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

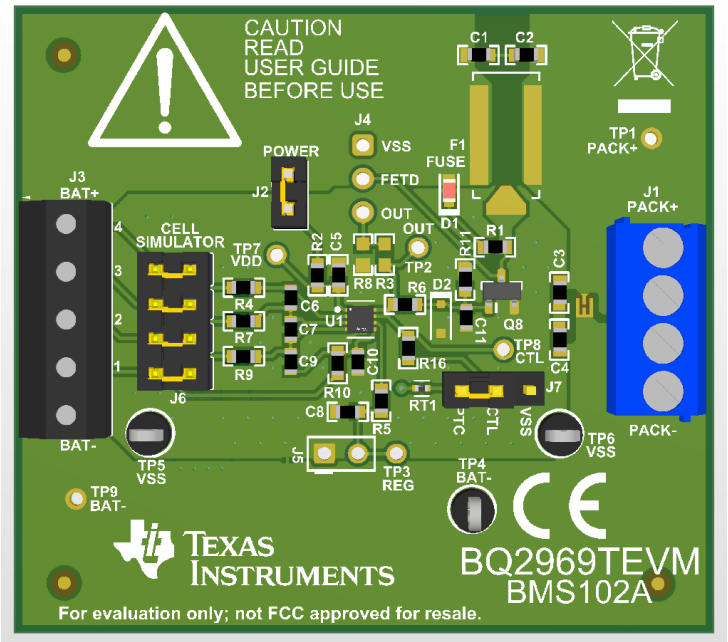
1. Order the BQ2969TEVM from ti.com.
2. Follow the instructions in this user's guide to get started.

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.

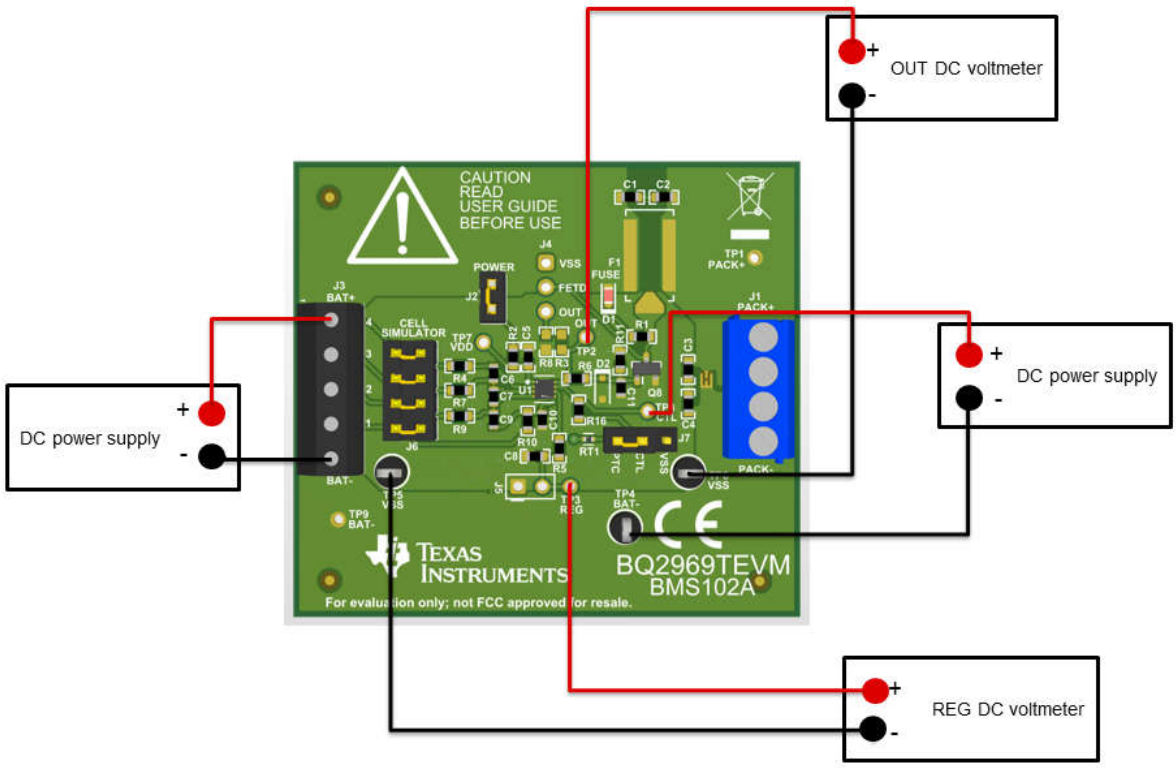


Figure 2-1. EVM Connection for Basic Operation

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 200Ω 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 200Ω 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.

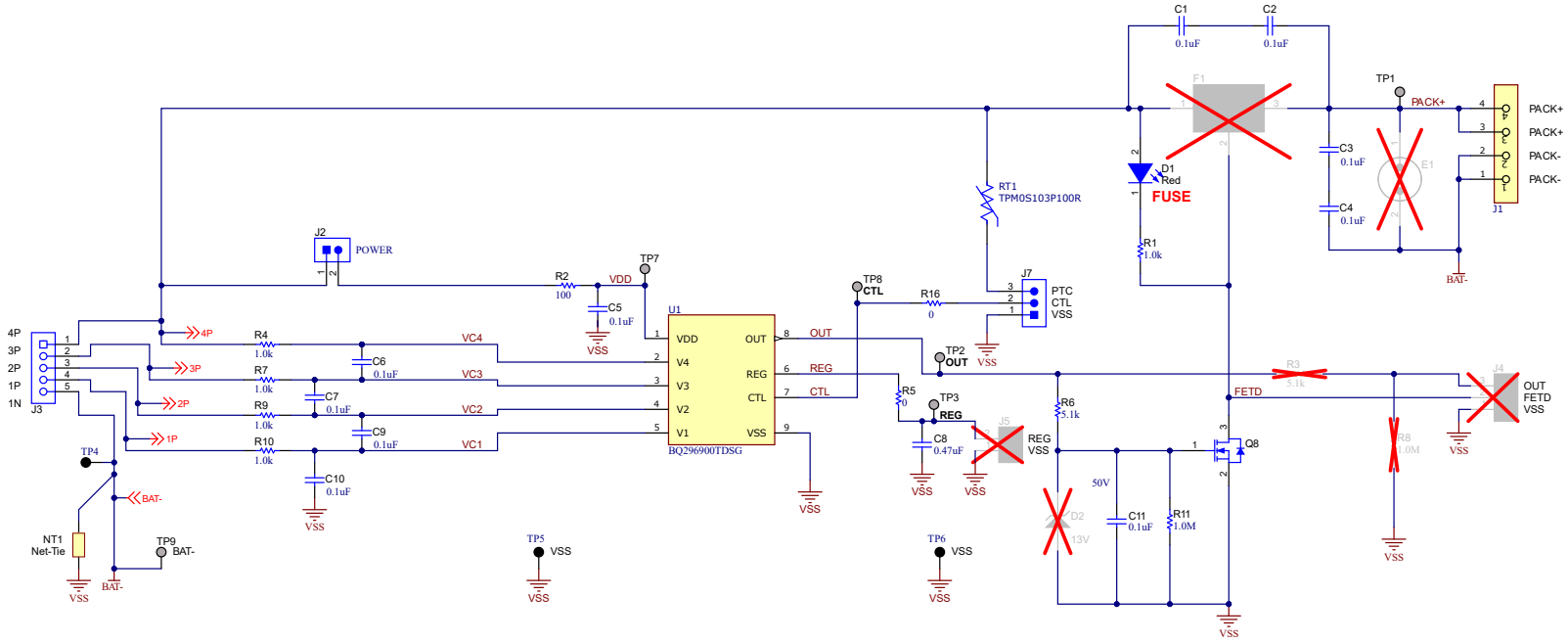


Figure 3-1. Schematic Diagram

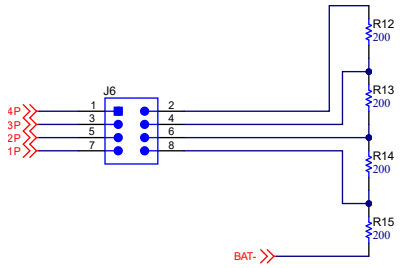


Figure 3-2. Cell Simulator

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.

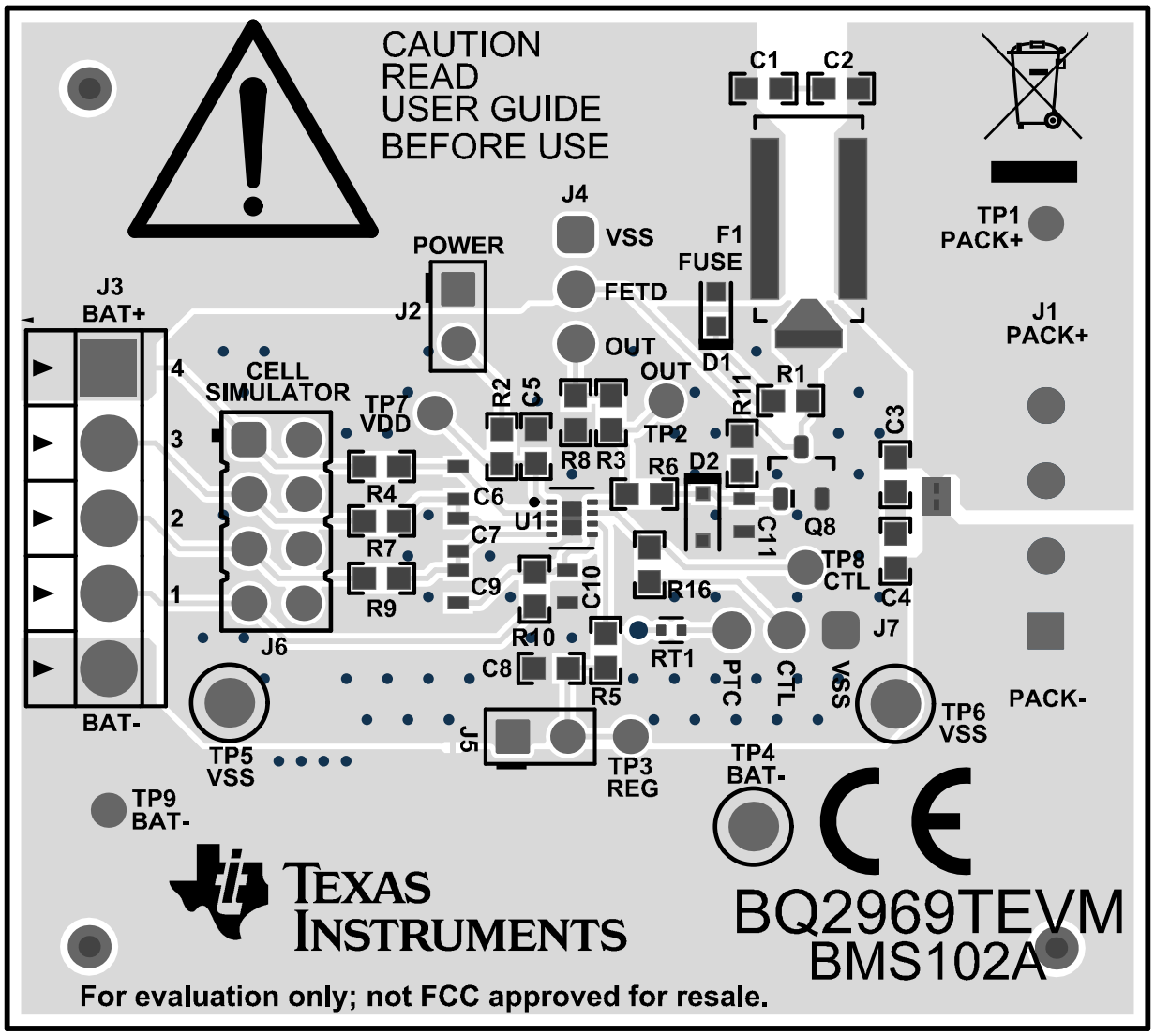


Figure 3-3. Top Layer

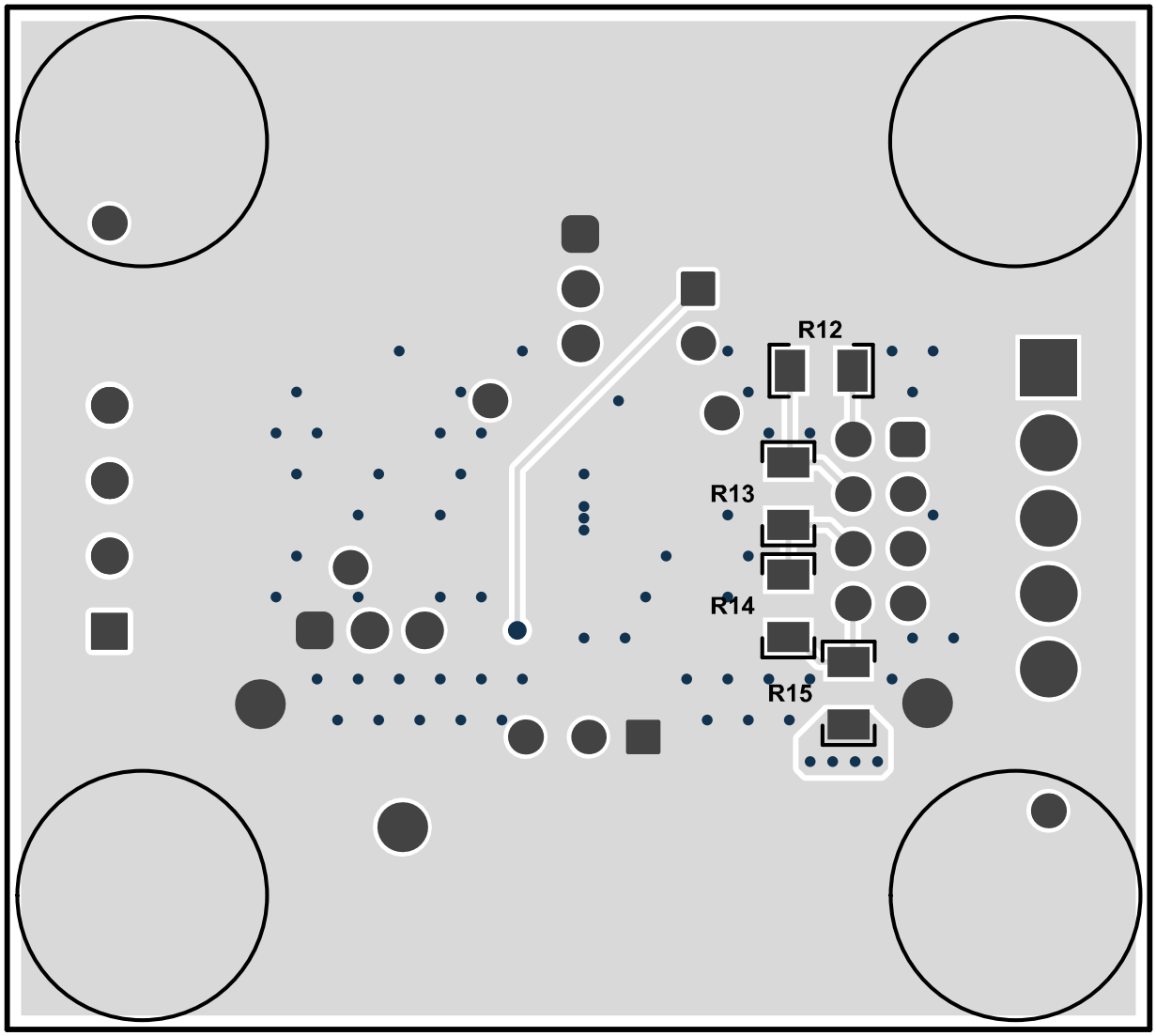


Figure 3-4. Bottom Layer

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

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