# CSD25404Q3 –20 V P-Channel NexFET™ Power MOSFET

## 1 Features

- Ultra-Low $Q_g$ and $Q_{gd}$
- Low Thermal Resistance
- Low $R_{DS(on)}$
- Halogen Free
- RoHS Compliant
- Pb Free Terminal Plating
- SON 3.3 mm × 3.3 mm Plastic Package

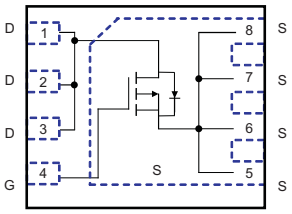
## 2 Applications

- DC-DC Converters
- Battery Management
- Load Switch
- Battery Protection

## 3 Description

This –20 V, 5.5 mΩ NexFET™ power MOSFET is designed to minimize losses in power conversion load management applications with a SON 3.3 mm × 3.3 mm package that offers an excellent thermal performance for the size of the device.

### Top View




### Product Summary

| $T_A$ = 25°C | | TYPICAL VALUE | | UNIT |
|---|---|---|---|---|
| $V_{DS}$ | Drain-to-source voltage | –20 | | V |
| $Q_g$ | Gate charge total (–4.5 V) | 10.9 | | nC |
| $Q_{gd}$ | Gate charge gate to drain | 2.2 | | nC |
| $R_{DS(on)}$ | Drain-to-source on resistance | $V_{GS}$ = –1.8 V | 40 | mΩ |
| | | $V_{GS}$ = –2.5 V | 10.1 | mΩ |
| | | $V_{GS}$ = –4.5 V | 5.5 | mΩ |
| $V_{th}$ | Threshold voltage | –0.9 | | V |

### Ordering Information(1)

| DEVICE | QTY | MEDIA | PACKAGE | SHIP |
|---|---|---|---|---|
| CSD25404Q3 | 2500 | 13-Inch Reel | SON 3.3 mm × 3.3 mm Plastic Package | Tape and Reel |
| CSD25404Q3T | 250 | 7-Inch Reel | | |

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

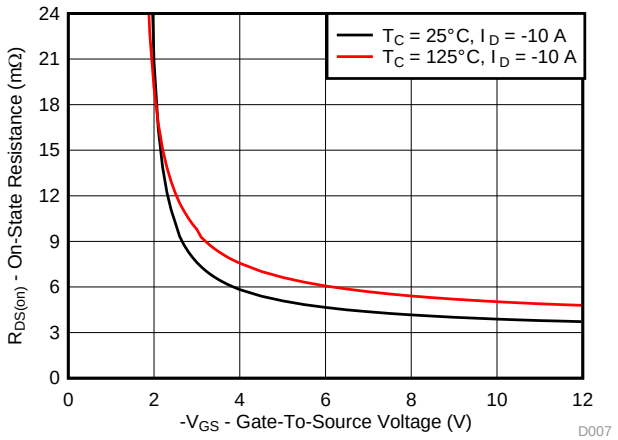
### Absolute Maximum Ratings

| $T_A$ = 25°C | | VALUE | UNIT |
|---|---|---|---|
| $V_{DS}$ | Drain-to-source voltage | –20 | V |
| $V_{GS}$ | Gate-to-source voltage | ±12 | V |
| $I_D$ | Continuous drain current, $T_C$ = 25°C | –104 | A |
| | Continuous drain current (package limit) | –60 | |
| | Continuous drain current(1) | –18 | |
| $I_{DM}$ | Pulsed drain current(2) | –240 | A |
| $P_D$ | Power dissipation(1) | 2.8 | W |
| | Power dissipation, $T_C$ = 25°C | 96 | |
| $T_J$, $T_{stg}$ | Operating junction, storage temperature | –55 to 150 | °C |

(1) $R_{\theta JA}$ = 45°C/W on 1 inch$^2$ Cu (2 oz.) on 0.060 inch thick FR4 PCB.

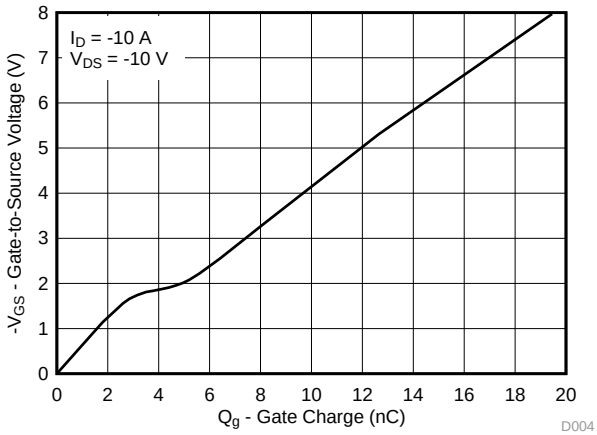
(2) Max $R_{\theta JC}$ = 1.3, pulse duration ≤100 µs, duty cycle ≤1%.

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




D007

### Gate Charge




D004

# Table of Contents



## 4 Revision History

| DATE | REVISION | NOTES |
|---|---|---|
| November 2015 | * | Initial release. |

# 5 Specifications

## 5.1 Electrical Characteristics

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

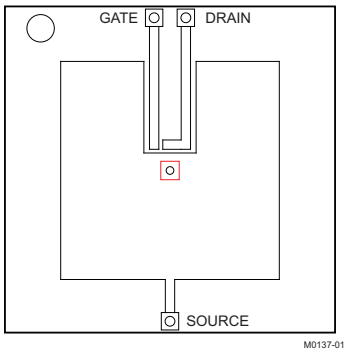
| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **STATIC CHARACTERISTICS** | | | | | | |
| $BV_{DSS}$ | Drain-to-source voltage | $V_{GS}$ = 0 V, $I_D$ = –250 µA | –20 | | | V |
| $I_{DSS}$ | Drain-to-source leakage current | $V_{GS}$ = 0 V, $V_{DS}$ = –16 V | | | –1 | µA |
| $I_{GSS}$ | Gate-to-source leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ±12 V | | | –100 | nA |
| $V_{GS(th)}$ | Gate-to-source threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = –250 µA | –0.65 | –0.90 | –1.15 | V |
| $R_{DS(on)}$ | Drain-to-source on resistance | $V_{GS}$ = –1.8 V, $I_D$ = –1 A | | 40 | 150 | mΩ |
| | | $V_{GS}$ = –2.5 V, $I_D$ = –10 A | | 10.1 | 12.1 | mΩ |
| | | $V_{GS}$ = –4.5 V, $I_D$ = –10 A | | 5.5 | 6.5 | mΩ |
| $g_{fs}$ | Transconductance | $V_{DS}$ = –10 V, $I_D$ = –10 A | | 47 | | S |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| $C_{ISS}$ | Input capacitance | $V_{GS}$ = 0 V, $V_{DS}$ = –10 V, $f$ = 1 MHz | | 1630 | 2120 | pF |
| $C_{OSS}$ | Output capacitance | | | 902 | 1170 | pF |
| $C_{RSS}$ | Reverse transfer capacitance | | | 52 | 68 | pF |
| $R_G$ | Series gate resistance | | | 0.8 | 2.4 | Ω |
| $Q_g$ | Gate charge total (–4.5 V) | $V_{DS}$ = –10 V, $I_D$ = –10 A | | 10.8 | 14.1 | nC |
| $Q_{gd}$ | Gate charge gate to drain | | | 2.2 | | nC |
| $Q_{gs}$ | Gate charge gate to source | | | 2.8 | | nC |
| $Q_{g(th)}$ | Gate charge at $V_{th}$ | | | 1.5 | | nC |
| $Q_{OSS}$ | Output charge | $V_{DS}$ = –10 V, $V_{GS}$ = 0 V | | 9.0 | | nC |
| $t_{d(on)}$ | Turn on delay time | $V_{DS}$ = –10 V, $V_{GS}$ = –4.5 V, $I_D$ = –10 A , $R_G$ = 5 Ω | | 13 | | ns |
| $t_r$ | Rise time | | | 8 | | ns |
| $t_{d(off)}$ | Turn off delay time | | | 35 | | ns |
| $t_f$ | Fall time | | | 13 | | ns |
| **DIODE CHARACTERISTICS** | | | | | | |
| $V_{SD}$ | Diode forward voltage | $I_S$ = –10 A, $V_{GS}$ = 0 V | | –0.8 | –1 | V |
| $Q_{rr}$ | Reverse recovery charge | $V_{DS}$ = –10 V, $I_F$ = –10 A, di/dt = 200 A/µs | | 20.5 | | nC |
| $t_{rr}$ | Reverse recovery time | | | 26 | | ns |

## 5.2 Thermal Information

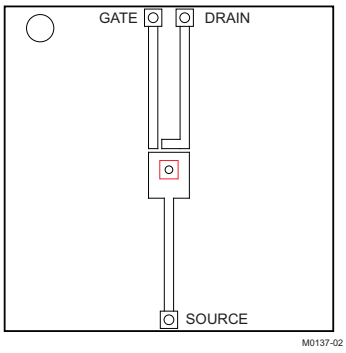
($T_A$ = 25°C unless otherwise stated)

| THERMAL METRIC | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-case thermal resistance(1) | | | 1.3 | °C/W |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance(1)(2) | | | 55 | °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 $R_{\theta JA}$ = 55°C/W when mounted on 1 inch$^2$ of 2 oz. Cu.




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

## 5.3 Typical MOSFET Characteristics

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

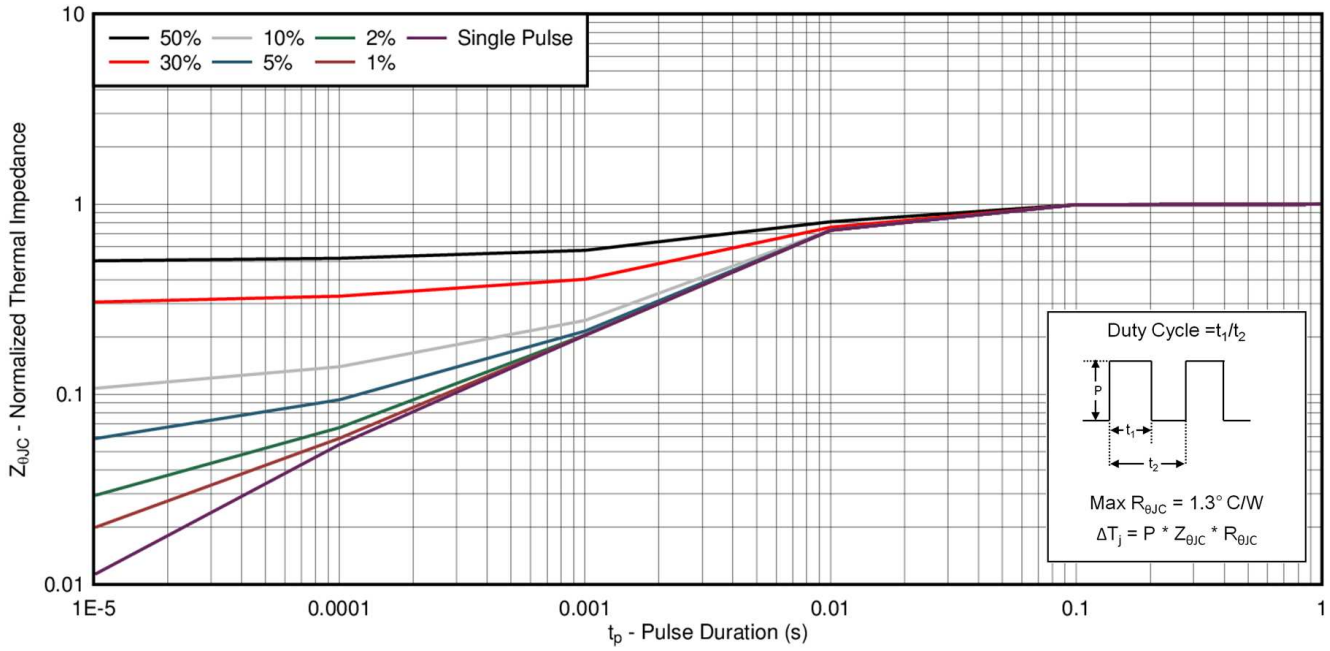



**Figure 1. Transient Thermal Impedance**

## Typical MOSFET Characteristics (continued)

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

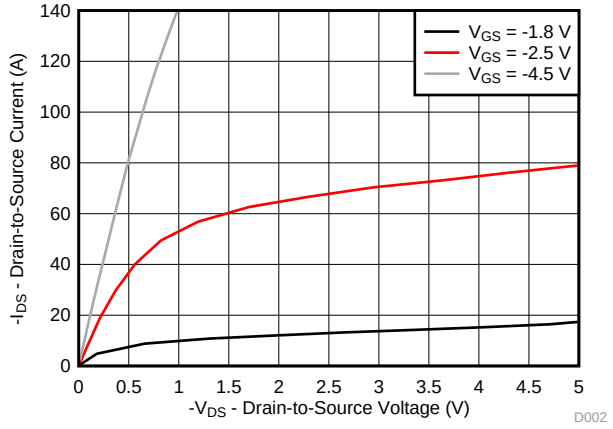
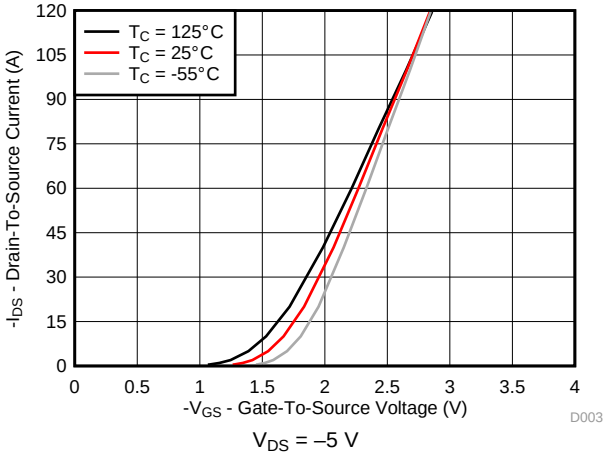
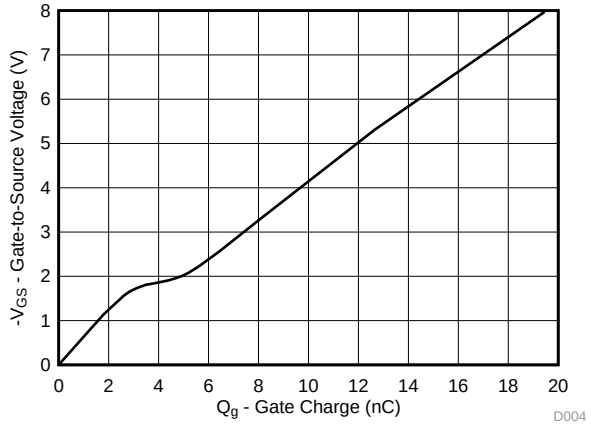



**Figure 2. Saturation Characteristics**




VDS = –5 V

**Figure 3. Transfer Characteristics**




ID = –10 A VDS = –10 V

**Figure 4. Gate Charge**

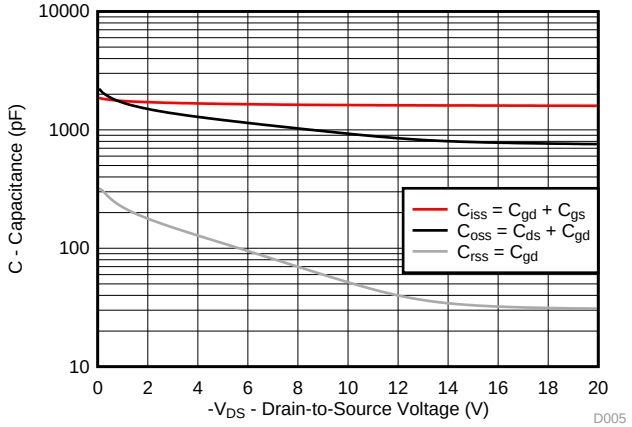
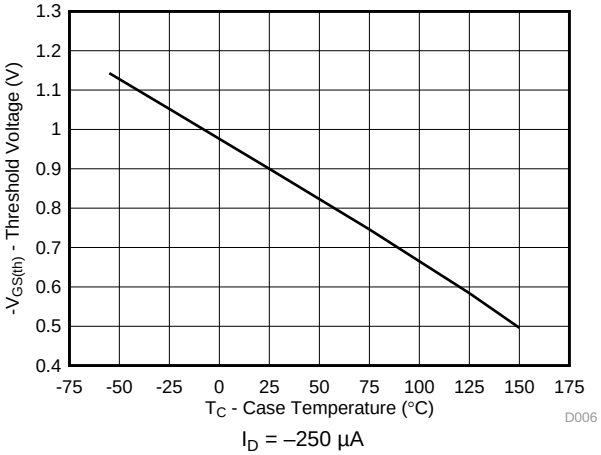



**Figure 5. Capacitance**




ID = –250 µA

**Figure 6. Threshold Voltage vs Temperature**

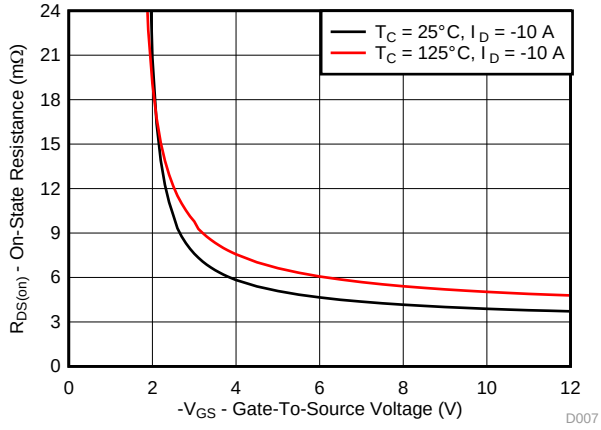
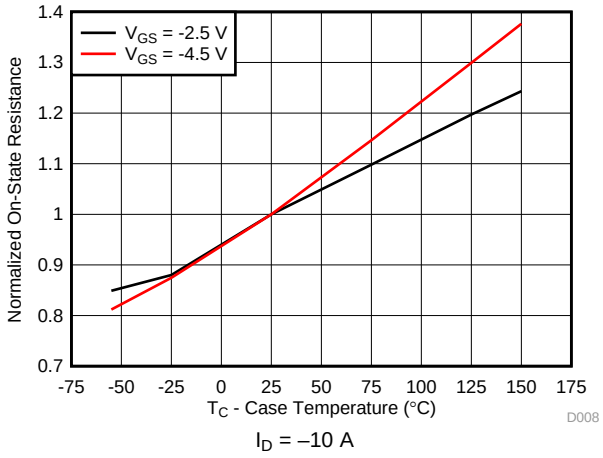



**Figure 7. On-State Resistance vs Gate-to-Source Voltage**

## Typical MOSFET Characteristics (continued)

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




$I_D$ = –10 A

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

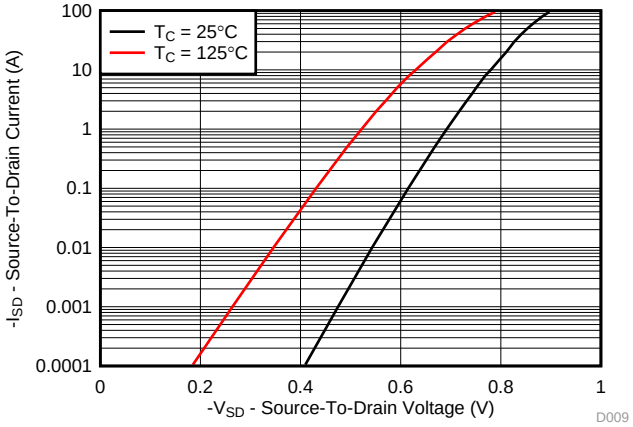
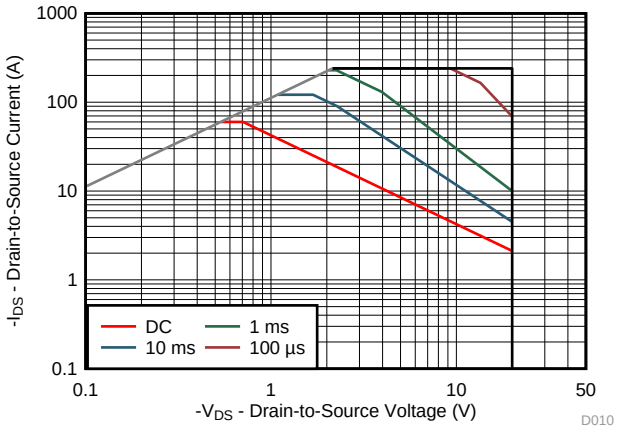



**Figure 9. Typical Diode Forward Voltage**




Single Pulse, Max $R_{\theta JC}$ = 1.3 °C/W

**Figure 10. Maximum Safe Operating Area**

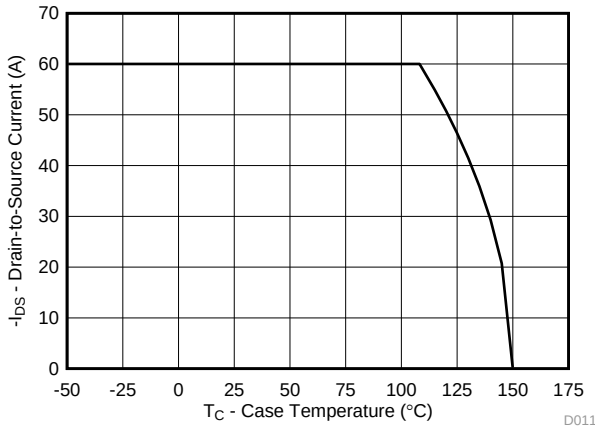



**Figure 11. Maximum Drain Current vs Temperature**

# 6 Device and Documentation Support

## 6.1 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.

## 6.2 Trademarks

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

## 6.3 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.

## 6.4 Glossary

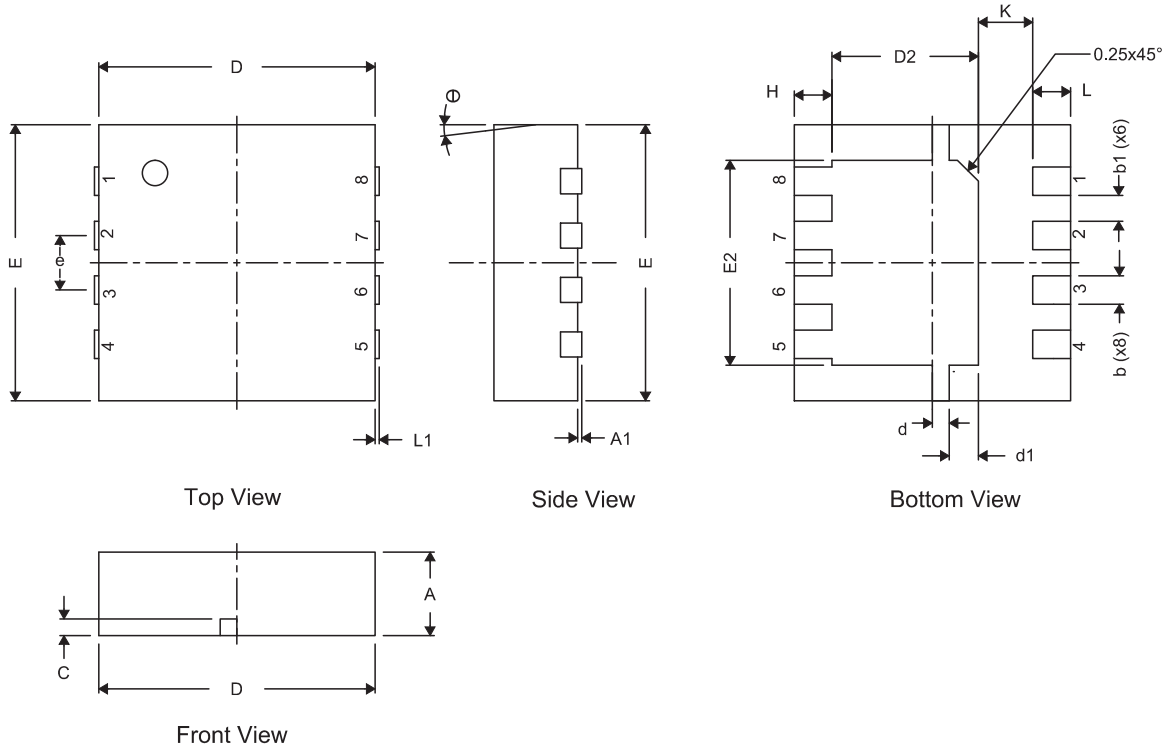
SLYZ022 — *TI Glossary*.

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

# 7 Mechanical, Packaging, and Orderable Information

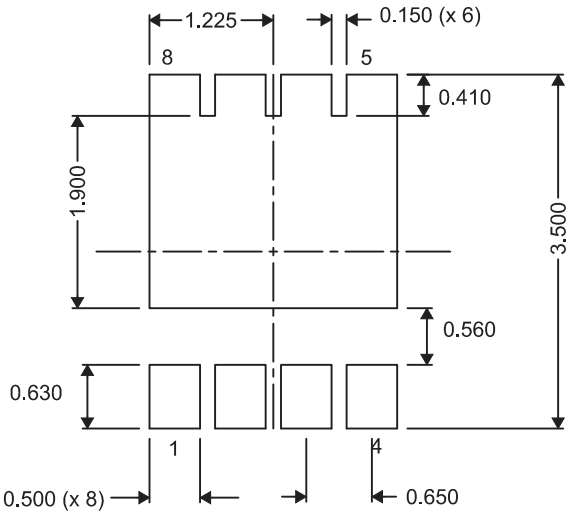
The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand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

## 7.1 CSD25404Q3 Package Dimensions



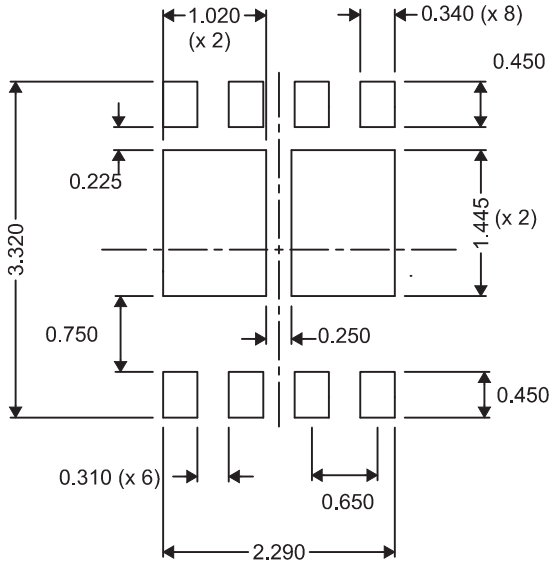

| DIM | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.950 | 1.000 | 1.100 | 0.037 | 0.039 | 0.043 |
| A1 | 0.000 | 0.000 | 0.050 | 0.000 | 0.000 | 0.002 |
| b | 0.280 | 0.340 | 0.400 | 0.011 | 0.013 | 0.016 |
| b1 | | 0.310 NOM | | | 0.012 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 |
| θ | 0 | — | 0 | 0 | — | 0 |

## 7.2 Recommended PCB Pattern



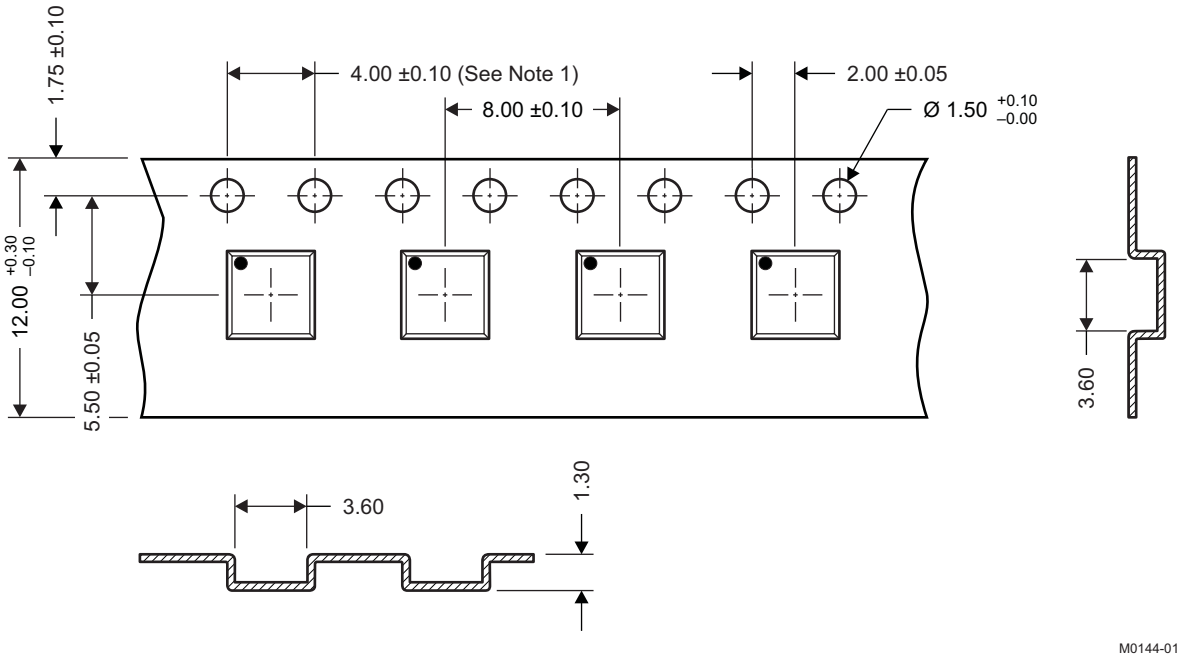

For recommended circuit layout for PCB designs, see application note SLPA005 – *Reducing Ringing Through PCB Layout Techniques*.

## 7.3 Recommended Stencil Opening




All dimensions are in mm, unless otherwise specified.

## 7.4 Q3 Tape and Reel Information




**Notes:**

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

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CSD25404Q3 | ACTIVE | VSON-CLIP | DQG | 8 | 2500 | Pb-Free (RoHS Exempt) | CU SN | Level-1-260C-UNLIM | -55 to 150 | CSD25404 | Samples |
| CSD25404Q3T | ACTIVE | VSON-CLIP | DQG | 8 | 250 | Pb-Free (RoHS Exempt) | CU SN | Level-1-260C-UNLIM | -55 to 150 | CSD25404 | 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.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

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 |
| Logic | logic.ti.com | Security | www.ti.com/security |
| Power Mgmt | power.ti.com | Space, Avionics and Defense | www.ti.com/space-avionics-defense |
| Microcontrollers | microcontroller.ti.com | Video and Imaging | www.ti.com/video |
| RFID | www.ti-rfid.com | | |
| OMAP Applications Processors | www.ti.com/omap | **TI E2E Community** | e2e.ti.com |
| Wireless Connectivity | www.ti.com/wirelessconnectivity | | |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265