



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

## 1 Features

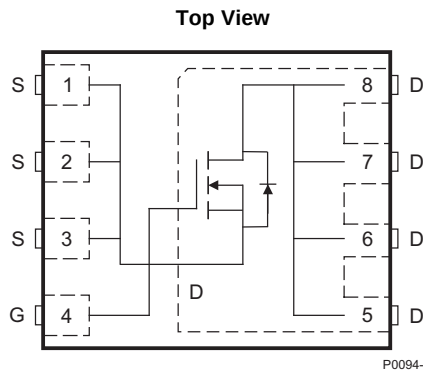
- Ultralow  $Q_g$  and  $Q_{gd}$
- Very Low On-Resistance
- Low Thermal Resistance
- Avalanche Rated
- Pb-Free Terminal Plating
- RoHS Compliant
- Halogen-Free

## 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  |
|                          |                               | $V_{GS} = 10\text{ V}$  | 0.99 |
| $V_{GS(th)}$             | Threshold Voltage             | 1.5                     | V    |

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

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

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

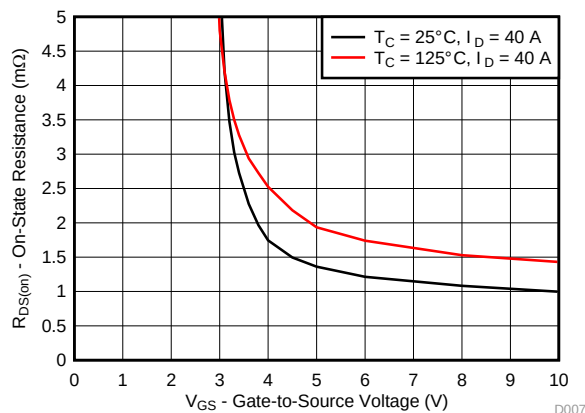
### Absolute Maximum Ratings

| $T_A = 25^\circ\text{C}$ |                                                                                                   | 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 | $^\circ\text{C}$ |
| $E_{AS}$                 | Avalanche Energy, Single-Pulse<br>$I_D = 100\text{ A}$ , $L = 0.1\text{ mH}$ , $R_G = 25\ \Omega$ | 500        | mJ               |

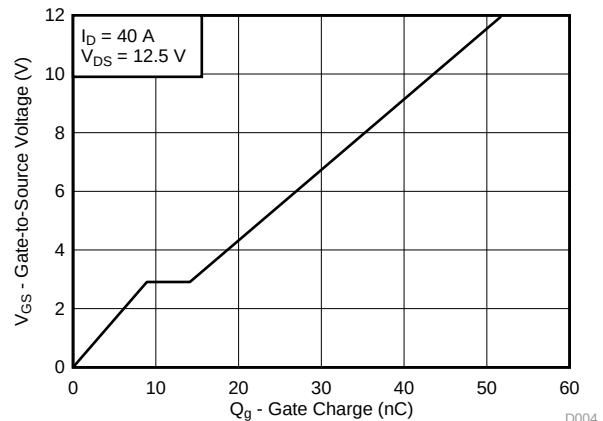
(1)  $R_{\theta JA} = 40^\circ\text{C/W}$  on 1 in<sup>2</sup> (6.45 cm<sup>2</sup>) Cu [2 oz. (0.071 mm thick)] on 0.060 inch (1.52 mm) thick FR4 PCB.

(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



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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 .....                                                                                               | <b>1</b>  |
| • Enhanced <a href="#">Description</a> .....                                                                                     | <b>1</b>  |
| • Added <i>Device and Documentation Support</i> section and <i>Mechanical, Packaging, and Orderable Information</i> section..... | <b>1</b>  |
| • Updated pulsed current .....                                                                                                   | <b>1</b>  |
| • Updated <a href="#">Figure 1</a> to a normalized $R_{\theta JC}$ curve .....                                                   | <b>4</b>  |
| • Updated the SOA in <a href="#">Figure 10</a> .....                                                                             | <b>5</b>  |
| • Deleted <i>Package Marking Information</i> section at the end of the data sheet.....                                           | <b>10</b> |

## 5 Specifications

### 5.1 Electrical Characteristics

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

| PARAMETER               |                                  | TEST CONDITIONS                                                                                  | MIN  | TYP  | MAX  | UNIT |
|-------------------------|----------------------------------|--------------------------------------------------------------------------------------------------|------|------|------|------|
| STATIC CHARACTERISTICS  |                                  |                                                                                                  |      |      |      |      |
| BV <sub>DSS</sub>       | Drain-to-Source Voltage          | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                   | 25   |      |      | V    |
| I <sub>DSS</sub>        | Drain-to-Source Leakage Current  | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 20 V                                                    | 1    |      |      | μA   |
| I <sub>GSS</sub>        | Gate-to-Source Leakage Current   | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = −12 V to 16 V                                           | 100  |      |      | nA   |
| V <sub>GS(th)</sub>     | Gate-to-Source Threshold Voltage | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                      | 1.2  | 1.5  | 1.9  | V    |
| R <sub>DS(on)</sub>     | Drain-to-Source On Resistance    | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 40 A                                                   | 1.5  |      | 1.8  | mΩ   |
|                         |                                  | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 40 A                                                    | 0.99 |      | 1.15 | mΩ   |
| g <sub>fs</sub>         | Transconductance                 | V <sub>DS</sub> = 15 V, I <sub>D</sub> = 40 A                                                    | 168  |      |      | S    |
| DYNAMIC CHARACTERISTICS |                                  |                                                                                                  |      |      |      |      |
| C <sub>ISS</sub>        | Input Capacitance                | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 12.5 V, f = 1 MHz                                       | 3150 | 4100 | pF   |      |
| C <sub>OSS</sub>        | Output Capacitance               |                                                                                                  | 2530 | 3300 | pF   |      |
| C <sub>RSS</sub>        | Reverse Transfer Capacitance     |                                                                                                  | 175  | 230  | pF   |      |
| R <sub>g</sub>          | Series Gate Resistance           |                                                                                                  | 1.2  | 2.4  | Ω    |      |
| Q <sub>g</sub>          | Gate Charge Total (4.5 V)        | V <sub>DS</sub> = 12.5 V, I <sub>D</sub> = 40 A                                                  | 21   | 29   | nC   |      |
| Q <sub>gd</sub>         | Gate Charge, Gate-to-Drain       |                                                                                                  | 5.2  | nC   |      |      |
| Q <sub>gs</sub>         | Gate Charge, Gate-to-Source      |                                                                                                  | 8.3  | nC   |      |      |
| Q <sub>g(th)</sub>      | Gate Charge at V <sub>th</sub>   |                                                                                                  | 4.8  | nC   |      |      |
| Q <sub>OSS</sub>        | Output Charge                    | V <sub>DS</sub> = 15 V, V <sub>GS</sub> = 0 V                                                    | 55   | nC   |      |      |
| t <sub>d(on)</sub>      | Turnon Delay Time                | V <sub>DS</sub> = 12.5 V, V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 40 A<br>R <sub>G</sub> = 2 Ω | 16.6 | ns   |      |      |
| t <sub>r</sub>          | Rise Time                        |                                                                                                  | 30   | ns   |      |      |
| t <sub>d(off)</sub>     | Turn Off Delay Time              |                                                                                                  | 20   | ns   |      |      |
| t <sub>f</sub>          | Fall Time                        |                                                                                                  | 12.7 | ns   |      |      |
| DIODE CHARACTERISTICS   |                                  |                                                                                                  |      |      |      |      |
| V <sub>SD</sub>         | Diode Forward Voltage            | I <sub>S</sub> = 40 A, V <sub>GS</sub> = 0 V                                                     | 0.85 | 1    | V    |      |
| Q <sub>rr</sub>         | Reverse Recovery Charge          | V <sub>DD</sub> = 15 V, I <sub>F</sub> = 40 A, di/dt = 300 A/μs                                  | 72   | nC   |      |      |
| t <sub>rr</sub>         | Reverse Tecovery Time            | V <sub>DD</sub> = 15 V, I <sub>F</sub> = 40 A, di/dt = 300 A/μs                                  | 45   | ns   |      |      |

### 5.2 Thermal Information

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

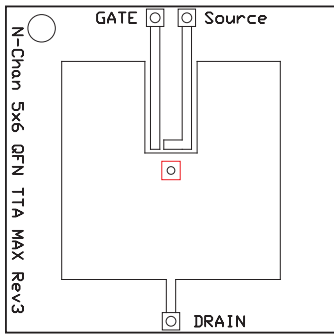
| THERMAL METRIC  |                                                            | MIN | TYP | MAX | UNIT                      |
|-----------------|------------------------------------------------------------|-----|-----|-----|---------------------------|
| $R_{\theta JC}$ | Thermal resistance, junction-to-case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

- $R_{\theta JC}$  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  $\times$  1.5 inch (3.81 cm  $\times$  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.
- 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

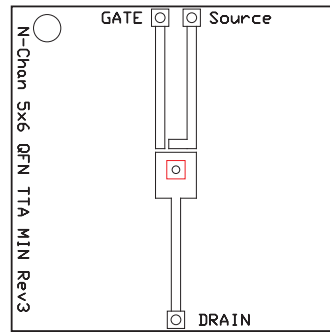
SLPS259A – DECEMBER 2011 – REVISED SEPTEMBER 2015

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M0137-01

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

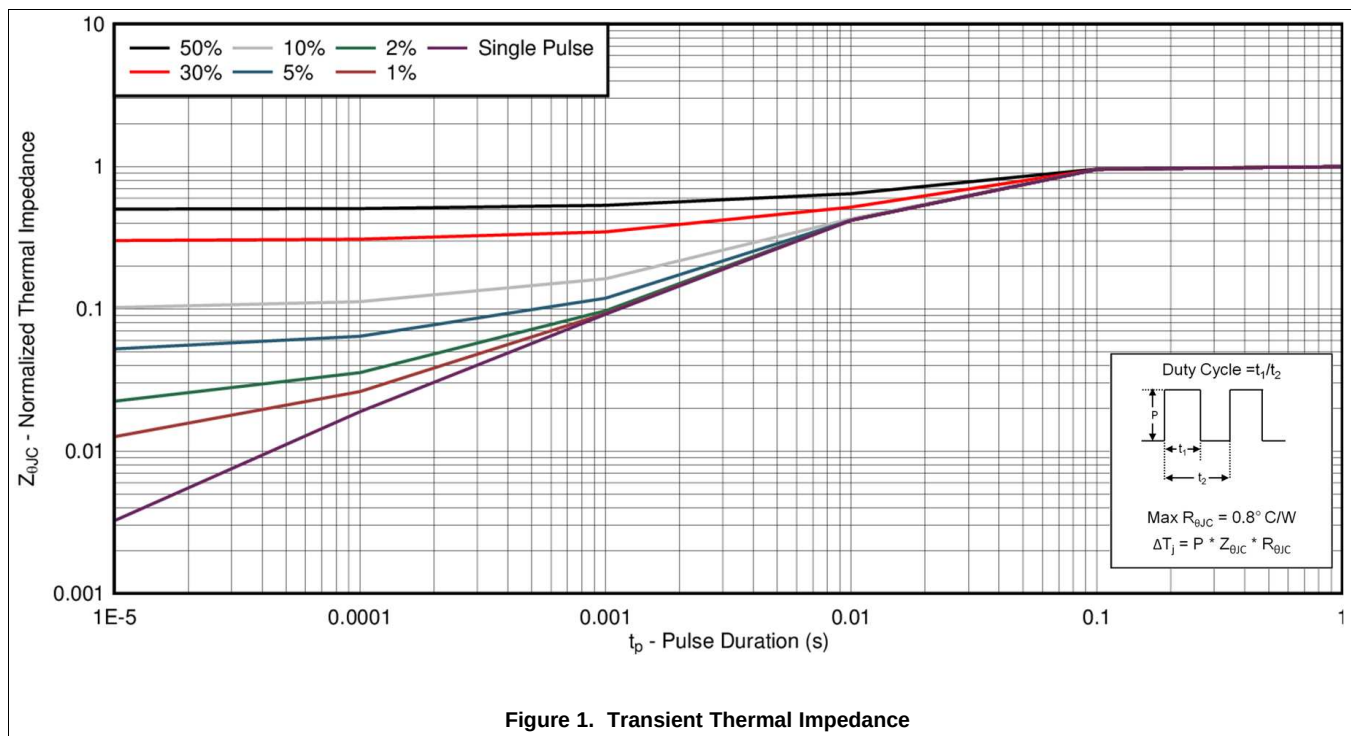


M0137-02

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)

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

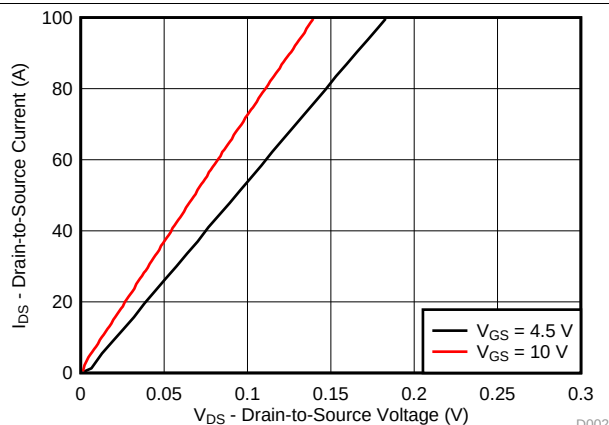


Figure 2. Saturation Characteristics

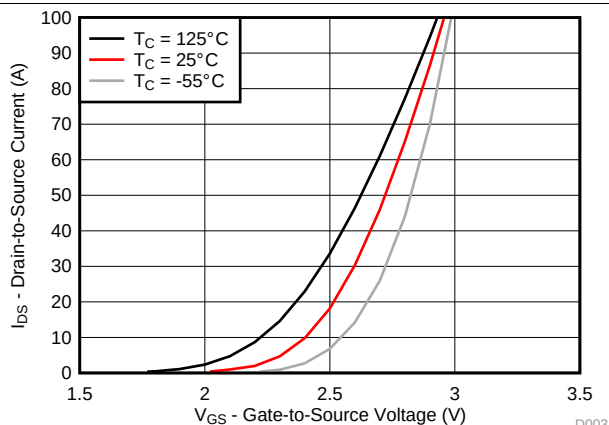


Figure 3. Transfer Characteristics

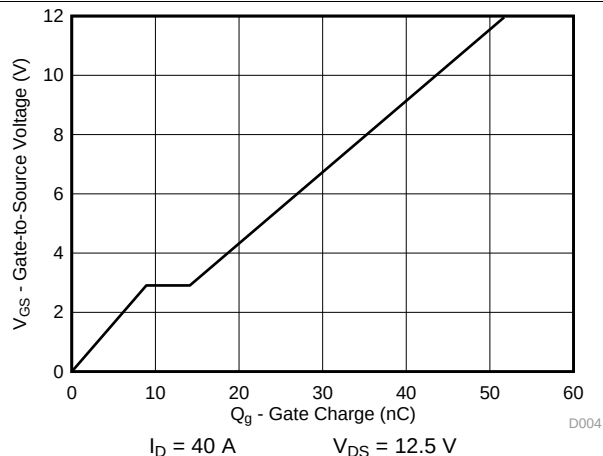


Figure 4. Gate Charge

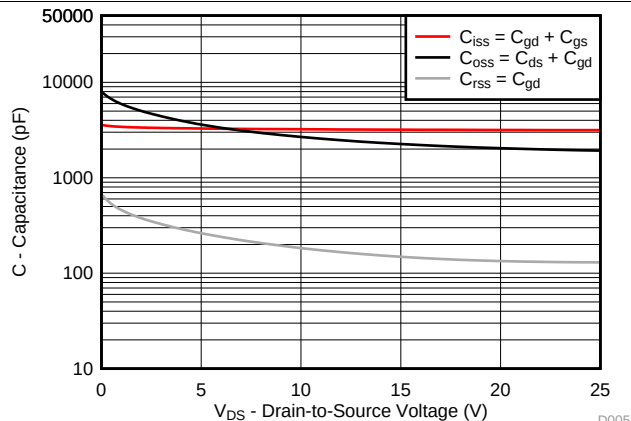


Figure 5. Capacitance

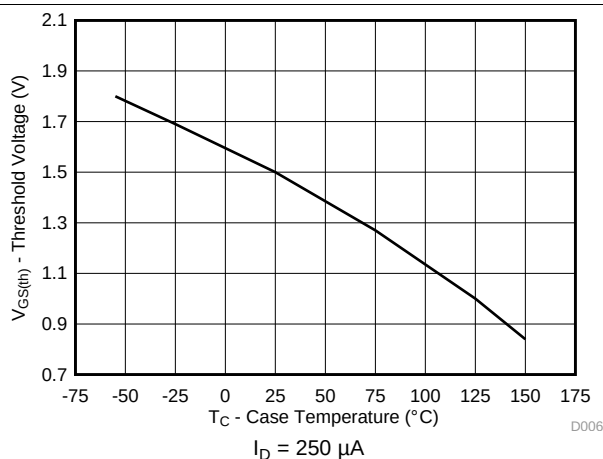


Figure 6. Threshold Voltage vs Temperature

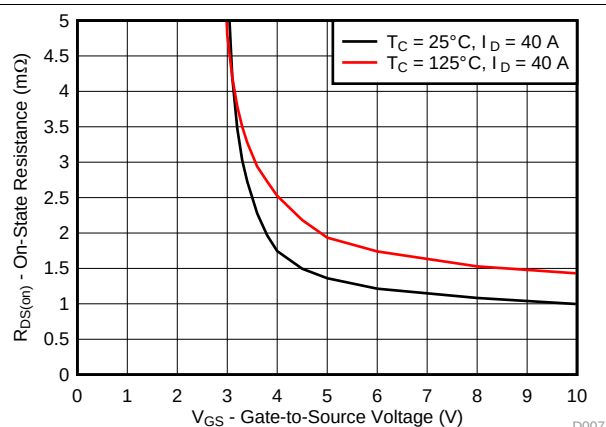


Figure 7. On-Resistance vs Gate Voltage

## Typical MOSFET Characteristics (continued)

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

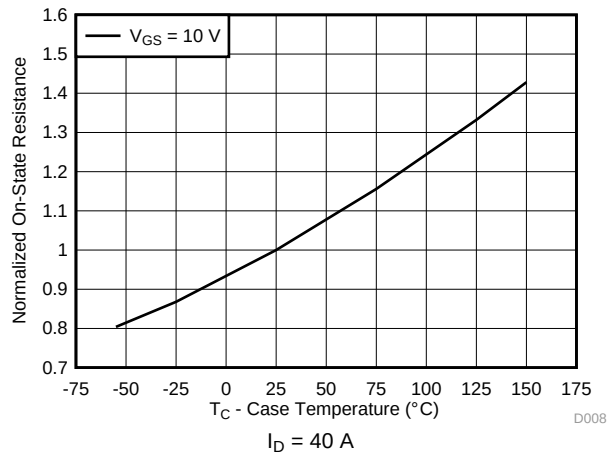


Figure 8. On-Resistance vs Temperature

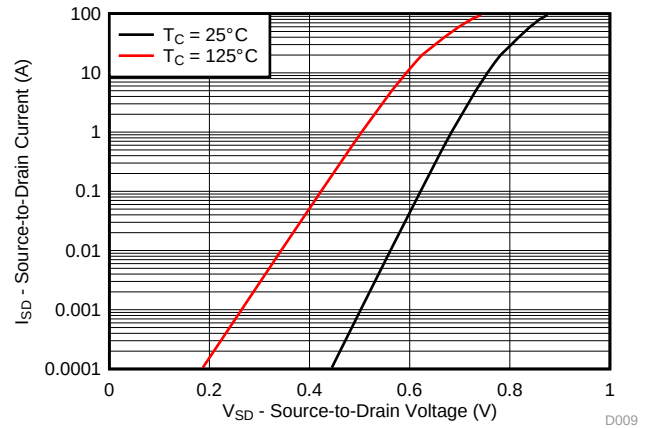


Figure 9. Typical Diode Forward Voltage

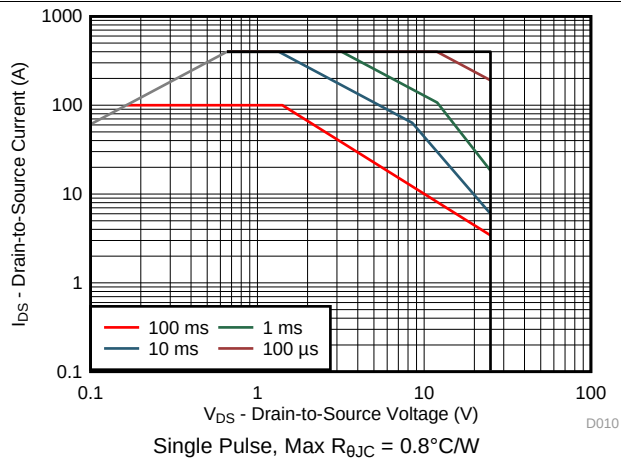


Figure 10. Maximum Safe Operating Area

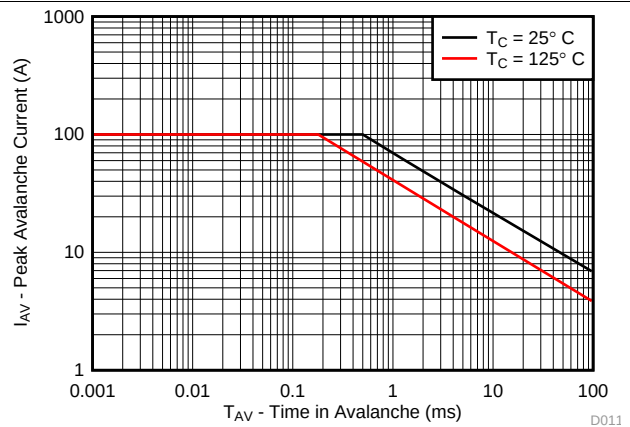


Figure 11. Single-Pulse Unclamped Inductive Switching

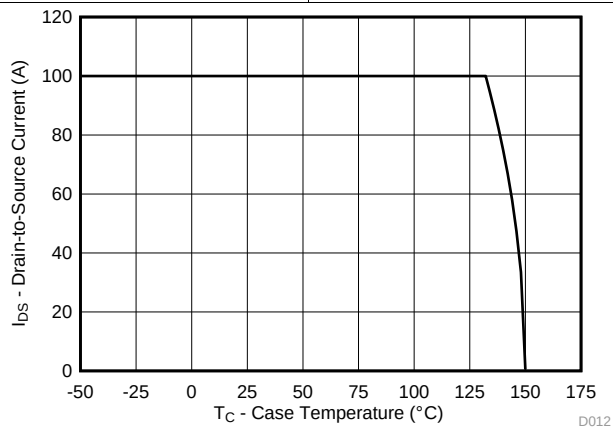


Figure 12. Maximum Drain Current vs Temperature

## 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

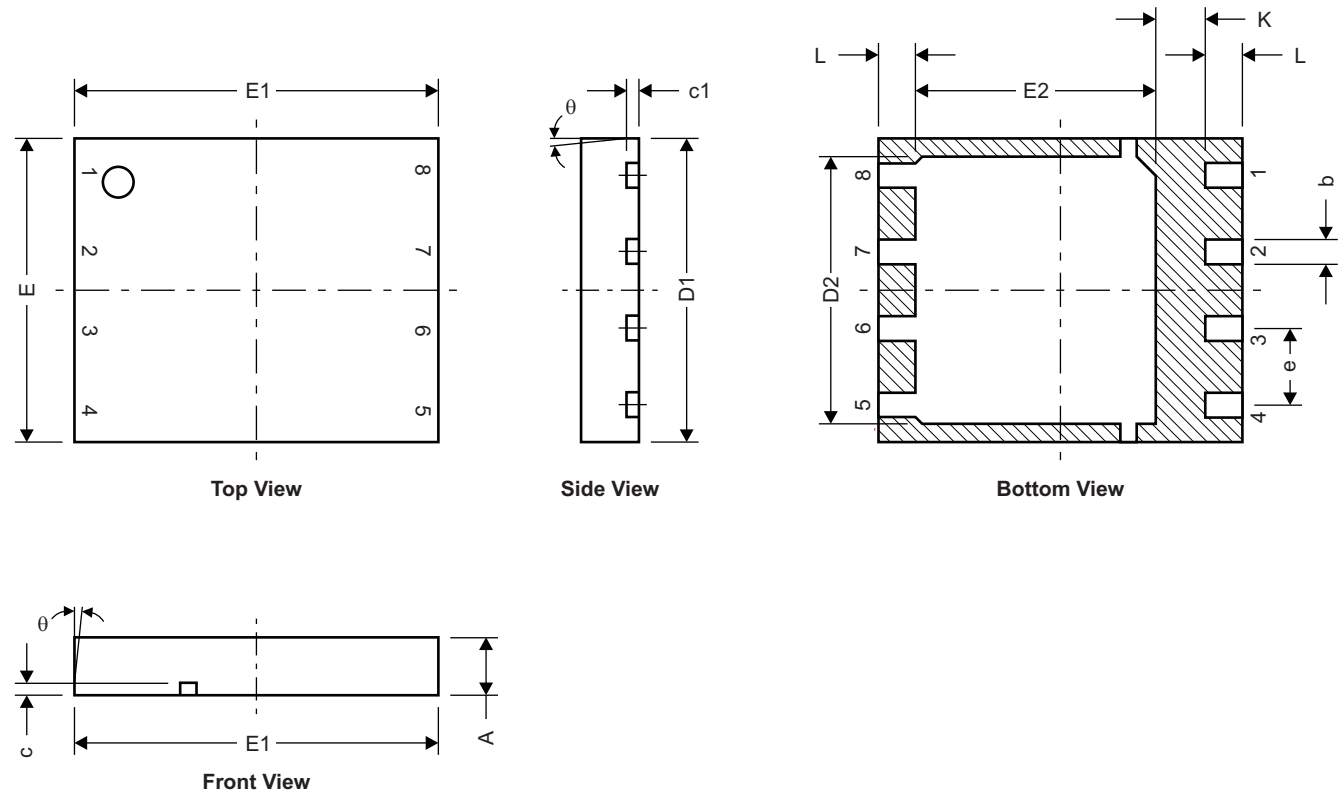
[SLYZ022](#) — *TI Glossary*.

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

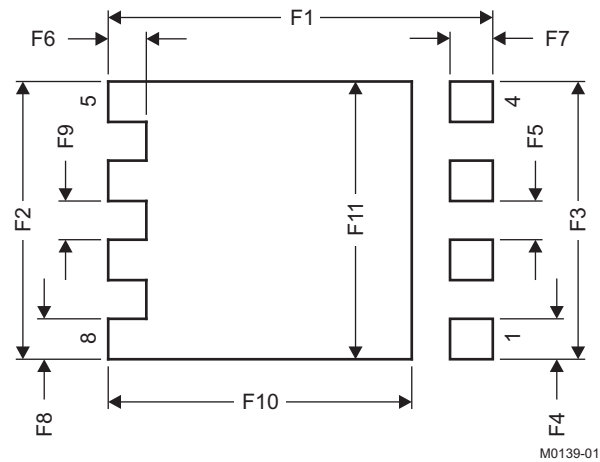


M0140-01

| 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        |      |       |        |       |       |



## 7.2 Recommended PCB Pattern

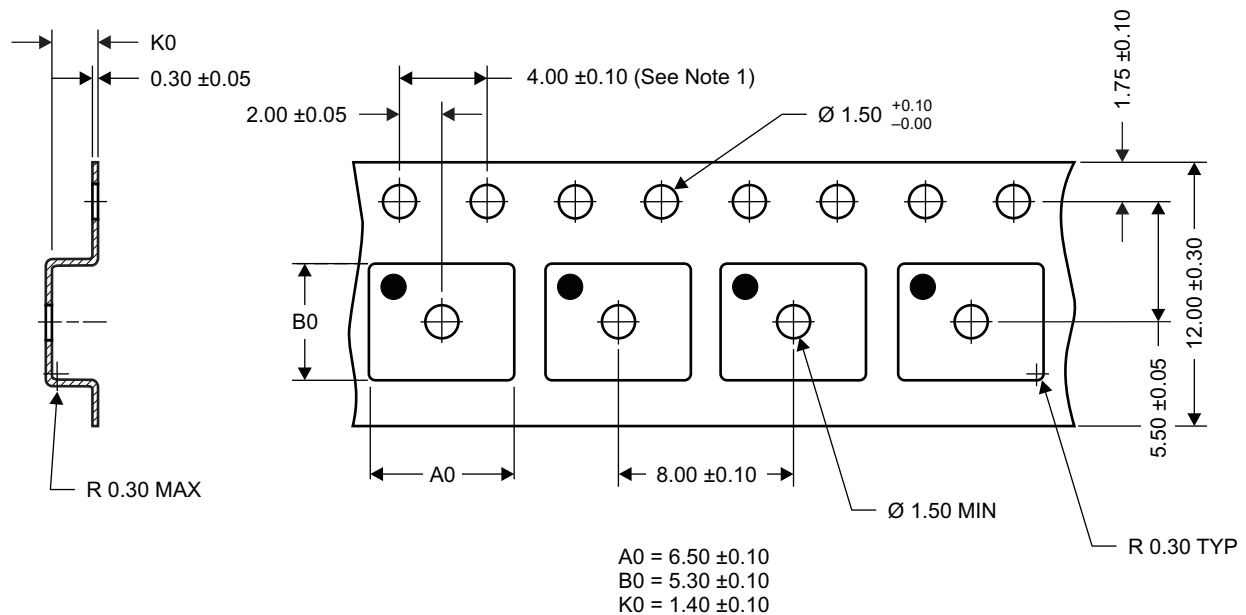


M0139-01

| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| F1  | 6.205       | 6.305 | 0.244  | 0.248 |
| F2  | 4.460       | 4.560 | 0.176  | 0.180 |
| F3  | 4.460       | 4.560 | 0.176  | 0.180 |
| F4  | 0.650       | 0.700 | 0.026  | 0.028 |
| F5  | 0.620       | 0.670 | 0.024  | 0.026 |
| F6  | 0.630       | 0.680 | 0.025  | 0.027 |
| F7  | 0.700       | 0.800 | 0.028  | 0.031 |
| F8  | 0.650       | 0.700 | 0.026  | 0.028 |
| F9  | 0.620       | 0.670 | 0.024  | 0.026 |
| F10 | 4.900       | 5.000 | 0.193  | 0.197 |
| F11 | 4.460       | 4.560 | 0.176  | 0.180 |

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

### 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 part number       | Status<br>(1) | Material type<br>(2) | Package   Pins      | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|-----------------------------|---------------|----------------------|---------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">CSD16415Q5</a>  | Active        | Production           | VSON-CLIP (DQH)   8 | 2500   LARGE T&R      | ROHS Exempt | SN                                   | Level-1-260C-UNLIM                | -55 to 150   | CSD16415            |
| CSD16415Q5.B                | Active        | Production           | VSON-CLIP (DQH)   8 | 2500   LARGE T&R      | ROHS Exempt | SN                                   | Level-1-260C-UNLIM                | -55 to 150   | CSD16415            |
| <a href="#">CSD16415Q5T</a> | Active        | Production           | VSON-CLIP (DQH)   8 | 250   SMALL T&R       | ROHS Exempt | SN                                   | Level-1-260C-UNLIM                | -55 to 150   | CSD16415            |
| CSD16415Q5T.B               | Active        | Production           | VSON-CLIP (DQH)   8 | 250   SMALL T&R       | ROHS Exempt | SN                                   | Level-1-260C-UNLIM                | -55 to 150   | CSD16415            |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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.

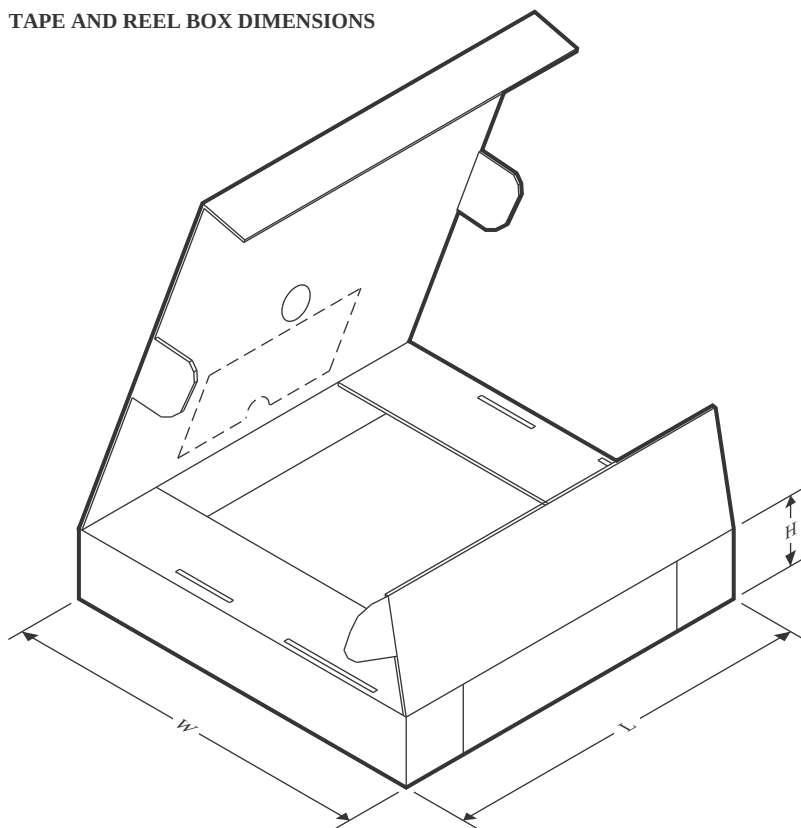
## TAPE AND REEL INFORMATION



\*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 |
|-------------|--------------|-----------------|------|-----|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CSD16415Q5T | VSON-CLIP    | DQH             | 8    | 250 | 178.0              | 12.4               | 6.3     | 5.3     | 1.2     | 8.0     | 12.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



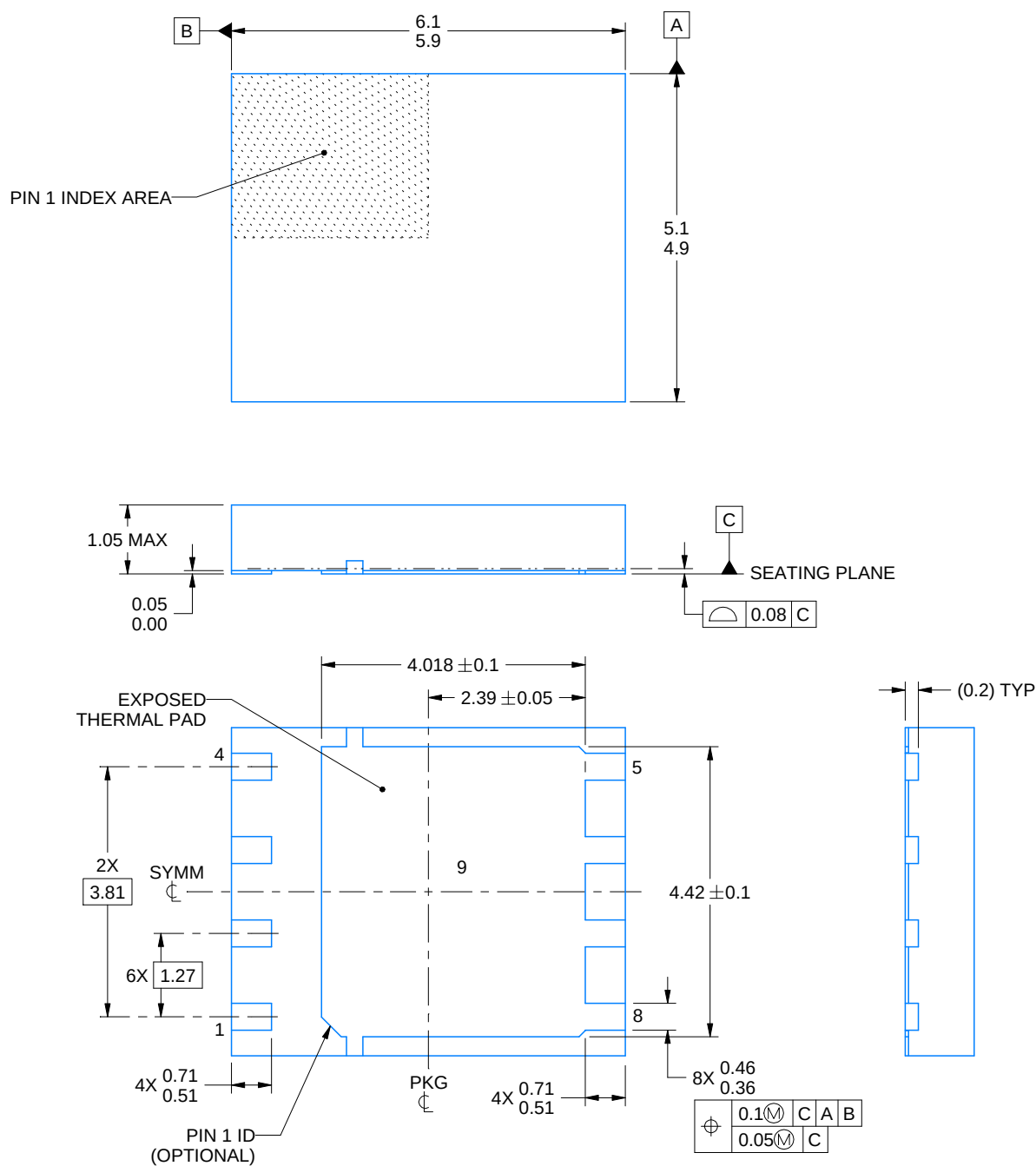
\*All dimensions are nominal

| Device      | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|-----|-------------|------------|-------------|
| CSD16415Q5T | VSON-CLIP    | DQH             | 8    | 250 | 180.0       | 180.0      | 79.0        |



## VSON-CLIP - 1.05 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



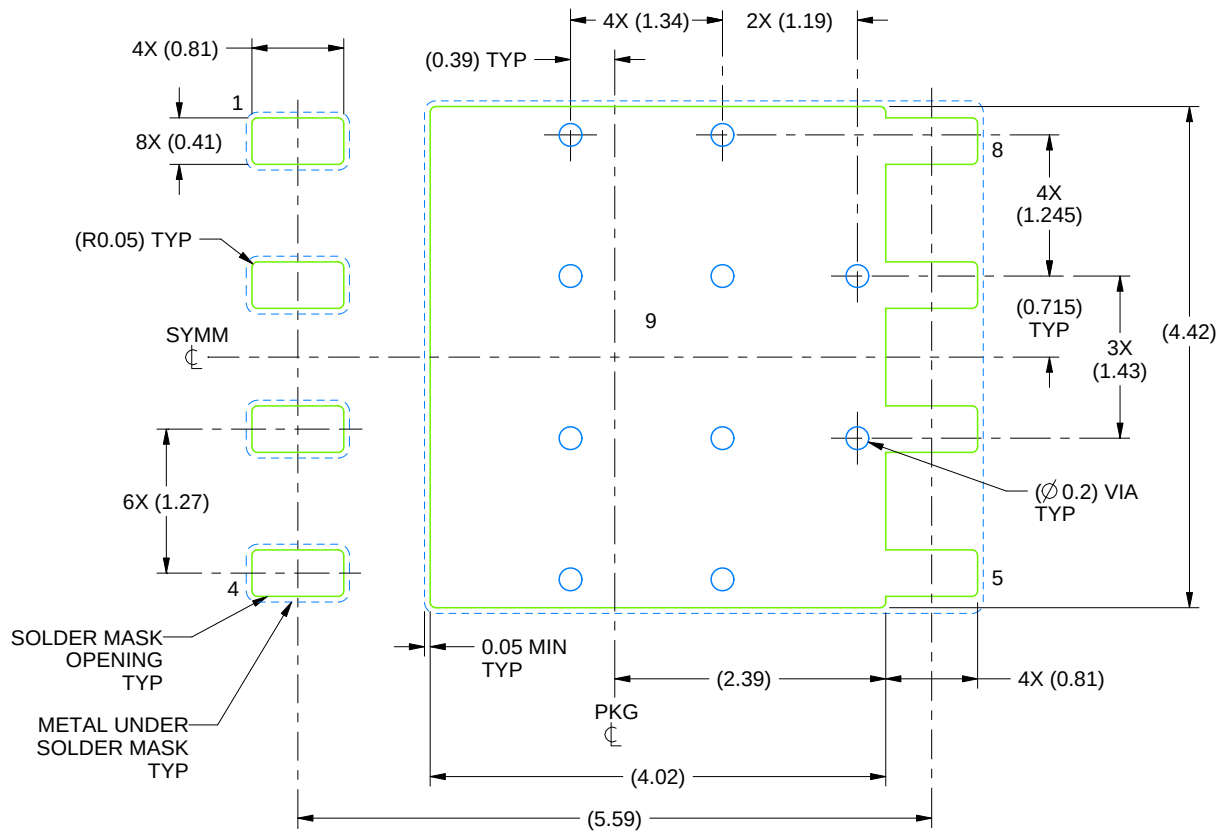
4223292/A 10/2016

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 pad must be soldered to the printed circuit board for thermal and mechanical performance.

**DQH0008A**

### VSON-CLIP - 1.05 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
SOLDER MASK DEFINED  
SCALE:15X

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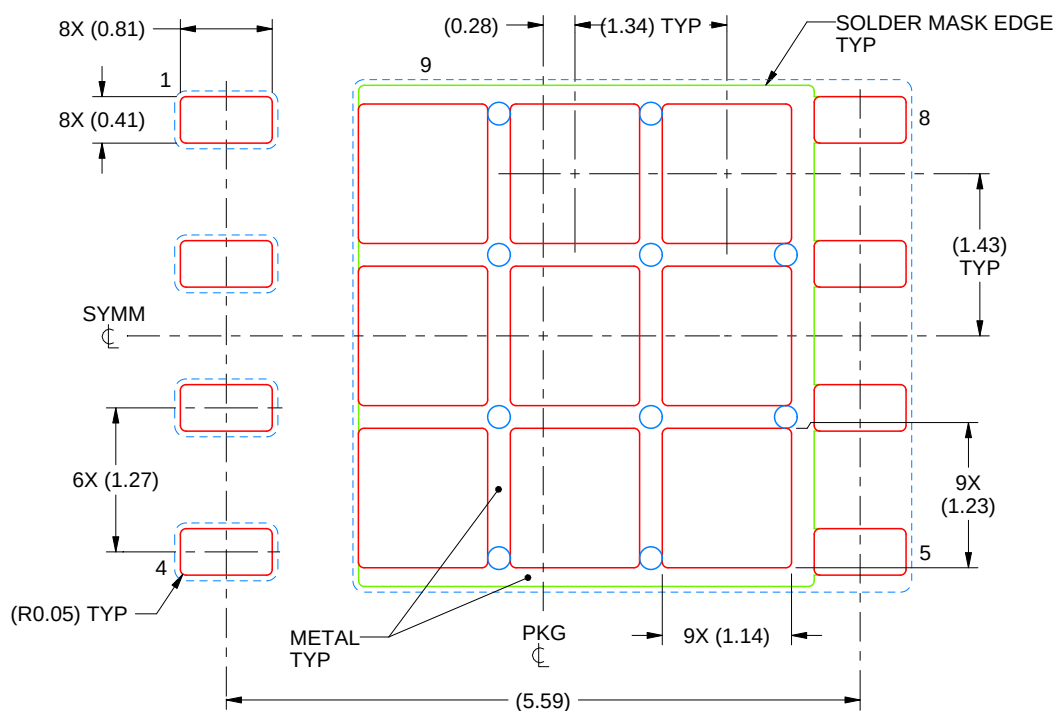
NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).
5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.

**DQH0008A**

## VSON-CLIP - 1.05 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



## SOLDER PASTE EXAMPLE BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 9:  
71% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:15X

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.



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