1 Features

- Ultra-Low $Q_g$ and $Q_{gd}$
- Low Thermal Resistance
- Lead-Free Terminal Plating
- RoHS Compliant
- Halogen Free
- SON 2-mm × 2-mm Plastic Package

2 Applications

- DC-DC Converters
- Battery and Load Management Applications

3 Description

This 25-V, 19-mΩ, 2-mm × 2-mm SON NexFET™ power MOSFET has been designed to minimize losses in power conversion and load management applications. The 2-mm × 2-mm SON package offers excellent thermal performance for the size of the package.

Product Summary

<table>
<thead>
<tr>
<th>$T_a = 25^\circ C$</th>
<th>TYPICAL VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DS}$</td>
<td>Drain-to-Source Voltage</td>
<td>25</td>
</tr>
<tr>
<td>$Q_g$</td>
<td>Gate Charge Total (4.5 V)</td>
<td>2</td>
</tr>
<tr>
<td>$Q_{gd}$</td>
<td>Gate Charge Gate-to-Drain</td>
<td>0.4</td>
</tr>
<tr>
<td>$R_{DS(on)}$</td>
<td>Drain-to-Source On Resistance</td>
<td></td>
</tr>
<tr>
<td>$V_{DS} = 3$ V</td>
<td>27</td>
<td>mΩ</td>
</tr>
<tr>
<td>$V_{DS} = 4.5$ V</td>
<td>23</td>
<td>mΩ</td>
</tr>
<tr>
<td>$V_{DS} = 8$ V</td>
<td>19</td>
<td>mΩ</td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>Threshold Voltage</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Device Information (1)

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>QTY</th>
<th>MEDIA</th>
<th>PACKAGE</th>
<th>SHIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD16301Q2</td>
<td>3000</td>
<td>7-Inch Reel</td>
<td>SON 2.00-mm × 2.00-mm Plastic Package</td>
<td>Tape and Reel</td>
</tr>
<tr>
<td>CSD16301Q2T</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>$T_a = 25^\circ C$</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DS}$</td>
<td>Drain-to-Source Voltage</td>
<td>25</td>
</tr>
<tr>
<td>$V_{GS}$</td>
<td>Gate-to-Source Voltage</td>
<td>+10 / –8</td>
</tr>
<tr>
<td>$I_D$</td>
<td>Continuous Drain Current (Package Limited)</td>
<td>5</td>
</tr>
<tr>
<td>$I_D$</td>
<td>Continuous Drain Current (Silicon Limited), $T_C = 25^\circ C$</td>
<td>20</td>
</tr>
<tr>
<td>$I_D$</td>
<td>Continuous Drain Current (1)</td>
<td>8.2</td>
</tr>
<tr>
<td>$I_{DM}$</td>
<td>Pulsed Drain Current (2)</td>
<td>85</td>
</tr>
<tr>
<td>$P_D$</td>
<td>Power Dissipation (1)</td>
<td>2.5</td>
</tr>
<tr>
<td>$P_D$</td>
<td>Power Dissipation, $T_C = 25^\circ C$</td>
<td>15</td>
</tr>
<tr>
<td>$T_J$, $T_{STG}$</td>
<td>Operating Junction, Storage Temperature</td>
<td>–55 to 150</td>
</tr>
<tr>
<td>$E_{AS}$</td>
<td>Avalanche Energy, Single Pulse $I_D = 14$ A, $L = 0.1$ mH, $R_G = 25$ Ω</td>
<td>10</td>
</tr>
</tbody>
</table>

(1) Typical $R_{\theta JA} = 50^\circ C/W$ on a 1-in$^2$, 2-oz Cu pad on a 0.06-in thick FR4 PCB.
(2) Max $R_{\theta JC} = 8.4^\circ C/W$, pulse duration ≤ 100 μs, duty cycle ≤ 1%.
Table of Contents

1 Features.................................................................................. 1
2 Applications ............................................................................. 1
3 Description ............................................................................... 1
4 Revision History ......................................................................... 2
5 Specifications ........................................................................... 3
   5.1 Electrical Characteristics................................................. 3
   5.2 Thermal Information.......................................................... 3
   5.3 Typical MOSFET Characteristics................................. 4
6 Device and Documentation Support................................. 7
   6.1 Receiving Notification of Documentation Updates.... 7

7 Mechanical, Packaging, and Orderable Information ... 8
   7.1 Q2 Package Dimensions ............................................ 8
   7.2 Recommended PCB Pattern .................................... 9
   7.3 Recommended Stencil Pattern .................................... 10
   7.4 Q2 Tape and Reel Information .............................. 11

4 Revision History

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

Changes from Revision C (July 2011) to Revision D Page

• Changed Description text ................................................................. 1
• Changed Qg voltage condition from –4.5 V : to 4.5 V in Product Summary table ................................................................. 1
• Added silicon limited continuous drain current to Absolute Maximum Ratings table ................................................................. 1
• Added max power dissipation at Tc = 25°C to Absolute Maximum Ratings table ................................................................. 1
• Changed Note 1 and Note 2 in Absolute Maximum Ratings table ......................................................................................... 1
• Changed RθJA max from 69°C/W : to 65°C/W ................................................................................................................................. 3
• Changed Figure 1 to reflect a transient RθJC curve .................................................................................................................... 4
• Changed the safe operating area in Figure 10 to reflect measured data......................................................................................... 5
• Added Device and Documentation Support section ................................................................................................................ 7
• Changed MECHANICAL DATA section to Mechanical, Packaging, and Orderable Information section .................. 8

Changes from Revision B (April 2010) to Revision C Page

• Added a 7-Inch Reel option to the Ordering Information Table.............................................................................................. 1

Changes from Revision A (December 2009) to Revision B Page

• Added title to Figure 11 - Single Pulse Unclamped Inductive Switching ................................................................................ 5

Changes from Original (October 2009) to Revision A Page

• Changed the Electrical Characteristics table - VGS(th) MAX value From: 1.4V To 1.55V ................................................................. 3
## 5 Specifications

### 5.1 Electrical Characteristics

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STATIC CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$BV_{DSS}$</td>
<td>$V_{GS} = 0$ V, $I_D = 250$ μA</td>
<td>25</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>$V_{GS} = 0$ V, $V_{DS} = 20$ V</td>
<td>1</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{GSS}$</td>
<td>$V_{DS} = 0$ V, $V_{GS} = +10$/$-8$ V</td>
<td>100</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>$V_{DS} = V_{GS}, I_D = 250$ μA</td>
<td>0.9</td>
<td>1.1</td>
<td>1.55</td>
<td>V</td>
</tr>
<tr>
<td>$R_{DS(on)}$</td>
<td>$V_{GS} = 3$ V, $I_D = 4$ A</td>
<td>27</td>
<td>34</td>
<td></td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td>$V_{GS} = 4.5$ V, $I_D = 4$ A</td>
<td>23</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{GS} = 8$ V, $I_D = 4$ A</td>
<td>19</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$g_m$</td>
<td>$V_{DS} = 15$ V, $I_D = 4$ A</td>
<td></td>
<td>16.5</td>
<td></td>
<td>S</td>
</tr>
<tr>
<td><strong>DYNAMIC CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{GS}$</td>
<td>$V_{GS} = 0$ V, $V_{DS} = 12.5$ V, $f = 1$ MHz</td>
<td>260</td>
<td>340</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{OSS}$</td>
<td>$V_{GS} = 0$ V, $V_{DS} = 12.5$ V, $f = 1$ MHz</td>
<td>165</td>
<td>215</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{RSS}$</td>
<td>$V_{DS} = 10$ V, $I_D = 4$ A</td>
<td>13</td>
<td>17</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$R_g$</td>
<td>$V_{DS} = 10$ V, $I_D = 4$ A</td>
<td>1.3</td>
<td>2.6</td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>$Q_{th}$</td>
<td>$V_{GS} = 0$ V, $V_{DS} = 0$ V</td>
<td>2.0</td>
<td>2.8</td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{gs}$</td>
<td>$V_{DS} = 12.5$ V, $V_{GS} = 0$ V</td>
<td>0.4</td>
<td></td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{g(th)}$</td>
<td>$V_{GS} = 0$ V, $V_{DS} = 12.5$ V</td>
<td>0.6</td>
<td></td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{OSS}$</td>
<td>$V_{DS} = 12.5$ V, $V_{GS} = 0$ V</td>
<td>0.3</td>
<td></td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>$t_{d(on)}$</td>
<td>$V_{DS} = 12.5$ V, $V_{GS} = 4.5$ V, $I_D = 4$ A, $R_G = 2$ Ω</td>
<td>2.7</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{r}$</td>
<td>$V_{DS} = 12.5$ V, $V_{GS} = 4.5$ V, $I_D = 4$ A, $R_G = 2$ Ω</td>
<td>4.4</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{d(off)}$</td>
<td>$V_{DS} = 12.5$ V, $V_{GS} = 4.5$ V, $I_D = 4$ A, $di/dt = 200$ A/μs</td>
<td>4.1</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{f}$</td>
<td>$V_{DS} = 12.5$ V, $V_{GS} = 4.5$ V, $I_D = 4$ A, $di/dt = 200$ A/μs</td>
<td>1.7</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td><strong>DIODE CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{GD}$</td>
<td>$I_D = 4$ A, $V_{GS} = 0$ V</td>
<td>0.8</td>
<td>1</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$Q_{tr}$</td>
<td>$V_{DD} = 12.5$ V, $I_F = 4$ A, $di/dt = 200$ A/μs</td>
<td>5.1</td>
<td></td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>$V_{DD} = 12.5$ V, $I_F = 4$ A, $di/dt = 200$ A/μs</td>
<td>11</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

### 5.2 Thermal Information

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

<table>
<thead>
<tr>
<th>THERMAL METRIC</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{JUC}$</td>
<td></td>
<td></td>
<td>8.4</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{JA}$</td>
<td></td>
<td></td>
<td>65</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

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

(2) Device mounted on FR4 material with 1-in$^2$ (6.45-cm$^2$), 2-oz (0.071-mm) thick Cu.
Max $R_{\text{thJA}} = 65^\circ\text{C/W}$ when mounted on 1 in$^2$ (6.45 cm$^2$) of 2-oz (0.071-mm) thick Cu.

Max $R_{\text{thJA}} = 250^\circ\text{C/W}$ when mounted on minimum pad area of 2-oz (0.071-mm) thick Cu.

5.3 Typical MOSFET Characteristics

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

Figure 1. Transient Thermal Impedance
Typical MOSFET Characteristics (continued)

\( T_A = 25^\circ C \) (unless otherwise specified)

![Saturation Characteristics](image1)

\( V_{DS} = 5 \text{ V} \)

![Transfer Characteristics](image2)

\( V_{GS} = 3 \text{ V}, \ V_{GS} = 4.5 \text{ V}, \ V_{GS} = 8 \text{ V} \)

![Gate Charge](image3)

\( I_D = 4 \text{ A}, \ V_{DS} = 50 \text{ V} \)

![Capacitance](image4)

\( C_{iss} = C_{gd} + C_{gs}, \ C_{oss} = C_{ds} + C_{gd}, \ C_{rss} = C_{gd} \)

![Threshold Voltage vs Temperature](image5)

\( I_D = 250 \mu \text{A}, \ T_C = -75^\circ C \rightarrow 175^\circ C \)

![On-State Resistance vs Gate-to-Source Voltage](image6)

\( T_C = 25^\circ C, I_D = 4 \text{ A}, \ T_C = 125^\circ C, I_D = 4 \text{ A} \)
Typical MOSFET Characteristics (continued)

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

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
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 Q2 Package Dimensions

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pads must be soldered to the printed circuit board for thermal and mechanical performance.
7.2 Recommended PCB Pattern

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

2. This package is designed to be soldered to a thermal pad on the board. For more information, see *QFN/SON PCB Attachment* (SLUA271).
7.3 Recommended Stencil Pattern

1. All linear dimensions are in millimeters.
2. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7.4 Q2 Tape and Reel Information

Notes:
1. Measured from centerline of sprocket hole to centerline of pocket.
2. Cumulative tolerance of 10 sprocket holes is ±0.2.
3. Other material available.
4. Typical SR of form tape Max 10⁹ OHM/SQ.
5. All dimensions are in mm, unless otherwise specified.
## PACKAGING INFORMATION

<table>
<thead>
<tr>
<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead/Ball Finish (6)</th>
<th>MSL Peak Temp (3)</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD16301Q2</td>
<td>ACTIVE</td>
<td>WSON</td>
<td>DQK</td>
<td>6</td>
<td>3000</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>-55 to 150</td>
<td>1631</td>
<td></td>
</tr>
</tbody>
</table>

(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 <=1000ppm 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/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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