# 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 or Synchronous 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) | 5.8 | | nC |
| $Q_{gd}$ | Gate Charge Gate to Drain | 1.5 | | nC |
| $R_{DS(on)}$ | Drain to Source On Resistance | $V_{GS}$ = 4.5V | 5.9 | mΩ |
| | | $V_{GS}$ = 10V | 4.2 | mΩ |
| $V_{th}$ | Threshold Voltage | 1.8 | | V |

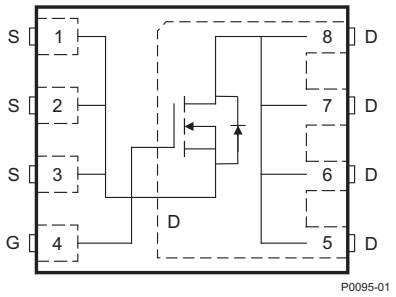
### ORDERING INFORMATION

| Device | Package | Media | Qty | Ship |
|---|---|---|---|---|
| CSD16406Q3 | SON 3.3 × 3.3 Plastic Package | 13-inch reel | 2500 | Tape and Reel |

### ABSOLUTE MAXIMUM RATINGS

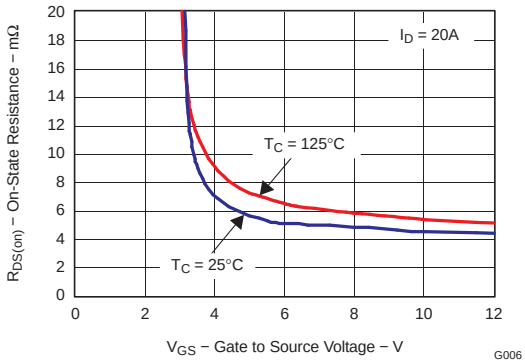
| $T_A$ = 25°C unless otherwise stated | | VALUE | UNIT |
|---|---|---|---|
| $V_{DS}$ | Drain to Source Voltage | 25 | V |
| $V_{GS}$ | Gate to Source Voltage | +16 / –12 | V |
| $I_D$ | Continuous Drain Current, $T_C$ = 25°C | 60 | A |
| | Continuous Drain Current(1) | 19 | A |
| $I_{DM}$ | Pulsed Drain Current, $T_A$ = 25°C(2) | 114 | A |
| $P_D$ | Power Dissipation(1) | 2.7 | W |
| $T_J$, $T_{STG}$ | Operating Junction and Storage Temperature Range | –55 to 150 | °C |
| $E_{AS}$ | Avalanche Energy, single pulse $I_D$ = 45A, L = 0.1mH, $R_G$ = 25Ω | 101 | mJ |

**Top View**

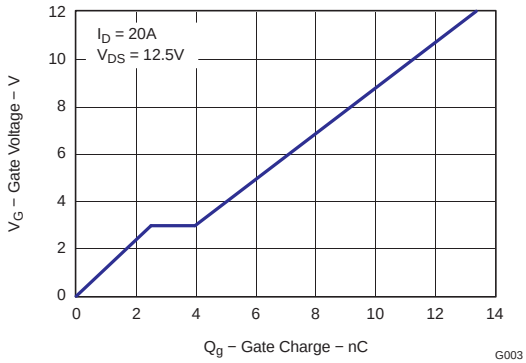



(1) $R_{\theta JA}$ = 46°C/W on 1in$^2$ Cu (2 oz.) on 0.060" thick FR4 PCB.
(2) Pulse width ≤300µs, duty cycle ≤2%

**$R_{DS(ON)}$ vs $V_{GS}$**




**Gate Charge**

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## ELECTRICAL CHARACTERISTICS

($T_A$ = 25°C unless otherwise stated)

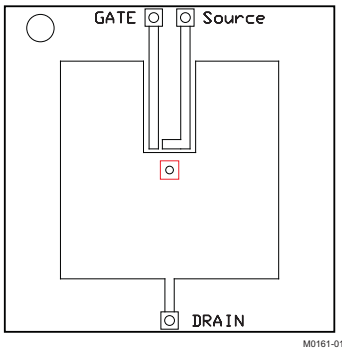
| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **Static Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain to Source Voltage | $V_{GS}$ = 0V, $I_D$ = 250µA | 25 | | | V |
| $I_{DSS}$ | Drain to Source Leakage Current | $V_{GS}$ = 0V, $V_{DS}$ = 20V | | | 1 | µA |
| $I_{GSS}$ | Gate to Source Leakage Current | $V_{DS}$ = 0V, $V_{GS}$ = +16/-12V | | | 100 | nA |
| $V_{GS(th)}$ | Gate to Source Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250µA | 1.4 | 1.8 | 2.2 | V |
| $R_{DS(on)}$ | Drain to Source On Resistance | $V_{GS}$ = 4.5V, $I_D$ = 20A | | 5.9 | 7.4 | mΩ |
| | | $V_{GS}$ = 10V, $I_D$ = 20A | | 4.2 | 5.3 | mΩ |
| $g_{fs}$ | Transconductance | $V_{DS}$ = 15V, $I_D$ = 20A | | 53 | | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{ISS}$ | Input Capacitance | $V_{GS}$ = 0V, $V_{DS}$ = 12.5V, f = 1MHz | | 840 | 1100 | pF |
| $C_{OSS}$ | Output Capacitance | | | 680 | 950 | pF |
| $C_{RSS}$ | Reverse Transfer Capacitance | | | 57 | 80 | pF |
| $R_g$ | Series Gate Resistance | | | 1.2 | 2.4 | Ω |
| $Q_g$ | Gate Charge Total (4.5V) | $V_{DS}$ = 12.5V, $I_D$ = 20A | | 5.8 | 8.1 | nC |
| $Q_{gd}$ | Gate Charge Gate to Drain | | | 1.5 | | nC |
| $Q_{gs}$ | Gate Charge Gate to Source | | | 2.5 | | nC |
| Qg(th) | Gate Charge at Vth | | | 1.5 | | nC |
| $Q_{OSS}$ | Output Charge | $V_{DS}$ = 13.6V, $V_{GS}$ = 0V | | 13.9 | | nC |
| $t_{d(on)}$ | Turn On Delay Time | $V_{DS}$ = 12.5V, $V_{GS}$ = 4.5V $I_D$ = 20A $R_G$ = 2Ω | | 7.3 | | ns |
| $t_r$ | Rise Time | | | 12.9 | | ns |
| $t_{d(off)}$ | Turn Off Delay Time | | | 8.5 | | ns |
| $t_f$ | Fall Time | | | 4.8 | | ns |
| **Diode Characteristics** | | | | | | |
| $V_{SD}$ | Diode Forward Voltage | $I_S$ = 20A, $V_{GS}$ = 0V | | 0.85 | 1.0 | V |
| $Q_{rr}$ | Reverse Recovery Charge | $V_{DD}$ = 13.6V, $I_F$ = 20A, di/dt = 300A/µs | | 18 | | nC |
| $t_{rr}$ | Reverse Recovery Time | $V_{DD}$ = 13.6V, $I_F$ = 20A, di/dt = 300A/µs | | 22 | | ns |

## THERMAL CHARACTERISTICS

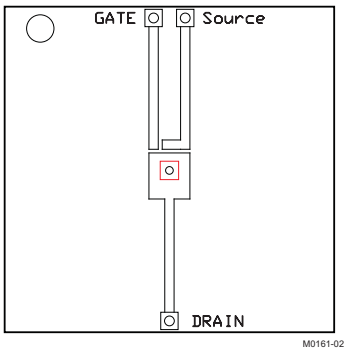
($T_A$ = 25°C unless otherwise stated)

| PARAMETER | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance Junction to Case(1) | | | 2.7 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance Junction to Ambient(1)(2) | | | 58 | °C/W |

(1) $R_{\theta JC}$ is determined with the device mounted on a 1 inch square 2 oz. Cu pad on a 1.5 × 1.5 in 0.06 inch 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 $inch^2$ of 2 oz. Cu.




Max $R_{\theta JA}$ = 58°C/W when mounted on 1 inch$^2$ of 2 oz. Cu.




Max $R_{\theta JA}$ = 162°C/W when mounted on minimum pad area of 2 oz. Cu.

## TYPICAL MOSFET CHARACTERISTICS

($T_A$ = 25°C unless otherwise stated)

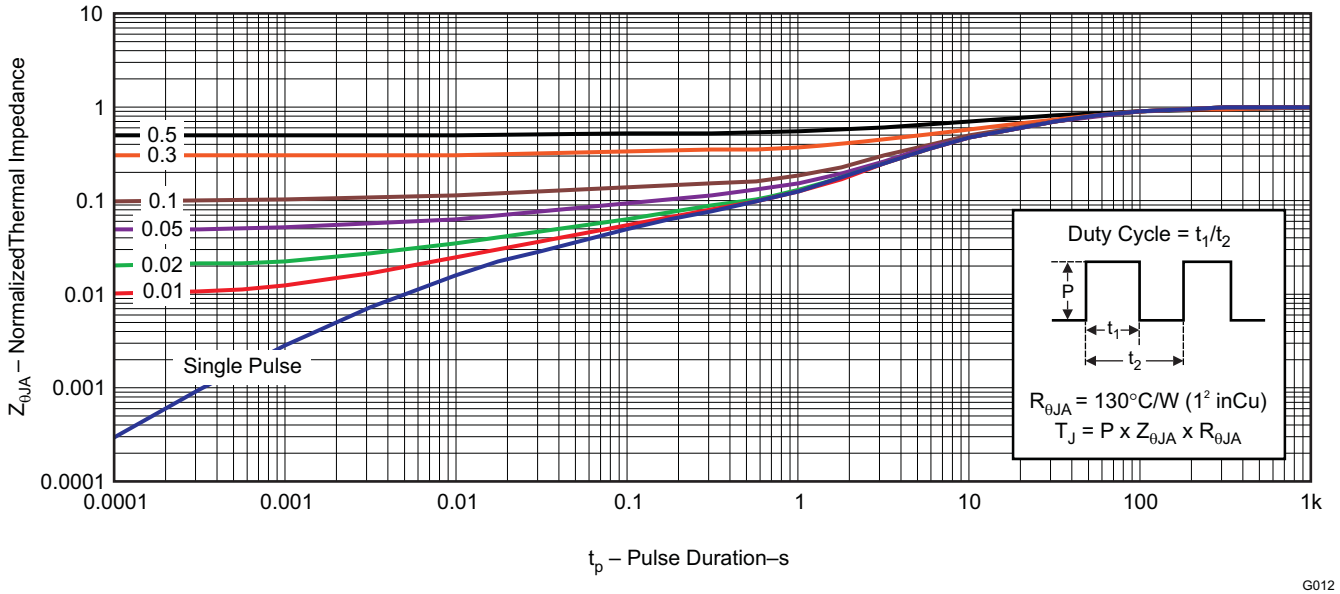



**Figure 1. Transient Thermal Impedance**

## TYPICAL MOSFET CHARACTERISTICS (continued)

($T_A$ = 25°C unless otherwise stated)

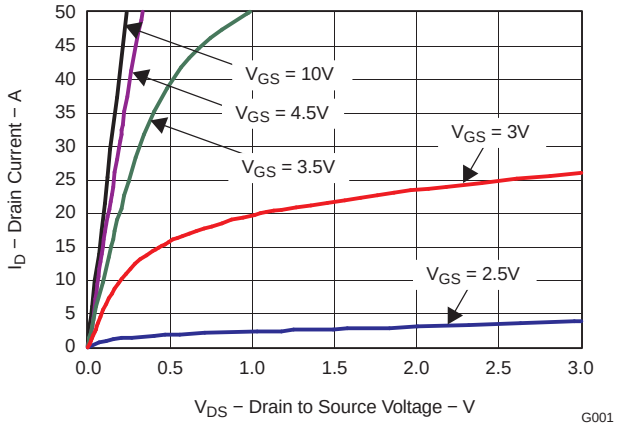



**Figure 2. Saturation Characteristics**

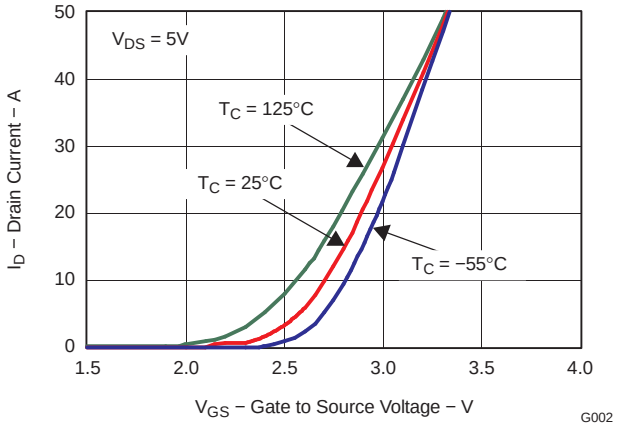



**Figure 3. Transfer Characteristics**

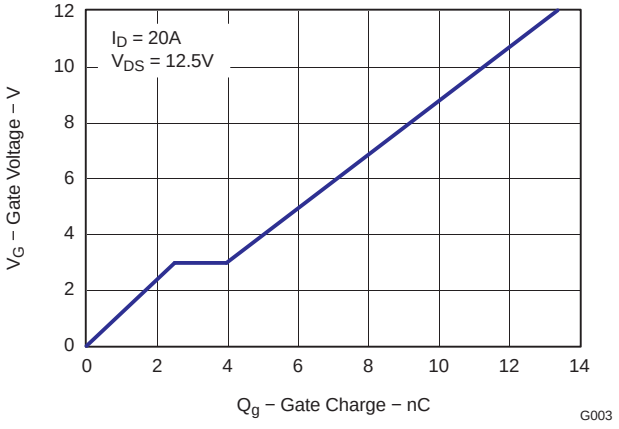



**Figure 4. Gate Charge**

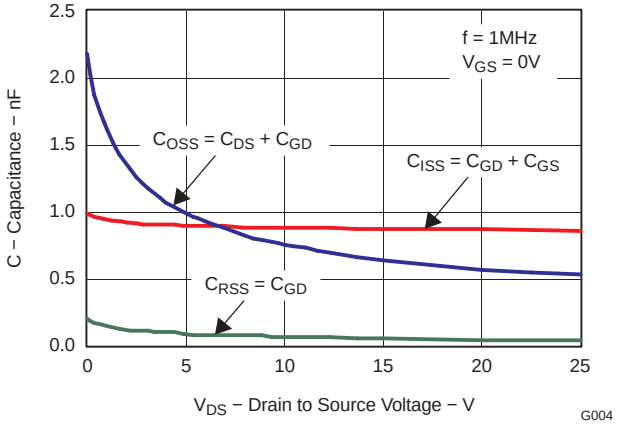



**Figure 5. Capacitance**

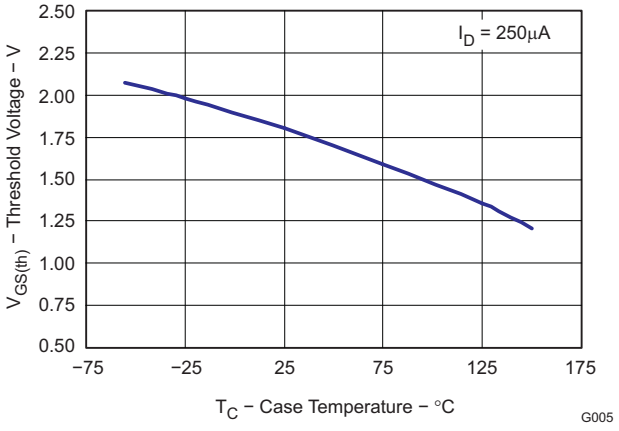



**Figure 6. Threshold Voltage vs. Temperature**

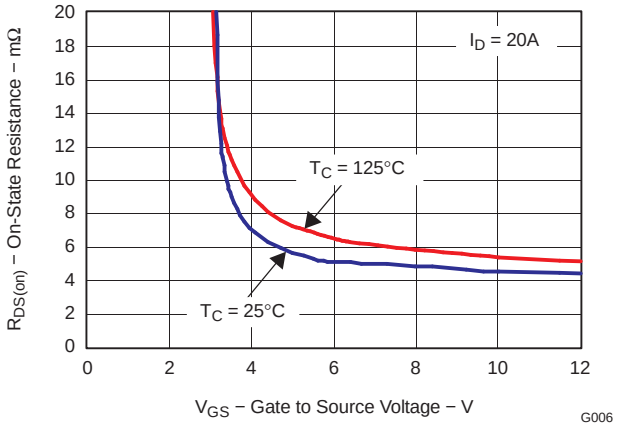



**Figure 7. On Resistance vs. Gate Voltage**

## TYPICAL MOSFET CHARACTERISTICS (continued)

($T_A$ = 25°C unless otherwise stated)

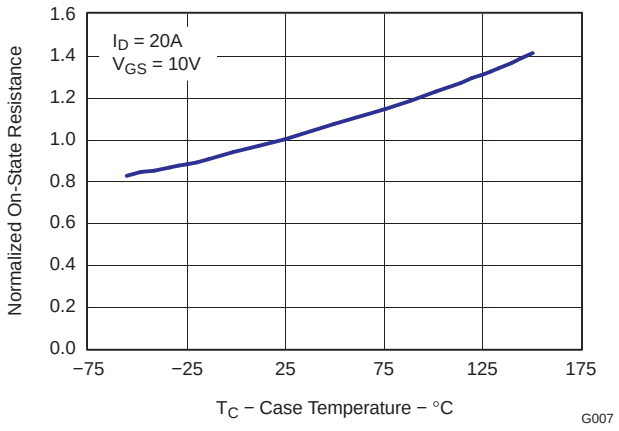



**Figure 8. Normalized On Resistance vs. Temperature**

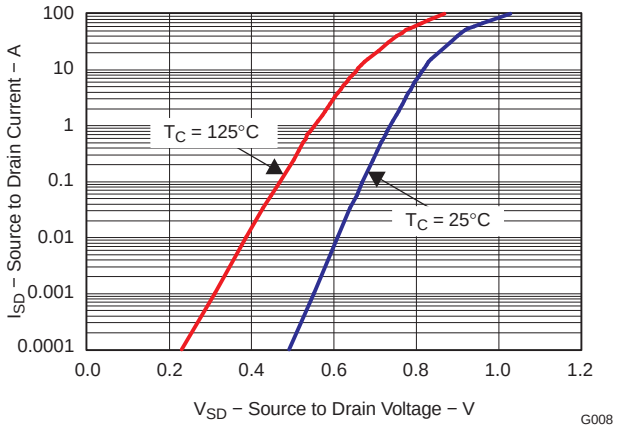



**Figure 9. Typical Diode Forward Voltage**

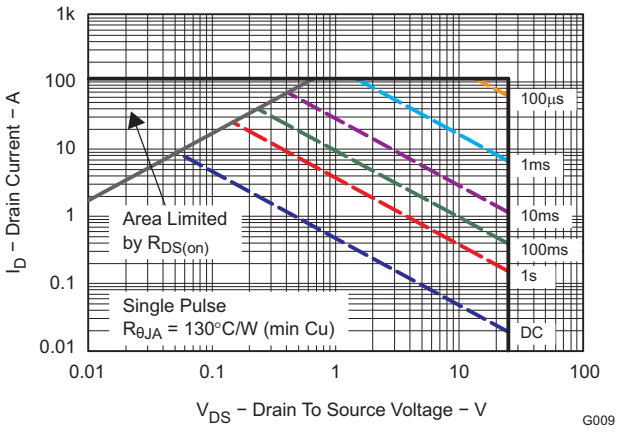



**Figure 10. Maximum Safe Operating Area**

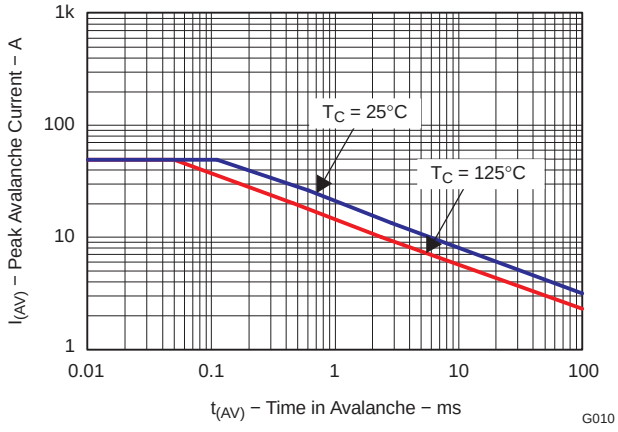



**Figure 11. Single Pulse Unclamped Inductive Switching**

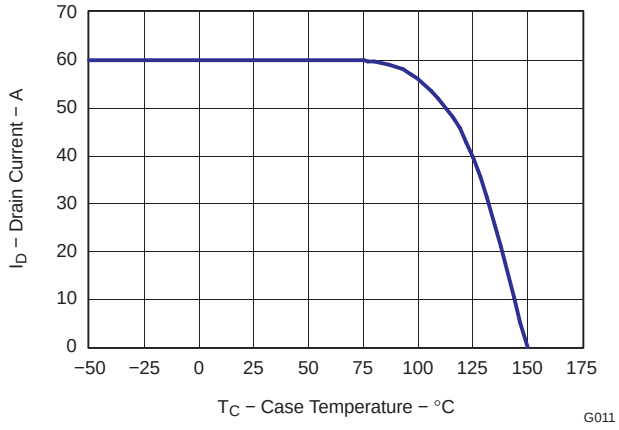
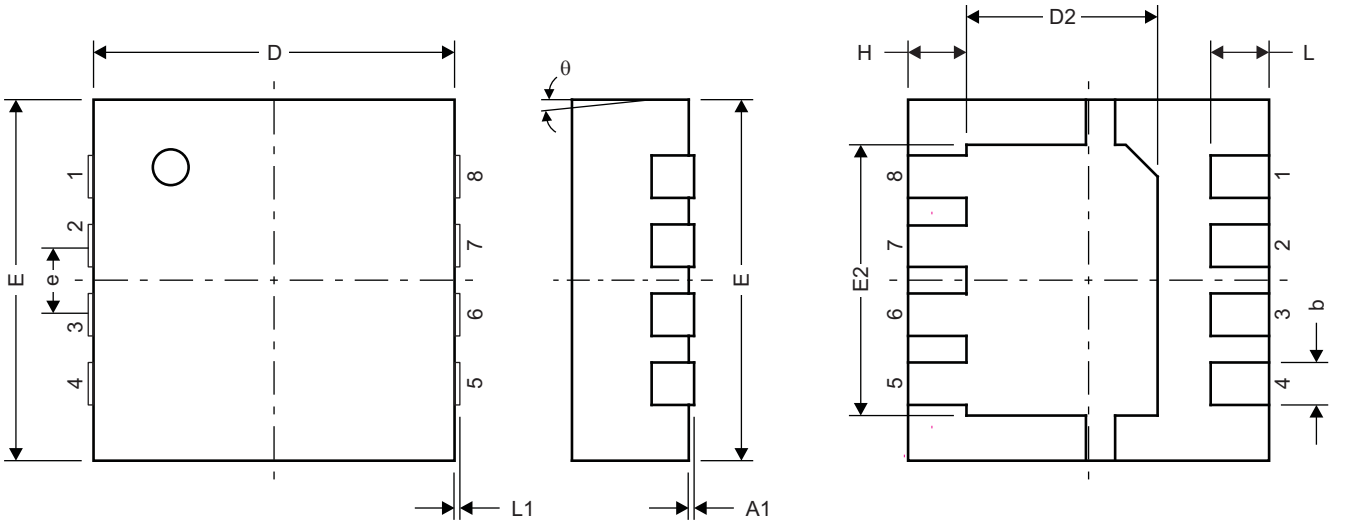


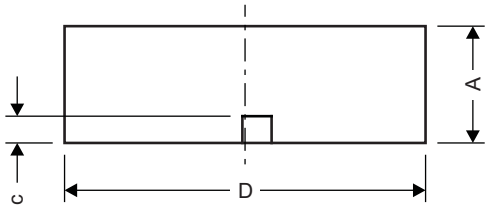

**Figure 12. Maximum Drain Current vs. Temperature**

## MECHANICAL DATA

### Q3 Package Dimensions




Top View Side View Bottom View

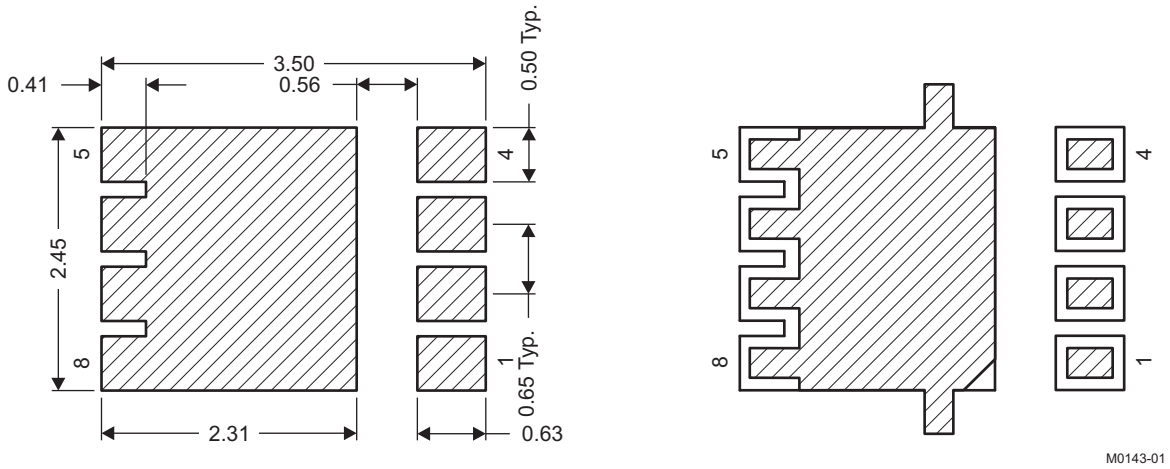



Front View

M0142-01

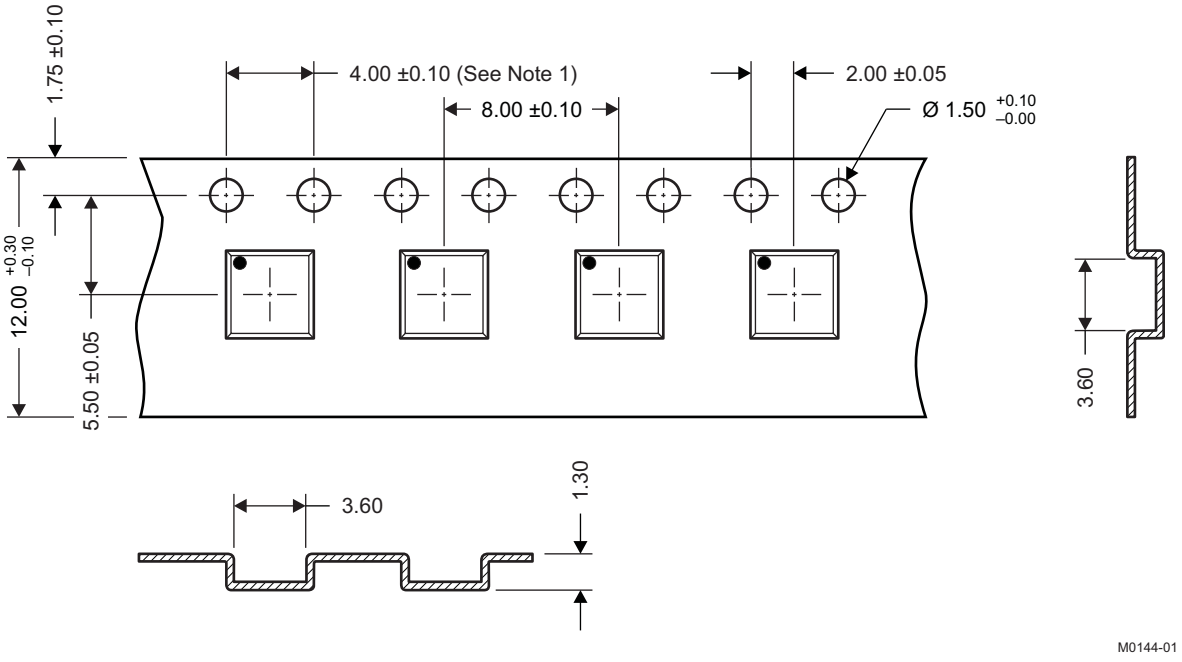
| DIM | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.950 | 1.000 | 1.100 | 0.037 | 0.039 | 0.043 |
| A1 | 0.000 | 0.000 | 0.050 | 0.000 | 0.000 | 0.002 |
| b | 0.280 | 0.340 | 0.400 | 0.011 | 0.013 | 0.016 |
| c | 0.150 | 0.200 | 0.250 | 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 | – | – | – | – | – | – |
| θ | – | – | – | – | – | – |

## Recommended PCB Pattern




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

## Q3 Tape and Reel Information




**Notes:**

1. 10 sprocket hole pitch cumulative tolerance ±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 ±0.05mm
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

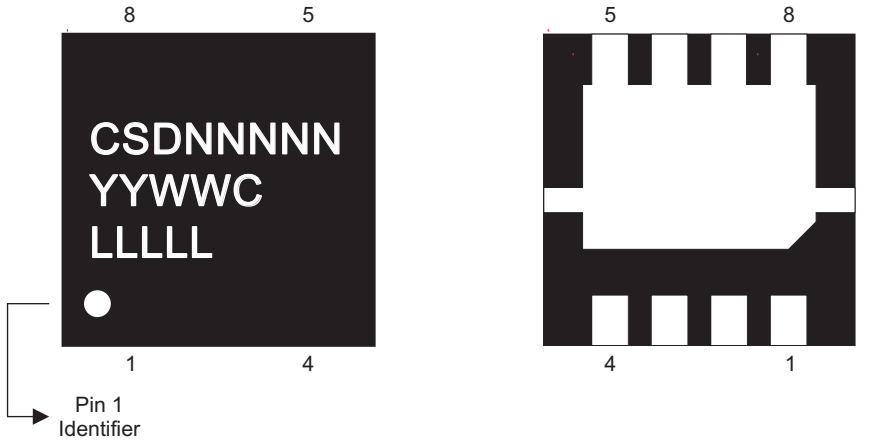
> Philippines = P

> Taiwan = T

> China = C

**3rd Line**

LLLLL = Last 5 digits of the Wafer Lot #



## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| CSD16406Q3 | ACTIVE | SON | DQG | 8 | 2500 | Pb-Free (RoHS Exempt) | CU SN | Level-1-260C-UNLIM |

(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) 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)

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

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

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