



**THE DATASHEET OF  
CSD16411Q3**



# CSD16411Q3 25-V N-Channel NexFET™ Power MOSFET

## 1 Features

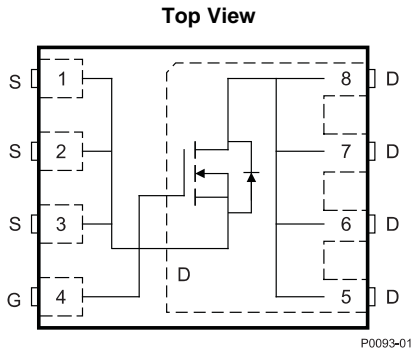
- Ultra-Low  $Q_g$  and  $Q_{gd}$
- Low-Thermal Resistance
- Avalanche Rated
- Lead-Free Terminal Plating
- RoHS Compliant
- Halogen Free
- SON 3.3-mm x 3.3-mm Plastic Package

## 2 Applications

- Point-of-Load Synchronous Buck Converter for Applications in Networking, Telecom and Computing Systems
- Optimized for Control FET Applications

## 3 Description

This 25-V, 8-m $\Omega$ , 3.3-mm x 3.3-mm SON NexFET™ power MOSFET has been designed to minimize losses in power conversion applications.



### Product Summary

| $T_A = 25^\circ\text{C}$ |                               | TYPICAL VALUE           |    | UNIT       |
|--------------------------|-------------------------------|-------------------------|----|------------|
| $V_{DS}$                 | Drain-to-Source Voltage       | 25                      |    | V          |
| $Q_g$                    | Gate Charge Total (4.5 V)     | 2.9                     |    | nC         |
| $Q_{gd}$                 | Gate Charge Gate-to-Drain     | 0.7                     |    | nC         |
| $R_{DS(on)}$             | Drain-to-Source On Resistance | $V_{GS} = 4.5\text{ V}$ | 12 | m $\Omega$ |
|                          |                               | $V_{GS} = 10\text{ V}$  | 8  |            |
| $V_{GS(th)}$             | Threshold Voltage             | 2                       |    | V          |

### Device Information<sup>(1)</sup>

| DEVICE      | QTY  | MEDIA        | PACKAGE                           | SHIP          |
|-------------|------|--------------|-----------------------------------|---------------|
| CSD16411Q3  | 2500 | 13-Inch Reel | SON                               | Tape and Reel |
| CSD16411Q3T | 250  |              | 3.30-mm x 3.30-mm Plastic Package |               |

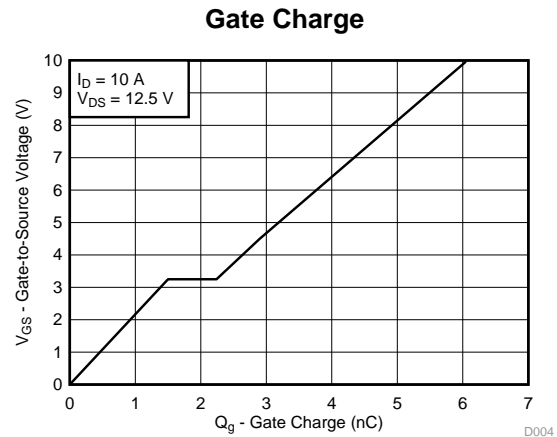
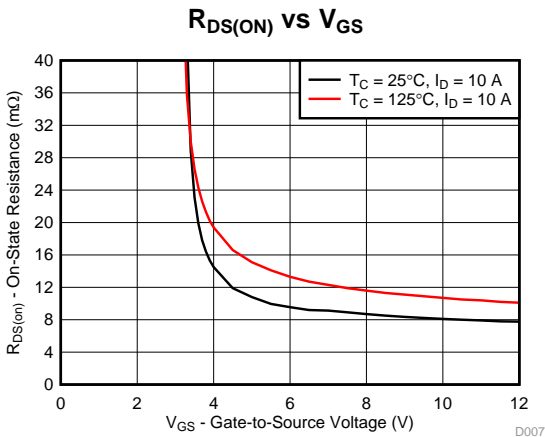
(1) For all available packages, see the orderable addendum at the end of the data sheet.

### Absolute Maximum Ratings

| $T_A = 25^\circ\text{C}$ |  | VALUE      | UNIT             |
|--------------------------|--|------------|------------------|
| $V_{DS}$                 | Drain-to-Source Voltage  | 25         | V                |
| $V_{GS}$                 | Gate-to-Source Voltage   | +16 / -12  | V                |
| $I_D$                    | Continuous Drain Current (Package Limited)   | 60         | A                |
|                          | Continuous Drain Current (Silicon Limited), $T_C = 25^\circ\text{C}$                       | 50         |                  |
|                          | Continuous Drain Current <sup>(1)</sup>  | 14         |                  |
| $I_{DM}$                 | Pulsed Drain Current, $T_A = 25^\circ\text{C}$ <sup>(2)</sup>                              | 130        | A                |
| $P_D$                    | Power Dissipation <sup>(1)</sup>   | 2.87       | W                |
|                          | Power Dissipation, $T_C = 25^\circ\text{C}$  | 35         |                  |
| $T_J, T_{STG}$           | Operating Junction Storage Temperature   | -55 to 150 | $^\circ\text{C}$ |
| $E_{AS}$                 | Avalanche Energy, Single Pulse<br>$I_D = 18\text{ A}, L = 0.1\text{ mH}, R_G = 25\ \Omega$ | 16         | mJ               |

(1)  $R_{\theta JA} = 45^\circ\text{C/W}$  on 1-in<sup>2</sup> Cu (2-oz) on 0.06-in thick FR4 PCB.

(2) Max  $R_{\theta JC} = 3.5^\circ\text{C/W}$ , pulse duration  $\leq 100\ \mu\text{s}$ , duty cycle  $\leq 1\%$ .



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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| <b>Changes from Revision A (September 2010) to Revision B</b>   | <b>Page</b> |
|---|-------------|
| • Changed <i>Description</i> text .....   | <b>1</b>    |
| • Added silicon limited continuous drain current to <i>Absolute Maximum Ratings</i> table .....                   | <b>1</b>    |
| • Added max power dissipation at $T_C = 25^\circ\text{C}$ to <i>Absolute Maximum Ratings</i> table .....          | <b>1</b>    |
| • Changed Note 2 in <i>Absolute Maximum Ratings</i> table.....  | <b>1</b>    |
| • Changed $R_{\theta JA}$ max from $59^\circ\text{C/W}$ : to $55^\circ\text{C/W}$ .....                           | <b>3</b>    |
| • Changed the SOA in <a href="#">Figure 10</a> to reflect measured data .....                                     | <b>6</b>    |
| • Added <i>Device and Documentation Support</i> section.....  | <b>7</b>    |
| • Changed <i>MECHANICAL DATA</i> section to <i>Mechanical, Packaging, and Orderable Information</i> section ..... | <b>8</b>    |

| <b>Changes from Original (August 2009) to Revision A</b>   | <b>Page</b> |
|--|-------------|
| • Changed <a href="#">Figure 1</a> text From: $R_{\theta JA} = 92^\circ\text{C/W}$ To: Typical $R_{\theta JA} = 93^\circ\text{C/W}$ .....  | <b>4</b>    |
| • Changed <a href="#">Figure 10</a> text From: $R_{\theta JA} = 92^\circ\text{C/W}$ To: Typical $R_{\theta JA} = 93^\circ\text{C/W}$ ..... | <b>5</b>    |
| • Changed <a href="#">Figure 11</a> X-axis values .....  | <b>5</b>    |

## 5 Specifications

### 5.1 Electrical Characteristics

 $T_A = 25^\circ\text{C}$  (unless otherwise stated)

| PARAMETER                      |                                  | TEST CONDITIONS   | MIN   | TYP  | MAX | UNIT          |
|--------------------------------|----------------------------------|---|---|------|-----|---------------|
| <b>STATIC CHARACTERISTICS</b>  |                                  |   |   |      |     |               |
| $BV_{DSS}$                     | Drain-to-source voltage          | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$   | 25  |      |     | V             |
| $I_{DSS}$                      | Drain-to-source leakage current  | $V_{GS} = 0\text{ V}, V_{DS} = 20\text{ V}$   |   |      | 1   | $\mu\text{A}$ |
| $I_{GSS}$                      | Gate-to-source leakage current   | $V_{DS} = 0\text{ V}, V_{GS} = +16 / -12\text{ V}$                                      |   |      | 100 | nA            |
| $V_{GS(th)}$                   | Gate-to-source threshold voltage | $V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$   | 1.7   | 2    | 2.3 | V             |
| $R_{DS(on)}$                   | Drain-to-source on resistance    | $V_{GS} = 4.5\text{ V}, I_D = 10\text{ A}$  |   | 12   | 15  | m $\Omega$    |
|                                |                                  | $V_{GS} = 10\text{ V}, I_D = 10\text{ A}$   |   | 8    | 10  |               |
| $g_{fs}$                       | Transconductance                 | $V_{DS} = 15\text{ V}, I_D = 10\text{ A}$   |   | 30   |     | S             |
| <b>DYNAMIC CHARACTERISTICS</b> |                                  |   |   |      |     |               |
| $C_{ISS}$                      | Input capacitance                | $V_{GS} = 0\text{ V}, V_{DS} = 12.5\text{ V}, f = 1\text{ MHz}$                         |   | 440  | 570 | pF            |
| $C_{OSS}$                      | Output capacitance               |   |   | 330  | 430 | pF            |
| $C_{RSS}$                      | Reverse transfer capacitance     |   |   | 33   | 43  | pF            |
| $R_g$                          | Series gate resistance           | $V_{DS} = 12.5\text{ V}, I_D = 10\text{ A}$   |   | 0.8  | 1.6 | $\Omega$      |
| $Q_g$                          | Gate charge total (4.5 V)        |   |   | 2.9  | 3.8 | nC            |
| $Q_{gd}$                       | Gate charge gate-to-drain        |   |   | 0.7  |     | nC            |
| $Q_{gs}$                       | Gate charge gate-to-source       |   |   | 1.5  |     | nC            |
| $Q_{g(th)}$                    | Gate charge at $V_{th}$          |   |   | 0.9  |     | nC            |
| $Q_{OSS}$                      | Output charge                    |   | $V_{DS} = 12.5\text{ V}, V_{GS} = 0\text{ V}$ |      | 6.5 |               |
| $t_{d(on)}$                    | Turnon delay time                | $V_{DS} = 12.5\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 10\text{ A}$<br>$R_G = 2\ \Omega$ |   | 5.3  |     | ns            |
| $t_r$                          | Rise time                        |   |   | 7.8  |     | ns            |
| $t_{d(off)}$                   | Turnoff delay time               |   |   | 6    |     | ns            |
| $t_f$                          | Fall time                        |   |   | 3.1  |     | ns            |
| <b>DIODE CHARACTERISTICS</b>   |                                  |   |   |      |     |               |
| $V_{SD}$                       | Diode forward voltage            | $I_S = 10\text{ A}, V_{GS} = 0\text{ V}$  | 0.85  |      | 1   | V             |
| $Q_{rr}$                       | Reverse recovery charge          | $V_{DD} = 12.5\text{ V}, I_F = 10\text{ A}, di/dt = 300\text{ A}/\mu\text{s}$           |   | 11.7 |     | nC            |
| $t_{rr}$                       | Reverse recovery time            | $V_{DD} = 12.5\text{ V}, I_F = 10\text{ A}, di/dt = 300\text{ A}/\mu\text{s}$           |   | 15.5 |     | ns            |

### 5.2 Thermal Information

 $T_A = 25^\circ\text{C}$  (unless otherwise stated)

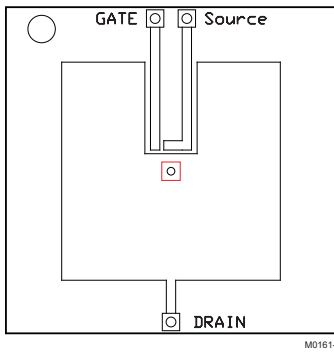
| PARAMETER       |   | MIN | TYP | MAX | UNIT                      |
|-----------------|---|-----|-----|-----|---------------------------|
| $R_{\theta JC}$ | Junction-to-case thermal resistance <sup>(1)</sup>        |     |     | 3.5 | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance <sup>(1) (2)</sup> |     |     | 55  | $^\circ\text{C}/\text{W}$ |

- (1)  $R_{\theta JC}$  is determined with the device mounted on a 1-in<sup>2</sup> 2-oz Cu pad on a 1.5-in × 1.5-in 0.06-in thick FR4 board.  $R_{\theta JC}$  is specified by design while  $R_{\theta JA}$  is determined by the user's board design.
- (2) Device mounted on FR4 Material with 1-in<sup>2</sup> of 2-oz Cu.

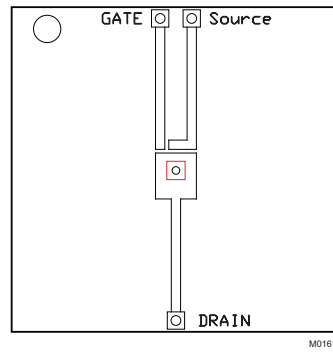
CSD16411Q3

SLPS206B – AUGUST 2009 – REVISED NOVEMBER 2016

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Max  $R_{\theta JA} = 55^{\circ}\text{C/W}$   
when mounted on 1-in<sup>2</sup>  
of 2-oz Cu.



Max  $R_{\theta JA} = 160^{\circ}\text{C/W}$   
when mounted on  
minimum pad area of  
2-oz Cu.

5.3 Typical MOSFET Characteristics

$T_A = 25^{\circ}\text{C}$  (unless otherwise stated)

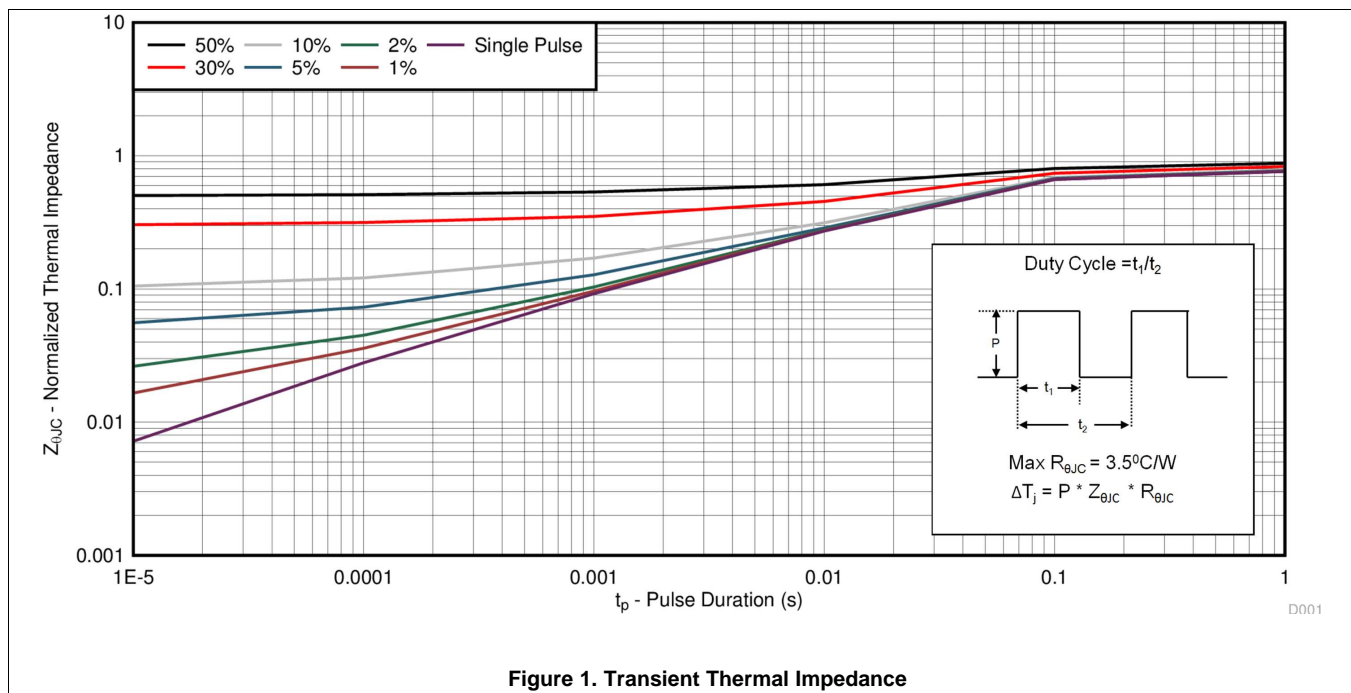


Figure 1. Transient Thermal Impedance

Typical MOSFET Characteristics (continued)

T<sub>A</sub> = 25°C (unless otherwise stated)

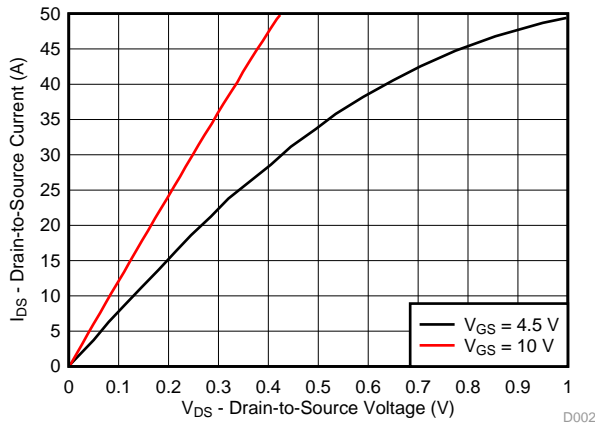


Figure 2. Saturation Characteristics

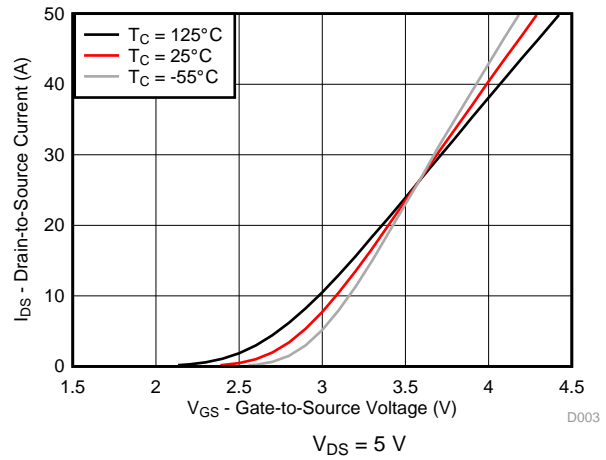


Figure 3. Transfer Characteristics

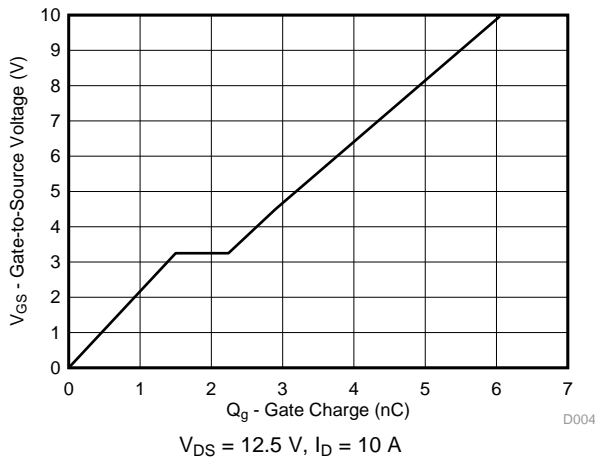


Figure 4. Gate Charge

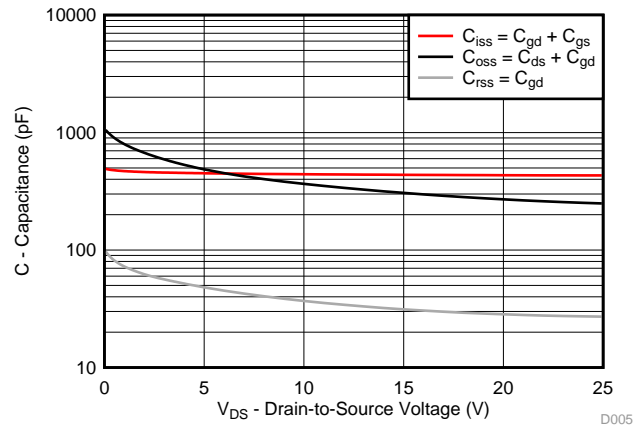


Figure 5. Capacitance

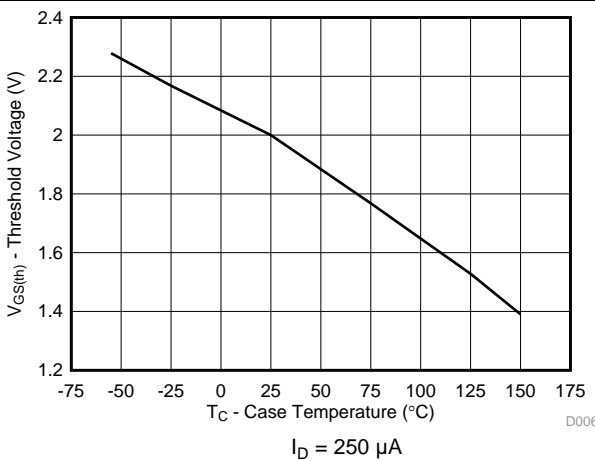


Figure 6. Threshold Voltage vs Temperature

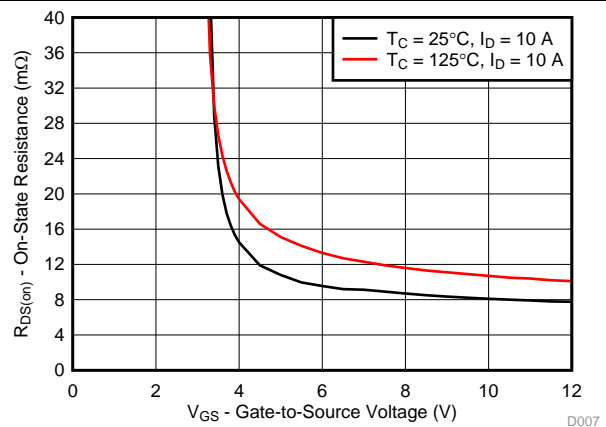


Figure 7. On Resistance vs Gate Voltage

Typical MOSFET Characteristics (continued)

T<sub>A</sub> = 25°C (unless otherwise stated)

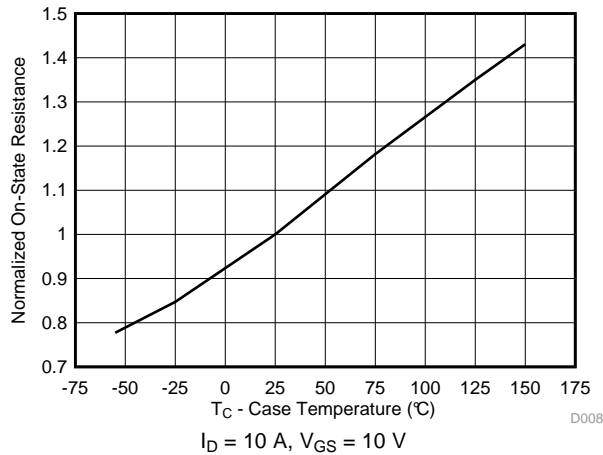


Figure 8. On Resistance vs Temperature

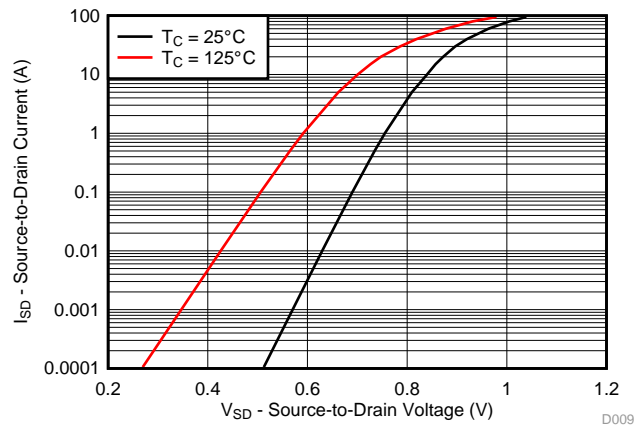


Figure 9. Typical Diode Forward Voltage

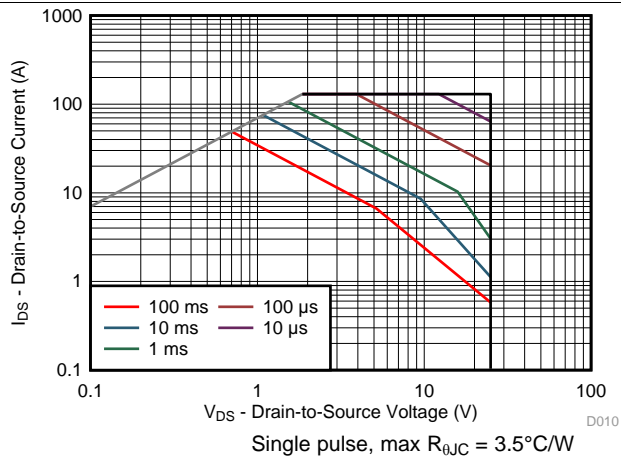


Figure 10. Maximum Safe Operating Area

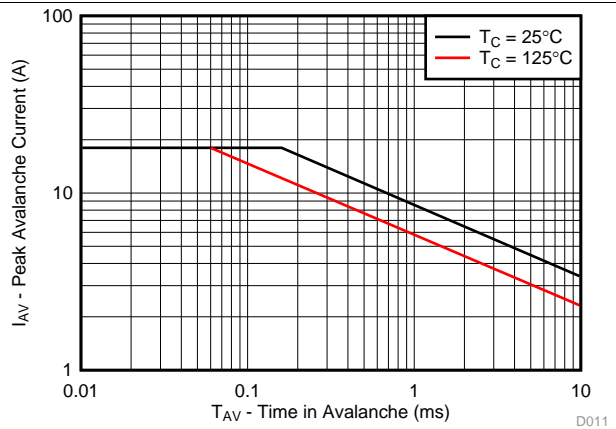


Figure 11. Single Pulse Unclamped Inductive Switching

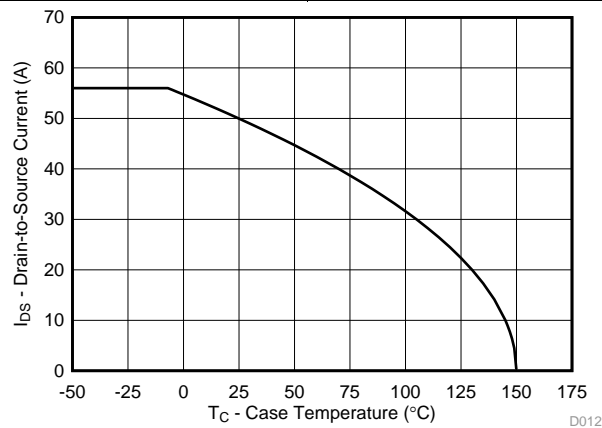


Figure 12. Maximum Drain Current vs Temperature

## 6 Device and Documentation Support

### 6.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

### 6.2 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 6.3 Trademarks

NexFET, E2E are trademarks of Texas Instruments.  
All other trademarks are the property of their respective owners.

### 6.4 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 6.5 Glossary

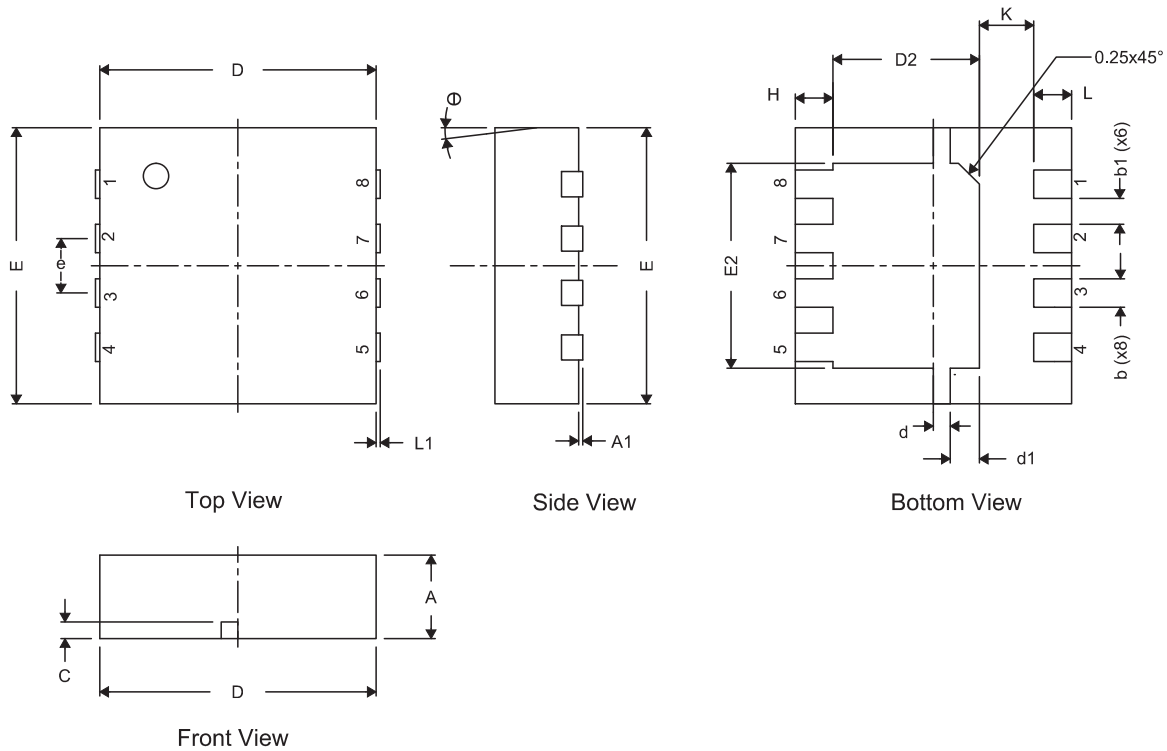
[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 7 Mechanical, Packaging, and Orderable Information

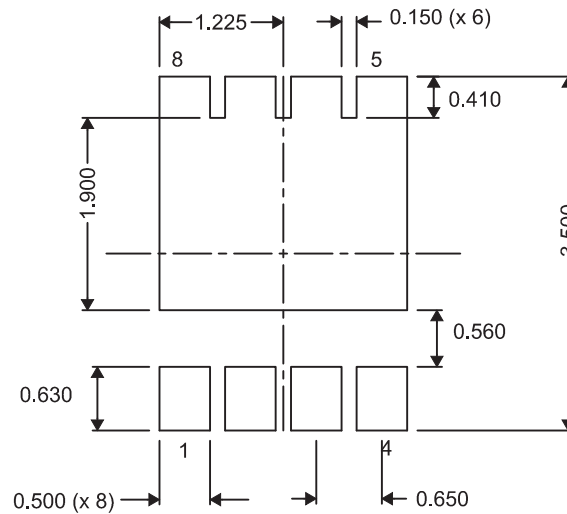
The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

### 7.1 Q3 Package Dimensions



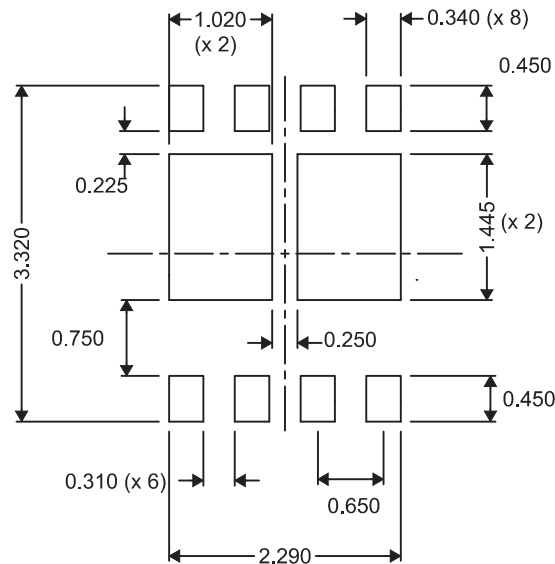
| DIM      | MILLIMETERS |       |       | INCHES    |       |       |
|----------|-------------|-------|-------|-----------|-------|-------|
|          | MIN         | NOM   | MAX   | MIN       | NOM   | MAX   |
| A        | 0.950       | 1.000 | 1.100 | 0.037     | 0.039 | 0.043 |
| A1       | 0.000       | 0.000 | 0.050 | 0.000     | 0.000 | 0.002 |
| b        | 0.280       | 0.340 | 0.400 | 0.011     | 0.013 | 0.016 |
| b1       | 0.310 NOM   |       |       | 0.012 NOM |       |       |
| c        | 0.150       | 0.200 | 0.250 | 0.006     | 0.008 | 0.010 |
| D        | 3.200       | 3.300 | 3.400 | 0.126     | 0.130 | 0.134 |
| D2       | 1.650       | 1.750 | 1.800 | 0.065     | 0.069 | 0.071 |
| d        | 0.150       | 0.200 | 0.250 | 0.006     | 0.008 | 0.010 |
| d1       | 0.300       | 0.350 | 0.400 | 0.012     | 0.014 | 0.016 |
| E        | 3.200       | 3.300 | 3.400 | 0.126     | 0.130 | 0.134 |
| E2       | 2.350       | 2.450 | 2.550 | 0.093     | 0.096 | 0.100 |
| e        | 0.650 TYP   |       |       | 0.026 TYP |       |       |
| H        | 0.35        | 0.450 | 0.550 | 0.014     | 0.018 | 0.022 |
| K        | 0.650 TYP   |       |       | 0.026 TYP |       |       |
| L        | 0.35        | 0.450 | 0.550 | 0.014     | 0.018 | 0.022 |
| L1       | 0           | —     | 0     | 0         | —     | 0     |
| $\theta$ | 0           | —     | 0     | 0         | —     | 0     |

### 7.2 Recommended PCB Pattern



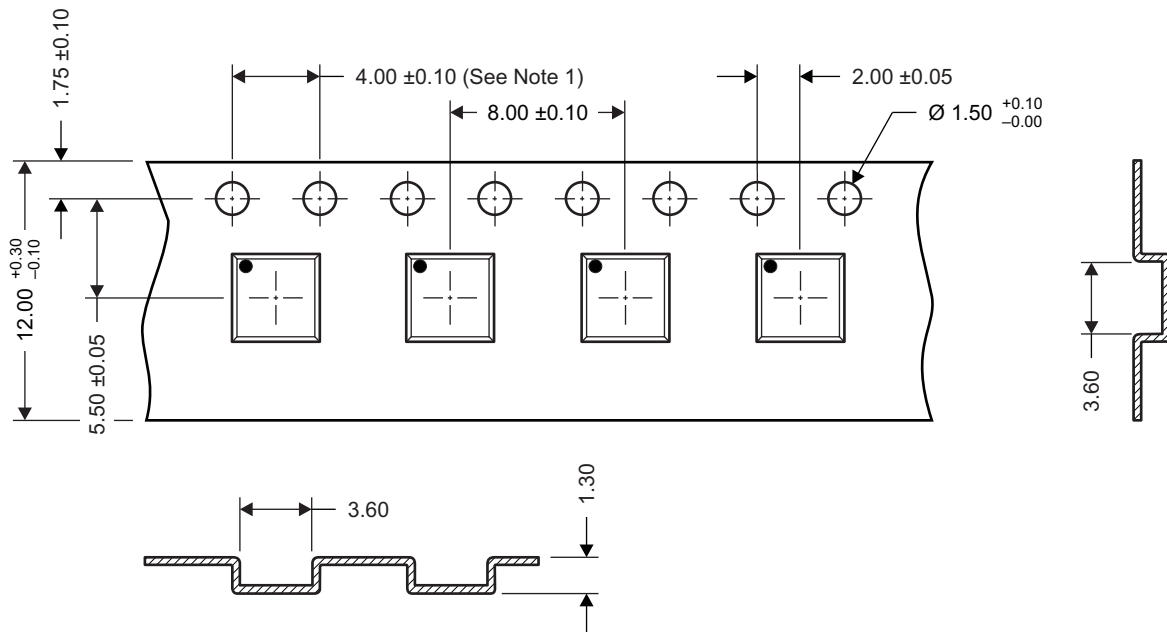
For recommended circuit layout for PCB designs, see [Reducing Ringing Through PCB Layout Techniques \(SLPA005\)](#).

### 7.3 Recommended Stencil Opening



All dimensions are in mm, unless otherwise specified.

## 7.4 Q3 Tape and Reel Information



M0144-01

### Notes:

- 10-sprocket hole pitch cumulative tolerance  $\pm 0.2$ .
- Camber not to exceed 1 mm in 100 mm, noncumulative over 250 mm.
- Material: black static dissipative polystyrene.
- All dimensions are in mm (unless otherwise specified).
- Thickness:  $0.30 \pm 0.05$  mm.
- MSL1 260°C (IR and Convection) PbF-Reflow Compatible.

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)     | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples        |
|------------------|---------------|--------------|-----------------|------|-------------|---------------------|--------------------------------------|----------------------|--------------|-------------------------|----------------|
| CSD16411Q3       | ACTIVE        | VSON-CLIP    | DQG             | 8    | 2500        | RoHS-Exempt & Green | SN                                   | Level-1-260C-UNLIM   | -55 to 150   | CSD16411                | <b>Samples</b> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=100ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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