

# CSD95378BQ5MC Synchronous Buck NexFET™ Smart Power Stage

## 1 Features

- 60-A Continuous Operating Current Capability
- 93.4% System Efficiency at 30 A
- Low-Power Loss of 2.8 W at 30 A
- High-Frequency Operation (up to 1.25 MHz)
- Diode Emulation Mode With FCCM
- Temperature Compensated Bidirectional Current Sense
- Analog Temperature Output (400 mV at 0°C)
- Fault Monitoring
  - High-Side Short, Overcurrent, and Overtemperature Protection
- 3.3-V and 5-V PWM Signal Compatible
- Tri-State PWM Input
- Integrated Bootstrap Diode
- Optimized Dead Time for Shoot-Through Protection
- High-Density SON 5-mm × 6-mm Footprint
- Ultra-Low-Inductance Package
- System-Optimized PCB Footprint
- DualCool™ Packaging
- RoHS Compliant – Lead-Free Terminal Plating
- Halogen-Free

## 2 Applications

- Multiphase Synchronous Buck Converters
  - High-Frequency Applications
  - High-Current, Low-Duty-Cycle Applications
- POL DC-DC Converters
- Memory and Graphic Cards
- Desktop and Server VR11.x / VR12.x V-core and Memory Synchronous Converters

## 3 Description

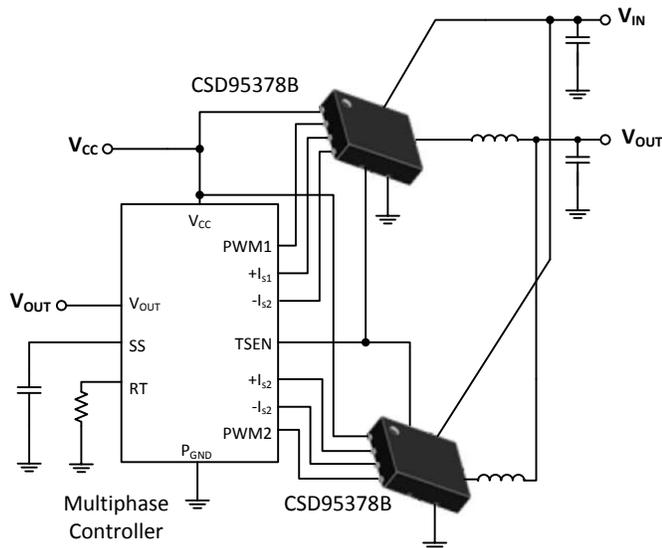
The CSD95378BQ5MC NexFET™ smart power stage is a highly-optimized design for use in a high-power, high-density synchronous buck converter. This product integrates the driver IC and power MOSFETs to complete the power stage switching function. This combination produces high-current, high-efficiency, and high-speed switching capability in a small 5-mm × 6-mm outline package. It also integrates the accurate current sensing and temperature sensing functionality to simplify system design and improve accuracy. In addition, the PCB footprint is optimized to help reduce design time and simplify the completion of the overall system design.

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

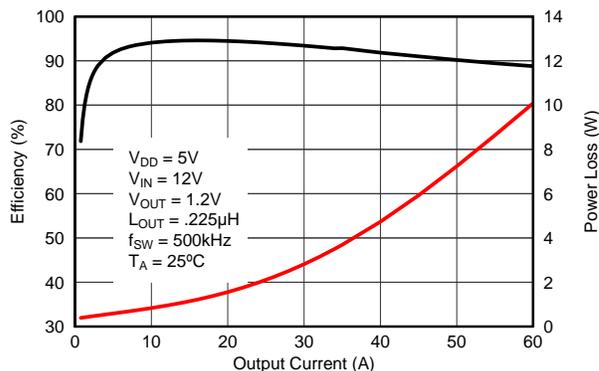
| DEVICE         | MEDIA        | QTY  | PACKAGE                                      | SHIP                |
|----------------|--------------|------|--|---------------------|
| CSD95378BQ5MC  | 13-Inch Reel | 2500 | SON<br>5.00-mm × 6.00-mm<br>DualCool Package | Tape<br>and<br>Reel |
| CSD95378BQ5MCT | 7-Inch Reel  | 250  |  |                     |

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

### Application Diagram



### Typical Power Stage Efficiency and Power Loss



G001



## Table of Contents

|  |          |   |          |
|--|----------|---|----------|
| <b>1 Features</b> .....                        | <b>1</b> | <b>8 Device and Documentation Support</b> .....                 | <b>7</b> |
| <b>2 Applications</b> .....                    | <b>1</b> | 8.1 Receiving Notification of Documentation Updates...          | 7        |
| <b>3 Description</b> .....                     | <b>1</b> | 8.2 Community Resources .....                                   | 7        |
| <b>4 Revision History</b> .....                | <b>2</b> | 8.3 Trademarks .....  | 7        |
| <b>5 Pin Configuration and Functions</b> ..... | <b>3</b> | 8.4 Electrostatic Discharge Caution .....                       | 7        |
| <b>6 Specifications</b> .....                  | <b>4</b> | 8.5 Glossary .....  | 7        |
| 6.1 Absolute Maximum Ratings .....             | 4        | <b>9 Mechanical, Packaging, and Orderable Information</b> ..... | <b>8</b> |
| 6.2 ESD Ratings .....                          | 4        | 9.1 Mechanical Drawing .....                                    | 8        |
| 6.3 Recommended Operating Conditions .....     | 4        | 9.2 Recommended PCB Land Pattern .....                          | 9        |
| 6.4 Thermal Information .....                  | 5        | 9.3 Recommended Stencil Opening .....                           | 9        |
| <b>7 Application Schematic</b> .....           | <b>6</b> |   |          |

## 4 Revision History

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

| <b>Changes from Revision B (June 2015) to Revision C</b>  | <b>Page</b> |
|---|-------------|
| • Changed the CSD95378B parts in the <i>Application Schematic</i> section .....   | 6           |
| • Added <i>Receiving Notification of Documentation Updates</i> section to the <i>Device and Documentation Support</i> section ..... | 7           |

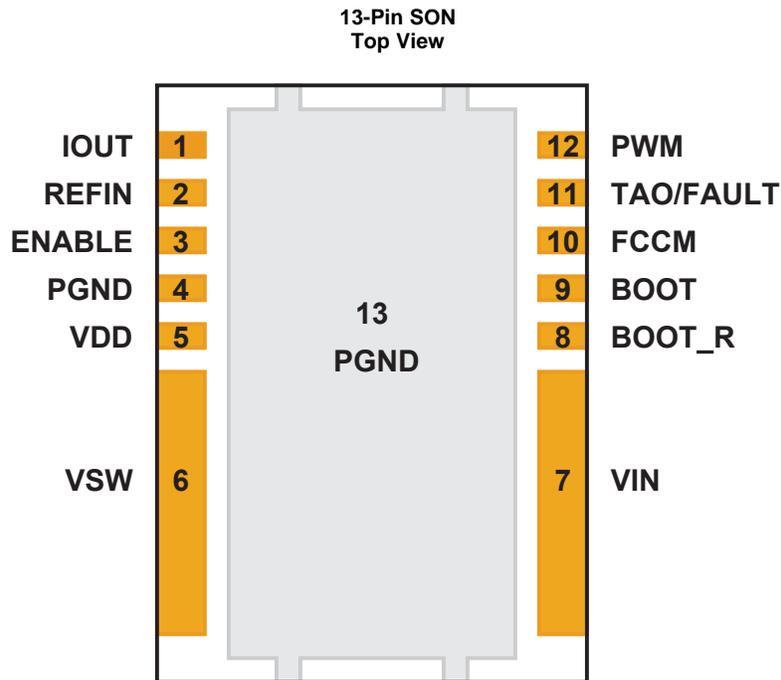
---

| <b>Changes from Revision A (June 2014) to Revision B</b>  | <b>Page</b> |
|---|-------------|
| • Corrected MAX A dimensions in <i>Mechanical Drawing</i> table to 1.050 mm (0.041 inch). ..... | 8           |

---

| <b>Changes from Original (April 2014) to Revision A</b>                               | <b>Page</b> |
|---|-------------|
| • Updated the controller IC in the <i>Application Schematic</i> to the TPS40428. .... | 6           |

## 5 Pin Configuration and Functions



### Pin Functions

| PIN           |        | DESCRIPTION  |
|---------------|--------|--|
| NAME          | NUMBER |  |
| BOOT          | 9      | Bootstrap capacitor connection. Connect a minimum of 0.1- $\mu$ F, 16-V, X7R ceramic capacitor from BOOT to BOOT_R pins. The bootstrap capacitor provides the charge to turn on the control FET. The bootstrap diode is integrated.  |
| BOOT_R        | 8      | Return path for HS gate driver, connected to $V_{SW}$ internally.  |
| ENABLE        | 3      | Enables device operation. If ENABLE = logic high, turns on device. If ENABLE = logic low, the device is turned off and both MOSFET gates are actively pulled low. An internal 100-k $\Omega$ pulldown resistor will pull the ENABLE pin low if left floating.  |
| FCCM          | 10     | This pin enables the diode emulation function. When this pin is held low, diode emulation mode is enabled for sync FET. When FCCM is high, the device is operated in Forced Continuous Conduction Mode. An internal 5- $\mu$ A current source will pull the FCCM pin to 3.3 V if left floating.  |
| IOUT          | 1      | Output of current sensing amplifier. $V(IOUT) - V(REFIN)$ is proportional to the phase current.  |
| $P_{GND}$     | 4      | Power ground, connected directly to pin 13.  |
| $P_{GND}$     | 13     | Power ground.  |
| PWM           | 12     | Pulse width modulated tri-state input from external controller. Logic low sets control FET gate low and sync FET gate high. Logic high sets control FET gate high and sync FET gate low. Open or Hi-Z sets both MOSFET gates low if greater than the tri-state shutdown hold-off time ( $t_{3HT}$ ).   |
| REFIN         | 2      | External reference voltage input for current sensing amplifier.  |
| TAO/<br>FAULT | 11     | Temperature Analog Output. Reports a voltage proportional to the die temperature. An ORing diode is integrated in the IC. When used in multiphase application, a single wire can be used to connect the TAO pins of all the ICs. Only the highest temperature will be reported. TAO will be pulled up to 3.3 V if thermal shutdown occurs. TAO should be bypassed to $P_{GND}$ with a 1-nF, 16-V, X7R ceramic capacitor. |
| $V_{DD}$      | 5      | Supply voltage to gate driver and internal circuitry.  |
| $V_{IN}$      | 7      | Input voltage pin. Connect input capacitors close to this pin.   |
| $V_{SW}$      | 6      | Phase node connecting the HS MOSFET source and LS MOSFET drain-pin connection to the output inductor.  |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

 $T_A = 25^\circ\text{C}$  (unless otherwise noted)<sup>(1)</sup>

|   | MIN  | MAX                     | UNIT             |
|---|------|-------------------------|------------------|
| $V_{IN}$ to $P_{GND}$                             | -0.3 | 25                      | V                |
| $V_{IN}$ to $V_{SW}$                              | -0.3 | 25                      | V                |
| $V_{IN}$ to $V_{SW}$ (10 ns)                      | -7   | 27                      | V                |
| $V_{SW}$ to $P_{GND}$                             | -0.3 | 20                      | V                |
| $V_{SW}$ to $P_{GND}$ (10 ns)                     | -7   | 23                      | V                |
| $V_{DD}$ to $P_{GND}$                             | -0.3 | 7                       | V                |
| ENABLE, PWM, FCCM, TAO, IOOUT, REFIN to $P_{GND}$ | -0.3 | $V_{DD} + 0.3\text{ V}$ | V                |
| BOOT to BOOT_R <sup>(2)</sup>                     | -0.3 | $V_{DD} + 0.3\text{ V}$ | V                |
| $P_D$ Power dissipation                           |      | 12                      | W                |
| $T_J$ Operating junction                          | -55  | 150                     | $^\circ\text{C}$ |
| $T_{stg}$ Storage temperature                     | -55  | 150                     | $^\circ\text{C}$ |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Should not exceed 7 V.

### 6.2 ESD Ratings

|                                     | VALUE                      | UNIT       |
|-------------------------------------|----------------------------|------------|
| $V_{(ESD)}$ Electrostatic discharge | Human-body model (HBM)     | $\pm 2000$ |
|                                     | Charged-device model (CDM) | $\pm 500$  |
|                                     |                            | V          |

### 6.3 Recommended Operating Conditions

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

|   | MIN  | MAX  | UNIT             |
|---|--|------|------------------|
| $V_{DD}$ Gate drive voltage                     | 4.5  | 5.5  | V                |
| $V_{IN}$ Input supply voltage <sup>(1)</sup>    |  | 16   | V                |
| $V_{OUT}$ Output voltage                        |  | 5.5  | V                |
| $I_{OUT}$ Continuous output current             | $V_{IN} = 12\text{ V}$ , $V_{DD} = 5\text{ V}$ , $V_{OUT} = 1.2\text{ V}$ ,<br>$f_{SW} = 500\text{ kHz}$ , $L_{OUT} = 0.225\text{ }\mu\text{H}$ <sup>(2)</sup> | 60   | A                |
| $I_{OUT-PK}$ Peak output current <sup>(3)</sup> |  | 90   | A                |
| $f_{SW}$ Switching frequency                    | $C_{BST} = 0.1\text{ }\mu\text{F}$ (min)   | 1250 | kHz              |
| On-time duty cycle                              | $f_{SW} = 1\text{ MHz}$  | 85%  |                  |
| Minimum PWM on time                             | 40   |      | ns               |
| Operating temperature                           | -40  | 125  | $^\circ\text{C}$ |

- (1) Operating at high  $V_{IN}$  can create excessive AC voltage overshoots on the switch node ( $V_{SW}$ ) during MOSFET switching transients. For reliable operation, the switch node ( $V_{SW}$ ) to ground voltage must remain at or below the *Absolute Maximum Ratings*.
- (2) Measurement made with six 10- $\mu\text{F}$  (TDK C3216X5R1C106KT or equivalent) ceramic capacitors placed across  $V_{IN}$  to  $P_{GND}$  pins.
- (3) System conditions as defined in Note 1. Peak output current is applied for  $t_p = 50\text{ }\mu\text{s}$ .

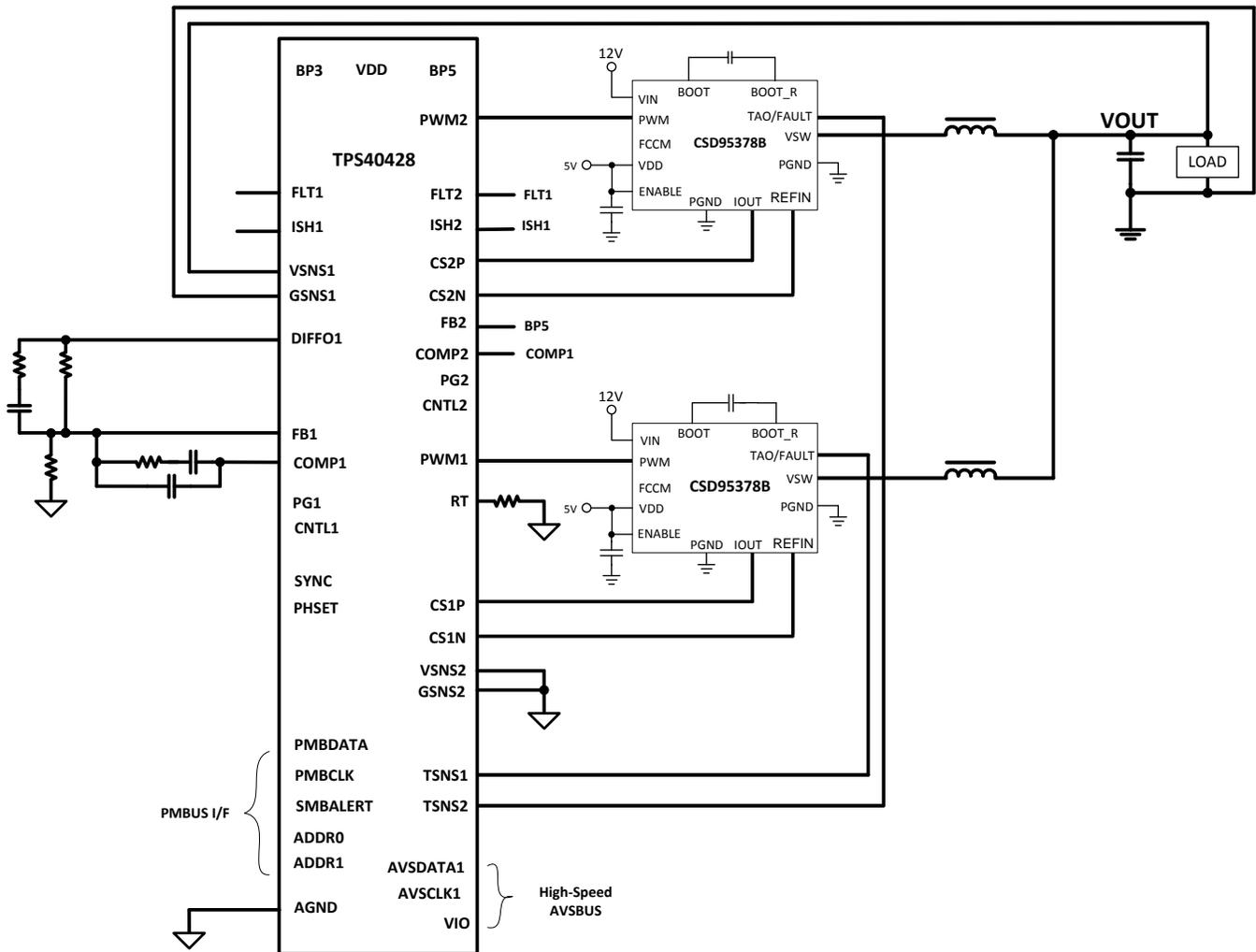
## 6.4 Thermal Information

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

| THERMAL METRIC  |   | MIN | TYP | MAX | UNIT               |
|-----------------|---|-----|-----|-----|--------------------|
| $R_{\theta JC}$ | Junction-to-case (top of package) thermal resistance <sup>(1)</sup> |     |     | 5   | $^\circ\text{C/W}$ |
| $R_{\theta JB}$ | Junction-to-board thermal resistance <sup>(2)</sup>                 |     |     | 1.5 | $^\circ\text{C/W}$ |

- (1)  $R_{\theta JC}$  is determined with the device mounted on a 1-in<sup>2</sup> (6.45-cm<sup>2</sup>), 2-oz (0.071-mm) thick Cu pad on a 1.5-in × 1.5-in, 0.06-in (1.52-mm) thick FR4 board.
- (2)  $R_{\theta JB}$  value based on hottest board temperature within 1 mm of the package.

## 7 Application Schematic



Copyright © 2017, Texas Instruments Incorporated

## 8 Device and Documentation Support

### 8.1 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.

### 8.2 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.

### 8.3 Trademarks

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

### 8.4 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### 8.5 Glossary

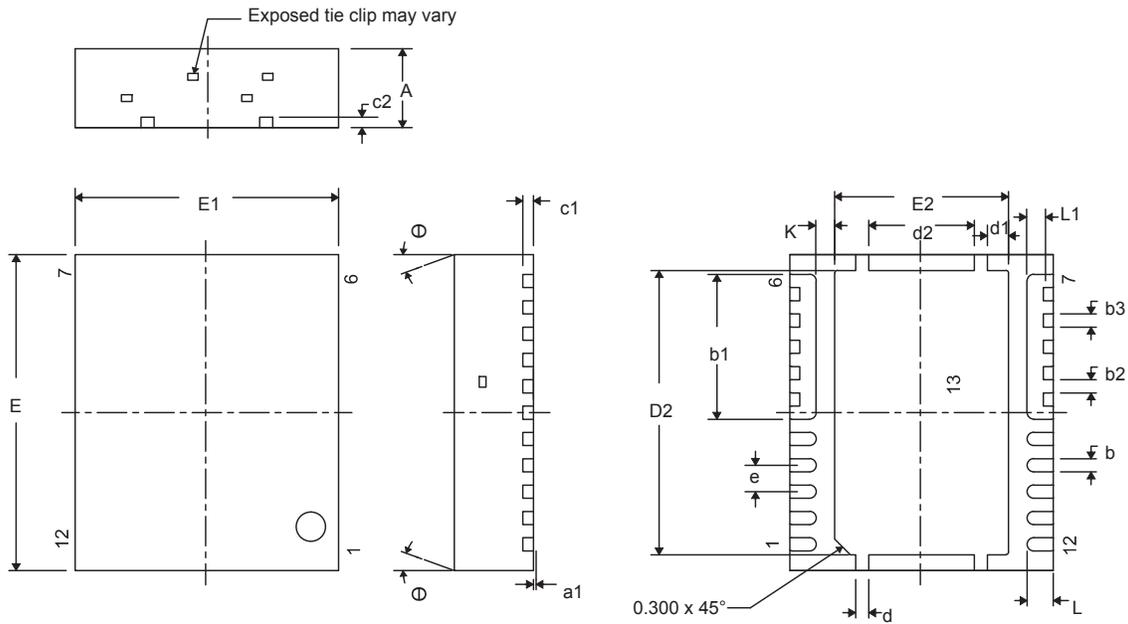
[SLYZ022](#) — *TI Glossary*.

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

## 9 Mechanical, Packaging, and Orderable Information

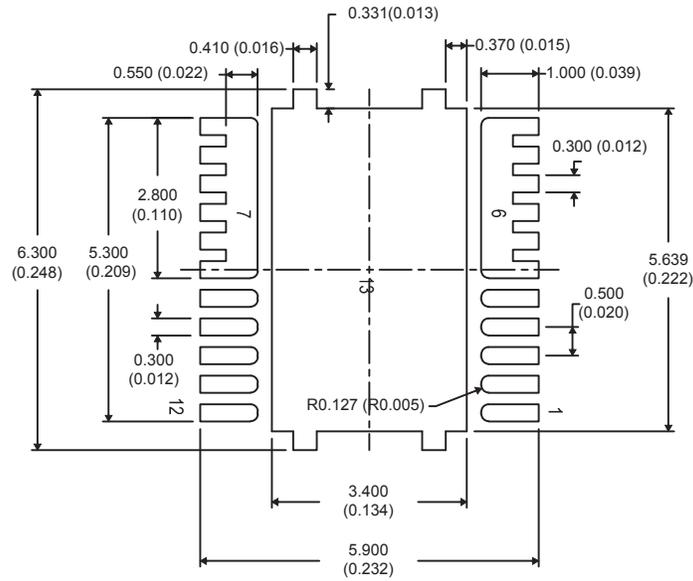
The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand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

### 9.1 Mechanical Drawing



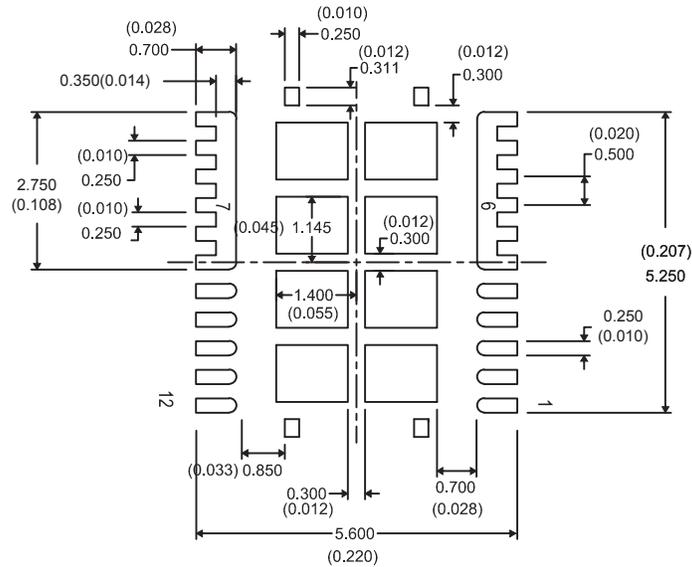
| DIM | MILLIMETERS |       |       | INCHES    |       |       |
|-----|-------------|-------|-------|-----------|-------|-------|
|     | MIN         | NOM   | MAX   | MIN       | NOM   | MAX   |
| A   | 0.950       | 1.000 | 1.050 | 0.037     | 0.039 | 0.041 |
| a1  | 0.000       | 0.000 | 0.050 | 0.000     | 0.000 | 0.002 |
| b   | 0.200       | 0.250 | 0.320 | 0.008     | 0.010 | 0.013 |
| b1  | 2.750 TYP   |       |       | 0.108 TYP |       |       |
| b2  | 0.200       | 0.250 | 0.320 | 0.008     | 0.010 | 0.013 |
| b3  | 0.250 TYP   |       |       | 0.010 TYP |       |       |
| c1  | 0.150       | 0.200 | 0.250 | 0.006     | 0.008 | 0.010 |
| c2  | 0.200       | 0.250 | 0.300 | 0.008     | 0.010 | 0.012 |
| D2  | 5.300       | 5.400 | 5.500 | 0.209     | 0.213 | 0.217 |
| d   | 0.200       | 0.250 | 0.300 | 0.008     | 0.010 | 0.012 |
| d1  | 0.350       | 0.400 | 0.450 | 0.014     | 0.016 | 0.018 |
| d2  | 1.900       | 2.000 | 2.100 | 0.075     | 0.079 | 0.083 |
| E   | 5.900       | 6.000 | 6.100 | 0.232     | 0.236 | 0.240 |
| E1  | 4.900       | 5.000 | 5.100 | 0.193     | 0.197 | 0.201 |
| E2  | 3.200       | 3.300 | 3.400 | 0.126     | 0.130 | 0.134 |
| e   | 0.500 TYP   |       |       | 0.020 TYP |       |       |
| K   | 0.350 TYP   |       |       | 0.014 TYP |       |       |
| L   | 0.400       | 0.500 | 0.600 | 0.016     | 0.020 | 0.024 |
| L1  | 0.210       | 0.310 | 0.410 | 0.008     | 0.012 | 0.016 |
| θ   | 0.000       | —     | —     | 0.000     | —     | —     |

## 9.2 Recommended PCB Land Pattern



1. Dimensions are in mm (in).

## 9.3 Recommended Stencil Opening



1. Dimensions are in mm (in).
2. Stencil thickness is 100  $\mu\text{m}$ .

**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="#">CSD95378BQ5MC</a>  | Active        | Production           | VSON-CLIP (DMC)   12 | 2500   LARGE T&R      | ROHS Exempt | SN                                   | Level-2-260C-1 YEAR               | -55 to 150   | 95378BMC            |
| CSD95378BQ5MC.A                | Active        | Production           | VSON-CLIP (DMC)   12 | 2500   LARGE T&R      | ROHS Exempt | SN                                   | Level-2-260C-1 YEAR               | -55 to 150   | 95378BMC            |
| <a href="#">CSD95378BQ5MCT</a> | Active        | Production           | VSON-CLIP (DMC)   12 | 250   SMALL T&R       | ROHS Exempt | SN                                   | Level-2-260C-1 YEAR               | -55 to 150   | 95378BMC            |
| CSD95378BQ5MCT.A               | Active        | Production           | VSON-CLIP (DMC)   12 | 250   SMALL T&R       | ROHS Exempt | SN                                   | Level-2-260C-1 YEAR               | -55 to 150   | 95378BMC            |

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

(2) **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.

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

(4) **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.

(5) **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.

(6) **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**

**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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CSD95378BQ5MC  | VSON-CLIP    | DMC             | 12   | 2500 | 330.0              | 15.4               | 5.3     | 6.3     | 1.2     | 8.0     | 12.0   | Q1            |
| CSD95378BQ5MC  | VSON-CLIP    | DMC             | 12   | 2500 | 330.0              | 12.4               | 5.3     | 6.3     | 1.2     | 8.0     | 12.0   | Q1            |
| CSD95378BQ5MCT | VSON-CLIP    | DMC             | 12   | 250  | 180.0              | 12.4               | 5.3     | 6.3     | 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) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CSD95378BQ5MC  | VSON-CLIP    | DMC             | 12   | 2500 | 336.6       | 336.6      | 41.3        |
| CSD95378BQ5MC  | VSON-CLIP    | DMC             | 12   | 2500 | 367.0       | 367.0      | 38.0        |
| CSD95378BQ5MCT | VSON-CLIP    | DMC             | 12   | 250  | 213.0       | 191.0      | 35.0        |

## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#), [TI's General Quality Guidelines](#), or other applicable terms available either on [ti.com](http://ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Copyright © 2026, Texas Instruments Incorporated

Last updated 10/2025