

# MOSFET - Power, Single N-Channel, Source-Down TDFN9

60 V, 1.5 mΩ, 235 A

## NTMFSS1D5N06CL

### 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
- These Devices are Pb-Free, Halogen-Free / BFR Free and are RoHS Compliant

### Typical Applications

- DC-DC Converters
- Power Load Switch
- Notebook Battery Management

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

| Parameter                                                                          |                                                            |                             | Symbol            | Value       | Unit               |
|------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|-------------------|-------------|--------------------|
| Drain-to-Source Voltage                                                            |                                                            |                             | $V_{DSS}$         | 60          | V                  |
| Gate-to-Source Voltage                                                             |                                                            |                             | $V_{GS}$          | $\pm 20$    | V                  |
| Continuous Drain Current $R_{\theta JC}$                                           | Steady State                                               | $T_C = 25^{\circ}\text{C}$  | $I_D$             | 237         | A                  |
|                                                                                    |                                                            | $T_C = 100^{\circ}\text{C}$ |                   | 149         |                    |
| Power Dissipation $R_{\theta JC}$                                                  | Steady State                                               | $T_C = 25^{\circ}\text{C}$  | $P_D$             | 144         | W                  |
|                                                                                    |                                                            | $T_C = 100^{\circ}\text{C}$ |                   | 57          |                    |
| Continuous Drain Current $R_{\theta JA}$ (Notes 1, 2)                              | Steady State                                               | $T_A = 25^{\circ}\text{C}$  | $I_D$             | 31          | A                  |
|                                                                                    |                                                            | $T_A = 100^{\circ}\text{C}$ |                   | 19          |                    |
| Power Dissipation $R_{\theta JA}$ (Notes 1, 2)                                     | Steady State                                               | $T_A = 25^{\circ}\text{C}$  | $P_D$             | 2.5         | W                  |
|                                                                                    |                                                            | $T_A = 100^{\circ}\text{C}$ |                   | 1           |                    |
| Pulsed Drain Current                                                               | $T_A = 25^{\circ}\text{C}$ , $t_p = 10\text{ }\mu\text{s}$ |                             | $I_{DM}$          | 1698        | A                  |
| Operating Junction and Storage Temperature Range                                   |                                                            |                             | $T_J$ , $T_{stg}$ | -55 to +150 | $^{\circ}\text{C}$ |
| Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 75\text{ A}$ )        |                                                            |                             | $E_{AS}$          | 207         | mJ                 |
| Lead Temperature Soldering Reflow for Soldering Purposes (1/8" from case for 10 s) |                                                            |                             | $T_L$             | 260         | $^{\circ}\text{C}$ |

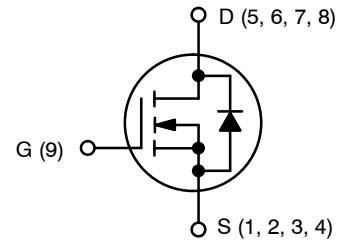
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL RESISTANCE MAXIMUM RATINGS

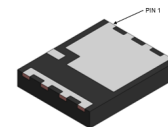
| Parameter                                   | Symbol          | Value | Unit               |
|---------------------------------------------|-----------------|-------|--------------------|
| Junction-to-Case – Steady State             | $R_{\theta JC}$ | 0.86  | $^\circ\text{C/W}$ |
| Junction-to-Ambient – Steady State (Note 2) | $R_{\theta JA}$ | 50    |                    |

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 1 in<sup>2</sup> pad size, 2 oz. Cu pad.

| $V_{(BR)DSS}$ | $R_{DS(ON)} \text{ MAX}$ | $I_D \text{ MAX}$ |
|---------------|--------------------------|-------------------|
| 60 V          | 1.5 mΩ @ 10 V            | 235 A             |
|               | 2.3 mΩ @ 4.5 V           |                   |



N-CHANNEL MOSFET



TDFN9 5x6  
CASE 520AE

### MARKING DIAGRAM

|                 |
|-----------------|
| 1D5N06<br>AYWZZ |
|-----------------|

1D5N06 = Specific Device Code  
A = Assembly Location  
Y = Year  
W = Work Week  
ZZ = Wafer Lot

### ORDERING INFORMATION

| Device         | Package         | Shipping†          |
|----------------|-----------------|--------------------|
| NTMFSS1D5N06CL | TDFN9 (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.

# NTMFSS1D5N06CL

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise specified)

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

### OFF CHARACTERISTICS

|                                                           |                                      |                                                                      |    |      |     |       |
|-----------------------------------------------------------|--------------------------------------|----------------------------------------------------------------------|----|------|-----|-------|
| Drain-to-Source Breakdown Voltage                         | V <sub>(BR)DSS</sub>                 | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                       | 60 |      |     | V     |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | V <sub>(BR)DSS</sub> /T <sub>J</sub> | I <sub>D</sub> = 250 μA, ref to 25°C                                 |    | 23.2 |     | mV/°C |
| Zero Gate Voltage Drain Current                           | I <sub>DSS</sub>                     | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 60 V, T <sub>J</sub> = 25°C |    |      | 10  | μA    |
| Gate-to-Source Leakage Current                            | I <sub>GSS</sub>                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = 20 V                        |    |      | 100 | nA    |

### ON CHARACTERISTICS (Note 3)

|                                   |                                     |                                                             |     |       |     |       |
|-----------------------------------|-------------------------------------|-------------------------------------------------------------|-----|-------|-----|-------|
| Gate Threshold Voltage            | V <sub>GS(TH)</sub>                 | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 μA | 1.2 |       | 2.0 | V     |
| Threshold Temperature Coefficient | V <sub>GS(TH)</sub> /T <sub>J</sub> | I <sub>D</sub> = 250 μA, ref to 25°C                        |     | -5.76 |     | mV/°C |
| Drain-to-Source On Resistance     | R <sub>DS(on)</sub>                 | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 50 A               |     | 1.05  | 1.5 | mΩ    |
|                                   |                                     | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 50 A              |     | 1.42  | 2.3 |       |
| Forward Transconductance          | g <sub>FS</sub>                     | V <sub>DS</sub> = 15 V, I <sub>D</sub> = 50 A               |     | 151   |     | S     |
| Gate Resistance                   | R <sub>G</sub>                      | T <sub>A</sub> = 25°C                                       |     | 1     |     | Ω     |

### CHARGES & CAPACITANCES

|                       |                     |                                                                        |  |       |  |    |
|-----------------------|---------------------|------------------------------------------------------------------------|--|-------|--|----|
| Input Capacitance     | C <sub>ISS</sub>    | V <sub>GS</sub> = 0 V, f = 1 MHz, V <sub>DS</sub> = 30 V               |  | 7526  |  | pF |
| Output Capacitance    | C <sub>OSS</sub>    |                                                                        |  | 3462  |  |    |
| Reverse Capacitance   | C <sub>RSS</sub>    |                                                                        |  | 42    |  |    |
| Total Gate Charge     | Q <sub>G(TOT)</sub> | V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 30 V, I <sub>D</sub> = 50 A  |  | 102.6 |  | nC |
| Total Gate Charge     | Q <sub>G(TOT)</sub> | V <sub>GS</sub> = 4.5 V, V <sub>DS</sub> = 30 V, I <sub>D</sub> = 50 A |  | 46.1  |  |    |
| Gate-to-Drain Charge  | Q <sub>GD</sub>     |                                                                        |  | 8.4   |  |    |
| Gate-to-Source Charge | Q <sub>GS</sub>     |                                                                        |  | 21    |  |    |
| Plateau Voltage       | V <sub>GP</sub>     |                                                                        |  | 2.9   |  | V  |

### SWITCHING CHARACTERISTICS (Note 3)

|                     |                     |                                                                                                   |  |      |  |    |
|---------------------|---------------------|---------------------------------------------------------------------------------------------------|--|------|--|----|
| Turn-On Delay Time  | t <sub>d(ON)</sub>  | V <sub>GS</sub> = 4.5 V, V <sub>DD</sub> = 30 V,<br>I <sub>D</sub> = 50 A, R <sub>G</sub> = 1.0 Ω |  | 16   |  | ns |
| Rise Time           | t <sub>r</sub>      |                                                                                                   |  | 7.1  |  |    |
| Turn-Off Delay Time | t <sub>d(OFF)</sub> |                                                                                                   |  | 41.3 |  |    |
| Fall Time           | t <sub>f</sub>      |                                                                                                   |  | 5.4  |  |    |

### SOURCE-TO-DRAIN DIODE CHARACTERISTICS

|                         |                 |                                                                   |                        |  |      |     |    |
|-------------------------|-----------------|-------------------------------------------------------------------|------------------------|--|------|-----|----|
| Forward Diode Voltage   | V <sub>SD</sub> | V <sub>GS</sub> = 0 V,<br>I <sub>S</sub> = 50 A                   | T <sub>J</sub> = 25°C  |  | 0.78 | 1.2 | V  |
|                         |                 |                                                                   | T <sub>J</sub> = 125°C |  | 0.66 |     |    |
| Reverse Recovery Time   | t <sub>RR</sub> | V <sub>GS</sub> = 0 V, dI/dt = 100 A/μs,<br>I <sub>S</sub> = 50 A |                        |  | 83   |     | ns |
| Charge Time             | t <sub>a</sub>  |                                                                   |                        |  | 39.9 |     |    |
| Discharge Time          | t <sub>b</sub>  |                                                                   |                        |  | 43.2 |     |    |
| Reverse Recovery Charge | Q <sub>RR</sub> |                                                                   |                        |  | 142  |     | 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.

3. Switching characteristics are independent of operating junction temperatures.

TYPICAL CHARACTERISTICS

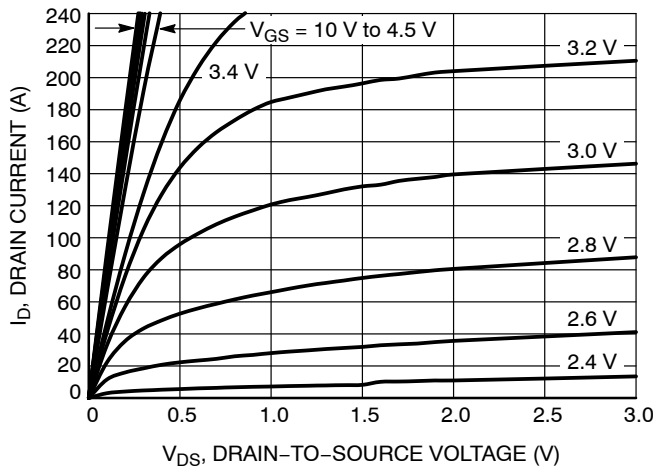


Figure 1. On-Region Characteristics

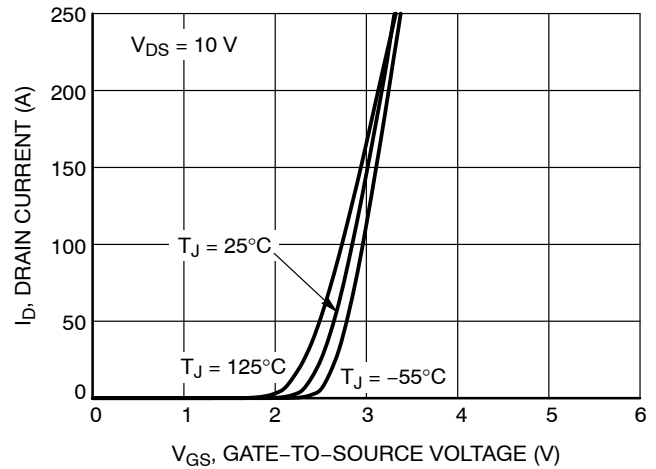


Figure 2. Transfer Characteristics

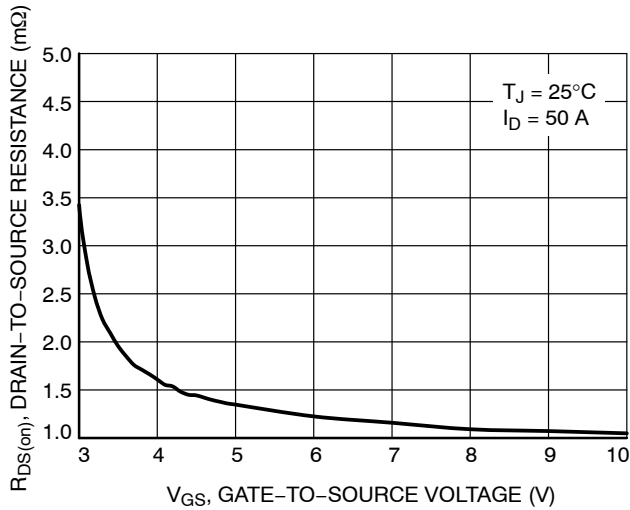


Figure 3. On-Resistance vs. Gate-to-Source Voltage

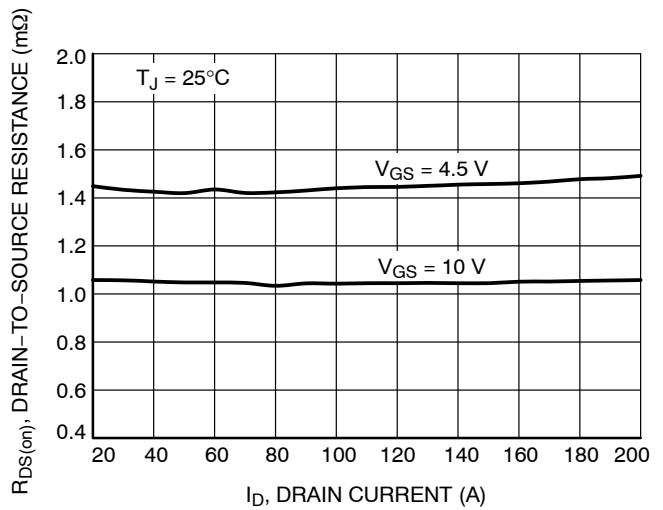


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

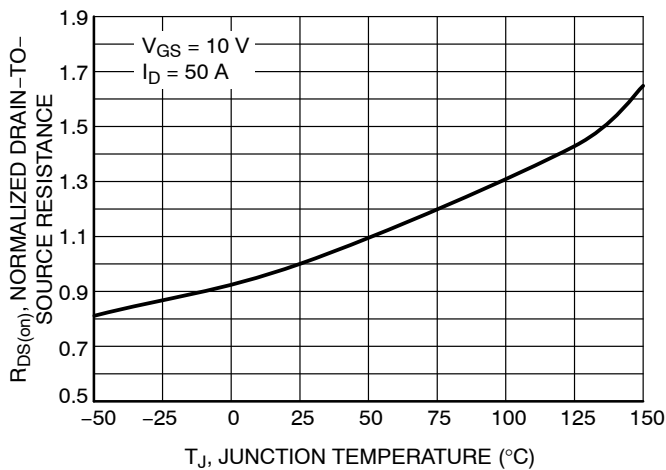


Figure 5. On-Resistance Variation with Temperature

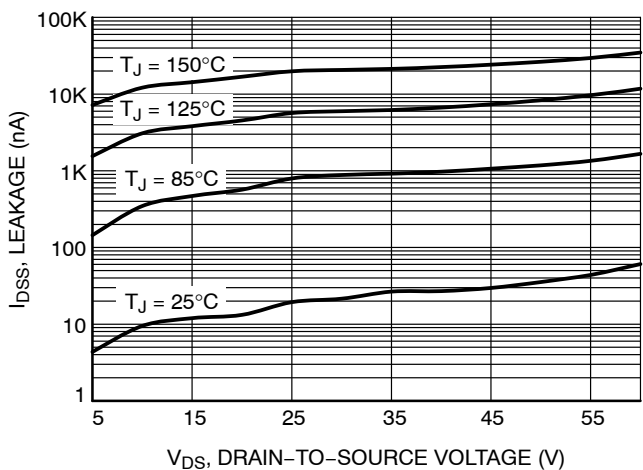


Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NTMFSS1D5N06CL

## TYPICAL CHARACTERISTICS

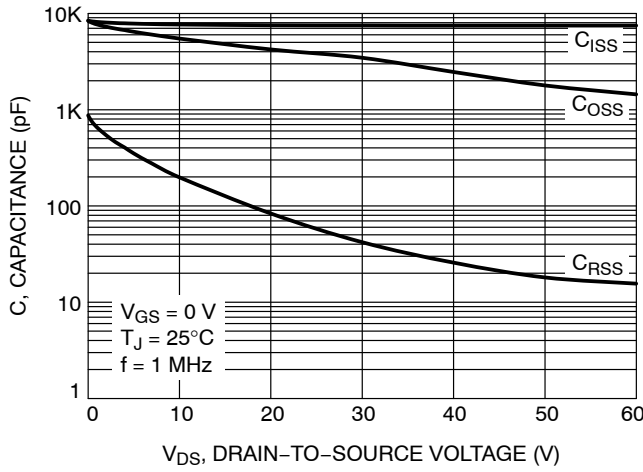


Figure 7. Capacitance Variation

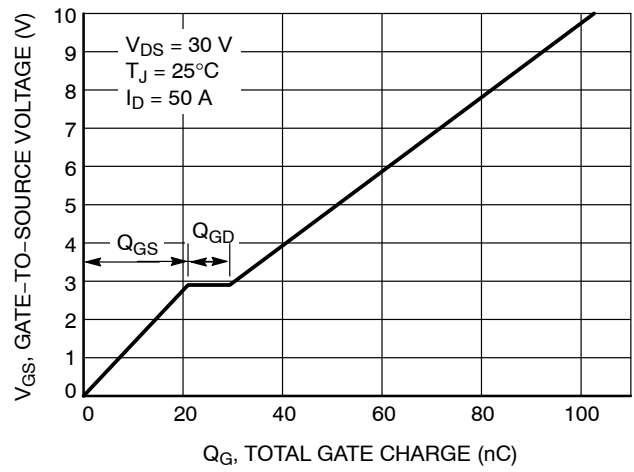


Figure 8. Gate-to-Source vs. Total Charge

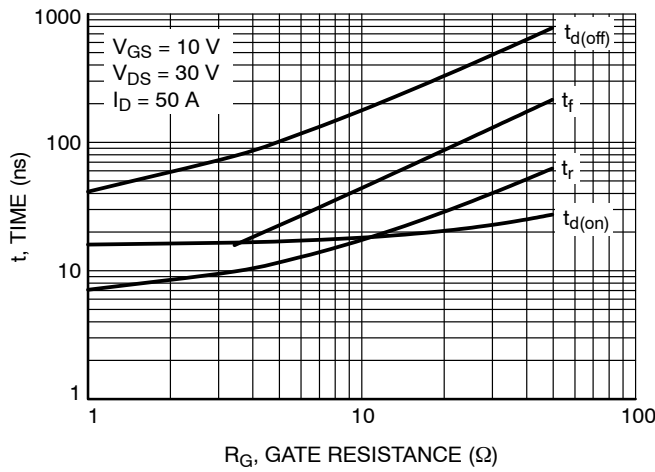


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

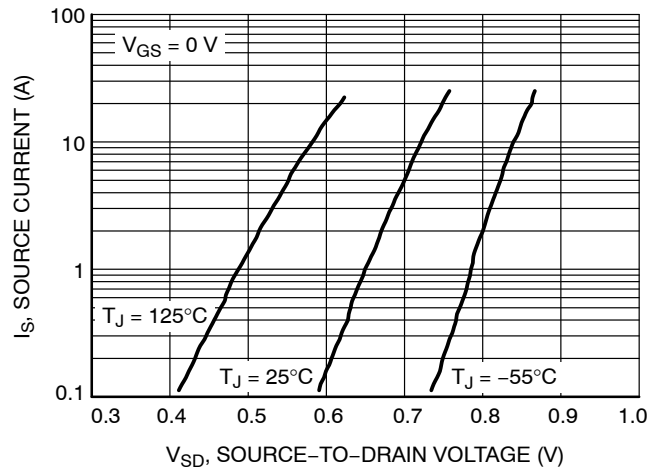


Figure 10. Diode Forward Voltage vs. Current

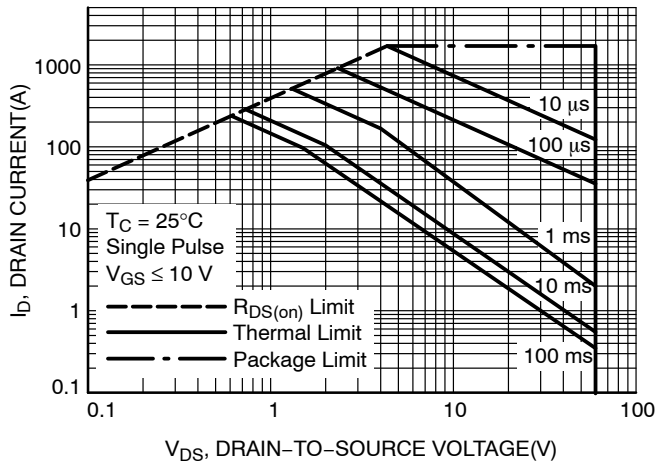


Figure 11. Safe Operating Area

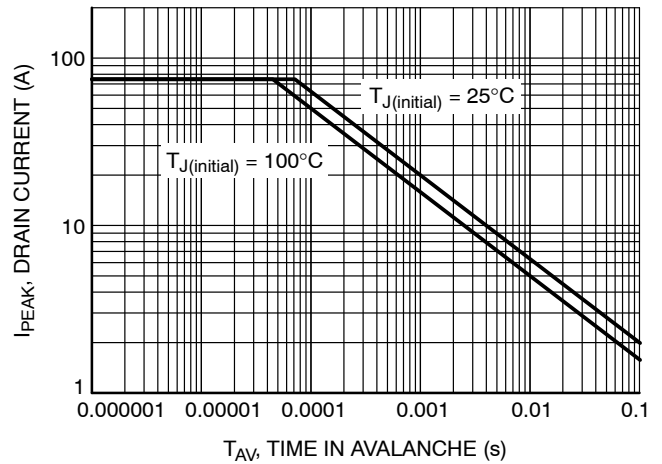


Figure 12.  $I_{PEAK}$  vs. Time in Avalanche

# NTMFSS1D5N06CL

## TYPICAL CHARACTERISTICS

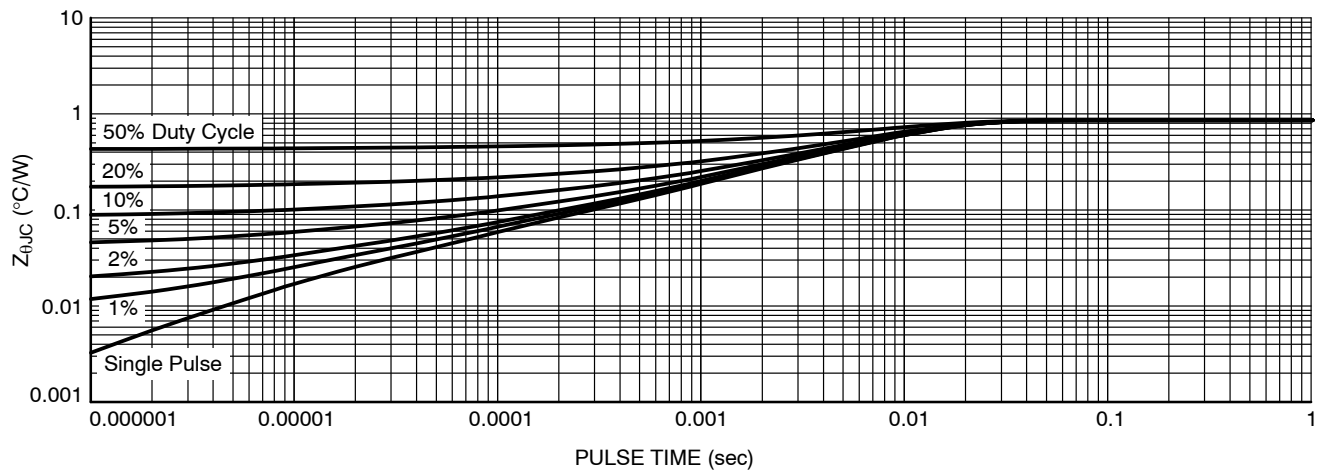
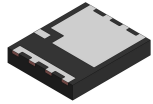
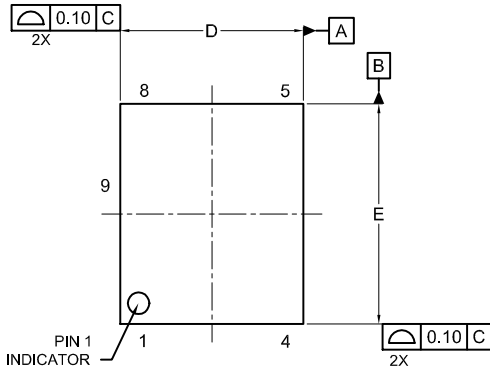


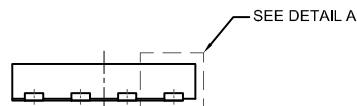
Figure 13. Thermal Characteristics


**TDFN9 5x6, 1.27P**  
**CASE 520AE**  
**ISSUE B**

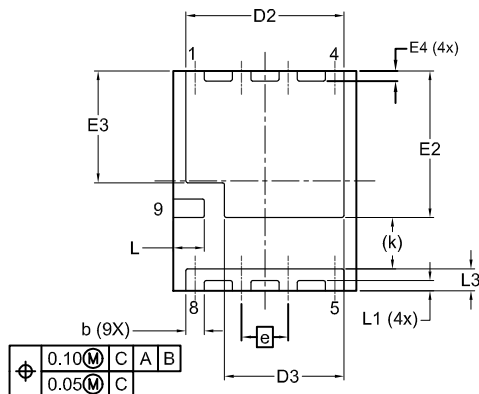
DATE 24 NOV 2022



TOP VIEW



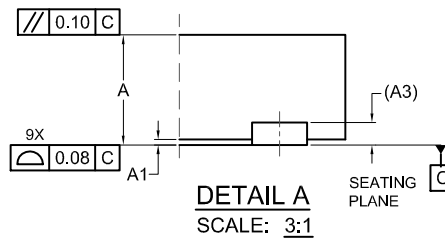
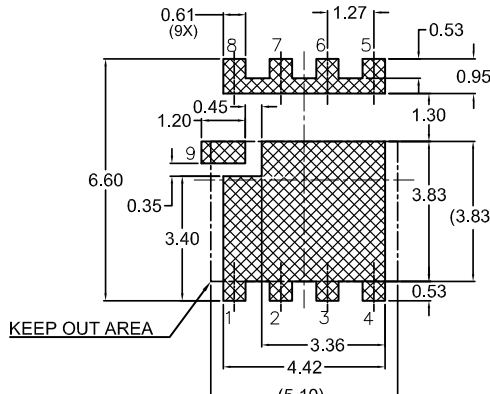
FRONT VIEW



BOTTOM VIEW

## NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. COPLANARITY APPLIES TO THE EXPOSED PADS AS WELL AS THE TERMINALS.
4. DIMENSIONS D1, D2, E1 AND E2 DO NOT INCLUDE MOLD FLASH.
5. SEATING PLANE IS DEFINED BY THE TERMINALS.  
"A1" IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.


**DETAIL A**  
SCALE: 3:1

LAND PATTERN  
RECOMMENDATION

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

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN         | NOM  | MAX  |
| A   | 0.95        | 1.00 | 1.05 |
| A1  | 0.00        | 0.02 | 0.05 |
| A3  | 0.20 REF    |      |      |
| b   | 0.45        | 0.50 | 0.55 |
| D   | 4.90        | 5.00 | 5.10 |
| D2  | 4.10        | 4.30 | 4.50 |
| D3  | 3.16        | 3.26 | 3.36 |
| E   | 5.90        | 6.00 | 6.10 |
| E2  | 3.90        | 4.00 | 4.10 |
| E3  | 2.95        | 3.05 | 3.15 |
| E4  | 0.18        | 0.28 | 0.38 |
| e   | 1.27 BSC    |      |      |
| k   | 1.40 REF    |      |      |
| L   | 0.75        | 0.85 | 0.95 |
| L1  | 0.18        | 0.28 | 0.38 |
| L3  | 0.50        | 0.60 | 0.70 |

**GENERIC**  
**MARKING DIAGRAM\***


XXXX = Specific Device Code  
A = Assembly Location  
WL = Wafer Lot  
Y = Year Code  
WW = Work Week Code

\*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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