bq76930 and bq76940 Evaluation Module

User's Guide

Literature Number: SLVU925B
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General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines

WARNING

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and the safety of those working around you. Contact TI's Product Information Center http://support/ti./com for further information.

Save all warnings and instructions for future reference.

Failure to follow warnings and instructions may result in personal injury, property damage, or death due to electrical shock and/or burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise, and knowledge of electrical safety risks in development and application of high-voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments. If you are not suitably qualified, you should immediately stop from further use of the HV EVM.

1. **Work Area Safety:**
   (a) Keep work area clean and orderly.
   (b) Qualified observer(s) must be present anytime circuits are energized.
   (c) Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
   (d) All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50 V_{RMS}/75 VDC must be electrically located within a protected Emergency Power Off (EPO) protected power strip.
   (e) Use a stable and non-conductive work surface.
   (f) Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
2. **Electrical Safety:**As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.
   (a) De-energize the TI HV EVM and all its inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   (b) With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   (c) Once EVM readiness is complete, energize the EVM as intended.

   WARNING: while the EVM is energized, never touch the EVM or its electrical circuits as they could be at high voltages capable of causing electrical shock hazard.
3. **Personal Safety:**
   (a) Wear personal protective equipment, for example, latex gloves and/or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.
4. **Limitation for Safe Use:**
   (a) EVMs are not to be used as all or part of a production unit.

bq76930 and bq76940 Evaluation Module User's Guide

The bq76930EVM evaluation module (EVM) is a complete evaluation system for the bq76930, a 6-cell to 10-cell Li-Ion battery analog front end (AFE) integrated circuit. The bq76940EVM evaluation module (EVM) is a complete evaluation system for the bq76940, a 9-cell to 15-cell Li-Ion battery analog front end (AFE) integrated circuit. The EVM consists of a circuit module which can be used for simple evaluation of the AFE and bq78350 gauge functions. The circuit module includes one bq76930 or bq76940 integrated circuit (IC), sense resistor, power FETs, and all other onboard components necessary to protect the cells from overcharge, over discharge, short circuit, and overcurrent discharge in a 10- or 15-series cell Li-Ion or Phosphate battery pack. The circuit module connects directly across the cells in a battery. With a compatible interface board and Microsoft® Windows® based PC graphical user interface (GUI) software, the user can view the device registers, adjust protection limits and enable FET control outputs.

1 Features

- Complete evaluation system for the bq76930 or bq76940 Li-Ion and Phosphate battery AFE
- Populated circuit module for 10-cell or 15-cell configuration for quick setup
- Power connections available on screw terminals
- Communication signals available on 4-pin connector
- Resistor cell simulator for quick setup with only a power supply
- PC software available for configuration

1.1 Kit Contents

- bq769x0 circuit module
- Cable to connect the EVM to an EV2400 or EV2300 interface board

1.2 Ordering Information

For complete ordering information, refer to the product folder at www.ti.com.

Table 1. Ordering Information

EVM Part Number	Chemistry	Configuration	Capacity
bq76930EVM	Li-Ion	10 cells	Any
bq76940EVM	Li-Ion	15 cells	Any

NOTE: Although capacity is shown as *Any*, practical limits of the physical construction of the module will typically limit the operation of the EVM to a 1P or 2P battery construction. Refer to the physical construction section for board details.

1.3 bq769x0 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq769x0 circuit module in its default 10- or 15-cell configuration.

Typical voltage depends on the number of cells configured. Typical current depends on the application. Board cooling may be required for continuous operation at or below maximum current.

Table 2. Performance Specification Summary

Specification		Min	Typ	Max	Unit
Input voltage BATT+ with respect to BATT–	bq76930EVM	26	–	44	V
	bq76940EVM	38	–	66	V
Continuous charge or discharge current		0	–	15	A
Operating temperature range		20	25	30	°C

1.4 Required Equipment

The following equipment is required to operate the bq769x0 EVM in a simple demonstration:

- DC power supply, 0-44 V (bq76930EVM) or 0-66 V (bq76940EVM) at 0.5 A for the AFE, 2.5 A for the gauge
- DC voltmeter
- TI EV2300 or EV2400 interface board
- Computer with USB port and compatible Windows operating system and access to the internet
- Test leads to connect equipment
- Electronic load or assorted resistors, calibrated load or load with accurate current meter required for gauge evaluation

Additional equipment may be desired to operate the bq769x0 with a more extensive demonstration.

2 bq769x0 EVM Quick Start Guide

2.1 Before You Begin

The following warnings and cautions are noted for the safety of anyone using or working close to the bq76920 EVM. Observe all safety precautions.

Warning Warning Hot surface. Contact may cause burns. Do not touch

Caution Do not leave EVM powered when unattended.

Danger High Voltage The bq76940EVM is not rated as a high voltage EVM, has smaller clearances than normally used on high voltage boards and does not have an isolation boundary. If you apply high voltage to this board, all terminals should be considered high voltage.

Electric shock is possible when connecting the board to live wire. The board should be handled with care by a professional.

For safety, use of isolated test equipment with overvoltage and overcurrent protection is highly recommended.

CAUTION

The circuit module has signal traces, components, 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.

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 1 power supply check your equipment requirements and use blocking diodes or other isolation techniques, as needed, to prevent damage to your equipment.

CAUTION

The communication interface is not isolated on the EVM. Be sure no ground potential exists between the computer and the EVM. Also be aware that the computer will be referenced to the Battery- potential of the EVM.

2.2 Quick Start

Determine if you wish to evaluate the AFE alone or with the gauge. For the AFE, proceed to Section 2.2.1. For the gauge, skip to Section 2.2.2.

2.2.1 AFE Quick Start

These steps describe quick connection of the bq76930 and bq76940 EVMs to demonstrate operation of the AFE portion of the EVM. For a more detailed description, refer to other sections of the user guide.

Refer to Figure 1 for the following steps:

1. Download the bq76940/bq76930/bq76920 evaluation software from the tool folder link www.ti.com/tool/bq76940EVM or search from www.ti.com.
2. Install the bq76940/bq76930/bq76920 Evaluation Software. Software can be obtained from www.ti.com. Install drivers for the EV2300, if necessary.
3. Remove shunts from headers connecting the AFE to the gauge
4. If the EV2300 is used, install shunts on the SCL and SDA pull-up headers. Remove any pull-up shunts when using the EV2400.
5. Close all dip switch positions (default is closed)
6. Attach the interface board communication adapter to the PC using the USB cable. The EV2400 is recommended, the EV2300 works if it is available and drivers are installed.
7. Attach the interface board I2C connector to the EVM I2C connector using the 4 pin cable.
8. Connect a 0-V DC power supply capable of 250 mA minimum to the “BATT” terminals and adjust to approximately 38 V
9. Press and release the “BOOT” switch
10. Start the bq769X0 evaluation software. The graphical user interface (GUI) should display. Click on the *Scan* box to enable repeated update of the display. The power supply may be adjusted within range of the part to observe voltage changes in the GUI display *Stack V/T/I* section.
11. Set the voltage to approximately 38 V or a mid-range operating level. Clear any faults present by clicking on the **Clear Faults** button of the *All Read/Write Registers* section of the GUI.
12. Click on the **Continuous** button in the GUI *Coulomb Counter* section. Enable the CHG_ON and DSG_ON bits by clicking on the bit and commit the changes. Apply a load to the PACK terminals. Load current must be within the capability of the supply and the components installed or 15 A, whichever is lower. Observe the Coulomb Counter value change in the GUI display *Stack V/T/I* section.

13. Make other adjustments as desired for evaluation.

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

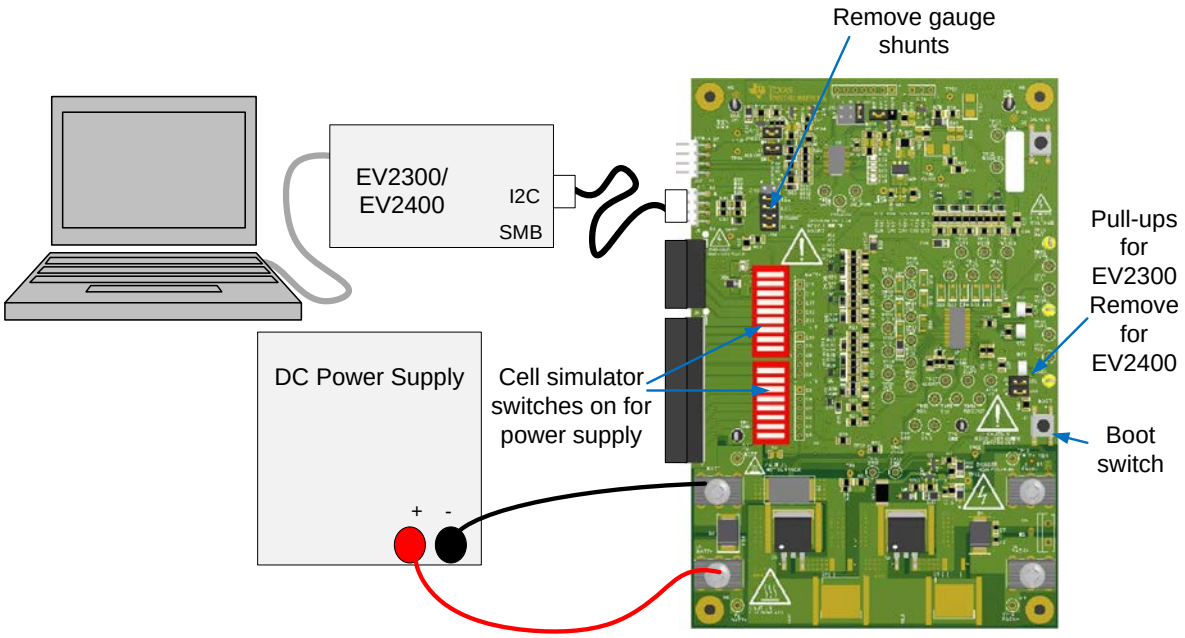

Figure 1. EVM Connection for Basic AFE Operation

2.2.2 Gauge Quick Start

These steps describe quick connection of the bq769x0 EVM to demonstrate operation of the gauge portion of the EVM. For more detailed descriptions, refer to other sections of the user guide. If you are new to bqStudio software, you may wish to refer to the more detailed instructions for installing the software in Section 5 before using the quick start.

Refer to Figure 2 for the following steps.

1. Download the Battery Management Studio (bqStudio) software from the bq78350 product folder link www.ti.com/product/bq78350 or search from www.ti.com.
2. Install the bqStudio software. Install drivers for the EV2300, if necessary.
3. Download the bq78350_xxxx.srec firmware file from the bq78350 product folder www.ti.com/product/bq78350 and save it to a temporary location on your computer.
4. Install 4 shunts on the J14 header connecting the AFE to the gauge: SCL, SDA, REGOUT and ALERT.
5. Install shunts on the SCL and SDA pull-up headers.
6. Install shunts on the /KEYIN, /PRES, 16/17 and H positions of the other headers.
7. Close all dip switch positions (default is closed).
8. Attach the interface board communication adapter to the PC using USB cable. The EV2400 is recommended, the EV2300 works if it is available and drivers are installed.
9. Attach the interface board SMB connector to the EVM SMB connector using the 4-pin cable.
10. Remove any connection to the I2C connector. This connector must remain open for operation with the gauge.
11. Connect a 0-V DC power supply capable of 2 A minimum to the "*BATT*" terminals and adjust to approximately 3V/cell (30 V for bq76930EVM, or 45 V for bq76940EVM) .
12. Press and release the *BOOT* switch.
13. Start the bqStudio software. The bq78350 on the EVM is shipped blank, so the bqStudio will present a Target Selection Wizard box. Select the latest version of the bq78350 from the list and select the **Finish** button. Acknowledge the Proceed and the Battery Management Studio Timeout windows. The

GUI should display.

14. Click on the **Firmware** button at the top of the window to select the firmware view. Click on the **Browse** button right of the program window, navigate to the .srec file you stored and select the file. Click on the **Program** button. Wait for the programming status window to close, typically about 45 s.
15. Restart the bqStudio software so it can autodetect the device.
16. In the registers view, select the **Refresh** button and observe that there are 3 cell voltages.
17. Change the cell count to the number of cells supported by the board: Select the *Data Memory* view, then the **Settings** button and the AFE Cell Map register. Change the value to the cells supported (0x03FF for bq76930EVM, or 0x7FFF for bq76940EVM) and click on the **Write to Data Memory** button. Read data memory if desired to confirm the new value.
18. Send a Reset command using the *Commands* view or the from the *Advanced Comm SMB* view.
19. Select the *Registers* view and Refresh the values. Observe that all supported cells now show a voltage reading.
20. Send the FET_EN command using the *Commands* view or the from the *Advanced Comm SMB* view.
21. Select the *Registers* view and Refresh the values. Observe that the FET_EN bit is now set and that the CHG and DSG FET status is shown enabled.
22. Select the *Calibration bq78350* view.
23. Enter the board temperature in the *Temperature Sensor* boxes and click on the **Calibrate Temperature** button. Wait until a check box appears next to the button.
24. Measure the voltage of the BATT terminals. Divide the value by the number of cells and enter the value in mV in the *Ext Average Cell Voltage* box. Click on the **Calibrate Voltage** button. Wait until a check box appears next to the button.
25. Disconnect the load from the PACK terminals. Click on the **Calibrate CC Offset** button and wait until the check mark appears next to the button.
26. Connect the load set to a known value of approximately 2 A to the PACK terminals. Enter the value in mA into the *Applied Current* box. Discharge current should be entered as a negative value. Click on the **Calibrate Current** button and wiat until the check mark appears next to the button.
27. Select the *Registers* view and Refresh the values. Observe the updated voltage, temperature and current values.

The EVM is functioning and ready for further configuration for evaluation. Refer to the TRM or other documents for the bq78350, and the other sections of this user guide for additional information.

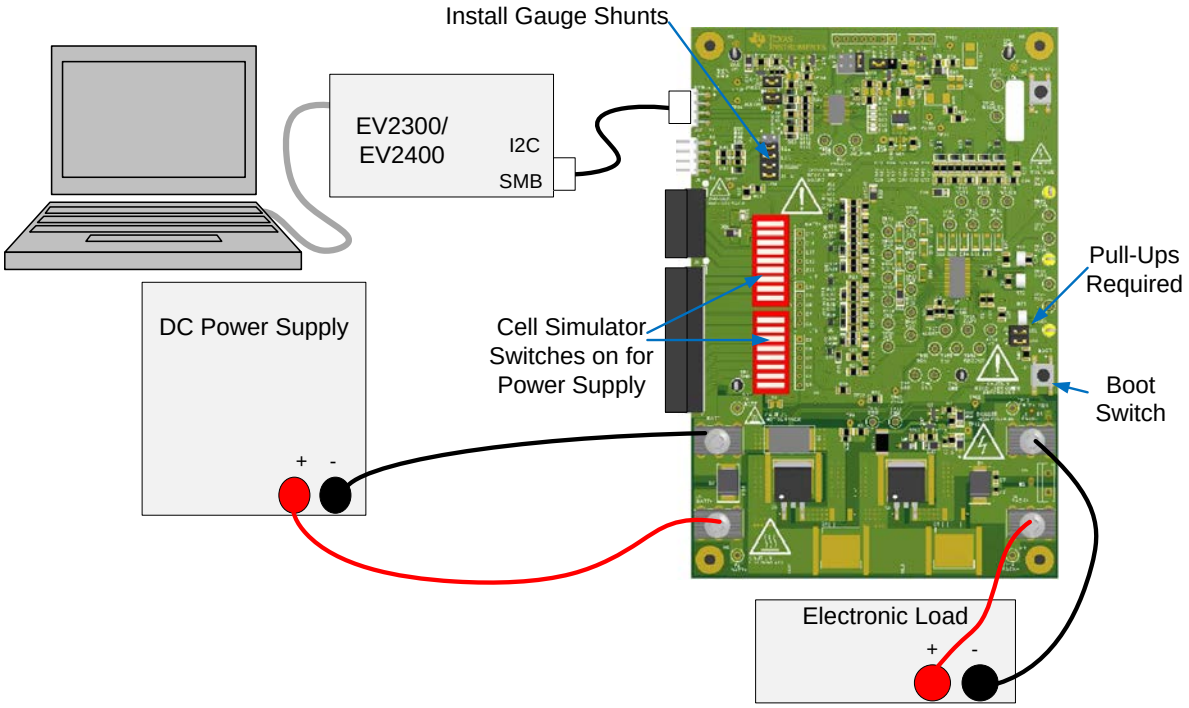

Figure 2. EVM Connection for Basic Gauge Operation

3 Interface Adapter

The bq76940/bq76930/bq76920 evaluation software and bqStudio software support either the TI EV2300 or EV2400 interface board to provide communication with the EVM board from the computer. Drivers must be installed for the EV2300. The EV2400 uses operating system drivers and no separate installation is required. Do not connect the EV2300 interface board to the computer until after the drivers are installed.

If you have used an EV2300 with your computer previously, no additional installation is required. EV2300 drivers are included in the installation package and can be found in the installation directory after installing the software, typically at C:\Program Files (x86)\Texas Instruments\bq76940. Alternatively or for the bqStudio software, drivers are found at http://e2e.ti.com/support/power_management/battery_management/m/videos__files/458983.aspx or http://www.ti.com/tool/ev2300. To install the drivers:

1. Navigate to the installation directory, typically C:\Program Files (x86)\Texas Instruments\bq76940
2. Run the file *InstallEV2300Drivers.exe*

4 bq76940/bq76930/bq76920 Software

This section describes how to install and use the bq76940/bq76930/bq76920 software for the EVM. This software is used when evaluating the AFE alone without the gauge. For evaluation with the bq78350 gauge, refer to Section 5.

The bq76940/bq76930/bq76920 software supports the bq769x0 AFE I^2C communication. This software is intended to demonstrate register control and operation of the bq76940 family of AFEs in the absence of a gauge or MCU. This software is not intended to operate on a bus with another master. The AFE does not turn on the protection FETs without control, the bq76940/bq76930/bq76920 Evaluation software allows the user to provide that control from the GUI.

The software may also be identified as bq76940 or bq769X0 in menus or windows as space permits.

4.1 System Requirements

The bq76940/bq76930/bq76920 software requires Windows 7, or later operating system. The computer must also have Microsoft® .NET connection software version 4.0 or higher installed. Examples in this document are from Windows 7.

4.2 Installing the bq76940/bq76930/bq76920 Software

Find the latest software version in the software section of the EVM tool folder http://www.ti.com/tool/bq76930EVM or http://www.ti.com/tool/bq76940EVM or search from power.ti.com. Check periodically for software updates. Use the following steps to install the bq76940/bq76930/bq76920 Software:

1. Copy the archive file to a directory of your choice, extract all files and run the setup.exe application.
2. Follow the instructions and make selections as required on the setup windows selecting **Next** as required. Installation in the default location is suggested.
3. On the last window, select **Close** to complete the bq76940/bq76930/bq76920 software installation.

4.3 Interface Adapter

The interface adapter should not be connected to the I2C connector if a gauge or MCU is connected to the bus. Board pull-up shunts must be installed for the EV2300 and removed for the EV2400

4.4 Software Operation

This section describes connection of the communication interface to the EVM and operation of the software.

Although the software runs without connection to a powered device, TI recommends having the device on when starting the software. Follow the directions in the quick start section. Figure 1 shows connections for operation with the GUI software.

Start the software from the desktop shortcut *bq769X0 Evaluation Software* or the menu *Start → All Programs → Texas Instruments → bq769X0 Eval Software*

When started, the software looks for the communication interface and the device. If either is not found, a popup window appears and must be acknowledged. When communication is established with the device, the main window appears as shown in Figure 3.

The bq76940/bq76930/bq76920 software uses popup help tips on many of the control features.

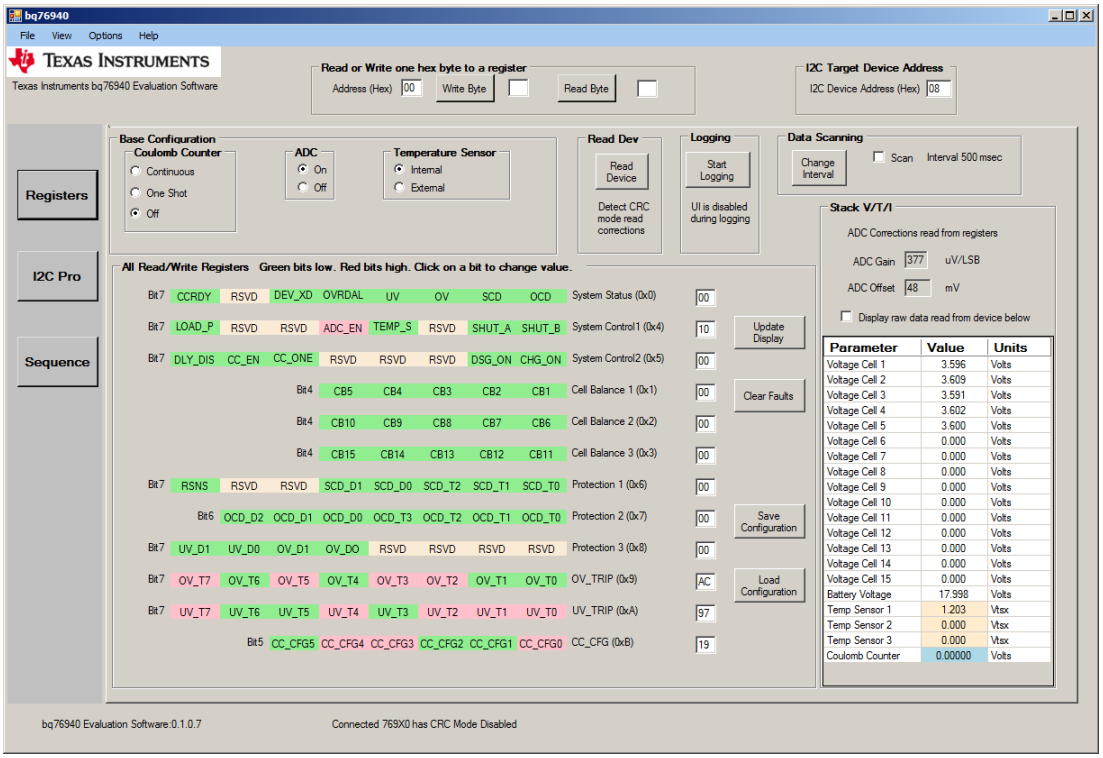

Figure 3. bq76940/bq76930/bq76920 Evaluation Software Display

The software window contains a menu bar and 3 sections. The top section is an I2C tool. The middle section has 3 selectable views. The bottom section is a status section. Details are described in following sections.

4.4.1 Status Section

The bottom section displays the software name and version, the CRC mode and the communication status. The CRC mode is automatically detected and the software communicates to the IC appropriately. To the right of the CRC mode is a communication status area which may display information about the communication with the device. Common displays and actions may include the following:

- *Data channel name is invalid*. Check the USB connection to the interface board. Exit and re-start the software
- *No acknowledge from device*. Check that the 4-pin cable is connected, the EVM is powered, and boot the device, then try to read the device.
- *CRC read from device does not match calculated CRC*. Check that the **Read Device** button was used to detect the device. Check the connection of the 4-pin cable or its routing near high noise sources.
- *Not able to find a free communication adapter*. Check the connection of the USB cable to the communication adapter.
- *USB adapter timeout*. Unplug and re-connect the USB cable and try to read from the device again.
- When the status area is blank, the last communication with the device was successful

4.4.2 I2C Section

The top section of the window below the menu bar has the I2C address and a byte communication tool.

The I2C address must be entered, the tool does not automatically detect the address. The default address is 0x08 which is the default address for the device on the EVM. If the AFE on the EVM has been changed to a different address, the address must be entered. The value is the 7 bit address and is shifted left 1 bit position when observed on the bus.

The byte communication tool is useful to read or write a register. It is present with all views.

4.4.3 Menu Commands

The Help > About menu selection displays version information about the program. Other selections may provide additional help or links to documentation.

The Options > Verify Writes selection allows selection of a readback of the registers once they are written.

The View menu allows selection of the center window display. Options are the Registers, I2C Pro, or Sequence views. Views can also be selected with buttons on the left side of the window.

The File menu allows exit of the program.

4.4.4 Registers View

The registers view is shown in Figure 4 and is the default display in the middle of the window when the software is started. It shows the control, status and data register values. If another view is displayed it can be selected using the **Registers** button on the left side of the window or from the menu.

Figure 4. Registers View

The **Read Device** button at the top of the Registers view provides important setup of the bq76940/bq76930/bq76920 software and the IC. The software reads the factory gain and offset data from the device and populates these in the *Stack V/T/I* section for use in calculating display values. The software writes the CC_CFG register to its proper value and also detects the CRC mode of the device and sets the software appropriately.

The control registers are shown in the center of the display in the *All Read/Write Registers* section. Bits are color coded as described in the section. Bits may be changed by clicking on the bit and selecting the **Commit** button in the Change value pop-up window. The default for the pop up window is to change the polarity of the bit. Since clearing status bits requires a write of 1, the *Set bit high* needs to be checked in the Change value pop-up window when clearing status register bits. A bit value change is displayed if the Options menu Verify Writes is selected.

Control registers can also be changed as register values by writing in the value box to the right of the value box. Scan must be disabled to enter values. Register values may also be changed using the I2C byte write tool at the top of the window. Register changes are visible if the Verify Writes option is enabled. The display may also be updated using the **Update Display** button or selecting **Scan**.

The *All Read/Write Registers* section contains 4 buttons to the right of the register display:

- **Update Display**: This button reads all control and value registers and updates the values, bit breakout fields and control features.
- **Clear Faults**: This button clears the status register.
- **Save Configuration**: This button allows saving the displayed values of the control register to a file. A pop-up box allows selection of the file name. The default file location is C:\Users\<account-name>\Documents\Texas Instruments\bq76940.
- **Load configuration**: This button allows loading the control register values from a file. A pop-up box allows selection of the file, another pop up box lets you select whether to write the values to the device. If faults are not set in the status register value in the file, they are not cleared by the write.

The *Base Configuration* section shown above the register detail provides convenient control of the Coulomb Counter, ADC, and Temperature Sensor selection as functional controls without locating the control bits.

The *Data Scanning* section allows periodic read of the device and display of the register values. The *Scan* check box enables a periodic read when checked. The update interval is displayed and can be changed with the **Change Interval** button.

The *Logging* section has the **Start Logging** button. The values read from the device can be saved to a file. Selecting the **Start Logging** button opens a bq76940 Logging popup window to enter the file name, comments and to select the data groups to be logged. The file name must be entered with the pop up window's **Browse** button. The scan interval can be changed, and the logging is actually started in the pop up window. When logging is active, the registers user interface cannot be used and the button changes to **Stop Logging**. Selecting the button stops the logging. Scan is not necessary before logging, it will start with logging and cannot be disabled during logging.

The *Stack V/T/I* section is on the right side of the Registers view (Figure 4). The ADC Gain and Offset boxes show the values that are used for converting the register data into values. These value boxes are read only, they are updated by the values read from the device with the **Read Device** button. The *Display raw data read from device below* check box allows display of the hex register values rather than converted values. The V/T/I values are updated by the **Read Device** button, the **Update Display** button, or the Scan option.

4.4.5 I2C Pro View

The I2C Pro view of the GUI is shown in Figure 5. The I2C Pro view is useful to read or write several sequential registers. If another view is displayed it can be selected using the **I2C Pro** button on the left side of the window or from the menu. The I2C Command box for each section specifies the starting register address for the transaction.

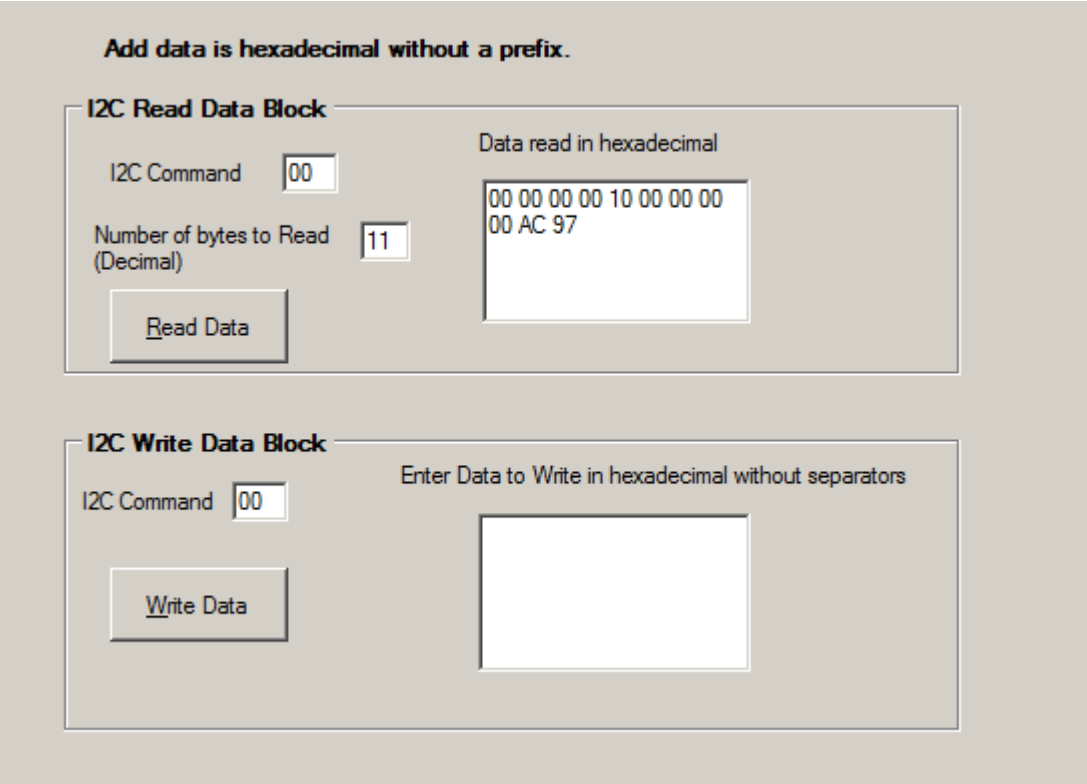

Figure 5. I2C Pro View

4.4.6 Sequence View

The Sequence view of the GUI is shown in Figure 6. This is useful to send timed sequences of register reads or writes to the device. It can be selected using the **Sequence** button on the left side of the window or from the menu. A sequence can be run by selecting its **Execute** button. The results of the sequence are shown in the Sequence Dialog section. The sequence can be edited by selecting the file name under the sequence name in the window.

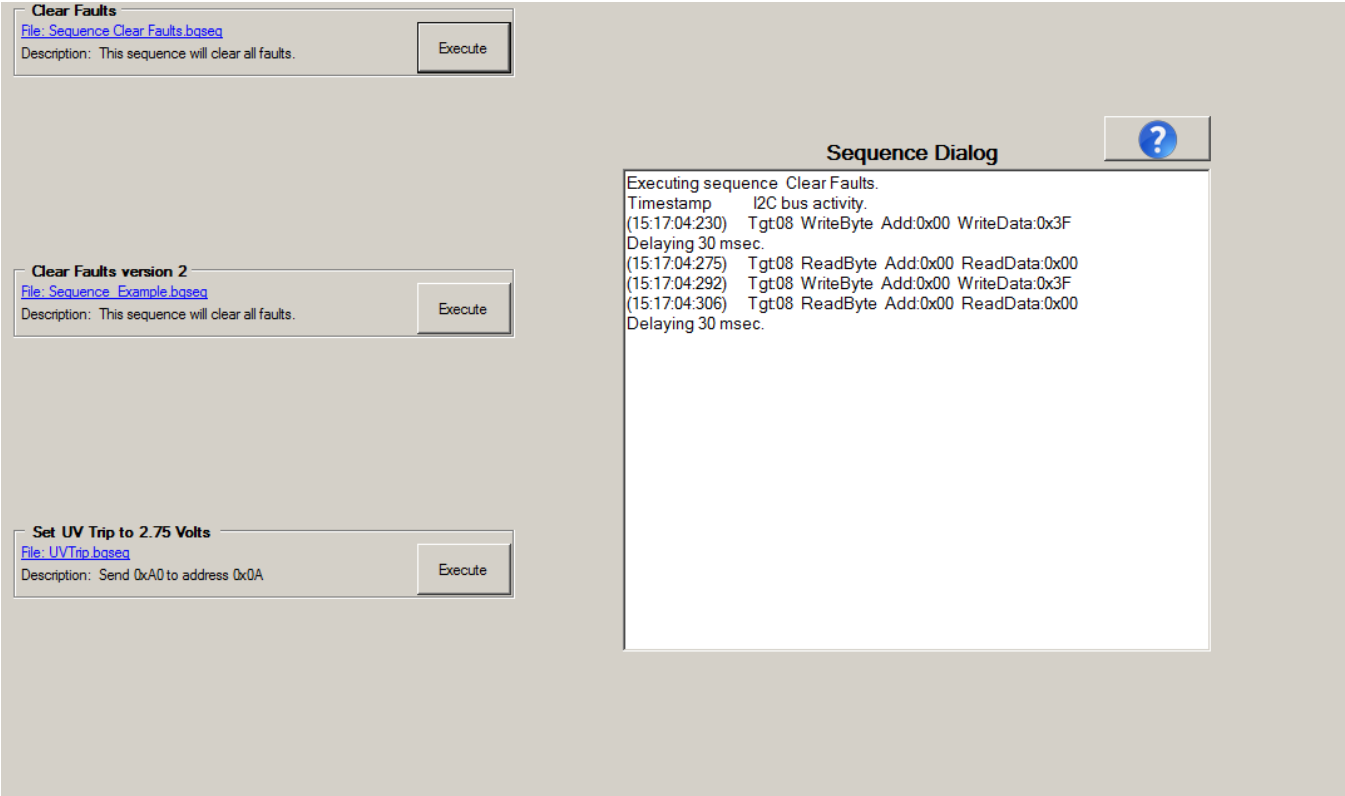

Figure 6. Sequence View

The installation comes with 3 sequence files. The *Clear Faults* files contain descriptions for requirements for a sequence file. *The Set UV Trip...* file shows an example of a simpler format. Sequence files are installed to: C:\Users\<account-name>\Documents\Texas Instruments\bq76940\sequence. Sequences are loaded from this location when the program starts. Create new sequences with a text editor and save them with the .bqseq extension. Up to 8 sequences can be stored, move other sequences to another directory or change the extension. The sequences *Sequence_Example.bqseq*, *Sequence Clear Faults.bqseq* and *UVTrip.bqseq* are required, do not move them from the directory.

Typical uses of a sequence might include:

- Reading & clearing faults, then enabling CHG and DSG outputs
- Setting ship mode
- Setting a balance pattern
- Any repetitive multiple-register write used in evaluation

While sequences can be executed during logging, the logging is paused while the sequence executes. Long sequences will leave gaps in the log data.

4.4.7 Typical Operation of Software

Typical operation of the software involves the following steps, much like described in the quick start section:

- Connect the EVM and related equipment
- Power the EVM
- Boot the EVM
- Start the software
- Read and change registers as desired

If the board is powered off during the evaluation process:

- Power the EVM
- Boot the EVM
- Select the **Read Device** button
- Read and change registers as desired

If the interface board is connected to a system already in operation, and the software has not been exited:

- Select the **Read Device** button
- Read and change registers as desired

4.4.8 Operation with Other Interfaces or Hosts

The bq76940/bq76930/bq76920 software does not support other interface boards or adapters other than the EV2300 and EV2400. The software does not operate in a multi-master environment. If operated with another host on the line, data collisions can occur. Also be aware that the EV2400 has internal pull up resistors to 3.3 V, connecting to some shared busses could damage devices on that bus if the bus voltage differs.

5 Battery Management Studio Software

The Battery Management Studio software is used for evaluation of the bq78350 gauge. It is also identified as bqStudio for a compact name. If an earlier version of the bqStudio software is already installed from another product evaluation, it should still be installed again to load the configuration files and tools specific to the current version of the bq78350.

5.1 System Requirements

The bqStudio software requires a Windows 7, or later, operating system. Additional items are required and are described in the installation windows. The examples in this document are from Windows 7.

5.2 Installing bqStudio

Find the latest software version in the software section of the product folder http://www.ti.com/product/bq78350 or search from power.ti.com. Check periodically for software updates. Use the following steps to install the bqStudio software:

1. Copy the archive file to a directory of your choice, extract all files and run the *Battery Management Studio-xxxxxx-Setup.exe* application.
2. Follow the instructions and make selections as required on the setup windows selecting **Next**, as required. TI recommends installing the software in the default location.
3. On the last window, select **Finish** to complete the bqStudio software installation.

5.3 Interface Adapter SMB

The interface adapter SMB connector must be connected to the SMB connector of the EVM for use with the bqStudio software. Pull-ups for the SMBus are provided inside the adapter. The interface adapter should not be connected to the I2C connector of the EVM.

5.4 bqStudio Operation

bqStudio is used to communicate to the bq78350 gauge for evaluation. It includes a number of tools to aid in configuration of the bq78350 for evaluation. bqStudio will not communicate with the AFE and the I2C connector of the EVM should not be connected while using bqStudio.

Although the software runs without connection to an interface board or powered device, it is recommended to have both connected and the device on when starting the software. Follow the directions in the gauge quick start section. Figure 2 shows connections for operation with the bqStudio software.

Start the software from the desktop shortcut *Battery Management Studio* or the menu *Start → All Programs → Texas Instruments → Battery Management Studio*.

When started, the software looks for the communication interface and the device. If the device is not found, it opens a Target Selection Wizard. This is expected for a new EVM since the bq78350 is not programmed. Select the newest bq78350 version in the list and click the **Finish** button. This selection will be remembered until the software is re-stared. If the device is not found, the user will be presented with a *Proceed?* popup window which must be acknowledged. If the software still can not find the device, a *Battery Management Studio* popup window appears indicating communication status. With a blank or un-powered part, this will indicate a timeout. Acknowledge the message to proceed.

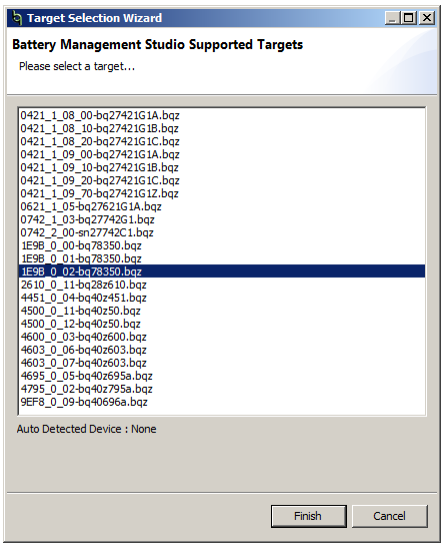

Figure 7. Target Selection Wizard

If the software was started without a communication interface adapter, a Battery Management Studio popup window will indicate a free adapter is not available. Acknowledge the message to proceed. Errors will appear in the left bottom border of the Battery Management Studio screen. Correct the problem with the adapter and restart the software.

When the software is first started in a new installation, a welcome view covers the main portion of the window. This offers an overview or tutorials of the software. After reviewing any desired content, close the welcome view. If it is desired to see this again, the welcome view can be opened from the menu selection Help | Welcome.

bqStudio contains a user guide for general operation of the software. Refer to the menu selection Help | Help Contents for information.

Once the welcome view is closed, the bqStudio window appears as shown in Figure 8. The register area is blank since communication with the blank device on the EVM does not provide data.

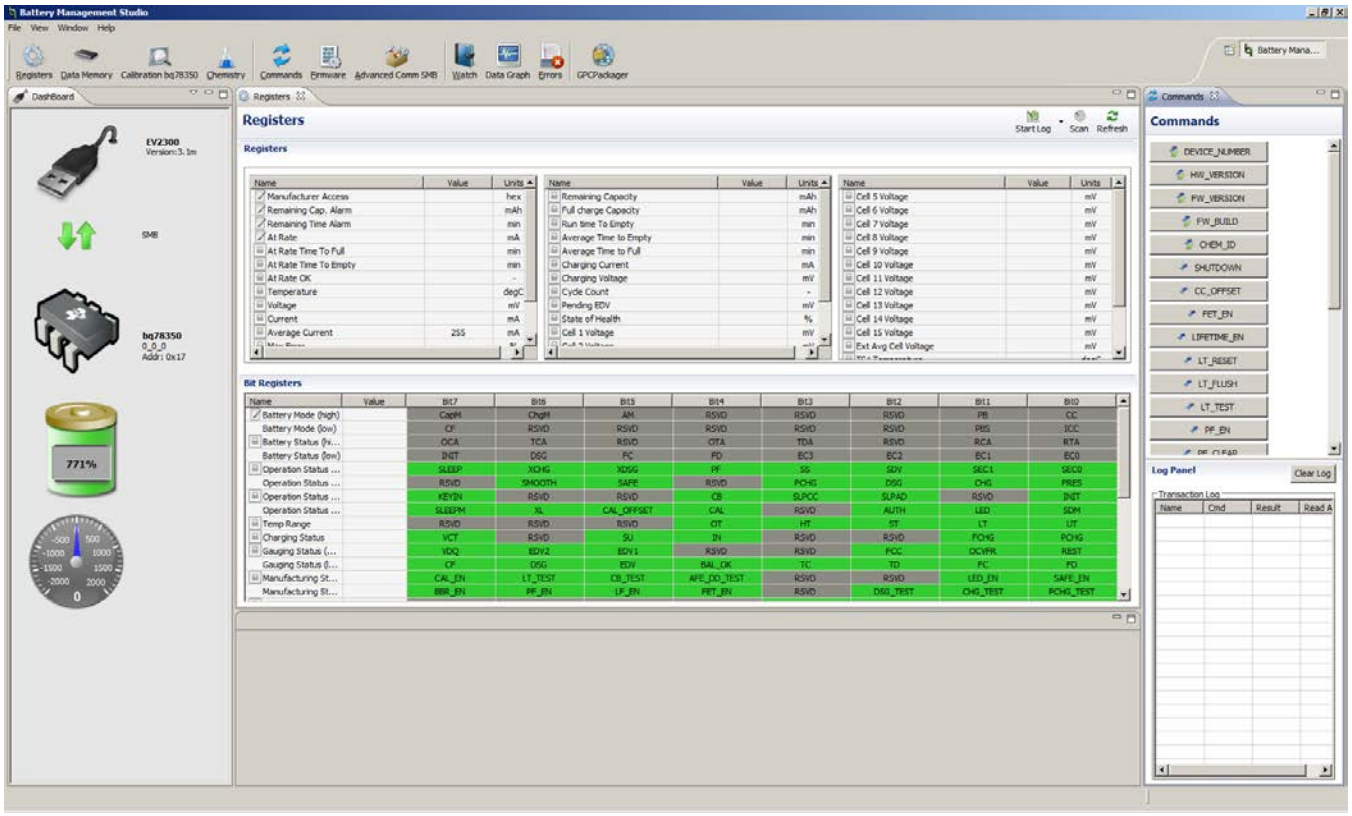

Figure 8. bqStudio Window with Blank Gauge

5.5 Firmware Programming

Firmware must be programmed to the bq78350 mounted to the EVM before operation. Firmware is programmed using the Firmware view. Click on the **Browse** button and select the file to be programmed. Using the *Execute after programming* feature is recommended. Click on the **Program** button to start programming. A *Progress Information* window will display during programming and will close when complete. Programming typically takes about 45 s.

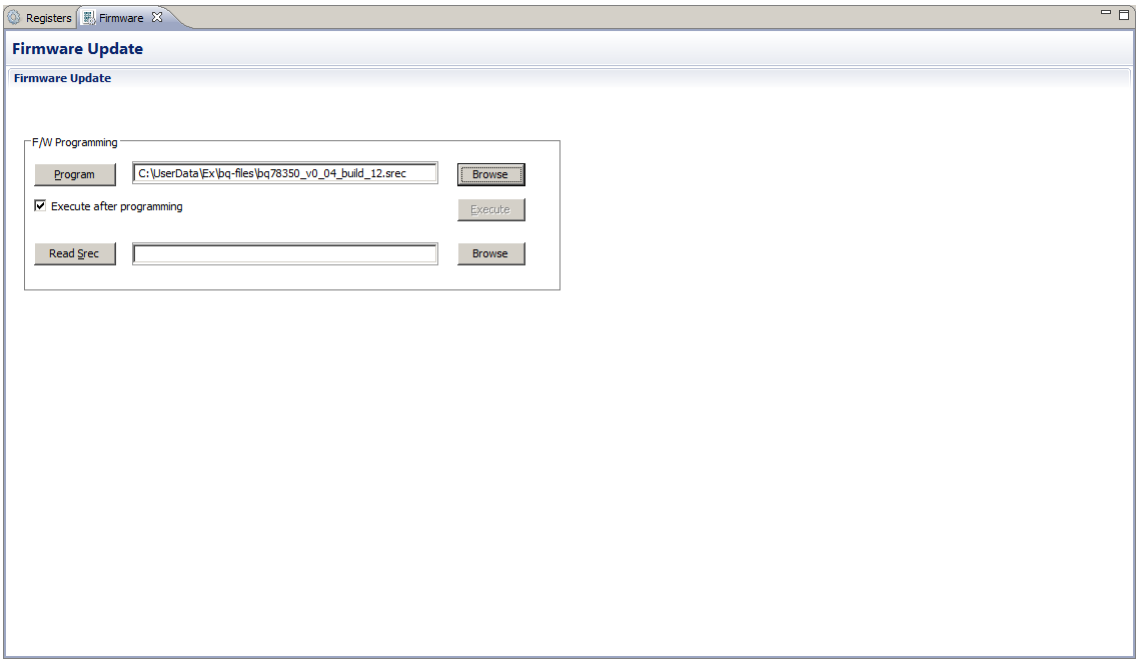

Figure 9. Firmware View

After programming, restart the bqStudio software so that it will autodetect the new firmware and load the proper configuration for the tools. After start with autodetection, the dashboard display should show the version read from the device rather than a version input from the Target Selection Wizard. An example of the dashboard display is shown in Figure 10. If the version read by the autodetect is the same as the version previously selected in the Target Selection Wizard, no change may be apparent, but restarting to allow tool configuration is still recommended.

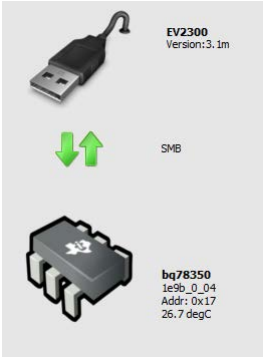

Figure 10. Dashboard Adapter and Device Version Display

The default configuration of the firmware is for 3 cells. An example of the register view after restart is shown in Figure 11. Note that 3 cell voltages are present. The device must be configured for operation with other cell counts, this includes basic operation of the EVM.

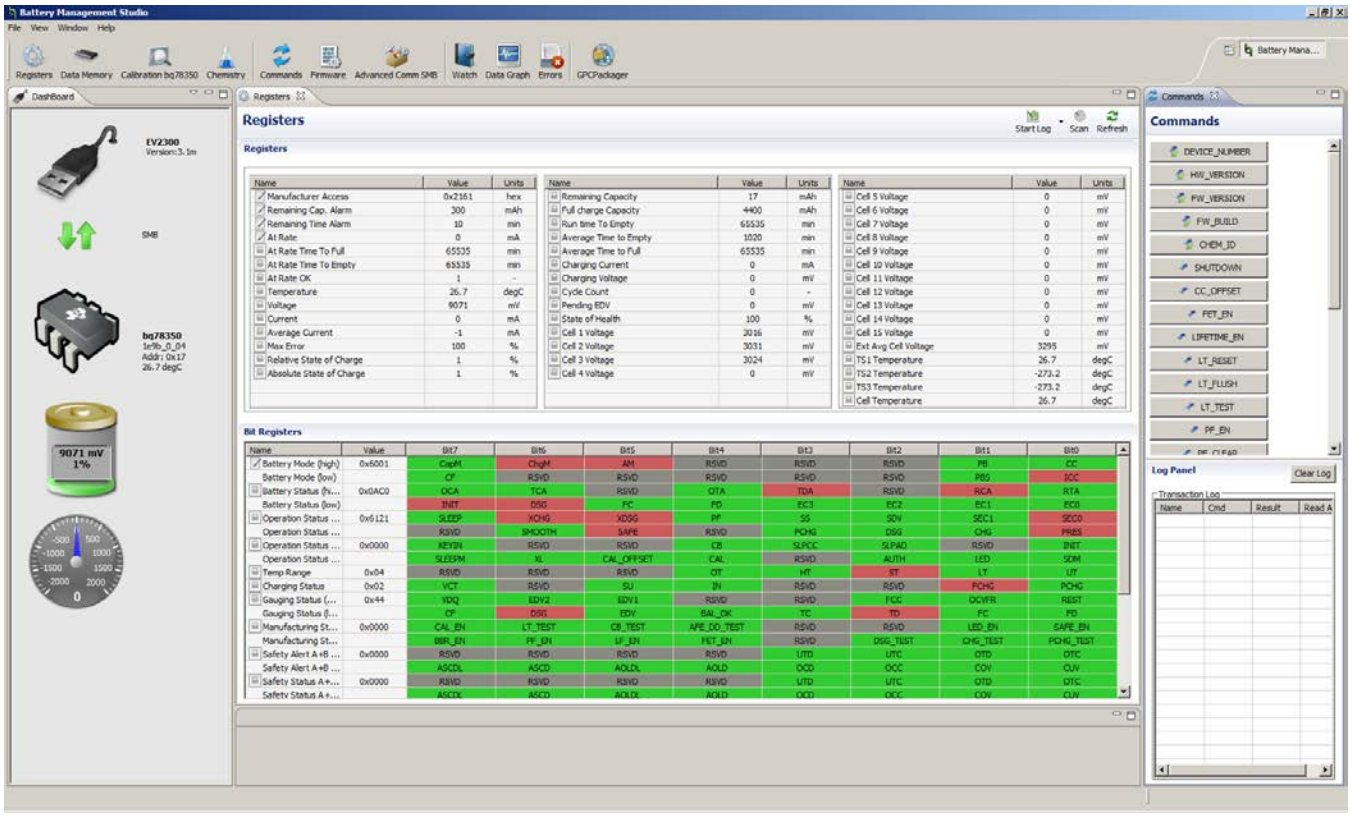

Figure 11. Register View After Restart

5.6 Data Memory Configuration

Most of the configuration of the bq78350 is accomplished through setting values in data memory. The data memory is accessed using the Data Memory view. Configuration values are orgainized in functional groups selected by buttons on the left side of the view. Data values may be changed by selecting and entering a value. Parameter registers which are bit fields may be changed by selecting the bit in the pop up when the register or its value is selected. Figure 12 shows the bit field for the AFE Cell Map which is one of the most basic settings that must typically be changed with the EVM. The AFE Cell Map is a physical location of the cells. Refer to the bq78350 TRM (SLUUAN7) for information on this and other configuration parameters. Data Memory must be written after change. See other technical documents in the bq78350 product folder www.ti.com/product/bq78350,

The *Export* tool in the Data Memory view allows saving the configuration data to a comma-separated-value file format which can be accessed by a spreadsheet program. Reading data before export will save the data from the part rather than values which may be only in the view. The *Import* tool allows loading such a file into the view so that it can be written to the device.

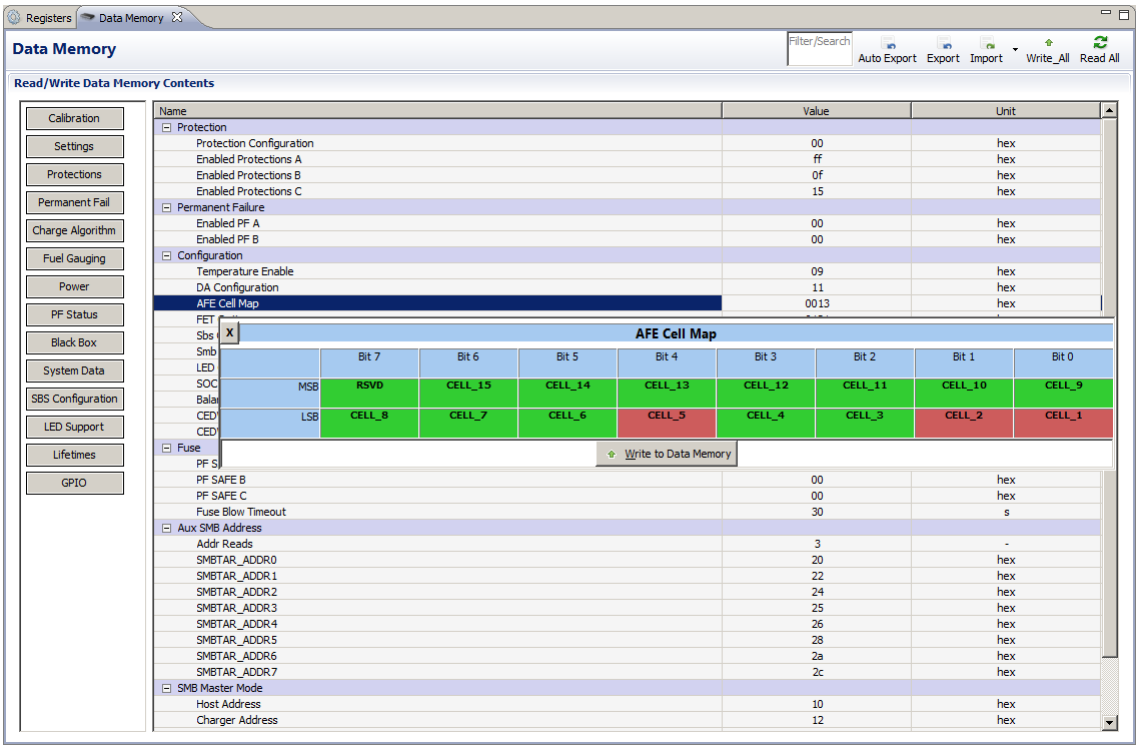

Figure 12. Data Memory Bit Field change

5.7 Chemistry View

The bq78350 uses the chemistry of the cells to estimate the state of charge of the pack after a reset. Chemistry information is not loaded to the device as a Data Memory parameter but by using the Chemistry view. Loading the chemistry is not required for simple operation of the EVM but will be desired for setup of the board or a part for operation with cells, particularly if the chemistry differs from the default. The chemistry view is shown in Figure 13.

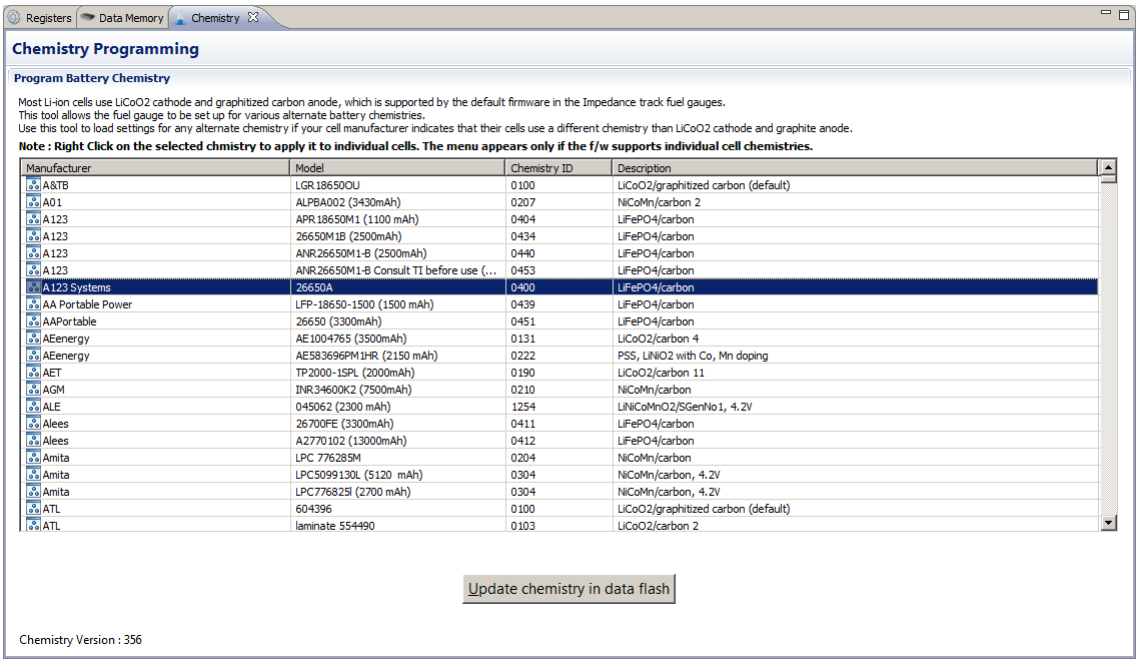

Figure 13. Chemistry View

5.8 Calibration

The EVM and all new boards should be calibrated before operation. The calibration view is shown in Figure 14. Temperature is typically calibrated first. Current Offset should be calibrated with no current flow and should be calibrated before Current Gain. The EVM uses a 1-mΩ sense resistor and calibration at low current will result in some granularity from the current resolution. This may result in an apparent error at higher currents. Calibration at higher currents will reduce this effect and should be done where it is important.

By default, the bq78350 uses the average cell voltage for gauging. This voltage must be calibrated. Measure the battery voltage, calculate the average cell value and enter the value in the box. Clicking the Calibrate Voltage button runs the calibration. Values left blank or entered as '0' are not calibrated. When successful, a green check appears next to the button as shown in Figure 15. If there is an error, a red X appears instead with a message. The bq769x0 contains factory voltage calibration data for cell voltage values. The bq78350 uses this data to determine the individual cell voltage. When it is desired to calibrate each cell's offset rather than relying on the average stored in the bq769x0, individual cell voltages can be measured and calibrated. Cells can be calibrated in groups or individually by entering or clearing the desired values.

Basic steps for calibration of the EVM is described in the quick start section. Since the EVM uses 1% values for the cell simulator resistors, measuring each cell voltage value is recommended rather than using a common value if individual cell voltage calibration is desired.

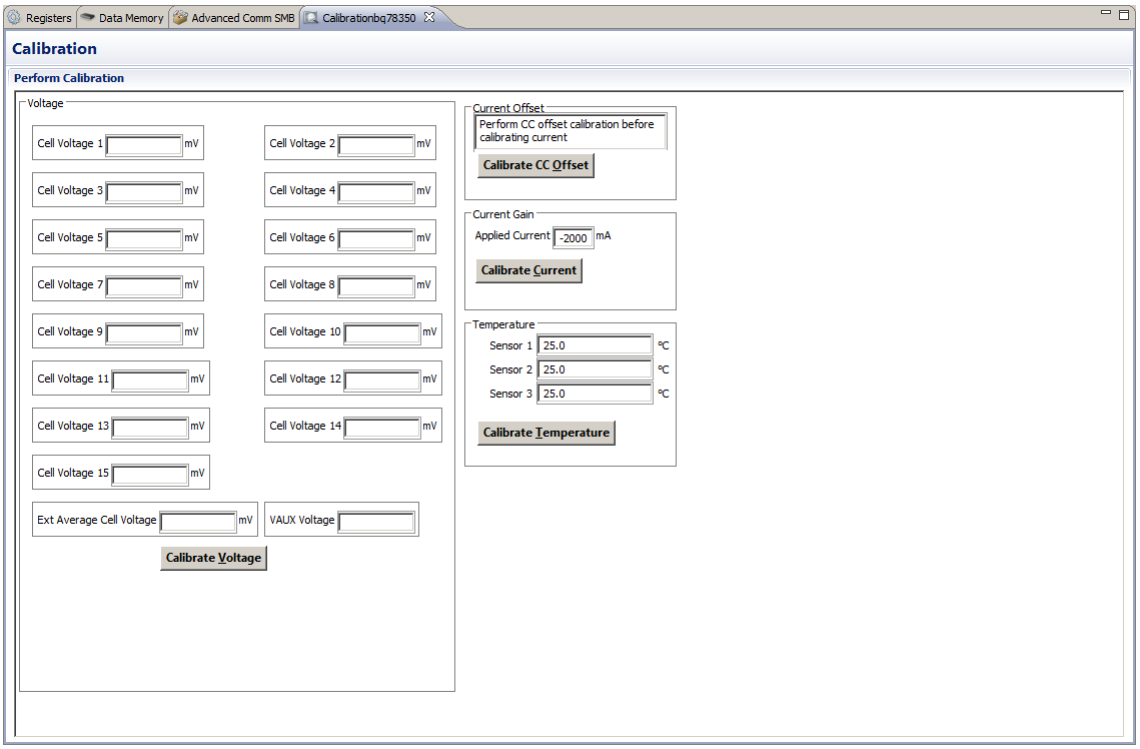

Figure 14. Calibration View

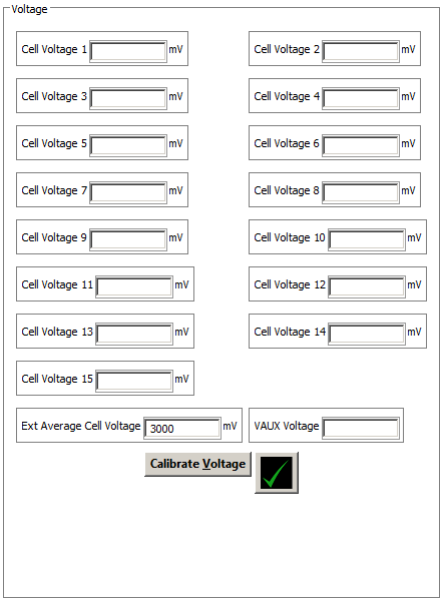

Figure 15. Example Voltage Calibration Successful

5.9 Device Control

Features are controlled by commands as described in the bq78350 TRM (SLUUAN7). One of the most basic for operation as described in the quick start section is the FET enable which is toggled by the *ManufacturerAccess() 0x0022* command. The Manufacturer Access commands may be sent using the *Advanced Comm SMB* view and the **Write Word** button. An example is shown in Figure 16. A number of the common commands are also available in buttons in the Commands view. Using the commands the gauge may be controlled for test or setup for further evaluation. Refer to the bq78350 TRM for additional information on the commands.

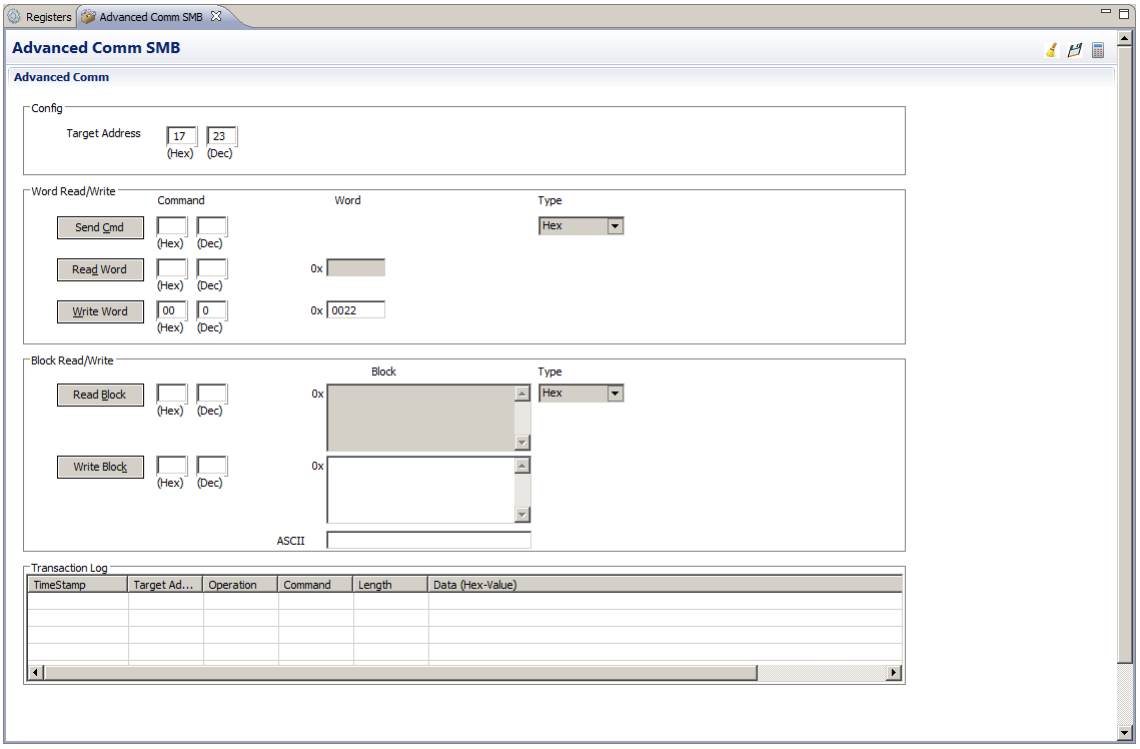

Figure 16. Advanced Comm SMB View

6 bq769x0 Circuit Module Use

The bq769x0 circuit module contains the bq769x0 IC and related circuitry to demonstrate the features of the IC. Surface mount FETs are provided for the high current path. Thermistors provide for temperature sensing on the board, 2 on the bq76930EVM, 3 on the bq76940EVM. Other components provide support for the IC and connections to the board. Basic operation is described in the quick start guide. For details of the circuit, refer to the physical construction section. Additional details may be described in the following subsections.

6.1 Cell Simulator

The EVM includes a resistive cell simulator made up of 200 ohm series resistors. The top section of the switch S3 connects the BATT+ node to the top of the resistor string. The bottom of the resistor string is connected to BATT-. The individual cell taps are connected to the cell monitor signals by other sections of the dip switch. When operating with a power supply all switch sections should be closed. When operating with cells, all the dip switch sections should be open to prevent loading the cells and discharging the battery. The cell simulator resistors are located on the bottom of the board. These may become warm during operation. The orange LED near the dip switch indicates the cell simulator has power.

6.2 Minimum Operating Voltage

The minimum operating voltage for the EVM is listed in the characteristics table is much higher than the minimum operating voltage since the EVM requires a sufficient VC5X voltage to provide a suitable REGSRC voltage to drive the DSG and CHG signals. The board can be operated at lower voltage to read cell voltages if the power FETs are not used. When the board is to be operated with low cell counts, provide an adequate REGSRC voltage to prevent damage to the board. When appropriate, R75 may be removed and installed at R74 for a higher REGSRC voltage, or Q14 bypassed at the J10 test point pattern. Modification of the board limits its voltage range.

CAUTION

Do not operate the board with current below the minimum operating voltage. If modified for low voltage operation, do not operate the board at its normal upper voltage limit. Operation of the board with voltages outside the operating range of the components on the board can damage the circuit module.

6.3 Evaluating with Simulated Current

The quick start guide describes connection for basic operation. Providing more than recognizable current in that configuration can require a power supply with a significant power rating. Applying a charge current can damage some power supplies. The figure below shows a method to force current through the control path without a high wattage power supply or special equipment. The *load* power supply should be set at a low voltage in a constant current mode. Polarity can be reversed on the *load* supply to simulate a charge current. The *battery* supply should never be reversed.

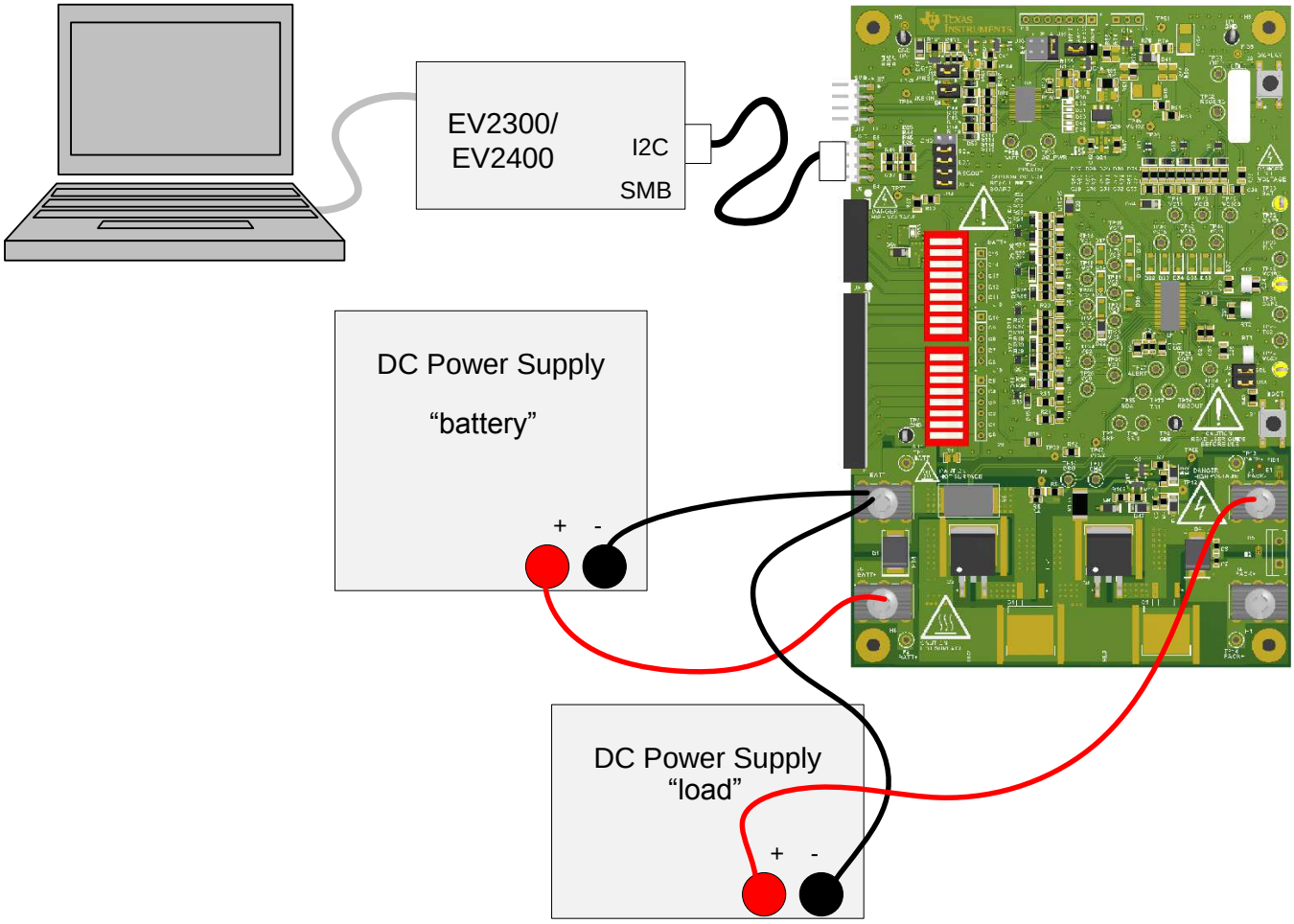

Figure 17. Simulating Current Setup

The power supply technique can also be used with the bq78350 to provide current for calibration or to show current flow. However the simulated current will not provide good gauging evaluation.

6.4 Reducing the Cell Count

Cell count can be reduced for basic evaluation by shorting unused cells at the input terminal block. Follow the recommendations in the datasheet for which cells to short. This works for both operation with the cell simulator and with cells, but can have some side effects in transient tests because it parallels the input and balance FET gate resistors of the used and unused inputs to the IC where the capacitor provides a signal path to the used input. For the best evaluation with reduced cells in a transient environment, short the VCx pins at the capacitor or VCx test points and remove the unused cell's input resistor and balance FET gate resistor. When using the cell simulator, shorting the unused cell input terminals is still required to eliminate the simulated cell voltage. Shorting the cell inputs at the terminal block screw terminals is suggested since it should be apparent if the board is reused for a different cell count.

Table 3. Reducing Cell Count

Unused Cell (Numbered from Bottom, Bottom = Cell 1)	Short Cell Terminals	Input and Balance FET Gate Resistors to Remove	Short AFE Inputs
Cell 14	C14 to C13	R65, R70	VC14 to VC13
Cell 13	C13 to C12	R66, R71	VC13 to VC12
Cell 9	C9 to C8	R23, R33	VC9 to VC8

Table 3. Reducing Cell Count (continued)

Unused Cell (Numbered from Bottom, Bottom = Cell 1)	Short Cell Terminals	Input and Balance FET Gate Resistors to Remove	Short AFE Inputs
Cell 8	C8 to C7	R24, R34	VC8 to VC7
Cell 4	C4 to C3	R28, R38	VC4 to VC3
Cell 3	C3 to C2	R29, R39	VC3 to VC2

When evaluating the gauge, it is recommended to reduce the cell count of the gauge configuration before connecting the cells. If the gauge does not see voltage it will shut down the AFE and require re-boot of the board. To avoid shutdown simulate a charge current until the cell count configuration can be corrected.

6.5 Connecting Cells

The EVM is constructed to sense the cell voltages at the cells. Separate wires are required from the bottom of the battery stack to the C0 connection at the terminal block for sensing voltage and from the bottom of the battery stack to the BATT- terminal to carry the load current. The AFE IC VSS is referenced to the BATT- connection. Similarly, separate wires are required from the top of the battery stack to the top cell input of the terminal block and from the top of the battery stack to the BATT+ terminal to carry the load current. The top cell sense connection also powers the AFE IC. To move the top sense connection from the cells to the board, R51 could be populated on the bq76940EVM, or R50 could be populated on the bq76930EVM. To move the bottom cell sense to the cells, R1 could be populated, or leave the bottom cell simulator switch section closed to connect C0 to BATT-.

The cell simulator provides resistors between the cell inputs. These resistors can help divide the voltage as cells are connected. If desired, the cell simulator switches can be closed during cell connection and opened after cell connection. The switches must be opened after connection of cells or the cells are discharged by the constant drain of the cell simulator. If you see the orange LED on when cells are connected, open the dip switch sections to remove the load.

Cell connection is generally considered safest from the bottom up. This minimizes the step size of the voltage applied to the board. Recommended connection sequence for the EVM when connecting wires individually is bottom up:

1. Connect BATT-
2. Connect cells bottom up, C0, C1, C2 ...
3. Connect BATT+
4. Open the cell simulator switches, if needed

When the top and bottom cells are connected on the board:

1. Connect BATT- (includes C0)
2. Connect cells bottom up; C1, C2, C3...
3. Connect BATT+ (includes top cell)
4. Open the cell simulator switches, if needed

When cells are mated with a connector or connectors such as on the EVM:

1. Connect BATT- or the node which connects VSS of the AFE, if separate
2. Mate the connector for the lower cells
3. Mate the connector for the upper cells, if separate
4. Connect the BATT+, if separate
5. Open the cell simulator switches, if needed

When using external balancing with P-channel MOSFETs, such as on the bq76930 and bq76940 EVMs, the inrush current for a cell can momentarily turn on the balance FET causing the next cell input below to rise. This can continue down the stack. Connecting C0 to BATT- on the board by closing the C0 cell simulator dip switch during cell connection can reduce stress on the VC0 input of the AFE. The switch can be opened after cell connection for sensing at the cell.

6.6 Connecting to a Host

After initial operation of the AFE with the bq76940/bq76930/bq76920 software, it may be desirable to operate the board connected to a microcontroller board. J14 can be used to connect to the microcontroller board. No voltages should be applied to the gauge terminals. Alternately, the microcontroller could be connected to the signal test points or J8 and the ALERT test point. The interface voltage for the installed AFE IC is 2.5 V.

6.7 Gauge Circuits

The EVM contains a gauge circuit consisting of U2 and an SMBus interface connector, J14. This bq78350 IC and circuit can be used to control the AFE if configured and connected at the J12 header. By default the AFE on the EVM is a 2.5V output device, only connect the gauge circuitry to a 2.5-V output AFE IC.

Shunts may be placed on the /KEYIN and /PRES headers to simulate control of these signals. An alternate SMBus address may be selected using the Addr select header. Refer to the bq78350 TRM for details and configuration selections for these device features.

The BV header typically has a shunt on the H position for the full number of supported cells. When the cell count or maximum cell voltage is reduced, refer to the schematic and the bq78350 documents for alternate positions which may better use the 1 V input range of the BAT pin. Making a selection which would exceed the 1V limit is not recommended.

6.8 Unused Components

The EVM contains a number of component patterns which may be useful for evaluation. Test points are not typically populated. The patterns may be used as probe points or wires or test points can be soldered to provide probing if desired.

The Q1 and Q3 patterns are for parallel power FETs.

A heatsink pattern is provided at each power FET position (HS1 - HS4) for optional heatsink attachment. Other heatsink options may be available in the evaluation environment.

D4 is a flyback diode to prevent PACK- from rising significantly above PACK+. The D5 pattern provides a place to mount a higher current diode or other transient suppression component.

D16 to D21 and D32 to D37 are patterns for Schottky diodes. When the battery is short circuited, the cell voltages will drop and the inputs are pulled below the group power reference pin and current flows from the inputs. If this causes problems, diodes at these locations would conduct to prevent high current from the input pins. These were not needed in EVM testing.

The ALERT line will switch high and low in normal operation as status bits are asserted and cleared. A large load is not desired, since it consumes power. If it is useful to slow the transition, the pattern C20 is available. C20 should not be large to avoid current and slowing the edge to where the bq769x0 would see the ALERT high as an input and set the OVRD_ALERT condition.

Normally the power filter components (Rf and Cf in the datasheet) R57-59 and C34-C36 keep the supply voltage for the AFE cell groups in a safe operating range. For situations with large transients, the D38-40 patterns provide positions for clamp diodes, if needed. The pattern is large and it may be easy to fit other component sizes, if needed. Be aware that if the system transients are large enough that a clamp is needed at the supply pins, the cell inputs should also be inspected for excessive voltages and an improved filter or clamp be added there, if needed.

The REGSRC pin also has the D42 pattern as a provision for a clamp diode. REGSRC is referenced to a filtered node by the gate of Q14 and should not normally have transients which need clamping.

R60-62 and R79 are current measurement shunt resistors. Current into the power pins of U1 can be determined by measuring the voltage across these resistors at the related test points and dividing by the resistance (100). These resistors are populated on the EVM but could be shorted or combined with other series resistance when using the EVM as a reference for a circuit design.

Q21 is an alternate transistor pattern for Q20 when a lower power transistor is suitable such as when using fewer LEDs or lower voltage.

R91 and R92 are options to pull down unused output pins on U2

J13, C38, R80, R81, R83, R88, R93, R98, R99, R100 and R113 provide patterns to bring signals to a convenient location for evaluation of optional external high side switching

7 Circuit Module Physical Construction

This section contains the PCB layout, bill of materials and schematic of the bq76930EVM and bq76940EVM circuit modules.

The circuit board is common to the 2 different assemblies.

7.1 Board Layout

The bq76930EVM and bq76940EVM circuit modules are assembled on a common 4.0-in × 6.0-in, 4-layer circuit board. It is designed for easy connection with cell connections on the left side to a terminal block and high-current screw terminals. Control connections are on the left top. Pack terminals are on the right side using screw terminals. Wide trace areas are used to reduce voltage drops on the high current paths. The EVM layout and construction allows easy understanding of the connections and access to the test points for evaluation, but the connector area and programming features result in a large board.

See additional information in the configuration and operation sections of this document. Figure 18 to Figure 23 show the board layout.

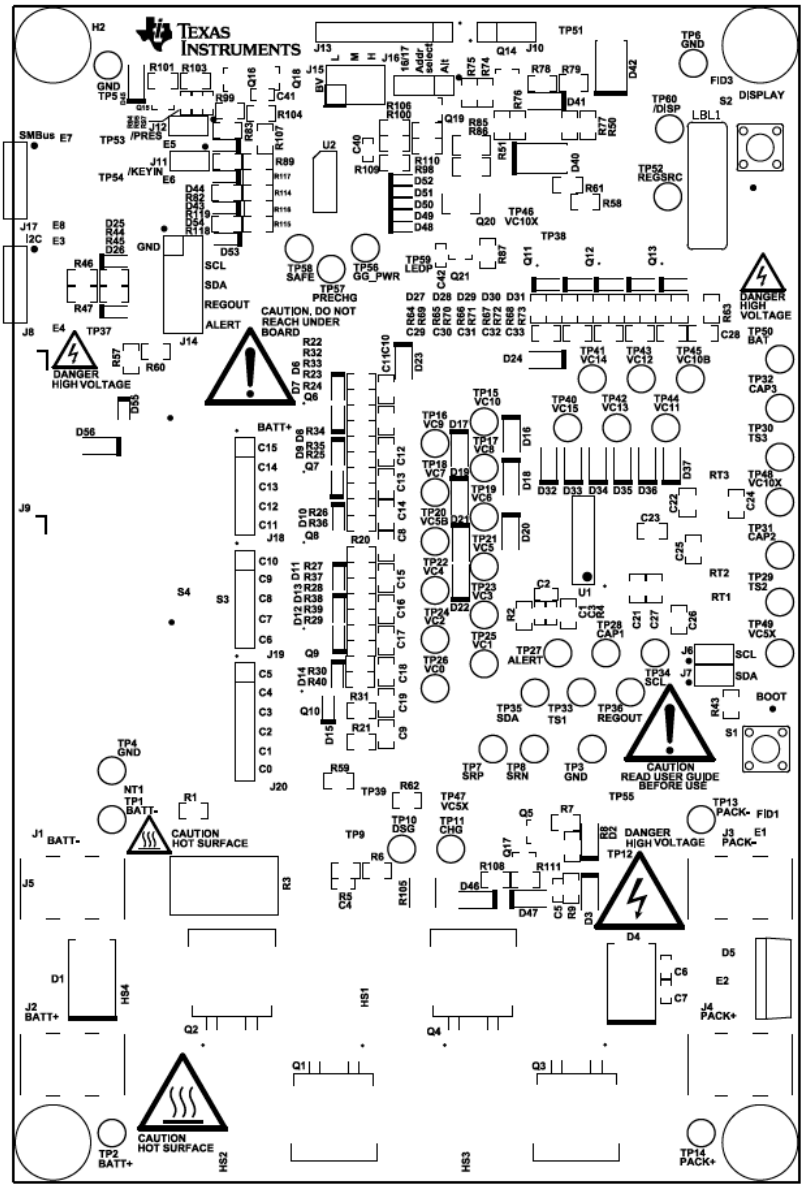

Figure 18. Top Silk Screen

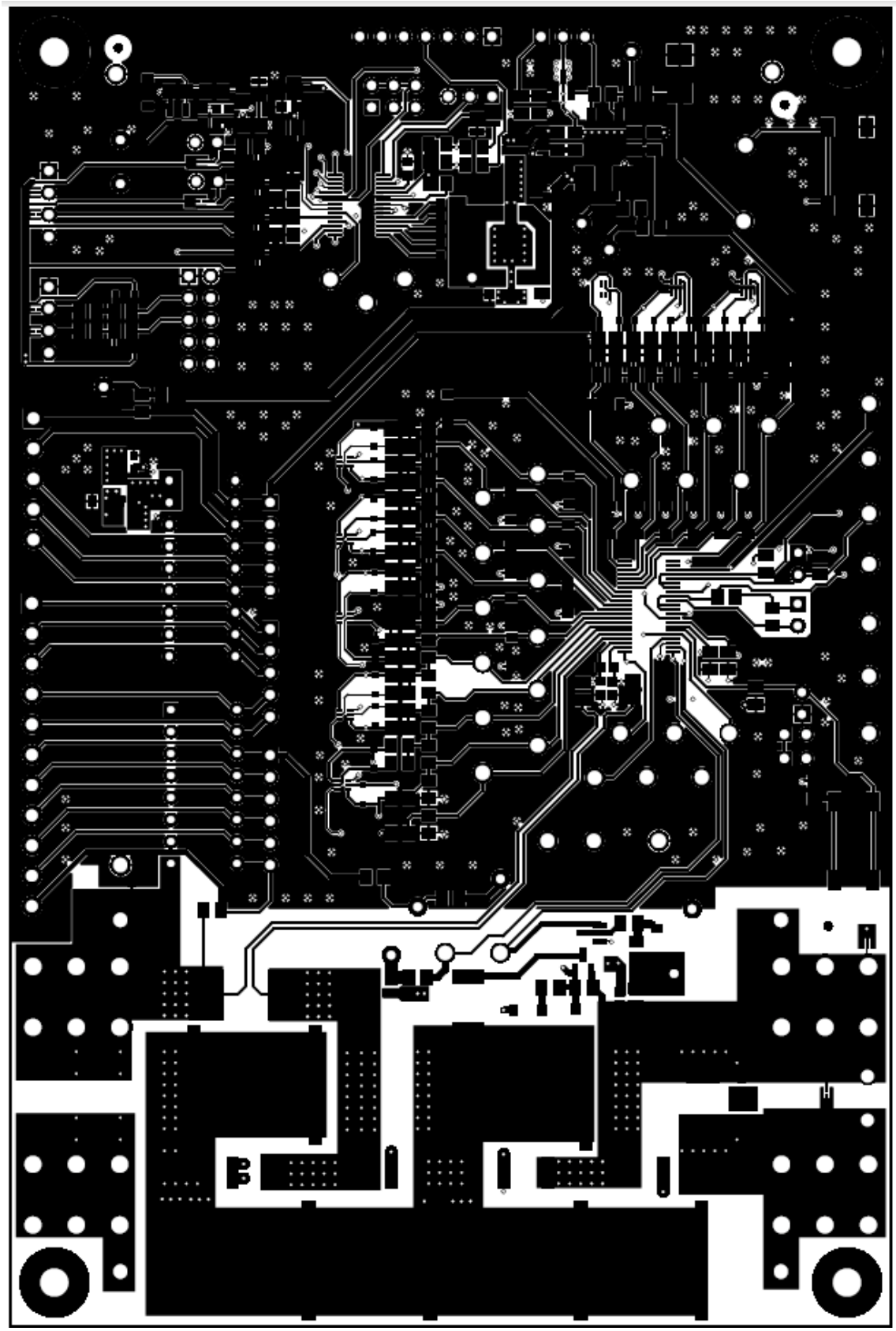

Figure 19. Top Layer

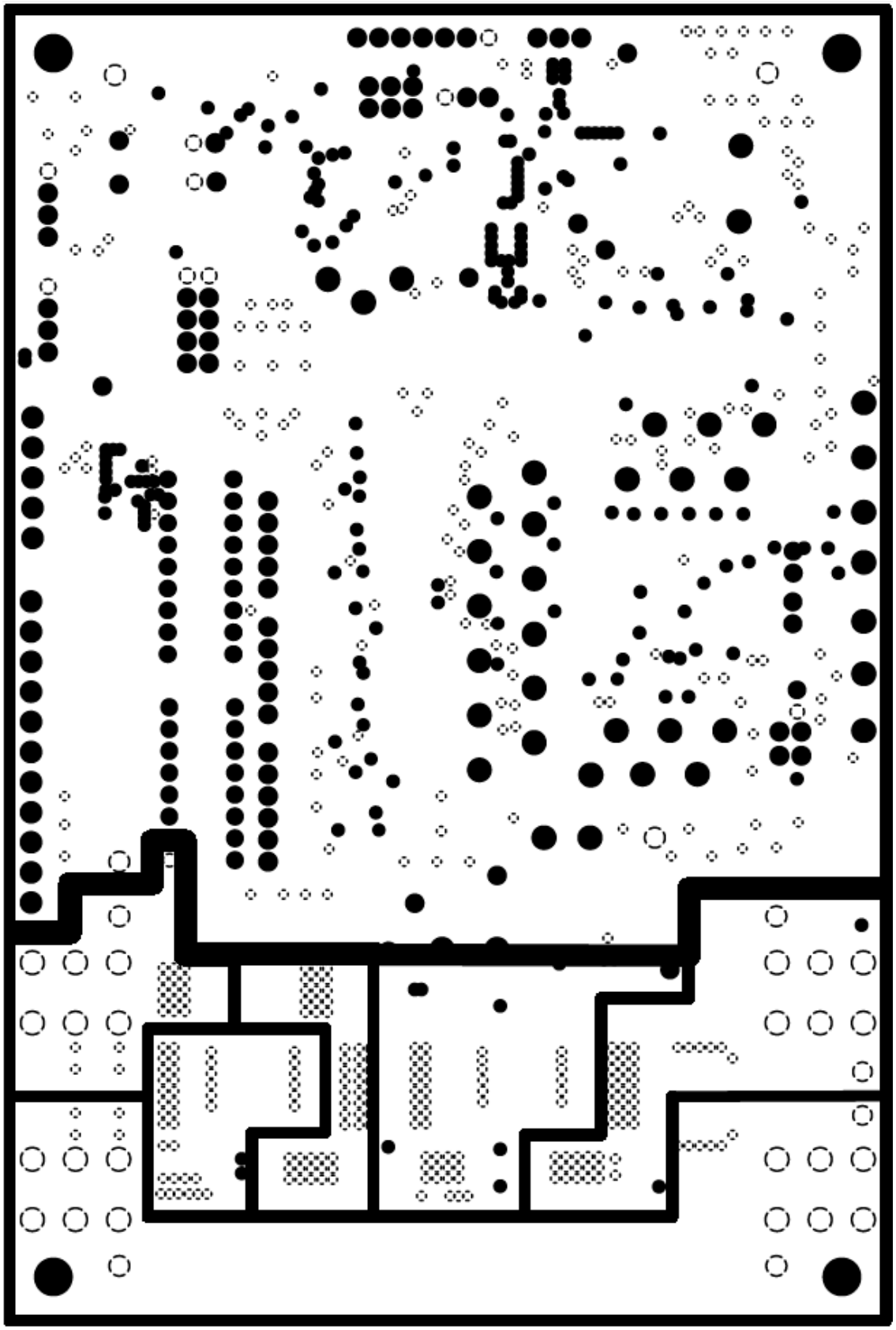

Figure 20. Layer 2

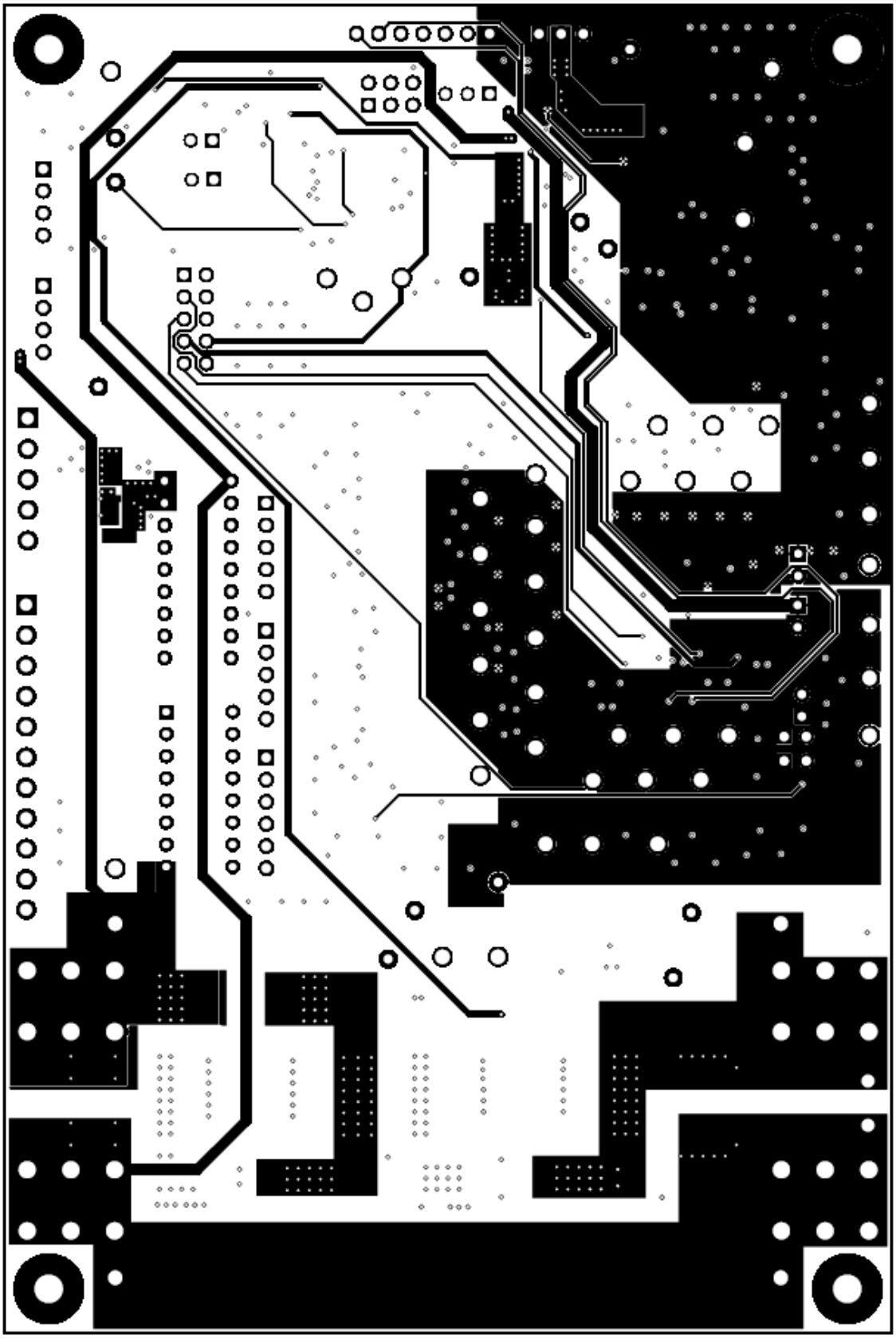

Figure 21. Layer 3

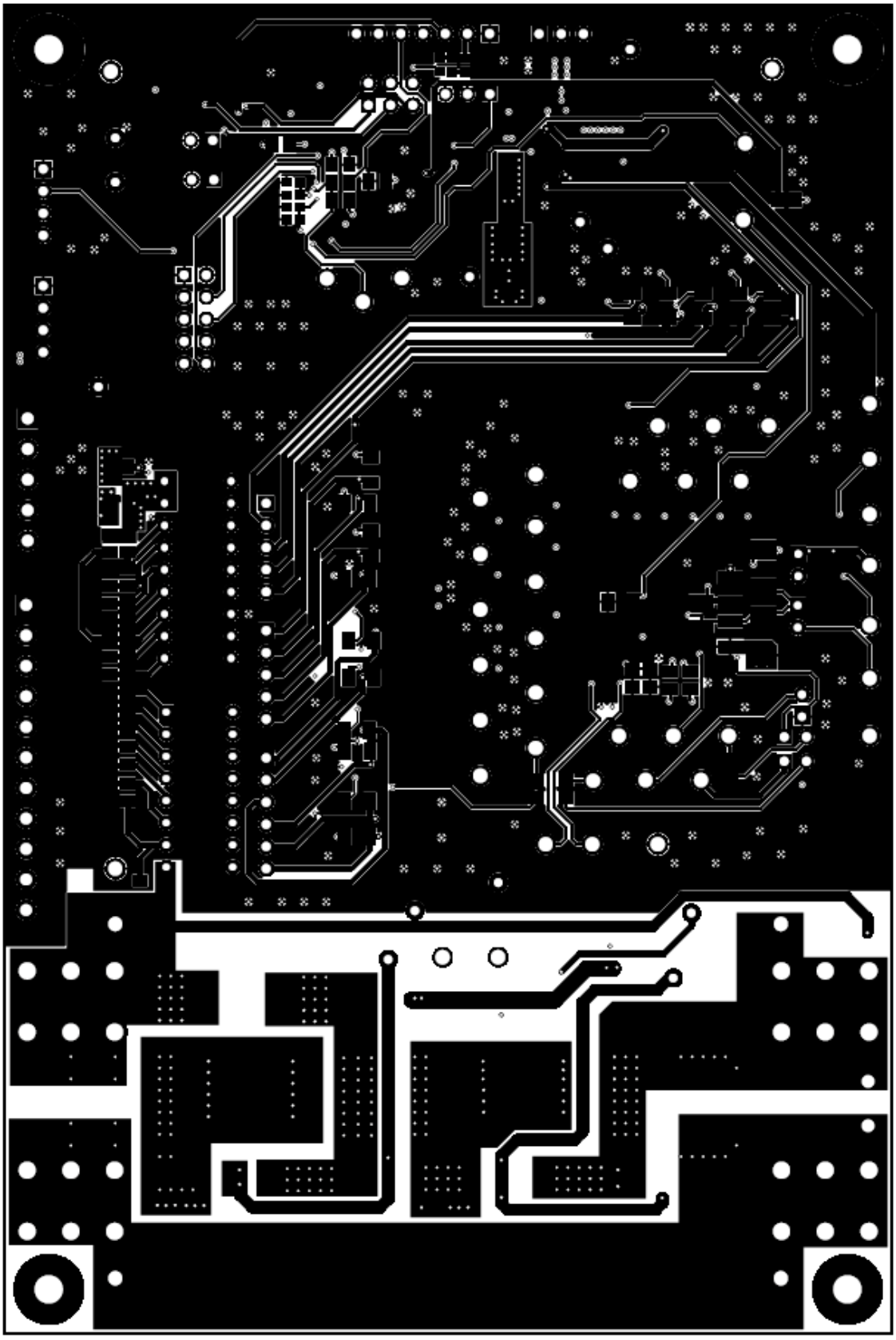

Figure 22. Bottom Layer

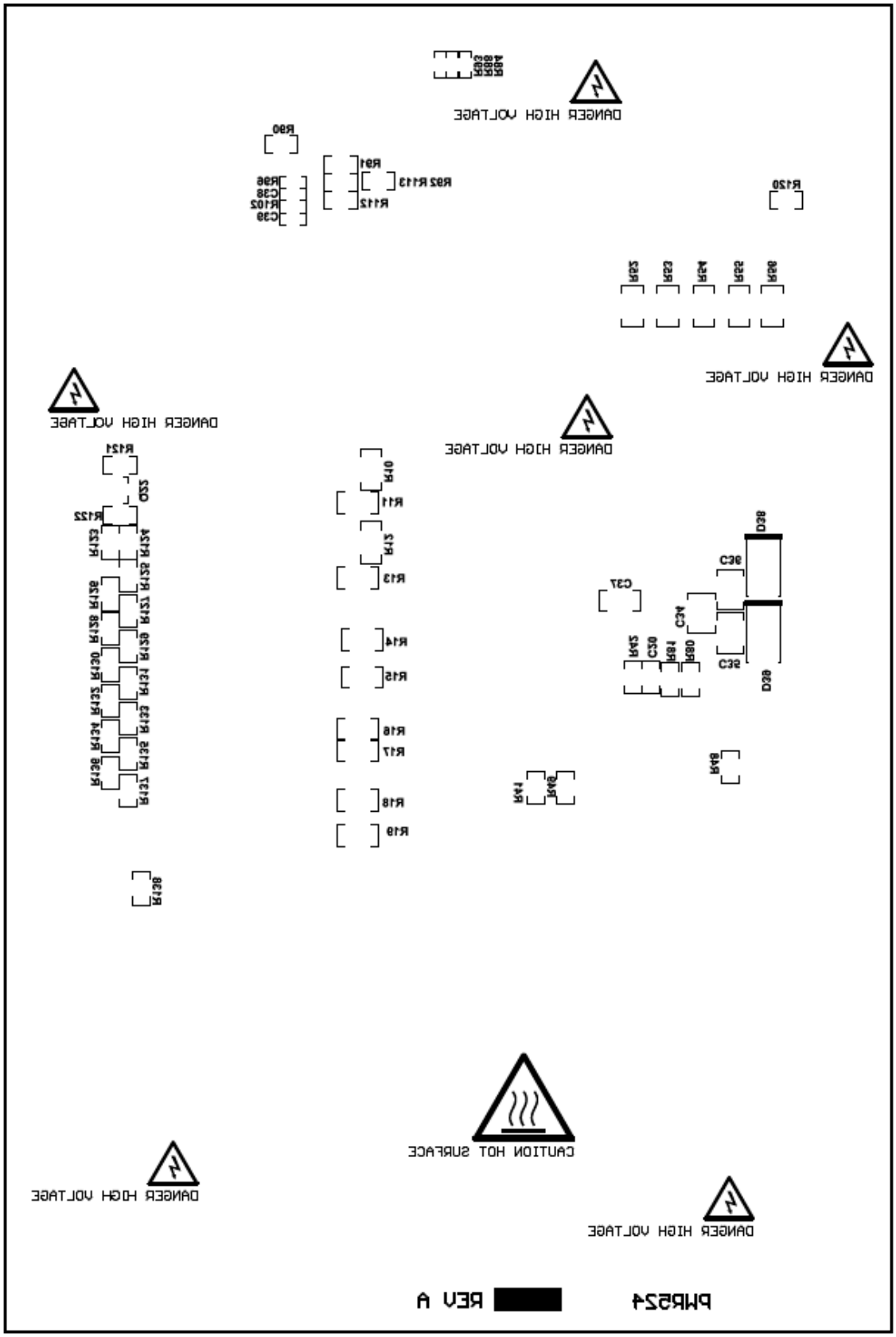

Figure 23. Bottom Silk Screen

7.2 bq76930EVM Circuit Module

7.2.1 bq76930EVM Assembly

The bq76930EVM supports 10 cells on the board which can support 15. The bq7693000 is aligned with pin 1 of the U1 board pattern. Components to support the upper cells are not installed. Figure 24 and Figure 25 show the bq76930EVM assembly.

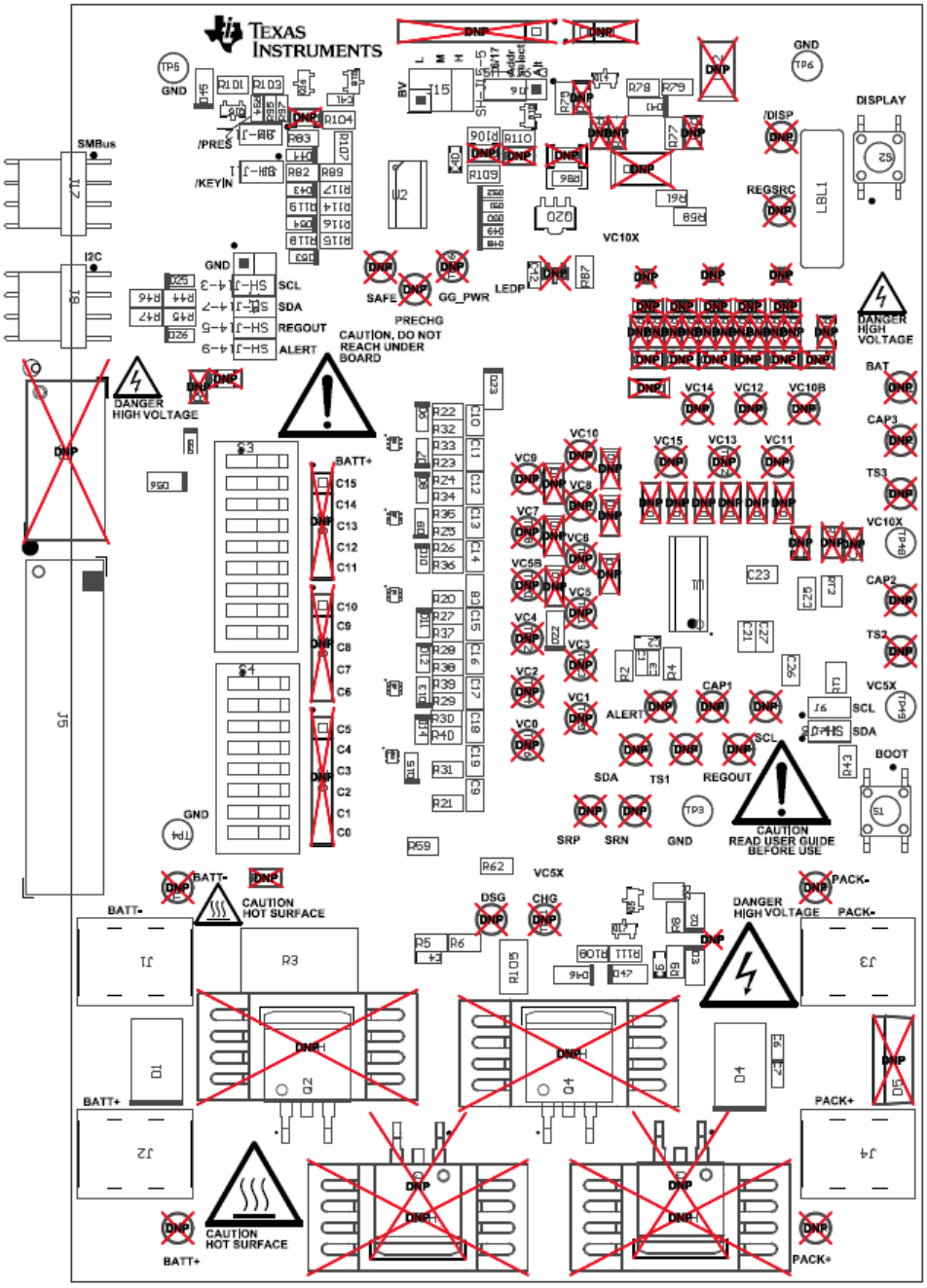

Figure 24. bq76930EVM Top Assembly

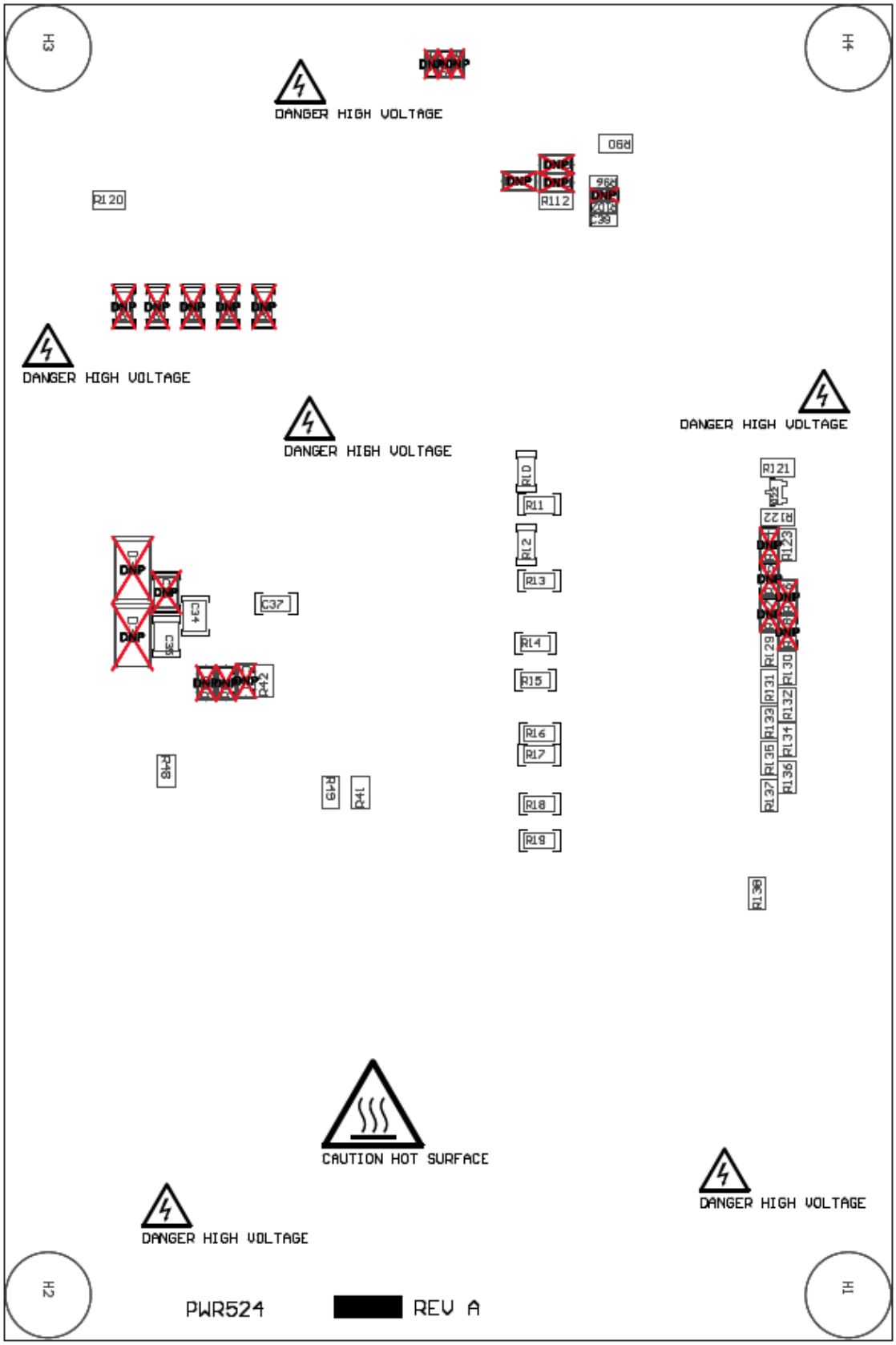

Figure 25. bq76930EVM Bottom Assembly

7.2.2 bq76930EVM Bill of Materials

The bill of materials for the bq76930EVM circuit module is shown in Table 4.

Table 4. bq76930EVM Circuit Module Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	MFR	Alt. Part Number	Alt. MFR
!PCB1	1		Printed Circuit Board		PWR524	Any	-	-
C1, C2, C3, C40, C41, C42	6	0.1uF	CAP, CERM, 0.1uF, 50V, +10/%, X7R, 0603	0603	GCM188R71H104KA57B	MuRata		
C4, C5, C6, C7	4	0.1uF	CAP, CERM, 0.1uF, 100V, +/-10%, X7R, 0603	0603	GRM188R72A104KA35D	MuRata		
C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C21, C23	14	1uF	CAP, CERM, 1uF, 16V, +10/%, X7R, 0805	0805	GRM21BR71C105KA01L	MuRata		
C25, C26	2	4700pF	CAP, CERM, 4700pF, 50V, +/-10%, X7R, 0805	0805	08055C472KAT2A	AVX		
C27	1	4.7uF	CAP, CERM, 4.7uF, 10V, +10/%, X7R, 0805	0805	GRM21BR71A475KA73L	MuRata		
C34, C35	2	10uF	CAP, CERM, 10uF, 35V, +/-10%, X7R, 1210	1210	GRM32ER7YA106KA12L	MuRata		
C37	1	1uF	CAP, CERM, 1uF, 50V, +/-10%, X7R, 1206	1206	GRM31MR71H105KA88L	MuRata		
C39	1	3300pF	CAP, CERM, 3300pF, 25V, +/-10%, X7R, 0603	0603	GRM188R71E332KA01D	MuRata		
D1	1	45V	Diode, TVS, Uni, 45V, 1500W, SMC	SMC	SMCJ45A	Fairchild Semiconductor		
D2, D22, D23, D41, D46	5	100V	Diode, Ultrafast, 100V, 0.15A, SOD-123	SOD-123	1N4148W-7-F	Diodes Inc.		
D3, D45, D47	3	16V	Diode, Zener, 16V, 500mW, SOD-123	SOD-123	MMSZ5246B-7-F	Diodes Inc.		
D4	1	600V	Diode, Ultrafast, 600V, 3A, SMC	SMC	MURS360T3G	ON Semiconductor		
D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D25, D26, D43, D44, D53, D54	16	5.6V	Diode, Zener, 5.6V, 200mW, SOD-323	SOD-323	MMSZ5232BS-7-F	Diodes Inc.		
D48, D49, D50, D51, D52	5	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On		
D55	1	Orange	LED, Orange, SMD	1.6x0.8x0.8mm	LTST-C190KFKT	Lite-On		
D56	1	6.8V	Diode, Zener, 6.8V, 500mW, SOD-123	SOD-123	MMSZ5235B-7-F	Diodes Inc.		
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.375 X 0.235, Black	Black Bumpon	SJ61A2	3M		
J1, J2, J3, J4	4		TERMINAL SCREW PC 30AMP, TH	12.9x6.3x7.9 mm	8199	Keystone		
J5	1		Header, 3.5mm, 11POS, R/A, TH	39.90x7.03x9.33 mm	395021011	Molex		
J6, J7, J11, J12	4		Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
J8, J17	2		Header, 100mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex		
J14	1		Header, 100mil, 5x2, Tin plated, TH	Header, 5x2, 100mil, Tin	PEC05DAAN	Sullins Connector Solutions		
J15	1		Header, 100mil, 3x2, Tin, TH	3x2 Header	PEC03DAAN	Sullins Connector Solutions		
J16	1		Header, 100mil, 3x1, Tin plated, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady	-	-
P1	1		CONN TERM BLOCK 3.5MM 11POS R/A	Term Block Plug	39500-0011	Molex Connector Corporation	1840450	Phoenix Contact
Q2, Q4	2	100V	MOSFET, N-CH, 100V, 18A, DDPAK	DDPAK	AOB290L	AOS		None
Q5, Q15	2	-100V	MOSFET, P-CH, -100V, -0.6A, SOT-23	SOT-23	ZXMP10A13FTA	Diodes Inc.		None

Table 4. bq76930EVM Circuit Module Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	MFR	Alt. Part Number	Alt. MFR
Q6, Q7, Q8, Q9, Q10	5	20V	MOSFET, P-CH, 20V, 0.83A,		FDY1002PZ	Fairchild Semiconductor		None
Q14, Q22	2	100V	MOSFET, N-CH, 100V, 0.19A, SOT-23	SOT-23	BST82,215	NXP Semiconductor		None
Q16, Q17	2	100V	MOSFET, N-CH, 100V, 0.17A, SOT-23	SOT-23	BSS123	Fairchild Semiconductor		None
Q18	1	0.5V	Transistor, PNP, 300V, 0.2A, SOT-23	SOT-23	MMBTA92	Fairchild Semiconductor	None	None
Q19	1	50V	MOSFET, N-CH, 50V, 0.22A, SOT-23	SOT-23	BSS138	Fairchild Semiconductor		None
Q20	1	0.21V	Transistor, NPN, 20V, 5.25A, SOT-89	SOT-89	ZXTN19100CZTA	Diodes Inc.		
R2, R4, R44, R45, R46, R47, R61, R62, R79, R82, R83, R89, R90, R114, R115, R118, R119	17	100	RES, 100 ohm, 1%, 0.125W, 0805	0805	CRCW0805100RFKEA	Vishay-Dale		
R3	1	0.001	RES, 0.001 ohm, 1%, 2W, 4527	4527	WSR21L000FEA	Vishay-Dale		
R5, R8, R9, R104, R111, R116, R117	7	1.00Meg	RES, 1.00Meg ohm, 1%, 0.125W, 0805	0805	CRCW08051M00FKEA	Vishay-Dale		
R6, R87, R123	3	0	RES, 0 ohm, 5%, 0.125W, 0805	0805	CRCW08050000Z0EA	Vishay-Dale		
R7, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31, R58, R59	15	1.00k	RES, 1.00k ohm, 1%, 0.125W, 0805	0805	CRCW08051K00FKEA	Vishay-Dale		
R10, R11, R12, R13, R14, R15, R16, R17, R18, R19	10	100	RES, 100 ohm, 1%, 0.25W, 1206	1206	CRCW1206100RFKEA	Vishay-Dale		
R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R48, R49, R108, R112	14	10.0k	RES, 10.0k ohm, 1%, 0.125W, 0805	0805	CRCW080510K0FKEA	Vishay-Dale		
R42	1	499k	RES, 499k ohm, 1%, 0.125W, 0805	0805	CRCW0805499KFKEA	Vishay-Dale		
R43	1	3.01k	RES, 3.01k ohm, 1%, 0.125W, 0805	0805	CRCW08053K01FKEA	Vishay-Dale		
R75, R78, R101, R103, R107, R109	6	100k	RES, 100k ohm, 1%, 0.125W, 0805	0805	CRCW0805100KFKEA	Vishay-Dale		
R77, R129, R130, R131, R132, R133, R134, R135, R136, R137, R138	11	200	RES, 200 ohm, 1%, 0.125W, 0805	0805	CRCW0805200RFKEA	Vishay-Dale		
R86	1	0	RES, 0 ohm, 5%, 0.25W, 1206	1206	CRCW12060000Z0EA	Vishay-Dale		
R94	1	300k	RES, 300k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-304-B-T5	Susumu Co Ltd		
R95, R97	2	100k	RES, 100k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-104-B-T5	Susumu Co Ltd		
R96, R102	2	11.3k	RES, 11.3k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-1132-B-T5	Susumu Co Ltd		
R105	1	5.6k	RES, 5.6k ohm, 5%, 1W, 2512	2512	ERJ-1TYJ562U	Panasonic		
R106	1	196k	RES, 196k ohm, 1%, 0.125W, 0805	0805	CRCW0805196KFKEA	Vishay-Dale		
R110, R122	2	49.9k	RES, 49.9k ohm, 1%, 0.125W, 0805	0805	CRCW080549K9FKEA	Vishay-Dale		
R120	1	221k	RES, 221k ohm, 1%, 0.125W, 0805	0805	CRCW0805221KFKEA	Vishay-Dale		
R121	1	698	RES, 698 ohm, 1%, 0.125W, 0805	0805	CRCW0805698RFKEA	Vishay-Dale		
RT1, RT2	2	10.0k ohm	Thermistor NTC, 10.0k ohm, 1%, Disc, 5x8.4 mm	Disc, 5x8.4 mm	103AT-2	SEMITEC Corporation		
S1, S2	2		Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	SW, SPST 6x6 mm	4-1437565-1	TE Connectivity		
S3	1		Switch, SPST 9Pos, Rocker, TH	9.65X8X24.9mm	76SB09ST	Grayhill		
S4	1		Switch, SPST 8Pos, Rocker, TH	9.65X8X22.4mm	76SB08ST	Grayhill		
SH-J6, SH-J7, SH-J11, SH-J12, SH-J14-3, SH-J14-5, SH-J14-7, SH-J14-9, SH-J15-5, SH-J16-3	10	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
TP3, TP4, TP5, TP6	4	Black	Test Point, TH, Multipurpose, Black	Keystone5011	5011	Keystone		

Table 4. bq76930EVM Circuit Module Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	MFR	Alt. Part Number	Alt. MFR
TP48, TP49	2	Yellow	Test Point, Multipurpose, Yellow, TH	Yellow Multipurpose Testpoint	5014	Keystone		
U1	1		µC-Controlled AFE Family for 5/10/15/16 Series Cell Lithium-Ion and Phosphate Battery Pack Applications, DBT0030A	DBT0030A	BQ7693000DBT	Texas Instruments		None
U2	1		CEDV Fuel Gauge and Battery Management Controller Companion to the bq769x0 AFE, DBT0030A	DBT0030A	BQ78350DBT	Texas Instruments		None
W1	1		Cable assembly, 4 pin	Assembly	CBL002	Texas Instruments	-	-
C20	0	470pF	CAP, CERM, 470pF, 50V, +/-10%, X7R, 0805	0805	08055C471KAT2A	AVX		
C22, C28, C29, C30, C31, C32, C33	0	1uF	CAP, CERM, 1uF, 16V, +10/%, X7R, 0805	0805	GRM21BR71C105KA01L	MuRata		
C24	0	4700pF	CAP, CERM, 4700pF, 50V, +/-10%, X7R, 0805	0805	08055C472KAT2A	AVX		
C36	0	10uF	CAP, CERM, 10uF, 35V, +/-10%, X7R, 1210	1210	GRM32ER7YA106KA12L	MuRata		
C38	0	3300pF	CAP, CERM, 3300pF, 25V, +/-10%, X7R, 0603	0603	GRM188R71E332KA01D	MuRata		
D5	0	600V	Diode, Ultrafast, 600V, 8A, TH	TO-220AC	MUR860G	ON Semiconductor		
D16, D17, D18, D19, D20, D21, D32, D33, D34, D35, D36	0	0.8V	Diode, Schottky, 30V, 0.2A, SOD-123	SOD-123	BAT54T1G	ON Semiconductor		
D24	0	100V	Diode, Ultrafast, 100V, 0.15A, SOD-123	SOD-123	1N4148W-7-F	Diodes Inc.		
D27, D28, D29, D30, D31	0	5.6V	Diode, Zener, 5.6V, 200mW, SOD-323	SOD-323	MMSZ5232BS-7-F	Diodes Inc.		
D37	0		Diode, Schottky, 30V, 0.2A, SOD-123	SOD-123	BAT54T1G	ON Semiconductor		
D38, D39, D40, D42	0		Diode, TVS, Uni, 30V, 600W, SMB	SMB	SMBJ30A-13-F	Diodes Inc.		
HS1, HS2, HS3, HS4	0		Heatsink, DDPAK/TO-263, SMT	Heatsink, DDPAk	573300D00010G	Aavid		
J9	0		Header, 3.5mm, 5POS, R/A, TH	19.03x7.03x9.33 mm	395021005	Molex		
J10	0		Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	TSW-103-07-G-S	TSW-103-07-G-S	Samtec, Inc.		
J13	0		Header, TH, 100mil, 7x1, Gold plated, 230 mil above insulator	7x1 Header	TSW-107-07-G-S	Samtec		
J18, J19	0		Header, TH, 100mil, 5x1, Gold plated, 230 mil above insulator	TSW-105-07-G-S	TSW-105-07-G-S	Samtec, Inc.		
J20	0		Header, TH, 100mil, 6x1, Gold plated, 230 mil above insulator	TSW-106-07-G-S	TSW-106-07-G-S	Samtec, Inc.		
P2	0		CONN TERM BLOCK 3.5MM 5POS R/A	Term Block Plug	39500-0005	Molex Connector Corporation	-	-
Q1, Q3	0	100V	MOSFET, N-CH, 100V, 18A, DDPAK	DDPAK	AOB290L	AOS		None
Q11, Q12, Q13	0	20V	MOSFET, P-CH, 20V, 0.83A,		FDY1002PZ	Fairchild Semiconductor		None
Q21	0	0.7V	Transistor, NPN, 65V, 0.1A, SOT-23	SOT-23	BC846BLT1G	ON Semiconductor	None	None
R1, R50, R51	0	0	RES, 0 ohm, 5%, 0.125W, 0805	0805	CRCW08050000Z0EA	Vishay-Dale		
R52, R53, R54, R55, R56	0	100	RES, 100 ohm, 1%, 0.25W, 1206	1206	CRCW1206100RFKEA	Vishay-Dale		
R57, R63, R64, R65, R66, R67, R68, R80, R81, R98, R99, R113	0	1.00k	RES, 1.00k ohm, 1%, 0.125W, 0805	0805	CRCW08051K00FKEA	Vishay-Dale		
R60	0	100	RES, 100 ohm, 1%, 0.125W, 0805	0805	CRCW0805100RFKEA	Vishay-Dale		
R69, R70, R71, R72, R73	0	10.0k	RES, 10.0k ohm, 1%, 0.125W, 0805	0805	CRCW080510K0FKEA	Vishay-Dale		
R74	0	100k	RES, 100k ohm, 1%, 0.125W, 0805	0805	CRCW0805100KFKEA	Vishay-Dale		

Table 4. bq76930EVM Circuit Module Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	MFR	Alt. Part Number	Alt. MFR
R76, R124, R125, R126, R127, R128	0	200	RES, 200 ohm, 1%, 0.125W, 0805	0805	CRCW0805200RFKEA	Vishay-Dale		
R84	0	300k	RES, 300k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-304-B-T5	Susumu Co Ltd		
R85	0	0	RES, 0 ohm, 5%, 0.25W, 1206	1206	CRCW12060000Z0EA	Vishay-Dale		
R88, R93	0	100k	RES, 100k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-104-B-T5	Susumu Co Ltd		
R91, R92, R100	0	1.00Meg	RES, 1.00Meg ohm, 1%, 0.125W, 0805	0805	CRCW08051M00FKEA	Vishay-Dale		
RT3	0	10.0k ohm	Thermistor NTC, 10.0k ohm, 1%, Disc, 5x8.4 mm	Disc, 5x8.4 mm	103AT-2	SEMITEC Corporation		
TP1	0	Black	Test Point, TH, Multipurpose, Black	Keystone5011	5011	Keystone		
TP2, TP14	0	Red	Test Point, TH, Multipurpose, Red	Keystone5010	5010	Keystone		
TP7, TP8, TP10, TP11, TP13, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP35, TP36, TP40, TP41, TP42, TP43, TP44, TP45, TP52, TP56, TP57, TP58, TP60	0	White	Test Point, TH, Multipurpose, White	Keystone5012	5012	Keystone		
TP50	0	Yellow	Test Point, Multipurpose, Yellow, TH	Yellow Multipurpose Testpoint	5014	Keystone		
	Notes:							
	Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.							

7.2.3 bq76930EVM Schematic

Figure 26 through Figure 30 illustrate the bq76930EVM schematic. The bq7693000 shows pin numbers for the IC, not for the board. Pins 16 through 30 of U1 align with pins 30 through 44 of the board.

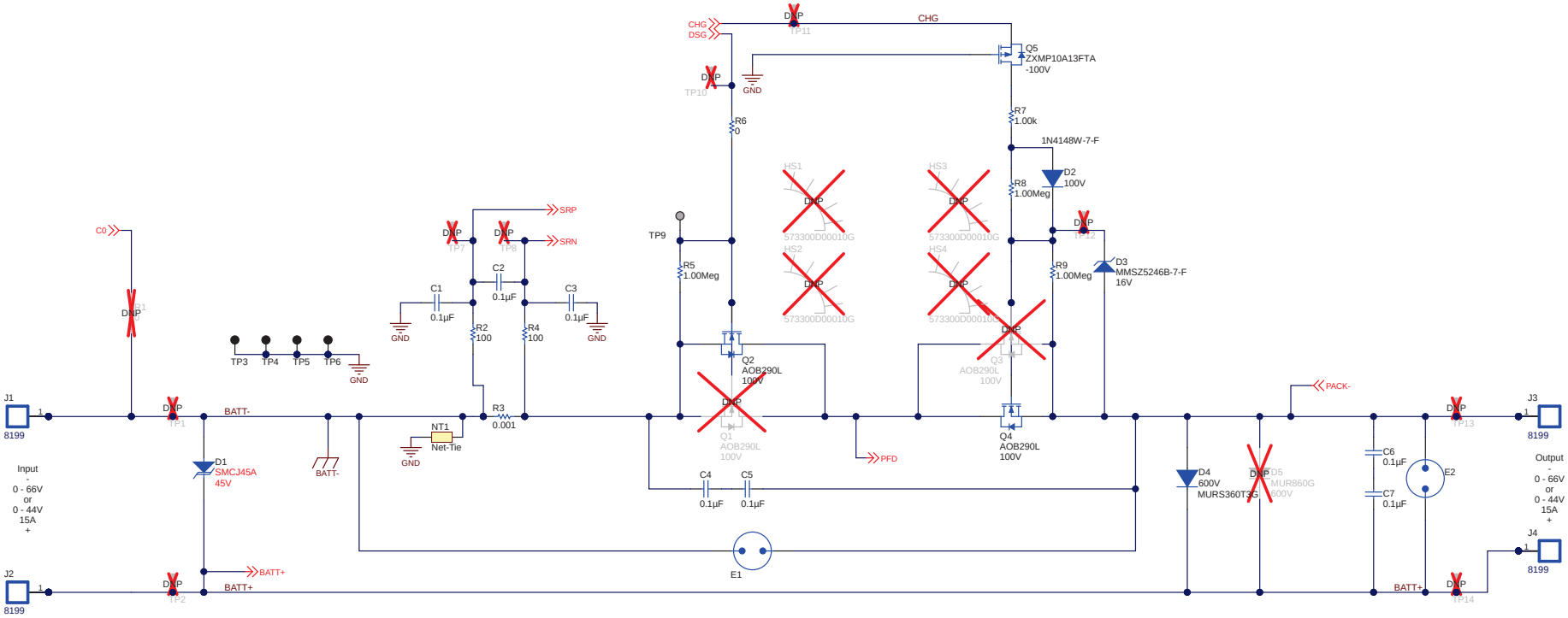

Figure 26. bq76930EVM Schematic Diagram FETs

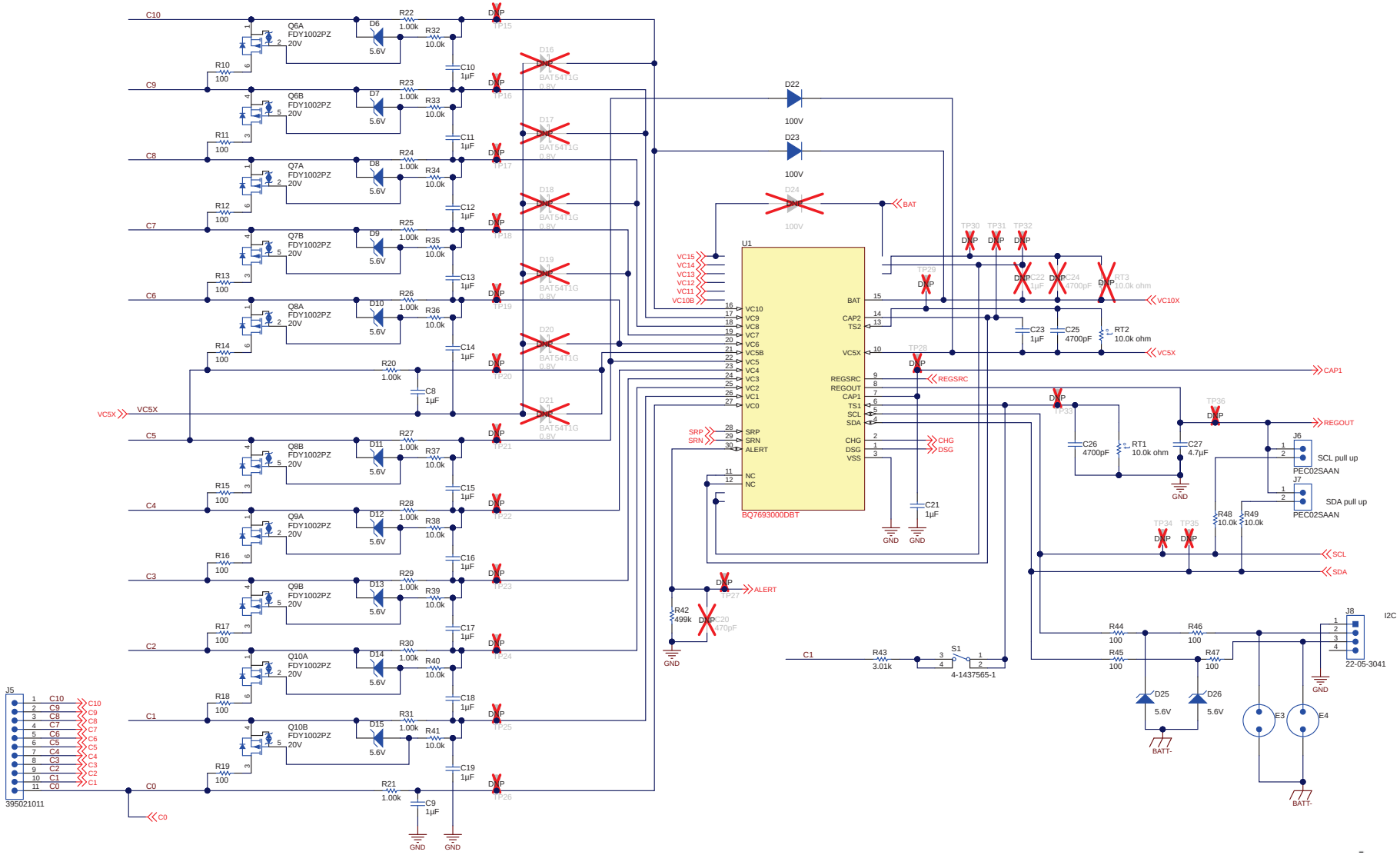

Figure 27. bq76930EVM Schematic Diagram AFE1

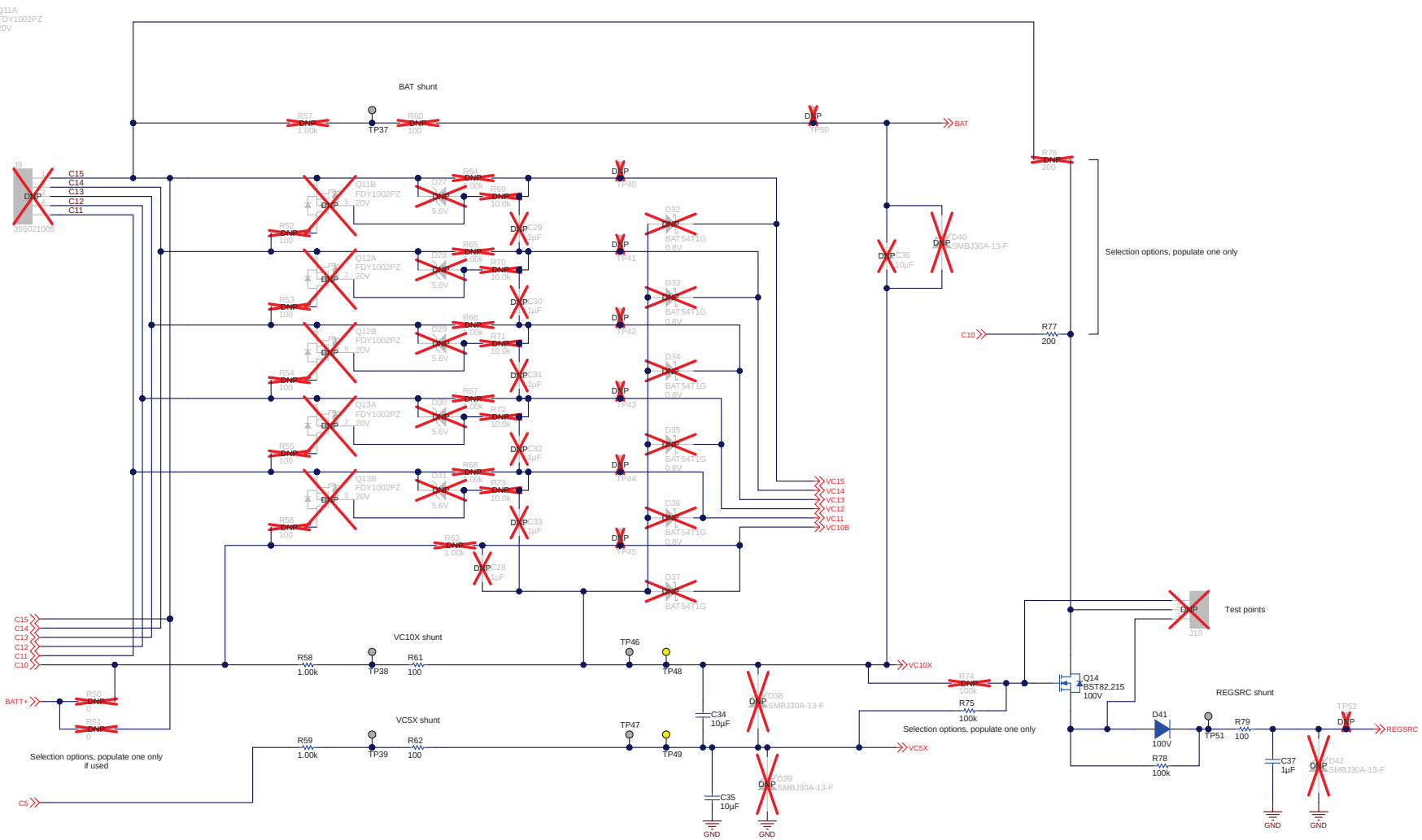

Figure 28. bq76930EVM Schematic Diagram AFE2

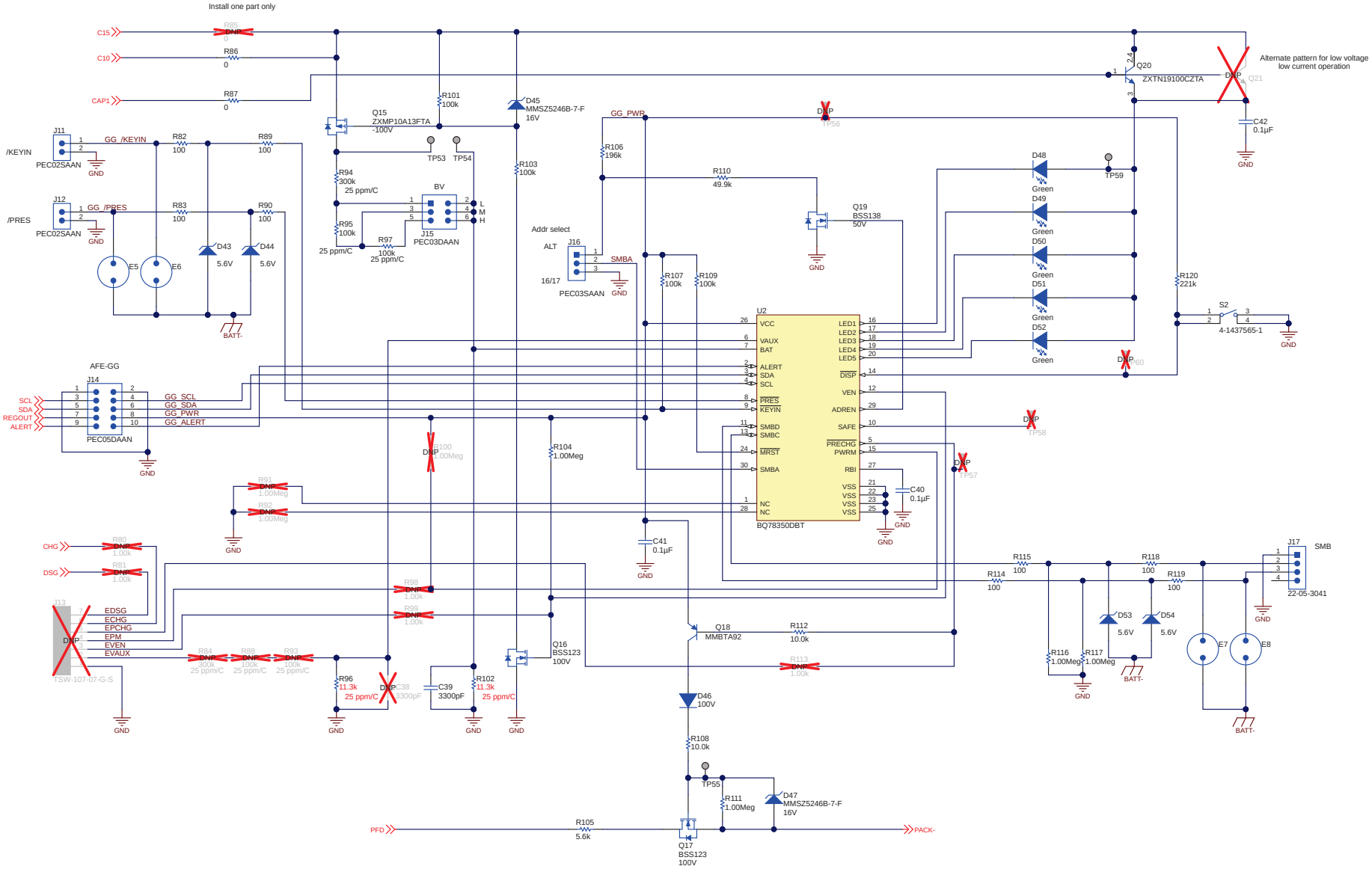

Figure 29. bq76930EVM Schematic Diagram Gauge

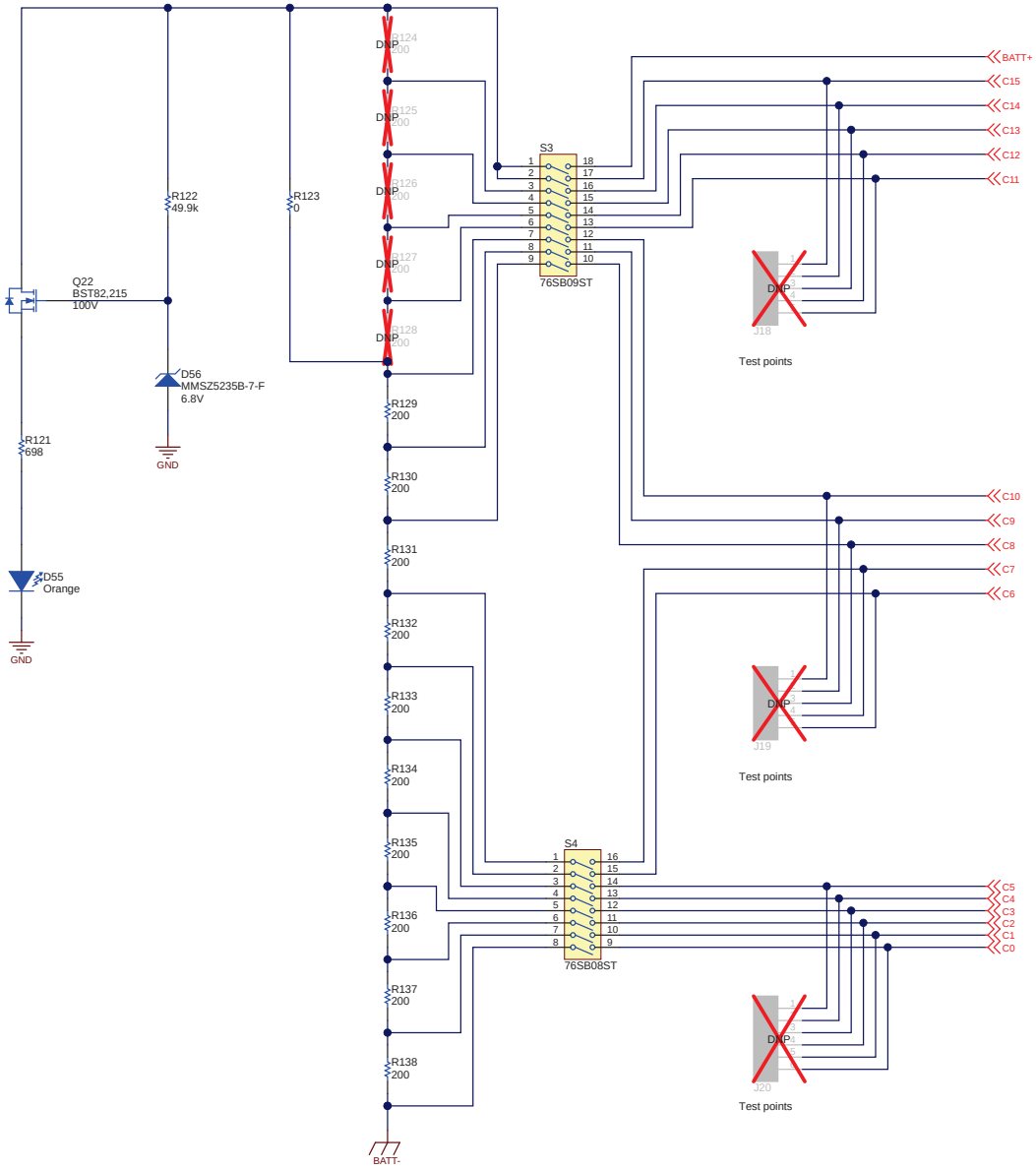

Figure 30. bq76930EVM Schematic Diagram Cell Simulator

7.3 bq76940EVM Circuit Module

7.3.1 bq76940EVM Assembly

The bq76940EVM uses all 15 cells provided on the board. Figure 31 and Figure 32 show the bq76940EVM assembly.

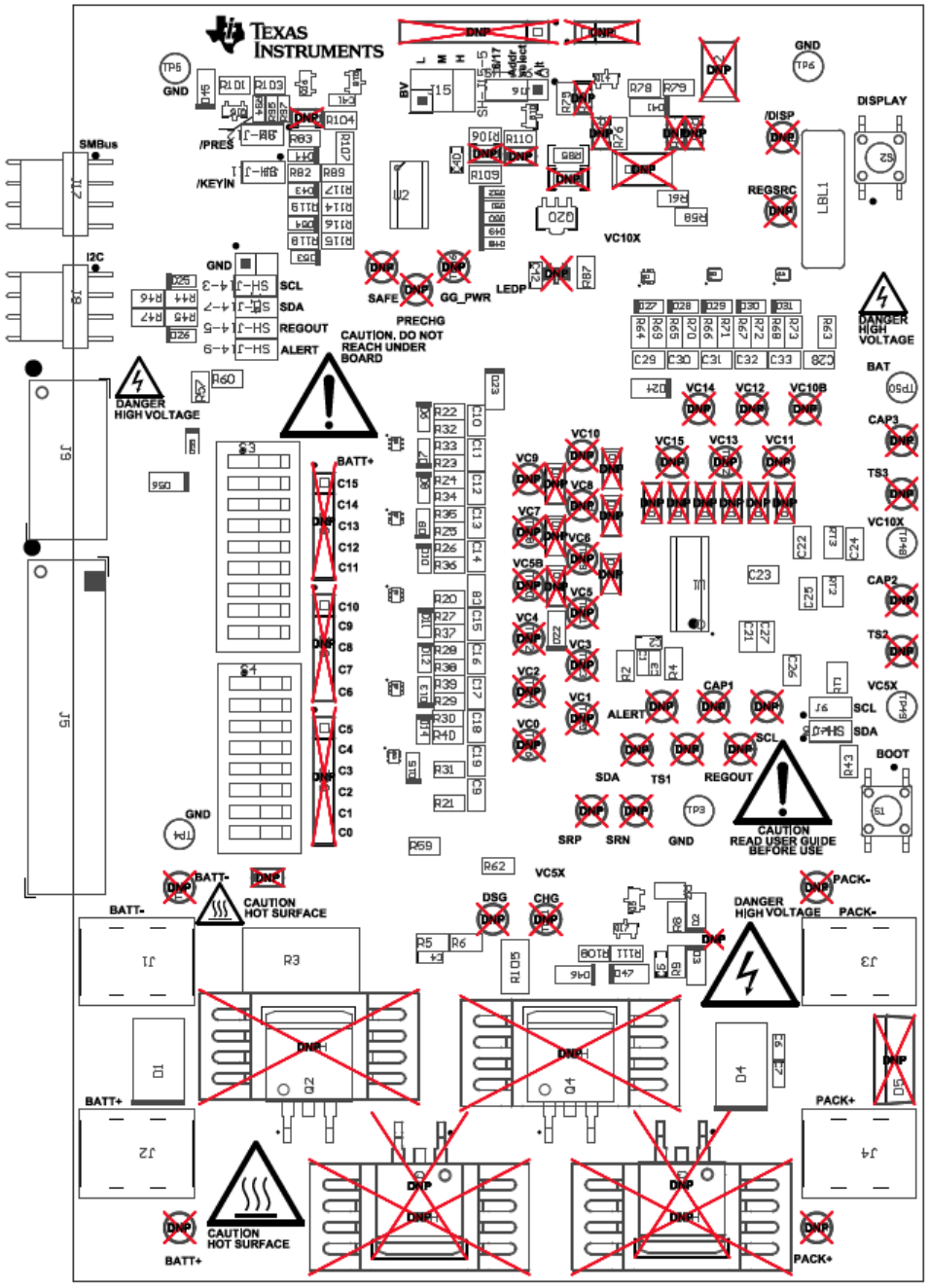

Figure 31. bq76940EVM Top Assembly

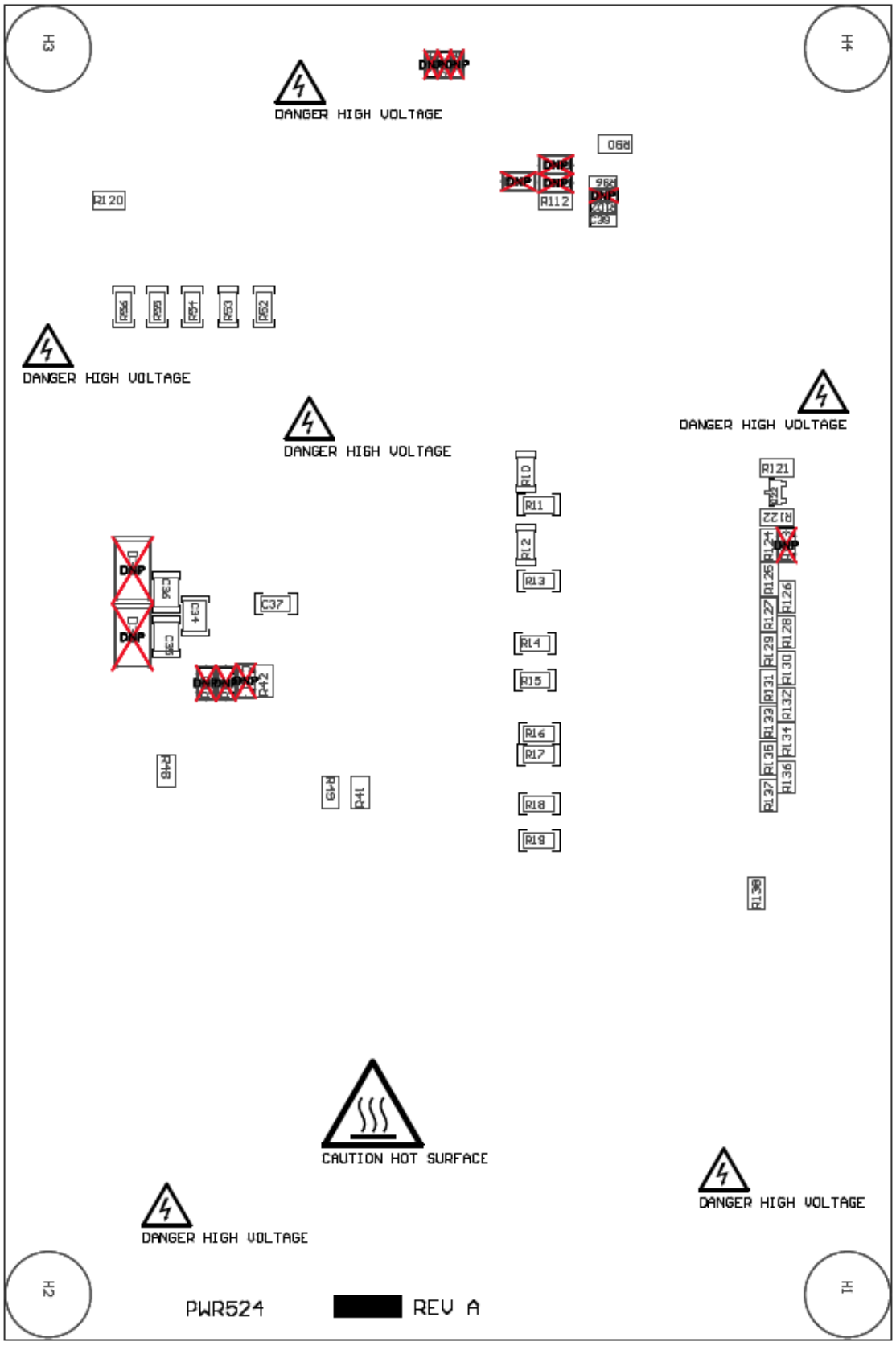

Figure 32. bq76940EVM Bottom Assembly

7.3.2 bq76940EVM Bill of Materials

The bill of materials for the bq76940EVM circuit module is shown in Table 5.

Table 5. bq76940EVM Circuit Module Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	MFR	Alt. Part Number	Alt. MFR
!PCB1	1		Printed Circuit Board		PWR524	Any	-	-
C1, C2, C3, C40, C41, C42	6	0.1uF	CAP, CERM, 0.1uF, 50V, +10/%, X7R, 0603	0603	GCM188R71H104KA57B	MuRata		
C4, C5, C6, C7	4	0.1uF	CAP, CERM, 0.1uF, 100V, +/-10%, X7R, 0603	0603	GRM188R72A104KA35D	MuRata		
C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C21, C22, C23, C28, C29, C30, C31, C32, C33	21	1uF	CAP, CERM, 1uF, 16V, +10/%, X7R, 0805	0805	GRM21BR71C105KA01L	MuRata		
C24, C25, C26	3	4700pF	CAP, CERM, 4700pF, 50V, +/-10%, X7R, 0805	0805	08055C472KAT2A	AVX		
C27	1	4.7uF	CAP, CERM, 4.7uF, 10V, +10/%, X7R, 0805	0805	GRM21BR71A475KA73L	MuRata		
C34, C35, C36	3	10uF	CAP, CERM, 10uF, 35V, +/-10%, X7R, 1210	1210	GRM32ER7YA106KA12L	MuRata		
C37	1	1uF	CAP, CERM, 1uF, 50V, +/-10%, X7R, 1206	1206	GRM31MR71H105KA88L	MuRata		
C39	1	3300pF	CAP, CERM, 3300pF, 25V, +/-10%, X7R, 0603	0603	GRM188R71E332KA01D	MuRata		
D1	1	75V	Diode, TVS, Uni, 75V, 1500W, SMC	SMC	SMCJ75A	Fairchild Semiconductor		
D2, D22, D23, D24, D41, D46	6	100V	Diode, Ultrafast, 100V, 0.15A, SOD-123	SOD-123	1N4148W-7-F	Diodes Inc.		
D3, D45, D47	3	16V	Diode, Zener, 16V, 500mW, SOD-123	SOD-123	MMSZ5246B-7-F	Diodes Inc.		
D4	1	600V	Diode, Ultrafast, 600V, 3A, SMC	SMC	MURS360T3G	ON Semiconductor		
D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D25, D26, D27, D28, D29, D30, D31, D43, D44, D53, D54	21	5.6V	Diode, Zener, 5.6V, 200mW, SOD-323	SOD-323	MMSZ5232BS-7-F	Diodes Inc.		
D48, D49, D50, D51, D52	5	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On		
D55	1	Orange	LED, Orange, SMD	1.6x0.8x0.8mm	LTST-C190KFKT	Lite-On		
D56	1	6.8V	Diode, Zener, 6.8V, 500mW, SOD-123	SOD-123	MMSZ5235B-7-F	Diodes Inc.		
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.375 X 0.235, Black	Black Bumpon	SJ61A2	3M		
J1, J2, J3, J4	4		TERMINAL SCREW PC 30AMP, TH	12.9x6.3x7.9 mm	8199	Keystone		
J5	1		Header, 3.5mm, 11POS, R/A, TH	39.90x7.03x9.33 mm	395021011	Molex		
J6, J7, J11, J12	4		Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
J8, J17	2		Header, 100mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex		
J9	1		Header, 3.5mm, 5POS, R/A, TH	19.03x7.03x9.33 mm	395021005	Molex		
J14	1		Header, 100mil, 5x2, Tin plated, TH	Header, 5x2, 100mil, Tin	PEC05DAAN	Sullins Connector Solutions		
J15	1		Header, 100mil, 3x2, Tin, TH	3x2 Header	PEC03DAAN	Sullins Connector Solutions		
J16	1		Header, 100mil, 3x1, Tin plated, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady	-	-
P1	1		CONN TERM BLOCK 3.5MM 11POS R/A	Term Block Plug	39500-0011	Molex Connector Corporation	1840450	Phoenix Contact

Table 5. bq76940EVM Circuit Module Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	MFR	Alt. Part Number	Alt. MFR
P2	1		CONN TERM BLOCK 3.5MM 5POS R/A	Term Block Plug	39500-0005	Molex Connector Corporation	-	-
Q2, Q4	2	100V	MOSFET, N-CH, 100V, 18A, DDPAK	DDPAK	AOB290L	AOS		None
Q5, Q15	2	-100V	MOSFET, P-CH, -100V, -0.6A, SOT-23	SOT-23	ZXMP10A13FTA	Diodes Inc.		None
Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13	8	20V	MOSFET, P-CH, 20V, 0.83A,		FDY1002PZ	Fairchild Semiconductor		None
Q14, Q22	2	100V	MOSFET, N-CH, 100V, 0.19A, SOT-23	SOT-23	BST82,215	NXP Semiconductor		None
Q16, Q17	2	100V	MOSFET, N-CH, 100V, 0.17A, SOT-23	SOT-23	BSS123	Fairchild Semiconductor		None
Q18	1	0.5V	Transistor, PNP, 300V, 0.2A, SOT-23	SOT-23	MMBTA92	Fairchild Semiconductor	None	None
Q19	1	50V	MOSFET, N-CH, 50V, 0.22A, SOT-23	SOT-23	BSS138	Fairchild Semiconductor		None
Q20	1	0.21V	Transistor, NPN, 20V, 5.25A, SOT-89	SOT-89	ZXTN19100CZTA	Diodes Inc.		
R2, R4, R44, R45, R46, R47, R60, R61, R62, R79, R82, R83, R89, R90, R114, R115, R118, R119	18	100	RES, 100 ohm, 1%, 0.125W, 0805	0805	CRCW0805100RFKEA	Vishay-Dale		
R3	1	0.001	RES, 0.001 ohm, 1%, 2W, 4527	4527	WSR21L000FEA	Vishay-Dale		
R5, R8, R9, R104, R111, R116, R117	7	1.00Meg	RES, 1.00Meg ohm, 1%, 0.125W, 0805	0805	CRCW08051M00FKEA	Vishay-Dale		
R6, R87	2	0	RES, 0 ohm, 5%, 0.125W, 0805	0805	CRCW08050000Z0EA	Vishay-Dale		
R7, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31, R57, R58, R59, R63, R64, R65, R66, R67, R68	22	1.00k	RES, 1.00k ohm, 1%, 0.125W, 0805	0805	CRCW08051K00FKEA	Vishay-Dale		
R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R52, R53, R54, R55, R56	15	100	RES, 100 ohm, 1%, 0.25W, 1206	1206	CRCW1206100RFKEA	Vishay-Dale		
R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R48, R49, R69, R70, R71, R72, R73, R108, R112	19	10.0k	RES, 10.0k ohm, 1%, 0.125W, 0805	0805	CRCW080510K0FKEA	Vishay-Dale		
R42	1	499k	RES, 499k ohm, 1%, 0.125W, 0805	0805	CRCW0805499KFKEA	Vishay-Dale		
R43	1	3.01k	RES, 3.01k ohm, 1%, 0.125W, 0805	0805	CRCW08053K01FKEA	Vishay-Dale		
R75, R78, R101, R103, R107, R109	6	100k	RES, 100k ohm, 1%, 0.125W, 0805	0805	CRCW0805100KFKEA	Vishay-Dale		
R76, R124, R125, R126, R127, R128, R129, R130, R131, R132, R133, R134, R135, R136, R137, R138	16	200	RES, 200 ohm, 1%, 0.125W, 0805	0805	CRCW0805200RFKEA	Vishay-Dale		
R85	1	0	RES, 0 ohm, 5%, 0.25W, 1206	1206	CRCW12060000Z0EA	Vishay-Dale		
R94	1	300k	RES, 300k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-304-B-T5	Susumu Co Ltd		
R95, R97	2	100k	RES, 100k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-104-B-T5	Susumu Co Ltd		
R96, R102	2	7.68k	RES, 7.68k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-7681-B-T5	Susumu Co Ltd		
R105	1	5.6k	RES, 5.6k ohm, 5%, 1W, 2512	2512	ERJ-1TYJ562U	Panasonic		
R106	1	196k	RES, 196k ohm, 1%, 0.125W, 0805	0805	CRCW0805196KFKEA	Vishay-Dale		
R110, R122	2	49.9k	RES, 49.9k ohm, 1%, 0.125W, 0805	0805	CRCW080549K9FKEA	Vishay-Dale		
R120	1	221k	RES, 221k ohm, 1%, 0.125W, 0805	0805	CRCW0805221KFKEA	Vishay-Dale		
R121	1	698	RES, 698 ohm, 1%, 0.125W, 0805	0805	CRCW0805698RFKEA	Vishay-Dale		
RT1, RT2, RT3	3	10.0k ohm	Thermistor NTC, 10.0k ohm, 1%, Disc, 5x8.4 mm	Disc, 5x8.4 mm	103AT-2	SEMITEC Corporation		

Table 5. bq76940EVM Circuit Module Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	MFR	Alt. Part Number	Alt. MFR
S1, S2	2		Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	SW, SPST 6x6 mm	4-1437565-1	TE Connectivity		
S3	1		Switch, SPST 9Pos, Rocker, TH	9.65X8X24.9mm	76SB09ST	Grayhill		
S4	1		Switch, SPST 8Pos, Rocker, TH	9.65X8X22.4mm	76SB08ST	Grayhill		
SH-J6, SH-J7, SH-J11, SH-J12, SH-J14-3, SH-J14-5, SH-J14-7, SH-J14-9, SH-J15-5, SH-J16-3	10	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
TP3, TP4, TP5, TP6	4	Black	Test Point, TH, Multipurpose, Black	Keystone5011	5011	Keystone		
TP48, TP49, TP50	3	Yellow	Test Point, Multipurpose, Yellow, TH	Yellow Multipurpose Testpoint	5014	Keystone		
U1	1		µC-Controlled AFE Family for 5/10/15-Series Cell Lithium-Ion and Phosphate Battery Pack Applications, DBT0044A	DBT0044A	BQ7694000DBT	Texas Instruments		None
U2	1		CEDV Fuel Gauge and Battery Management Controller Companion to the bq769x0 AFE, DBT0030A	DBT0030A	BQ78350DBT	Texas Instruments		None
W1	1		Cable assembly, 4 pin	Assembly	CBL002	Texas Instruments	-	-
C20	0	470pF	CAP, CERM, 470pF, 50V, +/-10%, X7R, 0805	0805	08055C471KAT2A	AVX		
C38	0	3300pF	CAP, CERM, 3300pF, 25V, +/-10%, X7R, 0603	0603	GRM188R71E332KA01D	MuRata		
D5	0	600V	Diode, Ultrafast, 600V, 8A, TH	TO-220AC	MUR860G	ON Semiconductor		
D16, D17, D18, D19, D20, D21, D32, D33, D34, D35, D36	0	0.8V	Diode, Schottky, 30V, 0.2A, SOD-123	SOD-123	BAT54T1G	ON Semiconductor		
D37	0		Diode, Schottky, 30V, 0.2A, SOD-123	SOD-123	BAT54T1G	ON Semiconductor		
D38, D39, D40, D42	0		Diode, TVS, Uni, 30V, 600W, SMB	SMB	SMBJ30A-13-F	Diodes Inc.		
HS1, HS2, HS3, HS4	0		Heatsink, DDPAK/TO-263, SMT	Heatsink, DDPAk	573300D00010G	Aavid		
J10	0		Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	TSW-103-07-G-S	TSW-103-07-G-S	Samtec, Inc.		
J13	0		Header, TH, 100mil, 7x1, Gold plated, 230 mil above insulator	7x1 Header	TSW-107-07-G-S	Samtec		
J18, J19	0		Header, TH, 100mil, 5x1, Gold plated, 230 mil above insulator	TSW-105-07-G-S	TSW-105-07-G-S	Samtec, Inc.		
J20	0		Header, TH, 100mil, 6x1, Gold plated, 230 mil above insulator	TSW-106-07-G-S	TSW-106-07-G-S	Samtec, Inc.		
Q1, Q3	0	100V	MOSFET, N-CH, 100V, 18A, DDPAK	DDPAK	AOB290L	AOS		None
Q21	0	0.7V	Transistor, NPN, 65V, 0.1A, SOT-23	SOT-23	BC846BLT1G	ON Semiconductor	None	None
R1, R50, R51, R123	0	0	RES, 0 ohm, 5%, 0.125W, 0805	0805	CRCW08050000Z0EA	Vishay-Dale		
R74	0	100k	RES, 100k ohm, 1%, 0.125W, 0805	0805	CRCW0805100KFKEA	Vishay-Dale		
R77	0	200	RES, 200 ohm, 1%, 0.125W, 0805	0805	CRCW0805200RFKEA	Vishay-Dale		
R80, R81, R98, R99, R113	0	1.00k	RES, 1.00k ohm, 1%, 0.125W, 0805	0805	CRCW08051K00FKEA	Vishay-Dale		
R84	0	300k	RES, 300k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-304-B-T5	Susumu Co Ltd		
R86	0	0	RES, 0 ohm, 5%, 0.25W, 1206	1206	CRCW12060000Z0EA	Vishay-Dale		
R88, R93	0	100k	RES, 100k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-104-B-T5	Susumu Co Ltd		
R91, R92, R100	0	1.00Meg	RES, 1.00Meg ohm, 1%, 0.125W, 0805	0805	CRCW08051M00FKEA	Vishay-Dale		
TP1	0	Black	Test Point, TH, Multipurpose, Black	Keystone5011	5011	Keystone		
TP2, TP14	0	Red	Test Point, TH, Multipurpose, Red	Keystone5010	5010	Keystone		

Table 5. bq76940EVM Circuit Module Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	MFR	Alt. Part Number	Alt. MFR
TP7, TP8, TP10, TP11, TP13, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP35, TP36, TP40, TP41, TP42, TP43, TP44, TP45, TP52, TP56, TP57, TP58, TP60	0	White	Test Point, TH, Multipurpose, White	Keystone5012	5012	Keystone		
	Notes:							
	Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.							

7.3.3 bq76940EVM Schematic

Figure 33 through Figure 37 illustrate the bq76940EVM schematic.

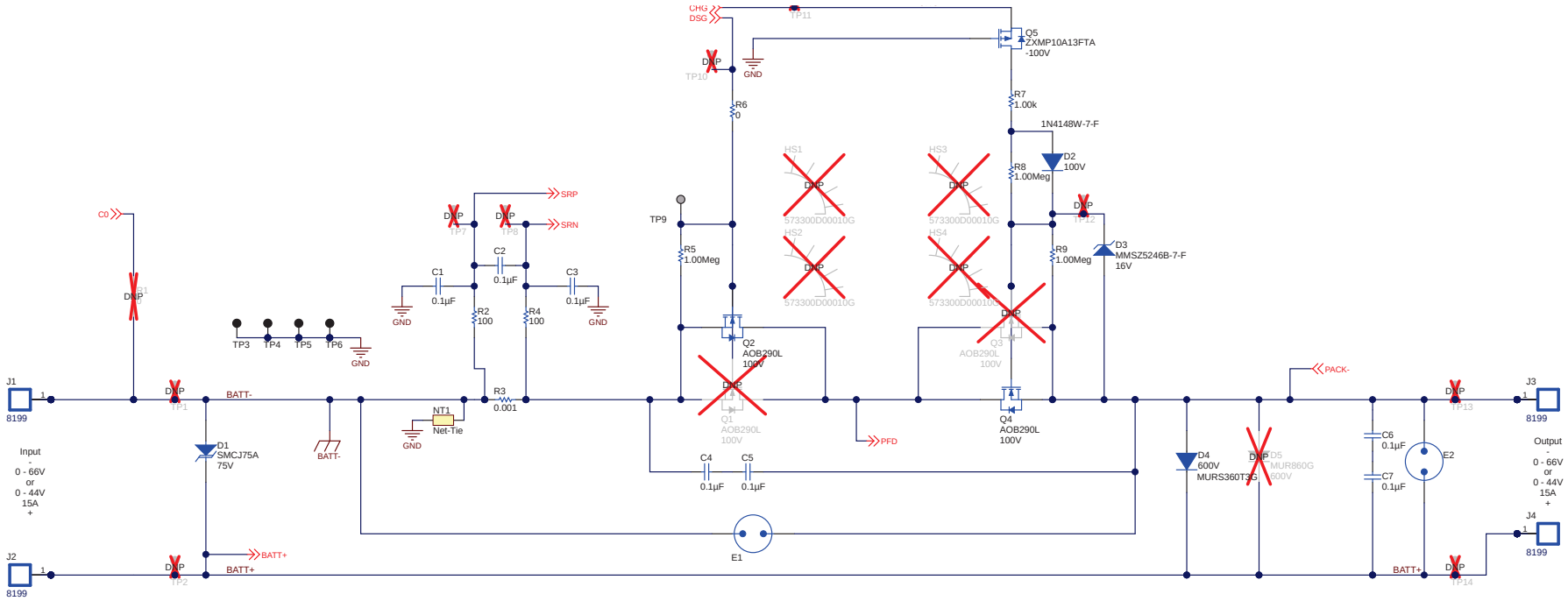

Figure 33. bq76940EVM Schematic Diagram FETs

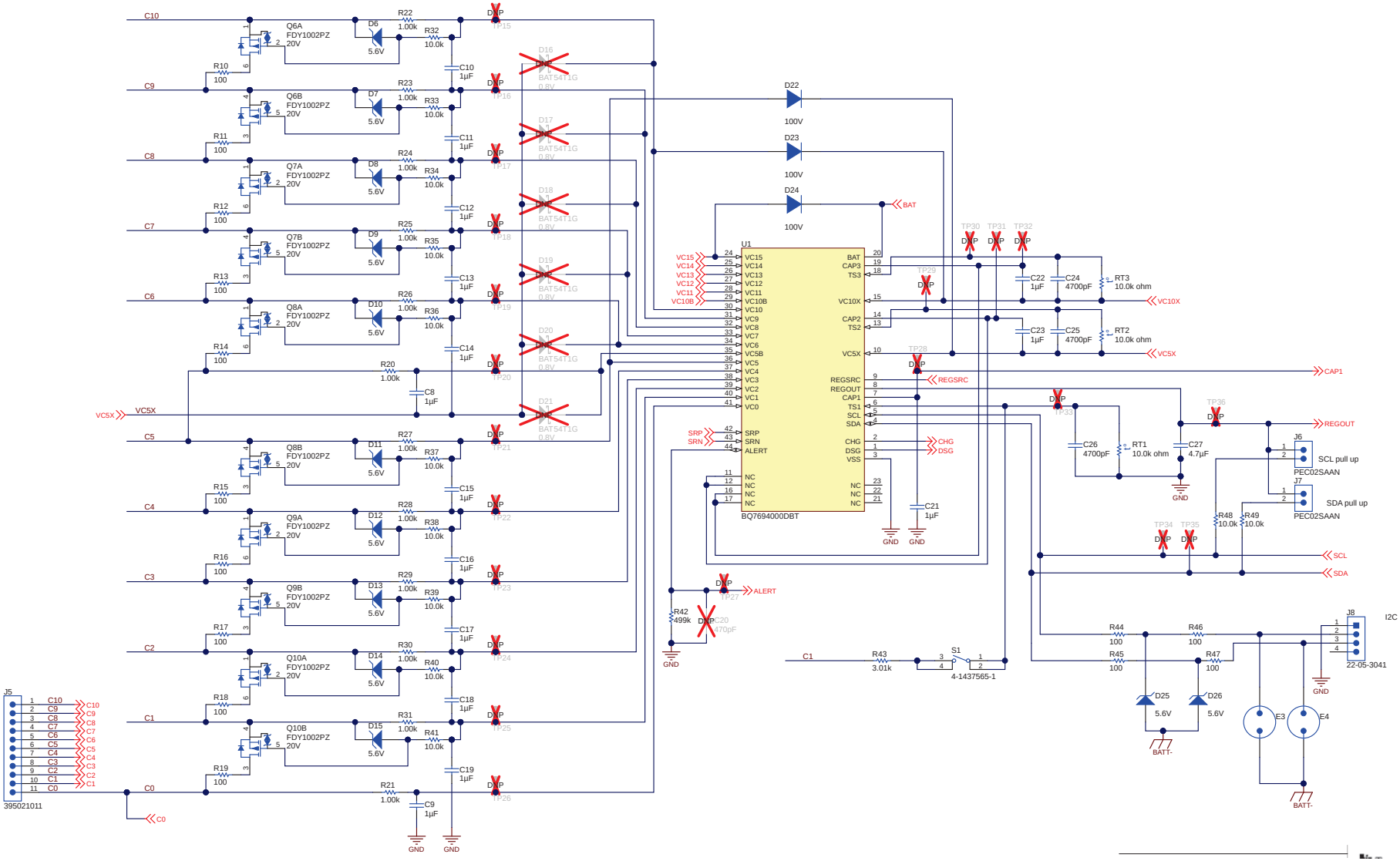

Figure 34. bq76940EVM Schematic Diagram AFE1

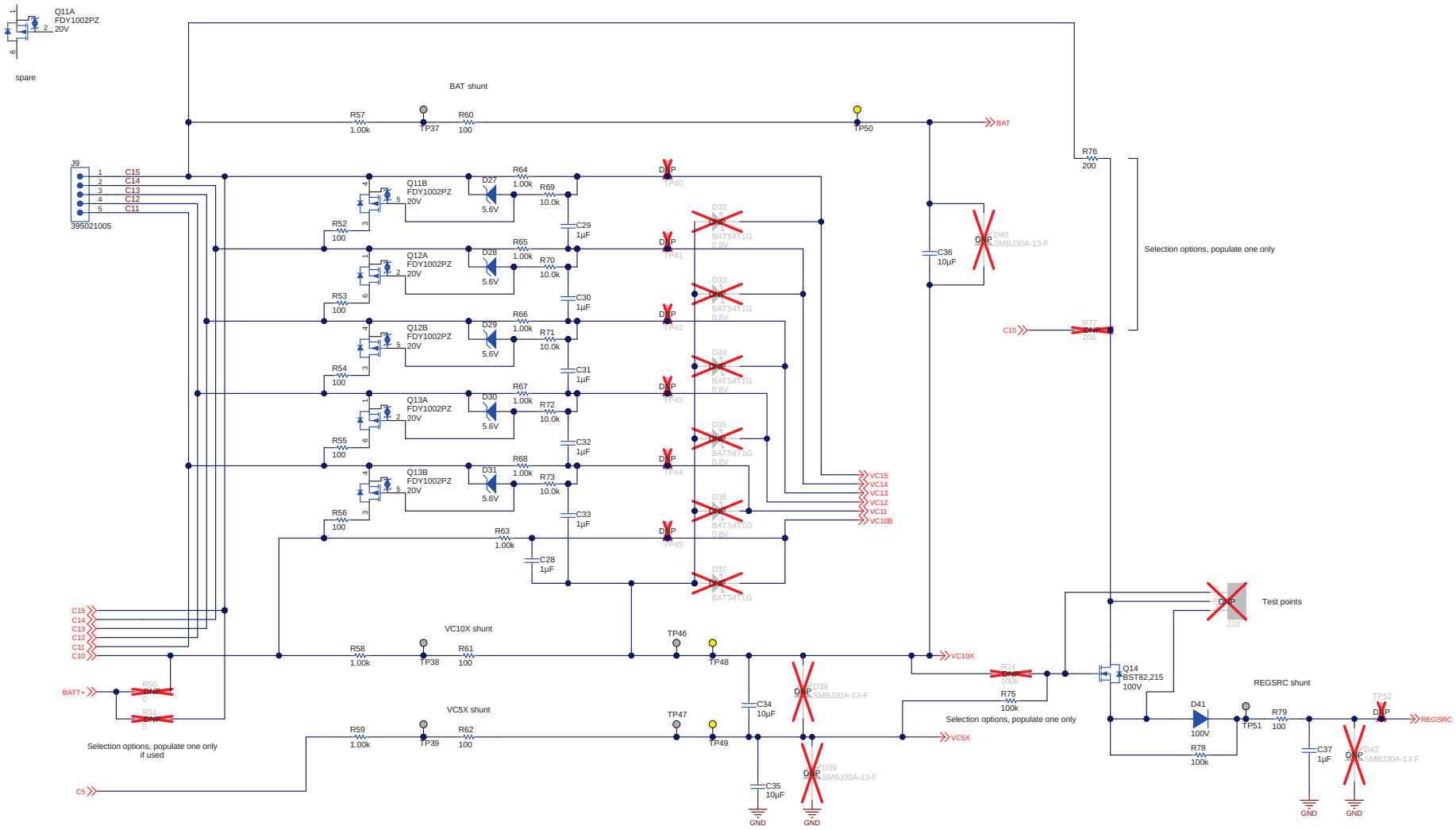

Figure 35. bq76940EVM Schematic Diagram AFE2

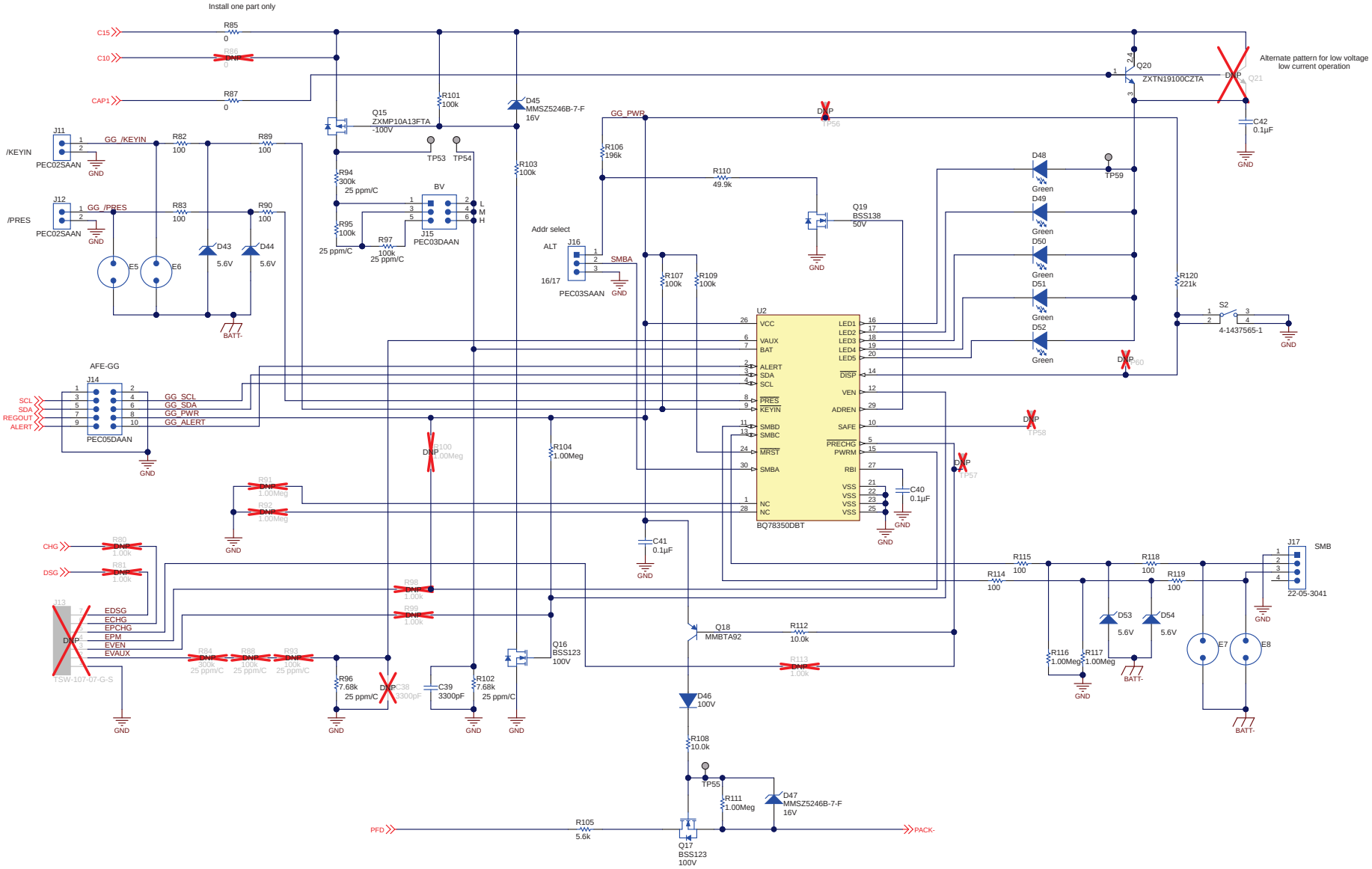

Figure 36. bq76940EVM Schematic Diagram Gauge

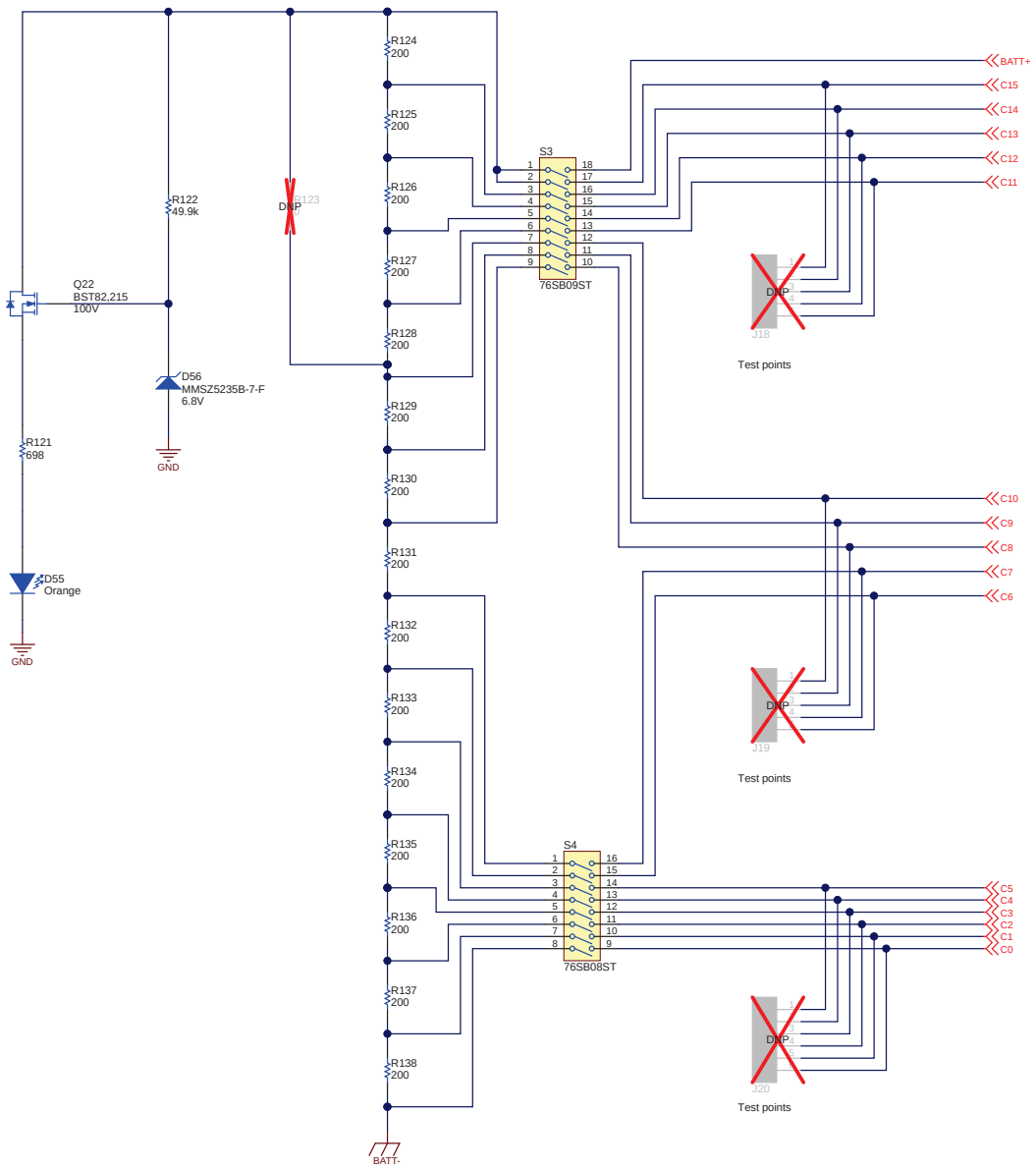

Figure 37. bq76940EVM Schematic Diagram Cell Simulator

8 Related Documents From Texas Instruments

Document	Literature Number
bq76920, bq76930, bq76940 µC-Controlled AFE Family for 5/10/15-Series Cell Li-Ion and Phosphate Battery Pack Applications Data Sheet	SLUSBK2
bq78350 CEDV Li-Ion Gas Gauge and Battery Management Controller Companion Data Sheet	SLUSB48
bq78350 Technical Reference Manual	SLUUAN7

Revision History

Changes from Original (April 2014) to A Revision **Page**

- Changed software title to *bq76940/bq76930/bq76920 Evaluation Software* in step one of the *Quick Start* section and globally throughout document. 8
- Changed *EVM Connection for Basic Gauge Operation* image. 11
- Changed path name to ...'\bq76940' in second paragraph of *Interface Adapter* section. 11
- Added clarification about device identifiers in menus or windows in the *bq76940/bq76930/bq76920 Software* section. 11
- Added sentence about how to start the software in the *Software Operation* section. 12
- Changed Evaluation Software Display image. 13
- Added *Sequence_Example.bqseq* to paragraph below *Sequence View* image. 17
- Changed content in the BOM in rows containing U1 and U2 in the Designator column. 40
- Changed content in the BOM in rows containing U1 and U2 in the Designator column. 51

Revision History

Changes from A Revision (April 2014) to B Revision **Page**

- Changed Abstract with the following: (1) 3rd sentence to encompass bq78350 use, (2) "Li-Polymer" to "Phosphate", (3) reference in last sentence to "device" to accommodate both AFE or gauge settings. 6
- Changed 'Li-Ion and Li-Polymer' to 'Li-Ion and Phosphate' in the first *Features* bullet. 6
- Changed "5-cell parallel FET" to "10- or 15-cell" in first sentence of the *bq769x0 Circuit Module Performance Specification Summary* section. 6
- Added 'for the AFE, 2.5 A for the gauge' to first bullet in *Required Equipment* section. 7
- Deleted bullet containing 'TI bq76940/bq76930/bq76920 Evaluation Software' in *Required Equipment* section. 7
- Added 'calibrated load or load with accurate current meter required for gauge evaluation' to sixth bullet in *Required Equipment* section. 7
- Added *Quick Start* section with introduction and moved *AFE Quick Start* to *Quick Start* subsection. 8
- Changed step 1 in *AFE Quick Start* section, moved install instruction from step 1 to step 2. 8
- Added AFE to *EVM Connection for Basic AFE Operation* figure caption. 9
- Added *Gauge Quick Start* section. 9
- Changed *Interface Adapter* section to a main heading and changed content of section. 11
- Changed *bq76940/bq76930/bq76920 Software* section to a new heading number and added clarification in first paragraph. 11
- Added *Interface Adapter* section with bq769x0-specific instructions. 12
- Added *Battery Management Studio Software* section. 18
- Added sentence to end of *Evaluating with Simulated Current* section. 28
- Added paragraph to end of *Reducing the Cell Count* section. 29
- Changed first sentence of *Connecting to a Host* section. 30
- Changed entire content of *Gauge Circuits* section. 30
- Added 3 paragraphs at the end of *Unused Components* section to describe unused gauge components. 30
- Added documents to the Related Documents section. 59

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