

# MOSFET – Dual, P-Channel, POWERTRENCH®

**-60 V**

## NDS9948

### General Description

This P-Channel MOSFET is a rugged gate version of onsemi's advanced POWERTRENCH process. It has been optimized for power management applications requiring a wide range of gate drive voltage ratings (4.5 V – 20 V).

### Features

- -2.3 A, -60 V  $R_{DS(on)} = 250 \text{ m}\Omega @ V_{GS} = -10 \text{ V}$   
 $R_{DS(on)} = 500 \text{ m}\Omega @ V_{GS} = -4.5 \text{ V}$
- Low Gate Charge (9 nC Typical)
- Fast Switching Speed
- High Performance Trench Technology for Extremely Low  $R_{DS(on)}$
- High Power and Current Handling Capability
- This is a Pb-Free and Halide Free Device

### Features

- Power Management
- Load Switch
- Battery Protection

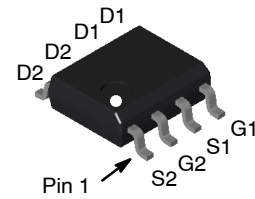
### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

| Symbol         | Parameter   | Ratings           | Unit             |
|----------------|---|-------------------|------------------|
| $V_{DSS}$      | Drain-Source Voltage  | -60               | V                |
| $V_{GSS}$      | Gate-Source Voltage   | $\pm 20$          | V                |
| $I_D$          | Drain Current – Continuous (Note 1a.)<br>– Pulsed                             | -2.3<br>-10       | A                |
| $P_D$          | Power Dissipation for Dual Operation  | 2                 | W                |
| $P_D$          | Power Dissipation (Note 1a.)<br>for Single Operation (Note 1b.)<br>(Note 1c.) | 1.6<br>1.0<br>0.9 | W                |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range                              | -55 to +175       | $^\circ\text{C}$ |

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.

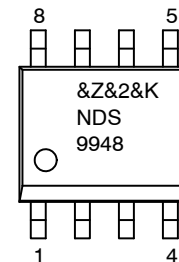
### THERMAL CHARACTERISTICS

| Symbol          | Parameter  | Ratings   | Unit                      |
|-----------------|--|-----------|---------------------------|
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1a.)<br>(Note 1c.) | 78<br>135 | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case (Note 1)                    | 40        | $^\circ\text{C}/\text{W}$ |



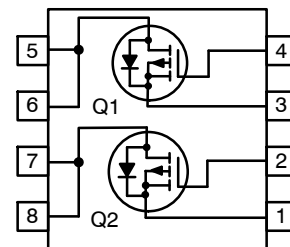
SOIC8  
CASE 751EB

### MARKING DIAGRAM



&Z = Assembly Plant Code  
&2 = 2-Digit Date Code (Year and Week)  
&K = 2-Digit Lot Run Code  
NDS9948 = Specific Device Code

### ELECTRICAL CONNECTION



### ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

# NDS9948

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

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

### DRAIN-SOURCE AVALANCHE RATINGS (Note 2)

|                  |                                |                                       |   |   |     |    |
|------------------|--------------------------------|---------------------------------------|---|---|-----|----|
| W <sub>DSS</sub> | Drain-Source Avalanche Energy  | Single Pulse, V <sub>DD</sub> = -54 V | - | - | 15  | mJ |
| I <sub>AR</sub>  | Drain-Source Avalanche Current |                                       | - | - | -10 | A  |

### OFF CHARACTERISTICS

|                                      |   |  |     |     |           |       |
|--------------------------------------|---|--|-----|-----|-----------|-------|
| BV <sub>DSS</sub>                    | Drain-Source Breakdown Voltage            | V <sub>GS</sub> = 0 V, I <sub>D</sub> = -250 μA  | -60 | -   | -         | V     |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = -250 μA, Referenced to 25°C   | -   | -52 | -         | mV/°C |
| I <sub>DSS</sub>                     | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = -40 V, V <sub>GS</sub> = 0 V<br>V <sub>DS</sub> = -40 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = -55°C | -   | -   | -2<br>-25 | μA    |
| I <sub>GSSF</sub>                    | Gate-Body Leakage Current, Forward        | V <sub>GS</sub> = 20 V, V <sub>DS</sub> = 0 V  | -   | -   | 100       | nA    |
| I <sub>GSSR</sub>                    | Gate-Body Leakage Current, Reverse        | V <sub>GS</sub> = -20 V, V <sub>DS</sub> = 0 V   | -   | -   | -100      | nA    |

### ON CHARACTERISTICS (Note 2)

|  |  |   |     |                   |                   |       |
|--|--|---|-----|-------------------|-------------------|-------|
| V <sub>GS(th)</sub>                    | Gate Threshold Voltage                         | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -250 μA  | -1  | -1.5              | -3                | V     |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | I <sub>D</sub> = -250 μA, Referenced to 25°C  | -   | 4                 | -                 | mV/°C |
| R <sub>DS(on)</sub>                    | Static Drain-Source On-Resistance              | V <sub>GS</sub> = -10 V, I <sub>D</sub> = -2.3 A<br>V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -1.6 A<br>V <sub>GS</sub> = -10 V, I <sub>D</sub> = -2.3 A, T <sub>J</sub> = 125°C | -   | 138<br>175<br>225 | 250<br>500<br>433 | mΩ    |
| I <sub>D(on)</sub>                     | On-State Drain Current                         | V <sub>GS</sub> = -10 V, V <sub>DS</sub> = -5 V   | -10 | -                 | -                 | A     |
| g <sub>FS</sub>                        | Forward Transconductance                       | V <sub>DS</sub> = -10 V, I <sub>D</sub> = -2.3 A  | -   | 5                 | -                 | S     |

### DYNAMIC CHARACTERISTICS

|                  |                              |   |   |     |   |    |
|------------------|------------------------------|---|---|-----|---|----|
| C <sub>iss</sub> | Input Capacitance            | V <sub>DS</sub> = -30 V, V <sub>GS</sub> = 0 V<br>f = 1.0 MHz | - | 394 | - | pF |
| C <sub>oss</sub> | Output Capacitance           |   | - | 53  | - | pF |
| C <sub>rss</sub> | Reverse Transfer Capacitance |   | - | 23  | - | pF |

### SWITCHING CHARACTERISTICS (Note 2)

|                     |                     |   |   |     |    |    |
|---------------------|---------------------|---|---|-----|----|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time  | V <sub>DD</sub> = -30 V, I <sub>D</sub> = -1 A<br>V <sub>GS</sub> = -10 V, R <sub>GEN</sub> = 6 Ω | - | 6   | 12 | ns |
| t <sub>r</sub>      | Turn-On Rise Time   |   | - | 9   | 18 | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |   | - | 16  | 29 | ns |
| t <sub>f</sub>      | Turn-Off Fall Time  |   | - | 3   | 6  | ns |
| Q <sub>g</sub>      | Total Gate Charge   | V <sub>DS</sub> = -30 V, I <sub>D</sub> = -2.3 A<br>V <sub>GS</sub> = -10 V                       | - | 9   | 13 | nC |
| Q <sub>gs</sub>     | Gate-Source Charge  |   | - | 1.4 | -  | nC |
| Q <sub>gd</sub>     | Gate-Drain Charge   |   | - | 1.7 | -  | nC |

### DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

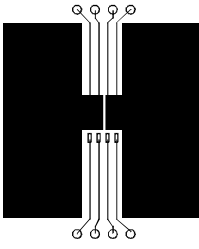
|                 |   |   |   |      |      |    |
|-----------------|---|---|---|------|------|----|
| I <sub>S</sub>  | Maximum Continuous Drain-Source Diode Forward Current |   | - | -    | -1.7 | A  |
| V <sub>SD</sub> | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = -1.7 A (Note 2)                           | - | -0.8 | -1.2 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>F</sub> = -2.3 A,<br>dI <sub>F</sub> /dt = 100 A/μs | - | 25   | -    | ns |

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.

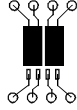
#### NOTES:

1. R<sub>θJA</sub> is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. R<sub>θJC</sub> is guaranteed by design while R<sub>θCA</sub> is determined by the user's board design.

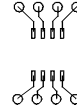
# NDS9948



a. 78°C/W when mounted on a 0.5 in<sup>2</sup> pad of 2 oz. Copper.



b. 125°C/W when mounted on a 0.02 in<sup>2</sup> pad of 2 oz. copper.



c. 135°C/W when mounted on a minimum pad.

Scale 1 : 1 on letter size paper

2. Pulse Test Pulse Width < 300 μs, Duty Cycle < 2.0%

TYPICAL CHARACTERISTICS

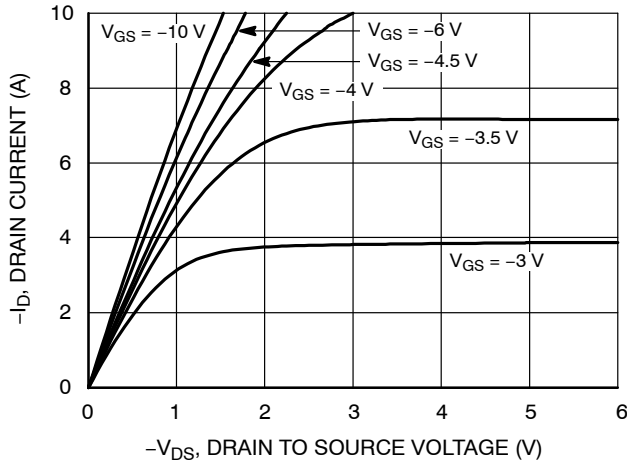


Figure 1. On-Region Characteristics

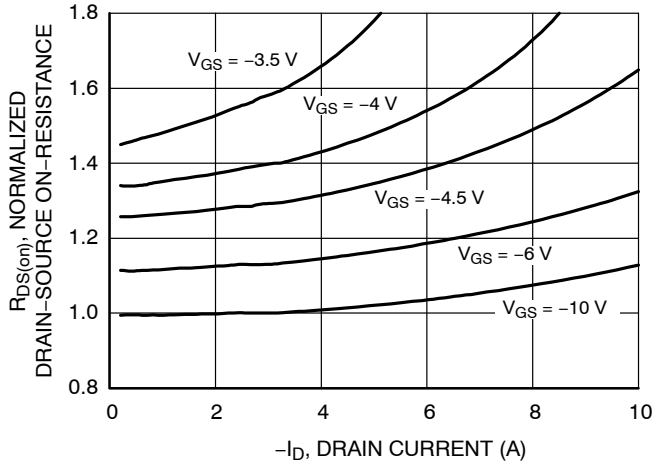


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

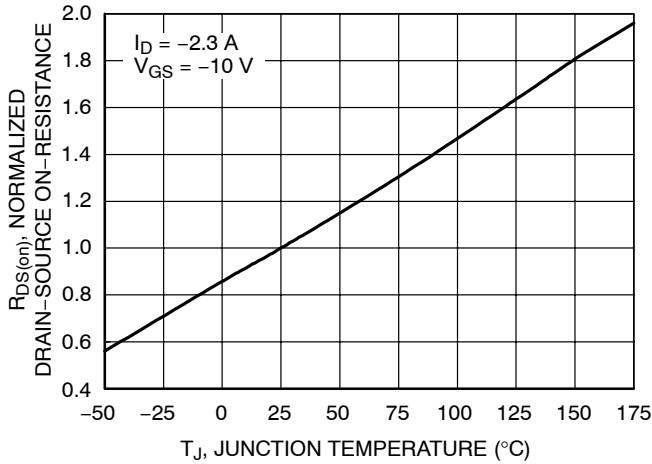


Figure 3. On-Resistance Variation with Temperature

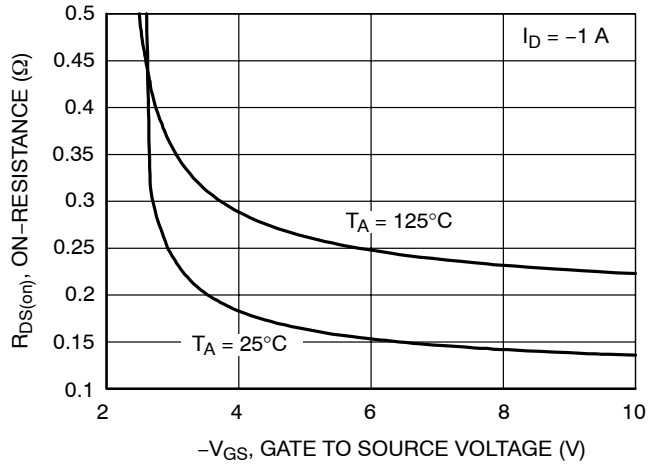


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

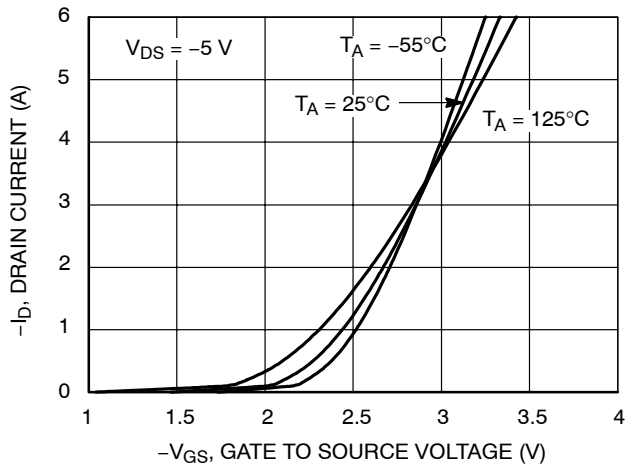


Figure 5. Transfer Characteristics

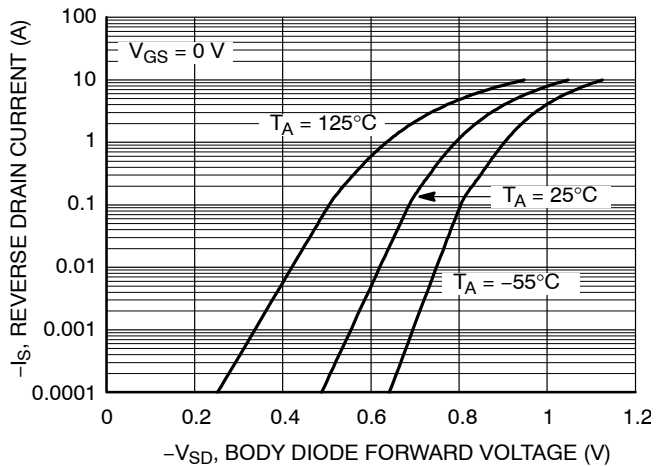


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

TYPICAL CHARACTERISTICS (continued)

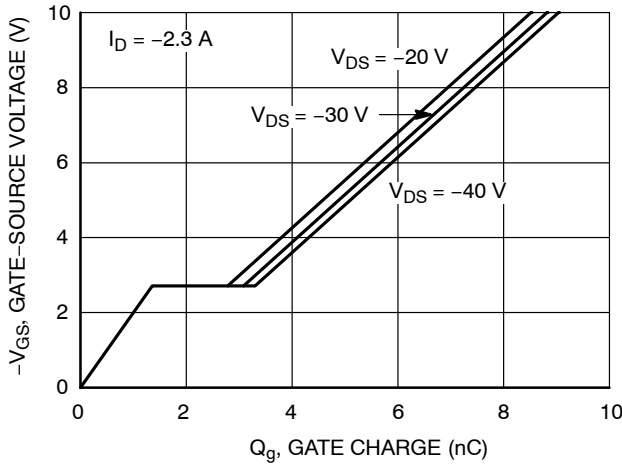


Figure 7. Gate-Charge Characteristics

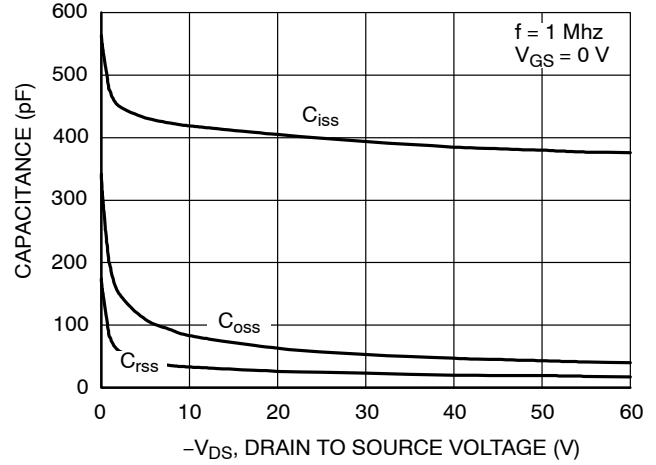


Figure 8. Capacitance Characteristics

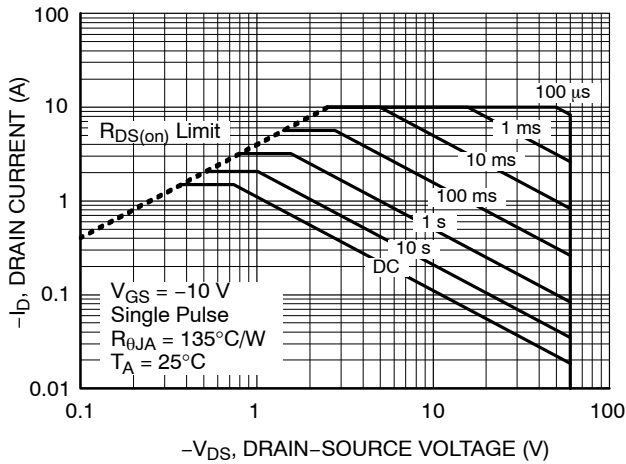


Figure 9. Maximum Safe Operating Area

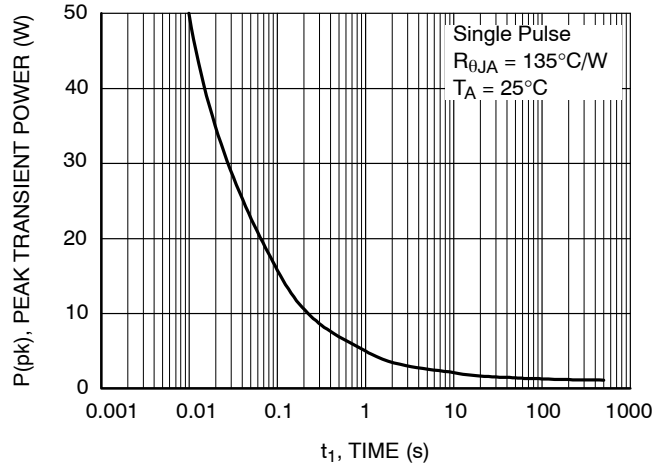


Figure 10. Single Pulse Maximum Power Dissipation

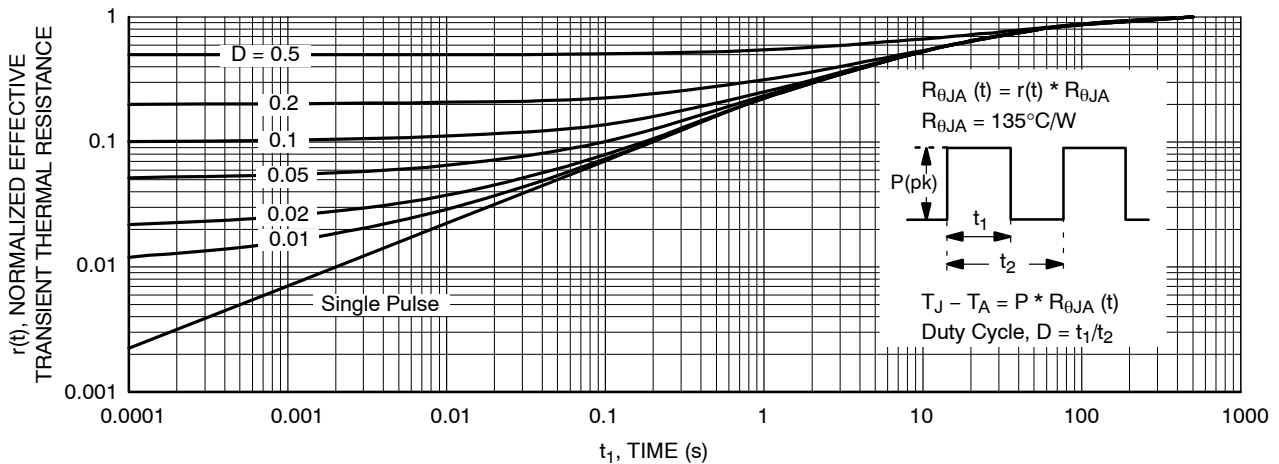


Figure 11. Transient Thermal Response Curve

Thermal characterization performed using the conditions described in Note 1c.  
Transient thermal response will change depending on the circuit board design.

# NDS9948

## ORDERING INFORMATION

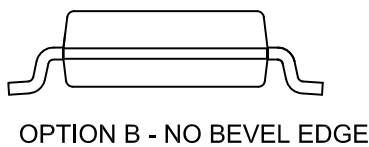
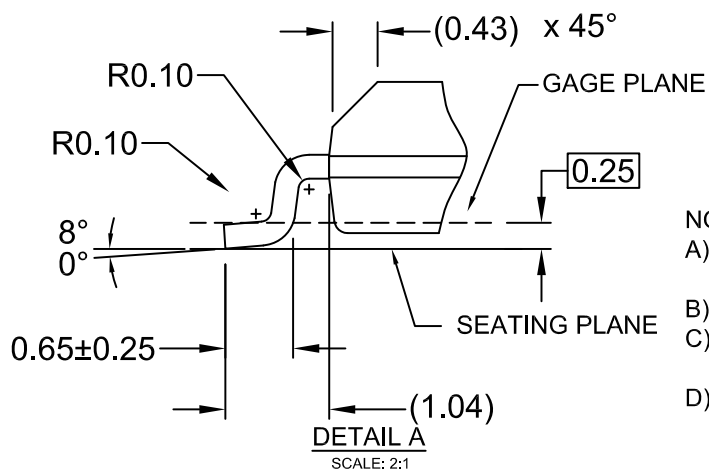
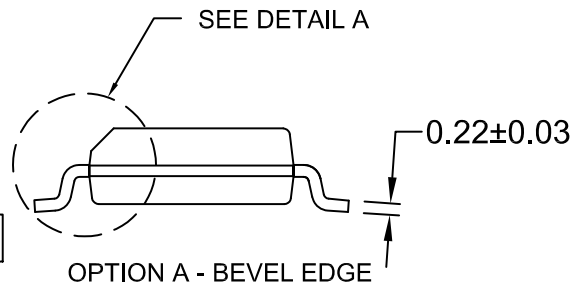
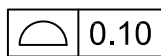
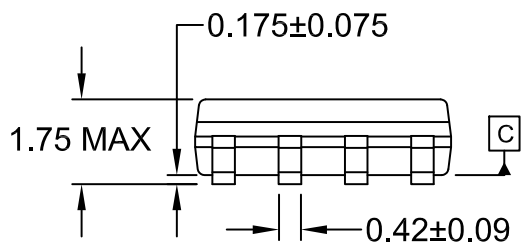
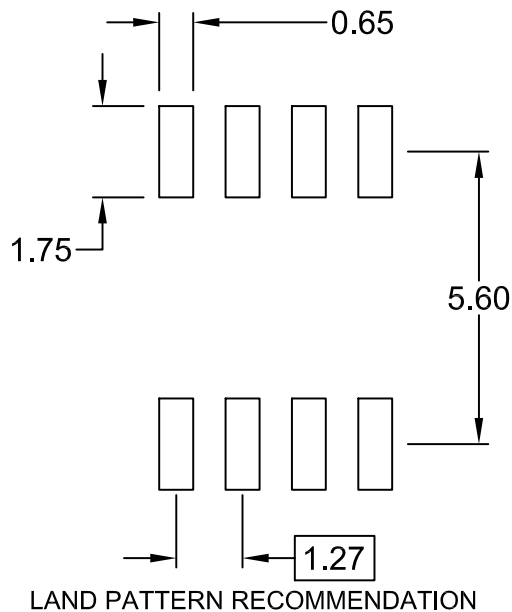
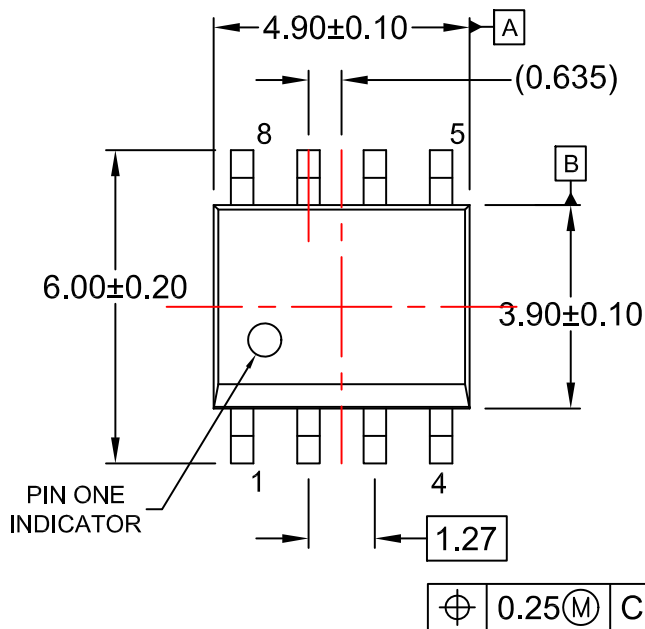
| Device Marking | Device  | Package Type                    | Reel Size | Tape Width | Shipping <sup>†</sup> |
|----------------|---------|---------------------------------|-----------|------------|-----------------------|
| NDS9948        | NDS9948 | SOIC8<br>(Pb-Free, Halide Free) | 13"       | 12 mm      | 2500 / 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](#).

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**SOIC8**  
CASE 751EB  
ISSUE A

DATE 24 AUG 2017



- NOTES:  
 A) THIS PACKAGE CONFORMS TO JEDEC MS-012, VARIATION AA.  
 B) ALL DIMENSIONS ARE IN MILLIMETERS.  
 C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.  
 D) LANDPATTERN STANDARD: SOIC127P600X175-8M

|                         |                    |   |
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