

BQ2980EVM-883 Evaluation Module for BQ2980 High-Side Driver

This engineering evaluation module (EVM) is a complete evaluation system for the bq2980 voltage, current, temperature protector with integrated high-side NFET drivers with external FETs shutdown control for single lithium-ion and lithium polymer cell. The EVM includes one bq2980 and dual FETs to control current in a configuration typical for switching currents to turn ON or OFF the charging and discharging power path for battery cell protection. The EVM module includes one bq2980 integrated circuit (IC), a 1-m Ω sense resistor, EFC8811R FETs, and all other onboard components necessary to switch charge and discharge current. The evaluation module connects between a "battery" source and a "pack" load or charger. In addition to the voltage and current protection, bq2980 also supports overtemperature protection that can be tested on this EVM.

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1 Features

This EVM has the following features:

- Complete evaluation system for the bq2980 fast charging single cell, integrated high-side driver low power protector IC
- Populated evaluation module bq2980EVM-PWR883 for quick setup and basic testing with load currents up to 8 A

1.1 Kit Contents

This EVM kit contains the following piece:

- bq2980EVM-PWR883 evaluation module

1.2 Ordering Information

The EVM orderable part number is bq2980EVM-883. For complete ordering information, see the [bq2980EVM](#) product page.

1.3 Documentation

See the bq2980 data sheet ([SLUSCS3](#)) on [www.ti.com](#) for information on device hardware.

1.4 bq2980 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq2980EVM.

Table 1. bq2980 Configuration on PWR883

Specification	Minimum	Typical	Maximum	Unit
Input voltage BATT+ to BATT-	0	3.6	5.5	V
Input voltage PACK+ to PACK-	0	3.8	12	V
Charge current	0	+1	+8	A
Discharge current	-0.1	-1	-8	A
Ambient operating temperature	15	25	35	°C
Surface temperature of EVM with 8 A of load current		50	80	°C
OCD threshold set on the PWR883		+8		mV
OCC threshold set on the PWR883		-8		mV
SCD threshold set on the PWR883		20		mV
Overvoltage delay set on the PWR883		1.25		s
Undervoltage delay set on the PWR883		144		ms
Overvoltage set on the PWR883		4.475		V
Undervoltage set on the PWR883		2.6		V
Overcurrent (OCC, OCD) detection delay		8		ms
Short-circuit discharge detection delay		250		μs
Internal overtemperature threshold		80		°C
Overtemperature detection delay		4.5		s
CTR	-	Enabled	-	

NOTE: The PWR883 board is constructed and rated to withstand an absolute maximum of 10 A. Using a 1-mΩ sense resistor and OCC and OCD threshold of +8 mV (the bq2980 is pre-programmed from the factory), OCC, OCD testing can be performed at 8 A. If performing SCD testing (SCD threshold set to 20 mV), the sense resistor must be scaled up and the necessary wattage resistor must be installed.

2 bq2980EVM Quick Start Guide

This section provides the step-by-step procedures required to use a new bq2980 EVM and configure it for operation in a engineering laboratory environment.

2.1 Before You Begin

The following warnings and cautions are noted for the safety of anyone using or working close to the bq2980 EVM. Observe all safety precautions.

WARNING

The circuit module has signal traces and component leads on the bottom of the board. This may result in exposed voltages, hot surfaces, or sharp edges. Do not reach under the board during operation. Do not operate the EVM on a conductive surface.

CAUTION

The circuit module may be damaged by overtemperature. To avoid damage, monitor the temperature during evaluation and provide cooling, as needed, for your system environment.

CAUTION

Some power supplies can be damaged by application of external voltages. If using more than one power supply, check your equipment requirements and use blocking diodes or other isolation techniques, as needed, to prevent damage to your equipment.

WARNING

The circuit module is not a finished product or electrical appliance. It must be used by qualified personnel with additional equipment for evaluation only. Do not leave EVM powered when unattended.

2.2 Items Needed for EVM Quick Start Evaluation

- bq2980 EVM module
- For the BAT+, BAT– connection terminal: One adjustable DC power supply to act as a 'cell connection' with capability to provide 1 V to 5.5 V and 0.25 A to 8 A maximum, with current source and sink to simulate a charging and discharging event.
- For the PACK+, PACK– connection terminal: One adjustable power supply to act as 'charger' with current source capability.
- An electronic load with current sink capability of 0.100 A to 8 A. (Note: electronic load is highly recommended as many models of the power supplies cannot sink high currents)

- A high impedance (greater than 10-M Ω input) digital multimeter or measurement to check voltage on the driver test points. DMM leads or scope probes connected on the CHG or DSG (CHG/DSG) line, increases the charge pump loading of the bq2980 at the expense of the device current consumption on VDD. Device power consumption returns to normal when the scope probes and leads are disconnected from the CHG/DSG line.
- Shielded high current cables for connection for battery connection and pack connection of the electronic load

2.3 EVM Connections

This section covers the hardware connections for the bq2980EVM-PWR883 (see Figure 1).

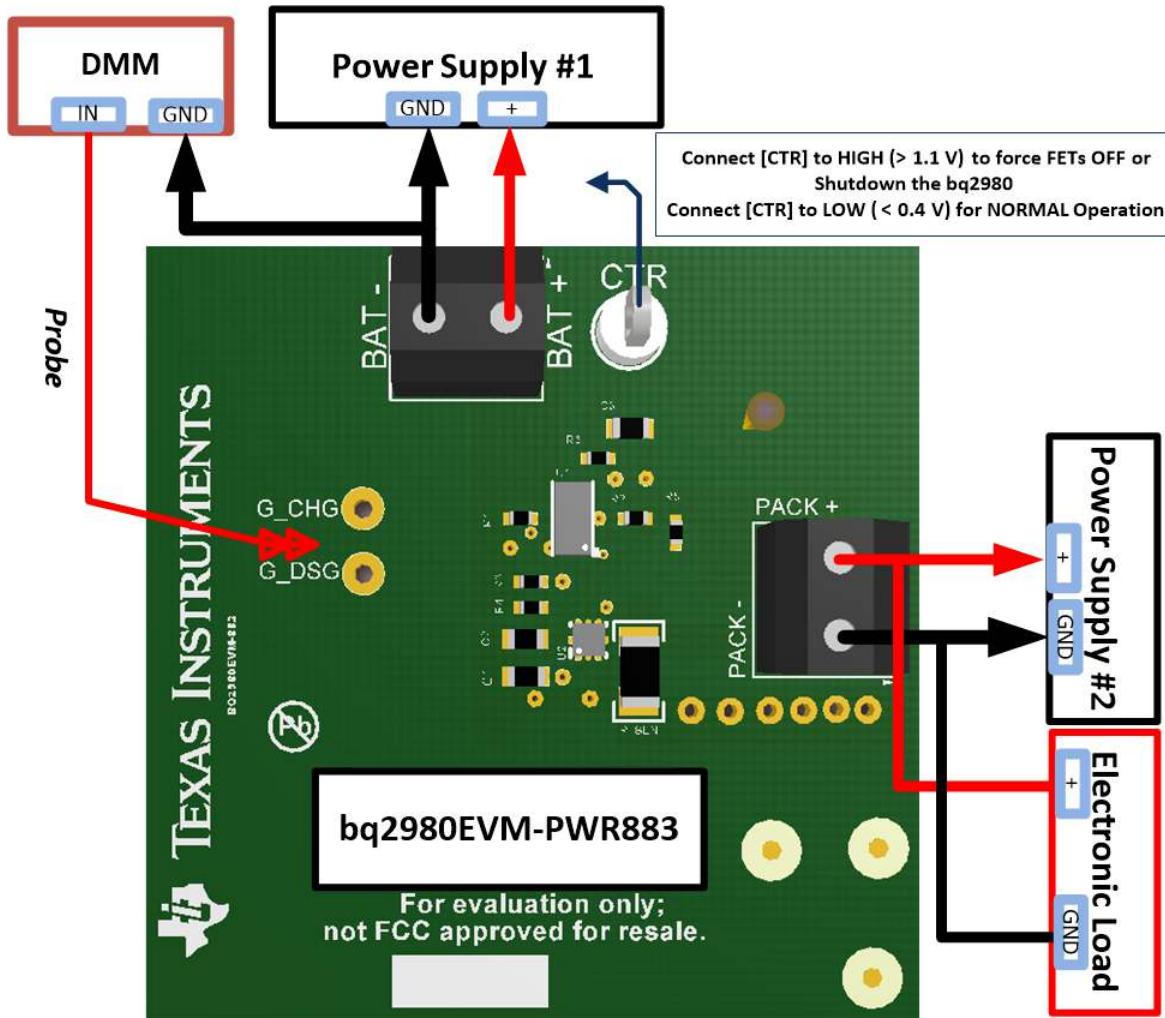


Figure 1. bq2980EVM-PWR883 Connection for Basic Operations

- On the bq2980 EVM-PWR883, BAT+ and BAT– are the positive and negative terminal of the power supply #1 - (VBAT).
- On the bq2980 EVM-PWR883, PACK+ and PACK– are the positive and negative terminal of the power supply #2 - (VPACK).

When using a power supply for evaluation, be sure the power supply can accept or is protected from any reverse current such as with a blocking diode if another supply is used in the system.

The PACK+ and PACK– terminals are for attachment of the load or charger. If using a power supply to simulate a charger, be sure it can accept or is protected from any reverse current.

2.4 Quick Start Testing Sequence

These steps describe a simple demonstration or check of the operation of the bq2980EVM in a 1S configuration.

1. Connect adjustable power supply #1 - (VBAT) as cell connection between the BAT+ and BAT- terminals as in [Figure 1](#).
2. Connect adjustable power supply #2 - (VPACK) as the charger between the PACK+ and PACK- terminals as in [Figure 1](#). The bq2980 will power up (starts up) at SHUTDOWN mode assuming undervoltage fault. If approximately 2 V is on PACK+, the device comes out of the SHUTDOWN assuming zero-voltage charging, hence the CHG FET will be ON. However, the DSG FET will still be OFF because the device assumes undervoltage fault.
3. Connect electronic load between the PACK+ and PACK- terminals, as required, refer to [Figure 1](#).
4. Set power supply #1 to 3.6 V with the ability to sink or source 100 mA–200 mA, enable the supply.
5. Set power supply #2 to 4.0 V with the ability sink or source 100 mA–200 mA, enable the supply and disable supply. Observe bq2980 to transition from SHUTDOWN to NORMAL mode. The bq2980 device can also enter NORMAL mode, if the VDD pin is SHORTED to the PACK pin. Also note in NORMAL mode, both drivers (charge and discharge FETs are ON) are to be operating at greater than 9.5 V, as detailed in [Figure 2](#).
6. If complete, power down BAT+ and PACK+. Disconnect setup, if complete.

2.5 Undervoltage(UV) Testing

1. Adjust the power supply #1 voltage to simulate an undervoltage condition.
2. Observe the DSG FET and CHG FET being disabled after the UV fault delay.
3. Refer to the EVM883 scope capture in [Figure 2](#).
4. Allow recovery from the undervoltage condition by removing the load from the PACK terminal and increase the power supply #1 voltage - (VBAT) > (Vuvp + Vuvp_hys) [or perform the next step].
5. Connect the power supply #2 - (VPACK) to act as the charger, with (VPACK – VBAT) > 700 mV for charger detection and increase the power supply #1 - (VBAT) voltage to greater than Vuvp threshold voltage as indicated in the data sheet.

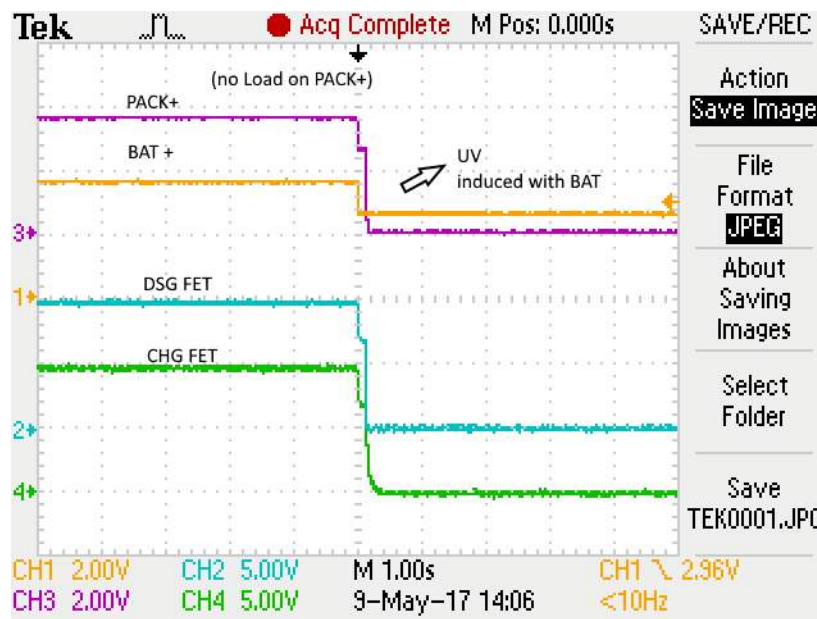


Figure 2. bq2980EVM-PWR883 Demonstration of Undervoltage

2.6 Overvoltage (OV) Testing

1. Adjust the power supply #1 voltage - (VBAT) to simulate an overvoltage condition.
2. Observe the CHG FET being disabled after the OV fault delay. Refer to the EVM scope capture in [Figure 3](#).
3. Allow recovery from the overvoltage condition by removing the charger and decreasing the power supply #1 voltage (VBAT) < $(V_{ovp} - V_{ovp_hys})$, **or** when the power supply #1 voltage - (VBAT) < (V_{ovp}) and the load resistor is in place and being detected.
4. For load detection, the bq2980 needs the condition of $(VBAT - V_{PACK}) > 400$ mV.
5. If complete, power down BAT+ and PACK+, disconnect setup, if complete.

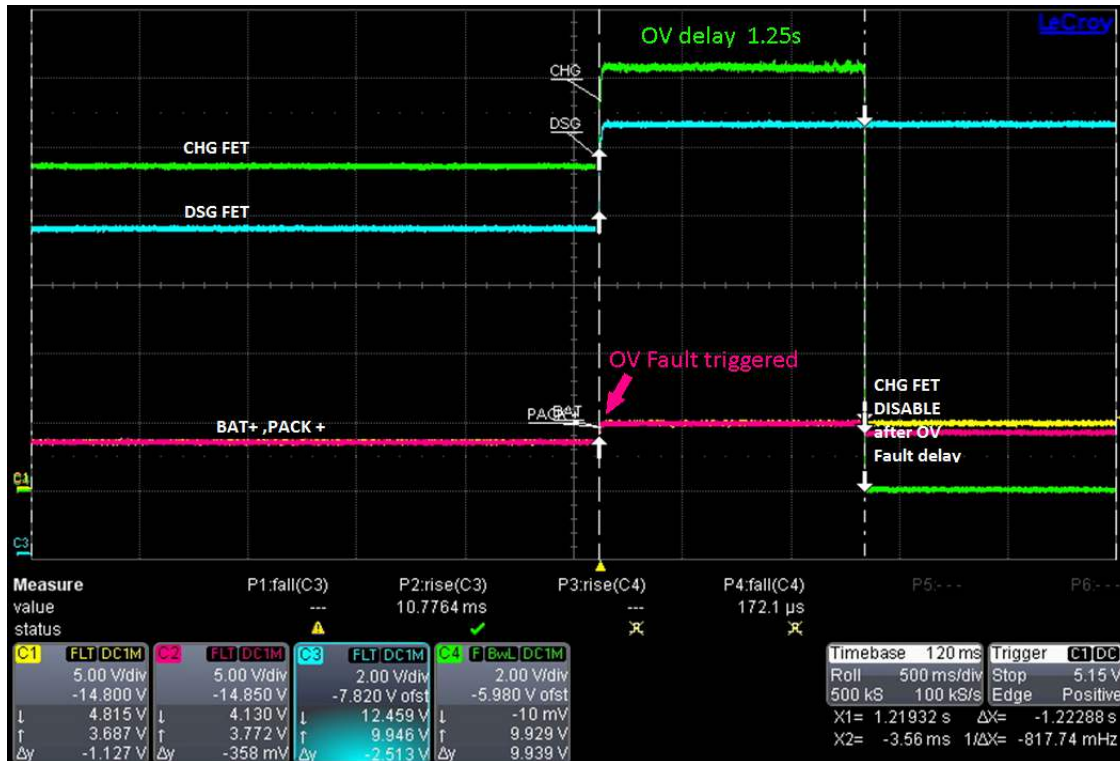


Figure 3. bq2980EVM-PWR883 Demonstration of Overvoltage

2.7 FET Override Testing With Control (CTR) Pin

1. Set power supply #1 to 3.6 V with the ability to sink or source 100 mA–200 mA, enable the supply.
2. Set power supply #2 to 4.0 V with the ability sink or source 100 mA–200 mA, enable the supply and disable supply. Observe that the bq2980 transitions from SHUTDOWN to NORMAL mode.
3. Connect CTR to LOW (< 400 mV) for NORMAL operation.
4. Note in NORMAL mode, both drivers (charge and discharge FETs are ON) are to be operating at greater than 9.5 V.
5. Connect CTR to HIGH (> 1.1 V).
6. Observe FETs are forced to shutoff as shown in Figure 4.

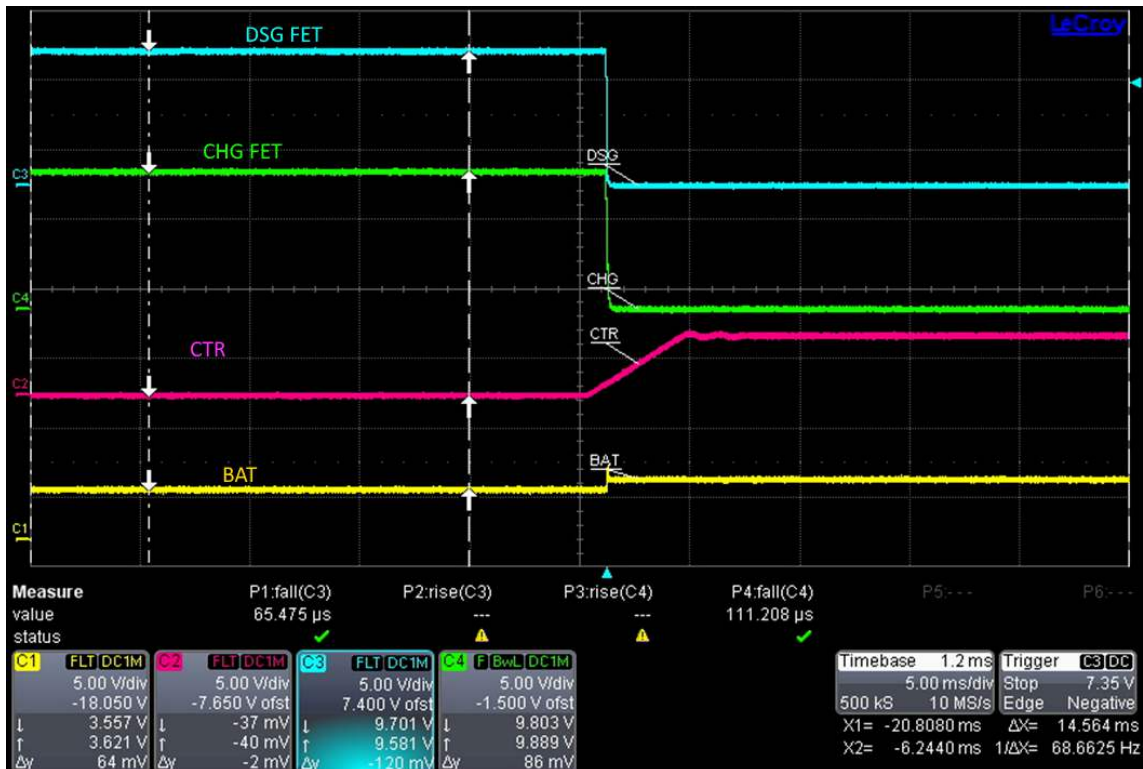


Figure 4. bq2980EVM-PWR883 Demonstration FET Override With Control Pin (CTR)

3 Additional Evaluation Setups

CAUTION

The bq2980EVM-PWR883 does not contain capacitors on the input or output current paths to dampen transients. Be sure to use appropriate transient suppression scheme to avoid damage to the board from cable or equipment transient responses during evaluation.

3.1 bq2980EVM-PWR883 Operation With Charge and Discharge Currents

Charge and discharge current operation can also be demonstrated with conventional supplies and loads.

Connect and operate the equipment within its performance limits. By design, the bq2980EVM-PWR883 can operate at 6 A–8 A with high reliability. If high current power supplies are available, current control can be demonstrated through the board in both directions (charge and discharge). Note OCD generation as detailed in [Figure 5](#).

Connect the electronic load to the PACK+, PACK– terminal.

Adjust the electronic load to the desired load current. (Note the load current is delivered from the battery power supply #1.)

Enable the electronic load.

Observe that the BAT+ and PACK+ voltage dip as the load current as detailed in [Figure 5](#) is increased and the power supply #1 - (VBAT) voltage may need to be increased. Compensation for the lossy cables between the power supply #1 and BAT+ and BAT– terminals may be required.

NOTE: When turning ON the load, the power supply #1 - (VBAT) can droop (due to extra IR drops) to levels that inadvertently can trigger an undervoltage fault. Likewise, when the load current is OFF, the power supply #1 (VBAT) voltage will bounce back to the set voltage limit of the power supply to inadvertently trigger an overvoltage event or exceed ABS maximum of VDD specification of the bq2980.

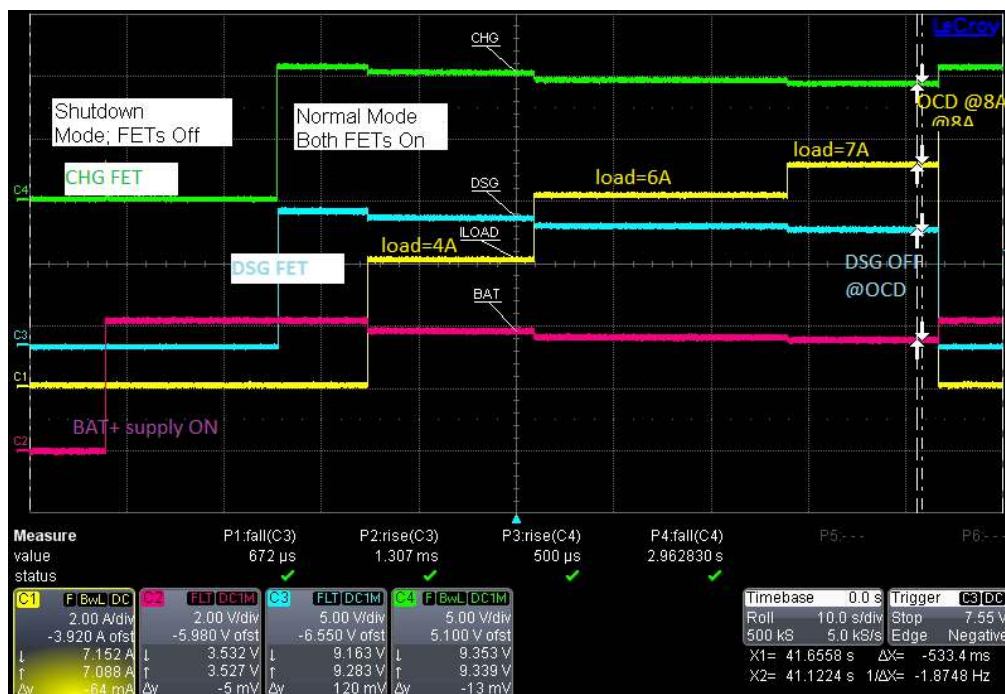


Figure 5. bq2980EVM-PWR883 Demonstration of Overcurrent Discharge Fault at 8 A

3.2 Troubleshooting

Table 2 is a good procedure to check the basic electrical integrity of the board, if SHUTDOWN or NORMAL mode currents being violated as described in the bq2980 data sheet (SLUSCS3).

- If the bq2980 does not appear to be operating after applying the wake pulse signal on the PACK+ pin, check the VDD voltage at the battery connection and PACK+ connectors.
- Check that the battery input voltages are within the operating range of the part. If a fault has been induced, check that the UV recovery condition has been met. Check the status of the CTR pin. If CTR is HIGH, the bq2980 will be in SHUTDOWN mode.
- After disconnecting the power supply #2 and the electronic load from the PACK+ terminal, in NORMAL mode (both FETs are ON), the voltage on the PACK+ voltage should almost be the same as that of BAT+.
- To ensure the voltage on BAT± is not below undervoltage due to $I \times R$ losses, check the BAT± voltage at the EVM terminal.

Table 2. Unpowered bq2980EVM-PWR883 Troubleshooting Guide

Resistance on bq2980EVM-PWR883 (Without the Power on the EVM)	Values (Typical)
G_DSG-GND	Open
GND-G_DSG	3.4 MΩ
BAT+ to G_DSG	Open
G_DSG to PACK+	Open
GND to PACK+	5.5 MΩ
PACK+ to GND	Open

3.3 Changing Configuration or Conditions

If the board is modified to change the IC or other components or is operated at an expanded temperature range, be sure to check component temperatures and other operating characteristics to be sure the board does not provide a hazard in evaluation. The bq2980 device (depending on the OCD, OCC thresholds) may allow more current flow through the FETS with higher surface temperatures.

4 bq2980EVM Specifics for Varying Conditions

This section contains information on EVM specifics in adapting to varying applications and conditions

4.1 Third Party Power MOSFETs

The bq2980EVM-PWR883 has on-semi EFC8811R, dual N-channel power MOSFET in CSP6 chip-scale footprint options. Alternate FETs and configurations, depending on the gate capacitance and gate charges, may require a change to the gate resistor to provide an appropriate rise and fall switching time.

4.2 BAT± Transient Pattern

To suppress transients currents, a 10-μF to 100-μF electrolytic capacitor across the battery input (±) terminals, may be desired during switching of high load- current (> 4 A) testing.

4.3 Other Uninstalled Components

The bq2980EVM contains specific variance in BOM configuration. Refer to the schematic diagram (Figure 6) for additional information. R1 and R2 resistors are not needed as they will load the CHG and DSG drivers and expend current from the charge pump of the device; therefore, they are not populated.

5 Circuit Module Physical Layouts

This section contains the schematics, the printed-circuit board (PCB) layout, and assembly drawings for the bq2980 circuit module.

5.1 Schematic

Figure 6 shows the bq2980EVM schematic.

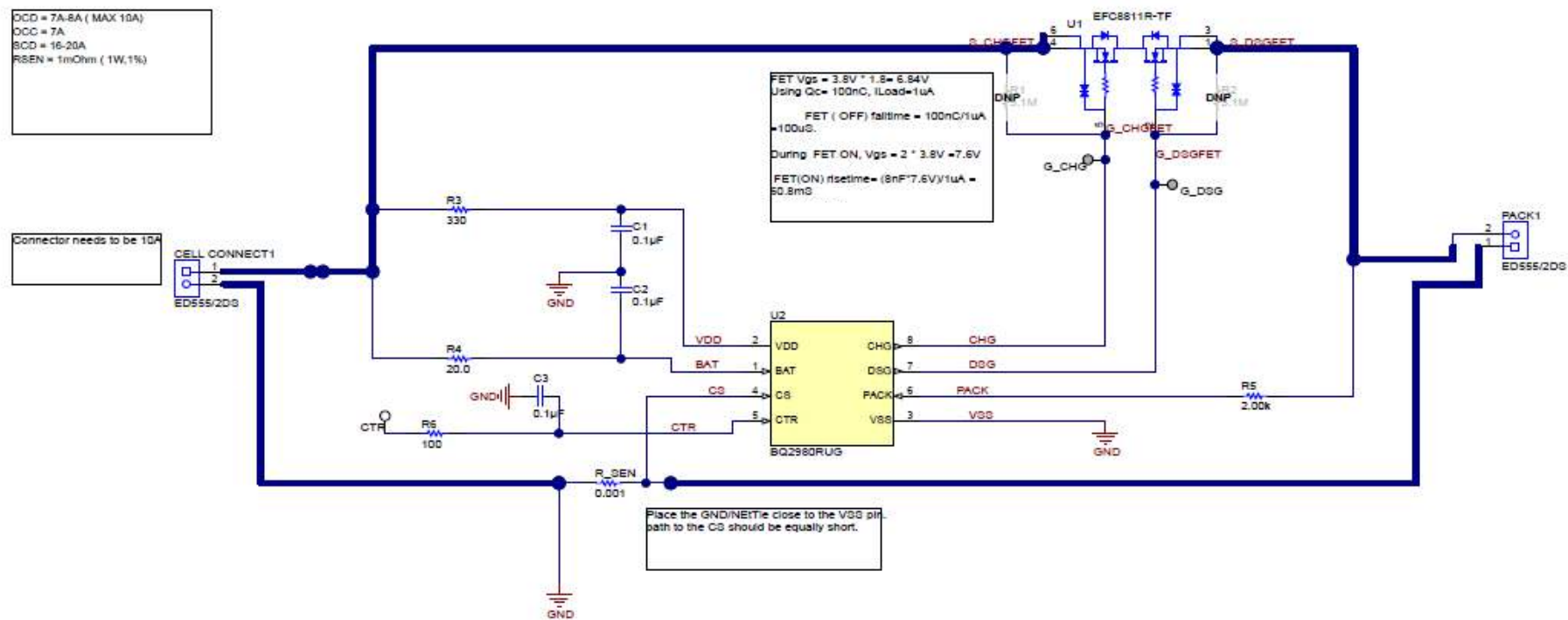


Figure 6. bq2980EVM Schematic

5.2 Board Layout

This section shows the PCB layers and assembly drawing for the bq2980 module (see [Figure 7](#) through [Figure 10](#)). The board is a 2-layer, 2-oz copper clad, single-sided assembly board. There are no components placed on the bottom of the EVM.

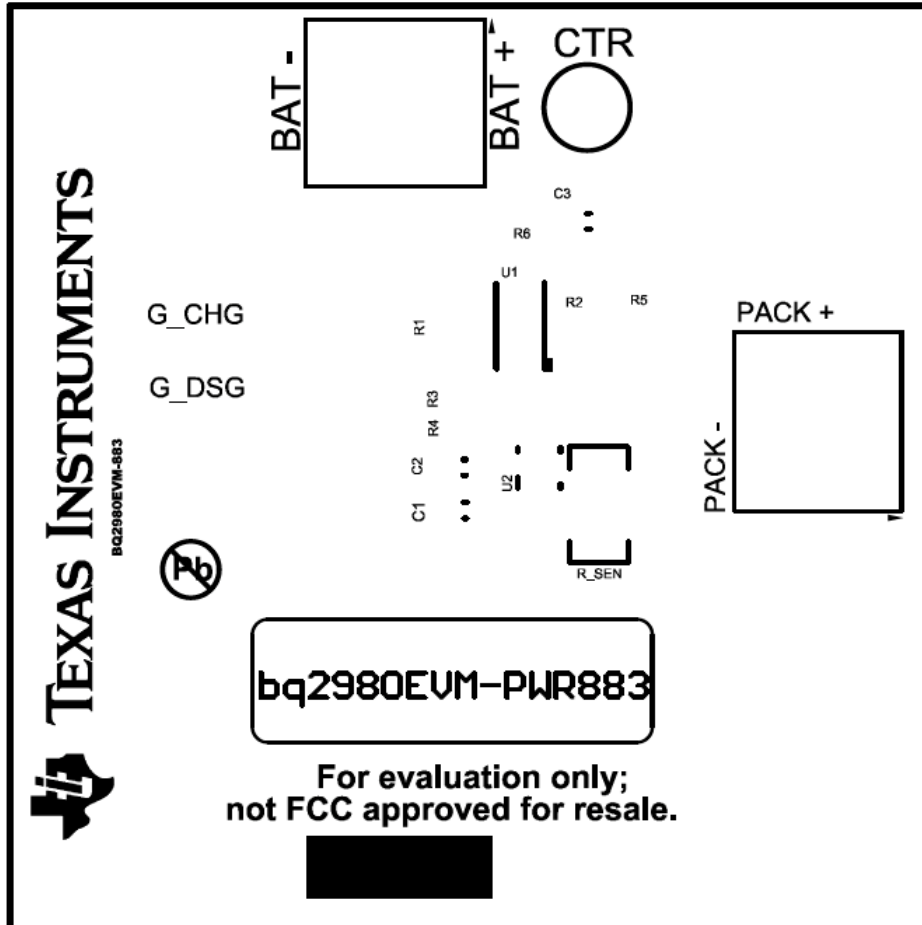


Figure 7. Top Silk Screen

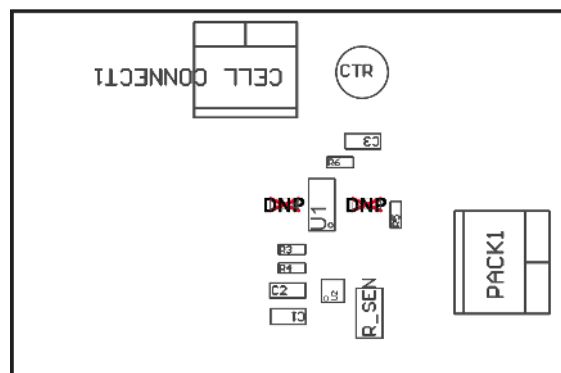


Figure 8. Top Assembly

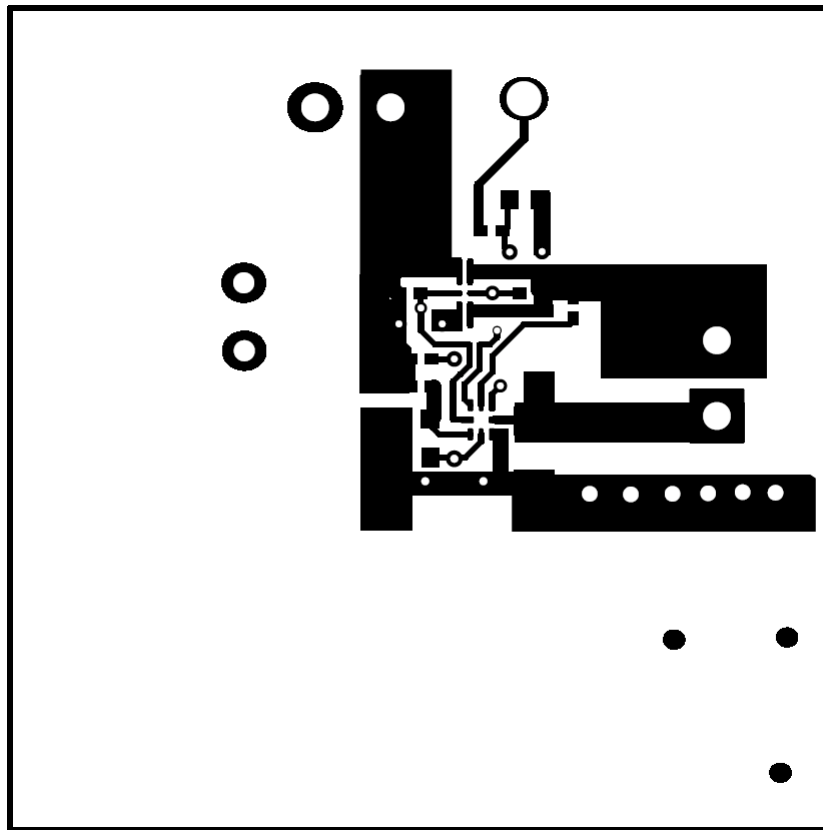


Figure 9. Top Layer

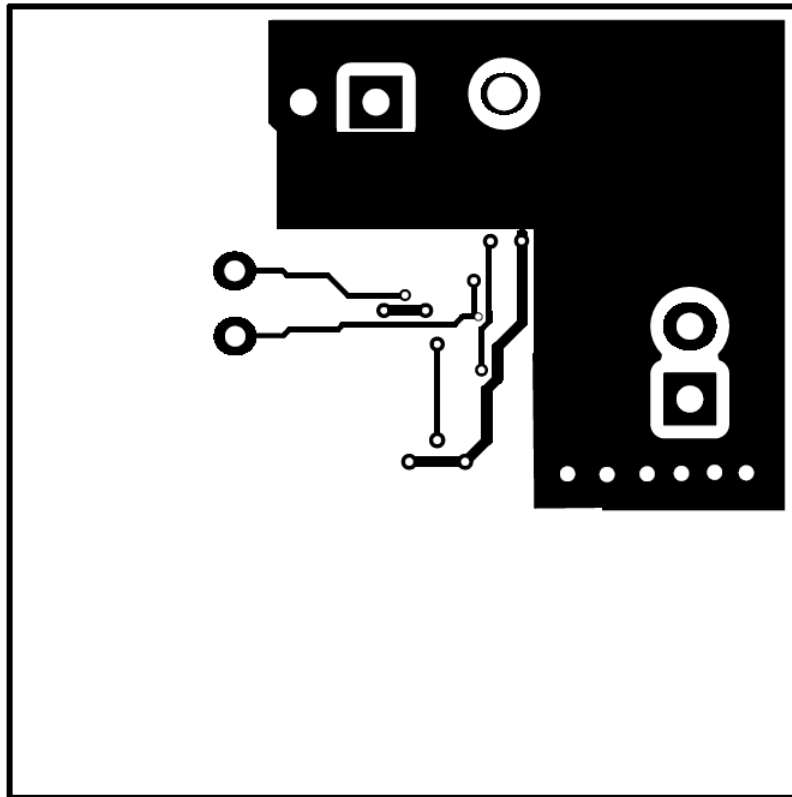


Figure 10. Bottom Layer

6 Bill of Materials

Table 3 lists the bq2980EVM-PWR883 bill of materials.

Table 3. bq2980EVM Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		PWR883	Any
C1, C2, C3	3	0.1uF	CAP, CERM, 0.1 μ F, 50 V, \pm 10%, X7R, 0603	0603	GRM188R71H104KA93D	Murata
CELL CONNECT1, PACK1	2		Terminal Block, 3.5mm Pitch, 2x1, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
CTR	1		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone
H9, H10, H11, H12	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R3	1	330	RES, 330, 5%, 0.063 W, 0402	0402	CRCW0402330RJNED	Vishay-Dale
R4	1	20.0	RES, 20.0, 1%, 0.063 W, 0402	0402	CRCW040220R0FKED	Vishay-Dale
R5	1	2.00k	RES, 2.00 k, 1%, 0.063 W, 0402	0402	CRCW04022K00FKED	Vishay-Dale
R6	1	100	RES, 100, 1%, 0.063 W, 0402	0402	CRCW0402100RFKED	Vishay-Dale
R_SEN	1	0.001	RES, 0.001, 1%, 1 W, AEC-Q200 Grade 0, 1206	1206	CSNL1206FT1L00	Stackpole Electronics Inc
U1	1		Power MOSFET for 1 Cell Lithium-ion Battery Protection 12V, 3.2mOhm, 27A, Dual N-Channel, SMD	1.77x3.54mm	EFC8811R-TF	ON Semiconductor
U2	1		1S High-Side Protector with External Shutdown Control, RUG0008A (X2QFN-8)	RUG0008A	BQ2980RUG	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R1, R2	0	5.1Meg	RES, 5.1 M, 5%, 0.063 W, 0402	0402	CRCW04025M10JNED	Vishay-Dale

7 Related Documentation from Texas Instruments

- bq2980 *Voltage, Current, Temperature Protector with Integrated High Side NFET Driver for Fast/Flash Charging Single-Cell Li-ion and Li-Polymer Batteries* ([SLUSCS3](#))

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