bq27742EVM Single-Cell Impedance Track™ Technology Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the bq27742-G1 fuel gauge. The EVM includes one bq27742 circuit module, a current sense resistor, two thermistors, and two protection N-FETs. An EV2400 PC interface board and a PC USB cable are required for fuel gauge interface, but must be ordered separately. The circuit module includes one bq27742 integrated circuit and all other onboard components necessary to monitor and predict capacity for a pack-side fuel gauge solution and to perform the protection. The circuit module connects directly across the battery cell. With the EV2400 interface board and software, the user can read the bq27742 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the bq27742 solution under different charge and discharge conditions. The latest Windows™-based PC software can be downloaded from the product folder on the Texas Instruments Web site.

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1 Features

- Complete evaluation system for the bq27742 fuel gauge with Impedance Track™ Technology
- Populated circuit module for quick setup
- Personal computer (PC) software and interface board for easy evaluation
- Software that allows data logging for system analysis
- Ability to upgrade to the latest firmware version by flash reprogramming

1.1 Kit Contents

- bq27742 circuit module

This EVM is used for the evaluation of different bq27742-based products. Please ensure that you visit the product Web folder at http://www.ti.com to download the latest firmware version, evaluation software, and documentation for the associated product to be evaluated.

1.2 Ordering Information

Table 1. Ordering Information

EVM Part Number	Chemistry	Configuration	Capacity
bq27742EVM	Li-Ion	1 cell	Any

2 bq27742-Based Circuit Module

The bq27742-based circuit module is a complete and compact example solution of a bq27742 circuit for battery management. The circuit module incorporates a bq27742 battery fuel gauge IC, dual N-FETs for high-side protection, and all other components necessary to protect and accurately predict the capacity of a 1-series Li-ion cell.

2.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct connection to the battery cell (TB1 or TP1/TP2): CELL+ and CELL–
- Connect a charger power to TB2: PACK+ and PACK–, or short the PACK+ and CELL+ to wake up the gauge, then remove the connection of PACK+ and CELL+ or the charger
- To the serial communications port: SDA, SCL, and VSS (J10) or HDQ and VSS (J8)
- The system load and charger connect across charger and load (TB2 or TP9/TP10): PACK–/LOAD– and PACK+/LOAD+.

2.2 Pin Descriptions

Pin Name	Description
PACK+	Pack positive terminal
PACK–	Pack negative terminal
CELL+	Cell positive terminal
CELL–	Cell negative terminal
TERM	Thermistor input that leads to IC TS pin
SDA	I^2C communication data line
SCL	I^2C communication clock line
HDQ	Single-wire communication line
VSS	Signal return for communication line

3 Circuit Module Physical Layouts, Bill of Materials, and Schematic

This section contains the printed-circuit board (PCB) layout, bill of materials, assembly drawings, and schematic for the bq27742 circuit module.

3.1 Board Layout

This section shows the printed-circuit board (PCB) layers (Figure 1 through Figure 4), assembly drawing, and schematic for the bq27742 module.

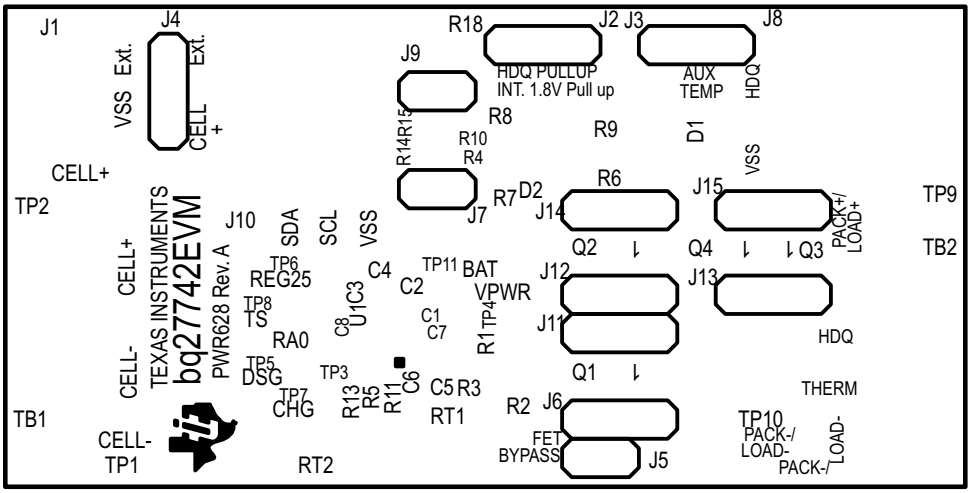

Figure 1. bq27742EVM Layout, Silk Screen

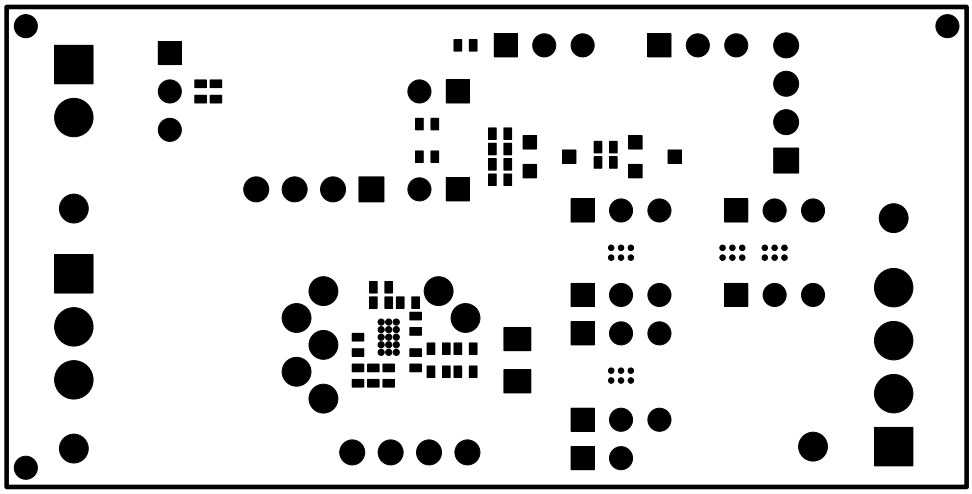

Figure 2. Top Assembly

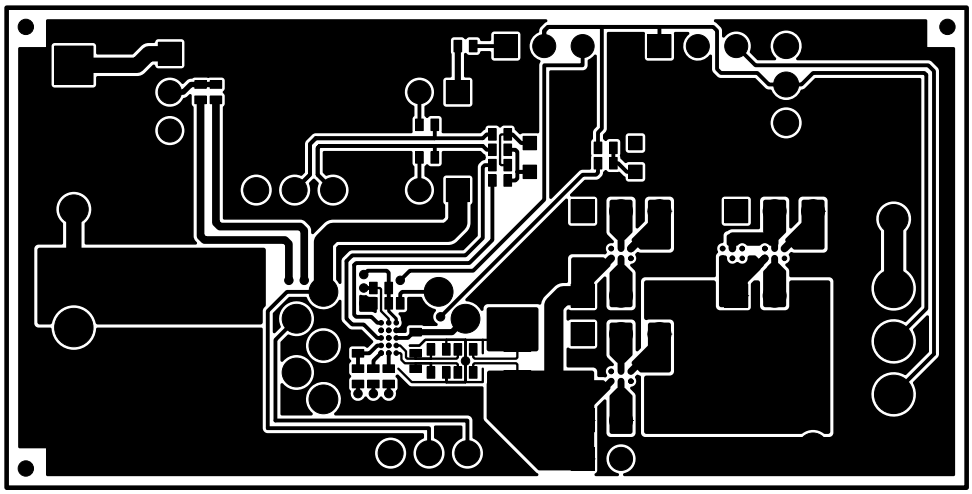

Figure 3. Top Layer

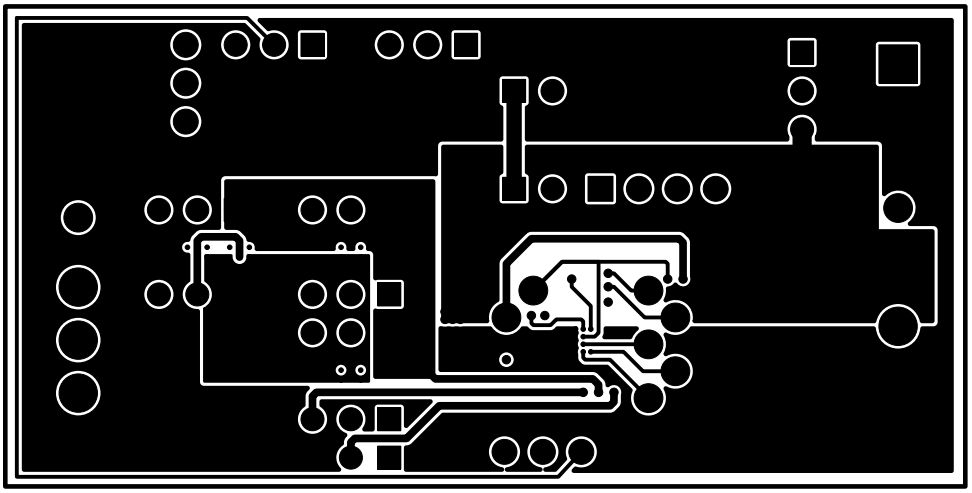

Figure 4. Bottom Layer

3.2 Bill of Materials and Schematic

Table 2. Bill of Materials

Count	Reference Designator	Value	Description	Size	Part Number	MFR
6	C1, C2, C5, C6, C7, C8	0.1 µF	Capacitor, Ceramic, 10 V, X5R, 10%	0402	GRM155R61A104KA01D	Murata
1	C3	1 µF	Capacitor, Ceramic, 6.3 V, X5R, 10%	0402	GRM155R60J105KE19D	Murata
1	C4	0.47 µF	Capacitor, Ceramic, 0.47 µF, 6.3 V, X5R, 10%	0402	GRM155R60J474KE19D	Murata
2	D1, D2	AZ23C5V6-7	Diode, Dual, Zener, 5.6 V, 300 mW	SOT23	AZ23C5V6-7-F	Diodes
1	J1	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5 mm	0.27 x 0.25 inch	ED555/2DS	OST
9	J2, J3, J4, J6, J11, J12, J13, J14, J15	PEC03SAAN	Header, Male 3-pin, 100mil spacing	0.100 inch x 3	PEC03SAAN	Sullins
3	J5, J7, J9	PEC02SAAN	Header, Male 2-pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
2	J8, J10	22-05-3041	Header, Friction Lock Ass'y, 4-pin Right Angle	0.400 x 0.500	22-05-3041	Molex
1	Q1	UPA2375T1P-E1-A	MOSFET, Dual N-Channel NexFET, 12 V 3.2 A	WSCP	UPA2375T1P-E1-A	Renesas Electronics America
0	Q2, Q3, Q4	DNP	MOSFET, Dual N-Channel NexFET, 12 V 3.2 A	WSCP	UPA2375T1P-E1-A	Renesas Electronics America
2	R1, R3	200 Ω	Resistor, Chip, 1/16-W, 5%	0402	CRCW0402200RJNED	Vishay Dale
1	R12	4.7 kΩ	Resistor, Chip, 1/16-W, 5%	0402	CRCW04024K70JNED	Vishay Dale
1	R13	2 kΩ	Resistor, Chip, 1/16-W, 5%	0402	CRCW04022K00JNED	Vishay Dale
2	R14, R15	10 kΩ	Resistor, Chip, 1/16-W, 5%	0402	CRCW040210K0JNED	Vishay Dale
2	R16, R17	10 Ω	Resistor, Chip, 1/16-W, 5%	0402	CRCW040210R0JNED	Vishay Dale
1	R2	5 mΩ	Res, Metal Current sense, 1W, ±1%, 50 ppm	1632	MCS1632R005FER	Ohmite
6	R4, R6, R7, R8, R9 R10	100 Ω	Resistor, Chip, 1/16-W, 5%	0402	CRCW0402100RJNED	Vishay Dale
2	R5, R11	1 kΩ	Resistor, Chip, 1/16-W, 5%	0402	CRCW04021K00JNED	Vishay Dale
2	RT1, RT2	10 kΩ	Thermistor, 10 kΩ	0.095 x 0.150 inch	103AT-2	Semitec
1	TB1	ED1515	Terminal Block, 3-pin, 6-A, 3.5 mm	0.41 x 0.25 inch	ED555/3DS	OST
1	TB2	ED555/4DS	Terminal Block, 4-pin, 6-A, 3.5 mm	0.55 x 0.25 inch	ED555/4DS	OST
7	TP1, TP4, TP5, TP7, TP8, TP10, TP11	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
4	TP2, TP3, TP6, TP9	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
1	U1	bq27742YZFR-G1	IC, Single Cell Li-Ion Pack Side Fuel Gauge with Integrated Protection	BGA-15	bq27742YZFR-G1	TI
1	--		PCB		PWR231	Any

(1) These assemblies are ESD sensitive, ESD precautions should be observed.

(2) These assemblies must be clean and free from flux and all contaminants.
Use of no clean flux is not acceptable.

(3) These assemblies must comply with workmanship standards IPC-A-610 Class 2.

(4) Reference designators marked with an asterisk ('**') cannot be substituted.
All other components can be substituted with equivalent manufacturer's components.

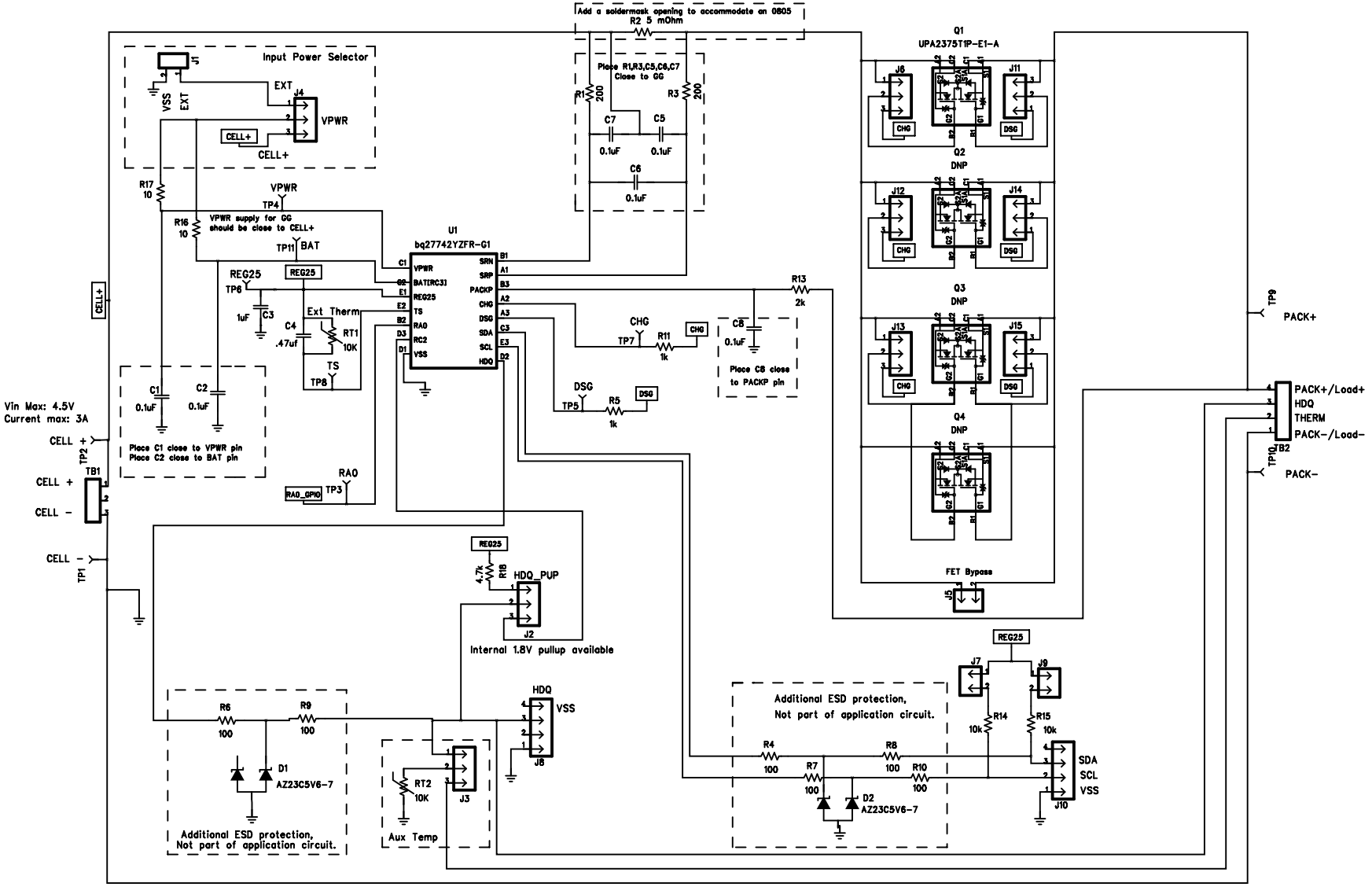

Figure 5. Schematic

3.3 bq27742 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq27742 circuit module.

Table 3. Performance Specification Summary

Specification	Min	Typ	Max	Unit
Input voltage Pack+ to Pack–	2.7	3.6	4.35	V
Charge and discharge current	0	1	2	A

4 EVM Hardware and Software Setup

This section describes how to install the bq27742EVM PC software, and how to connect the different components of the EVM.

4.1 System Requirements

The Battery Management Studio software requires Windows XP or later. Using later versions of Windows operating system can have issues with the USB driver support. The EV2300 USB drivers have been tested for Windows 98SE and Windows XP, but no assurance is made for problem-free operation with specific system configurations. The EV2300 interface board is not officially supported for 64-bit versions of Windows and typically does not work with Windows 7 or newer. The EV2400 interface board is the recommended USB-I^2C interface for Windows 7 and other 64-bit versions. No driver installation is required for use of EV2400 interface board. The EV2400 interface board has built-in I^2C pullups while the EV2300 interface board does not. Jumpers J7 and J9 can be removed from the bq27742EVM if the EV2400 interface board is used.

4.2 Software Installation

Find the latest software version in the bq27742 tool folder on power.ti.com. Make a search by Part Number for bq27742 to access the tool folder. Currently the most recent firmware version is bq27742-G1. Use the following steps to install the bq27742 Battery Management Studio software:

1. Ensure that the EV2300 or EV2400 interface board is not connected to the personal computer (PC) through the USB cable before starting this procedure.
2. Open the archive containing the installation package, and copy its contents into a temporary directory.
3. Open the software file that was downloaded from the TI Web site.
4. Follow the instructions on screen until completing the software installation.
5. Before starting the evaluation software, connect the EV2300 or EV2400 interface board to the computer using the USB cable.
6. If the EV2300 interface board is connected, wait until system prompt *New Hardware Found* appears. Choose *Select Location Manually*, and use the **Browse** button to point to subdirectory TIUSBWin2K-XP-1.
7. Answer **Continue** to the warning that drivers are not certified with Microsoft®.
8. If the EV2300 interface board is connected, after the previous installation finishes, another system prompt *New Hardware Found* appears. Repeat steps 1 through 5, but specify the directory as TIUSBWin2K-XP-2.
9. Answer **Continue** to the warning that drivers are not certified with Microsoft. Driver installation is now finished.
10. For the EV2400 interface board, the driver should be installed along with software installation.

5 Troubleshooting Unexpected Dialog Boxes

The user who is downloading the files must be logged in as the administrator. The driver is not signed, so the administrator must allow installation of unsigned drivers in the operating system. If using Windows 7, install the software with administrator privileges.

6 Hardware Connection

Use of the bq27742EVM-001 requires three hardware components:

- bq27742 circuit module
- EV2300 or EV2400 PC interface board
- Windows PC

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6.1 Connecting the bq27742 Circuit Module to a Battery Cell

Figure 6 shows how to connect the bq27742 circuit module to the cell and system load/charger.

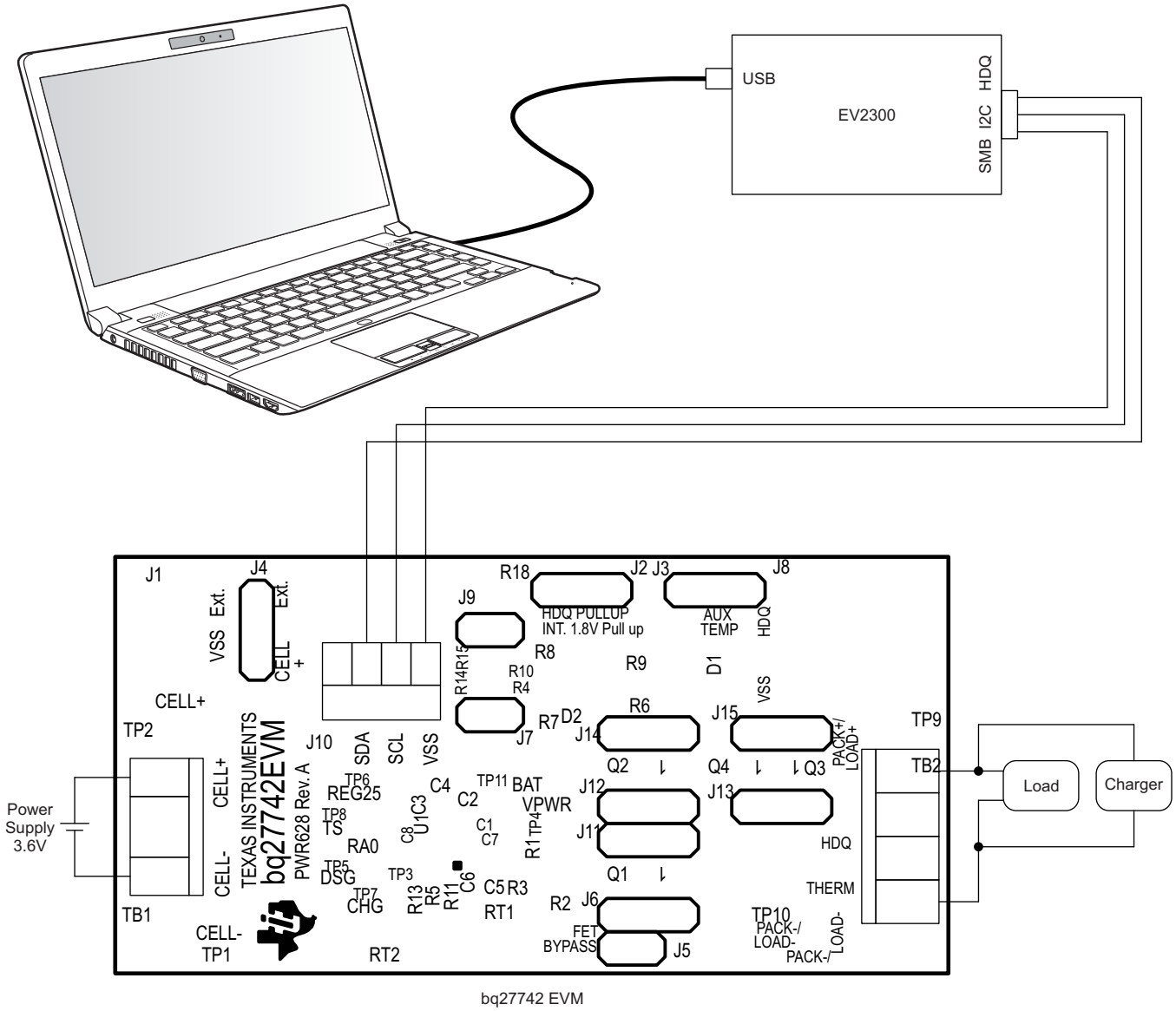

Figure 6. bq27742 Circuit Module Connection to Cell and System Load/Charger

6.2 PC Interface Connection

The bq27742 fuel gauge can be configured as an HDQ communication device or left in default as an I²C device. Once the bq27742 fuel gauge is configured for HDQ communication, it cannot be reverted to I²C mode. See Section 10 for information on configuring the bq27742 fuel gauge to HDQ mode.

The following steps configure the hardware for interfacing to the PC:

1. Connect the bq27742-based EVM to the EV2300 interface board using wire leads as shown in Table 4 and Table 5.

Table 4. Circuit Module to EV2300 Connections – I²C

bq27742-Based Battery (I²C Mode)	EV2300 (I²C Port)
SDA	SDA
SCL	SCL
VSS	GND

Table 5. Circuit Module to EV2300 Connections – HDQ

bq27742-Based Battery (HDQ Mode)	EV2300 (HDQ Port)
HDQ	HDQ
VSS	GND

2. Connect a charger to wake-up the gauge, can use a power supply between PACK+ and PACK– or short CELL+ and PACK+. After wake-up, the charger can be removed.
3. Connect the PC USB cable to the EV2300 interface board and the PC USB port.

The bq27742EVM is now set up for operation.

7 Operation

This section details the operation of the Battery Management Studio software.

7.1 Starting the Program

Run Battery Management Studio from the Start → Programs → Texas Instruments → Battery Management Studio menu sequence. The main Battery Management Studio window (see Figure 7) appears.

When Battery Management Studio first starts up the *Gauge Dashboard* window, the *Registers* window, and *Command* window should be seen in the main window. *DataMemory*, *chemistry*, and other windows can be added to the main window by clicking on the corresponding icon in the tools panel at the top of the main window.

Data should appear initially in the *Gauge Dashboard*, *Registers*, and *DataMemory* sections. The **Refresh** (single-time scan) or the **Scan** (continuous scan) buttons can be clicked to update the data in the *Registers* and *DataMemory* windows.

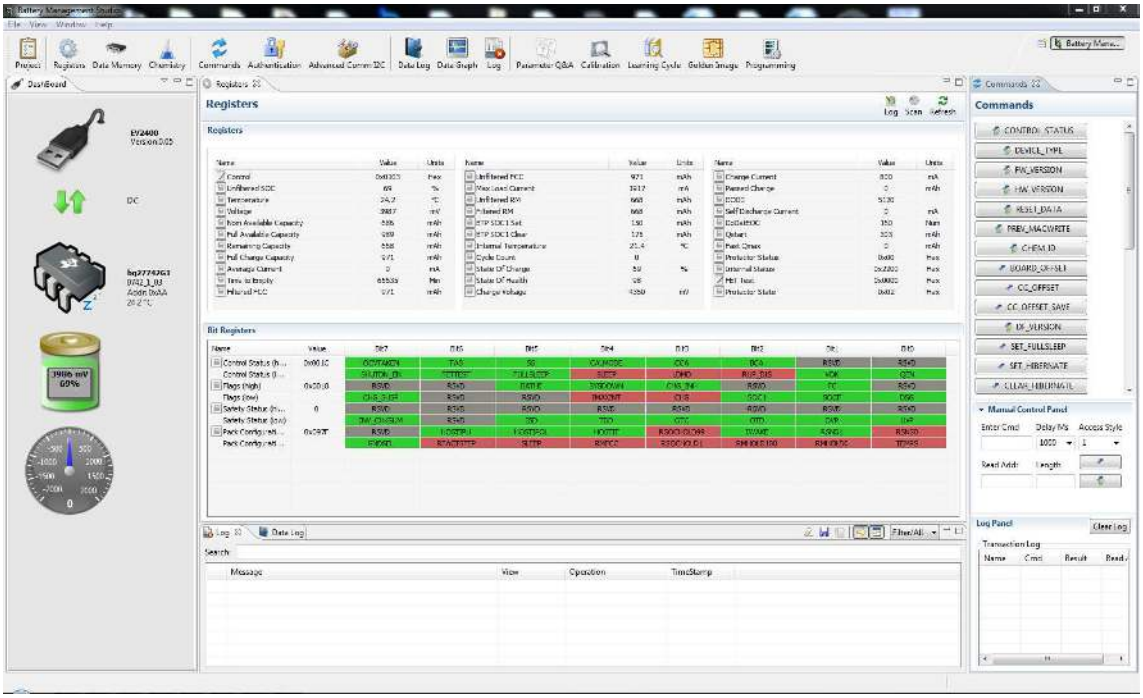

Figure 7. Battery Management Studio Screen

Battery Management Studio provides a logging function which logs selected Data Registers and Data Memory values last received from the bq27742 fuel gauge. To enable this function, click the *DataLog* icon. The *DataLog* window will appear below the *Registers* and *DataMemory* windows. Registers and DataMemory parameters can be added to the log by clicking on the *Add Register* and *Add DataMemory Parameter* drop-down menus in the *DataLog* window and then selected the desired Registers or DataMemory parameters to be added to the log. After all the desired Registers and DataMemory parameters have been added to the log, click the **Play** button in order to begin logging. A **Stop** button will replace the **Play** button once logging starts, the **Stop** button can be clicked to stop logging. The log can be saved by clicking on the *Save* icon and specifying a file name.

The logging intervals are specified by the value in the drop down menu in the *DataLog* window. To change the logging intervals, click the drop down menu and choose one of the intervals provided in the menu selections that appear.

Figure 7 shows the main *Battery Management Studio* window. Additional Flag and Status data can be viewed at the bottom of the *Registers* window.

Each window can be resized and docked in various positions within the main *Battery Management Studio* window. Each window can also be pulled out from the main window and allowed its own floating window. Also, the *Gauge Dashboard* window and all windows that are enabled in the *Tools* panel in the *Communication* and *Debug* sections can be set to autohide.

7.2 Setting Programmable bq27742 Options

The bq27742 data flash comes configured per the default settings detailed in the bq27742 data sheet (SLUSBV9). Ensure that the settings are correctly changed to match the pack and application for the bq27742 solution being evaluated.

IMPORTANT: The correct setting of these options is essential to get the best performance. The settings can be configured using the *DataMemory* window seen in the main *Battery Management Studio* window (see Figure 8).

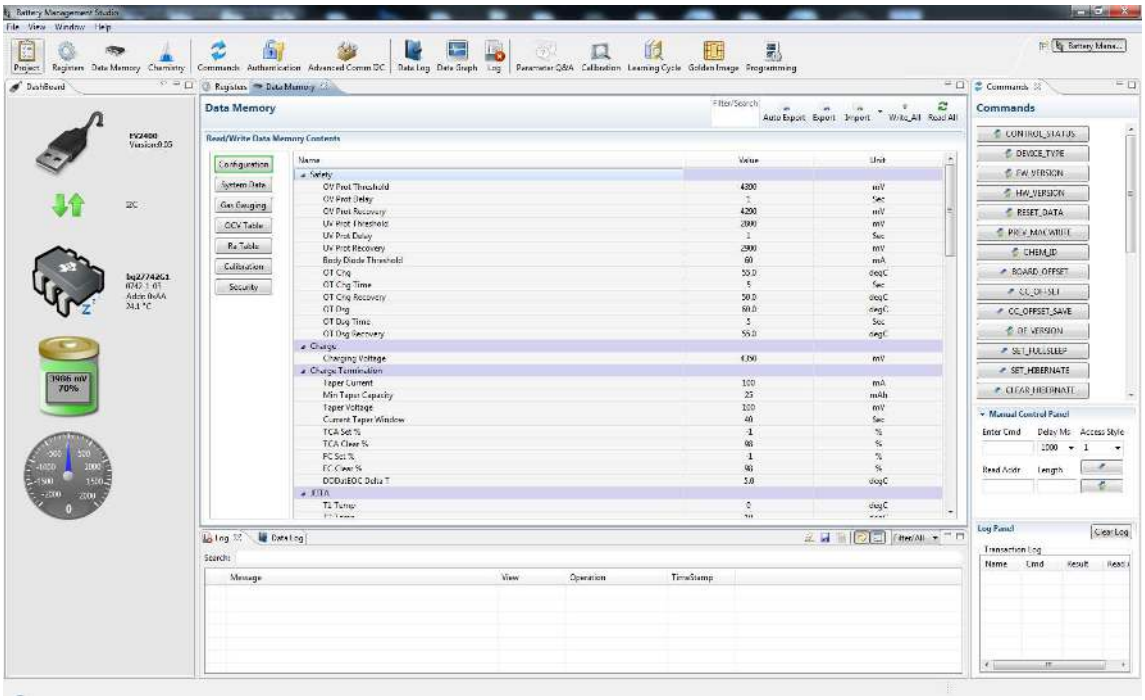

Figure 8. DataMemory Screen

To read all the data flash from the bq27742, click on the Refresh button in the *DataMemory* window.

To write to a data flash location, click on the desired location, enter the data in dialog box and click “OK” or hit the Enter key. The data flash must be read before any writes are performed to avoid any incorrect data being written to the device. Reading the data after any writes is also recommended.

The data-flash configuration can be saved to a file by clicking the Export button and entering a file name. A data-flash file also can be retrieved in this way by clicking the Import button. The exported file has a *.gg* extension and can be opened and edited with a text editor. It does not contain all of the data flash. It only contains the public volatile parameters and should not be used for production programming. The *.senc*, *.dfi*, *.dffs*, *.bqfs*, or *.dmi* file should be used for production as these contain the entire data flash image, including hidden static parameters such as the battery profile.

The module calibration data is also stored in the bq27742 data flash.

8 Calibrate Screen

To ensure proper calibration, perform the following steps. These steps may or may not be required, depending on the type of calibration being performed. Only one calibration item can be selected and calibrated at a time.

8.1 To Calibrate the bq27742

Calibrate each item one at a time in the order presented in this document. Select the types of calibration to be performed by checking the corresponding field (see Figure 9).

Enter the measured values for the types selected, if necessary.

Then press the “Calibrate” button. After all calibration is complete, close the Calibrate screen.

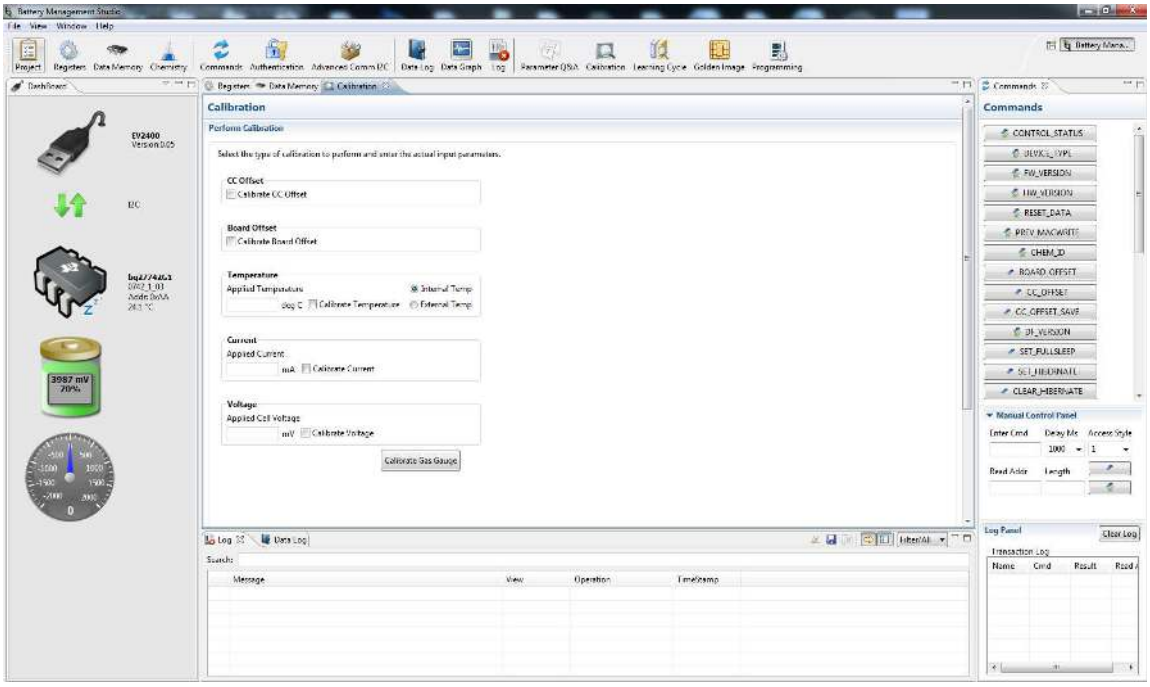

Figure 9. Calibration Screen

8.2 Temperature Calibration

- Select if the temperature sensor to calibrate is the internal or the external.
- Measure the temperature for PACK.
- Type the temperature value into *Enter measured value*.
- Press Calibrate Gas Gauge button.

8.3 Voltage Calibration

- Measure the voltage across Pack+ and Pack– with a calibrated meter.
- Type the voltage value in mV into *Enter measured value*.
- Press Calibrate Gas Gauge button.

8.4 Coulomb Counter Offset Calibration

This performs the internal calibration of the coulomb counter input offset. Check the Calibrate CC Offset field and press the Calibrate Gas Gauge button.

8.5 Board Offset Calibration

This performs the offset calibration for the current offset of the board. It takes approximately 35 seconds to complete.

It is expected that no current is flowing through the sense resistor while performing this calibration step. Remove load and short PACK– to LOAD–.

Press the “Calibrate” button.

Remember to calibrate board offset after coulomb counter calibration.

8.6 Current Calibration

- Connect a load to LOAD– and LOAD+ that draws approximately 1 A, or connect a current source to PACK+ and CELL+. Ensure that the Measured Current reported is negative, or else reverse the connections.
- Measure the current with a calibrated meter, and type the value into Enter measured Current using (–) for current in discharge direction.
- Check the Calibrate Current field
- Press the “Calibrate” button.
- Disconnect or stop the load current after calibration.

9 Firmware Screen

Firmware screen is used to save or program a complete flash image from or to the gauge. This is done using a .senc file, which contains the instruction flash image (firmware) and the data flash image (see Figure 10). The bq27742EVM may or may not be shipped with the latest firmware version (currently bq27742-G1 v1.03).

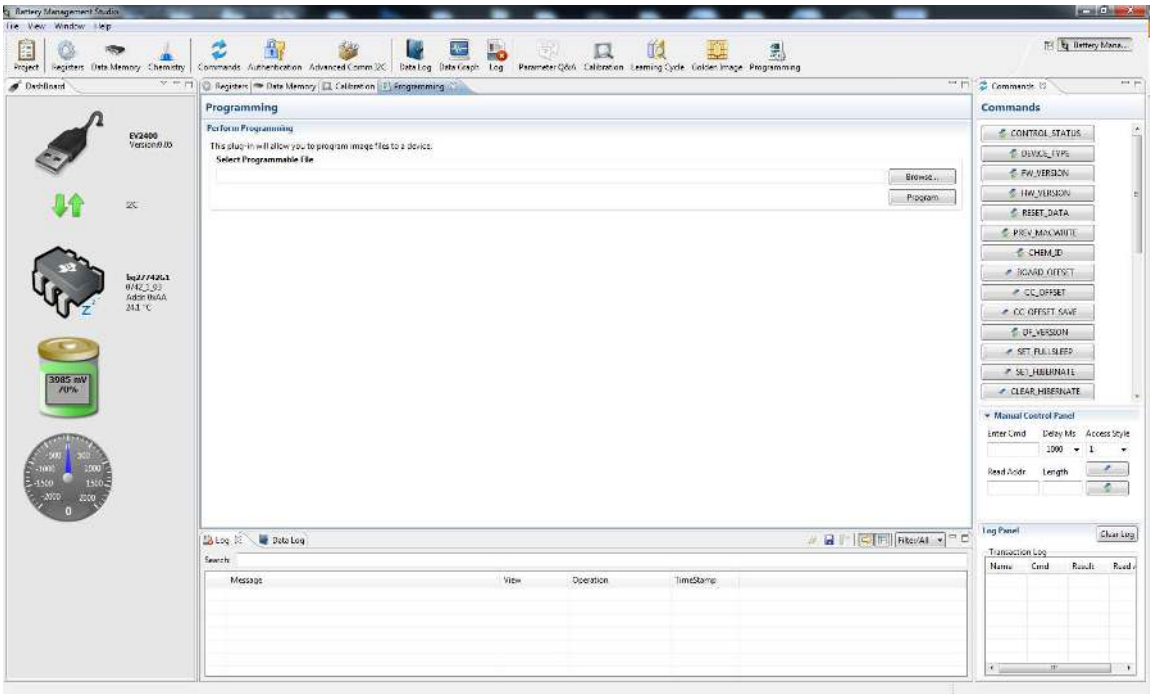

Figure 10. Firmware Screen

10 Send HDQ Screen

To configure a bq27742 fuel gauge into HDQ mode, navigate to the *Send HDQ* screen. It is possible that all the screen options on the left are not visible depending on screen resolution. If needed scroll within the left menu to access the *Send HDQ* link. Click on the "Change comm to HDQ8" button while having the bq27742 fuel gauge connected to the EV2300 interface board via I^2C. Clicking on the button causes a message to appear indicating that the process is not reversible and to confirm if the actions are desired. Also, it explains what to do once the HDQ mode has been activated.

Once converting the bq27742 fuel gauge into HDQ mode, it is required that you connect the HDQ terminal of the EV2300 interface board with the HDQ connector (J4) of the bq27742 EVM, then restart the EVSW, and select the "bq27742HDQR1" with the proper firmware version from the list of supported devices within the EVSW.

11 Related Documentation From Texas Instruments

To obtain a copy of any of the following TI documents, call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center (PIC) at (972) 644-5580. When ordering, identify this document by its title and literature number. Updated documents also can be obtained through the TI Web site at www.ti.com.

1. *bq27742-G1, Single Cell Li-Ion Battery Fuel Gauge with Integrated Protection* Data Sheet (SLUSBV9)
2. *bq27742-G1, Pack-Side Impedance Track™ Battery Fuel Gauge With Integrated Protector and LDO* User's Guide (SLUUAX8)

12 Revision History

Version	Date	Description
—	March 2014	Initial Release

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 6 V to 25 V and the output voltage range of 0 V to 16.4 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 60°C. The EVM is designed to operate properly with certain components above 60°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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