bq27350EVM Single Cell Impedance Track™ Technology Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the bq27350. The EVM includes one bq27350 circuit module, a current sense resistor, one thermistor, an EV2300 PC interface board for gas gauge interface, a PC USB cable, and Windows™-based PC software. The circuit module includes one bq27350 integrated circuit (IC), one TPS77025 IC, and all other onboard components necessary to monitor and predict capacity. The circuit module connects directly across the cell in a battery. With the EV2300 interface board and software, the user can read the bq27350 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the bq27350 solution under different charge and discharge conditions.

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1 Features

- Complete evaluation system for the bq27350 gas gauge with Impedance Track™ Technology
- Populated circuit module for quick setup
- PC software and interface board for easy evaluation
- Software that allows data logging for system analysis

1.1 Kit Contents

- bq27350/TPS77025 circuit module
- EV2300 PC interface board
- Software CD with the evaluation software
- USB connection cable to interface board
- Set of support documentation

1.2 Ordering Information

Table 1. Ordering Information

EVM PART NUMBER	CHEMISTRY	CONFIGURATION	CAPACITY
bq27350EVM-001	Li-ion	1 cell	Any

2 bq27350-Based Circuit Module

The bq27350-based circuit module is a complete and compact example solution of a bq27350 circuit for battery management. The circuit module incorporates a bq27350 battery gas gauge IC, a TPS77025 LDO regulator, and all other components necessary to accurately predict the capacity of 1-series Li-Ion cell.

2.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct connection to the cells: BAT+ and BAT-
- To the serial communications port (SDATA, SCLK)
- The system load and charger connect across PACK+ and PACK-

  Note that although this is an I2C device, the EVM is connected to the SMB port of the EV2300. The EVSW operates with I2C commands through the EV2300's SMB port.

2.2 Pin Descriptions

PIN NAME	DESCRIPTION
PACK+	Pack positive terminal
PACK-	Pack negative terminal
BAT+	Cell positive terminal
BAT-	Cell negative terminal
SDATA	I2C communication data line
SCLK	I2C communication clock line

3 bq27350 Circuit Module Schematic

3.1 Schematic

The schematic follows the bill of materials in this user's guide.

4 Circuit Module Physical Layouts and Bill of Materials

This section contains the board layout, bill of materials, and assembly drawings for the bq27350 circuit module.

4.1 Board Layout

This section shows the PCB layers (Figure 1 through Figure 4), and assembly drawing for the bq27350 module.

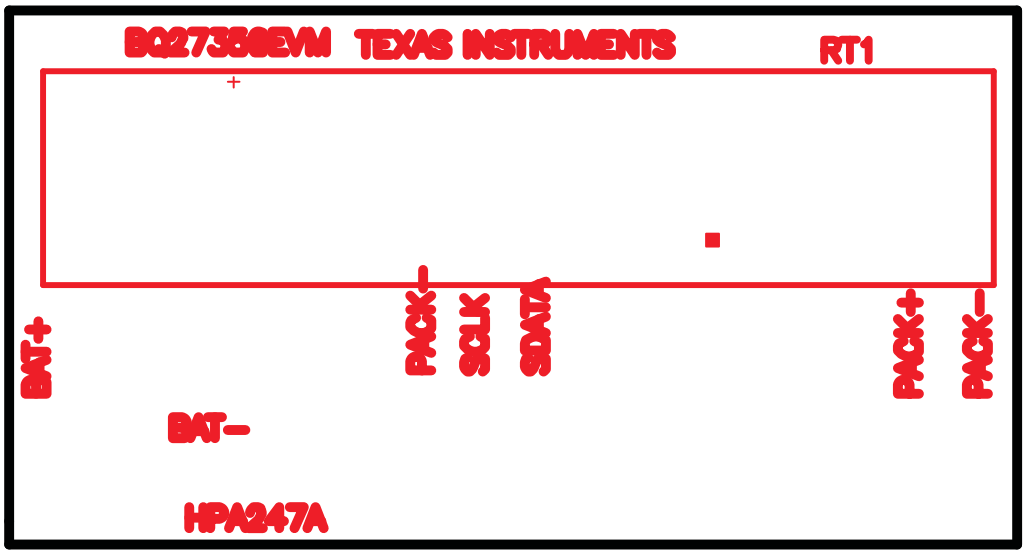

Figure 1. bq27350EVM-001 Layout (Silk Screen)

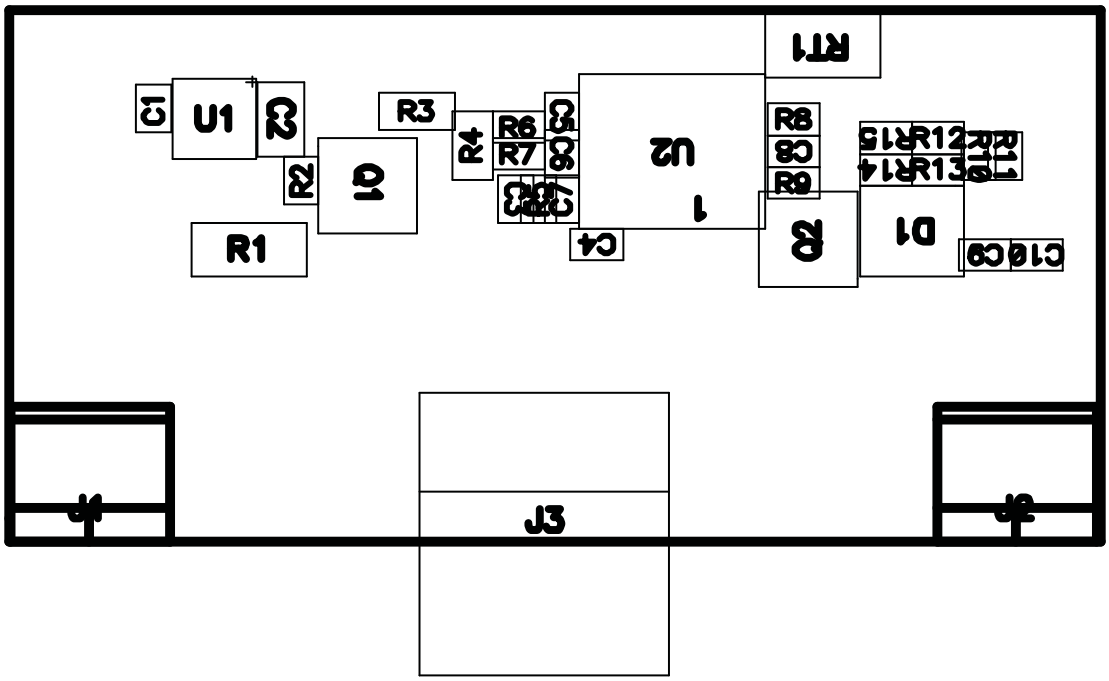

Figure 2. Top Assembly

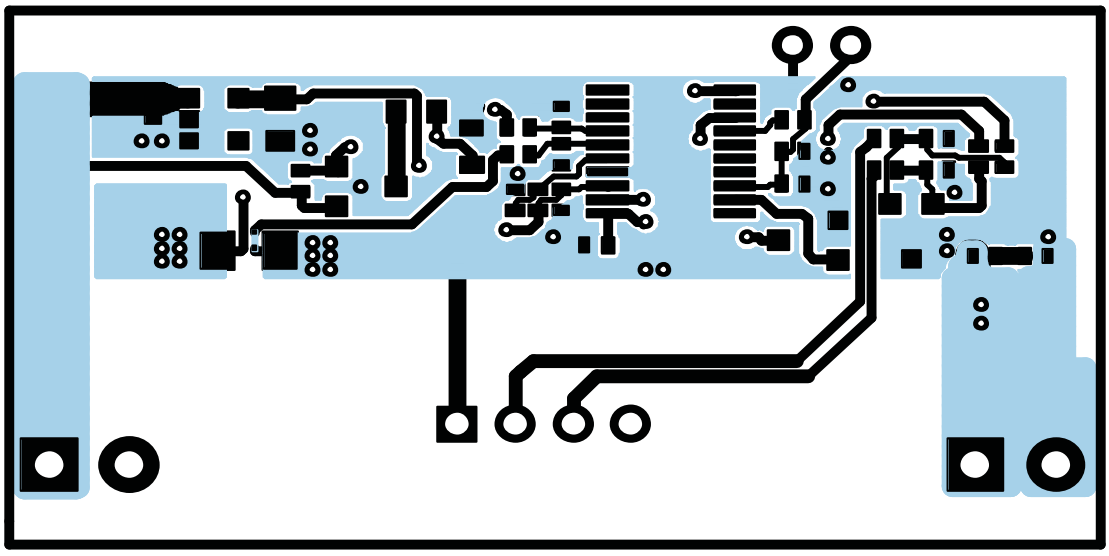

Figure 3. Top Layer

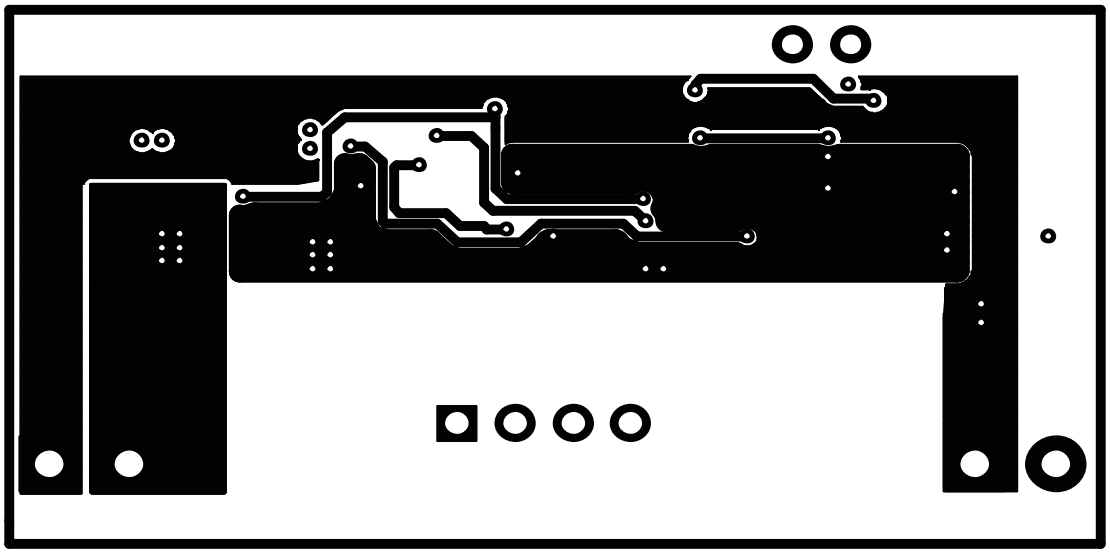

Figure 4. Bottom Layer

4.2 Bill of Materials and Schematic

Table 2. Bill of Materials

Count	Ref Des	Description	Size	Manufacturer	Part No.
1	C2	Capacitor, Tantalum, 4.7uF, 6.3V, 20%	2012	Rohm	TCP0J475M8R
8	C1, C3, C4, C5, C6, C7, C9, C10	Capacitor, Ceramic, 0.1uF, 10V, X5R	402	Murata	GRM155R61A104KA01D
1	C8	Capacitor, Ceramic, 0.47uF, 6.3V, X5R	402	Murata	GRM155R60J474KE19D
1	D1	Diode, Dual, Zener, 5.6V, 300mW	SOT23	Vishay-Telefunken	AZ23C5V6
2	J1, J2	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	OST	ED1514
1	J3	Header, Friction Lock Assy, 4-pin Right Angle,	0.400 x 0.500	Molex	22-05-3041
1	Q1	MOSFET, P-ch, 50-V, 130-mA, 10-Ohms	SOT23	Vishay	BSS84
1	Q2	MOSFET, N-ch, 20-V, 1.3A, 0.16-Ohms	SOT23	Fairchild	NDS331N or NDS335N
3	R2, R12, R13	Resistor, Chip, 1/16W, 1M, 5%	402	Std	Std
1	R3	Resistor, Chip, 20.0K-Ohms, 1/16-W, 1%, 50ppm	603	Vishay	TNPW-06032002BR75
1	R1	Resistor, Chip, 0.01-Ohms, 0.25W, 1%	1206	Vishay	WSL1206R0100FEA
1	R4	Resistor, Chip, 4.99K-Ohms, 1/16-W, 1%, 50ppm	603	Vishay	TNPW-06034991BR75
6	R6, R7, R10, R11, R14, R15	Resistor, Chip, 1/16W, 100, 5%	402	STD	STD
1	R5	Resistor, Chip, 1/16W, 100k, 5%	402	Std	Std
1	R8	Resistor, Chip, 1/16W, 8.45k, 5%	402	Std	Std
1	R9	Resistor, Chip, 1/16W, 61.9k, 5%	402	Std	Std
1	RT1	Thermistor, 10kOhms, 5%	0.095 x 0.150	Semitec	NTC103AT
1	U1	IC, Ultra Low-Power LDO Regulator, 2.5-V, 50-mA	SOT23-5	TI	TPS77025DBV
1	U2	IC, Single Cell Impedance Track Technology	TSSOP-20	TI	BQ27350PW

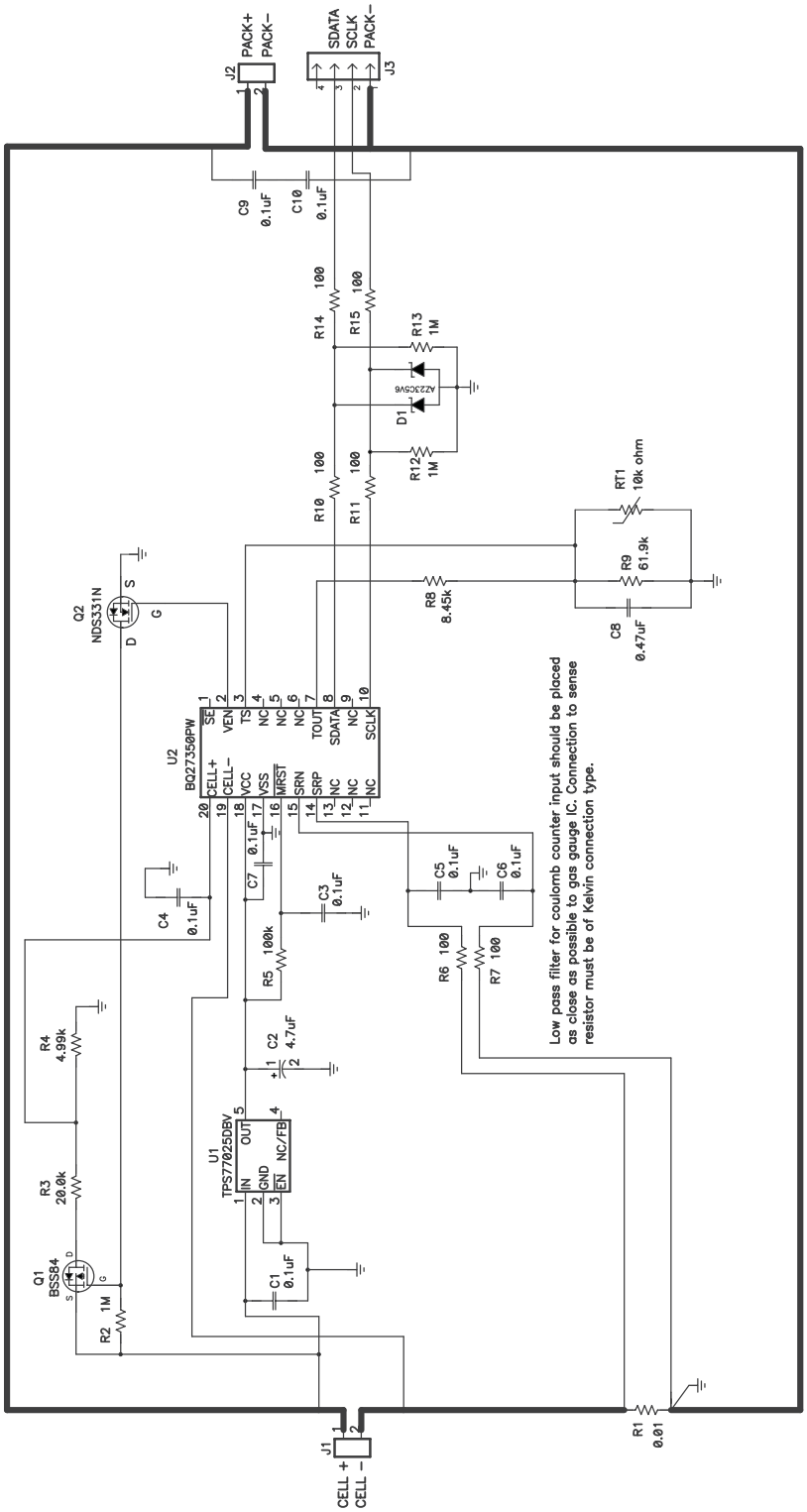

Figure 5. Schematic

4.3 bq27350 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq27350 circuit module.

Table 3. Performance Specification Summary

Specification	Min	Typ	Max	Units
Input voltage Pack+ to Pack–	2.8	3.6	4.3	V
Input voltage BAT+ to BAT-	2.8	3.6	4.3	
Charge and discharge current	0	1	2	A

5 EVM Hardware and Software Setup

This section describes how to install the bq27350EVM-001 PC software, and how to connect the different components of the EVM.

5.1 System Requirements

The bq27350EVSW software requires Windows 2000 or Windows XP. Drivers for Windows 98SE are provided, but Microsoft no longer supports Windows 98; and there may be issues in Windows 98 with USB driver support. The EV2300 USB drivers have been tested for Windows 98SE, but no assurance is made for problem-free operation with specific system configurations.

5.2 Software Installation

Find the latest software version in the bq27350 tool folder on power.ti.com. Use the following steps to install the bq27350EVSW software:

1. Copy the files from the CD into the temporary directory you selected, open the archive TI USB DRVRS.zip, and extract its contents in a subdirectory/drivers. Choose preserve *directory structure* option when extracting. Alternatively, run SETUP.EXE from the same directory.
2. Plug the EV2300 into a USB port.
3. Wait until system prompt *new hardware found* appears. Choose *select location manually*, and use the *browse* button to point to subdirectory TIUSBWin2K-XP-1.
4. Answer *continue* to the warning that drivers are not certified with Microsoft.
5. After installation finishes, another system prompt *new hardware found* appears. Repeat procedure above, but point to subdirectory TIUSBWin2K-XP-2
6. Answer *continue* to the warning that drivers are not certified with Microsoft. Installation of drivers is now finished.
7. For Windows 98, point to directory TIUSBWin98.
8. Return to the temporary directory where you extracted files; double-click on the *Setup.exe* icon to install EV Software.

If files were downloaded from the Web:

1. Open the archive containing the installation package, and copy its contents in a temporary directory.
2. Follow the preceding steps 1 - 8.

6 Troubleshooting Unexpected Dialog Boxes

Ensure that the files were extracted from the zip file using the *Preserve Folder names* option.

Ensure that all the files were extracted from the zip file.

The user that 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 policy.

7 Hardware Connection

The bq27350EVM-001 comprises three hardware components: the bq27350/TPS77025 circuit module, the EV2300 PC interface board, and the PC.

7.1 Connecting the bq27350 Circuit Module to a Battery Pack

Figure 6 shows how to connect the bq27350 circuit module to the cells and system load/charger. Note that although this is an I2C device, the EVM is connected to the SMB port of the EV2300. The EVSW operates with I2C commands through the EV2300's SMB port.

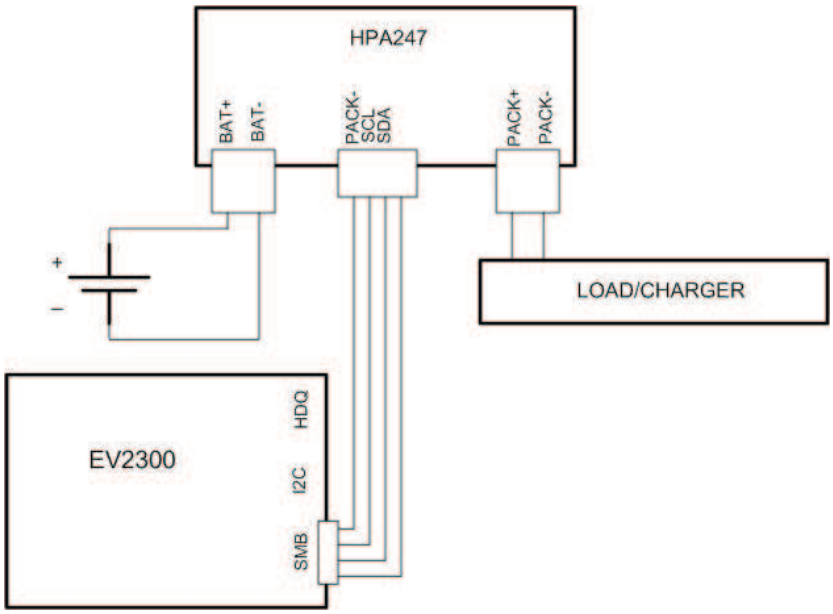

Figure 6. bq27350 Circuit Module Connection to Cell and System Load/Charger

7.2 PC Interface Connection

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

1. Connect the bq27350-based pack to the EV2300 using wire leads as shown in Table 4.

Table 4. Circuit Module to EV2300 Connections

bq27350-Based Battery	EV2300
SDATA	SMBD
SCLK	SMBC
PACK-	GND

2. Connect the PC USB cable to the EV2300 and the PC USB port.

The bq27350EVM-001 is now set up for operation.

8 Operation

This section details the operation of the bq27350 EVSW software.

8.1 Starting the Program

Run bq27350 EVSW from the Start | Programs | Texas Instruments | bq Evaluation Software menu sequence. The DataRAM screen (Figure 7) appears. Data begins to appear once the <Refresh> (single time scan) button is clicked, or when the <Keep Scanning> check box is checked. To disable the scan feature, deselect <Keep Scanning>.

The continuous scanning period can be set via the | Options | and | Set Scan Interval | menu selections. The range for this interval is 0 ms to 65535 ms. Only items that are selected for scanning are scanned within this period.

The bq27350 EVSW provides a logging function which logs the values that were last scanned by EVSW. To enable this function, select the *Start Logging* button, this causes the *Keep Scanning* button to be selected. When logging is *Stopped*, the keep scanning button is still selected and has to be manually unchecked.

The logging intervals are specified under the | Options | menu with the maximum value of 65535 ms. The *Log* interval cannot be smaller than scan interval because this results in the same value being logged at least twice.

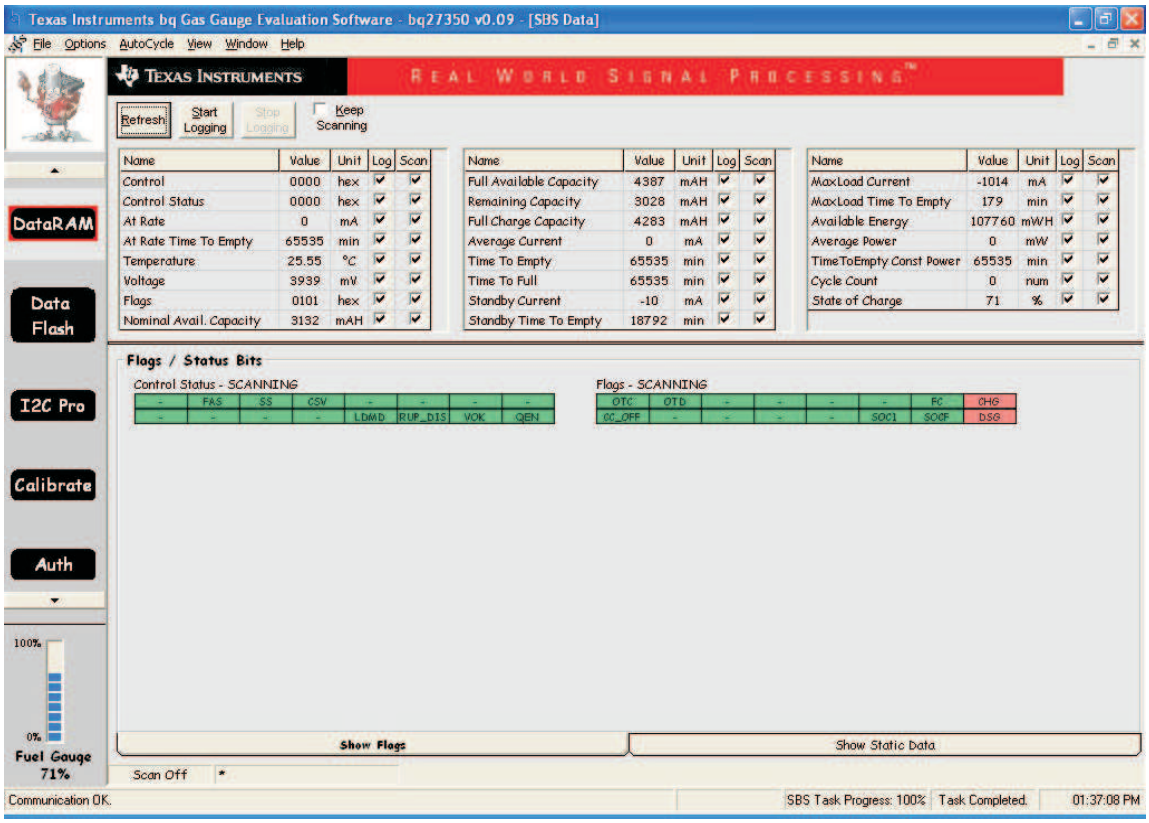

Figure 7. DataRAM Screen

This screen (Figure 7) shows the RAM data set Additional Flag and Status data can be viewed at the bottom of the DataRAM screen.

Dragging the splitter bar (line that separates the Flags/Static data from SBS values) changes the height of the Flags/Static Data display. Selecting | View |, then | Auto Arrange | returns the splitter bar to its original location.

8.2 Setting Programmable bq27350 Options

The bq27350 data flash comes configured per the default settings detailed in the bq27350 data sheet. Ensure that the settings are correctly changed to match the pack and application for the bq27350/bq29330 solution being evaluated.

IMPORTANT: The correct setting of these options is essential to get the best performance.

The settings can be configured using the Data Flash screen (Figure 8).

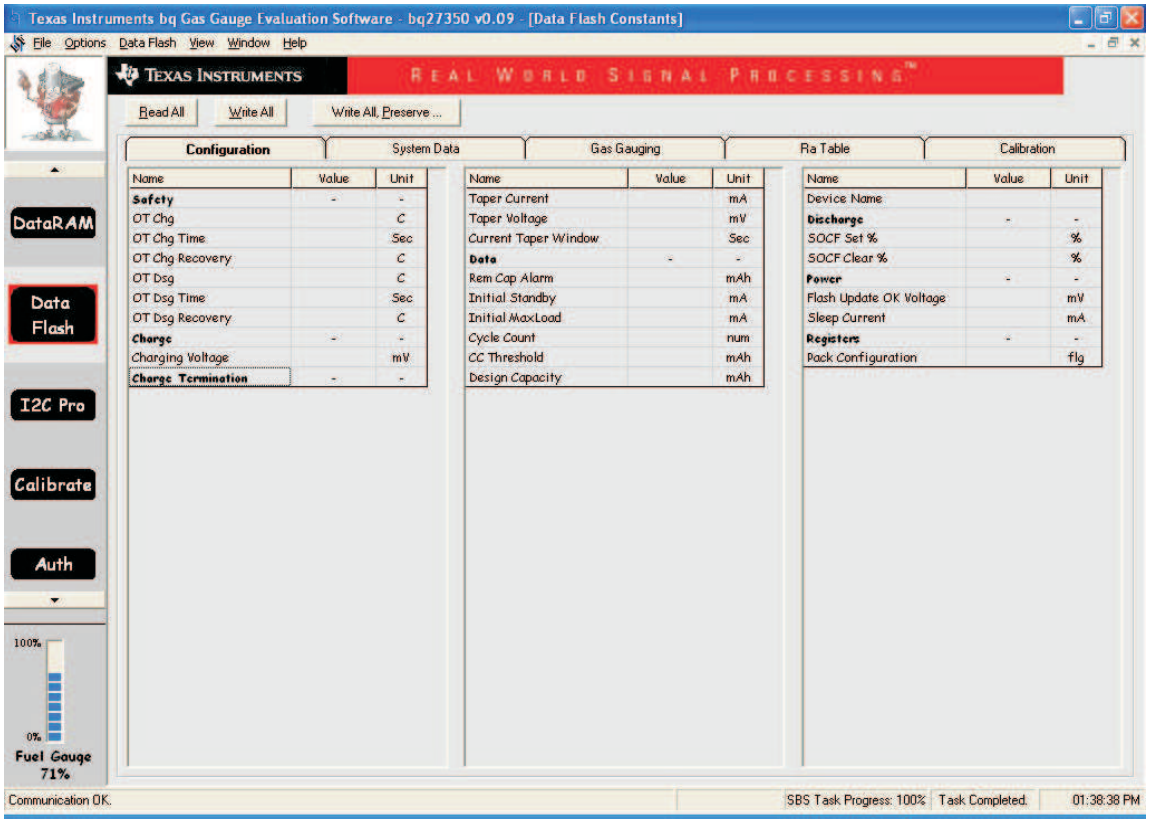

Figure 8. Data Flash Screen

To read all the data from the bq27350 data flash, click on menu option | Data Flash | Read All |.

To write to a data flash location, click on the desired location, enter the data and press <Enter>, which writes the entire tab of flash data, or select menu option | Data Flash | Write All |. The data flash must be read before any writes are performed to avoid any incorrect data being written to the device.

The | File | Special Export | menu options allows the data flash to be exported, but it configures the exported data flash to a learned state ready for mass production use.

The data flash configuration can be saved to a file by selecting | File | Export | and entering a file name. A data flash file can also be retrieved in this way, imported, and written to the bq27350 using the | Write All | button.

The module calibration data is also held in the bq27350 data flash.

The bq27350 allows for an automatic data flash export function, similar to the DataRAM logging function. This feature, when selected via | Options | Auto Export |, exports Data Flash to a sequential series of files named as *FilenameNNNNN.gg* where N = a decimal number from 0 to 9.

The AutoExport interval is set under the | Options menu | with a minimum value of 15 s. The AutoExport filename is also set under the | Options menu |.

When there is a check next to | AutoExport |, the AutoExport is in progress. The same menu selection is used to turn on / off AutoExport.

If the data flash screen is blank, then the bq27350 that is being used may not be supported by the bqEVSW version that is being used. An upgrade may be required.

9 Calibrate Screen

9.1 How to Calibrate

Before the bq27350 is calibrated:

- Connect a load to Pack- and Pack+ that draws approximately 1 A or connect a current source to Batt- and Pack-.
- Measure the pack voltage from Bat+ to Bat-.
- Measure the temperature of the pack.
- These steps may or may not be required, depending on the type of calibration being performed.

Note that voltage calibration with cells attached requires special consideration. Cells must be in a resting state. For additional information, go to the TI Web site (www.ti.com) and access the TI Knowledge Base and search for *bq27350 Calibration Using EV Software*.

9.2 To Calibrate the bq27350

Select the types of calibration to be performed (see Figure 9).

Enter the measured values for the types selected.

If *Voltage Calibration* is selected, then ensure that cell count is 1.

If *Temperature Calibration* is selected, then select the sensor that is to be calibrated.

Press the *Calibrate Part* button.

9.3 CC Offset Calibration

This performs the internal calibration of the coulomb counter input offset.

9.4 Board Offset Calibration

This performs the offset calibration for the current offset of the board.

Remove load/external voltage and short Pack- to Batt-.

Press the *CC Board Offset Calibration* button.

9.5 Pack Voltage Calibration

This calibrates the voltage sensed from the voltage divider across the cell.

Remove load applied between Pack+ and Pack-.

Ensure that voltage is stable before performing voltage calibration.

Press the *Pack Voltage* button to calibrate.

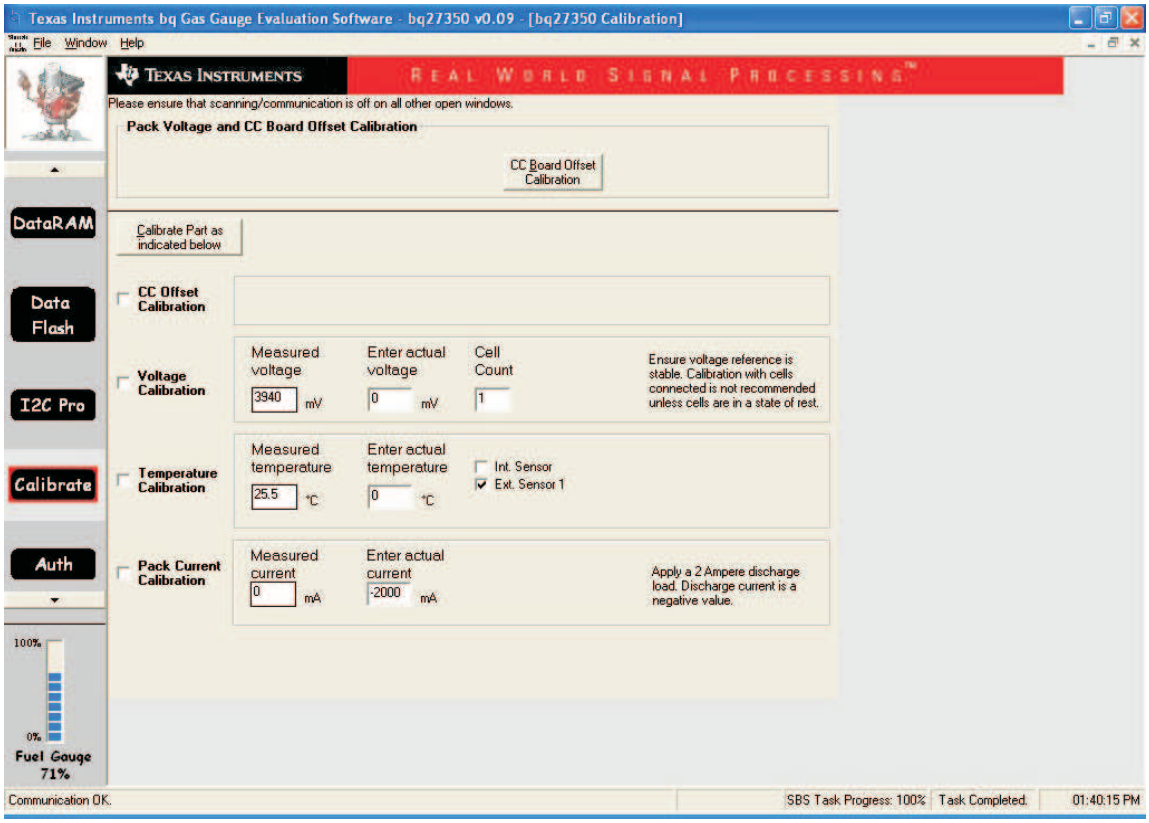

Figure 9. Calibration Screen

10 I2C Pro Screen

10.1 I2C Communication

The set of read/write operations over I2C are not specific to any gas gauge. These are provided as general-purpose communication tools (Figure 10).

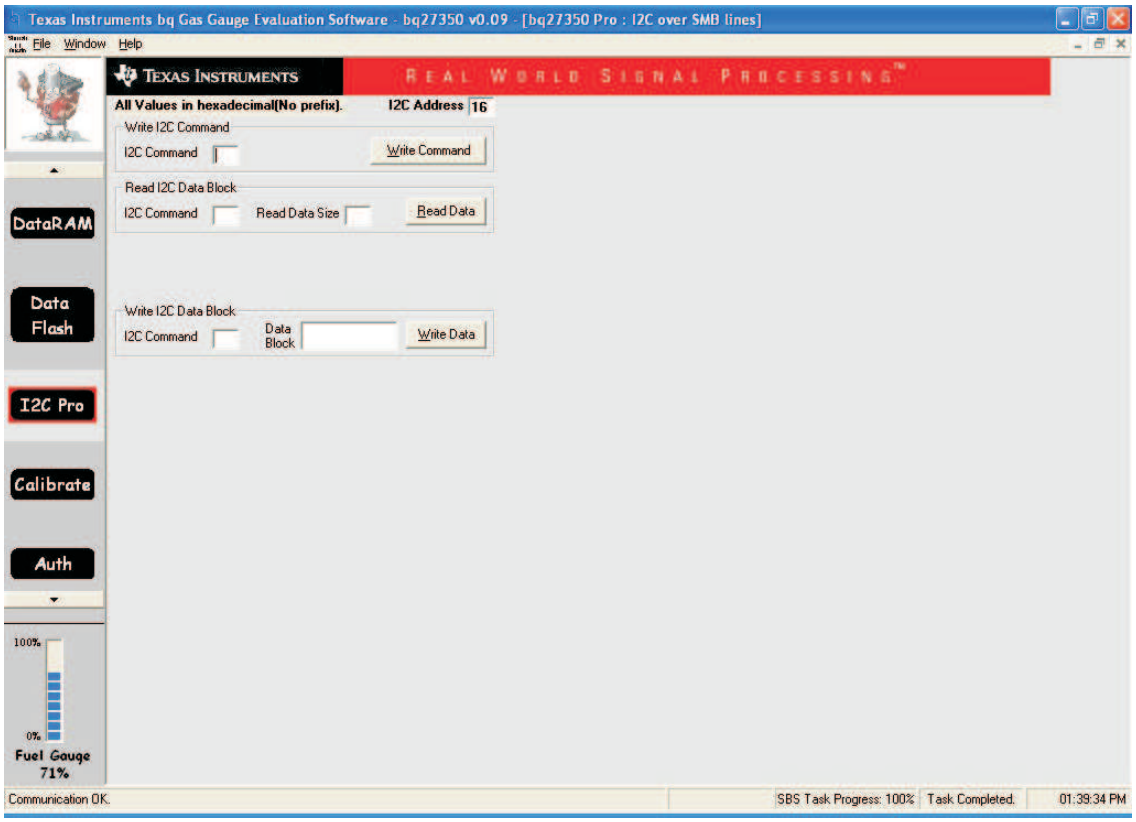

Figure 10. I2C Pro Screen

11 SMB Pro (Advanced) Screen

11.1 SMB Communication

The set of read/write operations over SMBus are not specific to any gas gauge. These are provided as general-purpose communication tools (Figure 11).

11.2 Hexadecimal/Decimal Converter

These two boxes convert between hexadecimal and decimal as soon as values are typed into the boxes. Invalid values may cause erroneous results.

When scaling converted hexadecimal values to a higher number of bytes, follow these rules:

- When unsigned is selected, the left pad contains zeroes.
- When signed is selected, the left pad contains zeroes for a positive number, or the left pad contains *F* for negative numbers.

11.3 Programming

This screen allows device reprogramming from unencrypted and encrypted files.

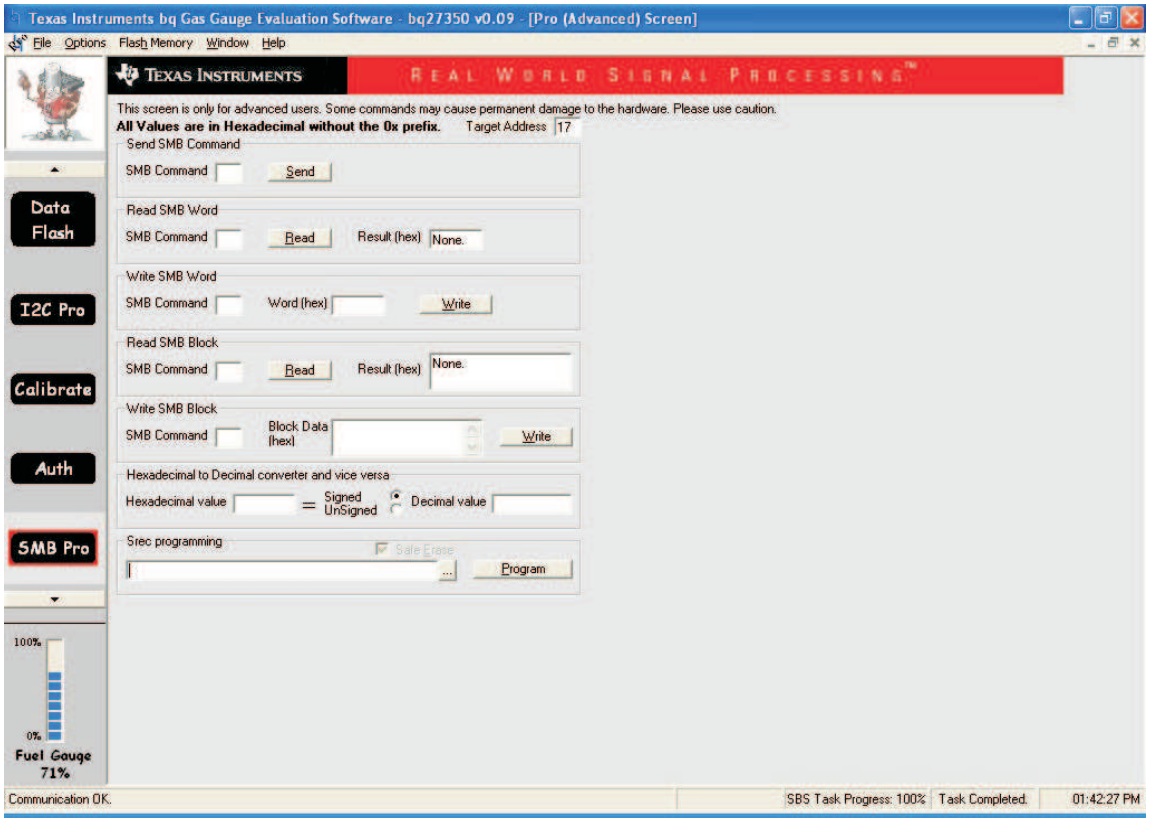

Figure 11. Pro (Advanced) Screen

Related Documentation from Texas Instruments

To obtain a copy of any of the following TI document, 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 can also be obtained through the TI Web site at www.ti.com

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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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