EVM User's Guide: BQ40Z80EVM-020

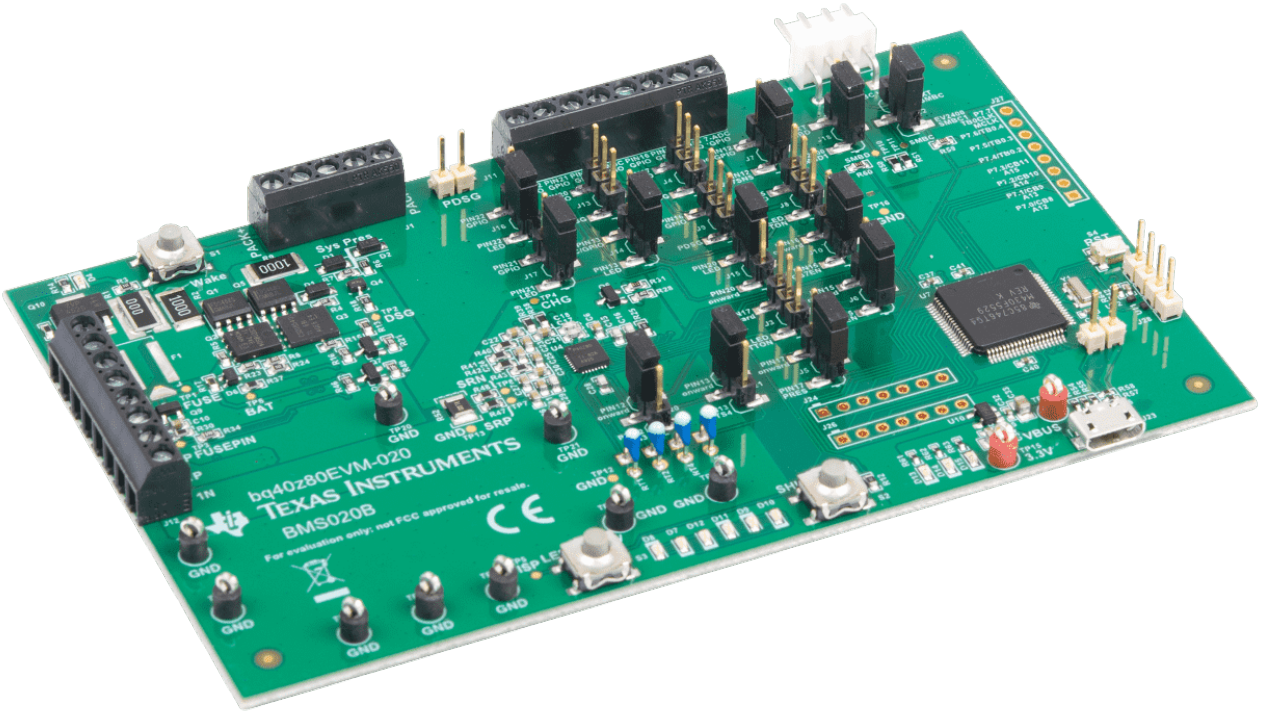
BQ40Z80 Li-Ion Battery Pack Manager Evaluation Module

Description

The BQ40Z80EVM-020 evaluation module (EVM) is a complete evaluation system for the BQ40Z80 battery management system. The EVM includes one BQ40Z80, two BQ771807 secondary protectors, and Microsoft® Windows®-based PC software, which can be used to monitor and predict capacity, perform cell balancing, monitor critical parameters, protect the cells from overcharge, over-discharge, short circuit, and overcurrent in 2-, 3-, 4-, 5-, 6-, or 7-series cell Li-ion or Li-polymer battery packs. The circuit includes an onboard EV2400 interface to USB so the software can read bqz40z80 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the design under different charge and discharge conditions.

Features

- Complete evaluation system for the bq40z80EVM Li-Ion Battery Pack Manager Evaluation Module and bq771807 independent overvoltage protection ICs
- Populated circuit module for quick setup
- Jumpers for configuring multifunction pins
- Software that allows data logging for system analysis
- 2s-7s battery gauging with protection
- Supports internal and external cell balancing
- Multiple GPIOs and LED support
- Protection features include:
  - Overvoltage and undervoltage
  - Short circuit in charge and discharge
  - Charge and precharge timeout
  - Overtemperature and undertemperaure



BQ40Z80EVM-020

1 Evaluation Module Overview

1.1 Introduction

The BQ40Z80EVM-020 circuit module includes one BQ40Z80 integrated circuit (IC), two BQ771807 secondary protectors, and all other onboard components necessary to monitor and predict capacity, perform cell balancing, monitor critical parameters, protect the cells from overcharge, over-discharge, short-circuit, and overcurrent in 2-, 3-, 4-, 5-, 6-, or 7-series cell Li-ion or Li-polymer battery packs. The circuit module connects directly across the cells in a battery. The BQ40Z80EVM can use the onboard EV2400 or an external EV2400 interface board and software to read the BQ40Z80 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the design under different charge and discharge conditions.

WARNING
Replace capacitor C6 with a 1nF capacitor for full functionality testing.

1.2 Kit Contents

- bq40z80 and BQ771807 circuit module
- Cable to connect the EVM to a PC using the onboard EV2400. If an external EV2400 is used, then purchase this separately

1.3 Ordering Information

For complete ordering information, see the product page at *www.ti.com*.

Table 1-1. Ordering Information

EVM PART NUMBER	CHEMISTRY	CONFIGURATION	CAPACITY
bq40z80EVM	Li-ion	1-, 2-, 3-, 4-, 5-, 6-, or 7-cell	Any

1.4 BQ40Z80 and BQ771807 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq40z80 and bq881707 EVM.

Table 1-2. Performance Specification Summary

Specification	Min	Typ	Max	Unit
Input voltage Pack+ to Pack–	3	15	32	V
Charge and discharge current	0	2	7	A

2 Hardware

2.1 BQ40Z80EVM Quick Start Guide

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

2.1.1 Items Needed for EVM Setup and Evaluation

- BQ40Z80 and BQ771807 circuit module
- EV2400 communications interface adapter or use on-board EV2400 function
- Cable to connect the EVM to an EV2400 communications interface adapter OR micro-USB cable to connect EVM directly to a computer
- If using an external EV2400 communications adapter, then this requires a USB cable to connect the communications interface adapter (EV2400 or on the EVM) to the computer
- Computer setup with Windows® XP, or higher, operating system
- Access to the Internet to download the Battery Management Studio software setup program
- One-to-seven battery cells or 1kΩ resistors to configure a cell simulator
- A DC power supply that can supply 32V and 2A (constant current and constant voltage capability is desirable). Caution: Some power supplies can be damaged by application of external voltages. If using more than 1 power supply, then check the equipment requirements and use blocking diodes or other isolation techniques, as needed, to prevent damage to equipment

2.1.2 Software Installation

Find the latest software version in the bq40z80 tool folder on www.ti.com. Version 1.3.83 or greater is required to use all the bq40z80 features. Use the following steps to install the bq40z80 Battery Management Studio software:

1. Download and run the Battery Management Studio setup program from the Development Tools section of the bq40z80EVM product folder on www.ti.com. See Section 2.2 for detailed information on using the tools in the Battery Management Studio.
2. If the communications interface adapter was not previously installed, then after the Battery Management Studio installation, a TI USB driver installer pops up. Click *Yes* for the agreement message and follow the instructions.
3. Plug the EVM into a USB port using the USB cable. The Windows system shows a prompt that new hardware has been found. When asked, *Can Windows connect to Windows Update to search for software?*, select *No, not this time*, and click *Next*. The next dialog window indicates *This wizard helps you install software for: TI USB Firmware Updater*. Select *Install the software automatically (Recommended)* and click *Next*. The next screen is the Confirm File Replace screen. Click *No* to continue. If this screen does not appear, then go to the next step. After Windows indicates that the installation was finished, a similar dialog window pops up to install the second driver. Proceed with the same installation preference as the first one.

2.1.3 EVM Connections

This section covers the hardware connections for the EVM. See Figure 2-1.

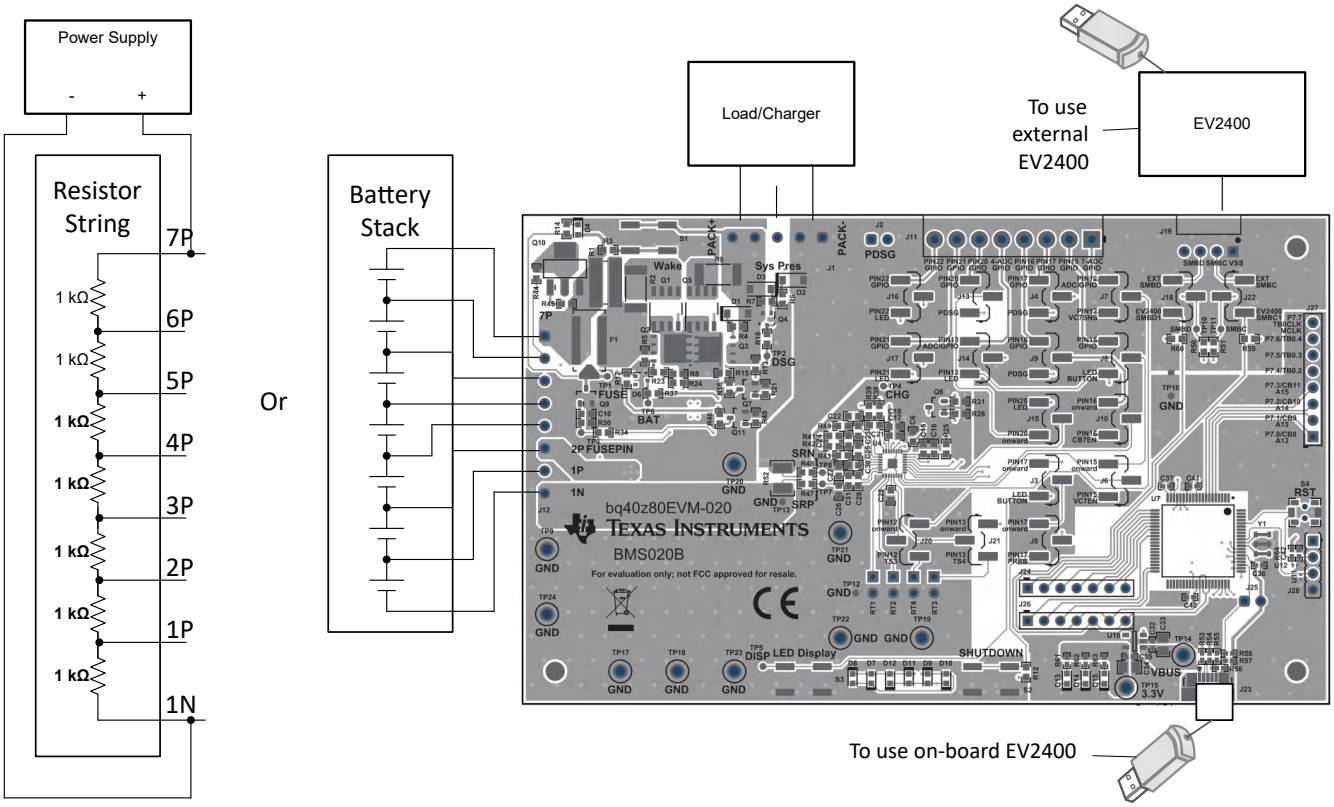


Figure 2-1. BQ40Z80 Circuit Module Connection to Cells and System Load or Charger

- Direct connection to the cells: 1N (BAT–), 1P, 2P, 3P, 4P, 5P, 6P, 7P (BAT+)

  Attach the cells to the J12 terminal block. A specific cell connection sequence is not required; although, a good practice is to start with lowest cell in the stack (cell 1), then attach cells 2 through 7 in sequence. The U1 and U2 devices is not damaged by other cell connection sequences, but there is a possibility that the BQ771807 can blow the fuse. Attaching cells starting with cell 1 eliminates this risk. A short needs to be placed across unused voltage sense inputs up to 7P.

Table 2-1. Cell Connection Configuration

Number of Cells	J12 Terminal Block Connections													
	1N		1P		2P		3P		4P		5P		6P		7P
1	⊕	-cell1+	⊕	short	⊕	short	⊕	short	⊕	short	⊕	short	⊕	short	⊕
2	⊕	-cell1+	⊕	-cell2+	⊕	short	⊕	short	⊕	short	⊕	short	⊕	short	⊕
3	⊕	-cell1+	⊕	-cell2+	⊕	-cell3+	⊕	short	⊕	short	⊕	short	⊕	short	⊕
4	⊕	-cell1+	⊕	-cell2+	⊕	-cell3+	⊕	-cell4+	⊕	short	⊕	short	⊕	short	⊕
5	⊕	-cell1+	⊕	-cell2+	⊕	-cell3+	⊕	-cell4+	⊕	-cell5+	⊕	short	⊕	short	⊕
6	⊕	-cell1+	⊕	-cell2+	⊕	-cell3+	⊕	-cell4+	⊕	-cell5+	⊕	-cell6+	⊕	short	⊕
7	⊕	-cell1+	⊕	-cell2+	⊕	-cell3+	⊕	-cell4+	⊕	-cell5+	⊕	-cell6+	⊕	-cell7+	⊕

A resistor cell simulator can be used instead of battery cells. Connect a resistor between each of the contacts on the J12 connector. For example, from 1N to 1P, from 1P to 2P, and so forth, until the desired number of cells has been achieved. A power supply can provide power to the cell simulator. Set the power supply to the

desired cell voltage × the number of cells and attach the ground wire to 1N and the positive wire to 4P. For example, for a 6S configuration with a 3.6V cell voltage, set the power supply to 6 × 3.6 = 21.6V.

- Serial communications port (SMBC, SMBD)

  If the external EV2400 is used, then attach the communications interface adapter cable to J19 and to the SMB port on the EV2400. The jumper settings for J18 are to connect pins 2 and 3, and the jumper settings for J22 are to connect pins 1 and 2. This allows the external EV2400 to talk to the BQ40Z80 over SMBus.

  Alternately, the onboard EV2400 can be used by connecting a micro-USB cable to the EVM at J23 directly to a computer. To use the onboard EV2400, the jumper settings for J18 are to connect pins 1 and 2, and the jumper settings for J22 are to connect pins 2 and 3. This allows the onboard EV2400 to talk to the bq40z80 over SMBus.

- System load and charger connections across PACK+ and PACK–

  Attach the load or power supply to the J1 terminal block. Connect the positive load or power supply wire to at least one of the first two terminal block positions labeled PACK+. Connect the ground wire for the load or power supply to the last terminal block positions labeled PACK–.

- System-present pin (SYS PRES)

  To start charge or discharge test, connect the SYS PRES position on the J1 terminal block to PACK–. The SYS PRES can be left open if the nonremovable (NR) bit is set to 1 in the Pack Configuration A register. To test sleep mode, disconnect the SYS PRES pin.

- Wake-up the device up from shutdown (WAKE)

  Press the *Wake* pushbutton switch (S1) to temporarily connect Bat+ to Pack+. This applies voltage to the PACK pin on the BQ40Z80 to power-up the regulators and start the initialization sequence.

- Parameter setup

  The default data flash settings configure the device for 7-series Li-Ion cells. Change the *Data Flash* > *Settings* > *DA Configuration* register to set up the number of series cells to match the physical pack configuration. This provides basic functionality to the setup. Update other data flash parameters to fine tune the gauge to the pack. See the BQ40Z80 TRM for help with setting the parameters.

2.1.4 Update Firmware

The BQ40Z80 needs updated firmware. Contact TI support if the device is pre-release, or find the latest firmware version in the appropriate bq40z80 folder on www.ti.com. Use the following steps to install the bq40z80 *Battery Management Studio* software:

1. Run *Battery Management Studio* from the *Start* | *Programs* | *Texas Instruments* | *Battery Management Studio* menu sequence, or the *Battery Management Studio* shortcut.
2. Follow the directions in Section 2.2.5, select the firmware .srec file downloaded from www.ti.com, and click the *Program* button.
3. Once programming is finished, the EVM is ready to use with the latest firmware.

2.2 Battery Management Studio

2.2.1 Registers Screen

Run Battery Management Studio from the Start | Programs | Texas Instruments | Battery Management Studio menu sequence, or the Battery Management Studio shortcut. The Registers screen (see Figure 2-2) appears. The Registers section contains parameters used to monitor gauging. The Bit Registers section provides bit level picture of status and fault registers. A green flag indicates that the bit is 0 (low state) and a red flag indicates that the bit is 1 (high state). Data begins to appear once the *Refresh* (single-time scan) button is selected, or scans continuously if the *Scan* button is selected.

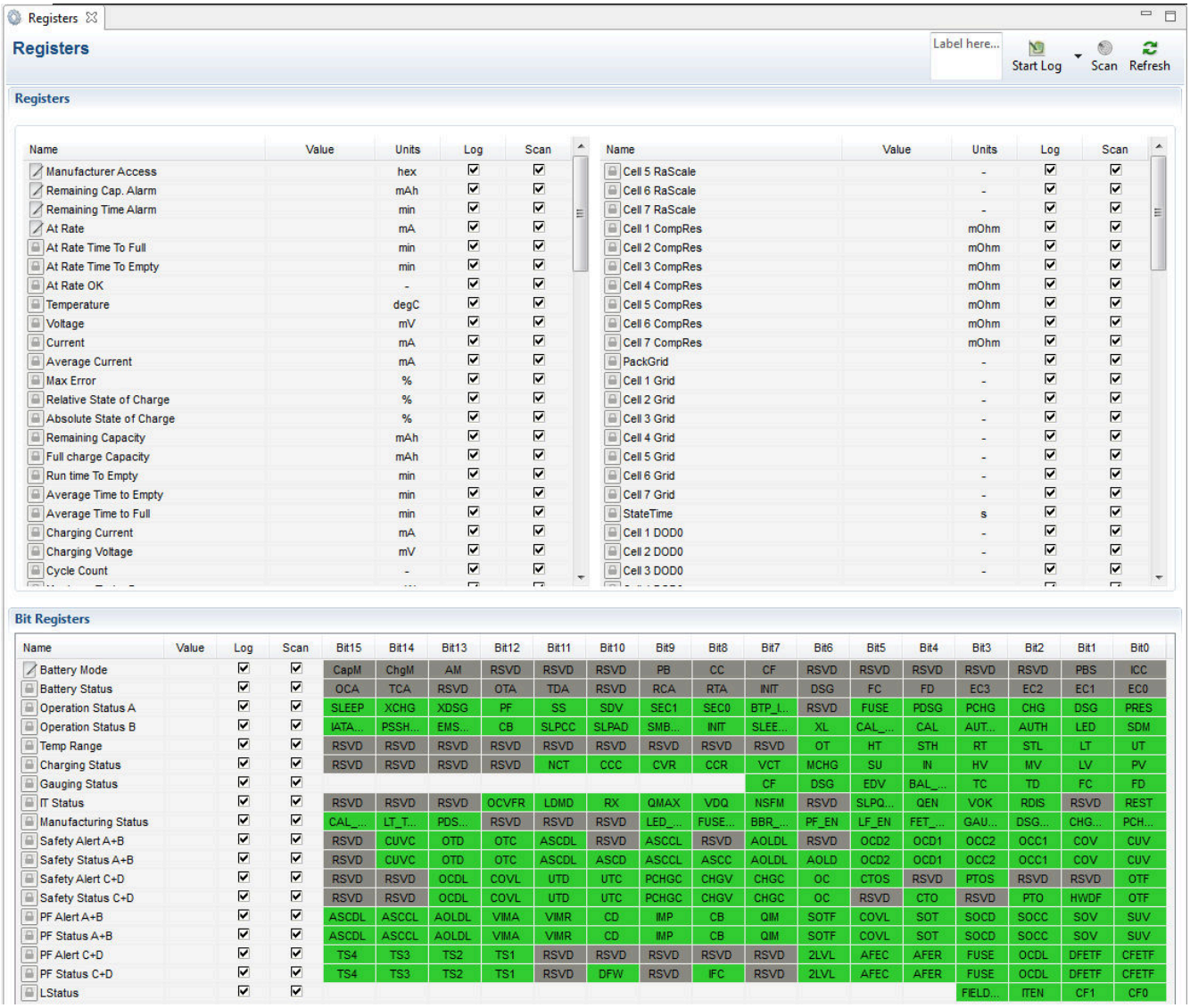


Figure 2-2. Registers Screen

The Battery Management Studio program provides a logging function which logs the values that are selected by the Log check boxes located beside each parameter in the Register section. To enable this function, select the *Log* button; this causes the *Scan* button to be selected. When logging is stopped, the *Scan* button is still selected and has to be manually deselected.

The Log Interval can be set by opening a Watch tab, and using the pull-down at the far right to select the desired Log Interval in milli-seconds.

2.2.2 Setting Programmable bq40z80 Options

The BQ40Z80 data memory comes configured per the default settings detailed in the BQ40Z80 Technical Reference Manual (TRM). Make sure that the settings are correctly changed to match the pack and application for the implementation being evaluated.

Note

The correct setting of these options is essential to get the best performance. The settings can be configured using the Data Memory screen (see Figure 2-3).

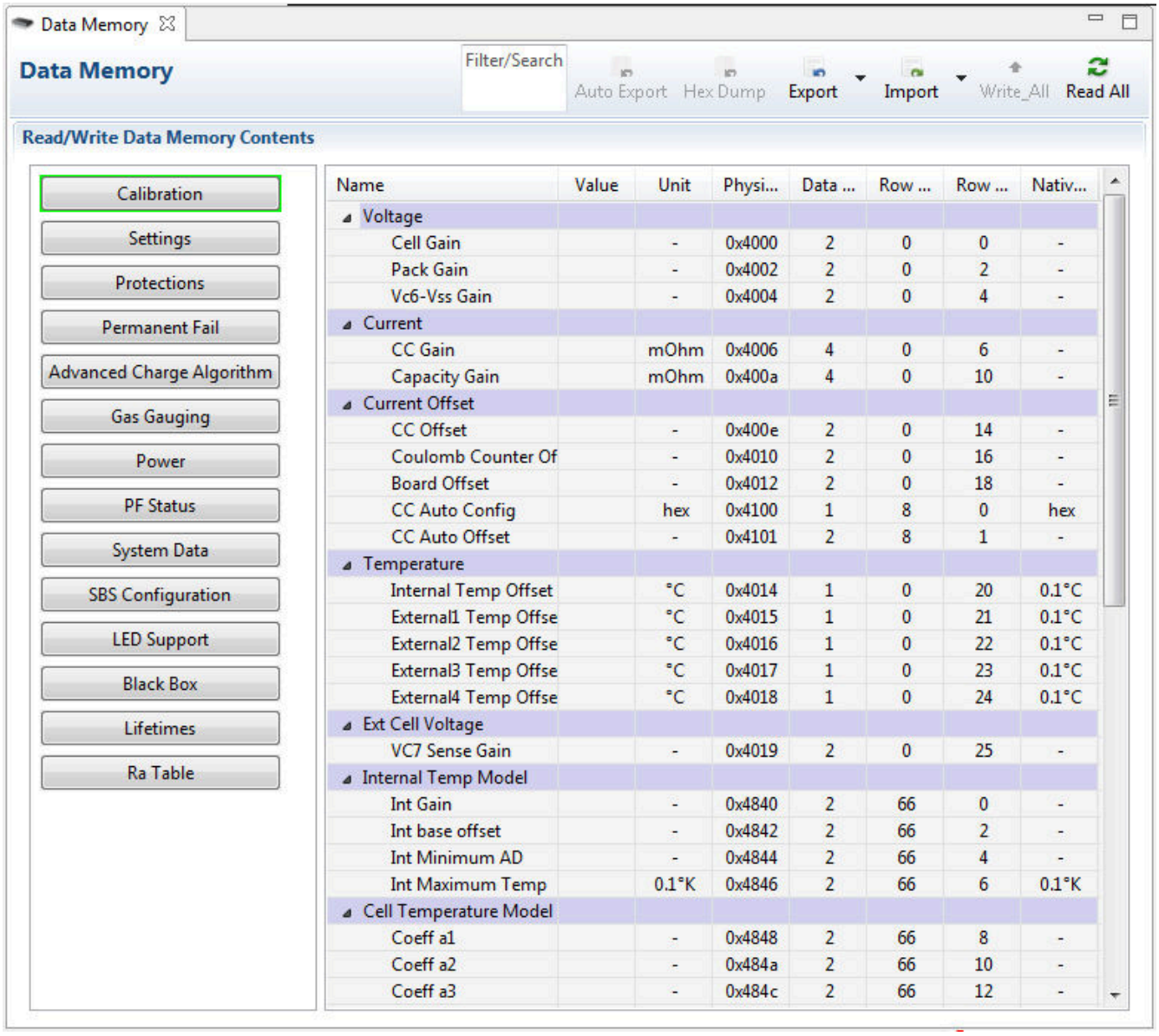


Figure 2-3. Data Memory Screen

2.2.3 Calibration Screen

Calibrate the voltages, temperatures, and currents to provide good gauging performance.

Press the *Calibration* button to select the Advanced Calibration window. See Figure 2-4.

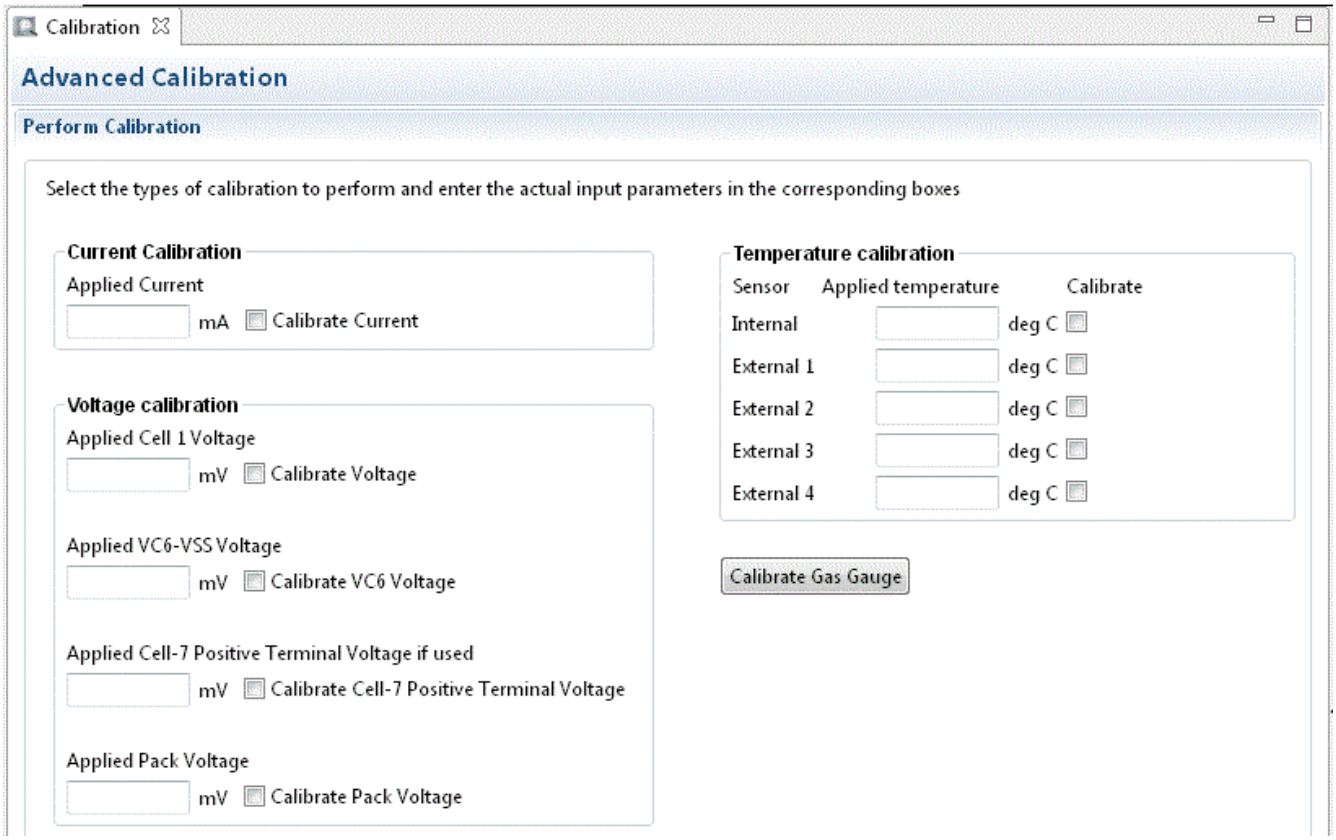


Figure 2-4. Calibration Screen

2.2.3.1 Voltage Calibration

- Measure the voltage from 1P to 1N (VSS) and enter this value in the Applied Cell 1 Voltage field and select the Calibrate Voltage box.
- Measure the voltage from 6P to 1N (VSS) and enter this value in the Applied Battery Voltage field and select the Calibrate Battery Voltage box.
- Measure the voltage from Pack+ to Pack– and enter this value in the Applied Pack Voltage field and select the Calibrate Pack Voltage box. If the voltage is not present, then turn the charge and discharge FETs on by entering a 0x0022 command in the Manufacturer Access register on the Register screen.
- If the device is configured for 7S, measure the voltage from 7P to 1N (VSS) and enter this value in the Applied Cell-7 Positive Terminal Voltage field and select the Calibrate Battery Voltage box.
- Press the *Calibrate Gas Gauge* button to calibrate the voltage measurement system.
- Deselect the Calibrate Voltage boxes after voltage calibration has completed.

2.2.3.2 Temperature Calibration

- Enter the room temperature in each of the Applied Temperature fields and select the Calibrate box for each thermistor to be calibrated. The temperature values must be entered in degrees Celsius.
- Press the *Calibrate Gas Gauge* button to calibrate the temperature measurement system.
- Deselect the Calibrate boxes after temperature calibration has completed.

2.2.3.3 Current Calibration

The Board Offset calibration option is not offered in Battery Management Studio, because this is not required when using the bq40z80EVM. The Board Offset calibration option is available in bqProduction.

- Connect and measure a 2A current source from 1N (–) and Pack– (+) to calibrate without using the FETs. (TI does not recommend calibration using the FETs.)
- Enter –2000 in the Applied Current field and select the Calibrate Current box.
- Press the *Calibrate Gas Gauge* button to calibrate.
- Deselect the Calibrate Current box after current calibration has completed.

Note

Current can also be calibrated using the FETs. Measure the current in the discharge path and enter this value in the Applied Current field.

2.2.4 Chemistry Screen

The chemistry file contains parameters that the simulations use to model the cell and the operating profile. Program a Chemistry ID that matches the cell into the device. Some of these parameters can be viewed in the Data Flash section of the Battery Management Studio.

Press the *Chemistry* button to select the Chemistry window.

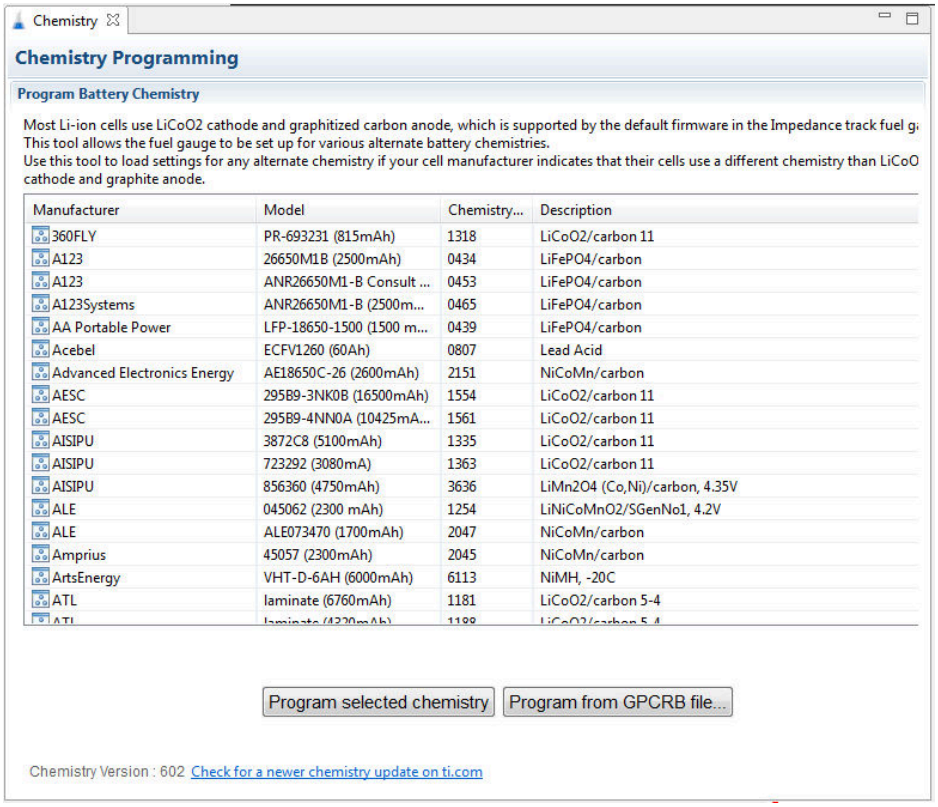


Figure 2-5. Chemistry Screen

- The table can be sorted by clicking the desired column. for example: Click the Chemistry ID column header.
- Select the ChemID that matches your cell from the table (see Figure 2-5).
- Press the Update Chemistry in the *Data Flash* button to update the chemistry in the device.

2.2.5 Firmware Screen

Press the *Firmware* button to select the Firmware Update window. This window allows the user to export and import the device firmware.

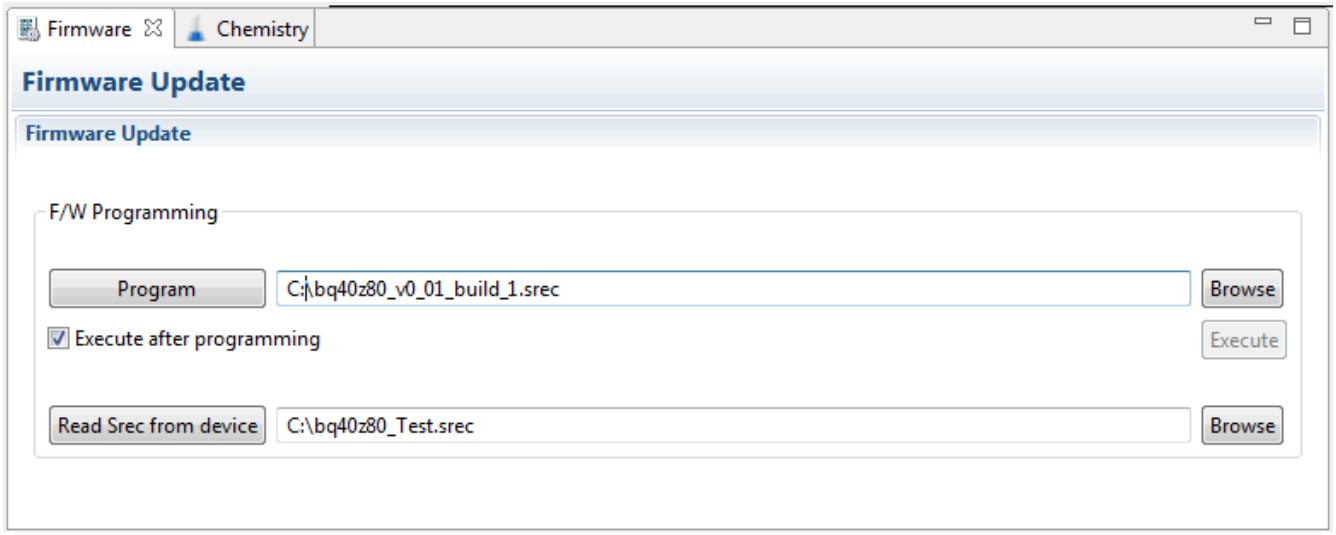


Figure 2-6. Firmware Screen

2.2.5.1 Programming the Flash Memory

The upper section of the Firmware screen is used to initialize the device by loading the default .srec into the flash memory (see Figure 2-6).

- Search for the .srec file using the *Browse* button.
- Select the *Execute after programming* box to automatically return the device to Normal mode after programming has completed.
- Press the *Program* button and wait for the download to complete.

2.2.5.2 Exporting the Flash Memory

The lower section of the Firmware screen is used to export all of the flash memory from the device (see Figure 2-6).

- Press the *Browse* button and enter an .srec filename.
- Press the *Read Srec* to save the flash memory contents to the file. Wait for the download to complete.

2.2.6 Advanced Comm SMB Screen

Press the *Advanced Comm SMB* button to select the Advanced SMB Comm window. This tool provides access to parameters using SMB and Manufacturing Access commands. See Figure 2-7.

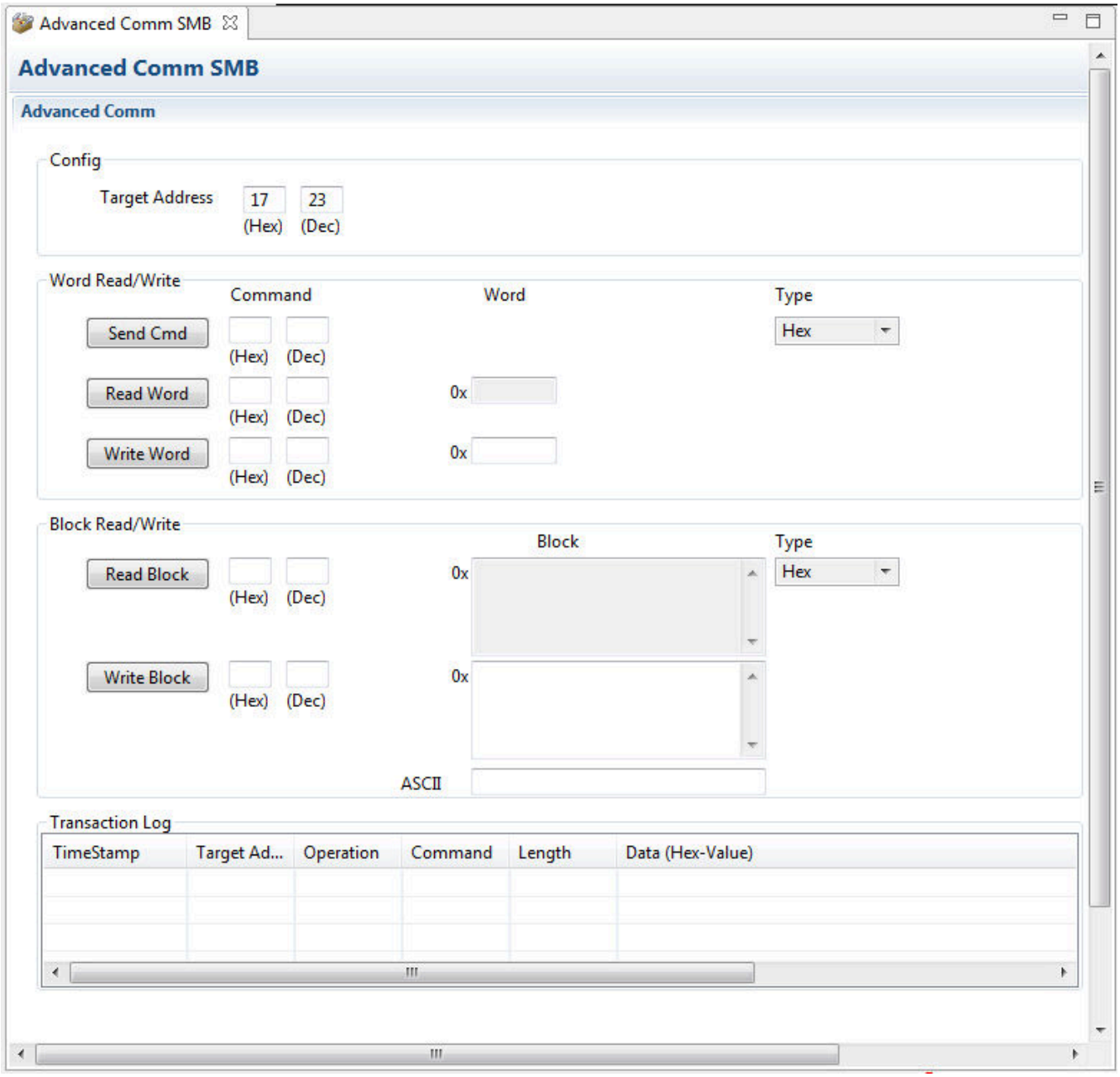


Figure 2-7. Advanced Comm Screen

Examples:

Reading an SMB Command.

- Read SBData Voltage (0x09)
  - SMBus Read Word. Command = 0x09
  - Word = 0x3A7B, which is hexadecimal for 14971mV

Sending a MAC Gauging() to enable IT by ManufacturerAccess().

- With Impedance Track™ disabled, send Gauging() (0x0021) to ManufacturerAccess().
  - SMBus Write Word. Command = 0x00. Data = 00 21

Reading Chemical ID() (0x0006) via ManufacturerAccess()

- Send Chemical ID() to ManufacturerAccess()
  - SMBus Write Word. Command = 0x00. Data sent = 00 06
- Read the result from ManufacturerData()
  - SMBus Read Block. Command = 0x23. Data read = 00 01
  - That is 0x0100, chem ID 100

3 Hardware Design Files

3.1 bq40z80EVM Circuit Module Schematic

This section contains information on modifying the EVM and using various features on the reference design. The jumpers on the board allow different pin configurations. The pin configuration in the registers must match the jumper configuration on the bq40z80EVM . The Pin Configuration register can be set in the Data Memory section of bqStudio. If a register is set to an undefined setting, the output is configured as high-Z.

General Description		Pin Configuration Register Setting	Jumper Connections	Comments
Pack connector with SYS_PRES			J1	Connect PACK+ and PACK– to the appropriate pins on the battery pack
Header for cell connections			J12	Pin 1: 7P, Pin2: 6P, Pin3: 5P, Pin4: 4P, Pin5: 3P, Pin6: 2P, Pin7: 1P, Pin8: 1N(GND). If using less than 7 cells, tie the unused cell pins (6P, 5P, etc) to the highest cell in the stack
Pin 12	V7SENSE	[MFP12_SEL2:MFP12_SEL0]=000 DEFAULT	J20[1,2], J7[1,2]	Connects Pin 12 as V7SENSE to the middle of the voltage divider
	TS3	[MFP12_SEL2:MFP12_SEL0]=001	J20[2,3]	Connects Pin 12 as TS3 to a 10k NTC
	ADCIN1	[MFP12_SEL2:MFP12_SEL0]=010	J20[1,2], J7[2,3]	Connects Pin 12 to Pin 1 of J11. Connect a voltage between 0V and 1V to have the ADC read the voltage at this pin
	GPIO	[MFP12_SEL2:MFP12_SEL0]=011	J20[1,2], J7[2,3]	Connects Pin 12 to Pin 1 of J11. Use this pin as a GPIO
Pin 13	/DISP	[MFP13_SEL2:MFP13_SEL0]=000 DEFAULT	J21[1,2], J14[1,2]	Connects Pin 13 (/DISP) to TP5 and S3
	TS4	[MFP13_SEL2:MFP13_SEL0]=001	J21[2,3]	Connects Pin 12 as TS4 to a 10k NTC
	ADCIN2	[MFP13_SEL2:MFP13_SEL0]=010	J21[1,2], J14[2,3]	Connects Pin 13 to Pin 5 of J11. Connect a voltage between 0V and 1V to have the ADC read the voltage at this pin
	GPIO	[MFP13_SEL2:MFP13_SEL0]=011	J21[1,2], J14[2,3]	Connects Pin 13 to Pin 5 of J11. Use this pin as a GPIO
Pin 15	VC7EN	[MFP15_SEL1:MFP15_SEL0]=00 DEFAULT	J6[1,2]	Connects Pin 15 (VC7EN) to the gate of Q6 to enable the voltage divider so a scaled voltage of the top of stack is applied to VC7SENSE
	/DISP	[MFP15_SEL1:MFP15_SEL0]=01	J6[2,3], J8[1,2]	Connects Pin 15 (/DISP) to TP5 and S3
	GPIO	[MFP15_SEL1:MFP15_SEL0]=10	J6[2, 3], J8[2, 3]	Connects Pin 15 (GPIO) to Pin 2 of J11
Pin 16	CB7EN	[MFP16_SEL1:MFP16_SEL0]=00 DEFAULT	J10[1,2]	Connects Pin 17 (CB7EN) to the gate of Q11 for external cell balancing for the 7th cell
	PDSG	[MFP16_SEL1:MFP16_SEL0]=01	J10[2, 3], J9[1,2]	Connects Pin 16 (PDSG) to the gate of Q7 to enable pre-discharge through Q5
	GPIO	[MFP16_SEL1:MFP16_SEL0]=10	J10[2,3], J9[2,3]	Connects Pin 62 to Pin 4 of J11. Use this pin as a GPIO
Pin 17	/PRES	[MFP17_SEL2:MFP17_SEL0]=000 DEFAULT	J5[1,2]	Connects Pin 17 (/PRES) to Pin 3 of J2
	SHUTDN	[MFP17_SEL2:MFP17_SEL0]=001	J5[1,2]	Connects Pin 17 (/SHUTDN) to S3 pushbutton
	/DISP	[MFP17_SEL2:MFP17_SEL0]=010	J5[2,3], J3[1,2]	Connects Pin 17 (/DISP) to TP5 and S2
	PDSG	[MFP17_SEL2:MFP17_SEL0]=011	J5[2,3], J3[2, 3], J4[1,2]	Connects Pin 17 (PDSG) to the gate of Q7 to enable pre-discharge through Q5
	GPIO	[MFP17_SEL2:MFP17_SEL0]=100	J5[2,3], J3[2,3], J4[2,3]	Connects Pin 17 (GPIO) to Pin 3 of J11
Pin 20	LEDCNTLA	[MFP20_SEL2:MFP20_SEL0]=000 DEFAULT	J15[2,3]	Connects pin 20 to LEDs to be used as LEDCNTLA. Must be used with LEDCNTLB and LEDCNTLC
	PDSG	[MFP20_SEL2:MFP20_SEL0]=010	J15[1,2], J13[1,2]	Connects pin 20 (PDSG) to the gate of Q7 to enable pre-discharge through Q5. In this mode, Pins 21 and Pin 22 are used as GPIOs.
	GPIO	[MFP20_SEL2:MFP20_SEL0]=001	J15[1,2], J13[2,3]	Connects Pin 20 to Pin 6 of J11. Use this pin as a GPIO
Pin 21	LEDCNTLB	[MFP20_SEL2:MFP20_SEL0]=000 DEFAULT	J17[1,2]	Connects pin 21 to LEDs to be used as LEDCNTLB. Must be used with LEDCNTLA and LEDCNTLC
	GPIO	[MFP20_SEL2:MFP20_SEL0]=010 or [MFP20_SEL2:MFP20_SEL0]=001	J17[2,3]	Connects Pin 21 to Pin 7 of J11. Use this pin as a GPIO
Pin 22	LEDCNTLC	[MFP20_SEL2:MFP20_SEL0]=000 DEFAULT	J16[1,2]	Connects pin 22 to LEDs to be used as LEDCNTLC. Must be used with LEDCNTLA and LEDCNTLB
	GPIO	[MFP20_SEL2:MFP20_SEL0]=010 or [MFP20_SEL2:MFP20_SEL0]=001	J16[2,3]	Connects Pin 22 to Pin 8 of J11. Use this pin as a GPIO

3.1.1 Precharge

The EVM provides a power resistor and FET to support a reduced current precharge path to charge the pack when cell voltages are below the precharge voltage threshold. This reduces heating that can lead to cell damage or reduced operating lifetime. For a 7-series cell application, the FET must be rated above the max voltage, and, for this reason, the CSD18504Q5A was chosen. The TI CSD18504Q5A is a 50A, 40V device with $R_{ds(on)}$ of 5.3mΩ when the gate drive voltage is 10V. The user can change R1 to setup the precharge current to a different value. R1 is calculated to limit the precharge current to the desired rate. Be sure to account for the power dissipation of the series resistor. The pre-charge current is limited to $(V_{CHARGER} – V_{BAT})/R1$ and maximum power dissipation is $(V_{charger} – V_{bat})^2/R1$.

3.1.2 Predischarge

The EVM provides a pre-discharge FET (Q5) and control options through jumpers to enable a pin to function as PDSG to turn the FET on and off. The predischarge FET is used in applications where there is a need to soft-start into a large capacitive load, such as a starter cap for a motor, to reduce the instantaneous load current. The predischarge FET slowly charges the cap based on voltage or time. See the *BQ40Z80 Technical Reference Manual* full details.

3.1.3 LED Control

The EVM is configured to support six LEDs to provide state-of-charge information for the cells. If configured with the correct jumpers, press the *LED DISPLAY* button to illuminate the LEDs for approximately 4 seconds. Alternately, the LED's can be turned on with in the Commands tab with the LED_TOGGLE to test the LED function, or DISPLAY_PRESS to display the Relative State of Charge.

3.1.4 Emergency Shutdown

The Emergency Shutdown function allows the user to disable the charge and discharge FETs with an external GPIO pin. The EMSHUT and NR bits must be set high in the DA Configuration register to enable this feature. Press the SHUTDOWN pushbutton switch for one second to disable these FETs, and press again for one second to enable them.

Note

Remember to remove the SYS PRES-to-PACK– short, if present.

3.1.5 Testing Fuse-Blowing Circuit

To prevent the loss of board functionality during the fuse-blowing test, the actual chemical fuse is not provided on the EVM. FET Q9 drives the FUSE test point low if a fuse-blow condition occurs. FUSE is attached to an open drain FET, so a pull-up resistor is required to check whether the FUSE pulls low. A FUSEPIN test point is attached to the gate of Q9; so, monitoring FUSEPIN can be used to test this condition without adding a pull-up resistor. Fuse placement on the application board is shown in the bq40z80 data sheet. A chemical fuse can also be soldered to the EVM for in-system testing. When using the chemical fuse, remove the shorting resistor R1 from the board.

3.2 Circuit Module Physical Layouts

This section contains the printed-circuit board (PCB) layout, assembly drawings, and schematic for the bq40z80 and bq771807 circuit modules.

3.2.1 Board Layout

This section shows the dimensions, PCB layers, and assembly drawing for the bq40z80 modules.

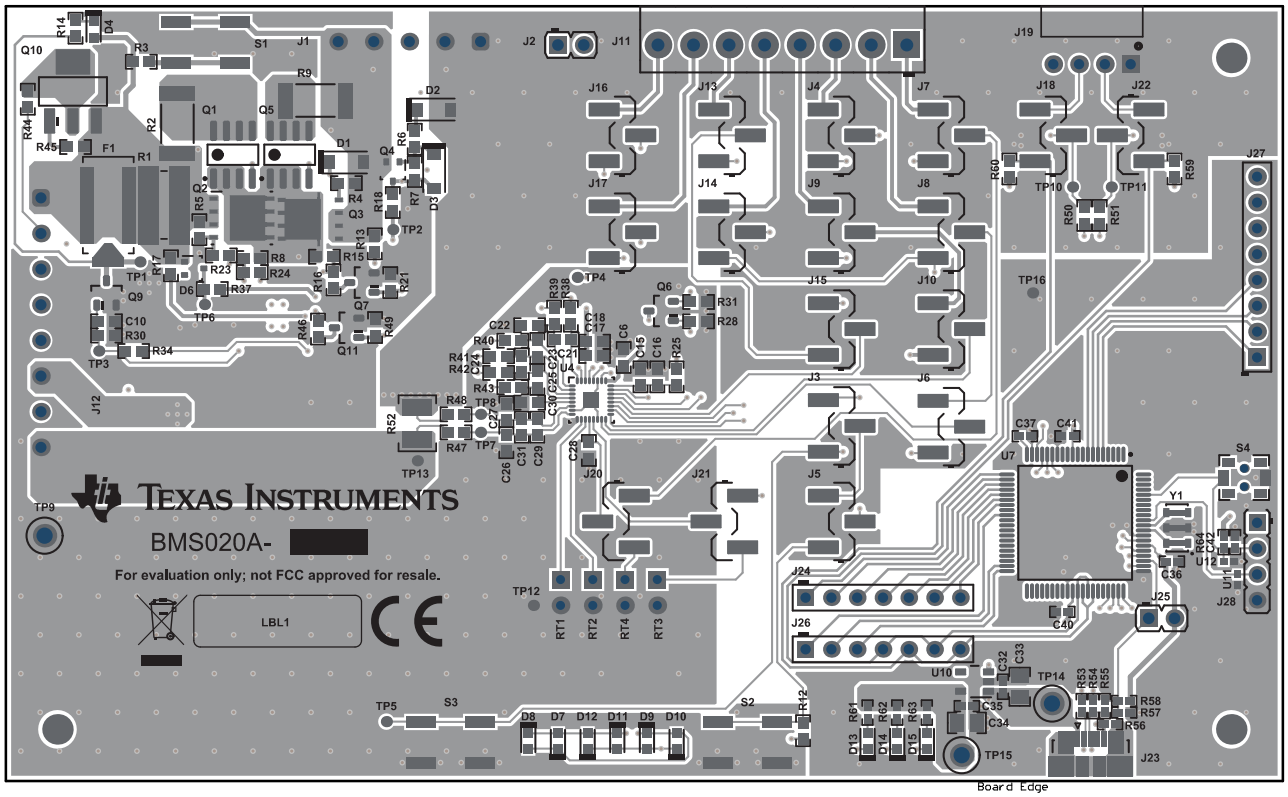


Figure 3-1. bq40z80EVM RevA Top Composite

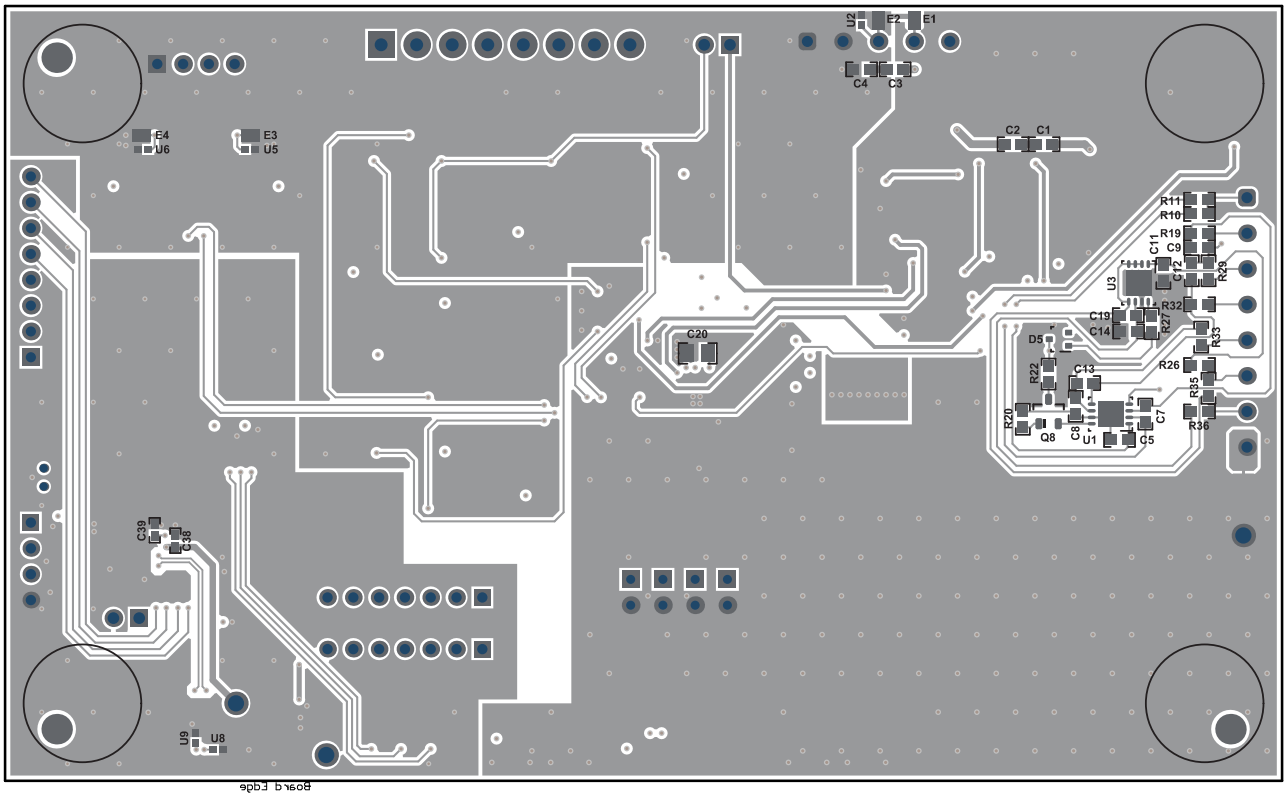


Figure 3-2. bq40z80EVM RevA Bottom Composite

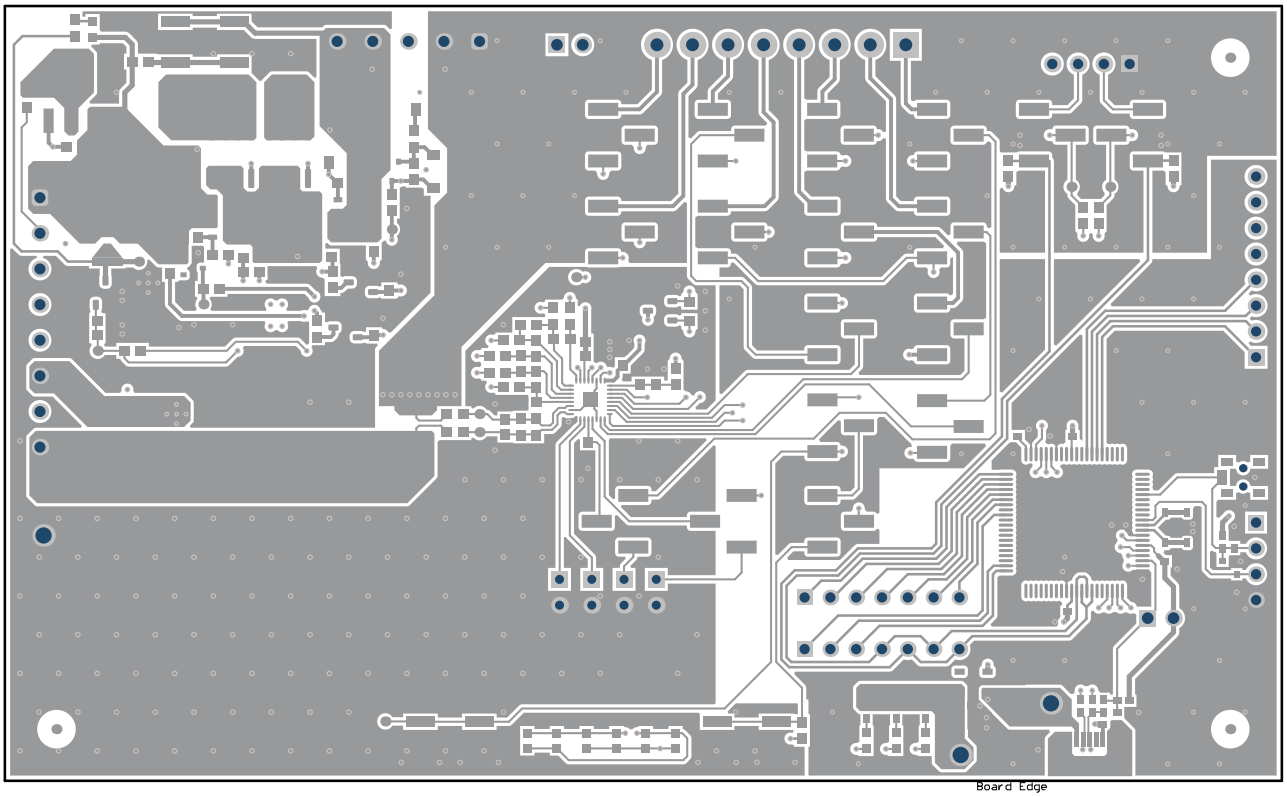


Figure 3-3. bq40z80EVM RevA Top Layer

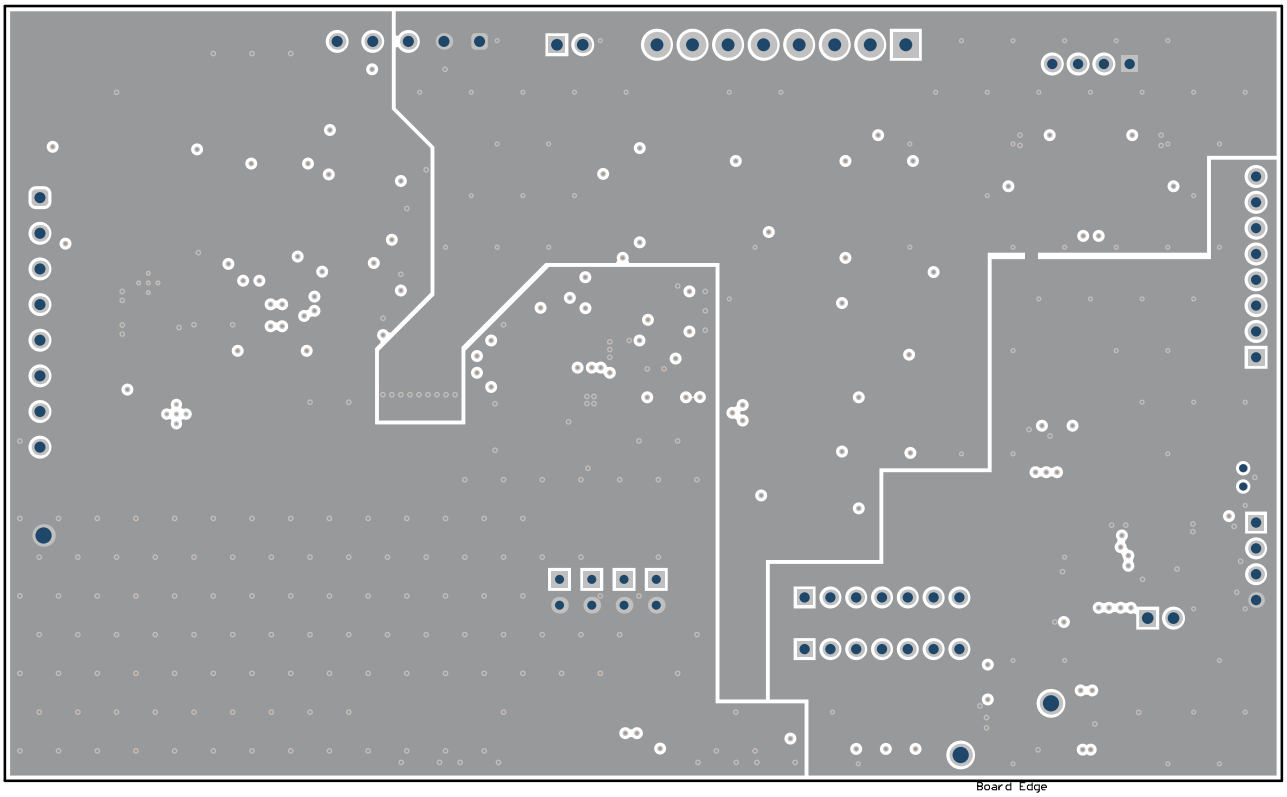


Figure 3-4. bq40z80EVM RevA Internal Layer 2 - GND

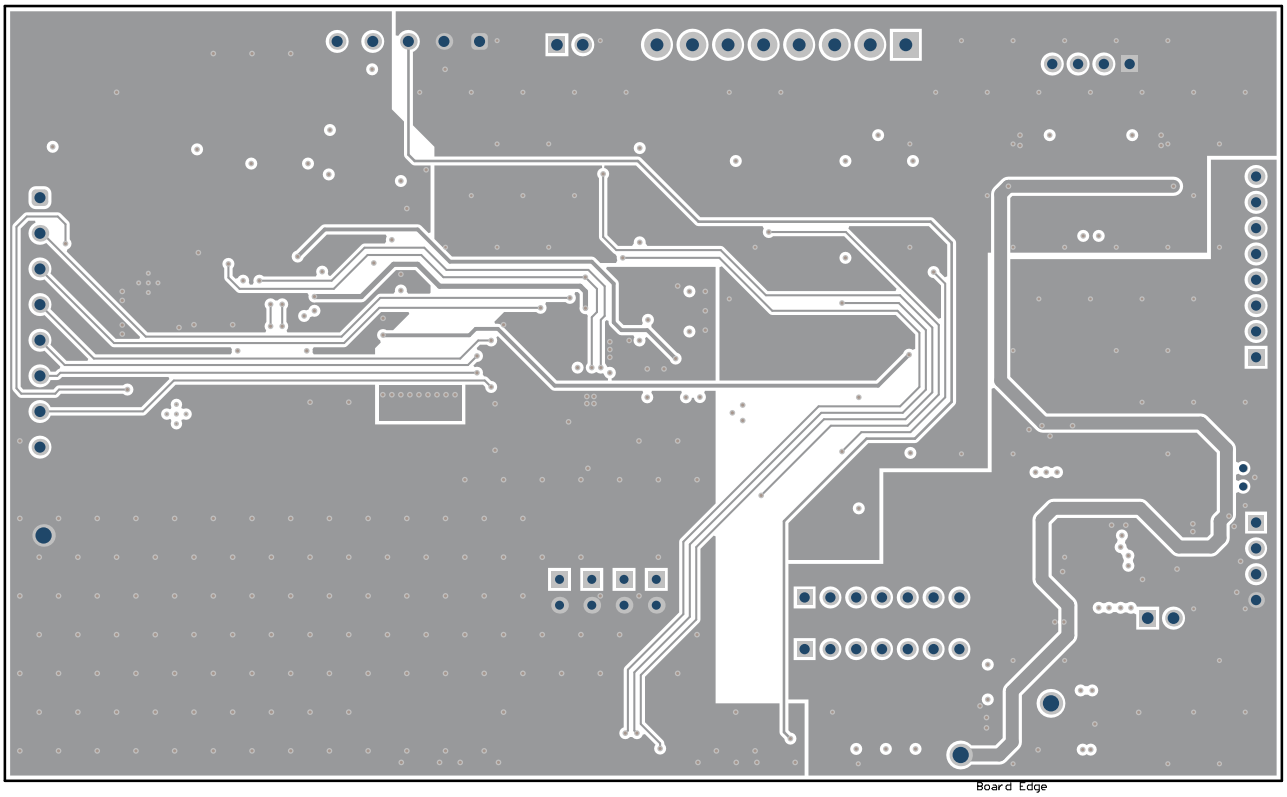


Figure 3-5. bq40z80EVM RevA Internal Layer 3 - Signal

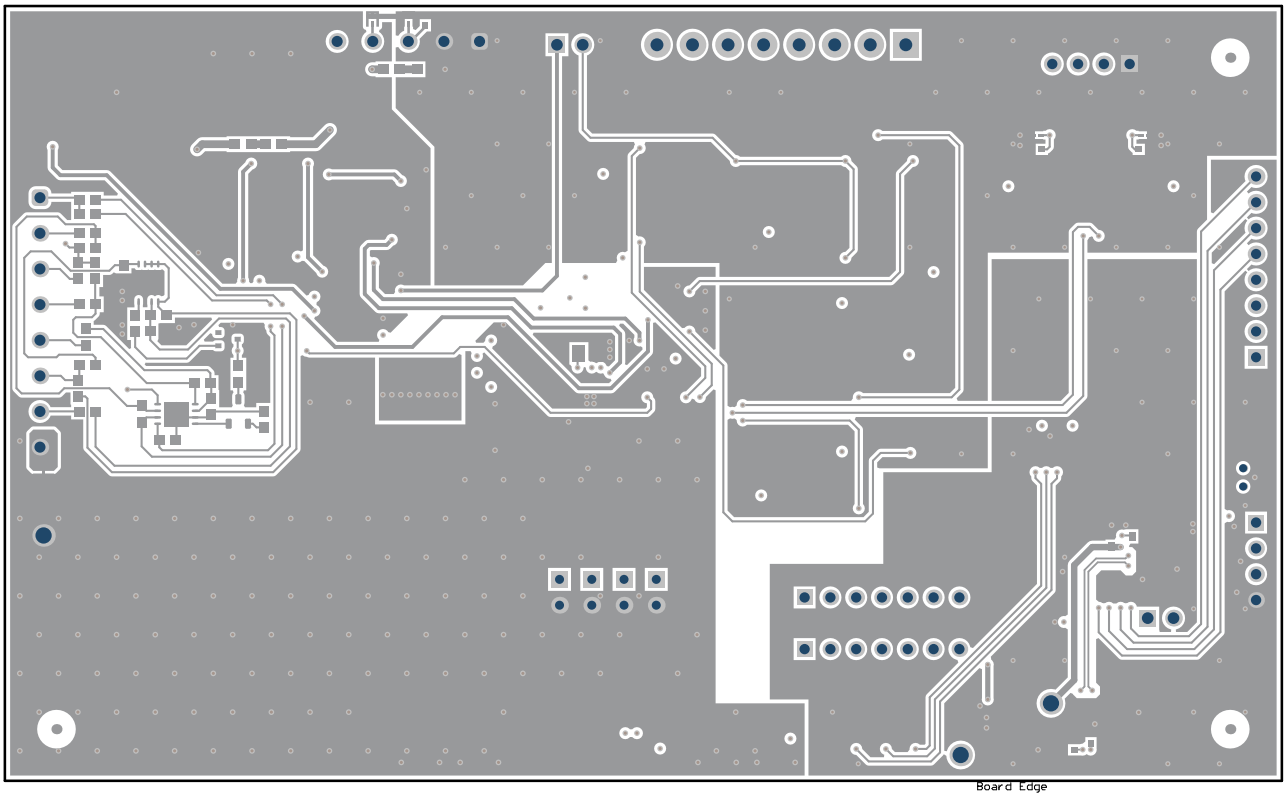
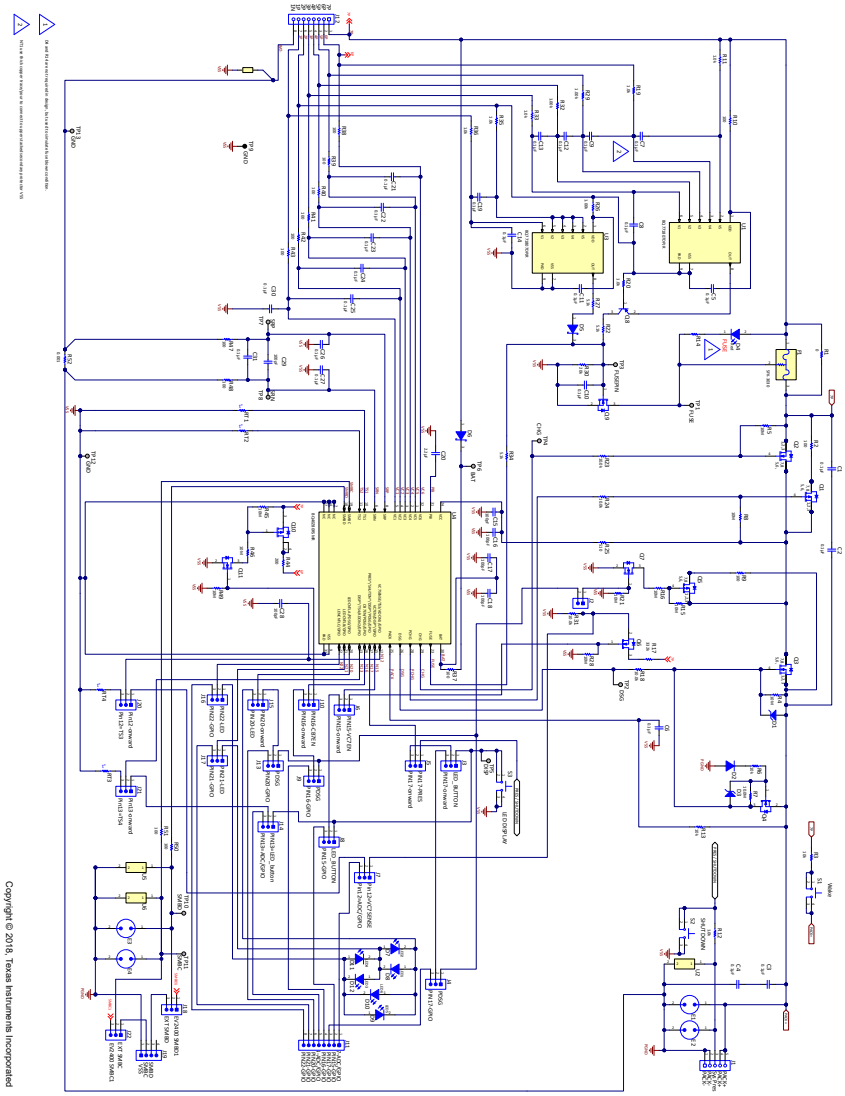


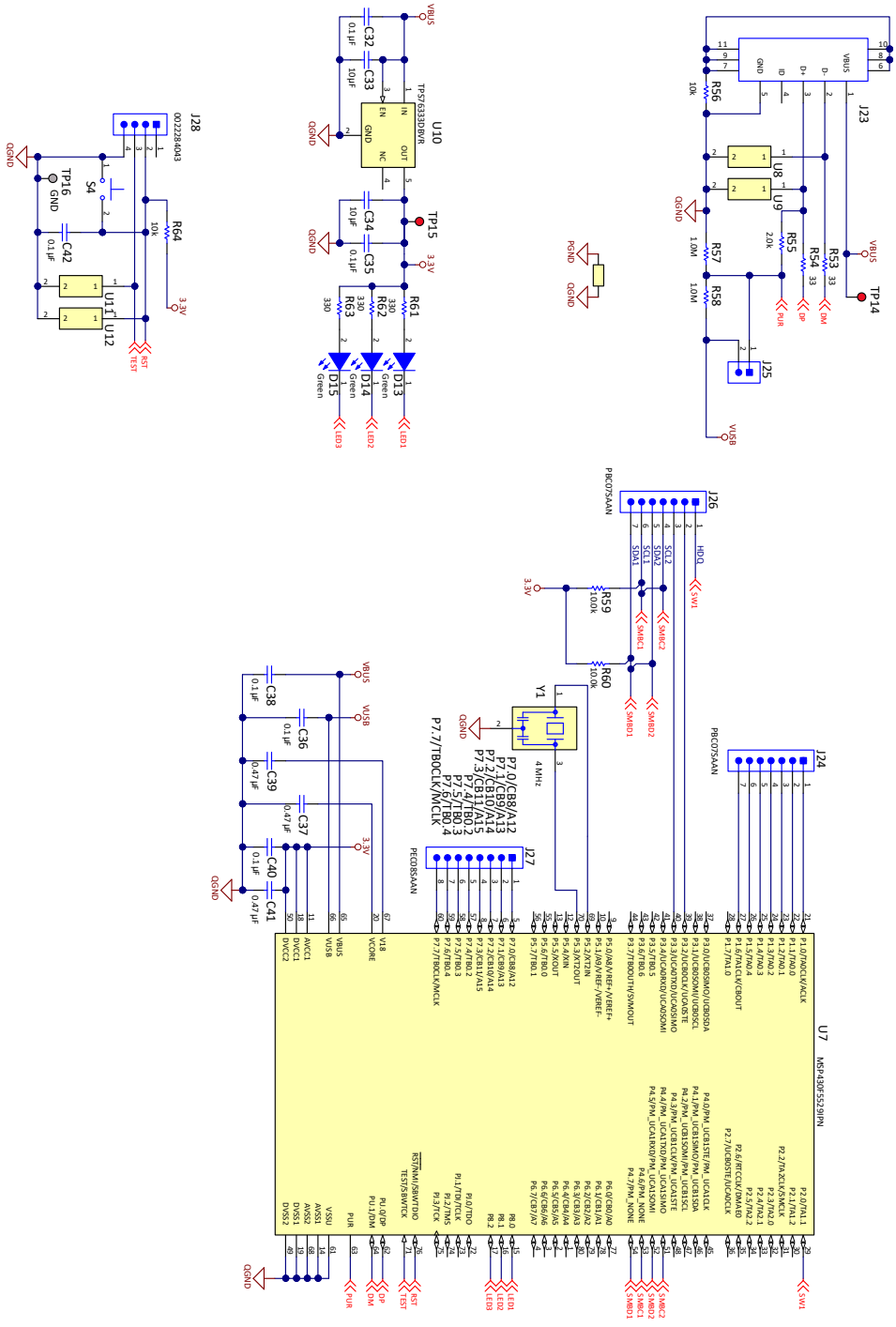
Figure 3-6. bq40z80EVM RevA Bottom Layer

3.2.2 bq40z80RevA Schematic



Note

The BQ40Z80EVM-020 has an incorrect implementation for the reverse polarity circuit. For proper charge and discharge behavior, remove D3 and R7. This will be corrected on a future version of the EVM.



3.3 bq40z80EVM Bill of Materials

Table 3-1. bq40z80EVM RevA

Count	Designator	Value	Description	Package Reference	Part Number	Manufacturer
24	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C19, C21, C22, C23, C24, C25, C26, C27, C30, C31	0.1uF	CAP, CERM, 0.1µF, 50V,+/- 10%, X7R, 0603	0603	GRM188R71H104KA93D	MuRata
6	C15, C16, C17, C18, C28, C29	100pF	CAP, CERM, 100pF, 50V,+/- 5%, C0G/NP0, 0603	0603	C0603C101J5GAC	Kemet
1	C20	2.2uF	CAP, CERM, 2.2µF, 25V,+/- 10%, X7R, 0805	0805	GRM21BR71E225KA73L	MuRata
6	C32, C35, C36, C38, C40, C42	0.1uF	CAP, CERM, 0.1µF, 10V,+/- 10%, X5R, 0402	0402	GRM155R61A104KA01D	MuRata
2	C33, C34	10uF	CAP, CERM, 10µF, 16V,+/- 10%, X5R, 0805	0805	0805YD106KAT2A	AVX
3	C37, C39, C41	0.47uF	CAP, CERM, 0.47µF, 6.3V,+/- 10%, X5R, 0402	0402	04026D474KAT2A	AVX
2	D1, D3	16V	Diode, Zener, 16V, 500mW, SOD-123	SOD-123	MMSZ5246B-7-F	Diodes Inc.
1	D2	100V	Diode, Ultrafast, 100V, 0.15A, SOD-123	SOD-123	1N4148W-7-F	Diodes Inc.
1	D4	Red	LED, Red, SMD	LED_0603	150060RS75000	Wurth Elektronik
2	D5, D6	40V	Diode, Schottky, 40V, 0.2A, SOT-323	SOT-323	BAS40W-7-F	Diodes Inc.
6	D7, D8, D9, D10, D11, D12	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
3	D13, D14, D15	Green	LED, Green, SMD	LED_0603	150060VS75000	Wurth Elektronik
1	F1		Fuse, 30A, 62 VDC, SMD	9.5x2x5mm	SFK-3030	Dexerials Corporation
4	H1, H2, H3, H4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
1	J1		Terminal Block, 3.5mm, 5x1, Tin, TH	Terminal Block, 3.5mm, 5x1, TH	393570005	Molex
2	J2, J25		Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Wurth Elektronik
17	J3, J4, J5, J6, J7, J8, J9, J10, J13, J14, J15, J16, J17, J18, J20, J21, J22		Header, 2.54mm, 3x1, Gold, SMT	Header, 2.54mm, 3x1, SMT	87898-0304	Molex
1	J11		Terminal Block, 3.5mm, 8-Pos, TH	Terminal Block, 3.5mm, 8-Pos, TH	ED555/8DS	On-Shore Technology
1	J12		Terminal Block, 3.5mm, 8x1, Tin, TH	Terminal Block, 3.5mm, 8x1, TH	393570008	Molex
1	J19		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex
1	J23		Receptacle, Micro-USB Type B, 0.65mm, 5x1, R/A, Bottom Mount SMT	Receptacle, 0.65mm, 5x1, R/A, SMT	47346-1001	Molex
2	J24, J26		Header, 2.54mm, 7x1, Gold, TH	Header, 2.54mm, 7x1, TH	PBC07SAAN	Sullins Connector Solutions

Table 3-1. bq40z80EVM RevA (continued)

Count	Designator	Value	Description	Package Reference	Part Number	Manufacturer
1	J27		Header, 100mil, 8x1, Tin, TH	Header, 8x1, 100mil, TH	PEC08SAAN	Sullins Connector Solutions
1	J28		Header, 2.54mm, 4x1, Tin, TH	Header, 2.54mm, 4x1, TH	0022284043	Molex
1	LBL1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
2	Q1, Q5	-40V	MOSFET, P-CH, -40 V, -8.2 A, SO-8	SO-8	FDS4685	ON Semiconductor
1	Q2	40V	MOSFET, N-CH, 40V, 15A, DQJ0008A (VSONP-8)	DQJ0008A	CSD18504Q5A	Texas Instruments
1	Q3	60V	MOSFET, N-CH, 60V, 100A, DNK0008A (VSON-CLIP-8)	DNK0008A	CSD18540Q5B	Texas Instruments
1	Q4	60V	MOSFET, N-CH, 60V, 0.31A, SOT-323	SOT-323	2N7002KW	Fairchild Semiconductor
3	Q6, Q7, Q11	50V	MOSFET, N-CH, 50V, 0.28A, SOT-23	SOT-23	CMPDM7003 TR	Central Semiconductor
1	Q8	40V	Transistor, PNP, 40V, 0.2A, SOT-23	SOT-23	CMPT3906 LEAD FREE	Central Semiconductor
1	Q9	60V	MOSFET, N-CH, 60V, 2A, AEC-Q101, SOT-23	SOT-23	DMN6075S-7	Diodes Inc.
1	Q10	-240V	MOSFET, P-CH, -240V, -0.48A, SOT-223	SOT-223	ZVP4424GTA	Diodes Inc.
1	R1	0	RES, 0, 5%, 2 W, 2512 WIDE	2512 WIDE	RCL12250000Z0EG	Vishay Draloric
2	R2, R9	100	RES, 100, 5%, 1 W, AEC-Q200 Grade 0, 2512	2512	CRCW2512100RJNEG	Vishay-Dale
3	R3, R6, R13	10k	RES, 10 k, 5%, 0.1 W, 0603	0603	CRCW060310K0JNEA	Vishay-Dale
10	R4, R5, R8, R15, R16, R21, R28, R45, R46, R49	10Meg	RES, 1M, 5%, 0.1W, 0603	0603	CRCW060310M0JNEA	Vishay-Dale
1	R7	10.0Meg	RES, 10.0M, 1%, 0.1W, 0603	0603	CRCW060310M0FKEA	Vishay-Dale
12	R10, R37, R38, R39, R40, R41, R42, R43, R47, R48, R50, R51	100	RES, 100, 5%, 0.1 W, 0603	0603	CRCW0603100RJNEA	Vishay-Dale
8	R11, R12, R14, R19, R20, R33, R35, R36	1.0k	RES, 1.0 k, 5%, 0.1 W, 0603	0603	CRCW06031K00JNEA	Vishay-Dale
1	R17	332k	RES, 332 k, 0.1%, 0.1 W, 0603	0603	RG1608P-3323-B-T5	Susumu Co Ltd
3	R18, R23, R24	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	RCG060310K0FKEA	Vishay Draloric
3	R22, R27, R34	5.1k	RES, 5.1 k, 5%, 0.1 W, 0603	0603	CRCW06035K10JNEA	Vishay-Dale
1	R25	510	RES, 510, 5%, 0.1 W, 0603	0603	CRCW0603510RJNEA	Vishay-Dale
3	R26, R29, R32	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale
1	R30	20k	RES, 20 k, 5%, 0.1 W, 0603	0603	CRCW060320K0JNEA	Vishay-Dale
3	R31, R59, R60	10.0k	RES, 10.0 k, 0.1%, 0.1 W, 0603	0603	RG1608P-103-B-T5	Susumu Co Ltd
1	R44	200	RES, 200, 1%, 0.1 W, 0603	0603	CRCW0603200RFKEA	Vishay-Dale
1	R52	0.001	RES, 0.001, 1%, 1 W, 1210	1210	PMR25HZPFV1L00	Rohm

Table 3-1. bq40z80EVM RevA (continued)

Count	Designator	Value	Description	Package Reference	Part Number	Manufacturer
2	R53, R54	33	RES, 33, 5%, 0.063 W, 0402	0402	CRCW040233R0JNED	Vishay-Dale
1	R55	2.0k	RES, 2.0 k, 5%, 0.063 W, 0402	0402	CRCW04022K00JNED	Vishay-Dale
2	R56, R64	10k	RES, 10 k, 5%, 0.063 W, 0402	0402	CRCW040210K0JNED	Vishay-Dale
2	R57, R58	1.0Meg	RES, 1.0M, 5%, 0.063W, 0402	0402	CRCW04021M00JNED	Vishay-Dale
3	R61, R62, R63	330	RES, 330, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF3300X	Panasonic
4	RT1, RT2, RT3, RT4	10.0k ohm	Thermistor NTC, 10.0k ohm, 1%, Disc, 5x8.4 mm	Disc, 5x8.4 mm	103AT-2	SEMITEC Corporation
3	S1, S2, S3		Switch, Tactile, SPST-NO, SMT	Switch, 6.2X5X6.2 mm	KST221JLFS	C & K Components
1	S4		Switch, SPST-NO, Off-Mom, 0.05A, 12VDC, SMD	3.9x2.9mm	PTS820 J20M SMTR LFS	C & K Components
20	SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13, SH-J14, SH-J15, SH-J16, SH-J17, SH-J18, SH-J19, SH-J20	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
1	TP9		Test Point, Compact, Black, TH	Black Compact Testpoint	5006	Keystone
2	U1, U3		Family 2-5S Overvoltage Protector with Internal Delay Timer, DPJ0008A (WSON-8)	DPJ0008A	BQ771807DPJR	Texas Instruments
7	U2, U5, U6, U8, U9, U11, U12		ESD in 0402 Package with 10pF Capacitance and 6V Breakdown, 1 Channel, -40 to +125 degC, 2-pin X2SON (DPY), Green (RoHS & no Sb/Br)	DPY0002A	TPD1E10B06DPYR	Texas Instruments
1	U4		Catalog 1S-7S Battery Gauge + Protector Based on bqExtend, RSM0032A (VQFN-32)	RSM0032A	BQ40Z80RSMR	Texas Instruments
1	U7		25MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 degC, 80-pin QFP (PN), Green (RoHS & no Sb/Br)	PN0080A	MSP430F5529IPN	Texas Instruments
1	U10		Single Output LDO, 150mA, Fixed 3.3V Output, 2.7 to 10V Input, with Low IQ, 5-pin SOT-23 (DBV), -40 to 125 degC, Green (RoHS & no Sb/Br)	DBV0005A	TPS76333DBVR	Texas Instruments
1	Y1		Resonator, 4MHz, 39pF SMD	4.5x1.2x2 mm	CSTCR4M00G15L99-R0	MuRata
0	FID1, FID2, FID3, FID4, FID5, FID6		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A

4 Additional Information

4.1 Trademarks

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5 Related Documentation from Texas Instruments

- Texas Instruments, *bq40z70 1-Series, 2-Series, 3-Series, and 4-Series Li-Ion Battery Pack Manager*, data sheet
- Texas Instruments, *BQ40Z80 Technical Reference Manual*
- Texas Instruments, *bq40z80 Manufacture, Production, and Calibration*, application note
- Texas Instruments, *How to Complete a Successful Learning Cycle for the bq40z80*, application note
- Texas Instruments, BQ296xxx Overvoltage Protection for 2-Series, 3-Series, and 4-Series Cell Li-Ion Batteries with Regulated Output Supply, data sheet

6 Revision History

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

Changes from Revision A (August 2018) to Revision B (June 2025)	Page
• Added a note for capacitor replacement	2

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