bq76920 Evaluation Module User's Guide

The bq76920EVM evaluation module (EVM) is a complete evaluation system for the bq76920, a 3-cell to 5-cell Li-Ion battery analog front end (AFE) integrated circuit. The EVM consists of a bq76920 circuit module which is used for simple evaluation of the bq76920 AFE and bq78350 gauge functions. The circuit module includes one bq76920 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 5-series cell Li-Ion or Li-Polymer 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.

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- Complete evaluation system for the bq76920 3-cell to 5-cell Li-Ion and Phosphate battery AFE
- Populated circuit module for 5-cell configuration for quick setup
- Power connections available on banana jacks
- 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

- bq76920 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
bq76920EVM	Li-Ion	5 cells	Any

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

1.3 bq76920 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq76920 circuit module in its default 5-cell series FET 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–	6	–	25	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 bq76920 EVM in a simple demonstration:

- DC power supply, 0–25 V 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 bq76920 with a more extensive demonstration.

2 bq76920 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 The bq76920EVM circuit module may become hot during operation due to dissipation of heat. Avoid contact with the board. Follow all applicable safety procedures applicable to your laboratory.

Caution Do not leave the EVM powered when unattended.

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 over temperature. 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 is 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 bq76920 EVM to demonstrate operation of the AFE portion of the EVM. For more detailed descriptions, 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/bq76920EVM or search from www.ti.com.

2. Install the bq76940/bq76930/bq76920 evaluation software (see Section 4). 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 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 18 V.
9. Press and release the *BOOT* switch.
10. Start the bq769X0 evaluation software. The 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 18 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.

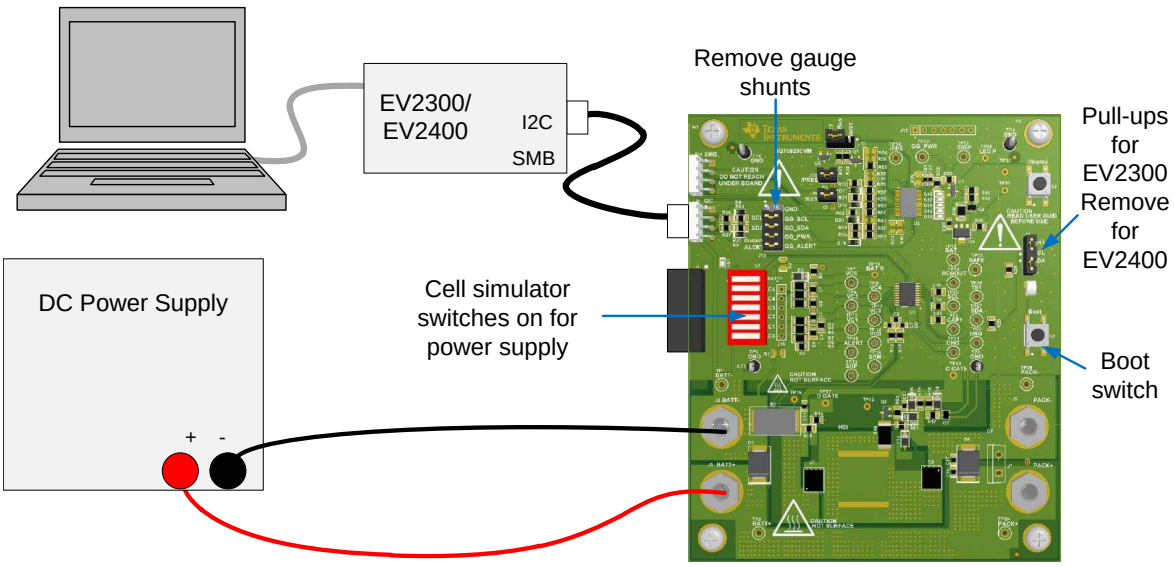

Figure 1. EVM Connection for Basic AFE Operation

2.2.2 Gauge Quick Start

These steps describe quick connection of the bq76920 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 J12 header connecting the AFE to the gauge: GG_SCL, GG_SDA, GG_PWR and GG_ALERT.
5. Install shunts on the SCL and SDA pull-up headers.
6. Install shunts on the /KEY, /PRES and 16/17 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 15 (3V/cell) V.
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 0x001F 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.

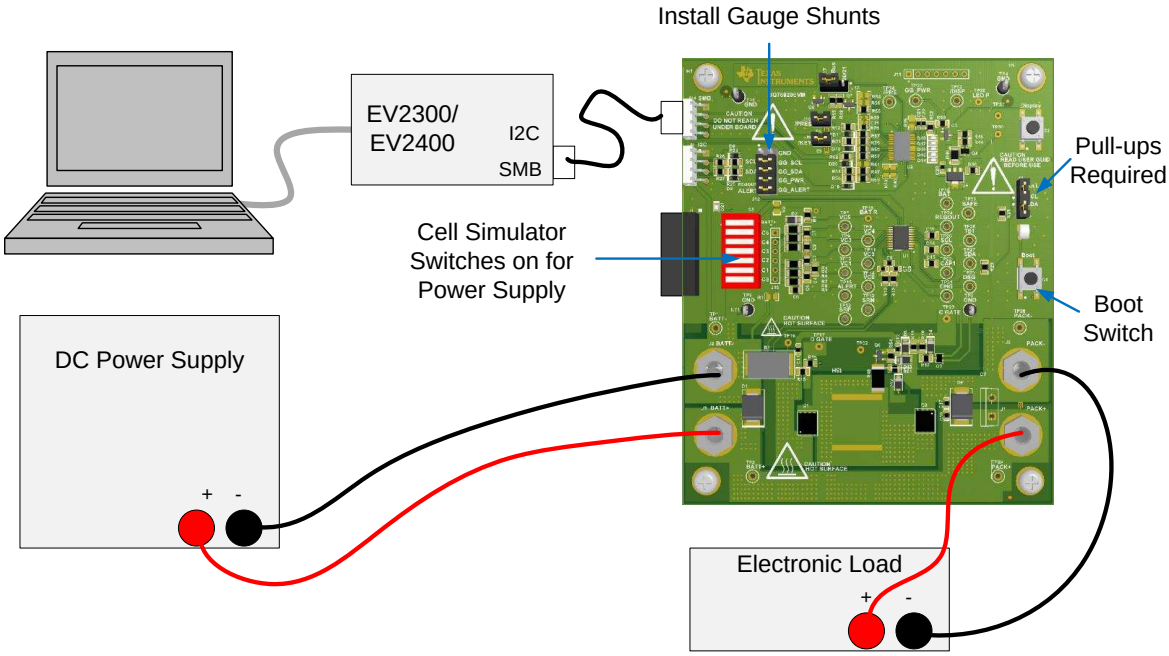

Figure 2. EVM Connection for Basic Gauge Operation

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 bq76940 software installation package and are 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. Install the drivers by following these steps:

1. Navigate to the directory with the drivers.
2. Run the file *EV2300....exe* file

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 bq76920 AFE I^2C communication. This software is intended to demonstrate register control and operation of the bq769x0 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 software provides 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 a Windows 7, or later operating system. The computer must also have Microsoft® .NET connection software version 4.0, or higher, installed. The 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/bq76920EVM 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. TI recommends installing the software in the default location.
3. On the last window, select **Close** to complete the bq76940/bq76930/bq76920 software installation.

4.3 Interface Adapter

The interface adapter I2C connector should be connected to the I2C connector for use with the bq76940 software. Board pull-up shunts must be installed for the EV2300 and removed for the EV2400. The interface adapter should not be connected to the I2C connector if a gauge or MCU is connected to the bus.

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, it is recommended to have 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.

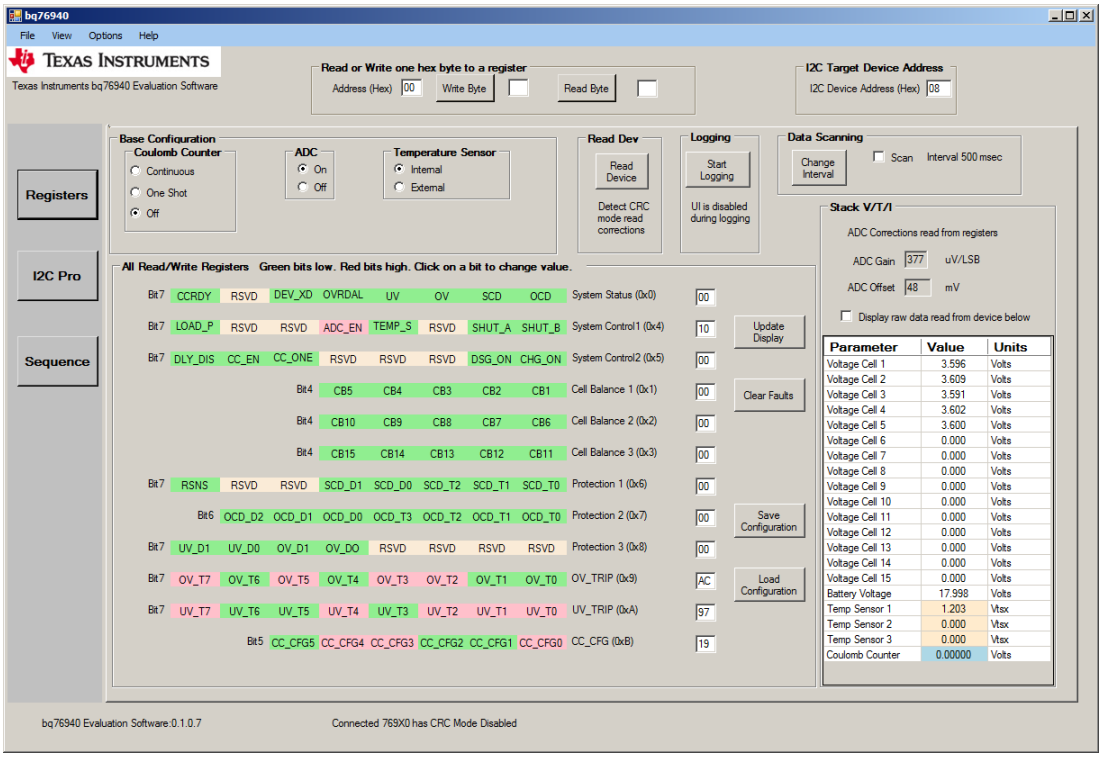

Figure 3. bq76940/bq76930/bq76920 Evaluation Software Display

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 restart 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.

Exit the program with the File menu.

4.4.4 Registers View

The registers view is the default display in the middle of the window when the software is started, see Figure 4. It shows the control register values. If another view is displayed it is 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 **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 the 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

Figure 5 shows the I2C Pro view of the GUI. 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.

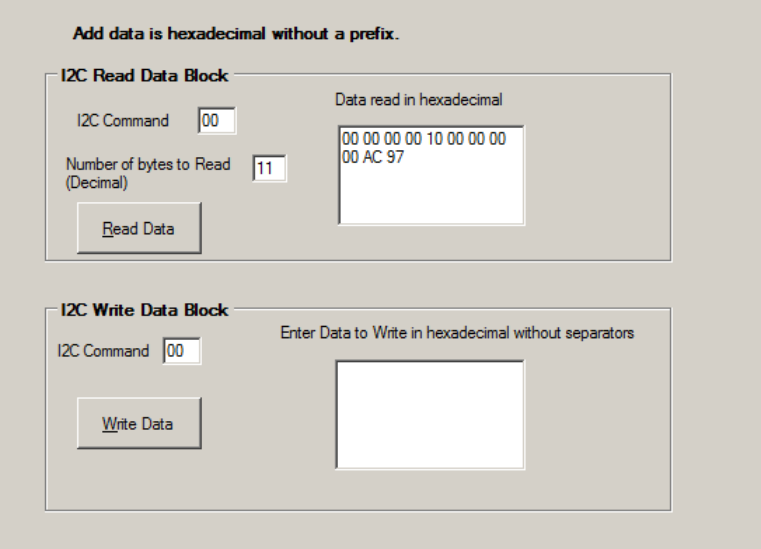

Figure 5. I2C Pro View

4.4.6 Sequence View

Figure 6 illustrates the Sequence view of the GUI. 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 is run by selecting its **Execute** button. The results of the sequence are shown in the Sequence Dialog section. Edit the sequence by selecting the file name under the sequence name in the window.

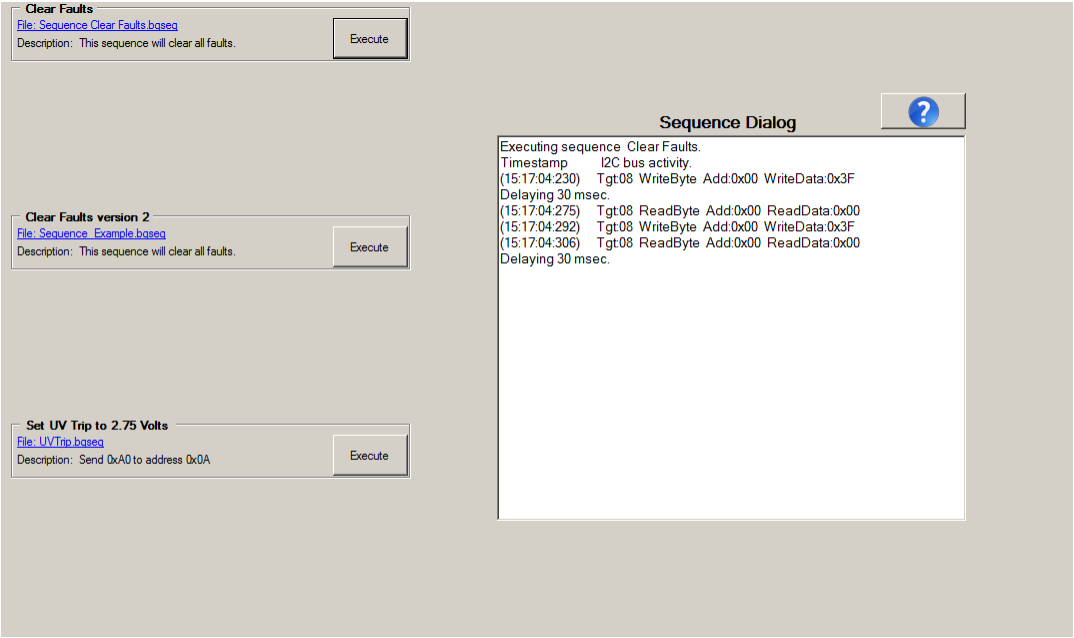

Figure 6. Sequence View

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 and 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 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 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?* 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.

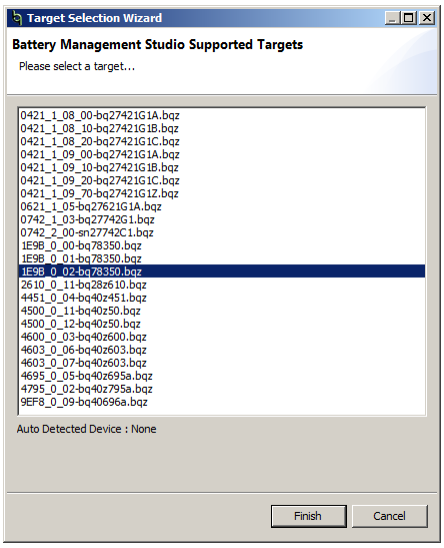

Figure 7. Target Selection Wizard

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.

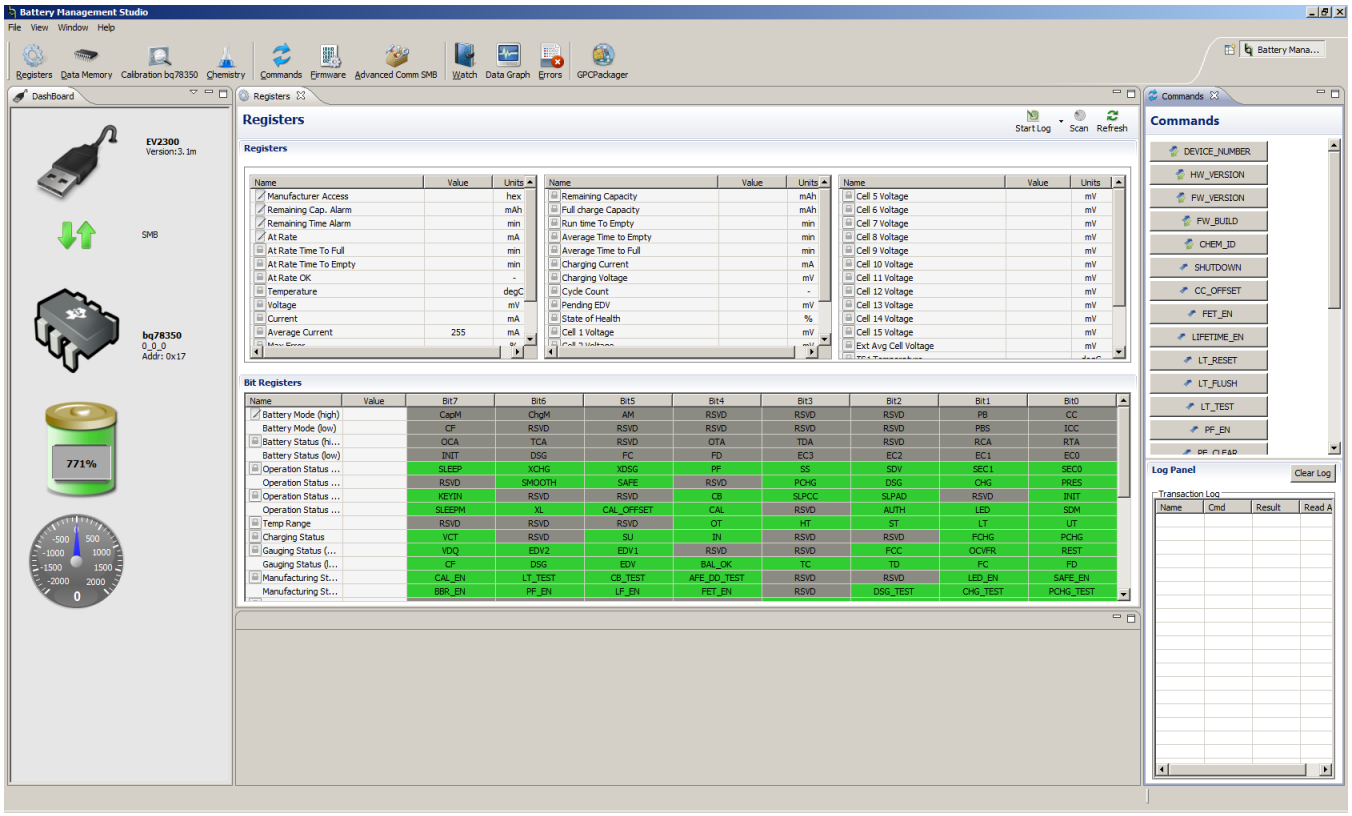

Figure 8. bqStudio Window with Blank Gauge

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 40 s.

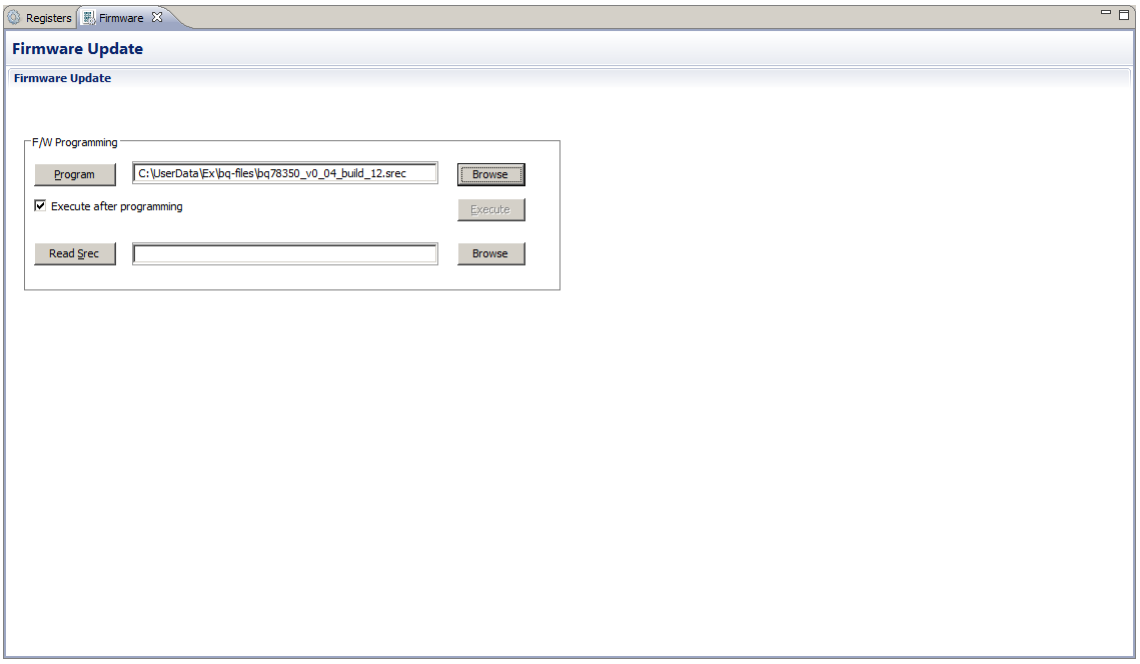

Figure 9. Firmware View

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.

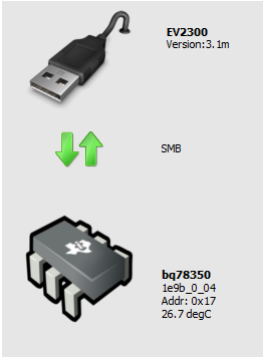

Figure 10. Dashboard Adapter and Device Version Display

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.

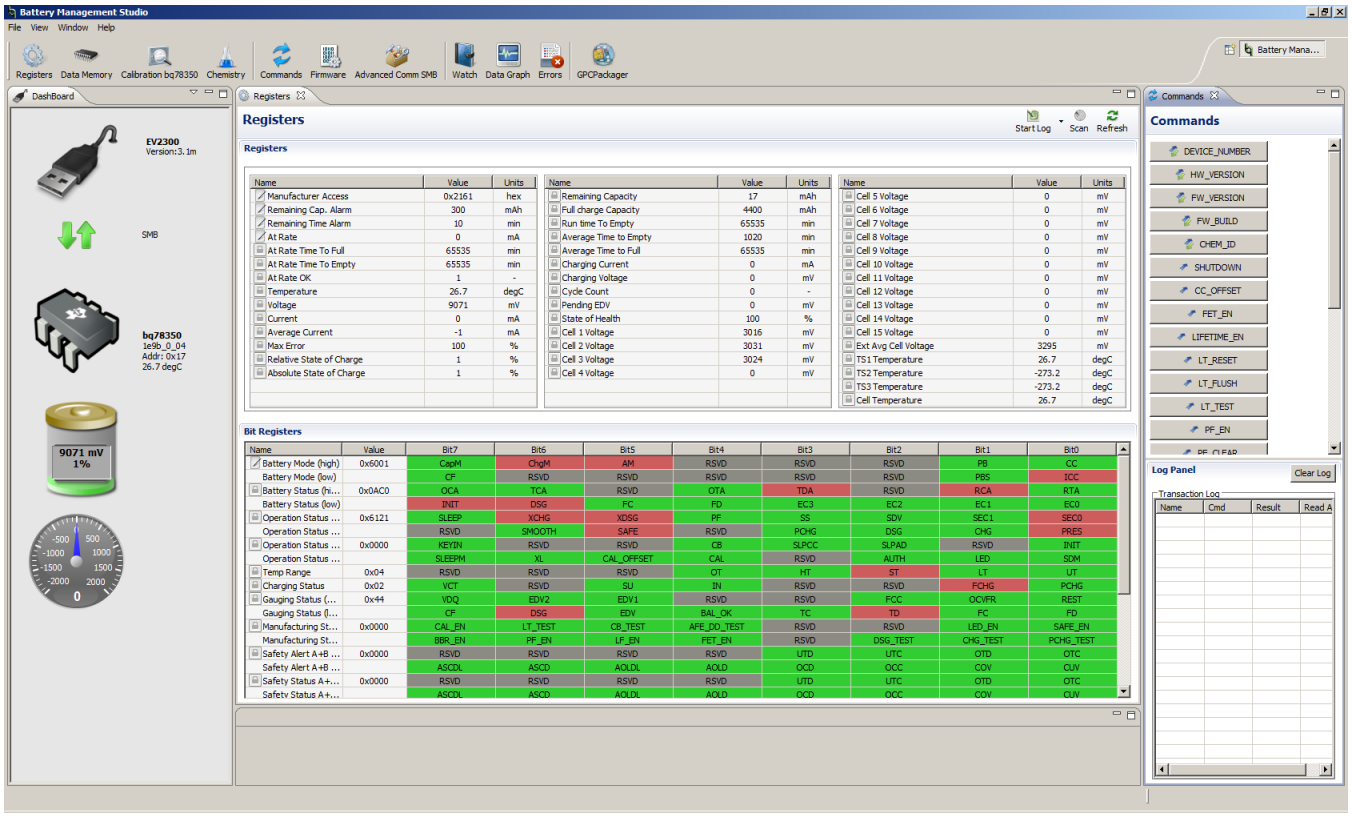

Figure 11. Register View After Restart

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.

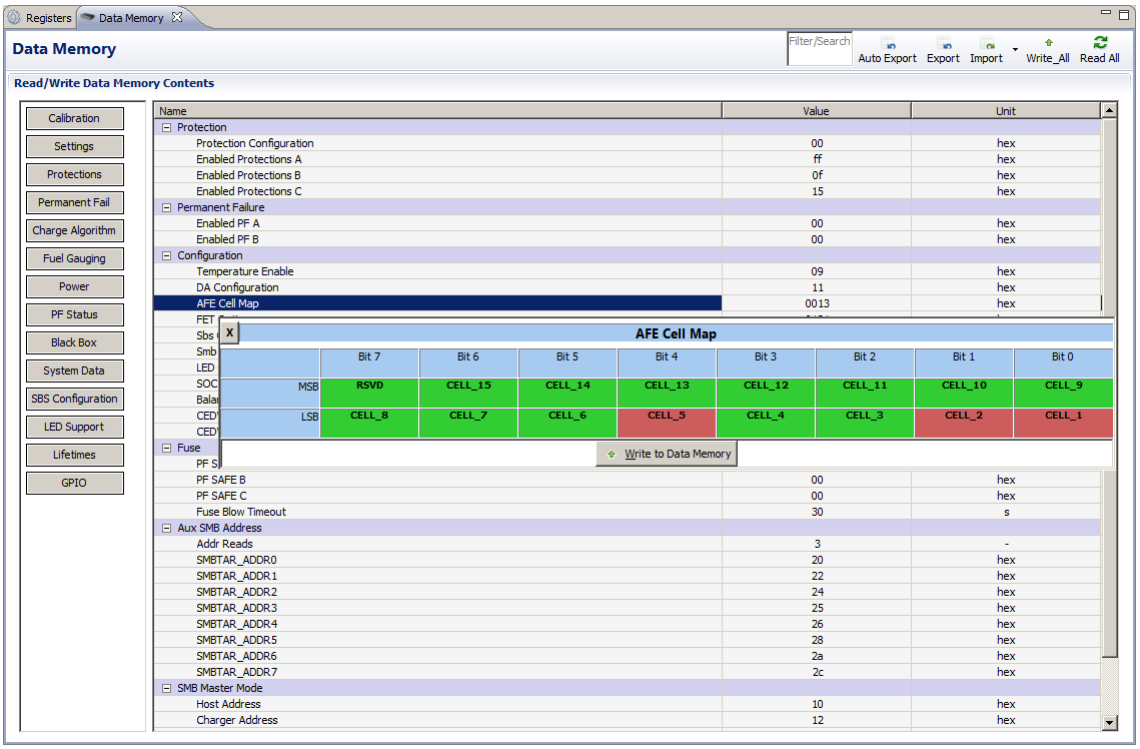

Figure 12. Data Memory Bit Field change

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.

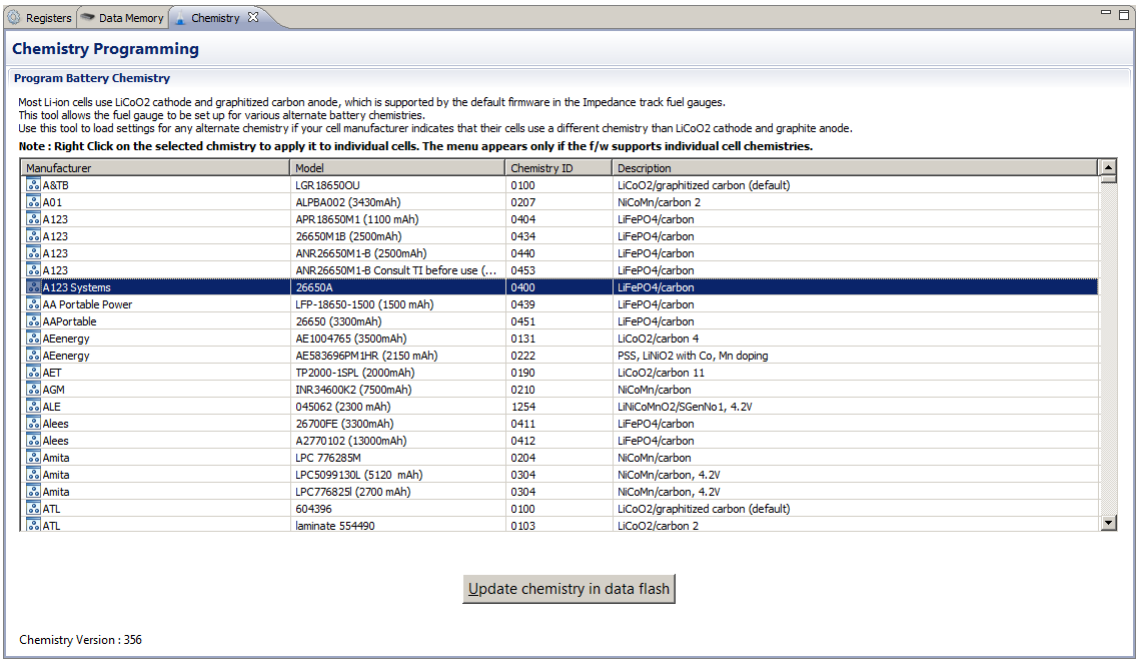

Figure 13. Chemistry View

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.

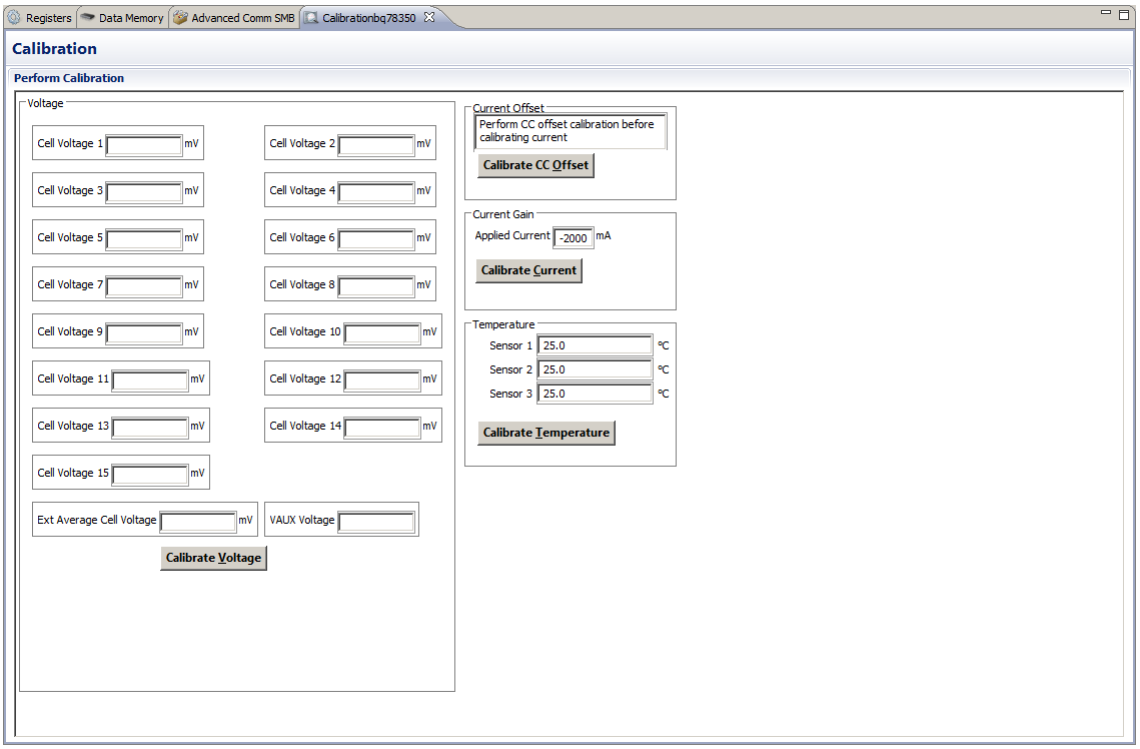

Figure 14. Calibration View

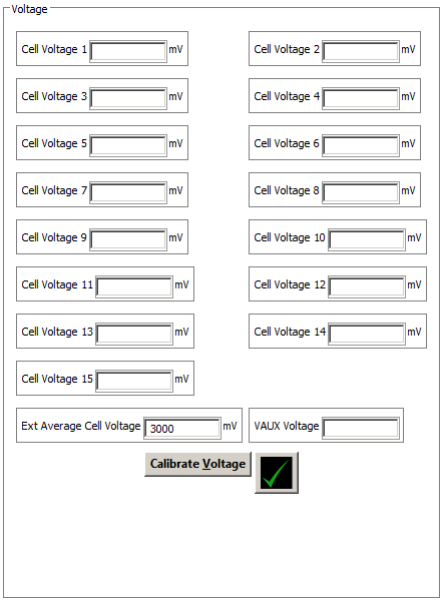

Figure 15. Example Voltage Calibration Successful

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.

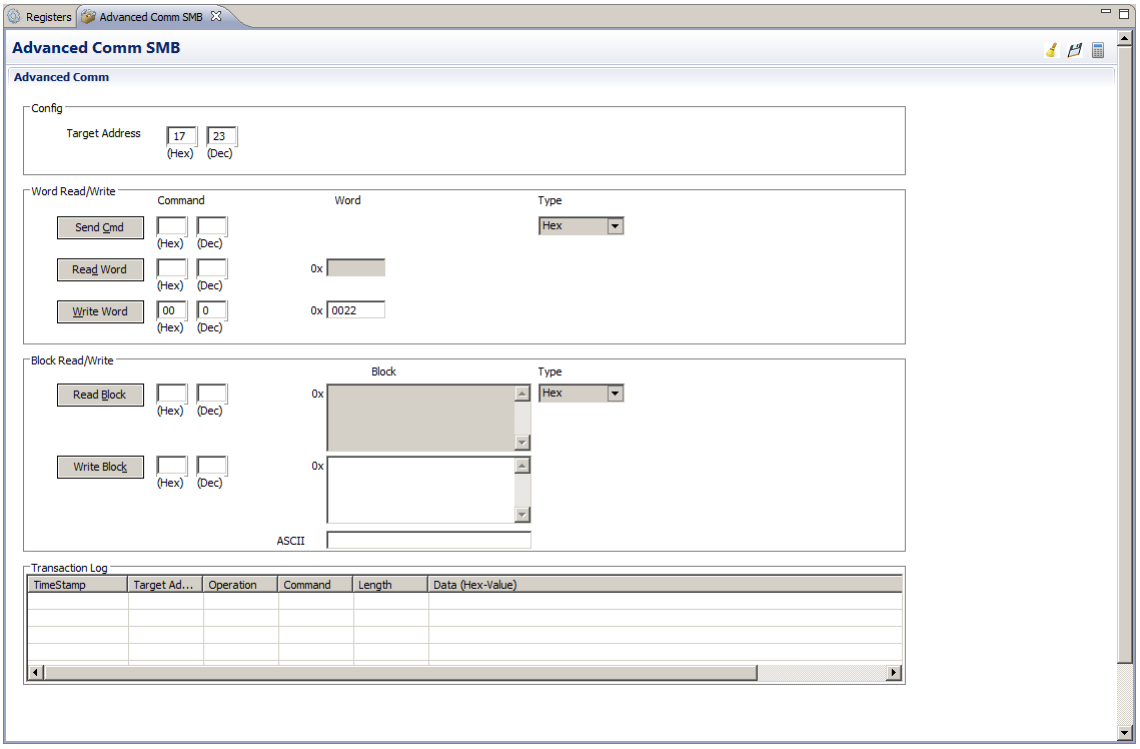

Figure 16. Advanced Comm SMB View

6 bq76920 Circuit Module Use

The bq76920 circuit module contains the bq76920 IC and related circuitry to demonstrate the features of the IC. Surface mount FETs are provided for the high current path. A thermistor provides temperature sensing on the board. 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.

6.1 Cell Simulator

The EVM includes a resistive cell simulator made up of 200-Ω series resistors. The top section of the S3 switch 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 and may become warm during operation. The orange LED near the dip switch indicates the cell simulator has power.

6.2 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. Figure 17 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 simulation supply should never be reversed. The diagram shows communication connection for AFE evaluation, the technique will also work for gauge evaluation with appropriate communication connection.

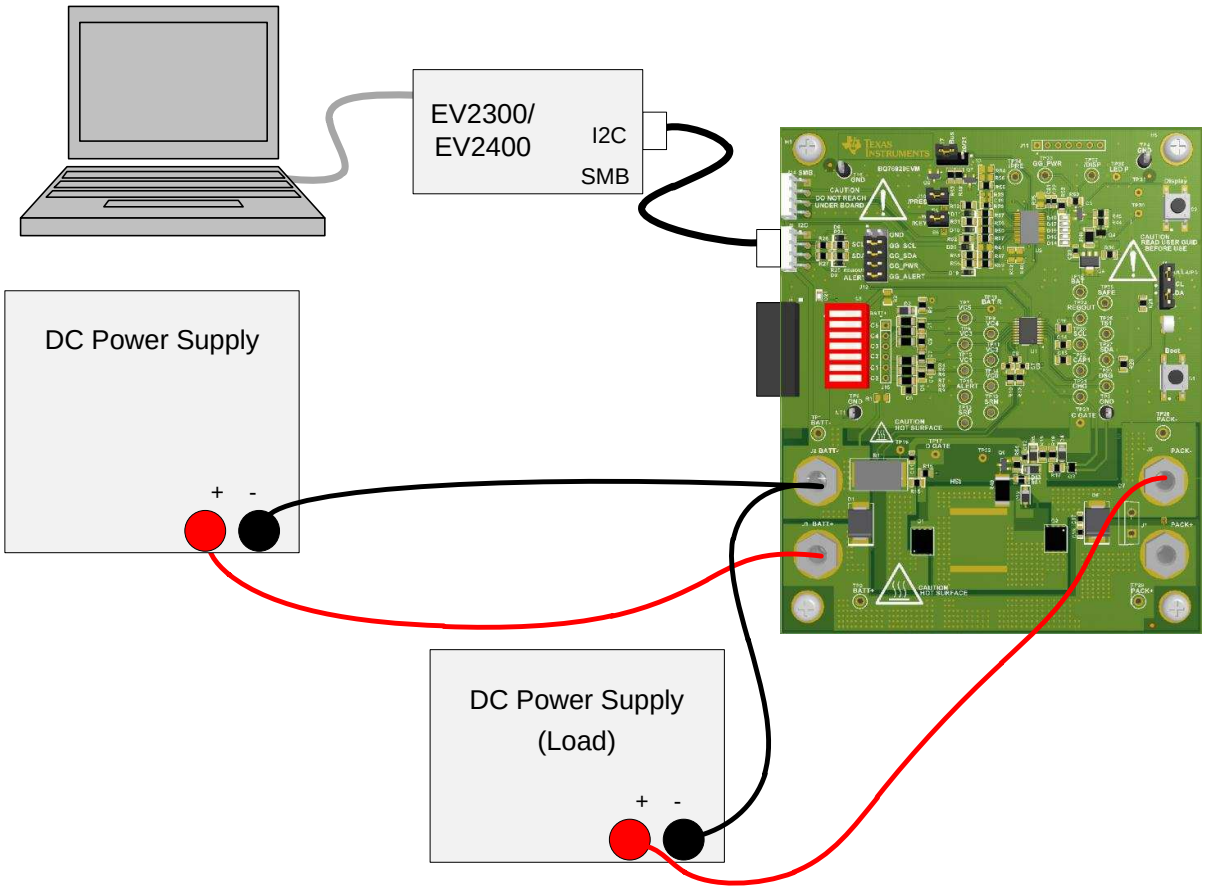

Figure 17. Simulating Current Setup

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.

6.3 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 cells, but can have some side effects in transient tests because it parallels the shorted resistors to the cell 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 input resistor. When using the cell simulator, shorting the unused cell resistor 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 re-used for a different cell count.

Table 3. Reducing Cell Count

Unused Cell (Numbered from Bottom Cell 1)	Short Cell Terminals	Input Resistor to Remove	Short AFE Inputs
Cell 4	C4 to C3	R5	VC4 to VC3
Cell 3	C3 to C2	R6	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.

6.4 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 sense connections from the cells to the board, populate R1 and R2. The bottom cell simulator switch can be 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 will be discharged by the constant drain of the cell simulator. If the orange LED is 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:

1. Connect BATT– or the node which connects VSS of the AFE, if separate
2. Mate the connector
3. Connect the BATT+. if separate
4. 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 on the board by closing the C0 dip switch during cell connection can reduce stress on the VC0 input of the AFE. Open the switch after cell connection for sensing at the cell.

6.5 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. J12 could be used to connect to the microcontroller board. No voltages should be applied to the gauge terminals. Alternately, the microcontroller is 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.

6.6 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 /KEY and /PRES headers to simulate control of these signals. An alternate SMBus address may be selected using the SMBus header. Refer to the bq78350 TRM for details and configuration selections for these device features.

6.7 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 could be soldered to provide probing, if desired.

Normally the power filter R14 and C13 keeps the supply voltage for the AFE in a safe operating range. For situations with large transients, D3 provides a clamp for the supply voltage to the AFE, if needed. The pattern is large and it is easy to fit other component sizes. Be aware that if the system transients are large enough that a clamp is needed at D3, the cell inputs should also be inspected for excessive voltages and an improved filter or clamp be added there, if needed.

The ALERT line switches 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 C10 is available. C10 should not be large in order to avoid current and slowing the edge to where the bq76920 would see the ALERT high as an input and set the OVRD_ALERT condition.

When the charge FET turns on with a large charger voltage present, a large voltage could be impressed on the gate of the charge FET. With the voltages typically used on the bq76920EVM, this should not be high enough to damage the charge FET. If special circumstances require, the D5 pattern is available for a clamp diode.

D6 is a flyback diode to prevent PACK- from rising significantly above PACK+. The D7 pattern provides a place to mount a higher current diode or other transient suppression component.

HS1 is a position to mount a suitable heatsink, if needed. Other heatsink options may be available in the evaluation environment.

R34 and R35 provide options to pull down unused signals. Connect as recommended in the datasheet for the bq78350 used.

J11, C19, R28, R29, R33, R40, R41, R42, and R56 provide component patterns to optinally bring signals to a convenient location for evaluating the behavior of the bq78350 with a high side switch configuration.

7 bq76920EVM Circuit Module Physical Construction

This section contains the PCB layout, bill of materials, and schematic of the bq76920EVM circuit module.

The bq76920EVM consists of one circuit module assembly, PWR523.

7.1 Board Layout

The bq76920EVM circuit module is a 4.0-inch × 4.805-inch 4-layer circuit card assembly. It is designed for easy assembly with cell connections on the left side to a terminal block and high current terminals through banana jacks. Control connections are on the left top. Pack terminals are on the right side using banana jacks. Wide trace areas are used reducing 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 25 show the board layout.

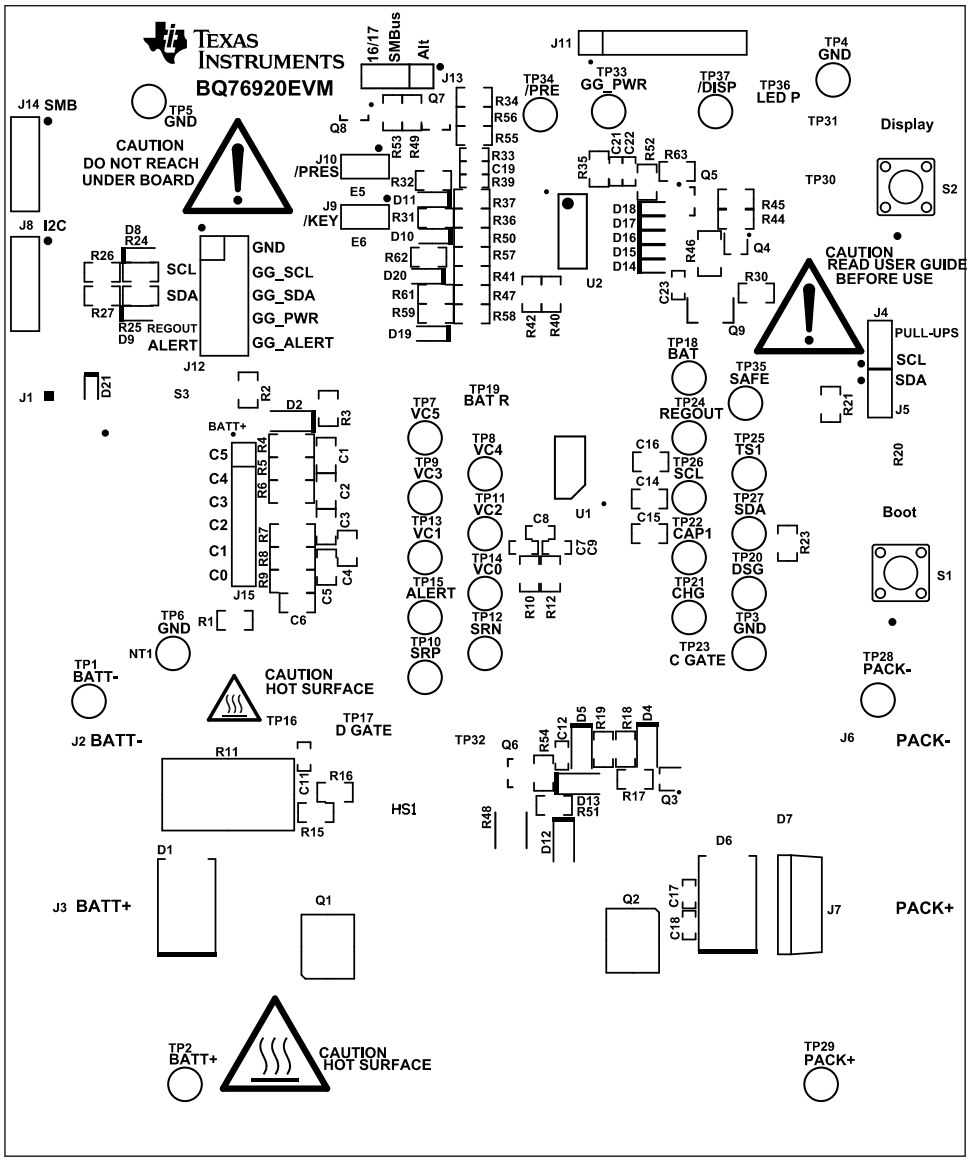

Figure 18. Top Silk Screen

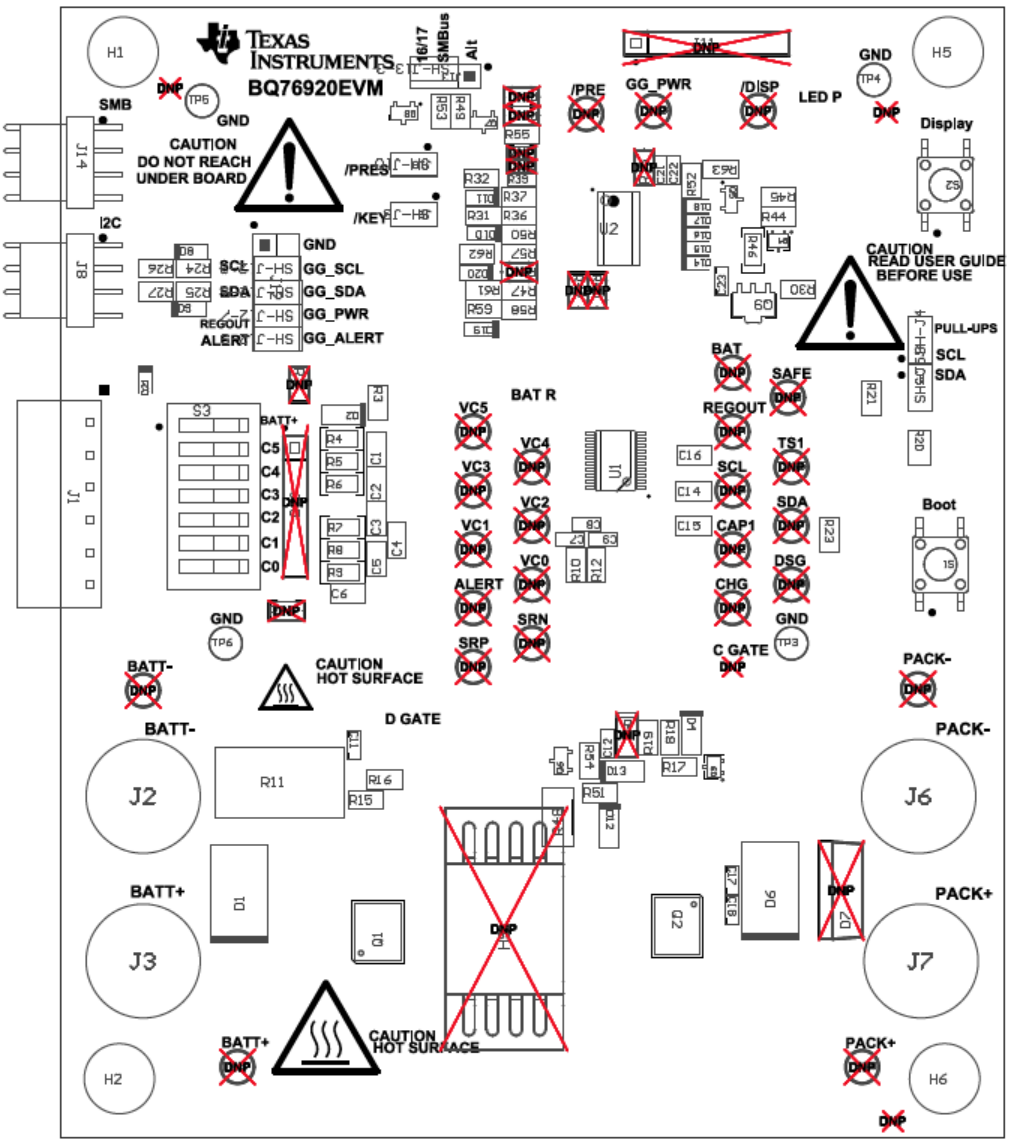

Figure 19. Top Assembly

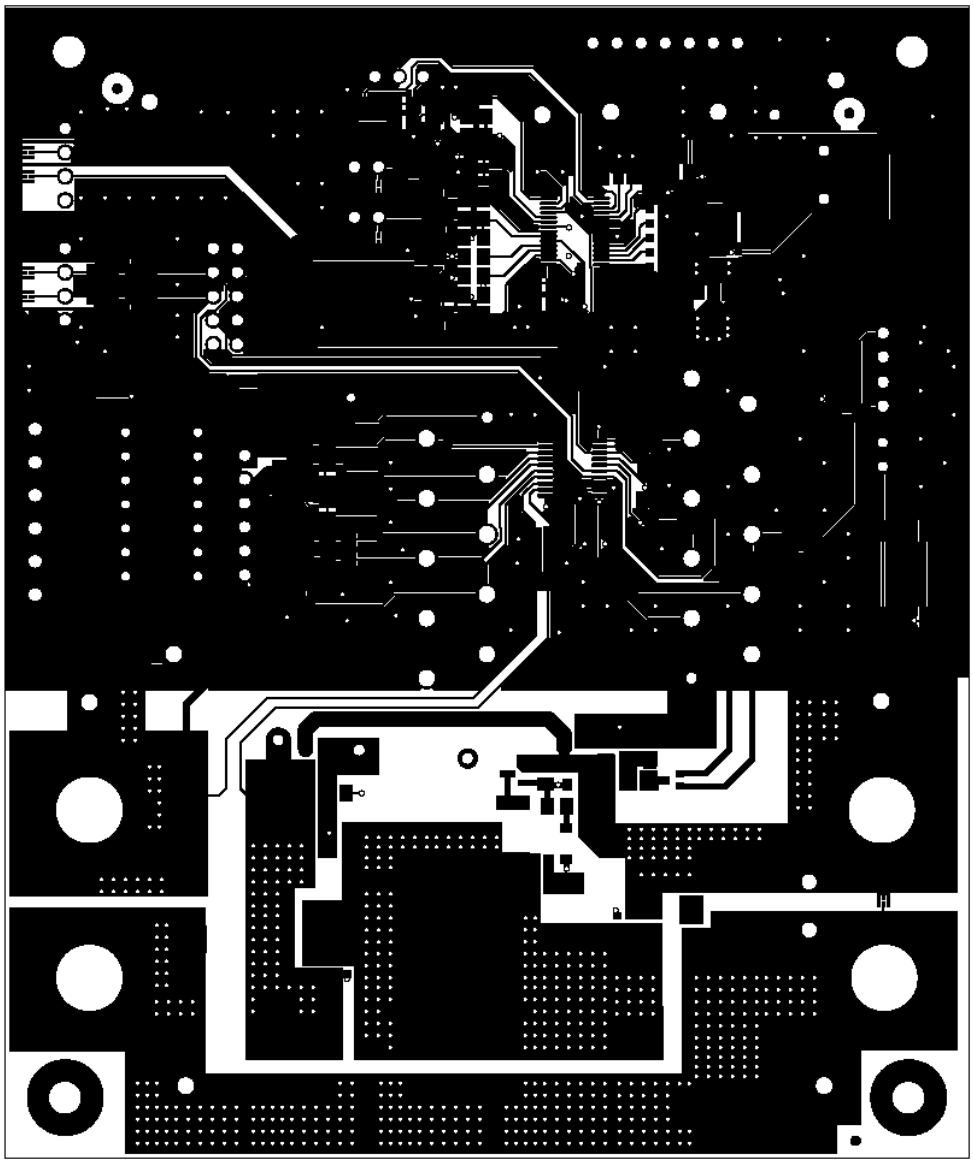

Figure 20. Top Layer

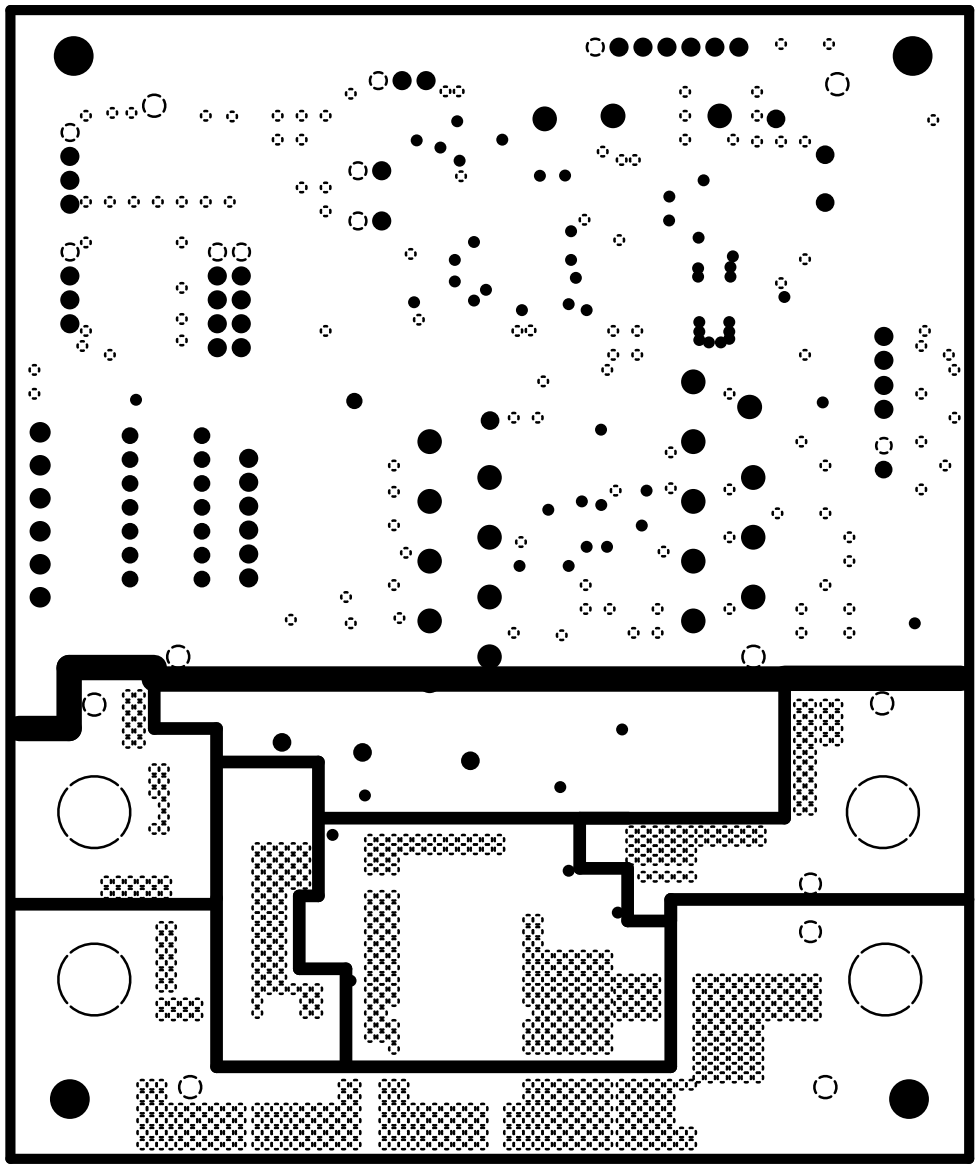

Figure 21. Layer 2

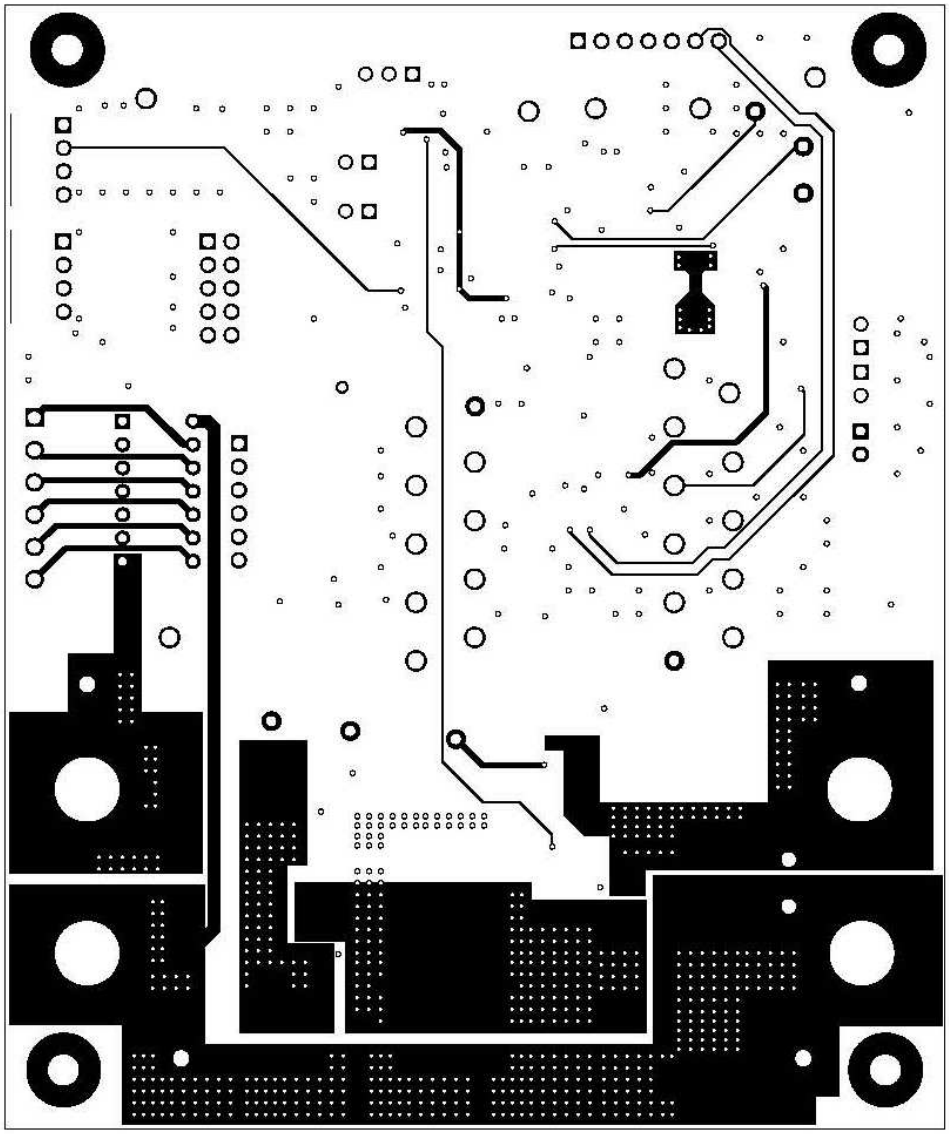

Figure 22. Layer 3

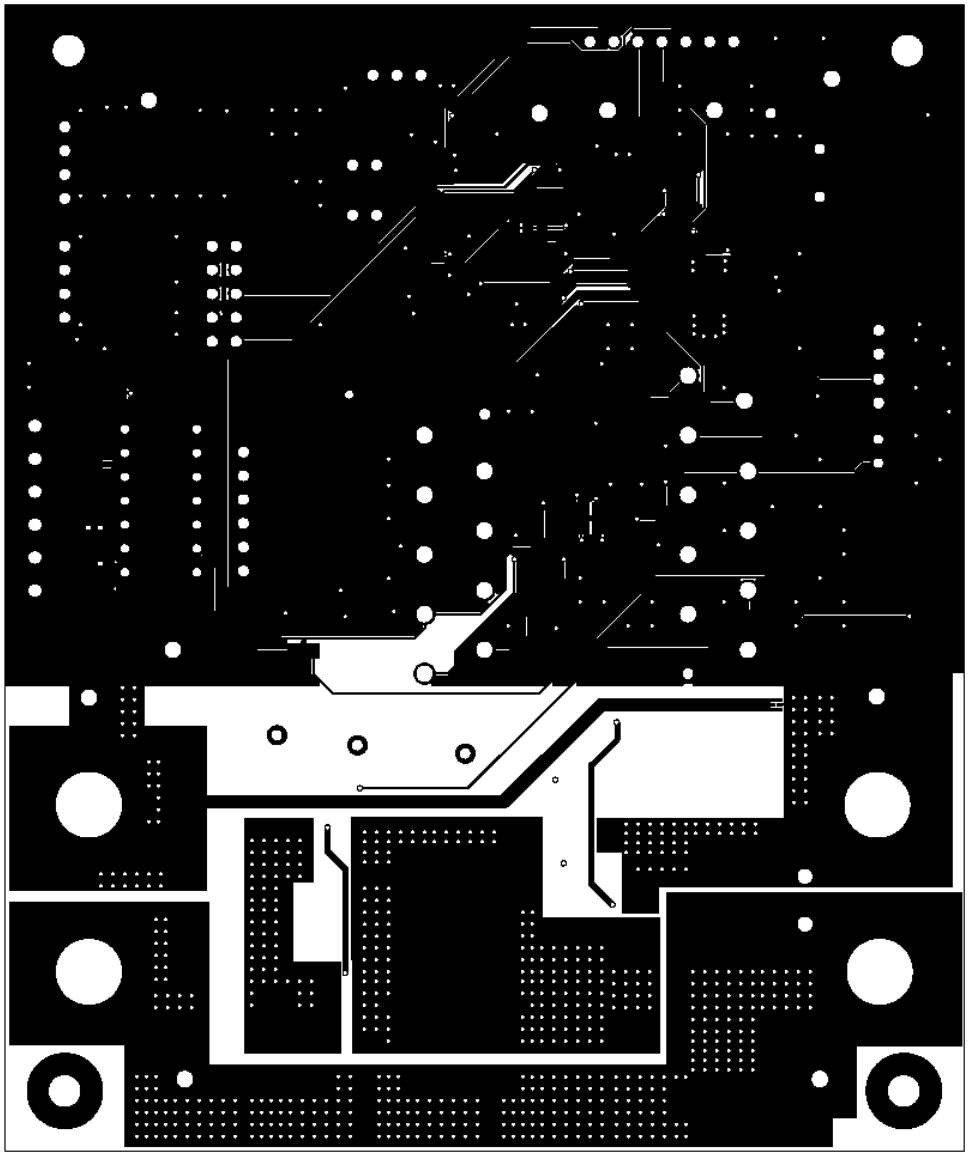

Figure 23. Bottom Layer

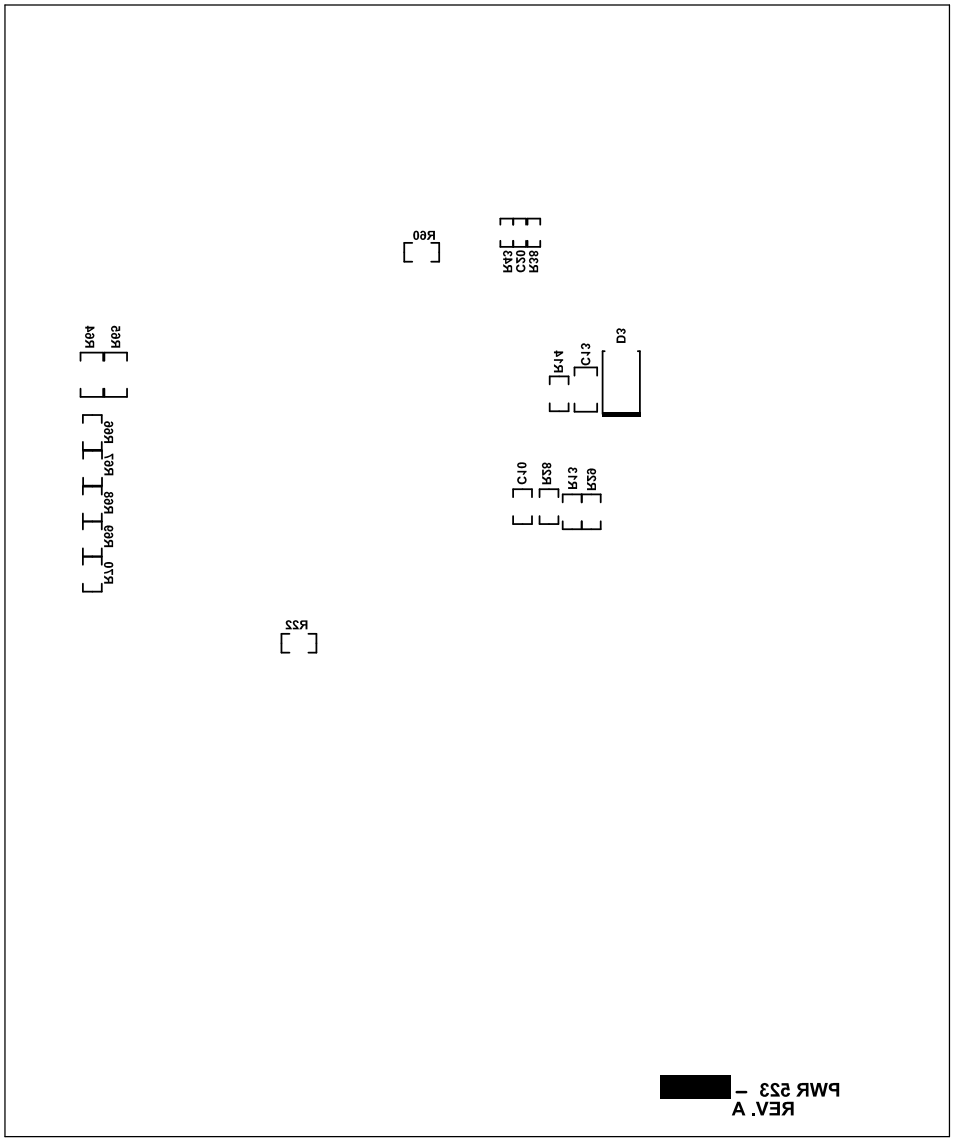

Figure 24. Bottom Silk Screen

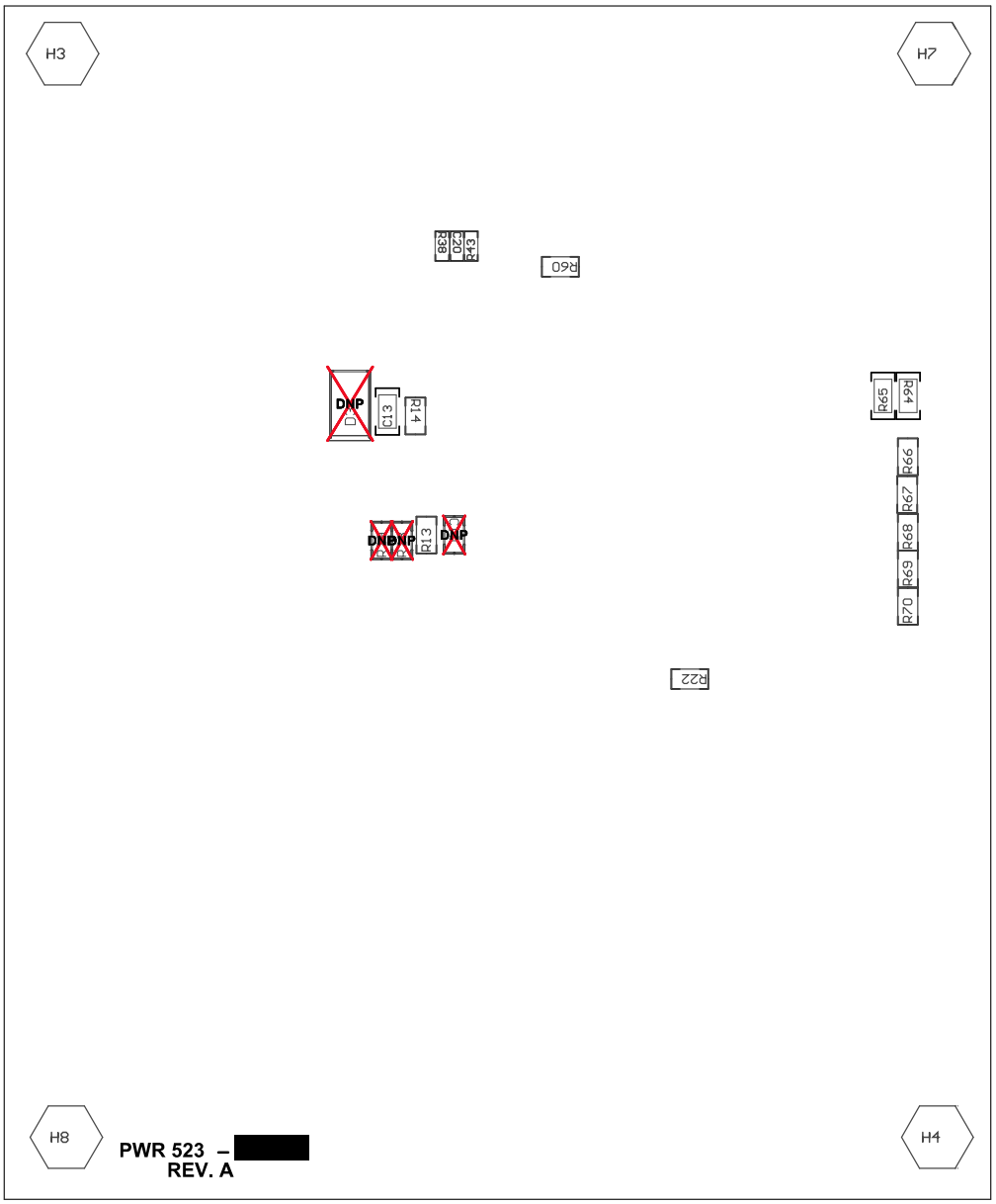

Figure 25. Bottom Assembly

7.2 Bill of Materials

The bill of materials for the circuit module is shown in Table 4. Substitute parts may be used in the manufacturing of the assembly.

Table 4. bq76920 Circuit Module Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	MFG	Alternate Part Number	Alternate MFG
PCB1	1		Printed Circuit Board		PWR523	Any	-	-
C1, C2, C3, C4, C5, C6, C14	7	1uF	CAP, CERM, 1uF, 16V, +/-10%, X7R, 0805	0805	GRM21BR71C105KA01L	MuRata		
C7, C8, C9, C11, C12, C17, C18, C21, C22, C23	10	0.1uF	CAP, CERM, 0.1uF, 50V, +/-10%, X7R, 0603	0603	GCM188R71H104KA57B	MuRata		
C13	1	2.2uF	CAP, CERM, 2.2uF, 50V, +/-10%, X5R, 1206	1206	GRM31CR61H225KA88L	MuRata		
C15	1	4700pF	CAP, CERM, 4700pF, 50V, +/-10%, X7R, 0805	0805	08055C472KAT2A	AVX		
C16	1	4.7uF	CAP, CERM, 4.7uF, 10V, +/-10%, X7R, 0805	0805	GRM21BR71A475KA73L	MuRata		
C20	1	3300pF	CAP, CERM, 3300pF, 25V, +/-10%, X7R, 0603	0603	GRM188R71E332KA01D	MuRata		
D1	1	28V	Diode, TVS, Uni, 28V, 1500W, SMC	SMC	SMCJ28A	Fairchild Semiconductor		
D2, D4, D12	3	1.25V	Diode, Ultrafast, 100V, 0.15A, SOD-123	SOD-123	1N4148W-7-F	Diodes Inc.		
D6	1	600V	Diode, Ultrafast, 600V, 3A, SMC	SMC	MURS360T3G	ON Semiconductor		
D8, D9, D10, D11, D19, D20	6	5.6V	Diode, Zener, 5.6V, 200mW, SOD-323	SOD-323	MMSZ5232BS-7-F	Diodes Inc.		
D13	1	16V	Diode, Zener, 16V, 500mW, SOD-123	SOD-123	MMSZ5246B-7-F	Diodes Inc.		
D14, D15, D16, D17, D18	5	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On		
D21	1	Orange	LED, Orange, SMD	1.6x0.8x0.8mm	LTST-C190KFKT	Lite-On		
H1, H2, H5, H6	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply	-	-
H3, H4, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone	-	-
J1	1		Receptacle, 3.5mm 6x1, R/A, TH	Header, 6x1 R/A	395021006	Molex		
J2, J3, J6, J7	4		Standard Banana Jack, Uninsulated, 15A	Banana Jack	108-0740-001	Emerson Network Power		
J4, J5, J9, J10	4		Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
J8, J14	2		Header, 100mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex		
J12	1		Header, 100mil, 5x2, Tin plated, TH	Header, 5x2, 100mil, Tin	PEC05DAAN	Sullins Connector Solutions		
J13	1		Header, 100mil, 3x1, Tin plated, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
P1	1		CONN TERM BLOCK 3.5MM 6POS R/A	Term Block Plug	39500-0006	Molex	-	-
Q1, Q2	2	30V	MOSFET, N-CH, 30V, 100A, SON 5x6mm	SON 5x6mm	CSD17501Q5A	Texas Instruments		None
Q3, Q4	2	-50V	MOSFET, P-CH, -50V, -0.13A, SOT-323	SOT-323	BSS84W-7-F	Diodes Inc.		None
Q5, Q6, Q8	3	50V	MOSFET, N-CH, 50V, 0.22A, SOT-23	SOT-23	BSS138	Fairchild Semiconductor		None
Q7	1	0.25V	Transistor, PNP, 40V, 0.2A, SOT-23	SOT-23	MMBT3906	Fairchild Semiconductor	None	None
Q9	1	0.5V	Transistor, NPN, 80V, 1A, SOT-89	SOT-89	BCX5616TA	Diodes Inc.		
R3, R21, R23, R51, R55	5	10.0k	RES, 10.0k ohm, 1%, 0.125W, 0805	0805	CRCW080510K0FKEA	Vishay-Dale		
R4, R5, R6, R7, R8, R9	6	100	RES, 100 ohm, 1%, 0.25W, 1206	1206	CRCW1206100RFKEA	Vishay-Dale		
R10, R12, R14, R24, R25, R26, R27, R31, R32, R36, R37, R57, R58, R61, R62	15	100	RES, 100 ohm, 1%, 0.125W, 0805	0805	CRCW0805100RFKEA	Vishay-Dale		
R11	1	0.001	RES, 0.001 ohm, 1%, 2W, 4527	4527	WSR21L000FEA	Vishay-Dale		
R13	1	499k	RES, 499k ohm, 1%, 0.125W, 0805	0805	CRCW0805499KFKEA	Vishay-Dale		
R15, R18, R19, R47, R54, R59, R60	7	1.00Meg	RES, 1.00Meg ohm, 1%, 0.125W, 0805	0805	CRCW08051M00FKEA	Vishay-Dale		

Table 4. bq76920 Circuit Module Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	MFG	Alternate Part Number	Alternate MFG
R16, R30	2	0	RES, 0 ohm, 5%, 0.125W, 0805	0805	CRCW08050000Z0EA	Vishay-Dale		
R17	1	1.00k	RES, 1.00k ohm, 1%, 0.125W, 0805	0805	CRCW08051K00FKEA	Vishay-Dale		
R20	1	10.0k ohm	Thermistor NTC, 10.0k ohm, 1%, Disc, 5x8.4 mm	Disc, 5x8.4 mm	103AT-2	SEMITEC Corporation		
R22	1	3.01k	RES, 3.01k ohm, 1%, 0.125W, 0805	0805	CRCW08053K01FKEA	Vishay-Dale		
R38	1	300k	RES, 300k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-304-B-T5	Susumu Co Ltd		
R39, R43	2	13.7k	RES, 13.7k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-1372-B-T5	Susumu Co Ltd		
R44, R45, R50, R52	4	100k	RES, 100k ohm, 1%, 0.125W, 0805	0805	CRCW0805100KFKEA	Vishay-Dale		
R46	1	0	RES, 0 ohm, 5%, 0.25W, 1206	1206	CRCW12060000Z0EA	Vishay-Dale		
R48	1	1.0k	RES, 1.0k ohm, 5%, 1W, 2512	2512	ERJ-1TYJ102U	Panasonic		
R49	1	196k	RES, 196k ohm, 1%, 0.125W, 0805	0805	CRCW0805196KFKEA	Vishay-Dale		
R53	1	49.9k	RES, 49.9k ohm, 1%, 0.125W, 0805	0805	CRCW080549K9FKEA	Vishay-Dale		
R63	1	221k	RES, 221k ohm, 1%, 0.125W, 0805	0805	CRCW0805221KFKEA	Vishay-Dale		
R64, R65	2	1.00k	RES, 1.00k ohm, 1%, 0.25W, 1206	1206	CRCW12061K00FKEA	Vishay-Dale		
R66, R67, R68, R69, R70	5	200	RES, 200 ohm, 1%, 0.125W, 0805	0805	CRCW0805200RFKEA	Vishay-Dale		
S1, S2	2		Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	SW, SPST 6x6 mm	4-1437565-1	TE Connectivity		
S3	1		Switch, SPST 7Pos, Rocker, TH	9.65X8X19.8mm	76SB07ST	Grayhill		
SH-J4, SH-J5, SH-J9, SH-J10, SH-J12-3, SH-J12-5, SH-J12-7, SH-J12-9, SH-J13-3	9	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		
U1	1		µC-Controlled AFE Family for 5/10/15-Series Cell Lithium-Ion and Phosphate Battery Pack Applications, PW0020A	PW0020A	BQ7692000PW	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	-	-
C10	0	470pF	CAP, CERM, 470pF, 50V, +/-10%, X7R, 0805	0805	08055C471KAT2A	AVX		
C19	0	3300pF	CAP, CERM, 3300pF, 25V, +/-10%, X7R, 0603	0603	GRM188R71E332KA01D	MuRata		
D3	0	30V	Diode, TVS, Uni, 30V, 600W, SMB	SMB	SMBJ30A-13-F	Diodes Inc.		
D5	0	16V	Diode, Zener, 16V, 500mW, SOD-123	SOD-123	MMSZ5246B-7-F	Diodes Inc.		
D7	0	600V	Diode, Ultrafast, 600V, 8A, TH	TO-220AC	MUR860G	ON Semiconductor		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
HS1	0		Heatsink, DDPAK/TO-263, SMT	Heatsink, DDPAk	573300D00010G	Aavid		
J11	0		Header, TH, 100mil, 7x1, Gold plated, 230 mil above insulator	7x1 Header	TSW-107-07-G-S	Samtec		
J15	0		Header, TH, 100mil, 6x1, Gold plated, 230 mil above insulator	TSW-106-07-G-S	TSW-106-07-G-S	Samtec, Inc.		
R1, R2	0	0	RES, 0 ohm, 5%, 0.125W, 0805	0805	CRCW08050000Z0EA	Vishay-Dale		
R28, R29, R40, R41, R56	0	1.00k	RES, 1.00k ohm, 1%, 0.125W, 0805	0805	CRCW08051K00FKEA	Vishay-Dale		
R33	0	300k	RES, 300k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-304-B-T5	Susumu Co Ltd		
R34, R35, R42	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		

Table 4. bq76920 Circuit Module Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	MFG	Alternate Part Number	Alternate MFG
TP2, TP29	0	Red	Test Point, TH, Multipurpose, Red	Keystone5010	5010	Keystone		
TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP18, TP20, TP21, TP22, TP24, TP25, TP26, TP27, TP28, TP33, TP34, TP35, TP37	0	White	Test Point, TH, Multipurpose, White	Keystone5012	5012	Keystone		

Figure 26 through Figure 28 illustrate the schematics.

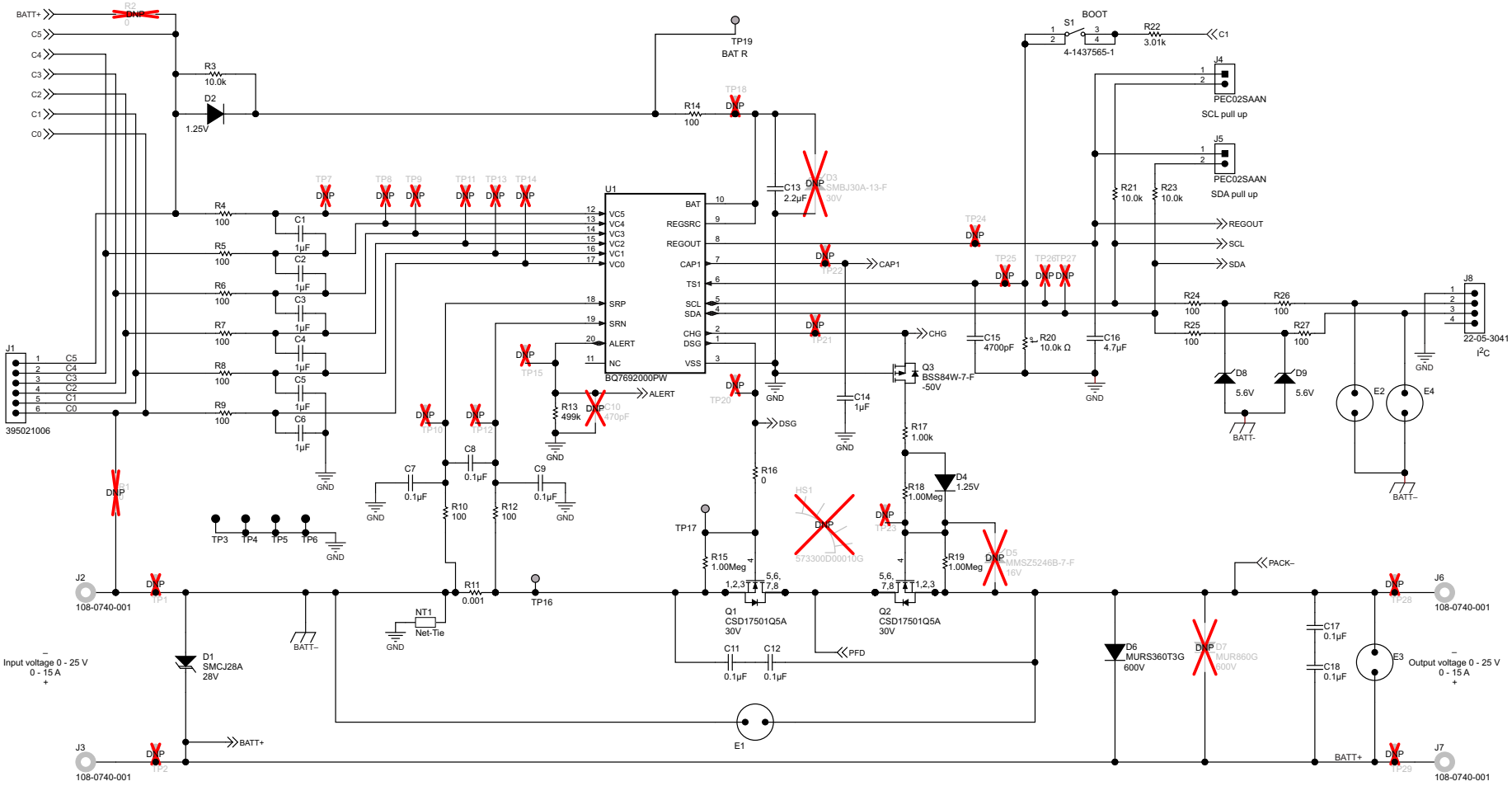

Figure 26. Schematic Diagram AFE

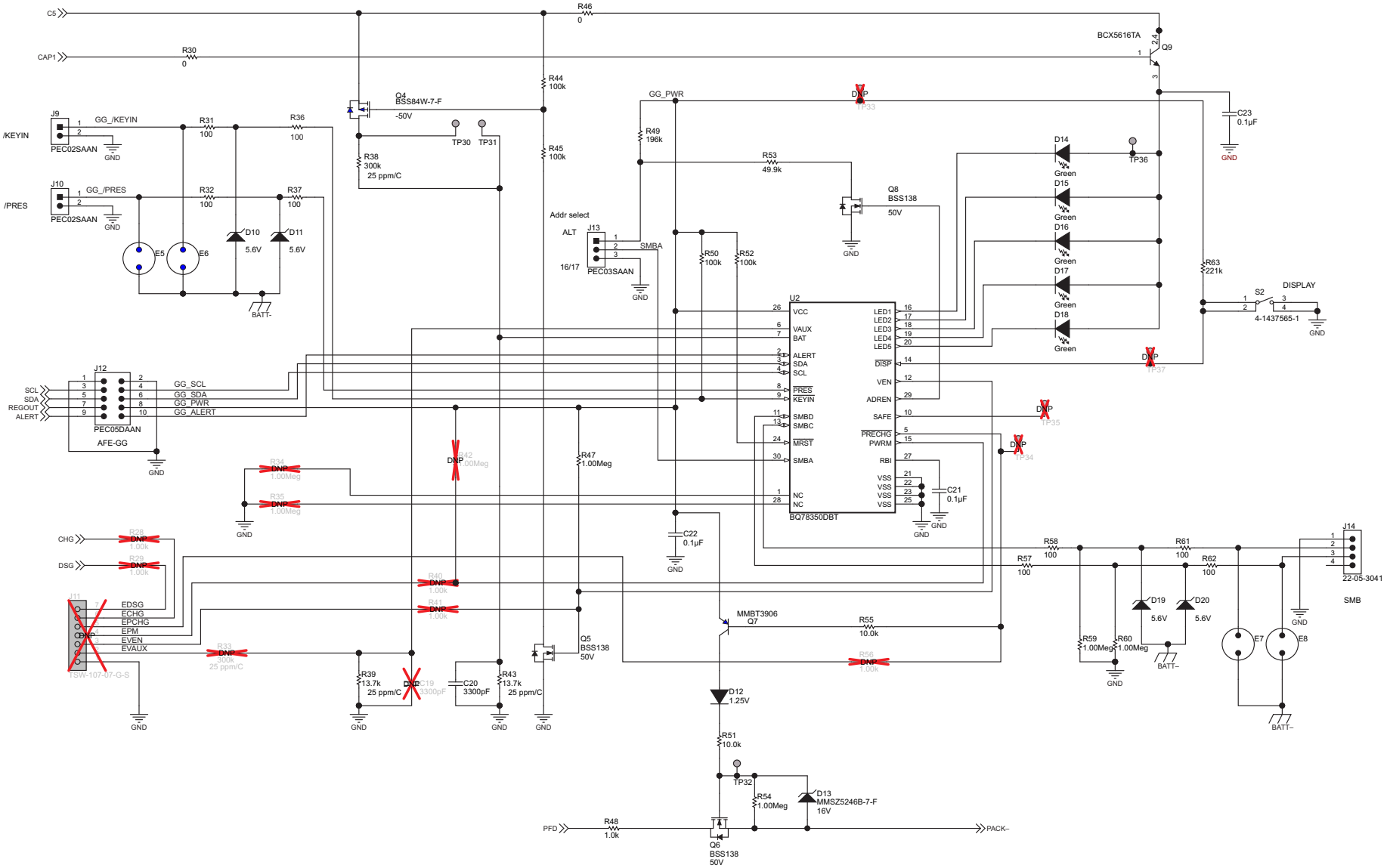

Figure 27. Schematic Diagram Gauge

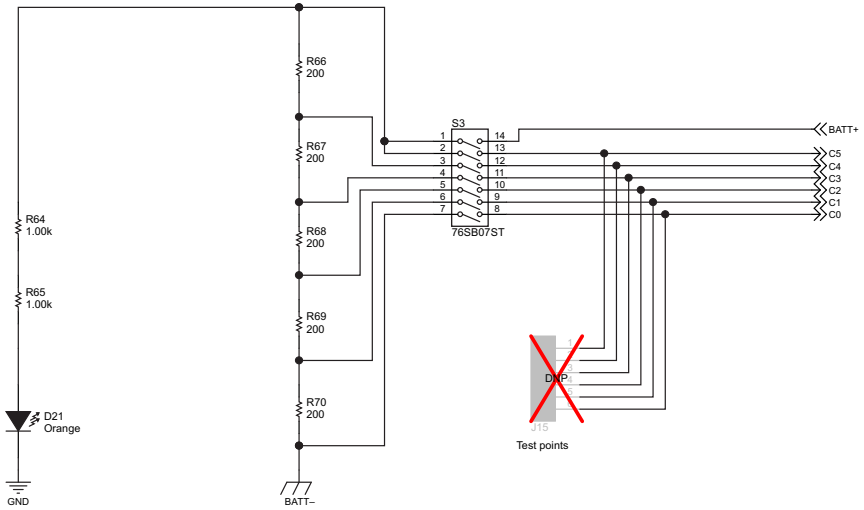

Figure 28. Schematic Diagram Cell Simulator

8 Related Documents From Texas Instruments

Document	Literature Number
bq76920, bq76930, bq76940 µC-Controlled AFE Family for 5-, 10-, and 15-Series Cell Lithium-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 (March 2014) to A Revision	Page
• Changed *EVM Connection for Basic Gauge Operation* image.	7
• Changed software display image.	8
• Changed registers view image.	10

Revision History

Changes from A Revision (April 2014) to B Revision	Page
• Changed software title to *bq76940/bq76930/bq76920 Evaluation Software* in step one of the *Quick Start* section and globally throughout document.	5
• Changed path name to ...'\bq76940' in second paragraph of *Interface Adapter* section.	7
• Added clarification about device identifiers in menus or windows in the *bq76940/bq76930/bq76920 Software* section	7
• Added sentence about how to start the software in the *Software Operation* section.	8
• Changed Evaluation Software Display image.	8
• Added *Sequence_Example.bqseq* to paragraph below *Sequence View* image.	12
• Changed content in the BOM in rows containing U1 and U2 in the Designator column.	33

Revision History

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

- Added 'AFE and bq78350 gauge' to second sentence in the Abstract. 1
- Changed '...the bq76920 registers...' to '...the device registers...' in the Abstract. 1
- Changed '5-cell Li-Ion and Li-Polymer' to '5-cell Li-Ion and Phosphate' in the first *Features* bullet. 3
- Changed 'parallel' to 'series' in the first sentence of the *bq76920 Circuit Module Performance Specification Summary* section. 3
- Added 'for the AFE 2.5 A for the gauge' to first bullet in *Required Equipment* section. 3
- Deleted bullet containing 'TI bq76940/bq76930/bq76920 Evaluation Software' in *Required Equipment* section. 3
- Added 'calibrated load or load with accurate current meter required for gauge evaluation' to sixth bullet in *Required Equipment* section. 3
- Added *Quick Start* section with introduction and moved *AFE Quick Start* to *Quick Start* subsection. 4
- Changed step 1 in *AFE Quick Start* section, moved install instruction from step 1 to step 2. 4
- Added AFE to *EVM Connection for Basic AFE Operation* figure caption. 5
- Added *Gauge Quick Start* section. 5
- Changed *Interface Adapter* section to a main heading and changed content of section. 7
- Added 'bqStudio software' to first paragrph of the *Interface Adapter* section. 7
- Changed *bq76940/bq76930/bq76920 Software* section to a new heading number and added clarification in first paragraph. 7
- Added *Interface Adapter* section with bq769x0-specific instructions. 8
- Added *Battery Management Studio Software* section. 13
- Added sentence to end of *Evaluating with Simulated Current* section. 22
- Added paragraph to end of *Reducing the Cell Count* section. 23
- Changed first sentence of *Connecting to a Host* section. 24
- Changed entire content of *Gauge Circuits* section. 24
- Added last two paragraphs in *Unused Components* section. 24
- Added link to *bq78350 Technical Reference Manual* in related documents. 39

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

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

Industry Canada Compliance (English)

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Concerning EVMs Including Detachable Antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Canada Industry Canada Compliance (French)

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada

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

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