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Texas Instruments
CSD16408Q5C

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# DualCool™ N-Ch NexFET™ Power MOSFET

## FEATURES

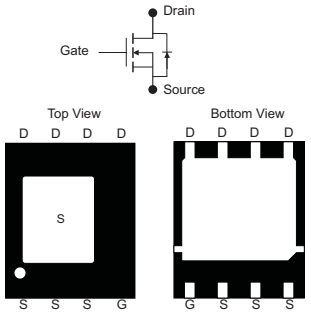
- **Ultra Low $Q_g$ and $Q_{gd}$**
- **DualCool™ Package**
- **Optimized for 2-Sided Cooling**
- **Low Thermal Resistance**
- **Avalanche Rated**
- **Pb Free Terminal Plating**
- **RoHS Compliant**
- **Halogen Free**
- **SON 5-mm x 6-mm Plastic Package**

## APPLICATIONS

- **Point-of-Load Synchronous Buck 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) | 6.7 | | nC |
| $Q_{gd}$ | Gate Charge Gate to Drain | 1.9 | | nC |
| $R_{DS(on)}$ | Drain to Source On Resistance | $V_{GS}$ = 4.5V | 5.4 | mΩ |
| | | $V_{GS}$ = 10V | 3.6 | mΩ |
| $V_{GS(th)}$ | Threshold Voltage | 1.8 | | V |

## ORDERING INFORMATION

| Device | Package | Media | Qty | Ship |
|---|---|---|---|---|
| CSD16408Q5C | SON 5-mm × 6-mm Plastic Package | 13-Inch Reel | 2500 | Tape and Reel |

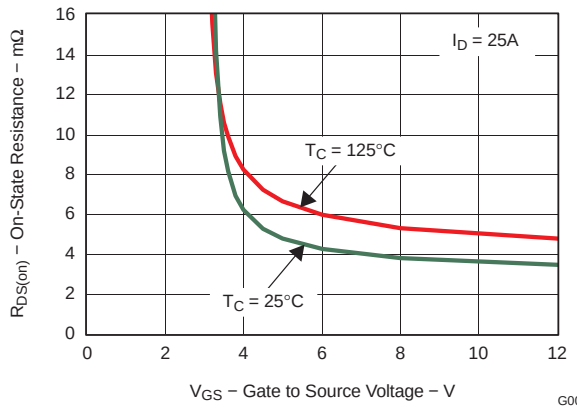
## ABSOLUTE MAXIMUM RATINGS

| $T_A$ = 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 | 113 | A |
| | Continuous Drain Current (1) | 22 | A |
| $I_{DM}$ | Pulsed Drain Current, $T_A$ = 25°C (2) | 141 | A |
| $P_D$ | Power Dissipation (1) | 3.1 | W |
| $T_J$, $T_{STG}$ | Operating Junction and Storage Temperature Range | –55 to 150 | °C |
| $E_{AS}$ | Avalanche Energy, single pulse $I_D$ = 23A, L = 0.1mH, $R_G$ = 25Ω | 126 | mJ |

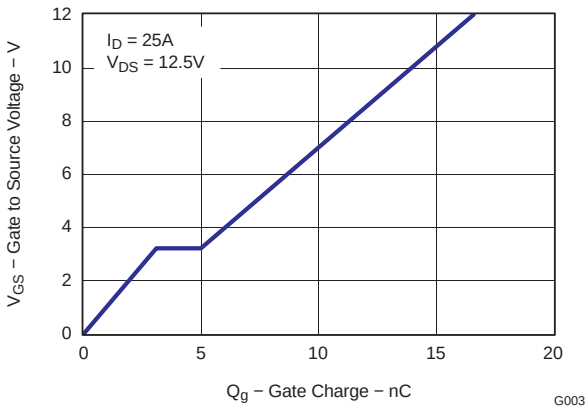
(1) Typical $R_{\theta JA}$ = 41°C/W on a 1-inch$^2$ (6.45-cm$^2$), 2-oz. (0.071-mm thick) Cu pad on a 0.06-inch (1.52-mm) thick FR4 PCB.

(2) Pulse duration ≤300μs, duty cycle ≤2%

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




**GATE CHARGE**




Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

DualCool, NexFET are trademarks of Texas Instruments.

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.

## ELECTRICAL CHARACTERISTICS

$T_A$ = 25°C unless otherwise stated

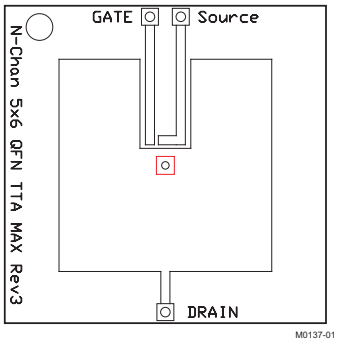
| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **Static Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain to Source Voltage | $V_{GS}$ = 0V, $I_D$ = 250µA | 25 | | | V |
| $I_{DSS}$ | Drain to Source Leakage | $V_{GS}$ = 0V, $V_{DS}$ = 20V | | | 1 | µA |
| $I_{GSS}$ | Gate to Source Leakage | $V_{DS}$ = 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 | 2.1 | V |
| $R_{DS(on)}$ | Drain to Source On Resistance | $V_{GS}$ = 4.5V, $I_D$ = 25A | | 5.4 | 6.8 | mΩ |
| | | $V_{GS}$ = 10V, $I_D$ = 25A | | 3.6 | 4.5 | mΩ |
| $g_{fs}$ | Transconductance | $V_{DS}$ = 15V, $I_D$ = 25A | | 60 | | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{ISS}$ | Input Capacitance | $V_{GS}$ = 0V, $V_{DS}$ = 12.5V , f = 1MHz | | 990 | 1300 | pF |
| $C_{OSS}$ | Output Capacitance | | | 760 | 1000 | pF |
| $C_{RSS}$ | Reverse Transfer Capacitance | | | 75 | 100 | pF |
| $R_g$ | Series Gate Resistance | | | 0.8 | 1.6 | Ω |
| $Q_g$ | Gate Charge Total (4.5V) | $V_{DS}$ = 12.5V, $I_D$ = 25A | | 6.7 | 8.9 | nC |
| $Q_{gd}$ | Gate Charge – Gate to Drain | | | 1.9 | | nC |
| $Q_{gs}$ | Gate Charge – Gate to Source | | | 3.1 | | nC |
| $Q_{g(th)}$ | Gate Charge at Vth | | | 1.8 | | nC |
| $Q_{OSS}$ | Output Charge | $V_{DS}$ = 13V, $V_{GS}$ = 0V | | 15.7 | | nC |
| $t_{d(on)}$ | Turn On Delay Time | $V_{DS}$ = 12.5V, $V_{GS}$ = 4.5V, $I_D$ = 25A, $R_G$ = 2Ω | | 11.3 | | ns |
| $t_r$ | Rise Time | | | 25 | | ns |
| $t_{d(off)}$ | Turn Off Delay Time | | | 11 | | ns |
| $t_f$ | Fall Time | | | 10.8 | | ns |
| **Diode Characteristics** | | | | | | |
| $V_{SD}$ | Diode Forward Voltage | $I_S$ = 25A, $V_{GS}$ = 0V | | 0.8 | 1 | V |
| $Q_{rr}$ | Reverse Recovery Charge | $V_{DD}$ = 13V, $I_F$ = 25A, di/dt = 300A/µs | | 17 | | nC |
| $t_{rr}$ | Reverse Recovery Time | $V_{DD}$ = 13V, $I_F$ = 25A, di/dt = 300A/µs | | 21 | | ns |

## THERMAL CHARACTERISTICS

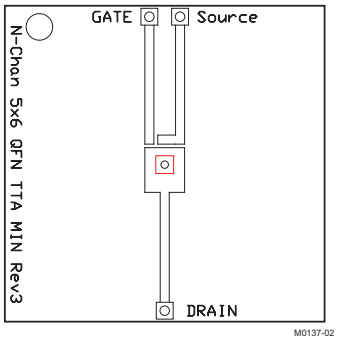
$T_A$ = 25°C unless otherwise stated

| PARAMETER | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance Junction to Case (Top Source)(1) | | | 3.1 | °C/W |
| $R_{\theta JC}$ | Thermal Resistance Junction to Case (Bottom Drain)(1) | | | 1.9 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance Junction to Ambient(1) (2) | | | 51 | °C/W |

(1) $R_{\theta JC}$ is determined with the device mounted on a 1-inch$^2$ (6.45-cm$^2$), 2-oz. (0.071-mm thick) Cu pad on a 1.5-inch × 1.5-inch (3.81-cm × 3.81-cm), 0.06-inch (1.52-mm) thick FR4 PCB. $R_{\theta JC}$ is specified by design, whereas $R_{\theta JA}$ is determined by the user's board design.
(2) Device mounted on FR4 material with 1-inch$^2$ (6.45-cm$^2$), 2-oz. (0.071-mm thick) Cu.




Max $R_{\theta JA}$ = 51ºC/W when mounted on 1 inch$^2$ (6.45 cm$^2$) of 2-oz. (0.071-mm thick) Cu.




Max $R_{\theta JA}$ = 125ºC/W when mounted on minimum pad area of 2-oz. (0.071-mm thick) Cu.

## TYPICAL MOSFET CHARACTERISTICS

$T_A$ = 25°C unless otherwise stated

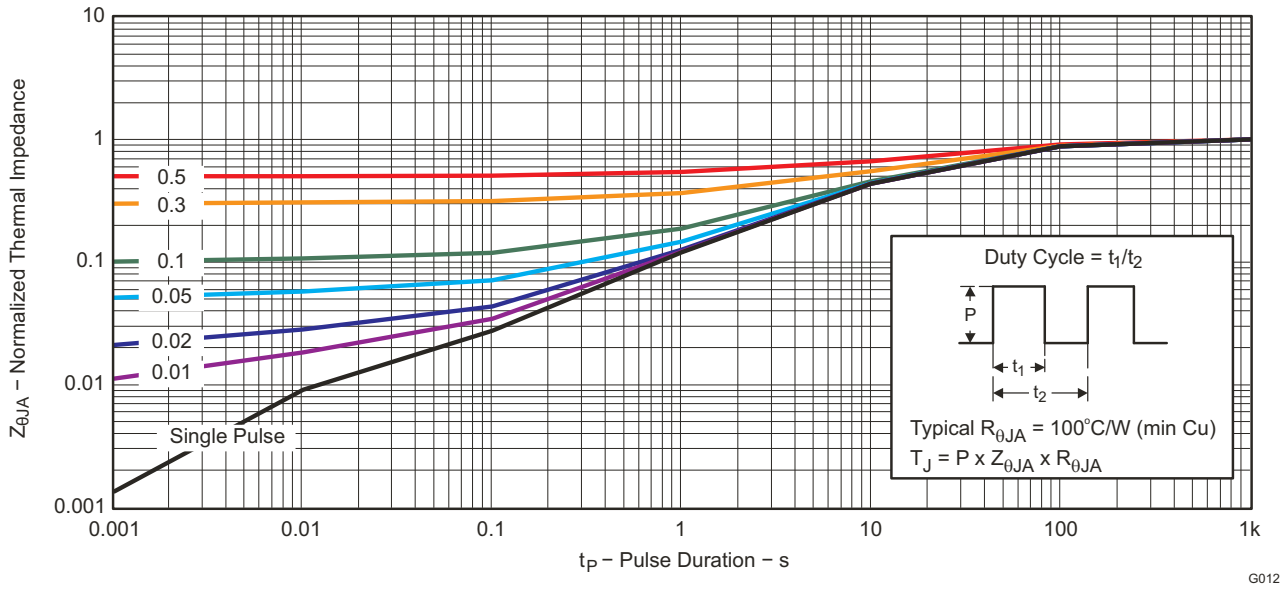



**Figure 1. Transient Thermal Impedance**

## TYPICAL MOSFET CHARACTERISTICS (continued)

$T_A$ = 25°C unless otherwise stated

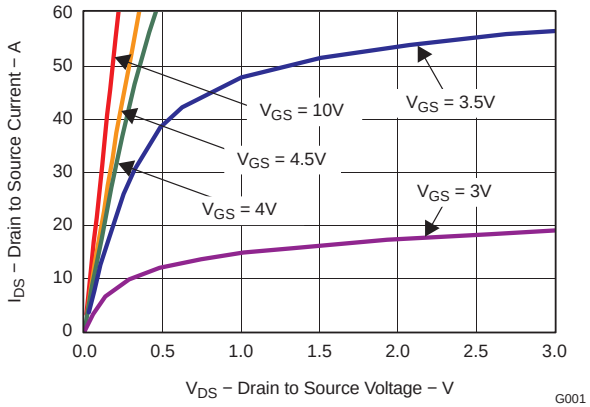



**Figure 2. Saturation Characteristics**

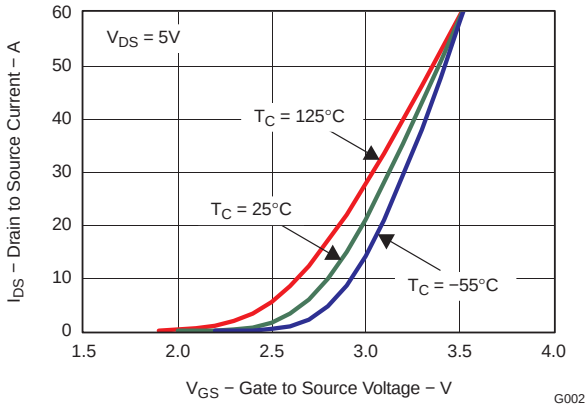



**Figure 3. Transfer Characteristics**

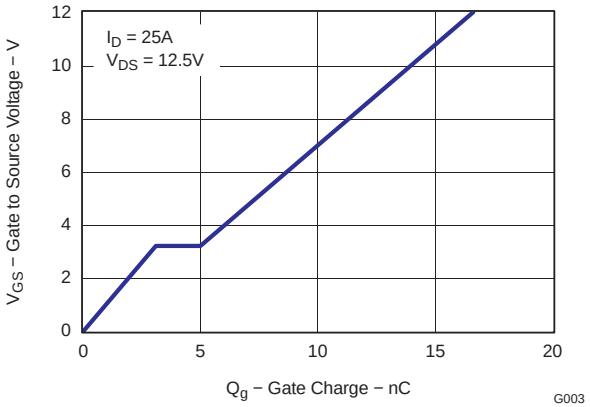



**Figure 4. Gate Charge**

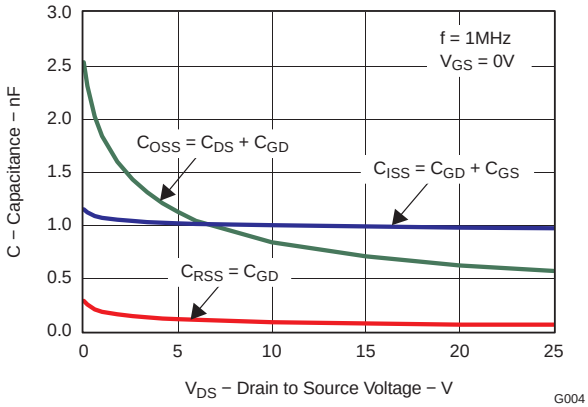



**Figure 5. Capacitance**

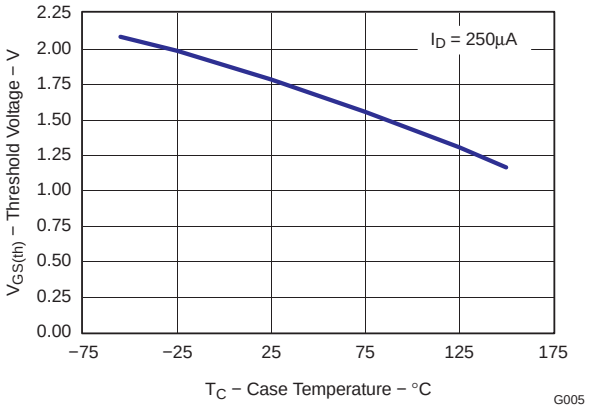



**Figure 6. Threshold Voltage vs. Temperature**

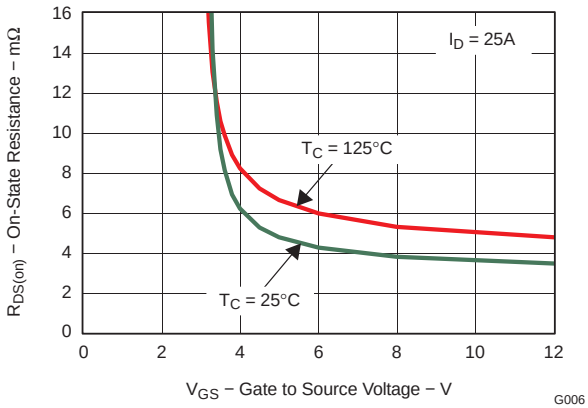



**Figure 7. On-State Resistance vs. Gate to Source Voltage**

## TYPICAL MOSFET CHARACTERISTICS (continued)

$T_A$ = 25°C unless otherwise stated

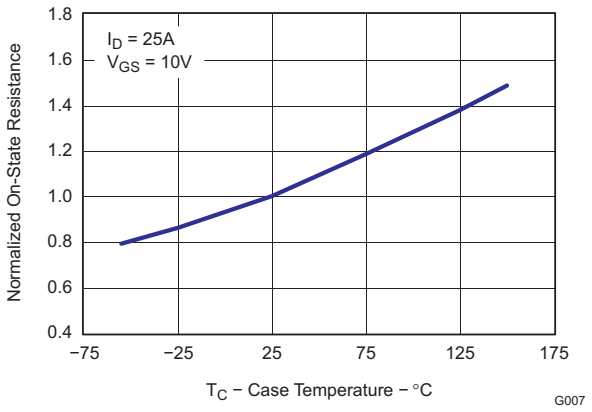



**Figure 8. Normalized On-State Resistance vs. Temperature**

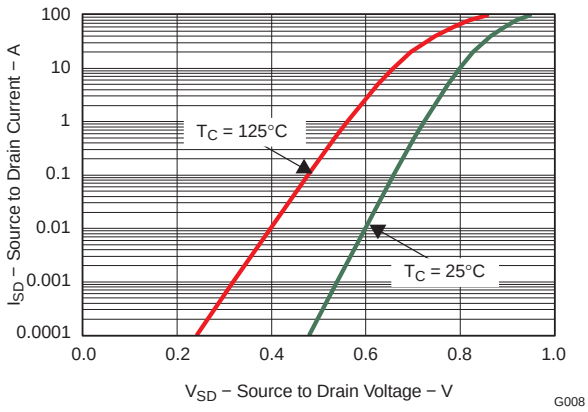



**Figure 9. Typical Diode Forward Voltage**

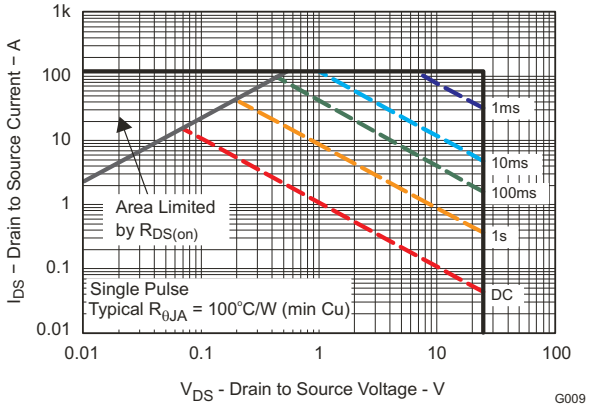



**Figure 10. Maximum Safe Operating Area**

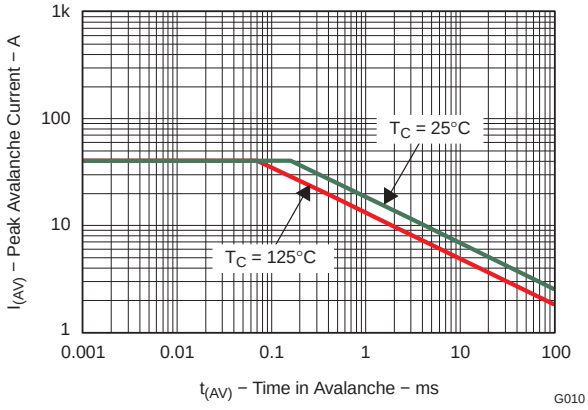



**Figure 11. Single Pulse Unclamped Inductive Switching**

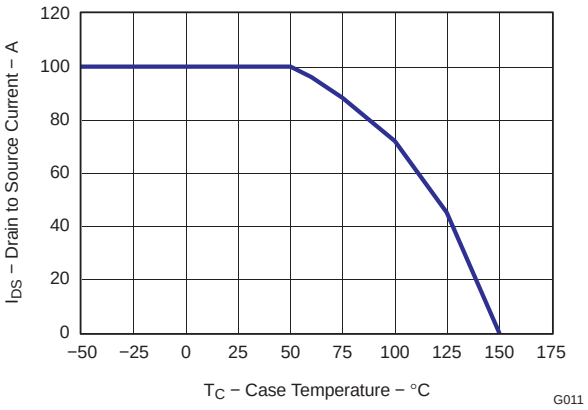
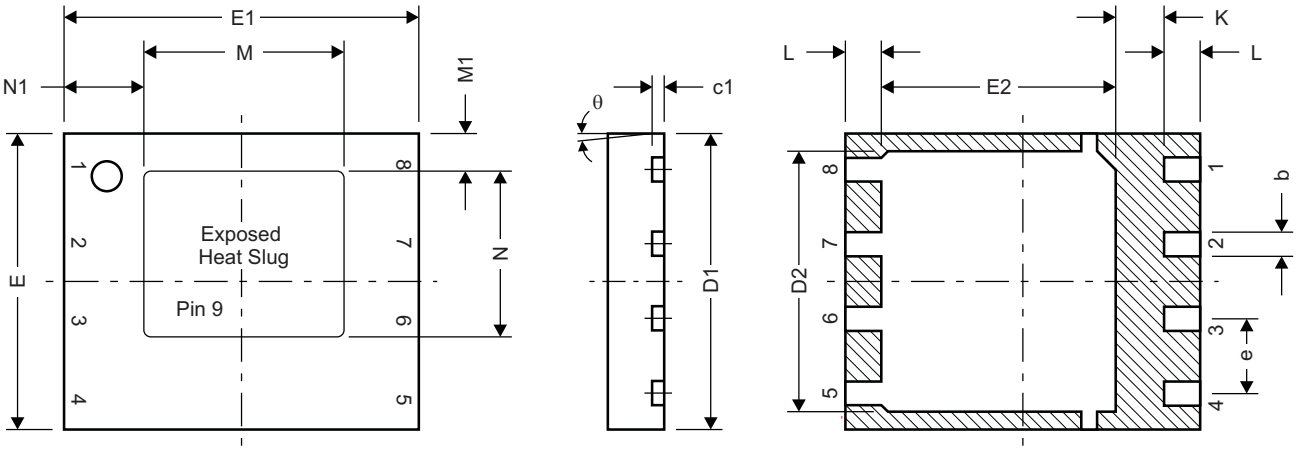
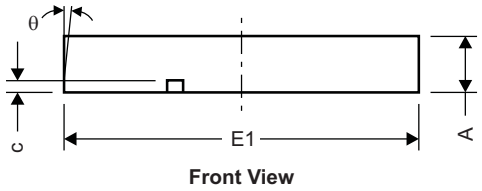



**Figure 12. Maximum Drain Current vs. Temperature**

## MECHANICAL DATA

### Q5C Package Dimensions



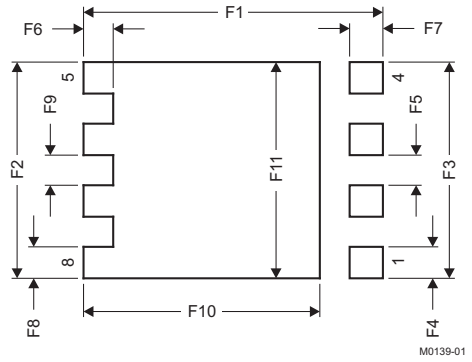




| DualCool™ Pinout | |
|---|---|
| Pin# | Label |
| 1, 2, 3, 9 | Source |
| 4 | Gate |
| 5, 6, 7, 8 | Drain |

M0162-01

| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.950 | 1.050 | 0.037 | 0.039 |
| b | 0.360 | 0.460 | 0.014 | 0.018 |
| c | 0.150 | 0.250 | 0.006 | 0.010 |
| c1 | 0.150 | 0.250 | 0.006 | 0.010 |
| D1 | 4.900 | 5.100 | 0.193 | 0.201 |
| D2 | 4.320 | 4.520 | 0.170 | 0.178 |
| E | 4.900 | 5.100 | 0.193 | 0.201 |
| E1 | 5.900 | 6.100 | 0.232 | 0.240 |
| E2 | 3.920 | 4.12 | 0.154 | 0.162 |
| e | 1.27 TYP | | 0.050 | |
| K | 0.760 | – | 0.030 | – |
| L | 0.510 | 0.710 | 0.020 | 0.028 |
| θ | – | – | – | – |
| M | 3.260 | 3.460 | 0.128 | 0.136 |
| M1 | 0.520 | 0.720 | 0.020 | 0.028 |
| N | 2.720 | 2.920 | 0.107 | 0.115 |
| N1 | 1.227 | 1.427 | 0.048 | 0.056 |

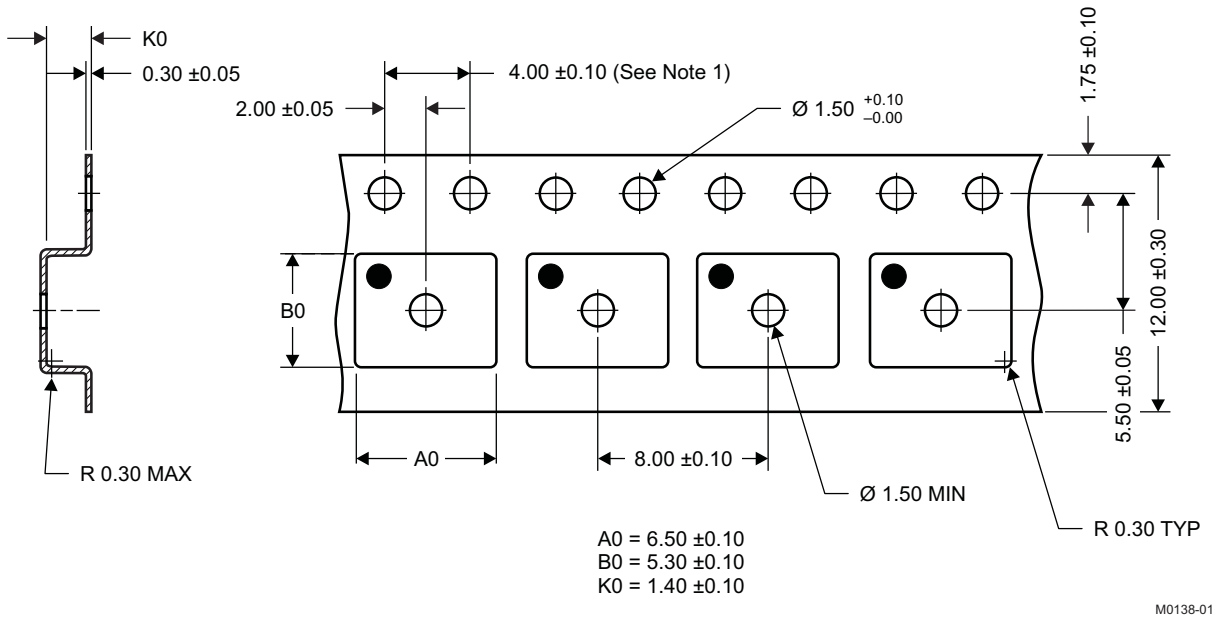
### Recommended PCB Pattern




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| F1 | 6.205 | 6.305 | 0.244 | 0.248 |
| F2 | 4.46 | 4.56 | 0.176 | 0.18 |
| F3 | 4.46 | 4.56 | 0.176 | 0.18 |
| F4 | 0.65 | 0.7 | 0.026 | 0.028 |
| F5 | 0.62 | 0.67 | 0.024 | 0.026 |
| F6 | 0.63 | 0.68 | 0.025 | 0.027 |
| F7 | 0.7 | 0.8 | 0.028 | 0.031 |
| F8 | 0.65 | 0.7 | 0.026 | 0.028 |
| F9 | 0.62 | 0.67 | 0.024 | 0.026 |
| F10 | 4.9 | 5 | 0.193 | 0.197 |
| F11 | 4.46 | 4.56 | 0.176 | 0.18 |

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

### Q5 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. A0 and B0 measured on a plane 0.3mm above the bottom of the pocket
6. MSL1 260°C (IR and convection) PbF reflow compatible

## REVISION HISTORY

| Changes from Original (December 2009) to Revision A | Page |
|---|---|
| • Changed the labels on the Bottom View pinout image | 1 |

| Changes from Revision A (February) to Revision B | Page |
|---|---|
| • the Package Marking Information section | 7 |

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CSD16408Q5C | ACTIVE | VSON-CLIP | DQU | 8 | 2500 | Pb-Free (RoHS Exempt) | CU SN | Level-1-260C-UNLIM | -55 to 150 | CSD16408C | Samples |

(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.

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

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TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

| **Products** | | **Applications** | |
|---|---|---|---|
| Audio | www.ti.com/audio | Automotive and Transportation | www.ti.com/automotive |
| Amplifiers | amplifier.ti.com | Communications and Telecom | www.ti.com/communications |
| Data Converters | dataconverter.ti.com | Computers and Peripherals | www.ti.com/computers |
| DLP® Products | www.dlp.com | Consumer Electronics | www.ti.com/consumer-apps |
| DSP | dsp.ti.com | Energy and Lighting | www.ti.com/energy |
| Clocks and Timers | www.ti.com/clocks | Industrial | www.ti.com/industrial |
| Interface | interface.ti.com | Medical | www.ti.com/medical |
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