

# ***bq20z655EVM and bq34z651EVM SBS 1.1 Impedance Track Technology-Enabled Evaluation Module***

This evaluation module (EVM) is a complete evaluation system for the bq20z655/bq29412 and bq34z651/bq29412 battery management system. The EVM includes one bq20z655/bq29412 or bq34z651/bq29412 circuit module and a link to Windows®-based PC software. The circuit module includes one bq20z655 or bq34z651 integrated circuit (IC), one bq29412 IC, 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 over-current in 2-, 3-, or 4-series cell Li-Ion or Li-Polymer battery packs. The circuit module connects directly across the cells in a battery. With the EV2300 or EV2400 interface board and software, the user can read the bq20z655 or bq34z651 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the solution under different charge and discharge conditions.

### Contents

1	Features .....	2
2	bq20z655-Based and bq34z651-Based Circuit Module .....	2
3	bq20z655 and bq34z651 Circuit Module .....	3
4	Circuit Module Physical Layouts and Bill of Materials .....	3
5	EVM Hardware and Software Setup .....	8
6	Troubleshooting Unexpected Dialog Boxes .....	8
7	Hardware Connection .....	8
8	Operation .....	9
9	Calibration Screen .....	12
10	Pro (Advanced) Screen .....	13
11	Related Documentation from Texas Instruments .....	14

### List of Figures

1	bq20z655EVM and bq34z651EVM Layout—Silk Screen.....	4
2	Top Assembly .....	4
3	Top Layer .....	4
4	Bottom Layer .....	4
5	Bottom Assembly .....	5
6	Schematic.....	7
7	bq20z655 and bq34z651 Circuit Module Connection to Cells and System Load/Charger.....	9
8	SBS Data Screen.....	10
9	Data Flash Screen, 1st Level Safety Class .....	11
10	Calibration Screen.....	13
11	Pro (Advanced) Screen.....	14

### List of Tables

1	Ordering Information.....	2
2	Components and Flash-Memory Settings for Different Precharge Modes .....	3
3	Bill of Materials .....	5
4	Performance Specification Summary.....	8
5	Circuit Module to EV2300 or EV2400 Connections .....	9

## 1 Features

- Complete evaluation system for the bq20z655 and bq34z651 SBS 1.1-compliant advanced gas gauges with Impedance Track™ technology and bq29412 independent overvoltage protection IC
- Populated circuit module for quick setup
- Software that allows data logging for system analysis

### 1.1 Kit Contents

- bq20z655/bq29412 and bq34z651/bq29412 circuit module
- Set of support documentation

### 1.2 Ordering Information

**Table 1. Ordering Information**

EVM Part Number	Chemistry	Configuration	Capacity
bq34z651EVM	Li-Ion	2-series, 3-series, or 4-series cell	Any
bq20z655EVM	Li-Ion	2-series, 3-series, or 4-series cell	Any

## 2 bq20z655-Based and bq34z651-Based Circuit Module

The bq20z655/bq29412 and bq34z651/bq29412-based circuit module is a complete and compact example solution of a bq20z655 and bq34z651 circuit for battery management and protection of Li-Ion or Li-Polymer packs. The circuit module incorporates a bq20z655 and bq34z651 battery monitor IC, bq29412 independent overvoltage protection IC, and all other components necessary to accurately predict the capacity of 2-series, 3-series, or 4-series cells.

### 2.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct connection to the cells: 1N (BAT–), 1P, 2P, 3P, 4P (BAT+)
- To the serial communications port (SMBC, SMBD)
- To the system load and charger connect across PACK+ and PACK–
- To the system-present pin (SYS PRES)
- To the LED/LCD interface (LED(1:5), common) (LCD option only on the bq20z655)
- To charge enable input (CE) (bq20z655 option only)
- To the heater control port (HEATER CNTRL) (bq34z651 option only)

### 2.2 Pin Descriptions

Pin Name	Description
1N	–ve connection of first (bottom) cell
1P	+ve connection of first (bottom) cell
2P	+ve connection of second cell
3P	+ve connection of third cell
4P	+ve connection of fourth (top) cell
CE	Charge enable overrides firmware control when high
COMMON	Output/open drain: LCD common connection
HEATER CNTRL (X3)	Drain connection to n-channel FET
LED1	Output/open drain: LED 1 current sink. LCD segment 1
LED2	Output/open drain: LED 2 current sink. LCD segment 2
LED3	Output/open drain: LED 3 current sink. LCD segment 3

Pin Name	Description
LED4	Output/open drain: LED 4 current sink. LCD segment 4
LED5	Output/open drain: LED 5 current sink. LCD segment 5
PACK-	Pack negative terminal
PACK+	Pack positive terminal
SMBC	Serial communication port clock
SMBD	Serial communication data port
SYS PRES	System present pin (if low, system is present)
VSS	Pack negative terminal

### 3 bq20z655 and bq34z651 Circuit Module

This section contains information for modifying and choosing a precharge mode for bq20z655/bq29412 and bq34z651/bq29412 implementation.

#### 3.1 Schematic

The schematic follows the bill of materials in this user's guide ([Figure 6](#)).

#### 3.2 Modifications for Choosing Particular Precharge Mode

To charge, the charge FET (CHG-FET) must be turned on to create a current path. When the  $V_{(BAT)}$  is 0 V and CHG-FET = ON, the  $V_{(PACK)}$  is as low as the battery voltage. In this case, the supply voltage for the device is too low to operate. This function has three possible configurations, and the IC can be easily configured according to the application needs. The three modes are 0-V Charge FET mode, Common FET mode, and Precharge FET mode.

1. 0-V Charge FET mode—Dedicates a precharge current path using an additional FET (ZVCHG-FET) to sustain the PACK+ voltage level.
2. Common FET mode—Does not use a dedicated precharge FET. The charge FET (CHG-FET) is set to ON state as default.
3. Precharge FET mode—Dedicates a precharge current path using an additional open-drain (OD) pin drive FET (PCHG-FET) to sustain the PACK+ voltage level.

To use a particular mode of charging with the EVM, add or remove some elements shown in [Table 2](#), and use the given settings of DF.Configuration, ZVCHG1, 0.

**Table 2. Components and Flash-Memory Settings for Different Precharge Modes**

Mode	Resistors	PRECHG FET	ZVCHG1	ZVCHG0
1. 0-V Chg (default)	R21, R28	Q3	0	0
2. Common FET	R24	Q2	0	1
3. Precharge	R23, R28	Q3	1	0

For more details about pre-charge operation and mode choices, see the bq20z655 datasheet ([SLUSAH8](#)) and the bq34z651 datasheet ([SLUSAL7](#)).

#### 3.3 Testing Fuse-Blowing Circuit

To prevent the loss of board functionality during the fuse-blowing test, the actual chemical fuse is not provided in the circuit. FET Q1 drives TP2 low if a fuse-blow condition occurs; so, monitoring TP2 can be used to test this condition. Fuse placement on the application board is shown in the bq20z655 and bq34z651 datasheet reference-board schematics.

### 4 Circuit Module Physical Layouts and Bill of Materials

This section contains the printed-circuit board (PCB) layout, bill of materials, and assembly drawings for the bq20z655/bq29412 and bq34z651/bq29412 circuit module.

### 4.1 Board Layout

This section shows the dimensions, PCB layers (Figure 1 through Figure 5), and assembly drawings for the bq20z655 and bq34z651 modules.

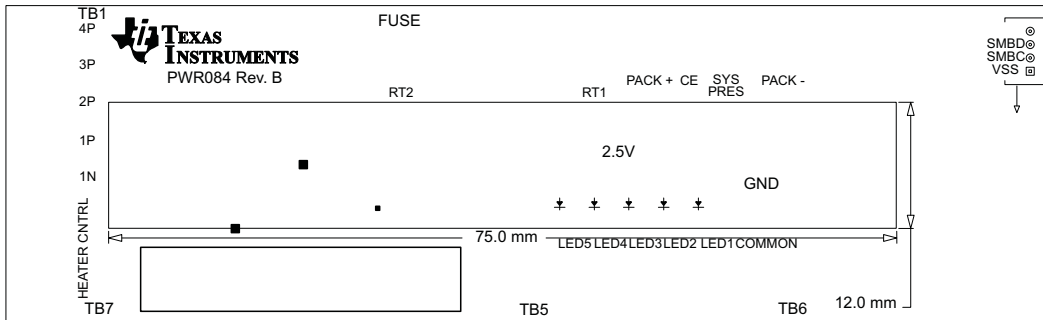


Figure 1. bq20z655EVM and bq34z651EVM Layout—Silk Screen

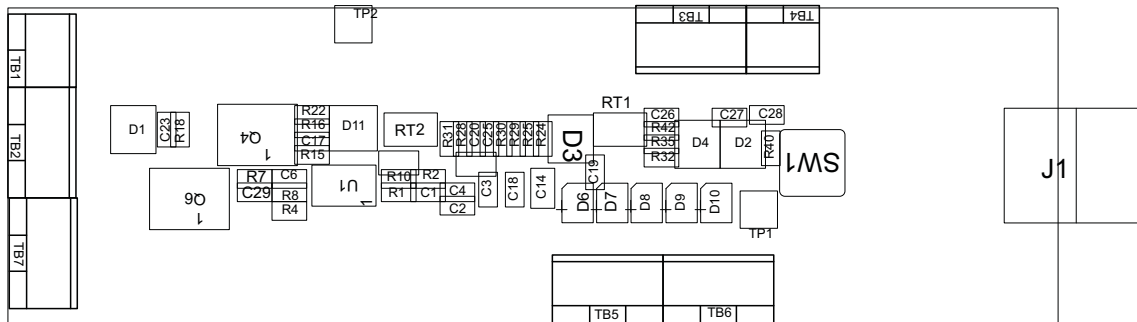


Figure 2. Top Assembly

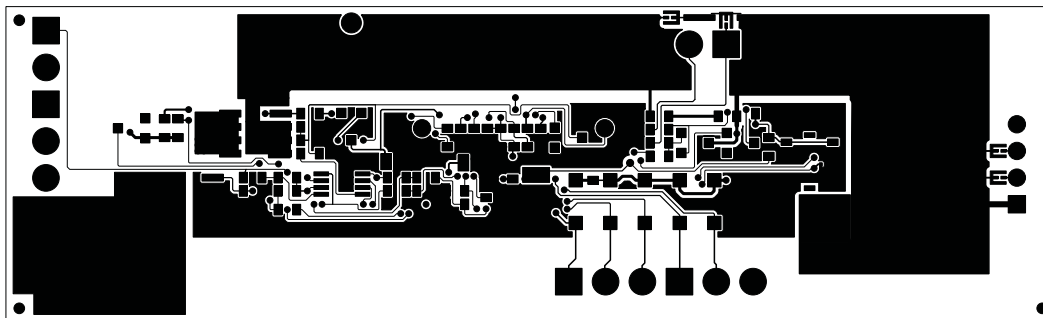


Figure 3. Top Layer

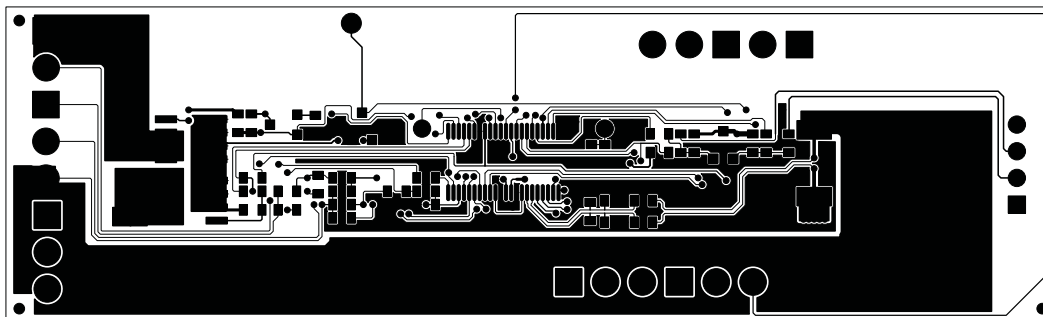
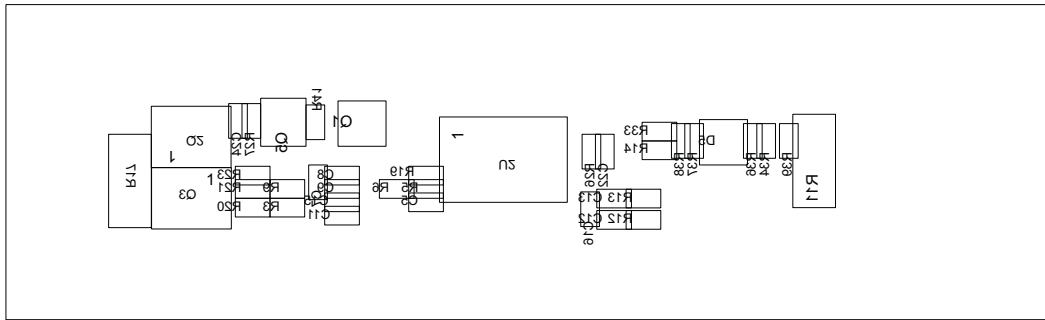


Figure 4. Bottom Layer


**Figure 5. Bottom Assembly**

## 4.2 Bill of Materials and Schematic

**Table 3. Bill of Materials**

Count	Reference Design	Description	Size	MFR	Part Number
21	C1, C2, C3, C4, C5, C6, C7, C8, C9, C12, C13, C15, C16, C17, C18, C20, C23, C24, C26, C27, C28	Capacitor, Ceramic, 50 V, X7R, 20%	0603	Any	STD
3	C10, C14, C21	Capacitor, Ceramic, 25 V, X7R, 20%	0805	Any	STD
1	C11	Capacitor, Ceramic, 25 V, X7R, 20%	0603	Any	STD
1	C19	Capacitor, Ceramic, 10 V, X7R, 20%	0603	Any	STD
2	C22, C25	Capacitor, Ceramic, 16 V, X7R, 20%	0603	Any	STD
1	C29	Capacitor, Ceramic, 16 V, X7R, 20%	0603	Any	STD
4	D1, D2, D3, D11	Diode, Switching, 150 mA, 75 V, 350 mW	SOT23	Fairchild	BAS16
2	D4, D5	Diode, Dual, Zener, 5.6 V, 300 mW	SOT23	Diodes	AZ23C5V6-7-F
5	D6, D7, D8, D9, D10	Diode, LED, Green, Gullwing, GW Type, 20 ma, 7.5 mcd typ.	0.120 x 0.087 inch	Panasonic	LN1361C
1	J1	Header, Friction Lock Ass'y, 4-pin Right Angle	0.400 x 0.500 inch	Molex	22-05-3041
1	Q1	MOSFET, N-Ch, 20 V, 1.3 A, 210 mΩ	SOT-23	Fairchild	NDS331N
3	Q2, Q4, Q6	MOSFET, NChan 30 V, 15 A, 7 mΩ	SO8	Fairchild	FDS8817NZ
1	Q3	MOSFET, Pch, -30 V, -8.8 A, 20 mΩ	SO8	Fairchild	FDS4435BZ
1	Q5	MOSFET, N-Ch, 50 V, 0.22 A, 3.5 Ω	SOT23	Fairchild	BSS138
12	R1, R2, R3, R4, R5, R12, R13, R32, R33, R34, R38, R39	Resistor, Chip, 1/16 W, 5%	0603	Any	STD
1	R11	Resistor, Chip, 1 W, 1%, 75 ppm	2512	Vishay	WSI2512R0100FEA
4	R14, R19, R21, R22	Resistor, Chip, 1/16 W, 5%	0603	Any	STD
3	R15, R16, R40	Resistor, Chip, 1/16 W, 5%	0603	Any	STD
1	R17	Resistor, Chip, 1 W, 5%	2512	Any	STD
2	R18, R27	Resistor, Chip, 1/16 W, 1%	0603	Any	STD

**Table 3. Bill of Materials (continued)**

Count	Reference Design	Description	Size	MFR	Part Number
4	R20, R36, R37, R41	Resistor, Chip, 1/16 W, 5%	0603	Any	STD
3	R23, R28, R24	Resistor, Chip, 1/16 W, 5%	0603	Any	STD
2	R25, R29	Resistor, Chip, 1/16 W, 1%	0603	Any	STD
2	R26, R30	Resistor, Chip, 1/16 W, 1%	0603	Any	STD
8	R6, R7, R8, R9, R10, R31, R35, R42	Resistor, Chip, 1/16 W, 5%	0603	Any	STD
2	RT1, RT2	Thermistor, NTC, 3-A	0.095 X 0.150 inch	Semitec	103AT-2
1	SW1	Switch, Push button, Momentary, N.O. Low Profile	0.200 x 0.200 inch	Panasonic	EVQ-PLHA15
2	TB1, TB4	Terminal Block, 2-pin, 6-A, 3.5 mm	0.27 x 0.25	OST	ED555/2DS
5	TB2, TB3, TB5, TB6, TB7	Terminal Block, 3-pin, 6-A, 3.5 mm	0.41 x 0.25	OST	ED555/3DS
1	TP1	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	Keystone	5001
1	TP2	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	Keystone	5002
1	U1	IC, Voltage Protection for 2, 3, 4 Cell Lion , 2nd Protection, 4.45 V OVP	SSOP-08	TI	bq29412DCT
1	U2	IC, Cool-GG Programmable Battery Management	TSSOP30	TI	bq34z651DBT or bq20z655DBT-R1
1		PCB, 3.94-inch x 1.18-inch x 0.062		Any	PWR084

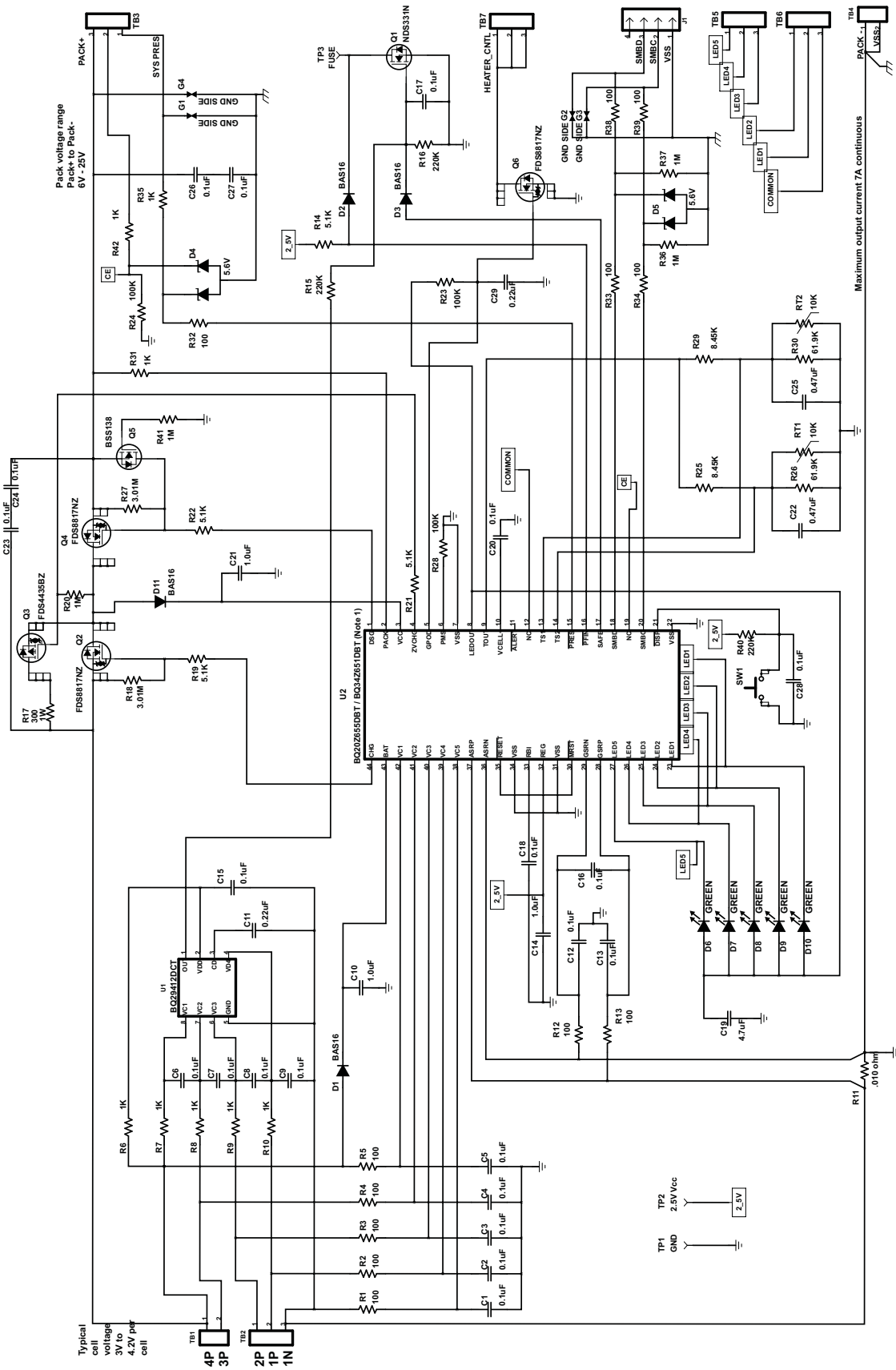


Figure 6. Schematic

### 4.3 bq20z655/bq29412 and bq34z651/bq29412 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq20z655/bq29412 and bq34z651/bq29412 circuit module.

**Table 4. Performance Specification Summary**

Specification	Minimum	Typical	Maximum	Units
Input voltage Pack+ to Pack-	6	15	25	V
Charge and discharge current	0	2	7	A

## 5 EVM Hardware and Software Setup

This section describes how to install the bq20z655 and bq34z651 PC software and how to connect the different components of the EVM.

### 5.1 System Requirements

The bq20z655EVSW or bq34z651EVSW software requires Windows® XP or later.

### 5.2 Software Installation

Find the latest software version in the bq20z655 and bq34z651 tool folder on [power.ti.com](http://power.ti.com). Use the following steps to install the bq20z655EVSW or bq34z651EVSW software:

1. Copy the files from the TI website into a temporary directory you select, double-click on *bqEV-EASYSetup00.09.xx.exe*, where xx indicates the version, and follow the installer instructions to complete the EVSW installation.
2. If the EV2300 or EV2400 was not previously installed, after the EVSW installation, a TI USB DRIVER INSTALLER pops up. Click **Yes** for the agreement message and follow its instructions. Two drivers are associated with the EV2300 or EV2400. Follow the instructions to install both. Do not reboot the computer, even if asked to do so.
3. Plug the EV2300 or EV2400 into a USB port. The Windows system may show 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**. In the next dialog window, it indicates *This wizard helps you install software for: TI USB Firmware Updater*, select **Install the software automatically (Recommended)** and click **NEXT**. It is common for the next screen to be 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 is completed, a similar dialog window pops up to install the second driver; proceed with the same installation preference as the first one. The second driver is TI USB bq80xx Driver.

## 6 Troubleshooting Unexpected Dialog Boxes

The following actions can help the user to avoid 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 bq20z655EVM and bq34z651EVM comprises three hardware components: the bq20z655/bq29412 or bq34z651/bq29412 circuit module, the EV2300 or EV2400 PC interface board, and the PC.



### 7.1 Connecting bq20z655/bq29412 and bq34z651/bq29412 Circuit Module to the Battery Pack

Figure 7 shows how to connect the bq20z655/bq29412 and bq34z651/bq29412 circuit module to the cells and system load/charger.

The cells must be connected in the following order:

1. 4-Cell Pack: 1N (BAT–), 1P, 2P, 3P, and 4P (see Section 2.1 for definitions).
2. 3-Cell Pack: 1N (BAT–), 1P, 2P, and then connect 4P and 3P together.
3. 2-Cell Pack: 1N (BAT–), 1P, and then connect 4P, 3P, and 2P together

To start charge or discharge test, connect PRES pin to PACK– pin to set SYS PRES state. To test sleep mode, disconnect the SYS PRES pin.

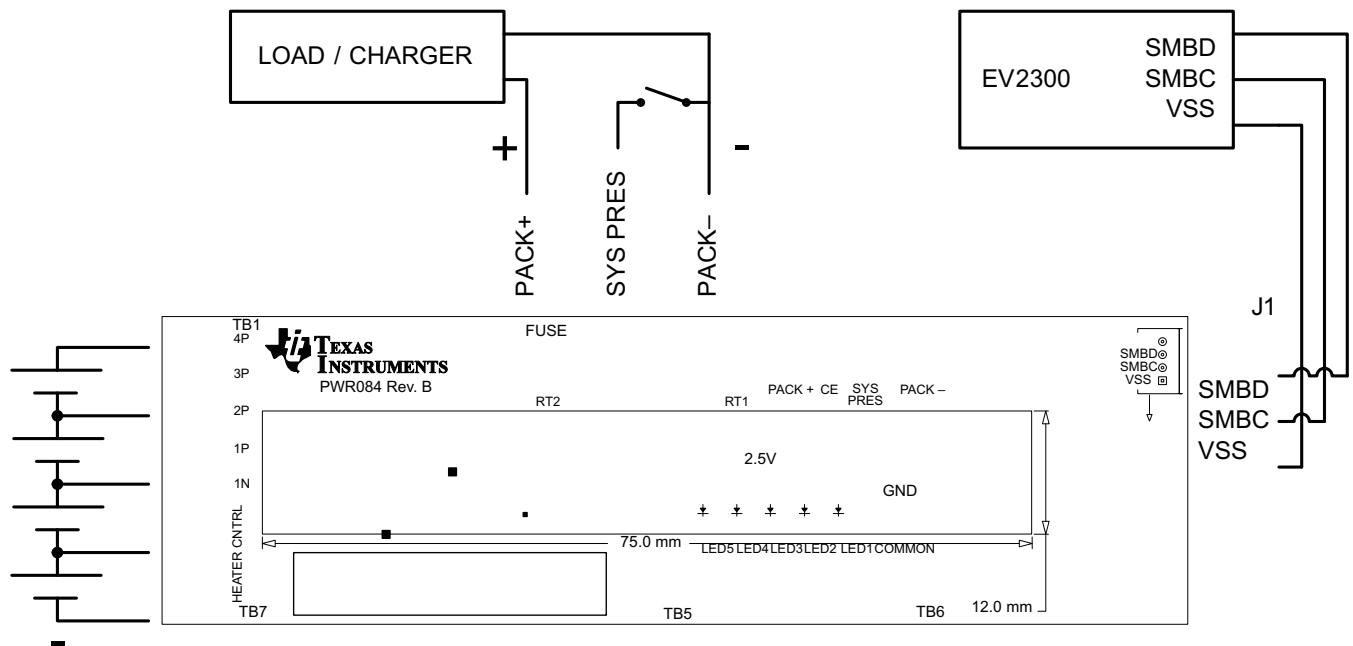


Figure 7. bq20z655 and bq34z651 Circuit Module Connection to Cells and System Load/Charger

### 7.2 PC Interface Connection

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

1. Connect the bq20z655-based and bq34z651-based smart battery to the EV2300 or EV2400 using wire leads as shown in Table 5.

Table 5. Circuit Module to EV2300 or EV2400 Connections

bq20z655-Based and bq34z651-Based Battery	EV2300 or EV2400
SMBD	SMBD
SMBC	SMBC
VSS	GND

2. Connect the PC USB cable to the EV2300 or EV2400 and the PC USB port.  
The bq20z655EVM and bq34z651EVM is now set up for operation.

## 8 Operation

This section details the operation of the bq20z655 and bq34z651 EVSW software.

### 8.1 Starting the Program

Run bq Evaluation Software from the **Start | Programs | Texas Instruments | bq20z655** (or bq34z651) **EVSU** menu sequence. The SBS Data screen (**Figure 8**) 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 bq Evaluation Software provides a logging function that 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 the scan interval because this results in the same value being logged at least twice.

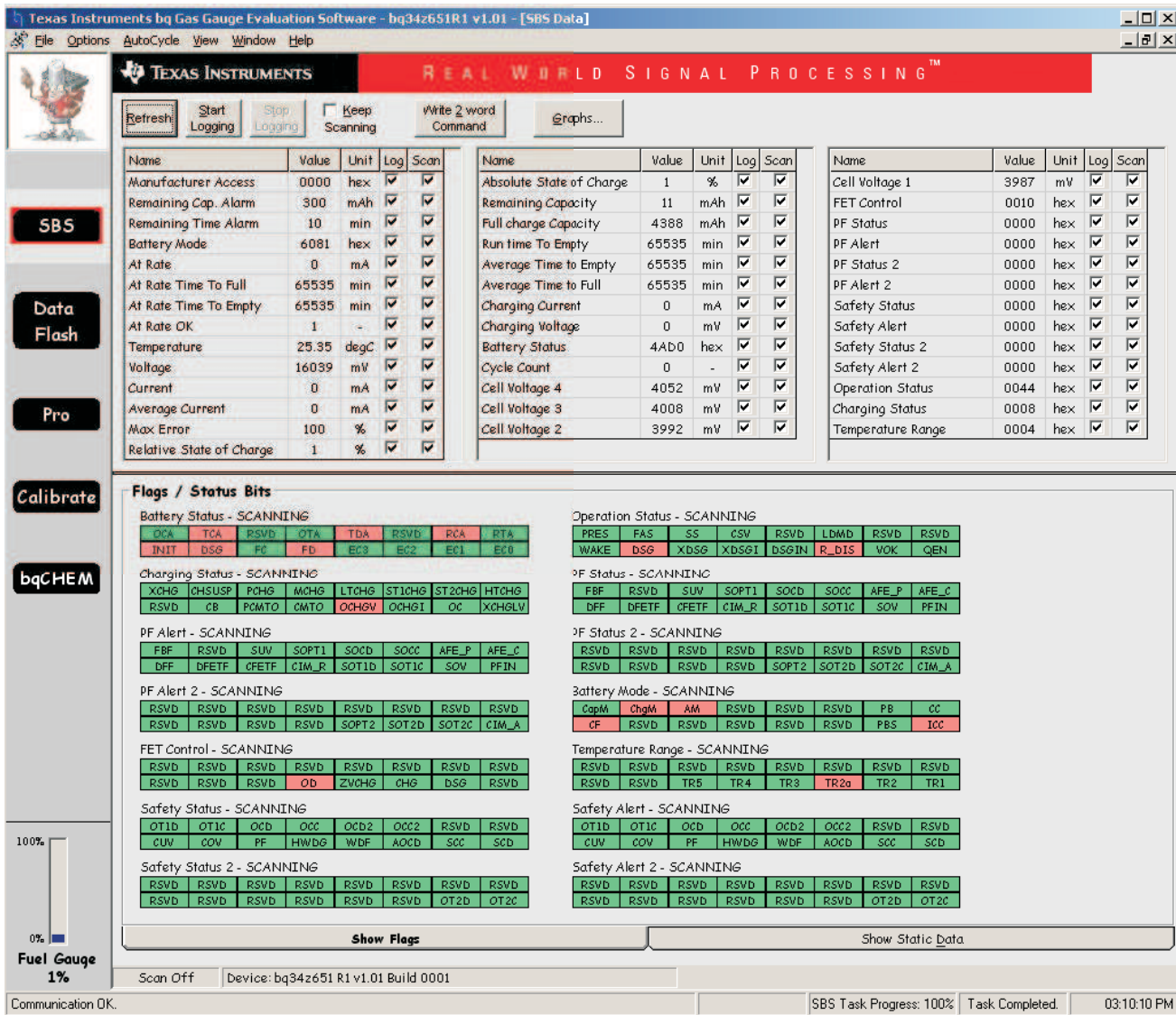


Figure 8. SBS Data Screen

This screen (Figure 8) shows the SBS data set along with additional ManufacturersAccess() command information such as individual cell measurements. Additional Flag and Static data can be viewed by selecting the appropriate tab at the bottom of the **SBS Data** screen.

Data such as SBS.ManufacturerName() is static and does not change. This data is viewed separately using the **Static Data** tab available at the bottom of the 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 bq20z655 and bq34z651 Options

The bq20z655 and bq34z651 data flash comes configured per the default settings detailed in the bq20z655 and bq34z651 datasheet. Ensure that the settings are correctly changed to match the pack and application for the bq20z655 and bq34z651 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 Constants** screen (Figure 9).



Figure 9. Data Flash Screen, 1st Level Safety Class

To read all the data from the bq20z655 and bq34z651 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 option 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 bq20z655 and bq34z651 using the | **Write All** | button.

The configuration information of the bq20z655 and bq34z651 and module calibration data also is held in the bq20z655 and bq34z651 data flash.

The bq20z655 and bq34z651 allows for an automatic data flash export function, similar to the SBS Data 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 checkmark 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 bq20z655 and bq34z651 that is being used may not be supported by the bqEVSW version that is being used. An upgrade may be required.

## 9 Calibration Screen

### 9.1 How to Calibrate

The bq20z655 and bq34z651 must be calibrated using power supplies or a power supply and cell simulation resistors (200  $\Omega$  to 1000  $\Omega$  each) before cells are attached. Before the bq20z655 and bq34z651 are calibrated:

- Connect and measure a 2-A current source from 1N (–) and PACK– (+) to calibrate without using the FETs. (Calibration using the FETs is not recommended.)
- Measure the pack voltage from Batt+ to Batt– (total of cell voltages).
- Measure the temperature of the pack.
- These steps may not be required, depending on the type of calibration being performed.

### 9.2 To Calibrate the bq20z655 and bq34z651

To calibrate the bq20z655 and bq34z651, perform the following steps.

1. Select the types of calibration to be performed (see [Figure 10](#)).
2. Enter the measured values for the types selected (except for CC Offset Calibration).
3. If *Voltage Calibration* is selected, then enter the number of cells on the pack.
4. If *Temperature Calibration* is selected, then select the sensor that is to be calibrated.
5. If the current source is connected between 1N and PACK–, then select the Off (bypassed) check box in the FET Control section.
6. Press the **Calibrate Part** button.

### 9.3 Board Offset Calibration

To perform the offset calibration for the current offset of the board, do these steps:

1. Remove load/external voltage and short PACK– to Batt–.
2. Press the **CC Board Offset Calibration** button.

### 9.4 Pack Voltage Calibration

To calibrate the voltage at the AFE Pack pin, follow these steps:

1. Ensure that *Voltage Calibration* has been performed for the pack. Ensure that a stable charger voltage higher than 8-V is present at Pack+.
2. Press the **Pack Voltage** button to calibrate.

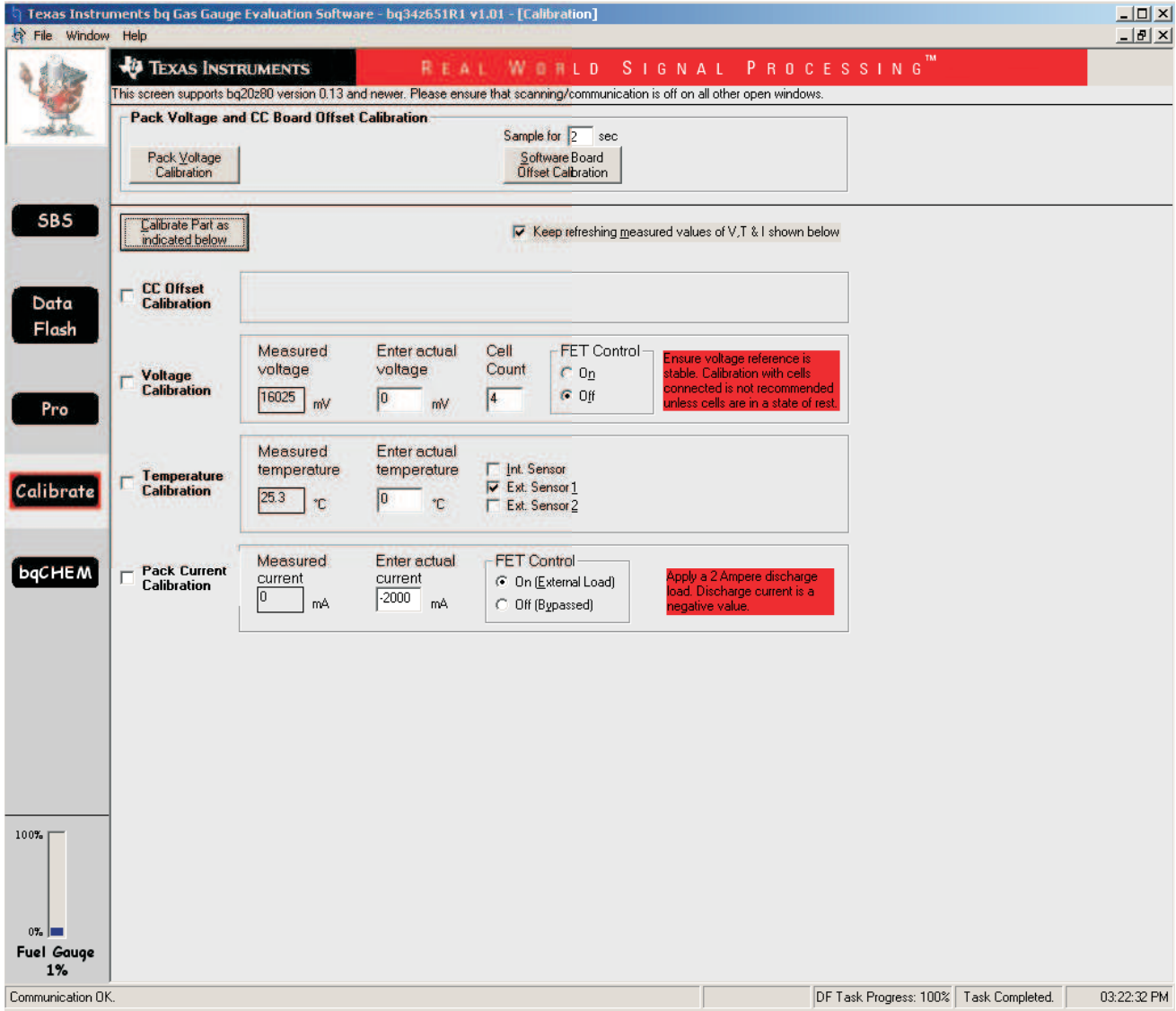


Figure 10. Calibration Screen

## 10 Pro (Advanced) Screen

### 10.1 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).

### 10.2 Hexadecimal/Decimal Converter

These two boxes convert between *Hexadecimal value* and *Decimal value* 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.

### 10.3 Programming

This screen allows device reprogramming from unencrypted and encrypted files.

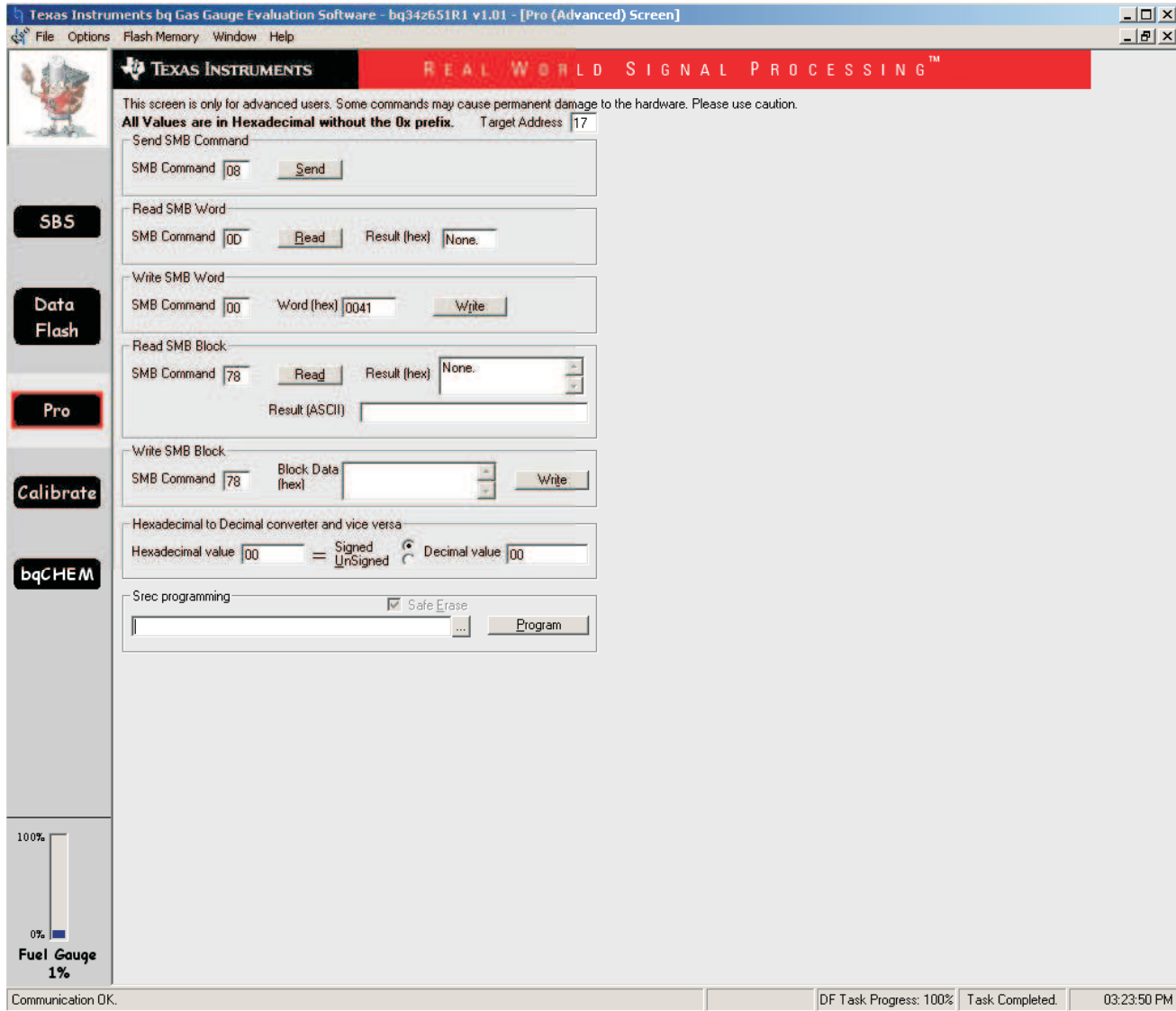


Figure 11. Pro (Advanced) Screen

## 11 Related Documentation from Texas Instruments

1. *bq20z655 SBS 1.1-Compliant Gas Gauge and Protection Enabled with Impedance Track™ Datasheet (SLUSAH8)*
2. *bq20z655 Technical Reference Manual (SLUU493)*
3. *bq20z655 SBS 1.1-Compliant Gas Gauge and Protection Enabled with Impedance Track™ and External Battery Heater Control Datasheet (SLUSAL7)*
4. *Quick-Start Guide for bq20zxx Family Gas Gauge Application Report (SLUA421A)*

5. *EV2400 Evaluation Module Interface Board User's Guide* ([SLUU446A](#))
6. *bqEasy™ User's Guide* ([SLUU278](#))

## EVALUATION BOARD/KIT IMPORTANT NOTICE

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.**

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

**EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.**

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive.**

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit [www.ti.com/esh](http://www.ti.com/esh).

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

### FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

### 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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2011, Texas Instruments Incorporated