

## N-Channel NexFET™ Power MOSFETs

### FEATURES

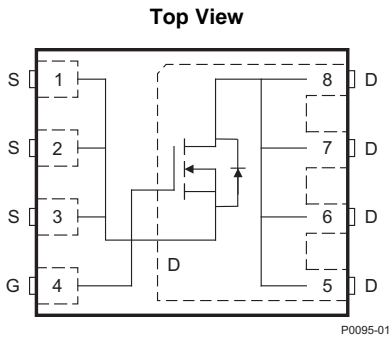
- Ultra Low Qg and Qgd
- Low Thermal Resistance
- Avalanche Rated
- Pb Free Terminal Plating
- RoHS Compliant
- Halogen Free
- SON 3.3mm x 3.3mm Plastic Package

### APPLICATIONS

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

### DESCRIPTION

The NexFET™ power MOSFET has been designed to minimize losses in power conversion applications.



### PRODUCT SUMMARY

|              |                               |                 |       |
|--------------|-------------------------------|-----------------|-------|
| $V_{DS}$     | Drain to Source Voltage       | 25              | V     |
| $Q_g$        | Gate Charge Total (4.5V)      | 2.9             | nC    |
| $Q_{gd}$     | Gate Charge Gate to Drain     | 0.7             | nC    |
| $R_{DS(on)}$ | Drain to Source On Resistance | $V_{GS} = 4.5V$ | 12 mΩ |
|              |                               | $V_{GS} = 10V$  | 8 mΩ  |
| $V_{GS(th)}$ | Threshold Voltage             | 2               | V     |

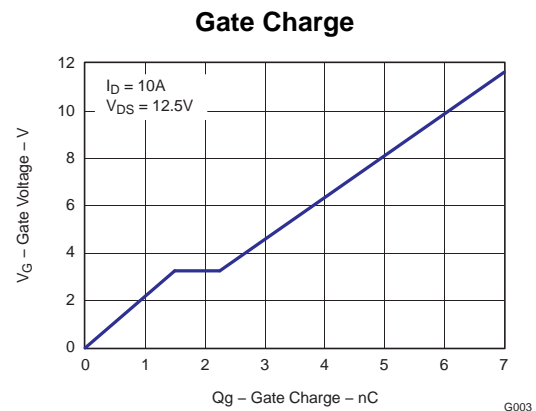
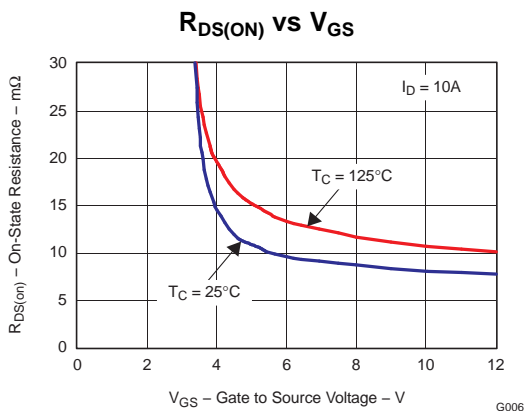
### ORDERING INFORMATION

| Device     | Package                     | Media        | Qty  | Ship          |
|------------|-----------------------------|--------------|------|---------------|
| CSD16411Q3 | SON 3.3x3.3 Plastic Package | 13-inch reel | 2500 | Tape and Reel |

### ABSOLUTE MAXIMUM RATINGS

| $T_A = 25^\circ\text{C}$ unless otherwise stated |  | VALUE      | UNIT |
|--|--|------------|------|
| $V_{DS}$   | Drain to Source Voltage  | 25         | V    |
| $V_{GS}$   | Gate to Source Voltage   | +16 / -12  | V    |
| $I_D$  | Continuous Drain Current, $T_C = 25^\circ\text{C}$                             | 56         | A    |
|  | Continuous Drain Current <sup>(1)</sup>  | 14         | A    |
| $I_{DM}$   | Pulsed Drain Current, $T_A = 25^\circ\text{C}$ <sup>(2)</sup>                  | 138        | A    |
| $P_D$  | Power Dissipation <sup>(1)</sup>   | 2.7        | W    |
| $T_J$ ,<br>$T_{STG}$                             | Operating Junction and Storage Temperature Range                               | -55 to 150 | °C   |
| $E_{AS}$   | Avalanche Energy, single pulse<br>$I_D = 18A$ , $L = 0.1mH$ , $R_G = 25\Omega$ | 16         | mJ   |

- (1)  $R_{\theta JA} = 47^\circ\text{C/W}$  on  $1\text{in}^2$  Cu (2 oz.) on 0.060" thick FR4 PCB.  
 (2) Pulse width  $\leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$



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## ELECTRICAL CHARACTERISTICS

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

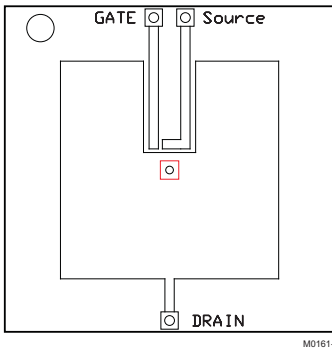
| PARAMETER                      |                                  | TEST CONDITIONS  | MIN | TYP  | MAX | UNIT |
|--------------------------------|----------------------------------|--|-----|------|-----|------|
| <b>Static Characteristics</b>  |                                  |  |     |      |     |      |
| BV <sub>DSS</sub>              | Drain to Source Voltage          | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA   | 25  |      |     | V    |
| I <sub>DSS</sub>               | Drain to Source Leakage Current  | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 20V  |     |      | 1   | μA   |
| I <sub>GSS</sub>               | Gate to Source Leakage Current   | V <sub>DS</sub> = 0V, V <sub>GS</sub> = +16 / -12  |     |      | 100 | nA   |
| V <sub>GS(th)</sub>            | Gate to Source Threshold Voltage | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA                                   | 1.7 | 2    | 2.3 | V    |
| R <sub>DS(on)</sub>            | Drain to Source On Resistance    | V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 10A   |     | 12   | 15  | mΩ   |
|                                |                                  | V <sub>GS</sub> = 10V, I <sub>D</sub> = 10A  |     | 8    | 10  | mΩ   |
| g <sub>fs</sub>                | Transconductance                 | V <sub>DS</sub> = 15V, I <sub>D</sub> = 10A  |     | 30   |     | S    |
| <b>Dynamic Characteristics</b> |                                  |  |     |      |     |      |
| C <sub>ISS</sub>               | Input Capacitance                | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 12.5V, f = 1MHz                                      |     | 440  | 570 | pF   |
| C <sub>OSS</sub>               | Output Capacitance               |  |     | 330  | 430 | pF   |
| C <sub>RSS</sub>               | Reverse Transfer Capacitance     |  |     | 33   | 43  | pF   |
| R <sub>g</sub>                 | Series Gate Resistance           |  |     | 0.8  | 1.6 | Ω    |
| Q <sub>g</sub>                 | Gate Charge Total (4.5V)         | V <sub>DS</sub> = 12.5V, I <sub>D</sub> = 10A  |     | 2.9  | 3.8 | nC   |
| Q <sub>gd</sub>                | Gate Charge Gate to Drain        |  |     | 0.7  |     | nC   |
| Q <sub>gs</sub>                | Gate Charge Gate to Source       |  |     | 1.5  |     | nC   |
| Q <sub>g(th)</sub>             | Gate Charge at V <sub>th</sub>   |  |     | 0.9  |     | nC   |
| Q <sub>OSS</sub>               | Output Charge                    | V <sub>DS</sub> = 12.5V, V <sub>GS</sub> = 0V  |     | 6.5  |     | nC   |
| t <sub>d(on)</sub>             | Turn On Delay Time               | V <sub>DS</sub> = 12.5V, V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 10A<br>R <sub>G</sub> = 2Ω |     | 5.3  |     | ns   |
| t <sub>r</sub>                 | Rise Time                        |  |     | 7.8  |     | ns   |
| t <sub>d(off)</sub>            | Turn Off Delay Time              |  |     | 6    |     | ns   |
| t <sub>f</sub>                 | Fall Time                        |  |     | 3.1  |     | ns   |
| <b>Diode Characteristics</b>   |                                  |  |     |      |     |      |
| V <sub>SD</sub>                | Diode Forward Voltage            | I <sub>S</sub> = 10A, V <sub>GS</sub> = 0V   |     | 0.85 | 1   | V    |
| Q <sub>rr</sub>                | Reverse Recovery Charge          | V <sub>DD</sub> = 12.5V, I <sub>F</sub> = 10A, di/dt = 300A/μs                               |     | 11.7 |     | nC   |
| t <sub>rr</sub>                | Reverse Recovery Time            | V <sub>DD</sub> = 12.5V, I <sub>F</sub> = 10A, di/dt = 300A/μs                               |     | 15.5 |     | ns   |

## THERMAL CHARACTERISTICS

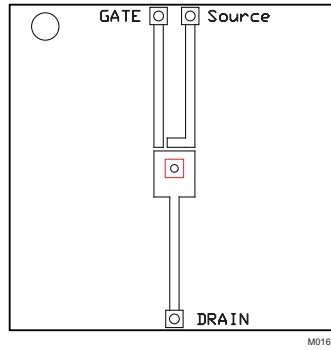
(T<sub>A</sub> = 25°C unless otherwise stated)

| PARAMETER        |  | MIN | TYP | MAX | UNIT |
|------------------|--|-----|-----|-----|------|
| R <sub>θJC</sub> | Thermal Resistance Junction to Case <sup>(1)</sup>       |     |     | 3.5 | °C/W |
| R <sub>θJA</sub> | Thermal Resistance Junction to Ambient <sup>(1)(2)</sup> |     |     | 59  | °C/W |

- (1) R<sub>θJC</sub> is determined with the device mounted on a 1 inch square 2 oz. Cu pad on a 1.5 × 1.5 in .060 inch thick FR4 board. R<sub>θJC</sub> is specified by design while R<sub>θJA</sub> is determined by the user's board design.  
 (2) Device mounted on FR4 Material with 1 inch<sup>2</sup> of 2 oz. Cu.



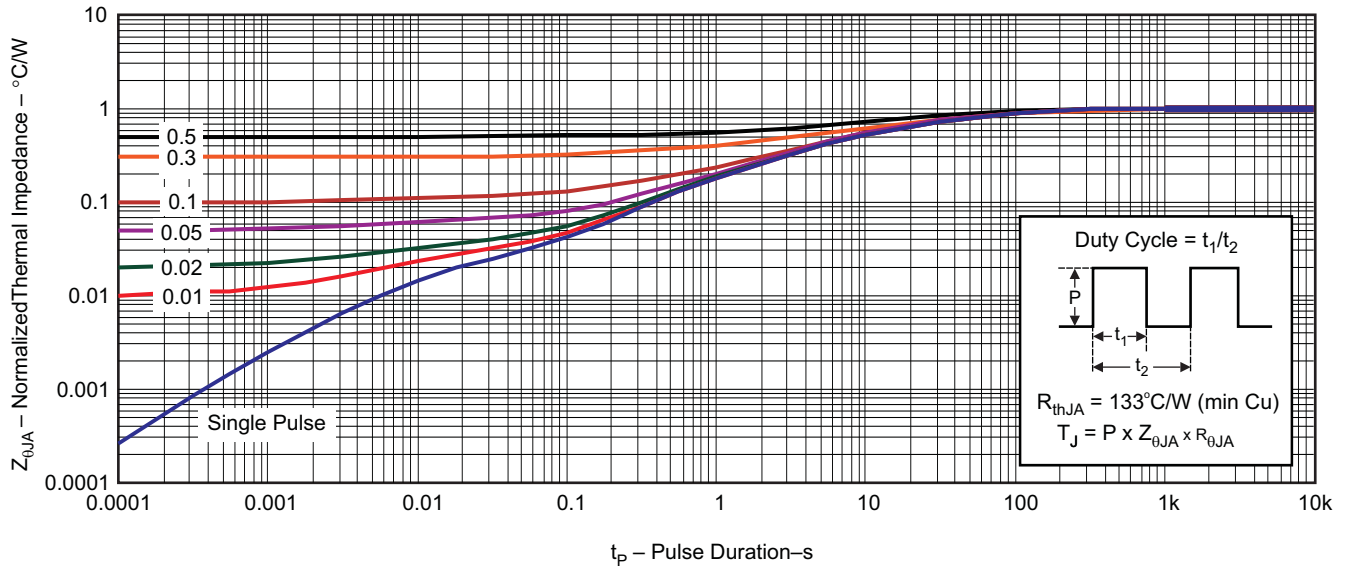
Max  $R_{\theta JA} = 59^{\circ}\text{C/W}$   
when mounted on  
 $1\text{inch}^2$  of 2 oz. Cu.



Max  $R_{\theta JA} = 165^{\circ}\text{C/W}$   
when mounted on  
minimum pad area of 2  
oz. Cu.

### TYPICAL MOSFET CHARACTERISTICS

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



G012

Figure 1. Transient Thermal Impedance

TYPICAL MOSFET CHARACTERISTICS (continued)

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

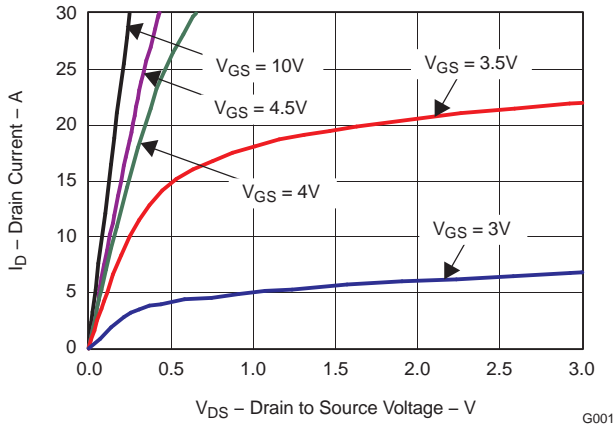


Figure 2. Saturation Characteristics

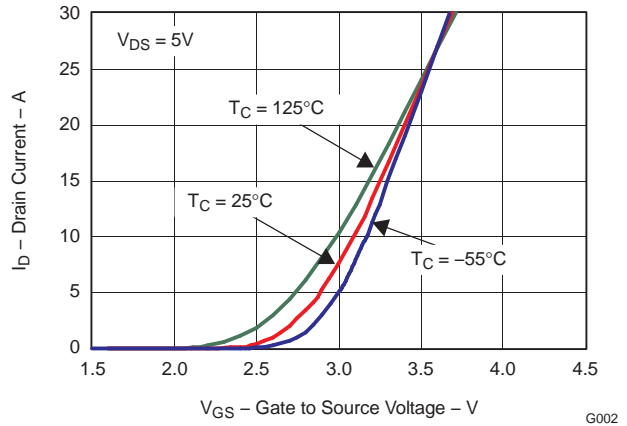


Figure 3. Transfer Characteristics

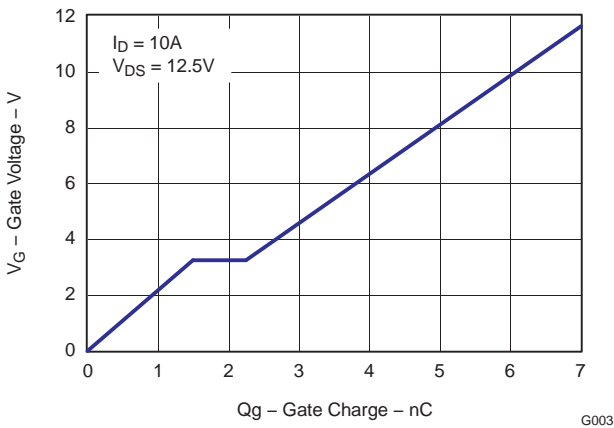


Figure 4. Gate Charge

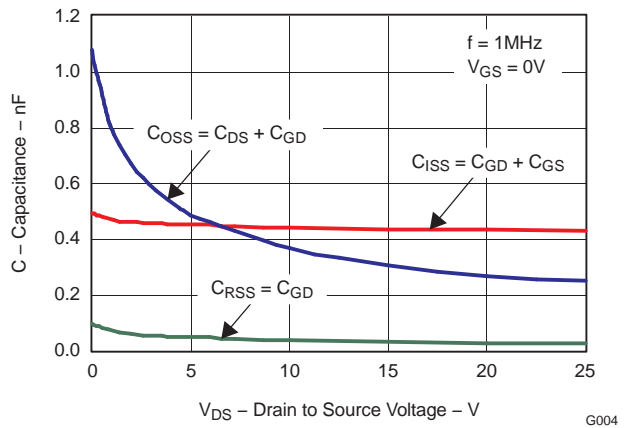


Figure 5. Capacitance

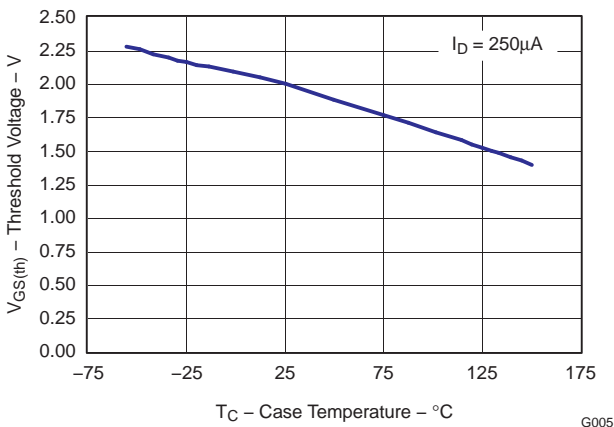


Figure 6. Threshold Voltage vs. Temperature

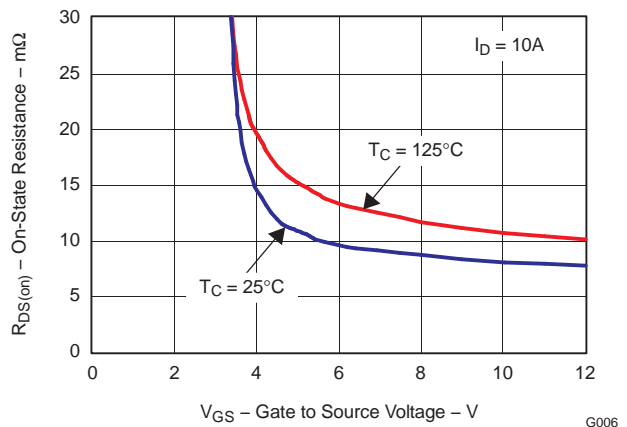


Figure 7. On Resistance vs. Gate Voltage

TYPICAL MOSFET CHARACTERISTICS (continued)

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

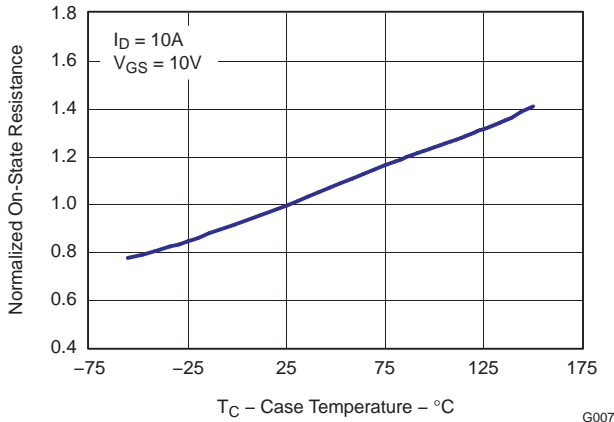


Figure 8. On Resistance vs. Temperature

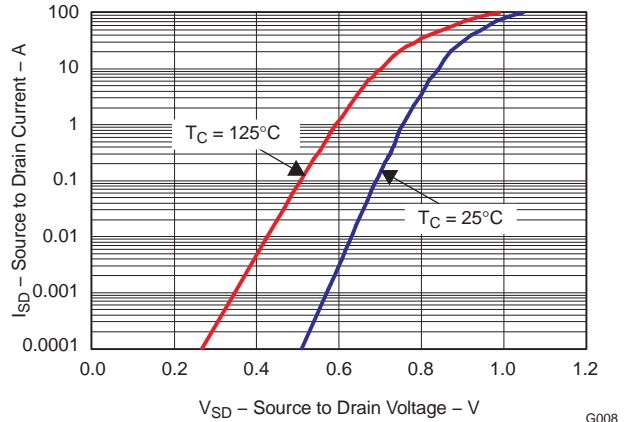


Figure 9. Typical Diode Forward Voltage

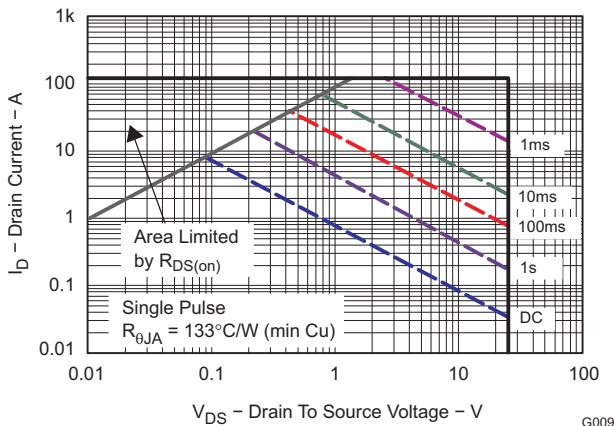


Figure 10. Maximum Safe Operating Area

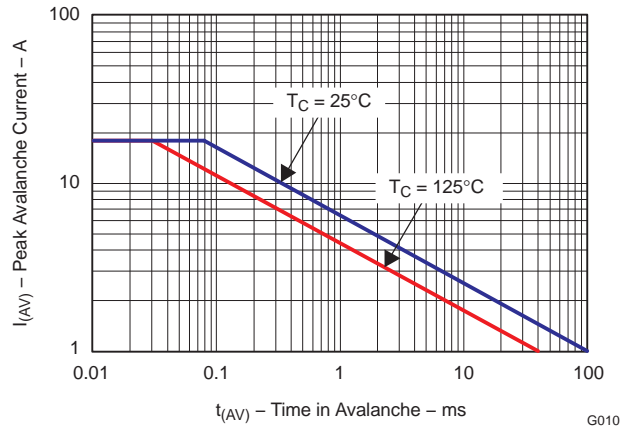


Figure 11. Single Pulse Unclamped Inductive Switching

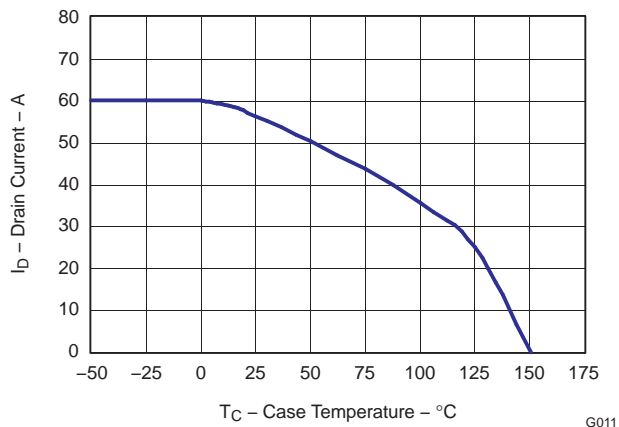
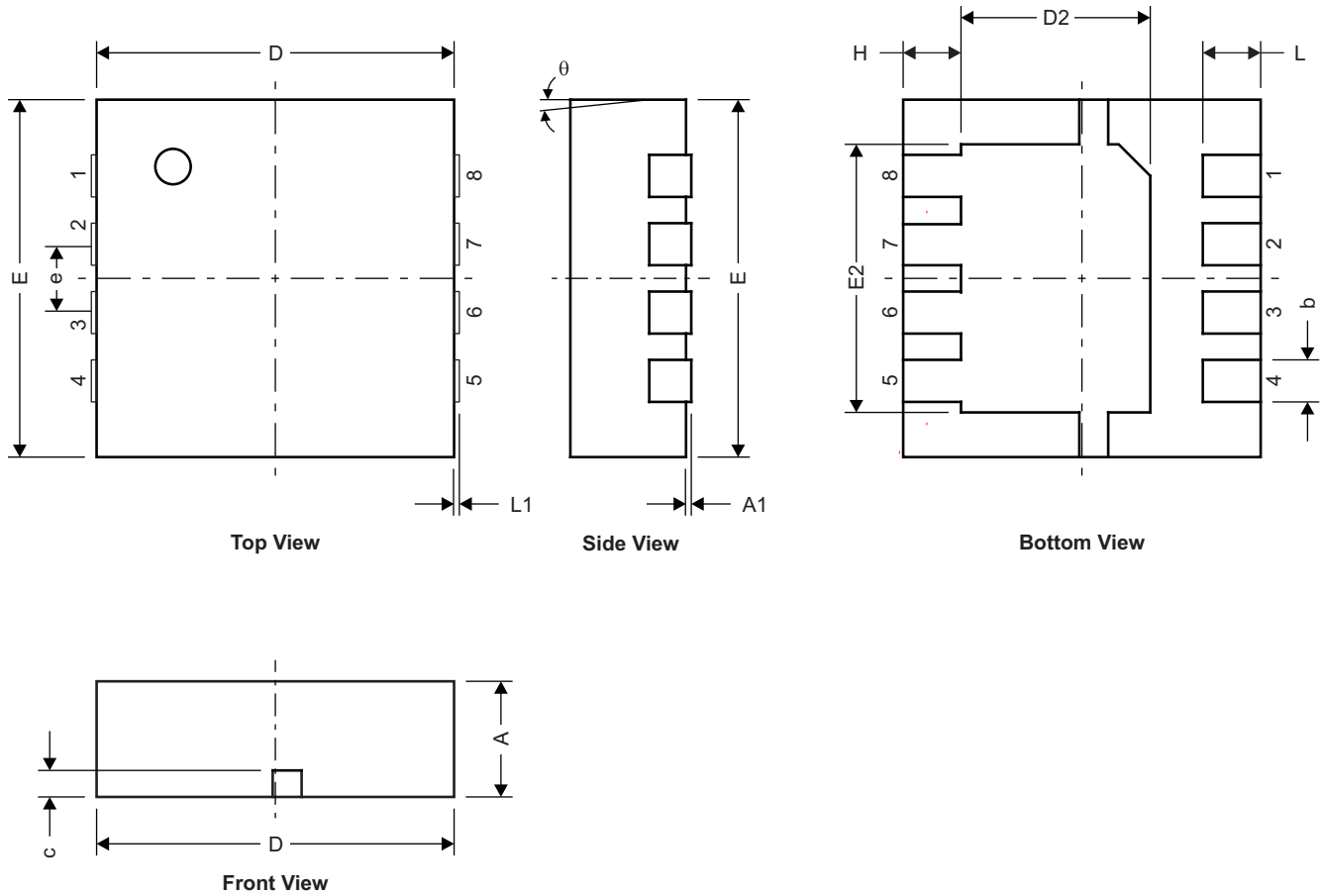


Figure 12. Maximum Drain Current vs. Temperature

MECHANICAL DATA

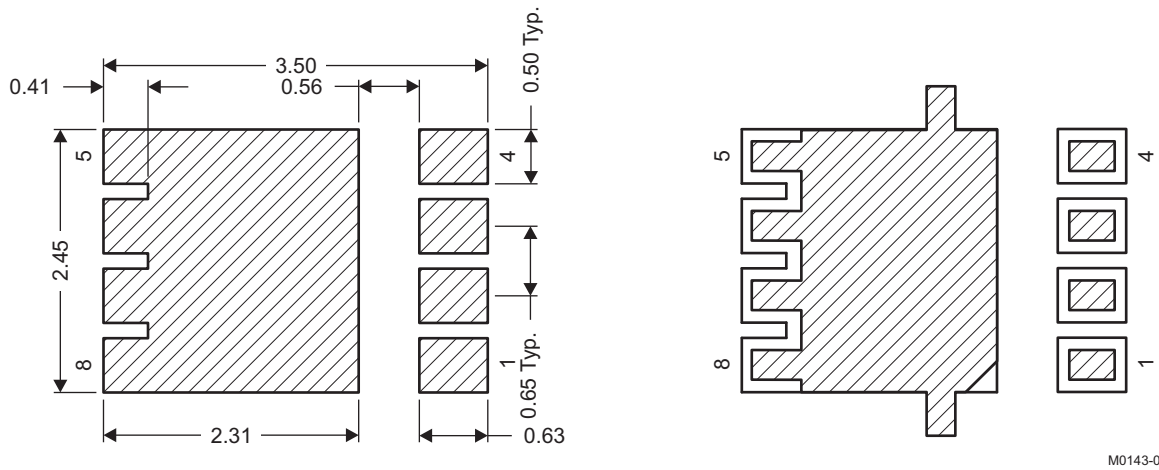
Q3 Package Dimensions



M0142-01

| 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 |
| 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 |
| D1    | –           | –     | –     | –      | –     | –     |
| D2    | 1.650       | 1.750 | 1.800 | 0.065  | 0.069 | 0.071 |
| E     | 3.200       | 3.300 | 3.400 | 0.126  | 0.130 | 0.134 |
| E1    | –           | –     | –     | –      | –     | –     |
| E2    | 2.350       | 2.450 | 2.550 | 0.093  | 0.096 | 0.100 |
| e     | 0.650 TYP   |       |       | 0.026  |       |       |
| H     | 0.35        | 0.450 | 0.550 | 0.014  | 0.018 | 0.022 |
| L     | 0.35        | 0.450 | 0.550 | 0.014  | 0.018 | 0.022 |
| L1    | –           | –     | –     | –      | –     | –     |
| theta | –           | –     | –     | –      | –     | –     |

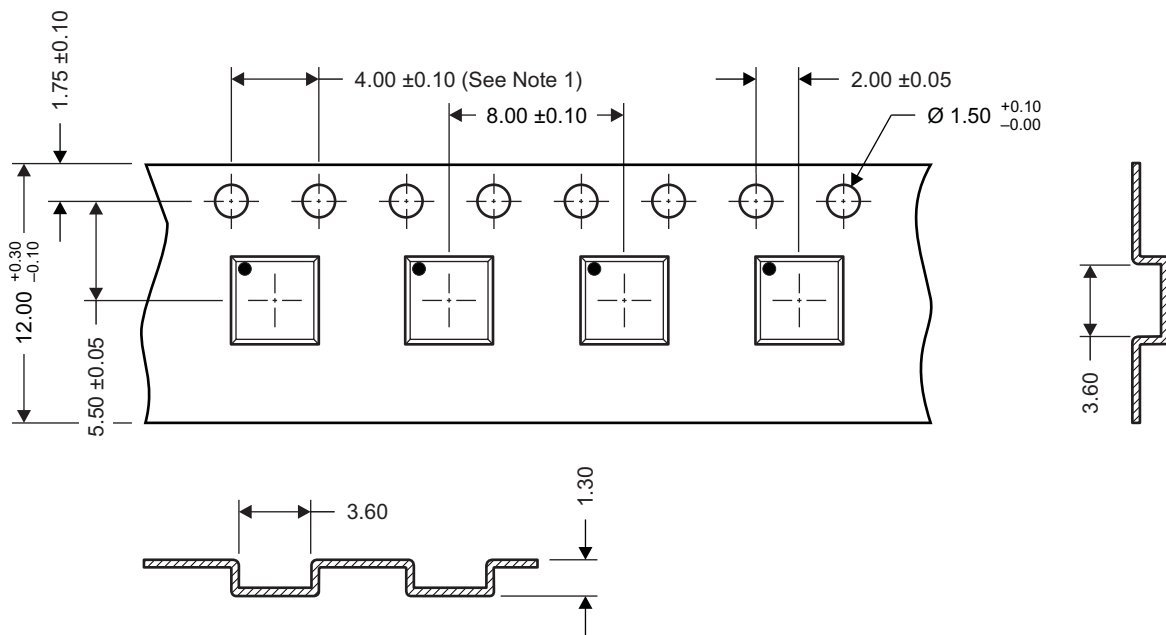
Recommended PCB Pattern



M0143-01

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

Q3 Tape and Reel Information



M0144-01

Notes:

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

### Package Marking Information

**Location**

**1st Line**

CSD = Fixed Characters

NNNNN = Product Code

**2nd Line (Date Code)**

YY = Last 2 digits of the Year

WW = 2-digit Work Week

C = Country of Origin

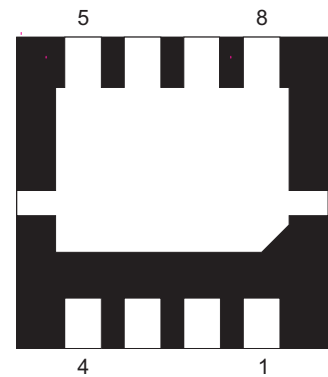
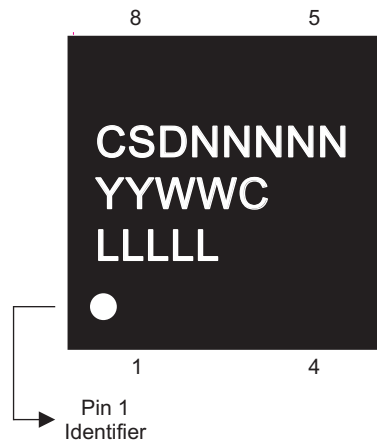
> Philippines = P

> Taiwan = T

> China = C

**3rd Line**

LLLLL = Last 5 digits of the Wafer Lot #



M0145-01



**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| CSD16411Q3       | ACTIVE                | SON          | DQG             | 8    | 2500        | Pb-Free (RoHS Exempt)   | CU SN            | Level-1-260C-UNLIM           |

<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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|-----------------------------|--|----------------------------|--|
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| Data Converters             | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     | Automotive                 | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| DLP® Products               | <a href="http://www.dlp.com">www.dlp.com</a>                       | Communications and Telecom | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| DSP                         | <a href="http://dsp.ti.com">dsp.ti.com</a>                         | Computers and Peripherals  | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Clocks and Timers           | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>           | Consumer Electronics       | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Interface                   | <a href="http://interface.ti.com">interface.ti.com</a>             | Energy                     | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Logic                       | <a href="http://logic.ti.com">logic.ti.com</a>                     | Industrial                 | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Power Mgmt                  | <a href="http://power.ti.com">power.ti.com</a>                     | Medical                    | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Microcontrollers            | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> | Security                   | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| RFID                        | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>               | Space, Avionics & Defense  | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| RF/IF and ZigBee® Solutions | <a href="http://www.ti.com/lprf">www.ti.com/lprf</a>               | Video and Imaging          | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |
|                             |  | Wireless                   | <a href="http://www.ti.com/wireless-apps">www.ti.com/wireless-apps</a>                   |

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