

# CSD16415Q5 25-V N-Channel NexFET™ Power MOSFET

## 1 Features

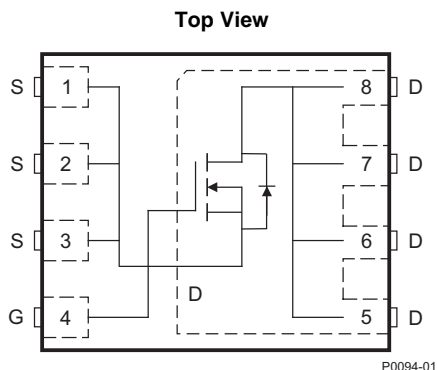
- Ultralow  $Q_g$  and  $Q_{gd}$
- Very Low On-Resistance
- Low Thermal Resistance
- Avalanche Rated
- Pb-Free Terminal Plating
- RoHS Compliant
- Halogen-Free

## 2 Applications

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

## 3 Description

This 25 V, 1.3 mΩ, 5 x 6 mm SON NexFET™ power MOSFET has been designed to minimize losses in power conversion applications.



### Product Summary

$T_A = 25^\circ\text{C}$		VALUE	UNIT
$V_{DS}$	Drain-to-Source Voltage	25	V
$Q_g$	Gate Charge, Total (4.5 V)	21	nC
$Q_{gd}$	Gate Charge, Gate-to-Drain	5.2	nC
$R_{DS(on)}$	Drain-to-Source On Resistance	$V_{GS} = 4.5\text{ V}$	1.5 mΩ
		$V_{GS} = 10\text{ V}$	0.99 mΩ
$V_{GS(th)}$	Threshold Voltage	1.5	V

### Device Information<sup>(1)</sup>

DEVICE	PACKAGE	MEDIA	QTY	SHIP
CSD16415Q5	SON 5-mm x 6-mm Plastic Package	13-inch Reel	2500	Tape and Reel

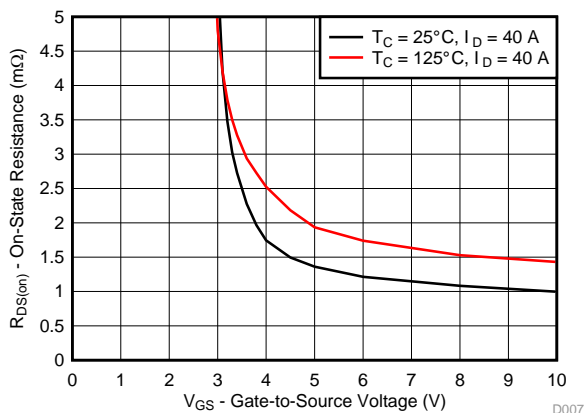
(1) For all available packages, see the orderable addendum at the end of the data sheet.

### Absolute Maximum Ratings

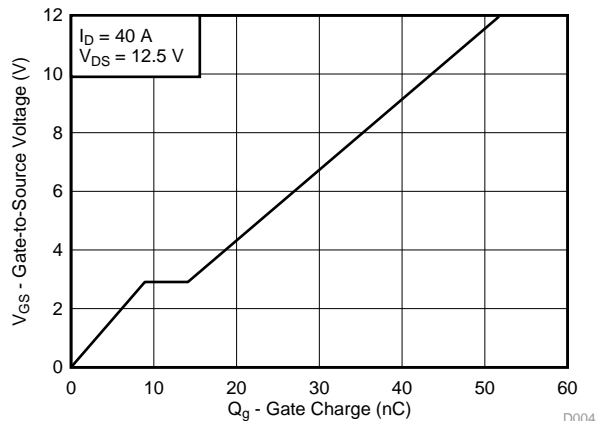
$T_A = 25^\circ\text{C}$		VALUE	UNIT
$V_{DS}$	Drain-to-Source Voltage	25	V
$V_{GS}$	Gate-to-Source Voltage	-12 to 16	V
$I_D$	Continuous Drain Current (Package Limited)	100	A
	Continuous Drain Current (Silicon Limited), $T_C = 25^\circ\text{C}$ <sup>(1)</sup>	261	
	Continuous Drain Current <sup>(1)</sup>	38	
$I_{DM}$	Pulsed Drain Current, $T_A = 25^\circ\text{C}$ <sup>(2)</sup>	200	A
$P_D$	Power dissipation <sup>(1)</sup>	3.2	W
	Power Dissipation, $T_C = 25^\circ\text{C}$	156	
$T_J$ , $T_{stg}$	Operating Junction and Storage Temperature	-55 to 150	°C
$E_{AS}$	Avalanche Energy, Single-Pulse $I_D = 100\text{ A}$ , $L = 0.1\text{ mH}$ , $R_G = 25\ \Omega$	500	mJ

- (1)  $R_{\theta JA} = 40^\circ\text{C/W}$  on 1 in<sup>2</sup> (6.45 cm<sup>2</sup>) Cu [2 oz. (0.071 mm thick)] on 0.060 inch (1.52 mm) thick FR4 PCB.
- (2) Max  $R_{\theta JC} = 0.8^\circ\text{C/W}$ , pulse duration  $\leq 100\ \mu\text{s}$ , duty cycle  $\leq 1\%$

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



**Gate Charge**



## Table of Contents

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## 4 Revision History

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

Changes from Original (August 2014) to Revision A	Page
• Added part number to title .....	1
• Enhanced <a href="#">Description</a> .....	1
• Added <i>Device and Documentation Support</i> section and <i>Mechanical, Packaging, and Orderable Information</i> section .....	1
• Updated pulsed current .....	1
• Updated <a href="#">Figure 1</a> to a normalized $R_{\theta JC}$ curve .....	4
• Updated the SOA in <a href="#">Figure 10</a> .....	5
• Deleted <i>Package Marking Information</i> section at the end of the data sheet.....	10

## 5 Specifications

### 5.1 Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>STATIC CHARACTERISTICS</b>						
$BV_{DSS}$	Drain-to-Source Voltage	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	25			V
$I_{DSS}$	Drain-to-Source Leakage Current	$V_{GS} = 0\text{ V}, V_{DS} = 20\text{ V}$			1	$\mu\text{A}$
$I_{GSS}$	Gate-to-Source Leakage Current	$V_{DS} = 0\text{ V}, V_{GS} = -12\text{ V to } 16\text{ V}$			100	nA
$V_{GS(th)}$	Gate-to-Source Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	1.2	1.5	1.9	V
$R_{DS(on)}$	Drain-to-Source On Resistance	$V_{GS} = 4.5\text{ V}, I_D = 40\text{ A}$		1.5	1.8	m $\Omega$
		$V_{GS} = 10\text{ V}, I_D = 40\text{ A}$	0.99	1.15		m $\Omega$
$g_{fs}$	Transconductance	$V_{DS} = 15\text{ V}, I_D = 40\text{ A}$		168		S
<b>DYNAMIC CHARACTERISTICS</b>						
$C_{ISS}$	Input Capacitance	$V_{GS} = 0\text{ V}, V_{DS} = 12.5\text{ V}, f = 1\text{ MHz}$		3150	4100	pF
$C_{OSS}$	Output Capacitance			2530	3300	pF
$C_{RSS}$	Reverse Transfer Capacitance			175	230	pF
$R_g$	Series Gate Resistance		1.2	2.4		$\Omega$
$Q_g$	Gate Charge Total (4.5 V)	$V_{DS} = 12.5\text{ V}, I_D = 40\text{ A}$		21	29	nC
$Q_{gd}$	Gate Charge, Gate-to-Drain			5.2		nC
$Q_{gs}$	Gate Charge, Gate-to-Source			8.3		nC
$Q_{g(th)}$	Gate Charge at $V_{th}$			4.8		nC
$Q_{OSS}$	Output Charge	$V_{DS} = 15\text{ V}, V_{GS} = 0\text{ V}$		55		nC
$t_{d(on)}$	Turnon Delay Time	$V_{DS} = 12.5\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 40\text{ A}$ $R_G = 2\ \Omega$		16.6		ns
$t_r$	Rise Time			30		ns
$t_{d(off)}$	Turn Off Delay Time			20		ns
$t_f$	Fall Time			12.7		ns
<b>DIODE CHARACTERISTICS</b>						
$V_{SD}$	Diode Forward Voltage	$I_S = 40\text{ A}, V_{GS} = 0\text{ V}$	0.85	1		V
$Q_{rr}$	Reverse Recovery Charge	$V_{DD} = 15\text{ V}, I_F = 40\text{ A}, di/dt = 300\text{ A}/\mu\text{s}$		72		nC
$t_{rr}$	Reverse Recovery Time	$V_{DD} = 15\text{ V}, I_F = 40\text{ A}, di/dt = 300\text{ A}/\mu\text{s}$		45		ns

### 5.2 Thermal Information

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

THERMAL METRIC		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Thermal resistance, junction-to-case <sup>(1)</sup>			0.8	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal resistance, junction-to-ambient <sup>(1) (2)</sup>			50	$^\circ\text{C}/\text{W}$

(1)  $R_{\theta JC}$  is determined with the device mounted on a 1 inch (2.54 cm) square, 2 oz. (0.071 mm thick) Cu pad on a 1.5 inch x 1.5 inch (3.81 cm x 3.81 cm), 0.060 inch (1.52 mm) thick FR4 board.  $R_{\theta JC}$  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<sup>2</sup> (6.45 cm<sup>2</sup>) of 2 oz. (0.071 mm thick) Cu.

CSD16415Q5

SLPS259A – DECEMBER 2011 – REVISED SEPTEMBER 2015

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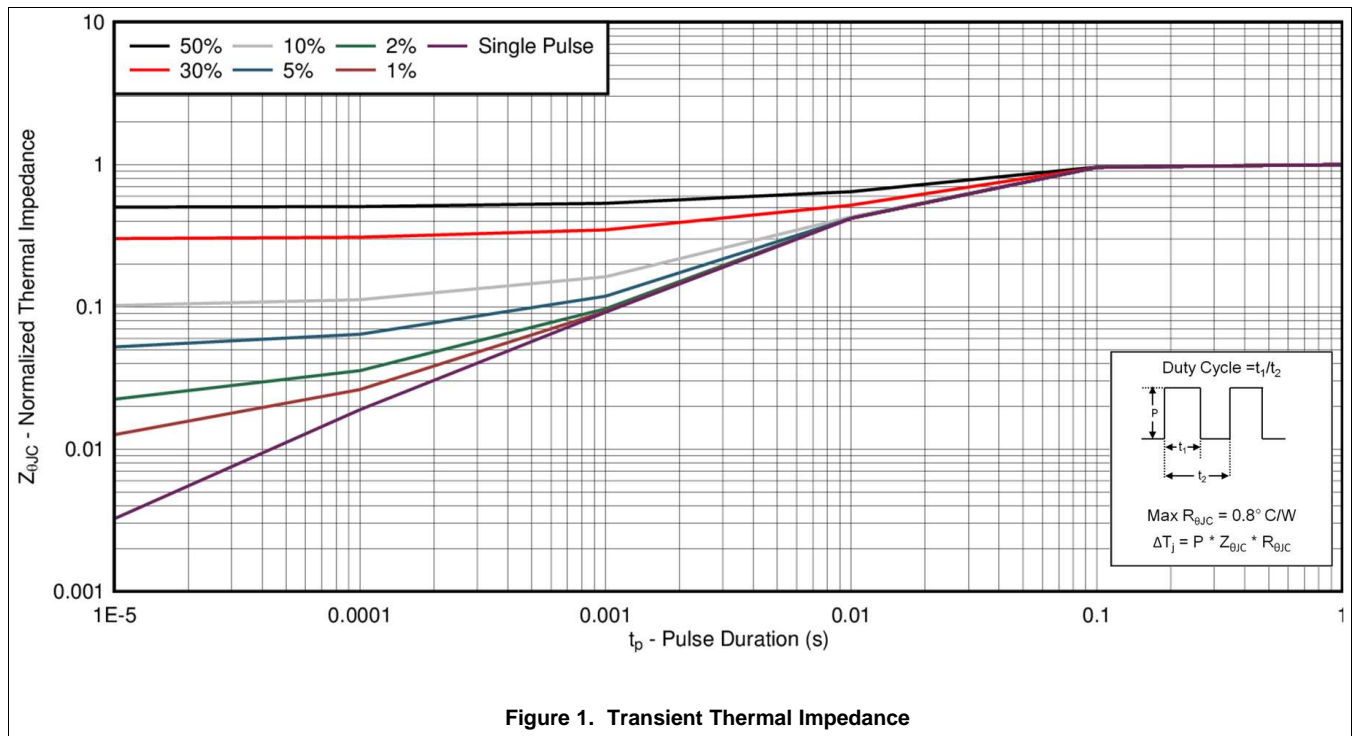
Max  $R_{\theta JA} = 50^{\circ}\text{C/W}$   
when mounted on 1  
 $\text{inch}^2$  ( $6.45 \text{ cm}^2$ ) of 2  
oz. (0.071 mm thick)  
Cu.



Max  $R_{\theta JA} = 125^{\circ}\text{C/W}$   
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 noted)



Typical MOSFET Characteristics (continued)

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

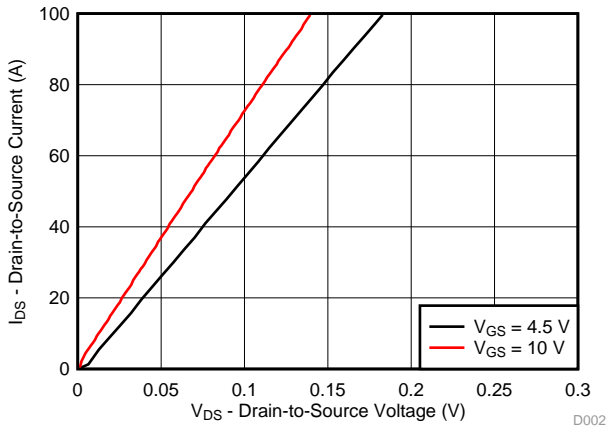


Figure 2. Saturation Characteristics

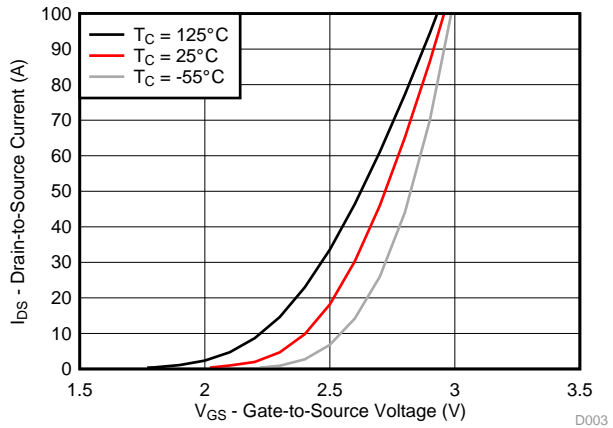


Figure 3. Transfer Characteristics

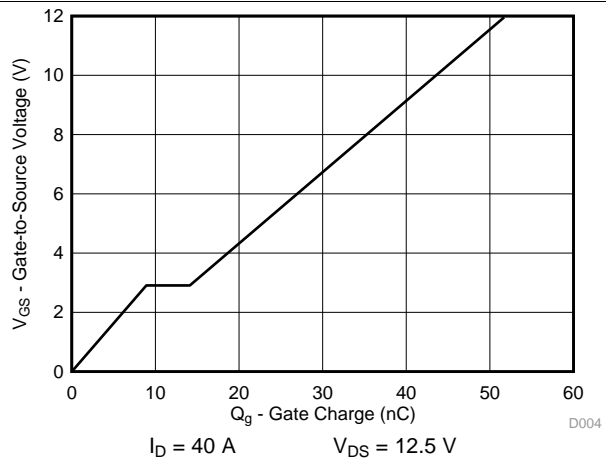


Figure 4. Gate Charge

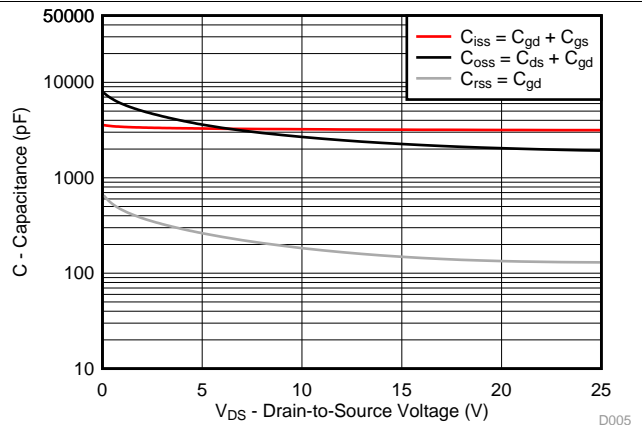


Figure 5. Capacitance

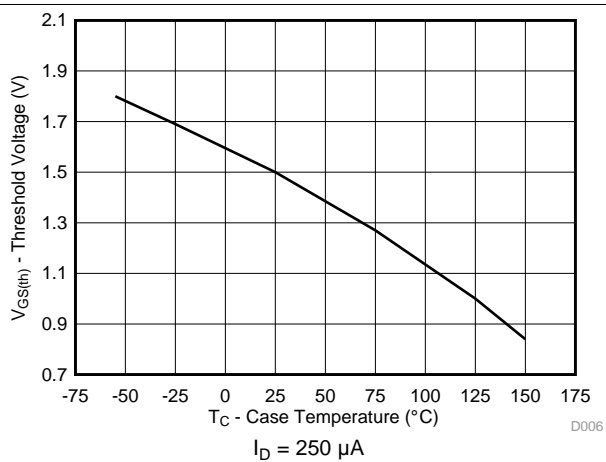


Figure 6. Threshold Voltage vs Temperature

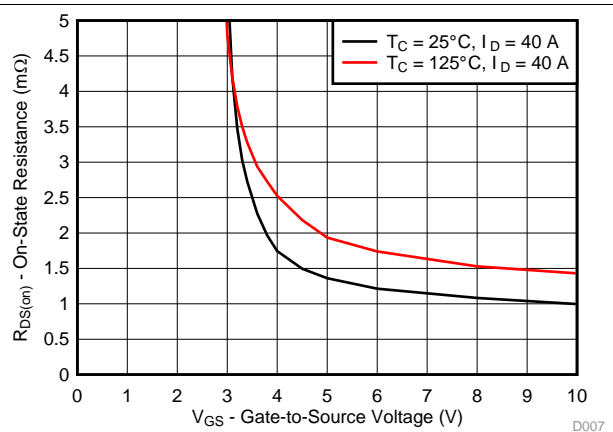


Figure 7. On-Resistance vs Gate Voltage

Typical MOSFET Characteristics (continued)

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

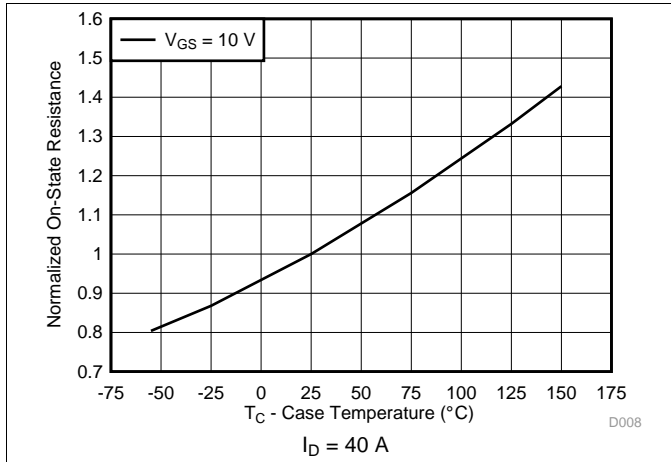


Figure 8. On-Resistance vs Temperature

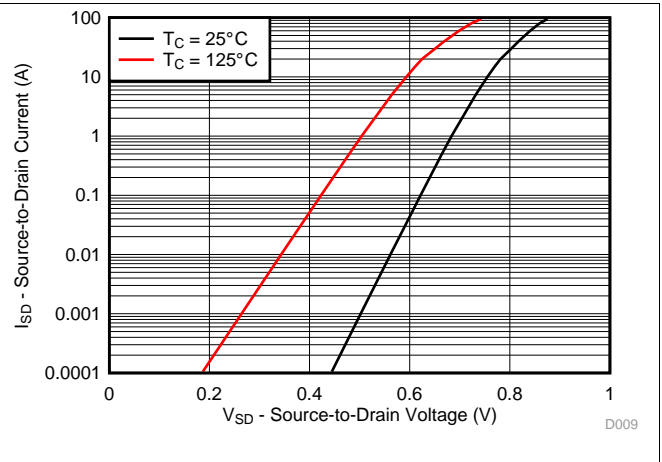


Figure 9. Typical Diode Forward Voltage

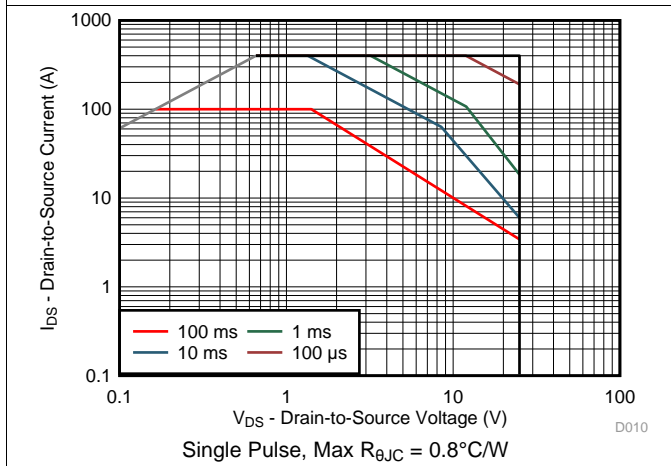


Figure 10. Maximum Safe Operating Area

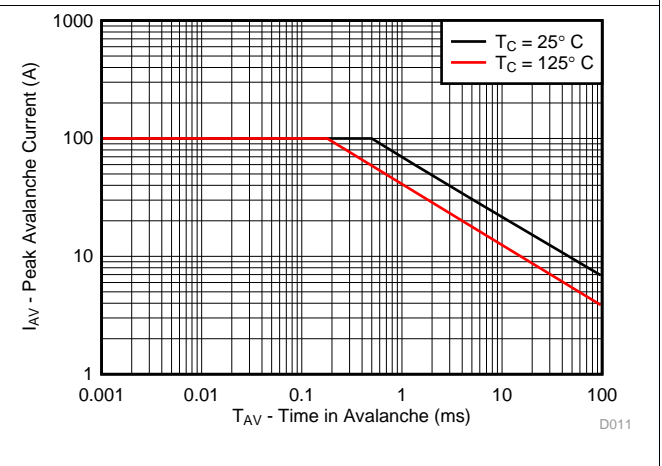


Figure 11. Single-Pulse Unclamped Inductive Switching

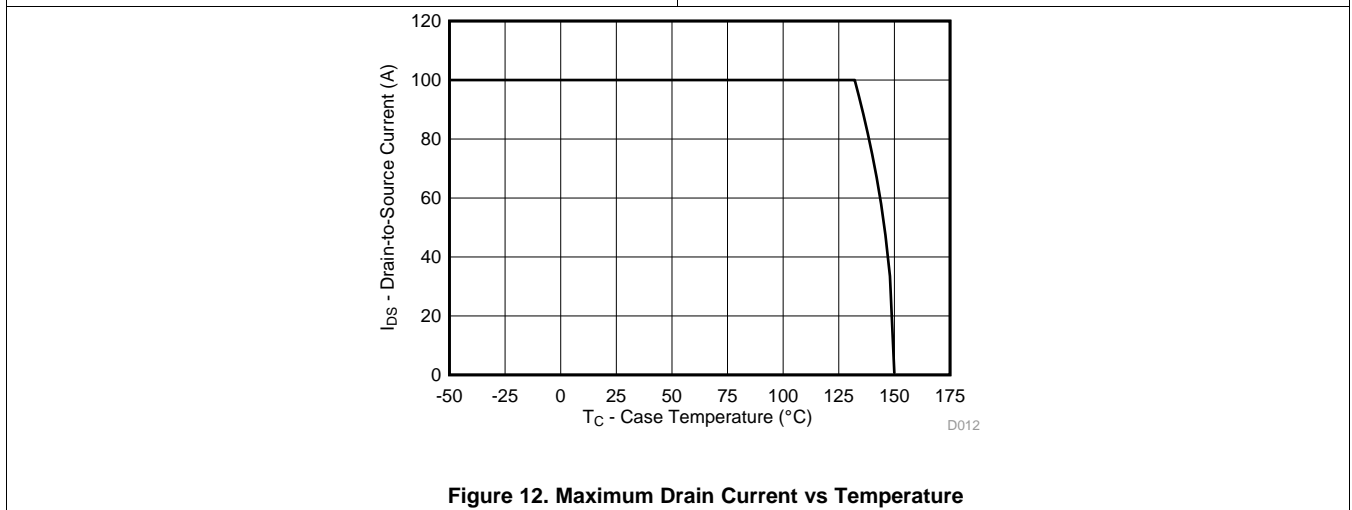


Figure 12. Maximum Drain Current vs Temperature

## 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](http://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

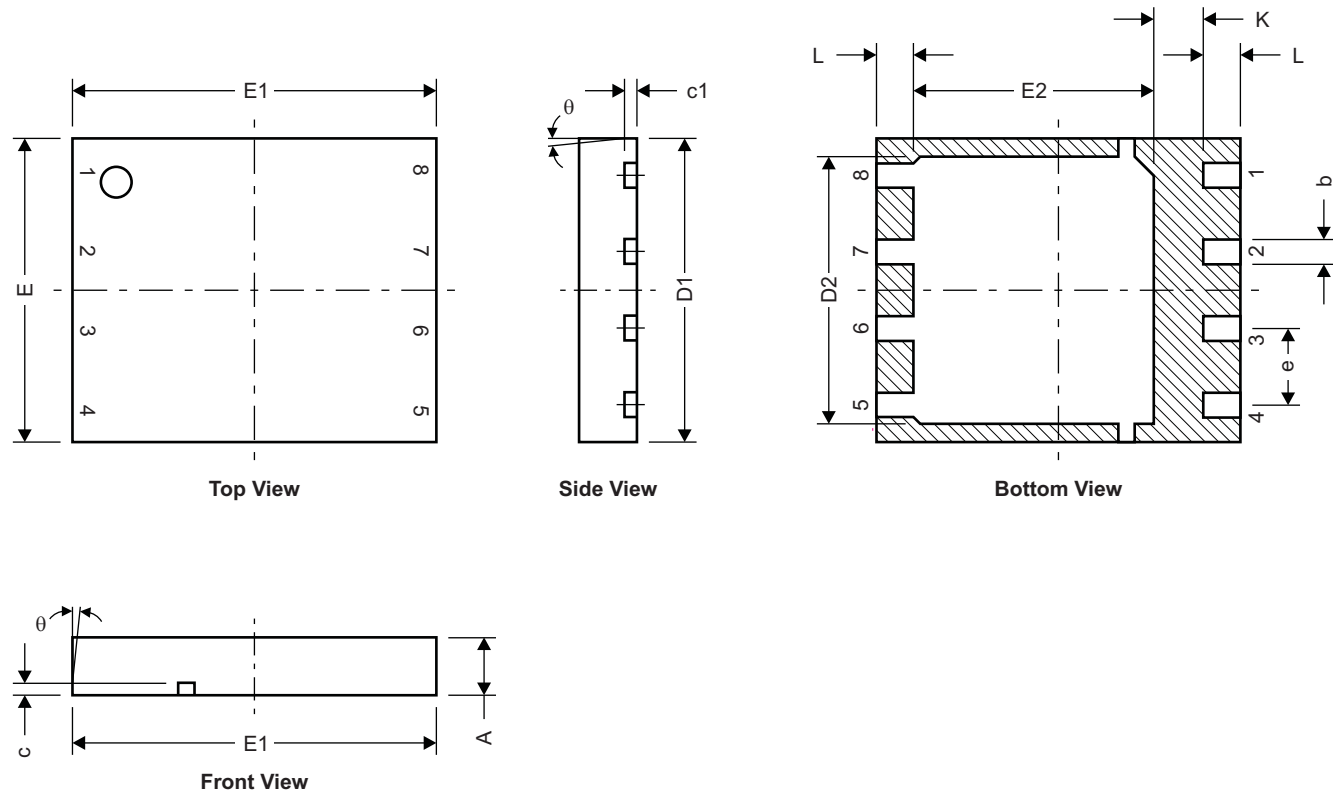
[SLYZ022](#) — *TI Glossary*.

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 Q5 Package Dimensions



M0140-01

DIM	MILLIMETERS			INCHES		
	MIN	TYP	MAX	MIN	TYP	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			0.050	
K	0.760			0.030		
L	0.510		0.710	0.020		0.028
$\theta$	0.00					





### 7.3 Q5 Tape and Reel Information



M0138-01

**Notes:**

1. 10 sprocket hole pitch cumulative tolerance  $\pm 0.2$
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. A0 and B0 measured on a plane 0.3 mm above the bottom of the pocket
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
CSD16415Q5	ACTIVE	VSON-CLIP	DQH	8	2500	Pb-Free (RoHS Exempt)	CU SN	Level-1-260C-UNLIM	-55 to 150	CSD16415	<a href="#">Samples</a>
CSD16415Q5T	ACTIVE	VSON-CLIP	DQH	8	250	Pb-Free (RoHS Exempt)	CU SN	Level-1-260C-UNLIM	-55 to 150	CSD16415	<a href="#">Samples</a>

(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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## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CSD16415Q5	VSON-CLIP	DQH	8	2500	330.0	12.4	6.3	5.3	1.2	8.0	12.0	Q1
CSD16415Q5	VSON-CLIP	DQH	8	2500	330.0	12.8	6.5	5.3	1.4	8.0	12.0	Q1
CSD16415Q5T	VSON-CLIP	DQH	8	250	178.0	12.4	6.3	5.3	1.2	8.0	12.0	Q1
CSD16415Q5T	VSON-CLIP	DQH	8	250	330.0	12.8	6.5	5.3	1.4	8.0	12.0	Q1

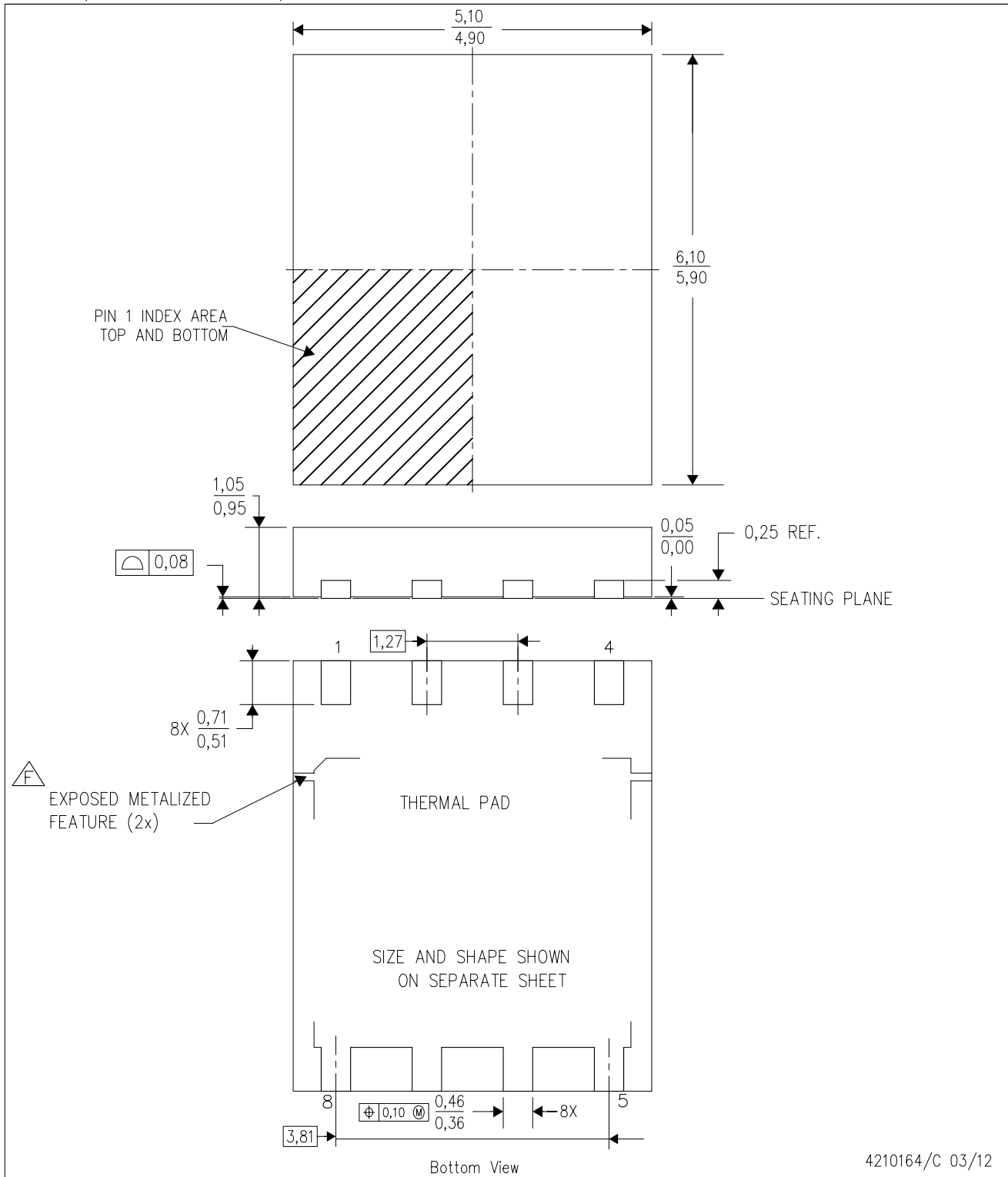
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal


Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CSD16415Q5	VSON-CLIP	DQH	8	2500	336.6	336.6	41.3
CSD16415Q5	VSON-CLIP	DQH	8	2500	335.0	335.0	32.0
CSD16415Q5T	VSON-CLIP	DQH	8	250	210.0	210.0	52.0
CSD16415Q5T	VSON-CLIP	DQH	8	250	335.0	335.0	32.0

DQH (R-PVSON-N8)

PLASTIC SMALL OUTLINE NO-LEAD



4210164/C 03/12

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Small Outline No-Lead (SON) package configuration.
  - D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
  - E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
-  Metalized features are supplier options and may not be on the package.

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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

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
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