

# EVM User's Guide: BQ2969TEVM

## BQ2969T Evaluation Module



### Description

The BQ2969TEVM is a complete evaluation system for the BQ2969T. The BQ2969T is a high accuracy, low-power overvoltage and overtemperature protector with an integrated LDO for 2-series to 4-series Li-Ion, and LiFePO4 battery packs.

The circuit module connects directly to the cells in a battery, or can be connected with a power supply and the included cell simulator resistors. The evaluation board includes all onboard components necessary to signal the conditions of overcharge and overdischarge in a 4-series cell Li-Ion or Li-Polymer battery pack.

### Get Started

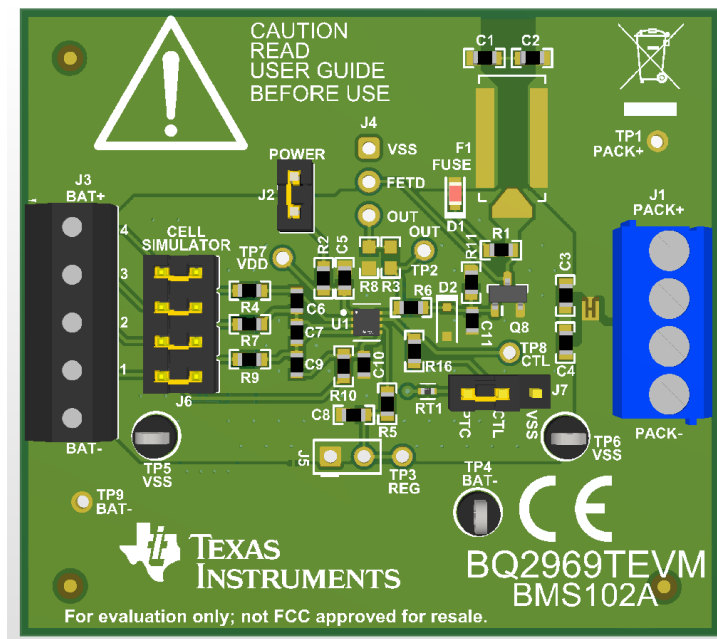
1. Order the BQ2969TEVM from [ti.com](https://www.ti.com).
2. Follow the instructions in this user's guide to get started.

### Features

- Complete evaluation system for the BQ2969T overvoltage and overtemperature protection for 2-series, 3-series, and 4-series cell Li-Ion batteries with integrated LDO.
- Populated circuit module for 4-cell configuration.
- Resistor cell simulator for quick setup with only a power supply.

### Applications

- [Notebook PCs](#)
- [Ultrabooks](#)
- [Portable medical electronics](#)
- [UPS battery backup systems](#)



# 1 Evaluation Module Overview

## 1.1 Introduction

The BQ2969TEVM evaluation module (EVM) is a complete evaluation system for the BQ2969T, a high accuracy, low-power overvoltage and overtemperature protector with an integrated LDO for 2-series to 4-series Li-Ion, and LiFePO4 battery packs. The EVM consists of a BQ2969T circuit module which is used for simple evaluation of the BQ2969T protection functions. The circuit module includes one BQ2969T integrated circuit (IC) and all other onboard components necessary to signal the conditions of overcharge, overdischarge, and overtemperature in a 4-series cell Li-Ion or Li-Polymer battery pack. The circuit module connects directly across the cells in a battery, or can be connected with a power supply and the included cell simulator resistors.

## 1.2 Kit Contents

- BQ2969T circuit module

### 1.2.1 Required Equipment

The following equipment is required to operate the BQ2969TEVM in a simple demonstration:

- DC power supply: 0V to 20V at 250mA
- 2x DC voltmeter
- Either a DC power supply or a temperature chamber, to simulate an overtemperature condition
- Test leads to connect equipment

Additional equipment can be desired to operate the BQ2969T with a more extensive demonstration.

## 1.3 Specification

This section summarizes the performance specifications of the BQ2969T circuit module in the default 4-series cell configuration.

Typical voltage depends on the number of cells configured. Because the board does not control current, if populating additional components, limit currents to appropriate levels.

**Table 1-1. Performance Specification Summary**

Specification	Min	Typ	Max	Unit
Input voltage BAT+ with respect to BAT–	6	–	22	V
Continuous current	0	-	1	A
Operating temperature range	20	25	30	°C

## 1.4 Device Information

**Table 1-2. Device Information**

EVM Part Number	Chemistry	Configuration	Capacity
BQ2969TEVM	Li-Ion	4 cells	Any

### Note

Capacity is shown as *Any* since the board does not control current. If making additional connections monitor board currents and temperatures to operate within the limits of the components and laboratory environment. Refer to the physical construction section for board details.

## 2 Hardware

### 2.1 Setup

The BQ2969T installed on the board outputs OUT high during overvoltage faults as described in the [BQ2969T data sheet](#).

The BQ2969T is configured for cell count by the connections on the board. By default the board is set up for four cells and this quick start is for all four cells. When fewer cells are used, refer to [Section 2.2](#) and adjust the supply voltage appropriately.

These steps describe quick connection of the BQ2969TEVM to demonstrate operation of the protector function of the EVM. For more detailed descriptions, refer to other sections of the user guide.

Refer to [Figure 2-1](#) for the following steps:

1. Install the cell simulator shunts on J6 and the power supply shunt on J2.
2. Connect a 0V DC power supply capable of approximately 250mA between the *BAT-* and *BAT+* terminals and adjust to approximately 14V.
3. Connect a voltage meter to a VSS test point and monitor the TP2-OUT test point. Note that J4 (pin 3 - OUT) is not electrically connected by default.
4. Connect a voltage meter to a VSS test point and monitor the TP3-REG test point.
5. With nominal conditions observe that OUT (TP2) is low, approximately 0V, and REG (TP3) is high, approximately 3.3V.
6. Demonstrate an overvoltage condition:
  - a. Adjust the supply voltage to approximately 20V.
  - b. Observe that OUT transitions to approximately 7V and the on-board LED turns on after 6.5 seconds.
  - c. Adjust the supply voltage to approximately 14V.
7. Demonstrate an undervoltage condition:
  - a. Adjust the supply voltage to approximately 8V.
  - b. Observe that REG transitions to approximately 0V after 6.5 seconds.
  - c. Adjust the supply voltage to approximately 14V.
8. Demonstrate an overtemperature condition:
  - a. If using a DC power supply to simulate an overtemperature:
    - i. Remove the shunt on J7. Note: the OT protection will likely trigger from this step.
    - ii. Connect a DC power supply to TP8-CTL.
    - iii. Adjust the power supply to equal the voltage at VDD.
    - iv. Wait for the OT protection to recover.
    - v. Adjust the DC power supply to VDD - 3V.
    - vi. Observe that OUT transitions to approximately 7V and the on-board LED turns on after 6.5 seconds.
    - vii. Adjust the DC power supply to VDD.
  - b. If using a temperature chamber to simulate an overtemperature:
    - i. Install the shunt on J7 between the CTL and PTC pins.
    - ii. Increase the temperature of RT1 until the voltage drop across the thermistor is approximately 2.8V.
    - iii. Observe that OUT transitions to approximately 7V and the on-board LED turns on after 6.5 seconds.
9. Make other adjustments as desired for evaluation. See other sections of this user guide for details of operation.
10. When complete with this quick start demonstration, turn off the power supply.

Refer to other sections of this user's guide for additional details.

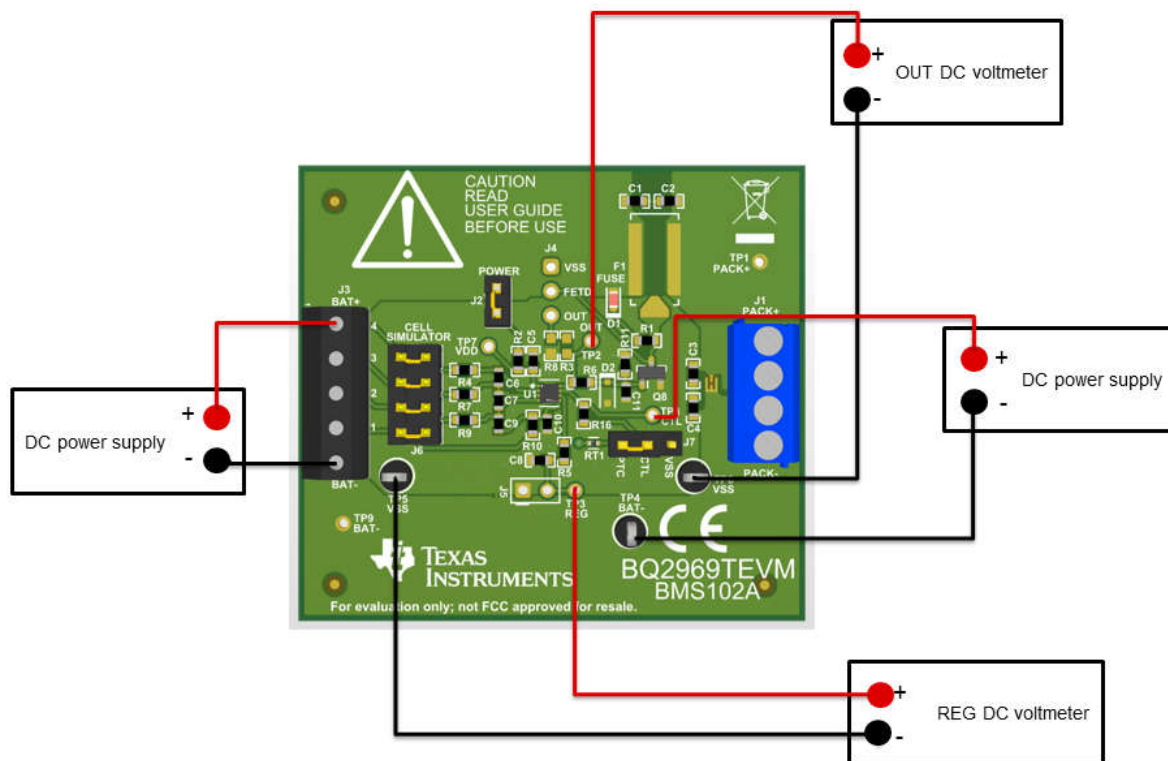


Figure 2-1. EVM Connection for Basic Operation

## 2.2 BQ2969T Circuit Module Use

The BQ2969T circuit module contains the BQ2969T IC and related circuitry to demonstrate the features of the IC. The board does not control current, the OUT signal passes directly to the TP2 connector. TP2 has no current limit or ESD protection on the signals, provide any necessary protection during evaluation external to the EVM. J2 provides a method to separate the supply feed from the input terminal block to measure current or to apply a voltage for customer test mode. Other components provide support for the IC and connections to the board. Basic operation is described in [Section 2.1](#). For details of the circuit, refer to [Section 3.1](#).

### 2.2.1 Cell Simulator

The EVM includes a resistive cell simulator made up of 200 $\Omega$  series resistors. The taps of the resistor network are connected to the cell inputs using shunts on the J6 header. BAT- is always connected to the resistor divider network. Install a shunt on the top cell location to connect BAT+ to the resistor divider to provide simulated voltages for the other cell inputs. With the top shunt installed the resistor divider is connected and shunts on the lower cell positions connect the inputs to the simulated voltages. With the top shunt removed all lower inputs with installed shunts are pulled to VSS. There is no indication of the cell simulator connection, the user must be aware of the shunt installation. The 200 $\Omega$  resistors provide a load of 5mA per volt on each cell.

### 2.2.2 Reducing the Cell Count

The BQ2969T cell count is reduced by shorting unused cells, normally from the top down but cells between the top and bottom can be shorted. The inputs are usually shorted at the IC as shown in the data sheet. The bottom cell must be used for proper operation. Power for the IC comes from the BAT+ terminal so power must be connected when using the EVM. While not recommended, the inputs of the EVM can typically be shorted at the terminal block for quick evaluation. For the best transient environment and to match the data sheet example,

short the VCx pins at the capacitor and remove the unused input resistor. When using the cell simulator, shorting the unused cell at the terminal block is still required to eliminate the simulated cell voltage. Shorting the cell inputs at the terminal block screw terminals is also suggested since shorting the cell inputs is a visual indication that the device is configured for a different cell count. While different connections are possible, [Table 2-1](#) shows configuration recommendations for reduced cell counts.

**Table 2-1. Reducing the Cell Count**

Unused Cell (Numbered from Bottom Cell 1)	Short Cell Input Terminals	Input Resistor to Remove	Replace Capacitor with 0Ω	IC Inputs Shorted
Cell 4	BAT+ to CELL3	R4	C6	VC4 to VC3
Cell 3	CELL3 to CELL2	R7	C7	VC3 to VC2

### 2.2.3 Connecting Cells

The EVM is constructed with a single connection to the top and bottom of the cell stack. Cell voltage for these cells is sensed on the board. The board is not configured to control current into or out of the cells.

The cell simulator provides resistors between the cell inputs. While in the process of installing physical cells, the cell simulator resistors load the cells and divide the voltage between any other unconnected inputs. The shunts must be removed once all the cells are connected or the cells are discharged by the constant drain of the cell simulator resistors.

BAT- is the reference voltage for the IC and must be connected first. After BAT-, cells can be connected in any order. Cell connection from the bottom up minimizes the voltage step size applied to the board. The recommended connection sequence for the EVM when connecting cells is bottom up:

1. Connect BAT-.
2. Connect cells bottom up: CELL1, CELL2, CELL3.
3. Make sure the cell simulator shunts are removed.

## 2.3 Best Practices

### CAUTION

The BQ2969T does not limit performance to the ratings of the EVM. Set equipment appropriately to limit voltage and current for safe operation.

### CAUTION

The circuit module has signal traces, components, and component leads on the bottom of the board. This can result in exposed voltages, warm surfaces, or sharp edges. Do not reach under the board during operation.

## 3 Hardware Design Files

### 3.1 BQ2969TEVM Circuit Module Physical Construction

This section contains the PCB layout, bill of materials, and schematic of the BQ2969TEVM circuit module. The BQ2969TEVM consists of one circuit module assembly, BMS102.

#### 3.1.1 Schematics

Figure 3-1 and Figure 3-2 illustrate the schematics.

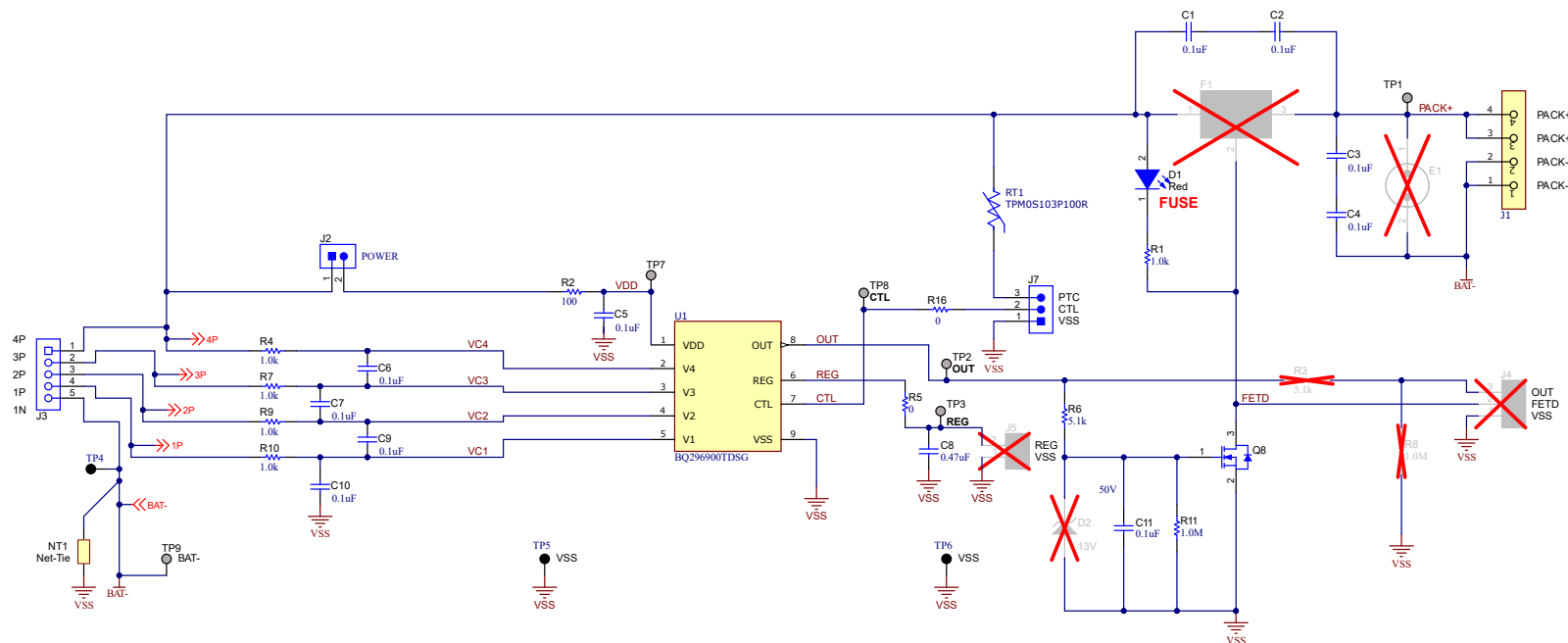


Figure 3-1. Schematic Diagram

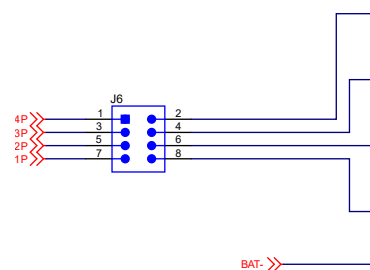


Figure 3-2. Cell Simulator

### 3.1.2 Board Layout

The BQ2969TEVM circuit module is a 47.5mm × 53mm 2-layer circuit card assembly. The EVM is designed for easy assembly with cell connections on the left edge to a terminal block. Output terminals are on the right edge using a header. The EVM layout and construction allows easy understanding of the connections and access to the test points for evaluation.

See additional information in the configuration and operation sections of this document. [Figure 3-3](#) to [Figure 3-4](#) show the board layout.

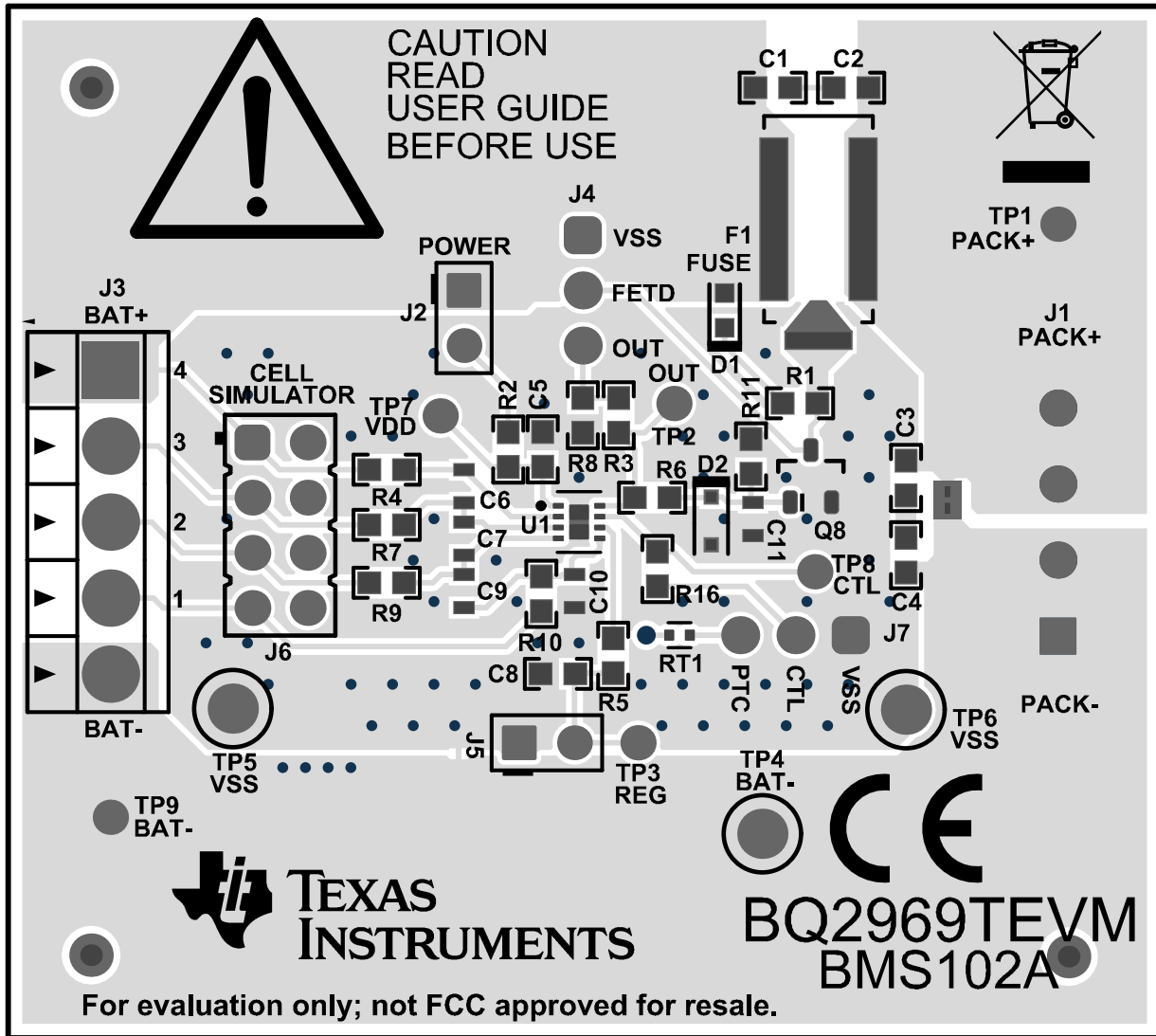


Figure 3-3. Top Layer

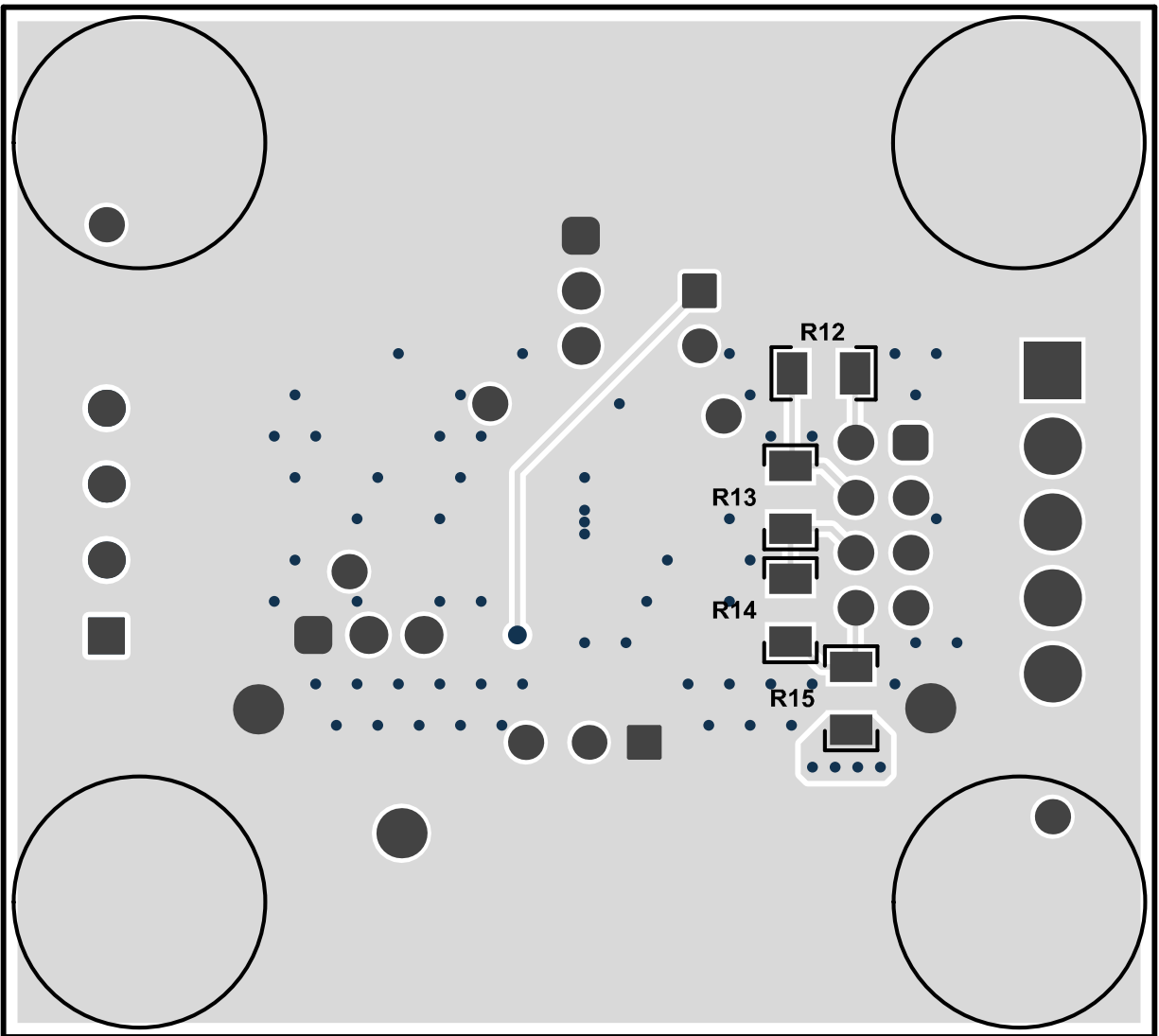


Figure 3-4. Bottom Layer



### 3.1.3 Bill of Materials

The bill of materials for the circuit module is shown in [Table 3-1](#). Substitute parts can be used in the manufacturing of the assembly.

**Table 3-1. Bill of Materials**

Designator	Quantity	Value	Description	PackageReference	Manufacturer
!PCB1	1		Printed Circuit Board		Any
C1, C2, C3, C4, C5	5	0.1uF	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	MuRata
C6, C7, C9, C10, C11	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	Wurth Elektronik
C8	1	0.47uF	CAP, CERM, 0.47 uF, 10 V, +/- 10%, X5R, 0603	0603	Kemet
D1	1	Red	LED, Red, SMD	LED_0603	Wurth Elektronik
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	3M
J1	1		TERM BLOCK 3.5MM VERT 4POS PCB	HDR4	On Shore Technology
J2	1		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	Sullins Connector Solutions
J3	1		Terminal Block, 3.5mm Pitch, 5x1, TH	17.5x8.2x6.5mm	On-Shore Technology
J6	1		Header, 2.54mm, 4x2, Gold, TH	Header, 2.54mm, 4x2, TH	Samtec
J7	1		Header, 100mil, 3x1, Gold, TH	3x1 Header	Samtec
Q8	1	60V	MOSFET, N-CH, 60 V, 2 A, AEC-Q101, SOT-23	SOT-23	Diodes Inc.
R1, R4, R7, R9, R10	5	1.0k	RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	Vishay-Dale
R2	1	100	RES, 100, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	Vishay-Dale
R5, R16	2	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	Stackpole Electronics Inc
R6	1	5.1k	RES, 5.1 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	Vishay-Dale
R11	1	1.0Meg	RES, 1.0 M, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	Vishay-Dale
R12, R13, R14, R15	4	200	RES, 200, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	Vishay-Dale
RT1	1	10kΩ	THERMISTOR PTC 0402 10K 100±5°C	0402	Thinking Electronic

**Table 3-1. Bill of Materials (continued)**

Designator	Quantity	Value	Description	PackageReference	Manufacturer
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J	6	1x2	Shunt, 100mil, Gold plated, Black	Shunt	Samtec
TP4	1		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	Keystone Electronics
TP5, TP6	2		Test Point, Compact, Black, TH	Black Compact Testpoint	Keystone Electronics
U1	1		BQ2969T00DSGT	WSON8	Texas Instruments
D2	0	13V	Diode, Zener, 13 V, 200 mW, SOD-323	SOD-323	Diodes Inc.
F1	0		Fuse, 30 A, 62 VDC, SMD	9.5x2x5mm	Dexerials Corporation
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A
J4	0		Header, 100mil, 3x1, Gold, TH	3x1 Header	Samtec
J5	0		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	Sullins Connector Solutions
R3	0	5.1k	RES, 5.1 k, 5%, 0.1 W, AEC- Q200 Grade 0, 0603	0603	Vishay-Dale
R8	0	1.0Meg	RES, 1.0 M, 5%, 0.1 W, AEC- Q200 Grade 0, 0603	0603	Vishay-Dale

## **4 Additional Information**

### **4.1 Trademarks**

All trademarks are the property of their respective owners.

## **5 Related Documentation**

- Texas Instruments, [BQ2969T Overvoltage and Overtemperature Protection for 2-Series, 3-Series, and 4-Series Cell Li-Ion Batteries](#)

## STANDARD TERMS FOR EVALUATION MODULES

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  - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
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  - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
  - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

### **WARNING**

**Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.**

**User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.**

**NOTE:**

**EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.**

### 3 Regulatory Notices:

#### 3.1 United States

##### 3.1.1 Notice applicable to EVMs not FCC-Approved:

**FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

##### 3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

#### **CAUTION**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

#### **FCC Interference Statement for Class A EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

#### **FCC Interference Statement for Class B EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

#### 3.2 Canada

##### 3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

#### **Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

#### **Concernant les EVMs avec appareils radio:**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### **Concerning EVMs Including Detachable Antennas:**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

### Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

#### 3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page) 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page)

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#### 3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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- 4 *EVM Use Restrictions and Warnings:*
    - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
    - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
    - 4.3 *Safety-Related Warnings and Restrictions:*
      - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
      - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
    - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
  5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
  6. *Disclaimers:*
    - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
    - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
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8. *Limitations on Damages and Liability:*

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8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

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