bq27410EVM: Single-Cell Impedance Track™ Technology

This evaluation module (EVM) is a complete evaluation system for the bq27410. The EVM includes one bq27410 circuit module. The circuit module includes one bq27410 integrated circuit and all other onboard components necessary to monitor and predict capacity for a system-side fuel gauge solution. The circuit module connects directly across the battery pack. With the EV2300 or EV2400 interface board and software, the user can read the bq27410 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the bq27410 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 bq27410 gas 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

- bq27410 circuit module (HPA707)

This EVM is used for the evaluation of different bq27410-based products. Ensure that you visit the product Web folder at www.ti.com to download the latest firmware version for the associated product to be evaluated. EV2300 and EV2400 can also be ordered from TI Website seperately.

1.2 Ordering Information

Table 1. Ordering Information

EVM Part Number	Chemistry	Configuration	Capacity
bq27410EVM	Li-ion	1 Cell	Any

2 bq27410-Based Circuit Module

The bq27410-based circuit module is a complete and compact example solution of a bq27410 circuit for battery management. The circuit module incorporates a bq27410 battery gas gauge integrated circuit (IC) 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 battery pack (J1 or J6): PACK+, PACK–
- To the serial communications port (J3): SDA, SCL, and VSS
- The system load and charger connect across charger and load (J5 and J4): CHARGER–/LOAD– and CHARGER+/LOAD+.
- Access to signal outputs (J2): BIN, and GPOUT

2.2 Pin Description

Pin Name	Description
PACK+	Pack positive terminal
PACK–	Pack negative terminal
SDA	I^2C™ communication data line
SCL	I^2C communication clock line
VSS	Signal return for communication line, shared with charger and ground
CHG+/LOAD+	High potential of load or charger connection
CHG–/LOAD–	Low potential of load or charger connection (system VSS)
BIN	Battery insertion detection input
GPOUT	General purpose output

3 bq27410 Circuit Module Schematic

3.1 Schematic

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

4 Circuits Module Physical Layout and Bill of Material

This section contains the board layout, bill of materials, and assembly drawings for the bq27410 circuit module.

4.1 Board Layout

This section shows the printed-circuit board (PCB) layers (Figure 1 through Figure 4), and assembly drawing for the bq27410 module.

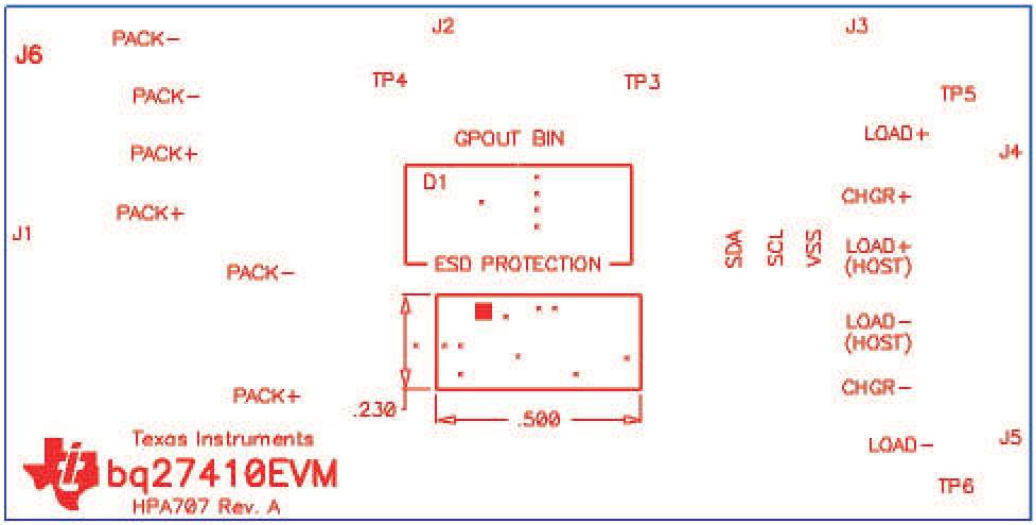

Figure 1. bq27410EVM Layout – Silk Screen

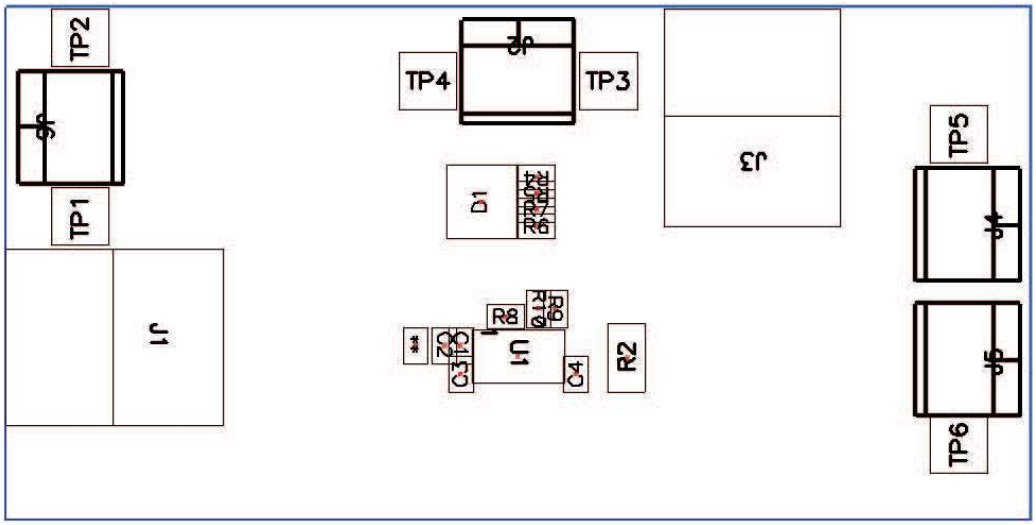

Figure 2. bq27410EVM Layout – Top Assembly

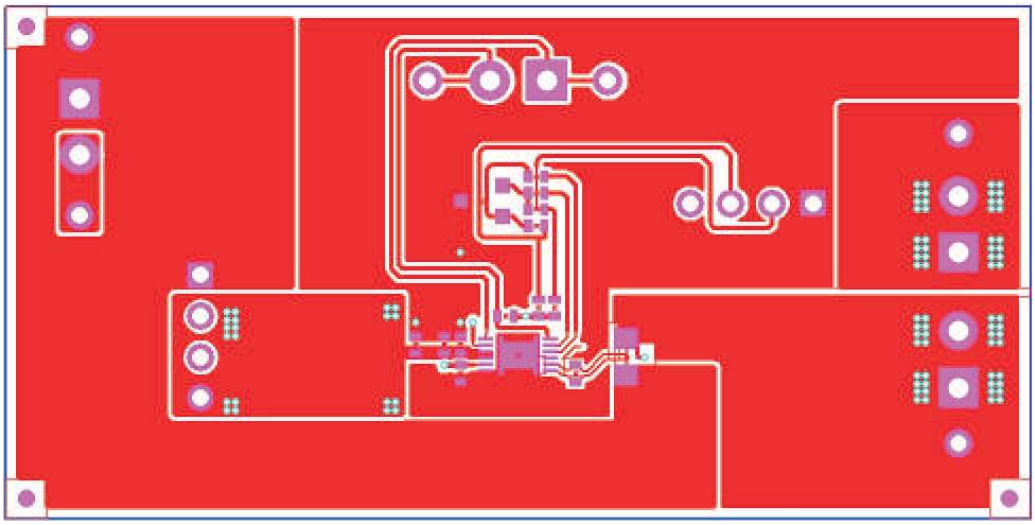

Figure 3. bq27410EVM Layout – Top Layer

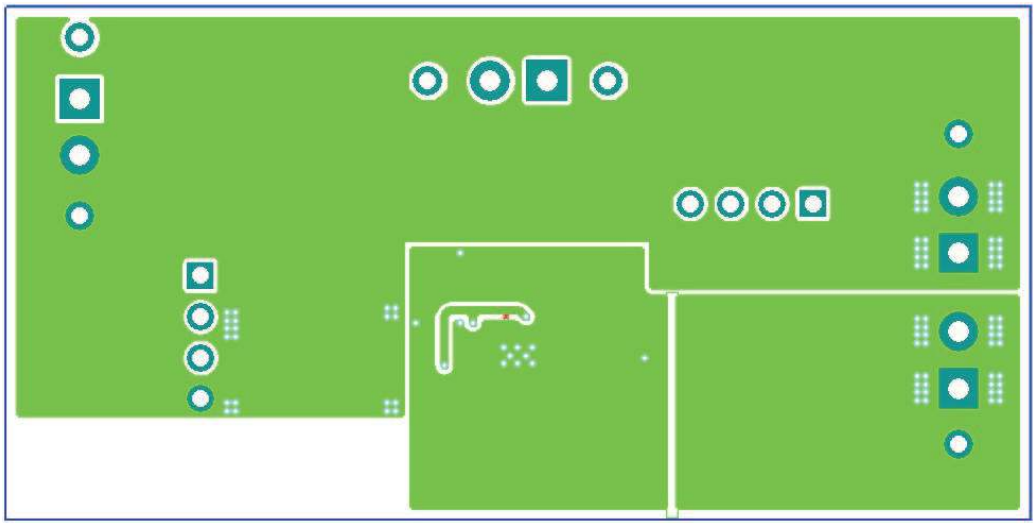

Figure 4. bq27410EVM Layout – Bottom Layer

4.2 Bill of Materials

Table 2. Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	Mfr
3	C1, C2, C4	0.1 µF	Capacitor, Ceramic, 0.1 µF, 10V, X5R	0402	GRM155R61A104KA01D	Murata
1	C3	0.47 µF	Capacitor, Ceramic, 0.47 µF, 6.3V, X5R	0402	GRM155R60J474KE19D	Murata
1	D1	AZ23C5V6-7	Diode, Dual, Zener, 5.6 V, 300mW	SOT23	AZ23C5V6-7	Diodes
2	J1, J3	22-05-3041	Header, Friction Lock Ass'y, 4-pin Right Angle	0.400 x 0.500	22-05-3041	Molex
4	J2, J4, J5, J6	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED555/2DS	OST
1	R2	0.01	Resistor, Chip, 1/10W, 1%, <75ppm/C	0805	CRCW0805-xxxx-F	Vishay
4	R4, R5, R6, R7	100	Resistor, Chip, 1/16-W, 5%	0402	Std	Std
3	R8, R9, R10	10k	Resistor, Chip, 1-kΩ, 1/16-W, 5%	0402	Std	Std
2	TP1, TP5	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone

Table 2. Bill of Materials (continued)

Count	RefDes	Value	Description	Size	Part Number	Mfr
4	TP2, TP3, TP4, TP6	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
1	U1	BQ27410DRZ	IC, Single-Cell Impedance Track™ Gas Gauge	QFN12	BQ27410DRZ	TI

4.3 Schematic

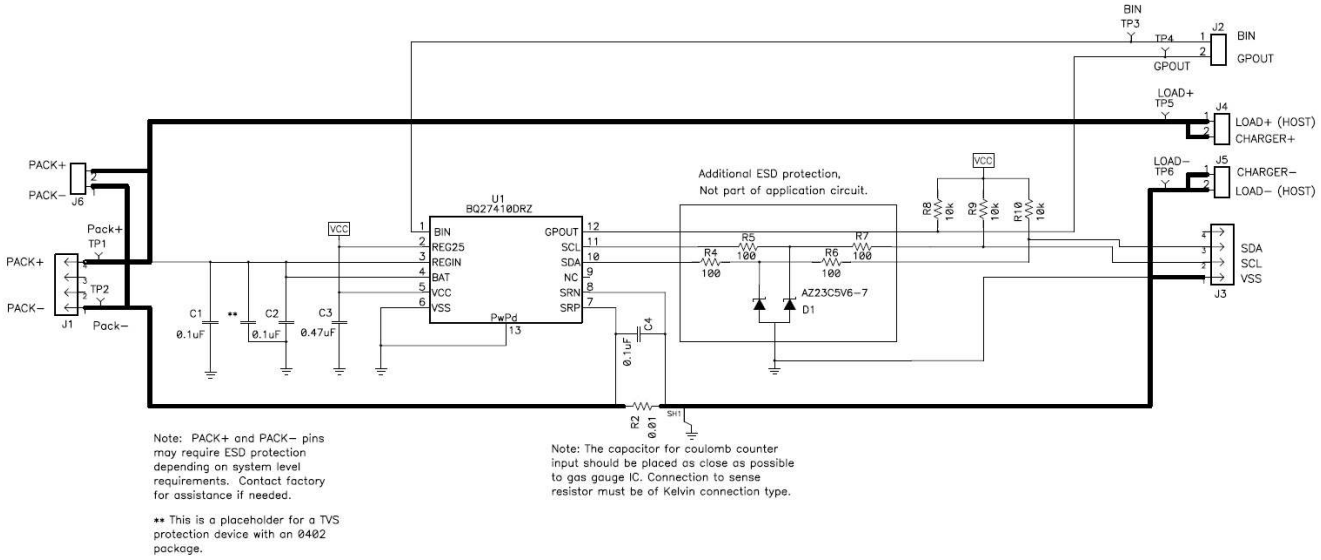

Figure 5. bq27410EVM Schematic

4.4 bq27410 Circuits Module Performance Specification Summary

This section summarizes the performance specifications of the bq27410 circuit module.

Table 3. Performance Specification Summary

Specification	Min	Typ	Max	Units
Input voltage Pack+ to Pack–	2.7	3.6	4.3	V
Charge and discharge current	0	1	2	A

5 EVM Hardware and Software Setup

This section describes how to install the bq27410EVM PC software and how to connect the different components of the EVM.

5.1 System Requirements

The bq27410EVSW software requires Windows 2000 or Windows XP. Drivers for Windows 98SE are provided, but Microsoft™ no longer supports Windows 98; therefore, Windows 98 can have issues with USB driver support. The EV2300 or EV2400 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 bq27410 tool folder on power.ti.com. Make a search by Part Number for bq27410 to access the tool folder. Use the following steps to install the bq27410EVSW software:

1. Ensure that the EV2300 or EV2400 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 to the computer using the USB cable.
6. 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. After 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.

6 Troubleshooting Unexpected Dialog Boxes

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 bq27410EVM comprises three hardware components: the bq27410 circuit module, the EV2300 or EV2400 PC interface board, and the PC.

7.1 Connecting the bq27410 Circuit Module to a Battery Pack

Figure 6 shows how to connect the bq27410 circuit module to the cells and system load/charger.

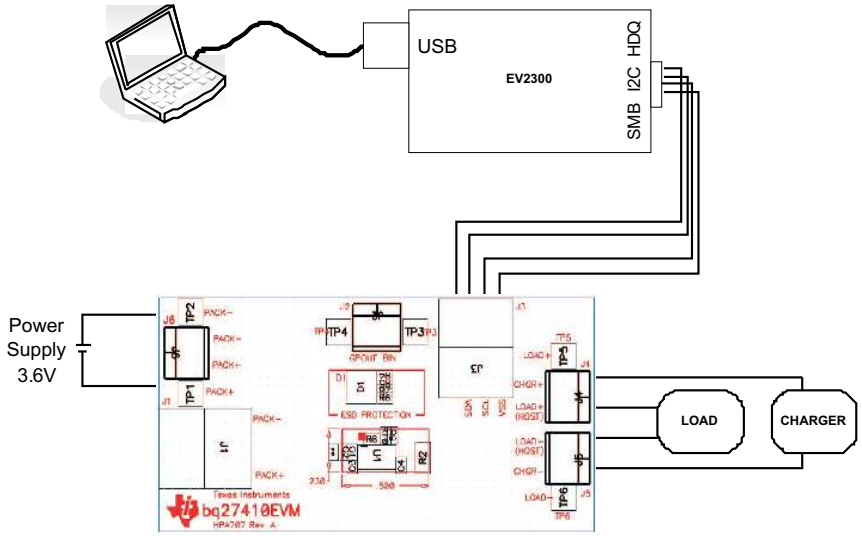

Figure 6. bq27410 Circuit Module Connection to Pack and System Load/Charger

7.2 PC Interface Connection

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

- Connect the bq27410-based EVM to the EV2300 using wire leads as shown in Table 4.

Table 4. Circuit Module to EV2300 Connections

bq27410EVM	EV2300
SDA	SDA
SCL	SCL
VSS	GND

- Connect the PC USB cable to the EV2300 and the PC USB port.
- For battery insertion detection configuration, see the data sheet for details.

The bq27410EVM is now set up for operation.

8 Operation

This section details the operation of the bq27410 EVSW software.

8.1 Starting the Program

Run bq27410 EVSW from the Start | Programs | Texas Instruments | bq Evaluation Software menu sequence. The DataRAM screen (see 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 with the | Options | and | Set Scan Interval | menu selections. The range for this interval is 0 ms to 65,535 ms. Only items that are selected for scanning are scanned within this period.

The bq27410 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 65,535 ms. The *Log* interval cannot be smaller than the scan interval because this results in the same value being logged at least twice.

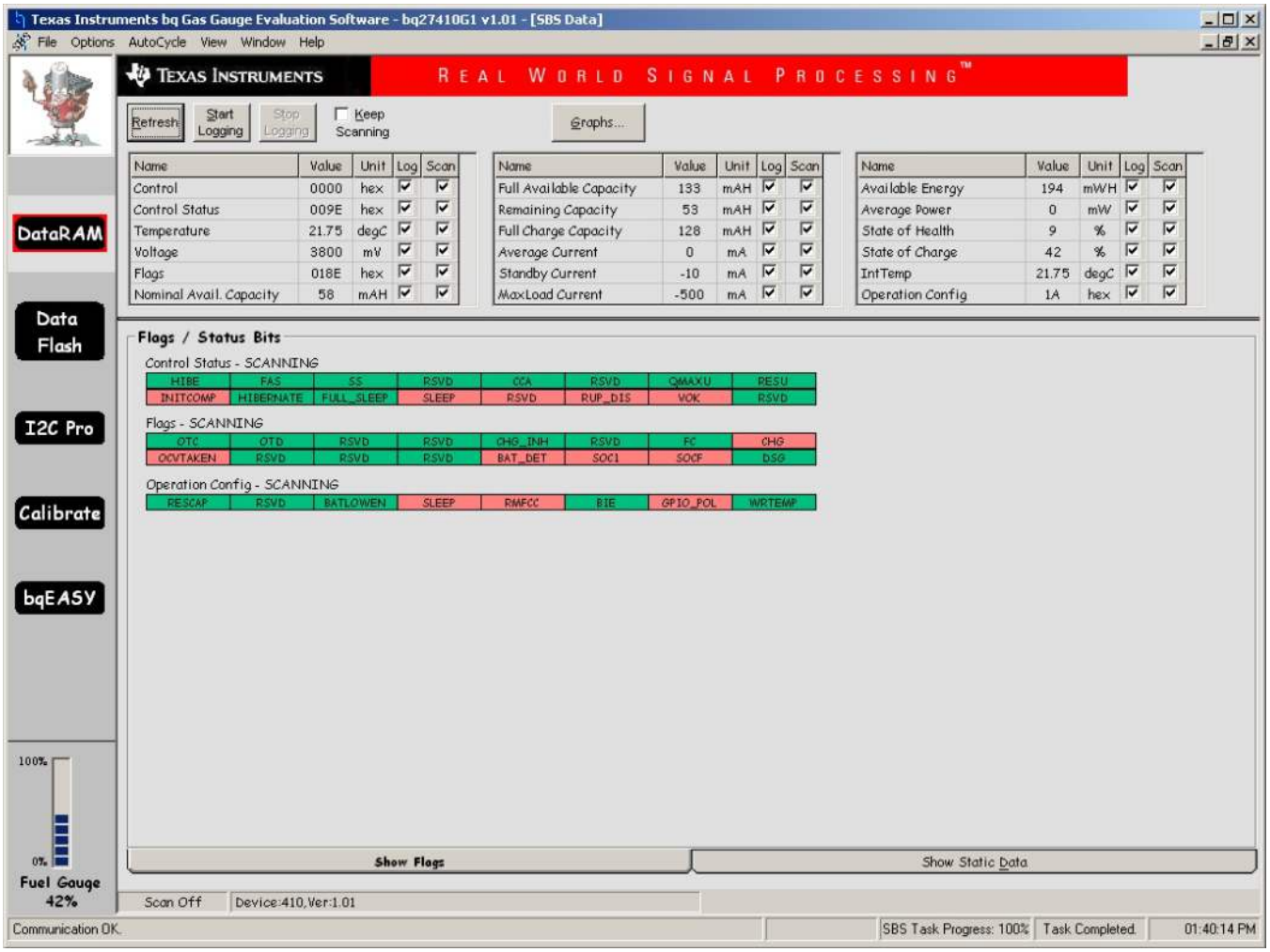

Figure 7. DataRAM Screen

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/Status data from Data Ram register values) changes the height of the Flags/Status Data display. Selecting | View |, then | Auto Arrange | returns the splitter bar to its original location.

8.2 Setting Programmable bq27410 Options

The bq27410 data flash comes configured per the default settings detailed in the bq27410 data sheet. Ensure that the settings are correctly changed to match the pack and application for the bq27410 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 (see Figure 8).

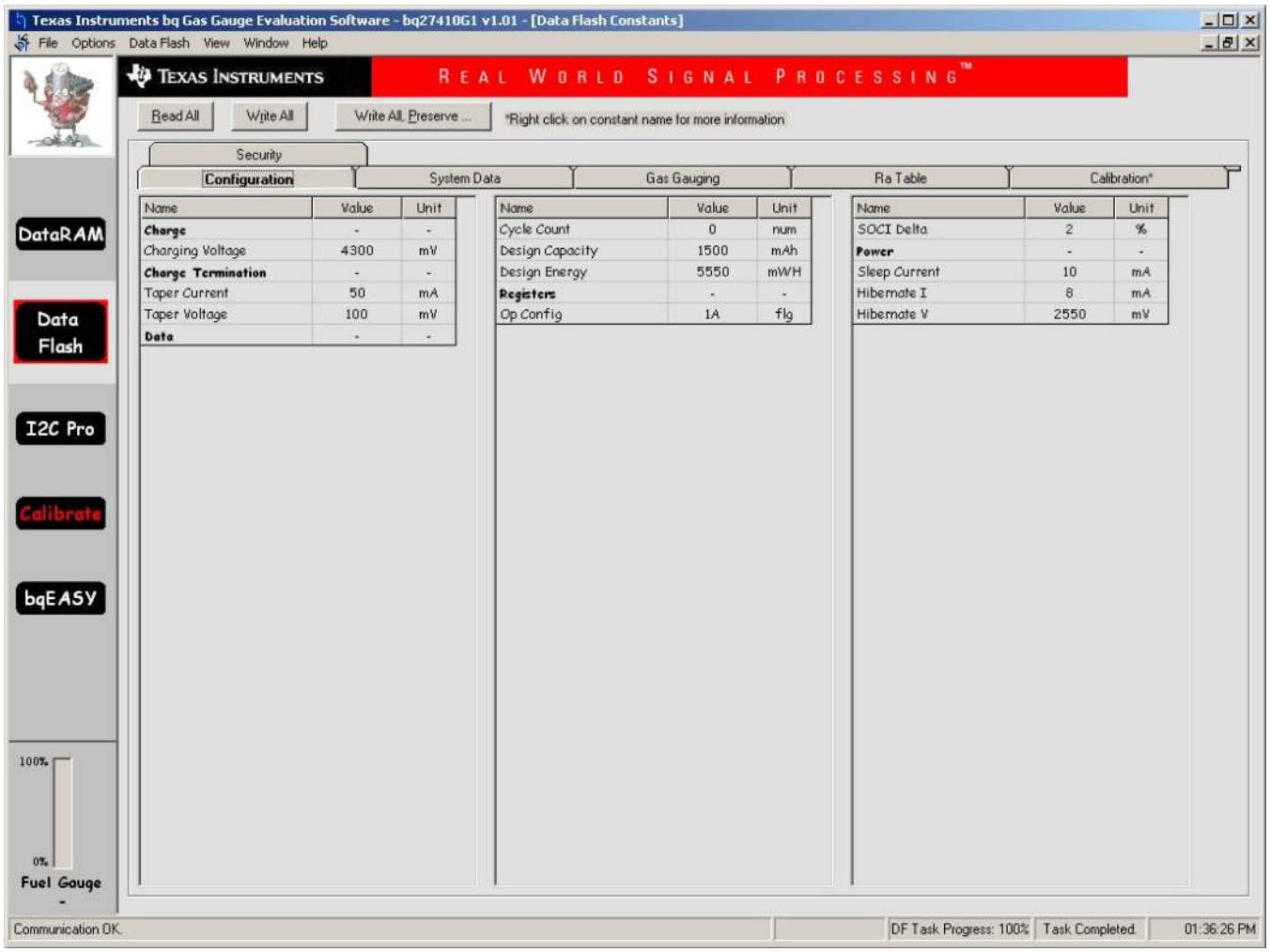

Figure 8. Data Flash Screen

To read all the data from the bq27410 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 also can be retrieved in this way, imported, and written to the bq27410 using the | Write All | button.

The module calibration data is also held in the bq27410 data flash.

The bq27410 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 also is set under the | Options menu |.

When a check is 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 bq27410 that is being used may not be supported by the bqEVSW version that is being used. An upgrade may be required.

9 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 once.

9.1 To Calibrate the bq27410

- Select the types of calibration to be performed (see Figure 9).
- Enter the measured values for the types selected.
- Press the *Calibrate Part as indicated below* button.

9.2 CC Offset Calibration

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

9.3 Voltage Calibration

- Measure the voltage across Pack+ and Pack–.
- Type the voltage value in mV into *Enter Actual Voltage*.
- Press the *Calibrate Voltage and Temperature as indicated below* button.

9.4 Temperature Calibration

- Measure the temperature for PACK.
- Type the temperature value into *Enter Actual Temperature*.
- Select if the temperature sensor to calibrate is the internal or external.
- Press the *Calibrate Voltage and Temperature as indicated below* button.

9.5 Board Offset Calibration

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

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 Board Offset* button.

9.6 Pack Current Calibration

- Connect a load to LOAD– and LOAD+ that draws approximately 1 A, or connect a current source to LOAD– and Pack–.
- Measure the current and type value into *Enter Actual Current* using (–) for current in discharge direction.
- Press the *Calibrate Pack Current* button.

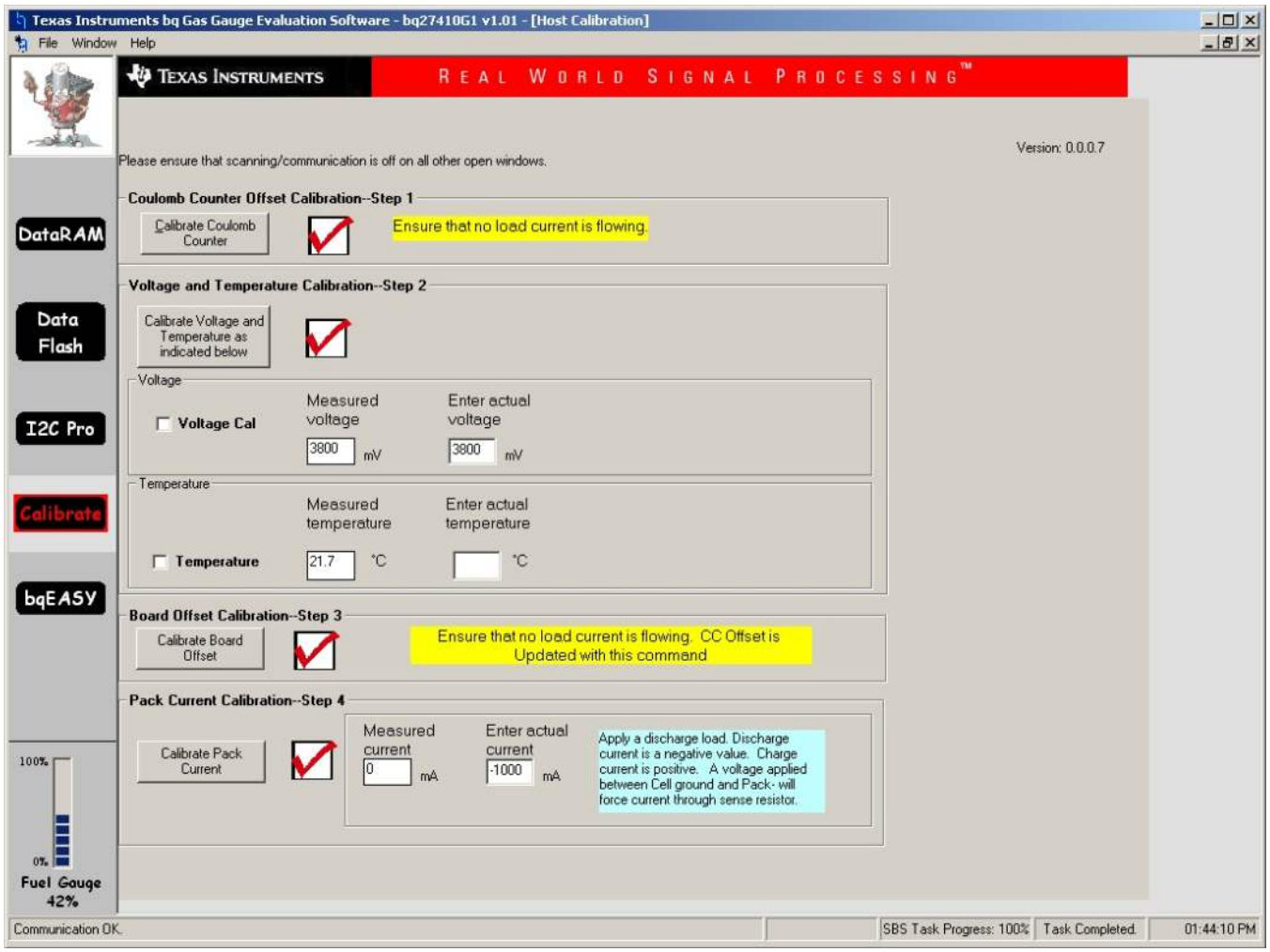

Figure 9. Calibration Screen

10 I2C Pro Screen

10.1 12C Communication

The read/write operations of the I2C Pro function are not specific to any gas gauge. These operations serve as general-purpose communication tools (see Figure 10).

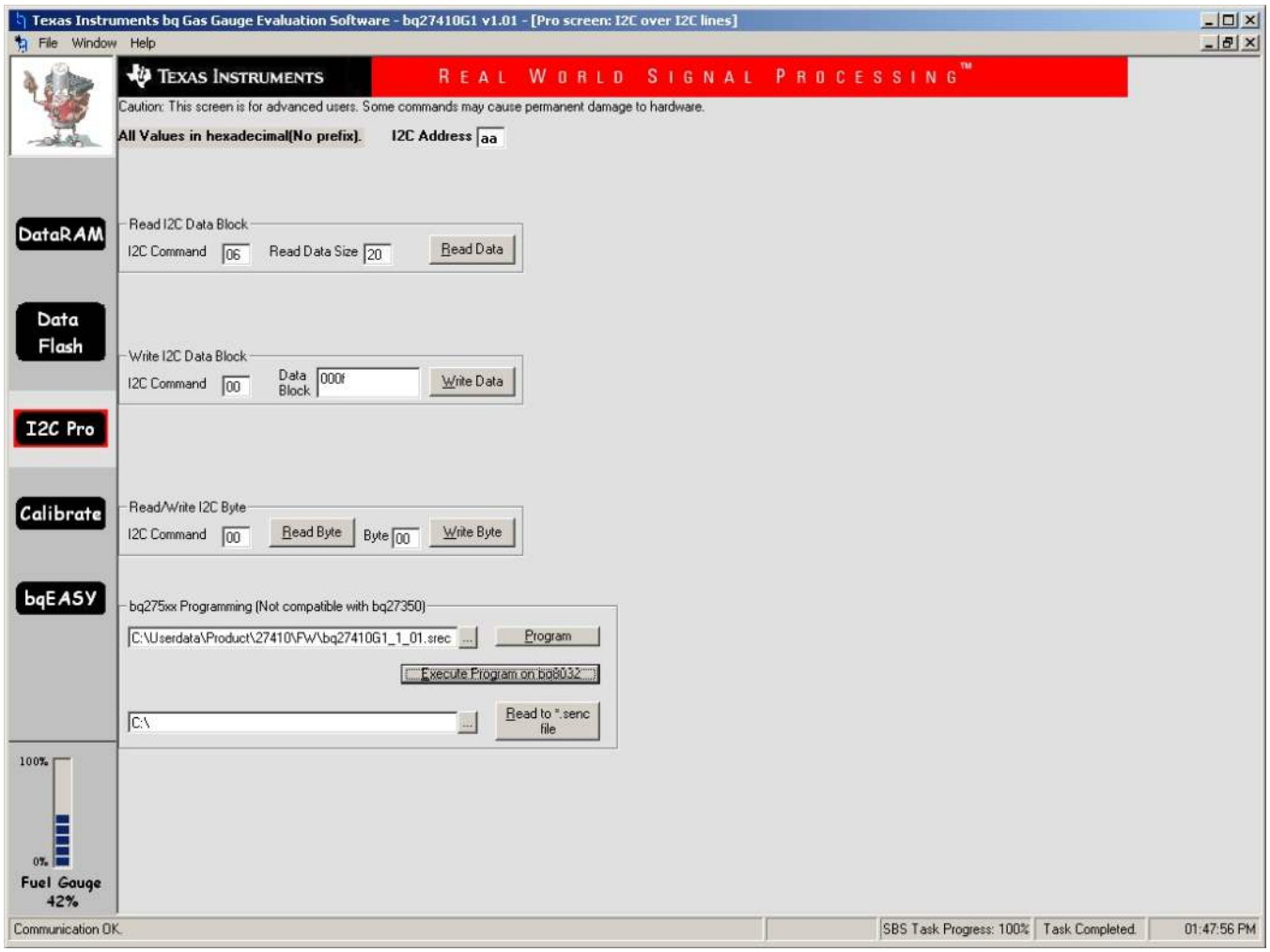

Figure 10. I2C Pro Screen

11 bqEASY™ Software

11.1 Introduction

Texas Instruments fuel gauges, employing the Impedance Track™ algorithm, offer an unmatched array of features and benefits. Sometimes, however, the wide range of configuration settings can seem challenging to get started with the evaluation process. In addition, determining the correct chemistry model and producing the 'golden image' file can be time consuming. The bqEASY™ program is designed to greatly simplify the process of configuring, calibrating, selecting chemistry, and performing learning cycles through the step-by-step use of a wizard program.

The bqEASY™ software runs inside the current EV software when it is executed by clicking the bqEASY button in the left column of buttons below the Calibrate button in the EV software

Figure 11. bqEASY™ Welcome Screen

11.2 Program Navigation and Flowchart

The sequence of operation of the bqEASY™ program can be understood by reviewing the basic flowchart in Figure 12. Using the program is simple – just start a new project and follow the steps sequentially from 1A to 5C. You can use the Next button, or click on the top tabs and left subsection labels to move to any desired page. Some operations must be completed in sequence due to data dependencies, or to implement the proper flow. Therefore, it is recommended that the prescribed sequence be followed, at least at first.

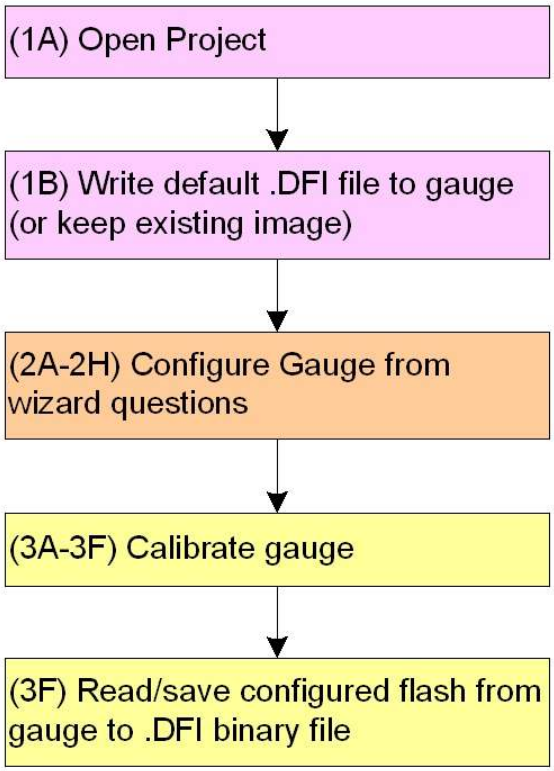

Figure 12. bqEASY™ Flow Chart

11.3 Simplified Configuration Procedures

These simplified configuration procedures can be used to quickly set up the parameters without navigating through the entire user interface.

1. Simple configuration of the gas gauge with default or custom data:
   (a) Open the current EV software, and click the bqEASY button in the left column of buttons below the Calibrate button in the EV software.
   (b) Click the "2. Configure" tab at the top row of bqEASY™ tabs. (Note: You can skip the first tab.)
   (c) Answer all questions, or leave defaults for all of tab "2", but be sure to click the OK button at the bottom of each tab "2" page to ensure that a Completion Checkmark appears for each page.
   (d) On page 2H, when you click the OK button, the software asks you to write to the data-flash memory. Click Yes for OK to write to the data flash.

   Your Gas Gauge Module now has the data flash configured as you declared with all the information entered in tab "2. Configure".

11.4 Files

The bqEASY™ software uses four types of files to configure a fuel gauge.

1. **ENCR** – These are default data-flash definition files found in the \bq_Evaluation_Software folder. The .ENCR file is basically a copy of the entire data flash from a fresh gas gauge prior to any data-flash updates either by the user or the gas gauge. They are unique for each version of each TI fuel gauge product. If you are working with a new version fuel gauge and an older version of bqEASY™ software, the correct file may not be present. This requires a new version of the EV software with bqEASY™ software. Navigate to the TI Web site in the EVM tool folder for the device being used, and download the latest version, or contact TI. For the bqEASY™ program, the .ENCR files act mainly as a dictionary to look up the address for a given data-flash location. For bqEVSW, they define screen parameters including address, display formulas, and data type. An error message appears if the correct .ENCR file

cannot be found.

2. **DFI (Data-Flash Image Files)** – These are binary images of the fuel gauge data flash with modified values based on the application. Because of the binary format, it is quick and easy to transfer them to and from a gauge. Each fuel gauge model and firmware version has a unique read-only .DFI which is found in the ..\bq_Evaluation_Software\Plugins\Device_Defaults folder of the application. During the bqEASY™ process, intermediate versions of .DFI files are recorded with current updated data in order to prevent the possibility of corruption. Then, the final output of the bqEASY™ software is also a .DFI file which is the 'golden image' that is programmed into each production unit. This output file is placed in the ..\bq_Evaluation _Software\Plugins\Projects folder.
3. **EZY (bqEASY™ Project Files)** – These are read-write text files which record header information regarding a project, answers to the wizard questions, and status regarding the stage of completion (the red check marks). They are kept in the ..\bq_Evaluation _Software\Plugins\Projects folder.

11.5 Completion Checkmark

As the wizard questions and tasks are completed, completion checkmarks appear in two places – along the task list on the left and on the category tabs on top. A checkmark on a top tab only appears after all tasks in the category have been completed. Completion marks are saved in the .EZY project text file. When a completed or partially completed project file is opened, the user is given the chance to erase the checkmarks.

11.6 Device Detection

The bqEASY™ program is designed to work with a fuel gauge present and already communicating with the bqEVSW evaluation software through the EV2300 or EV2400 USB interface. When the evaluation software is started, it reads the device type and displays it on the upper title block. This information is used by the bqEASY™ program to select the correct default data-flash image (.DFI) and data-flash configuration file (.ENCR) for this particular device. To ensure that the device has not changed, the bqEASY™ software also checks the device type when the bqEASY button is pressed. If the correct files are not found, first check the TI Web site in the EVM tool folder for the part being used, and download the latest version of EV software with bqEASY™ support. If that fails to help, contact TI.

1. **Setup**
   As the wizard questions and tasks are completed, completion checkmarks appear in two places – along the task list on the left and on the category tabs on top. A checkmark on a top tab only appears after all tasks in the category have been completed. Completion marks are saved in the .EZY project text file. When a completed or partially completed project file is opened, the user is given the chance to erase the checkmarks.
2. **Configure**
   A series of eight screens is used to collect information about the battery pack application to enable automatic configuration of the most critical data-flash parameters.
3. **Calibrate**
   If you wish to proceed with either automatic chemistry selection or *golden* unit learning cycles, the Impedance Track™ fuel gauge must be accurately calibrated. The bqEASY™ screens simply ask the user to use the calibration screen of the bqEVSW for this purpose.

12 Related Documentation from Texas Instruments

To obtain a copy off 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. *bq27410, System-Side Impedance Track™ Fuel Gauge* data sheet (SLUSAF4)

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 0 V to 5 V and the output voltage range of 0 V to 5 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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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