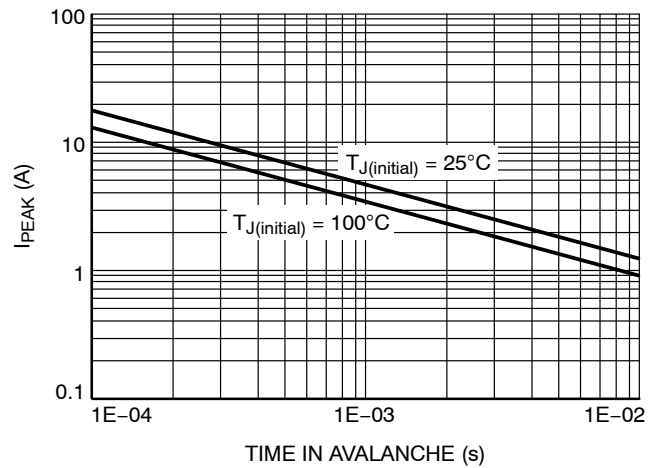
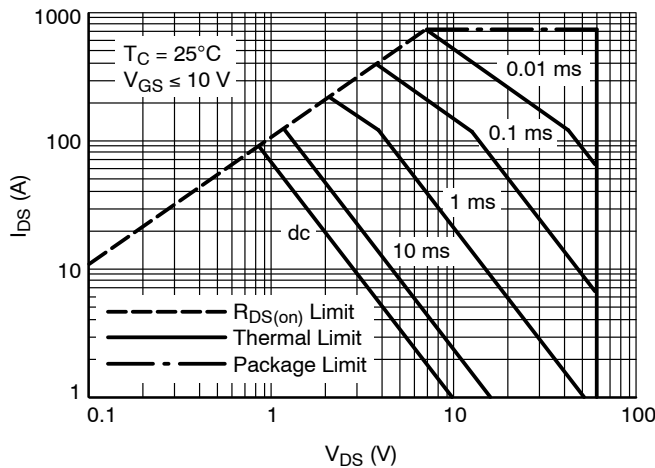
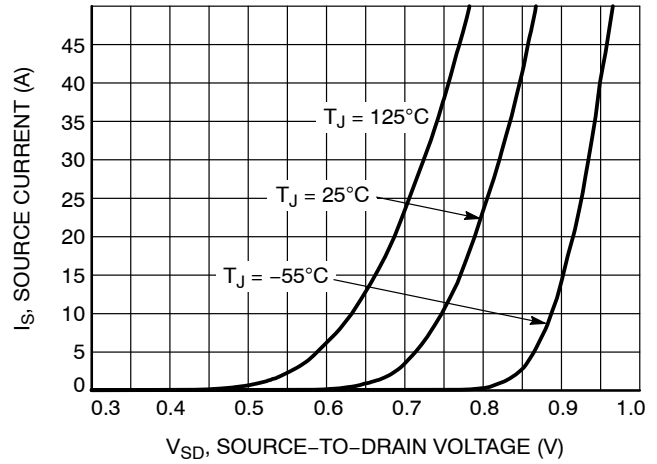
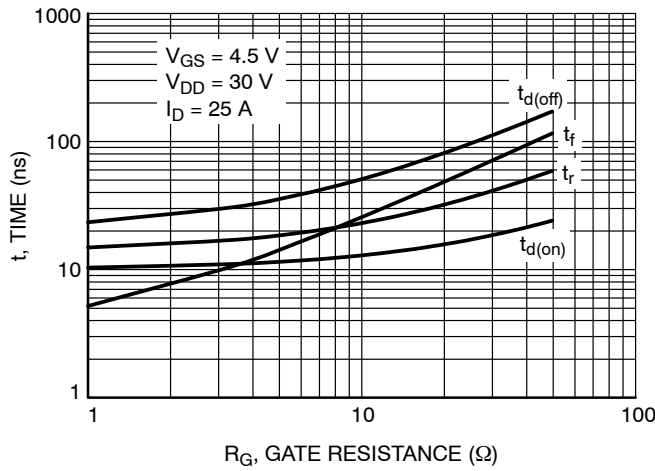
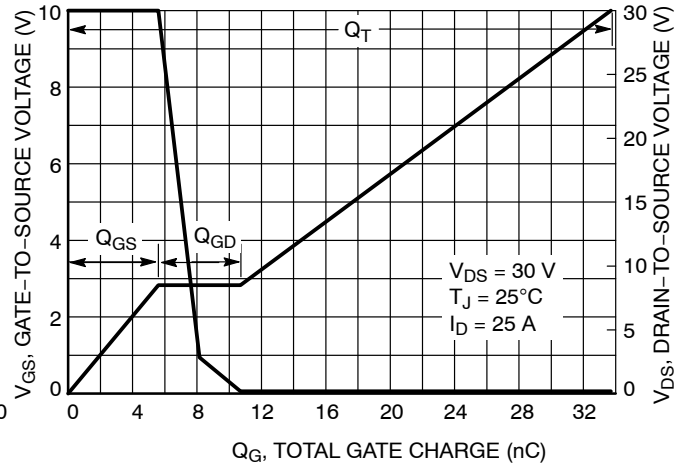
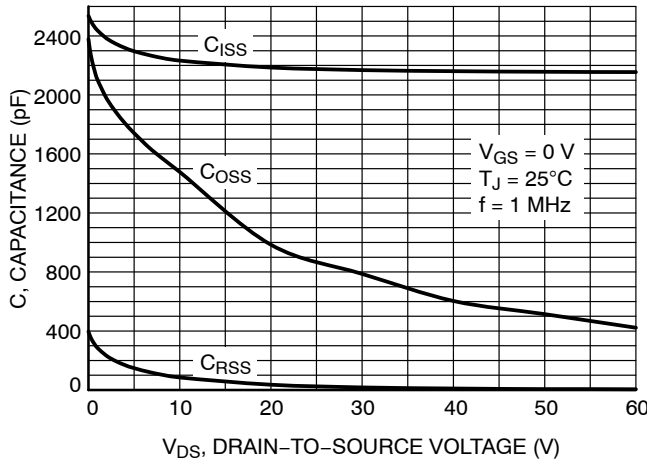


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS



## NVMFS5C646NL

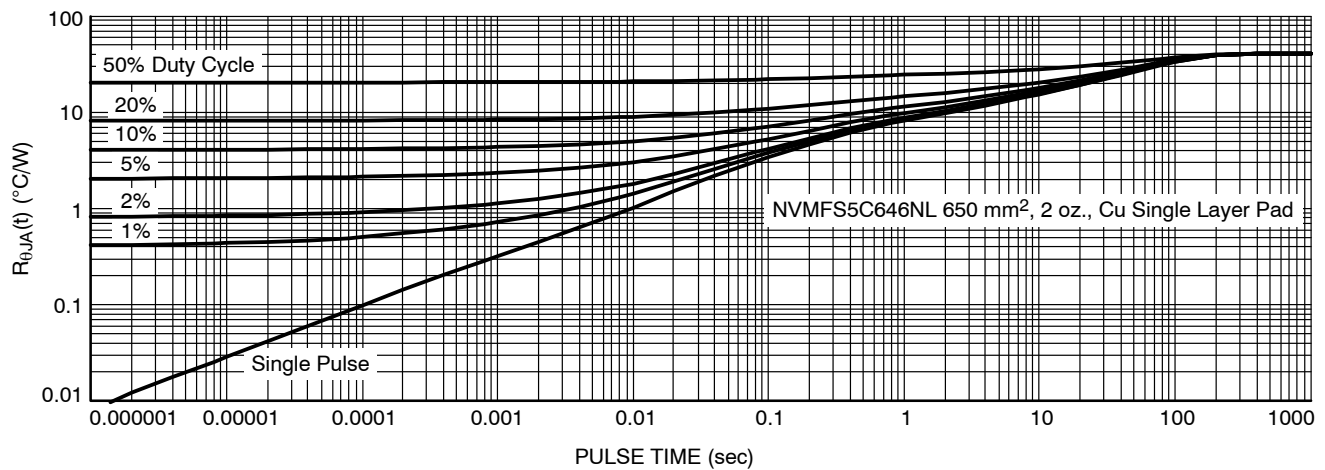


Figure 13. Thermal Characteristics

### DEVICE ORDERING INFORMATION

| Device               | Marking | Package                             | Shipping <sup>†</sup> |
|----------------------|---------|-------------------------------------|-----------------------|
| NVMFS5C646NLT1G      | 5C646L  | DFN5<br>(Pb-Free)                   | 1500 / Tape & Reel    |
| NVMFS5C646NLAFT1G    | 5C646L  | DFN5<br>(Pb-Free)                   | 1500 / Tape & Reel    |
| NVMFS5C646NLAFT1G-YE | 5C646L  | DFN5<br>(Pb-Free)                   | 1500 / Tape & Reel    |
| NVMFS5C646NLWFAFT1G  | 646LWF  | DFNW5<br>(Pb-Free, Wettable Flanks) | 1500 / Tape & Reel    |
| NVMFS5C646NLWFET1G   | 646LWF  | DFNW5<br>(Pb-Free, Wettable Flanks) | 1500 / Tape & Reel    |

### DISCONTINUED (Note 5)

| Device            | Package Type | Package                             | Shipping <sup>†</sup> |
|-------------------|--------------|-------------------------------------|-----------------------|
| NVMFS5C646NLWFT1G | 646LWF       | DFNW5<br>(Pb-Free, Wettable Flanks) | 1500 / Tape & Reel    |
| NVMFS5C646NLT3G   | 5C646L       | DFN5<br>(Pb-Free)                   | 5000 / Tape & Reel    |
| NVMFS5C646NLWFT3G | 646LWF       | DFNW5<br>(Pb-Free, Wettable Flanks) | 5000 / 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.

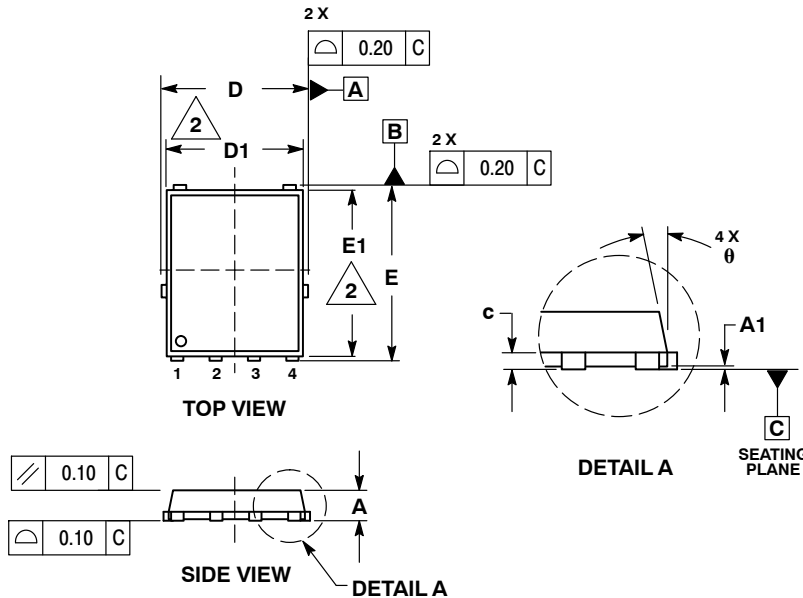
6. **DISCONTINUED:** This device is not recommended for new design. Please contact your **onsemi** representative for information. The most current information on this device may be available on [www.onsemi.com](http://www.onsemi.com).



SCALE 2:1

**DFN5 5x6, 1.27P**  
**(SO-8FL)**  
**CASE 488AA**  
**ISSUE N**

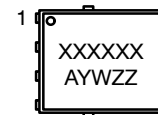
DATE 25 JUN 2018



## NOTES:

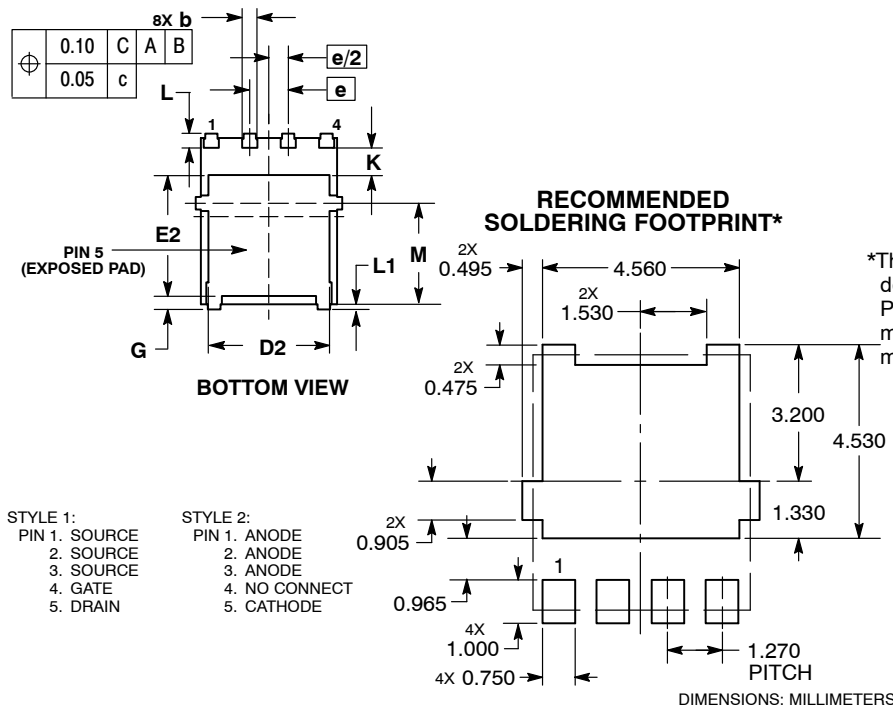
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION D1 AND E1 DO NOT INCLUDE MOLD FLASH PROTRUSIONS OR GATE BURRS.

| 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 |
| e     | 1.27 BSC    |       |      |
| G     | 0.51        | 0.575 | 0.71 |
| K     | 1.20        | 1.35  | 1.50 |
| L     | 0.51        | 0.575 | 0.71 |
| L1    | 0.125 REF   |       |      |
| M     | 3.00        | 3.40  | 3.80 |
| theta | 0°          | ---   | 12°  |

**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.



STYLE 1:  
PIN 1. SOURCE  
2. SOURCE  
3. SOURCE  
4. GATE  
5. DRAIN

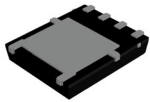
STYLE 2:  
PIN 1. ANODE  
2. ANODE  
3. ANODE  
4. NO CONNECT  
5. CATHODE

DIMENSIONS: MILLIMETERS

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

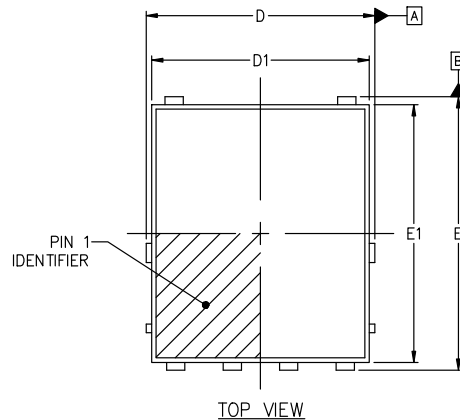
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| <b>DESCRIPTION:</b>     | <b>DFN5 5x6, 1.27P (SO-8FL)</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                               |

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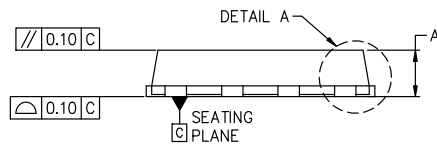


DFNW5 4.90x5.90x1.00, 1.27P  
CASE 507BE  
ISSUE B

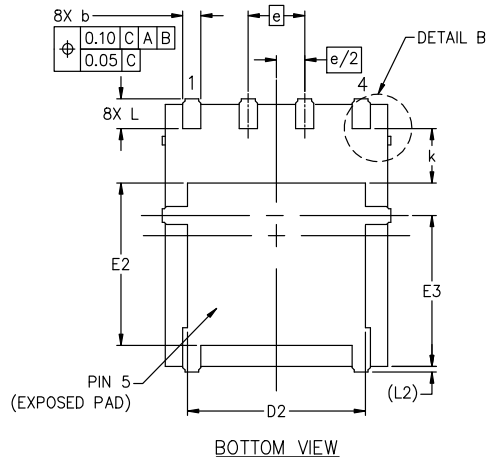
DATE 19 SEP 2024



TOP VIEW



SIDE VIEW



BOTTOM VIEW

GENERIC  
MARKING DIAGRAM\*

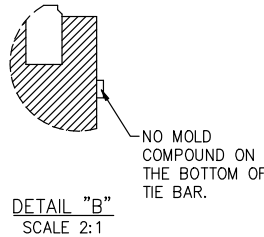
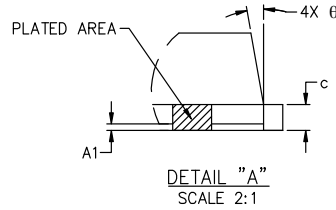


XXXXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
W = Work Week  
ZZ = Lot Traceability

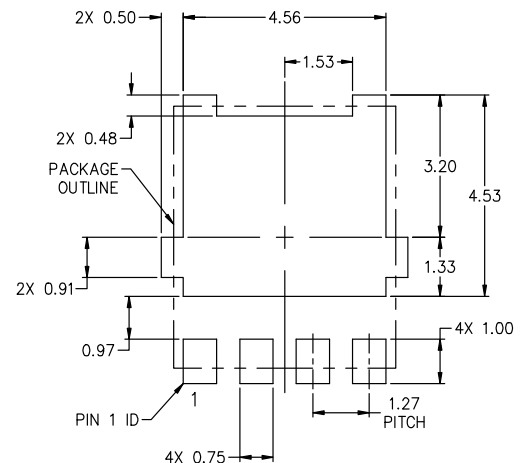
\*This information is generic. Please refer to device data sheet for actual part marking.  
Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

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.

|                  |                             |                                                                                                                                                                                     |
|------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOCUMENT NUMBER: | 98AON33319H                 | Electronic versions are uncontrolled except when accessed directly from the Document Repository.<br>Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| DESCRIPTION:     | DFNW5 4.90x5.90x1.00, 1.27P | PAGE 1 OF 1                                                                                                                                                                         |

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