

bq30z55-R1EVM SBS 1.1 Impedance Track™ Enabled Battery Management Solution EVM

The bq30z55-R1EVM is a complete evaluation system for the bq30z55-R1/bq29412 battery management solution. This system includes one bq30z55-R1/bq29412 circuit module, a current sense resistor, two thermistors, and a link to Windows®-based PC software.

The circuit module includes one bq30z55-R1 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, overdischarge, short circuit, and overcurrent in 2-series, 3-series, 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, users can read the bq30z55-R1 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the bq30z55-R1/bq29412 solution under different charge and discharge conditions.

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1 Features

- Complete evaluation system for the bq30z55-R1 SBS 1.1-Compliant Advanced Gas Gauge with Impedance Track™ technology, bq30z55-R1 and bq29412 independent overvoltage protection integrated circuit (IC)
- Populated circuit module for quick setup
- Link to software that allows data logging for system analysis

1.1 Kit Contents

- bq30z55-R1/bq29412 circuit module
- Links to support documentation

1.2 Ordering Information

Table 1. Ordering Information

EVM PART NUMBER	CHEMISTRY	CONFIGURATION	CAPACITY
bq30z55EVM	Li-Ion	2-series, 3-series, or 4-series cell	Any

2 bq30z55-R1 Device-Based Circuit Module

The bq30z55-R1/bq29412-based circuit module is a complete and compact example solution of a bq30z55-R1 circuit for battery management and protection of Li-Ion or Li-Polymer packs. The circuit module incorporates a bq30z55-R1 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, VSS)
- The system load and charger connect across PACK+ and PACK-
- To the system present pin (SYS PRES)

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
SMBC	Serial communication port clock
SMBD	Serial communication data port
VSS	Pack negative terminal
PACK–	Pack negative terminal
SYS PRES	System present pin (if low, system is present)
PACK+	Pack positive terminal

3 bq30z55-R1 Circuit Module Schematic

This section contains information on the schematic for the bq30z55-R1/bq29412 implementation.

3.1 Schematic

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

3.2 Choosing Particular Precharge Mode

The bq30z55-R1 contains an internal precharge FET; however, the default firmware configuration uses the Charge FET for precharge. To evaluate the internal precharge FET, change the least two significant bits in DF:Configuration:Charging Configuration to be 0,0. See the *bq30z5x-R1 Technical Reference Manual (SLUU852)* for additional information.

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 TP8 low if a fuse-blow condition occurs; monitoring TP8 can be used to test this condition.

NOTE: TP8 should be pulled up to test the fuse circuit.

4 Circuit Module Physical Layouts and Bill of Materials

This section contains the board layout, bill of materials, and assembly drawings for the bq30z55-R1/bq29412 circuit module.

4.1 Board Layout

This section shows the dimensions, PCB layers, and assembly drawing for the bq30z55-R1 module.

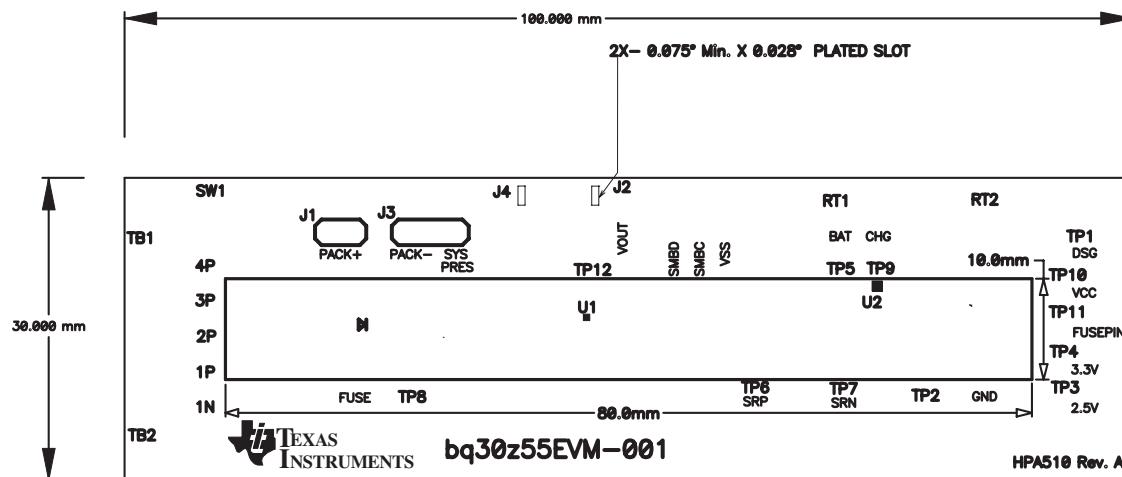


Figure 1. bq30z55-R1EVM-001 Layout (Silk Screen)

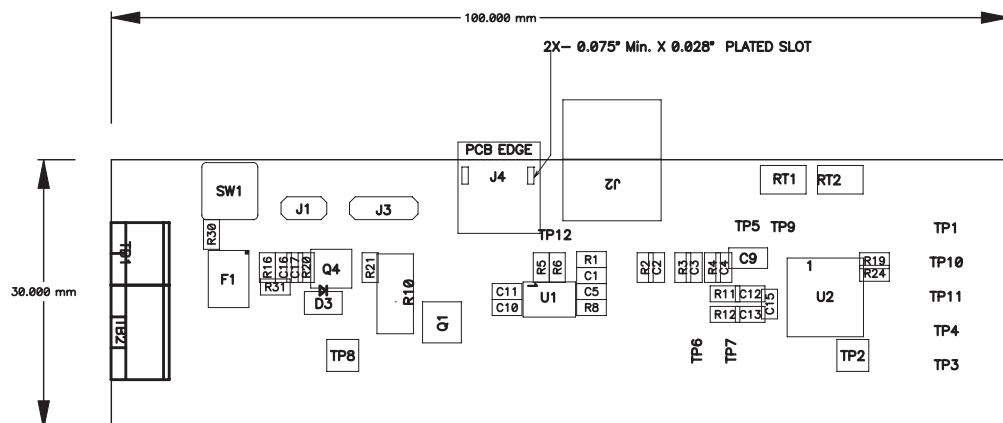


Figure 2. Top Assembly

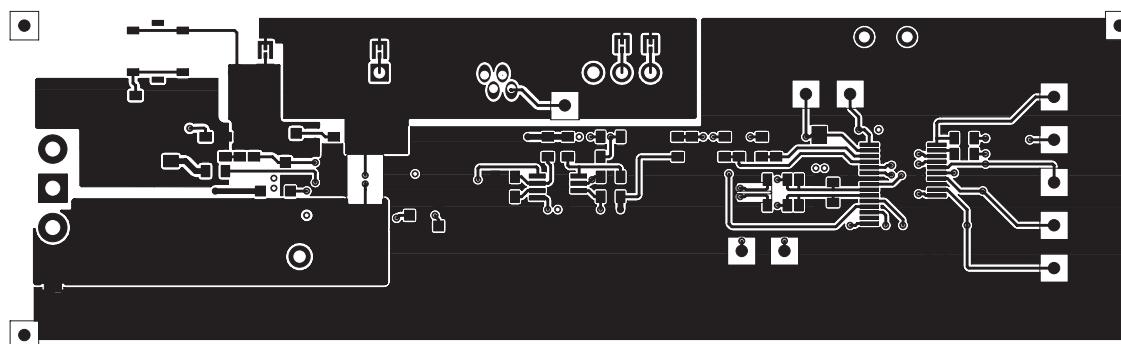


Figure 3. Top Layer

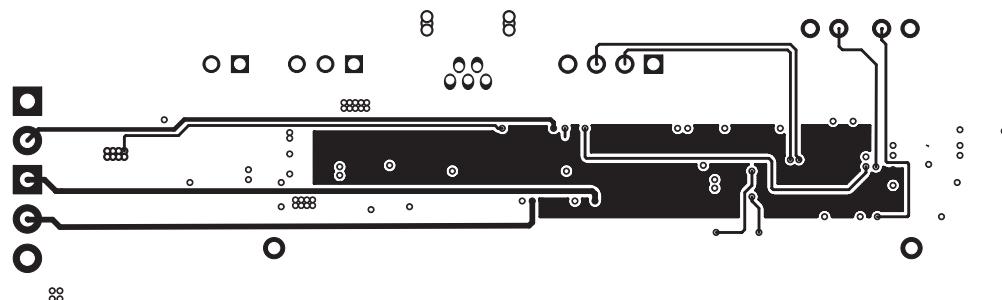


Figure 4. Inner Layer 1

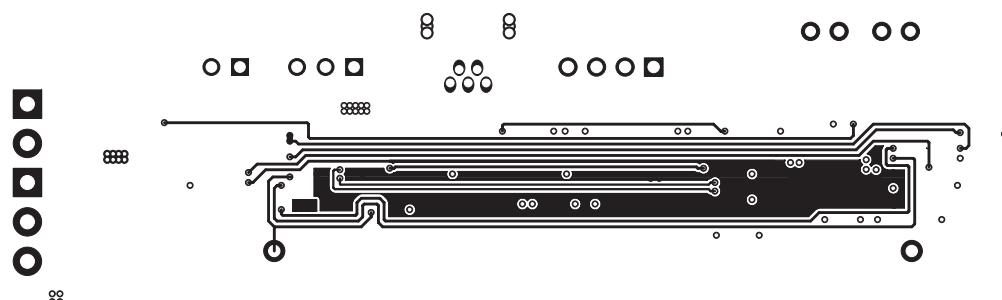


Figure 5. Inner Layer 2

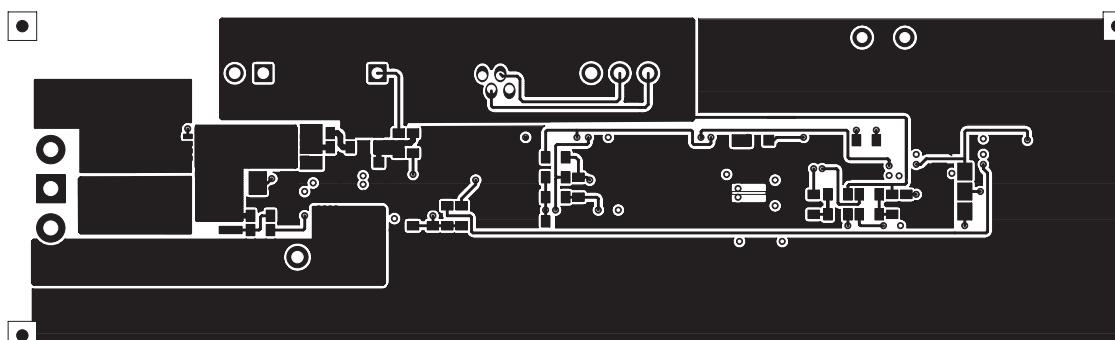


Figure 6. Bottom Layer

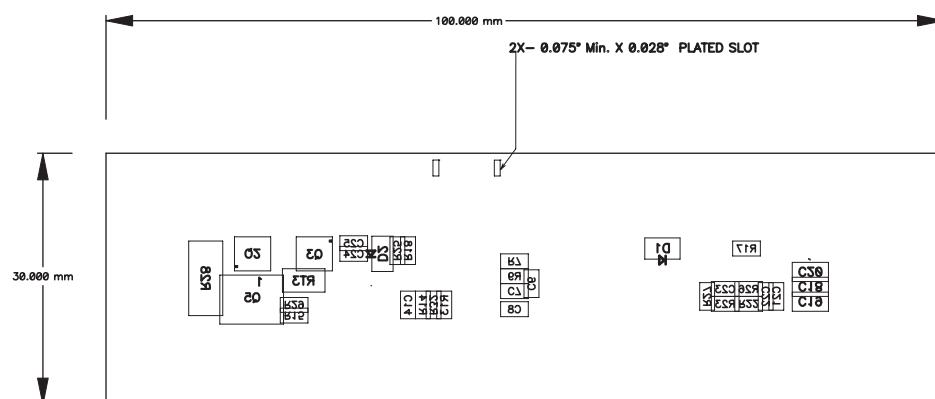


Figure 7. Bottom Assembly

4.2 Bill of Materials

Table 2. Bill of Materials

Count	Reference Design	Value	Description	Size	Part Number	Manufacturer
18	C1, C2, C3, C4, C5, C6, C7, C8, C11, C12, C13, C14, C15, C16, C17, C21, C24, C25	0.1 μ F	Capacitor, Ceramic, 50 V, X7R, 20%	0603	Std	Std
1	C10	0.22 μ F	Capacitor, Ceramic, 25 V, X7R, 20%	0603	Std	Std
4	C20, C9, C18, C19	1.0 μ F	Capacitor, Ceramic, 25 V, X7R, 20%	0805	Std	Std
2	C22, C23	0.1 nF	Capacitor, Ceramic, 50 V, X7R, 20%	0603	Std	Std
2	D1, D3	1SS355	Diode, Switching, 90 V, 225 mA Ifm, High speed	SOD-323	1SS355-17	Rohm
1	D2	MM3Z5V6C	Diode, Zener, 5.6 V, 200 mW	SOD323	MM3Z5V6C	Fairchild
0	F1	Un-install	Fuse, Chemical, Thermal, xxA	SFDxxx	SFDxxxx	Sony
1	J1	PEC02SAAN	Header, Male 2-pin, 100-m spacing	0.100 inch x 2	PEC02SAAN	Sullins
1	J2	22-05-3041	Header, Friction Lock Ass'y, 4-pin Right Angle	0.400 x 0.500	22-05-3041	Molex
1	J3	PEC03SAAN	Header, Male 3-pin, 100-m spacing, (36-pin strip)	0.100 inch x 3	PEC03SAAN	Sullins
1	J4	56579-0519	Connector, USB, Mini AB 5 pins	0.354 X 0.307 Inches	56579-0519	Molex
1	Q1	FDN339AN	MOSFET, N-ch, 20-V, 3 A, 0.05 Ω	SOT23	FDN339AN	Fairchild
2	Q2, Q3	Si7114DN	MOSFET, Fast Switching, NChan, 30 V, 18.3 A, 7.5 m Ω	PWRPAK 1212	Si7114DN-T1-E3	Vishay
1	Q4	2N7002K	MOSFET, Nch, 60 V, 300 mA, 2 Ω	SOT23	2N7002K-T1-E3	Vishay
1	Q5	FDS4435BZ	MOSFET, Pch, -30 V, -8.8 A, 20-m Ω	SO8	FDS4435BZ	Fairchild
9	R1, R2, R3, R4, R11, R12, R18, R26, R27	100	Resistor, Chip, 1/16-W, 5%	0603	Std	Std
1	R10	0.01	Resistor, Chip, 1-W, 1%, 75 ppm	2512	WSL2512R0100FEA	Vishay
2	R13, R32	50K	Resistor, Chip, 1/16-W, 5%	0603	Std	Std
1	R14	220K	Resistor, Chip, 1/16-W, 5%	0603	Std	Std
3	R15, R17, R19	5.1K	Resistor, Chip, 1/16-W, 5%	0603	Std	Std
2	R16, R20	3M	Resistor, Chip, 1/16-W, 5%	0603	Std	Std
3	R21, R24, R30	10K	Resistor, Chip, 1/16-W, 5%	0603	Std	Std
2	R22, R23	200	Resistor, Chip, 1/16-W, 5%	0603	Std	Std
6	R25, R5, R6, R7, R8, R9	1K	Resistor, Chip, 1/16-W, 5%	0603	Std	Std
1	R28	300	Resistor, Chip, 1W, 5%	2512	Std	Std
1	R29	1M	Resistor, Chip, 1/16W, 5%	0603	Std	Std
1	R31	0	Resistor, Chip, 1/16-W, 5%	0603	Std	Std
2	RT1, RT2	10K	Thermistor	0.095 X 0.150	BN35-3H103 or 103AT-2	Mitsubishi Material or Semitec
1	RT3	10K	Thermistor, PTC, 5%	1206	TFPT1206L1002JV	Vishay
1	SW1	EVQ-PLHA15	Switch, Push button, Momentary, 1P1T, 50-mA, 12 V	0.200 x 0.200 inch	EVQ-PLHA15	Panasonic
1	TB1	ED1514	Terminal Block, 2-pin, 6-A, 3.5 mm	0.27 x 0.25	ED555/2DS	OST
1	TB2	ED1515	Terminal Block, 3-pin, 6-A, 3.5 mm	0.41 x 0.25	ED555/3DS	OST
12	TP10, TP11, TP1, TP12, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9		Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	U1	BQ29412DCT	IC, Voltage Protection for 2, 3, 4 Cell Lion, 2nd Protection, 4.45 v OVP	SSOP-08	BQ29412DCT	TI
1	U2	BQ30Z55DBT	IC, CoolRISC Programmable Battery Manager	TSSOP-38 (DBT)	BQ30Z55-R1DBT	TI
1	—	PCB			HPA510	Std
Notes:	1. These assemblies are ESD sensitive, ESD precautions shall 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. Ref designators marked with an asterisk (**) cannot be substituted. All other components can be substituted with equivalent MFG's components. 5. Make one SMBus connector wire assembly for each assembly produced, from J4 mate, 4-24 Awg wires and Crimp terminals. Wire colors for Pin numbers are listed below. The wire assembly shall have a J4 mate on each end. Red - Pin # 4 (Signal USB_5V) Brown - Pin # 3 (Signal SDA)					

Table 2. Bill of Materials (continued)

Count	Reference Design	Value	Description	Size	Part Number	Manufacturer
		White - Pin # 2 (Signal SCL)				
		Black - Pin # 1 (GND)				

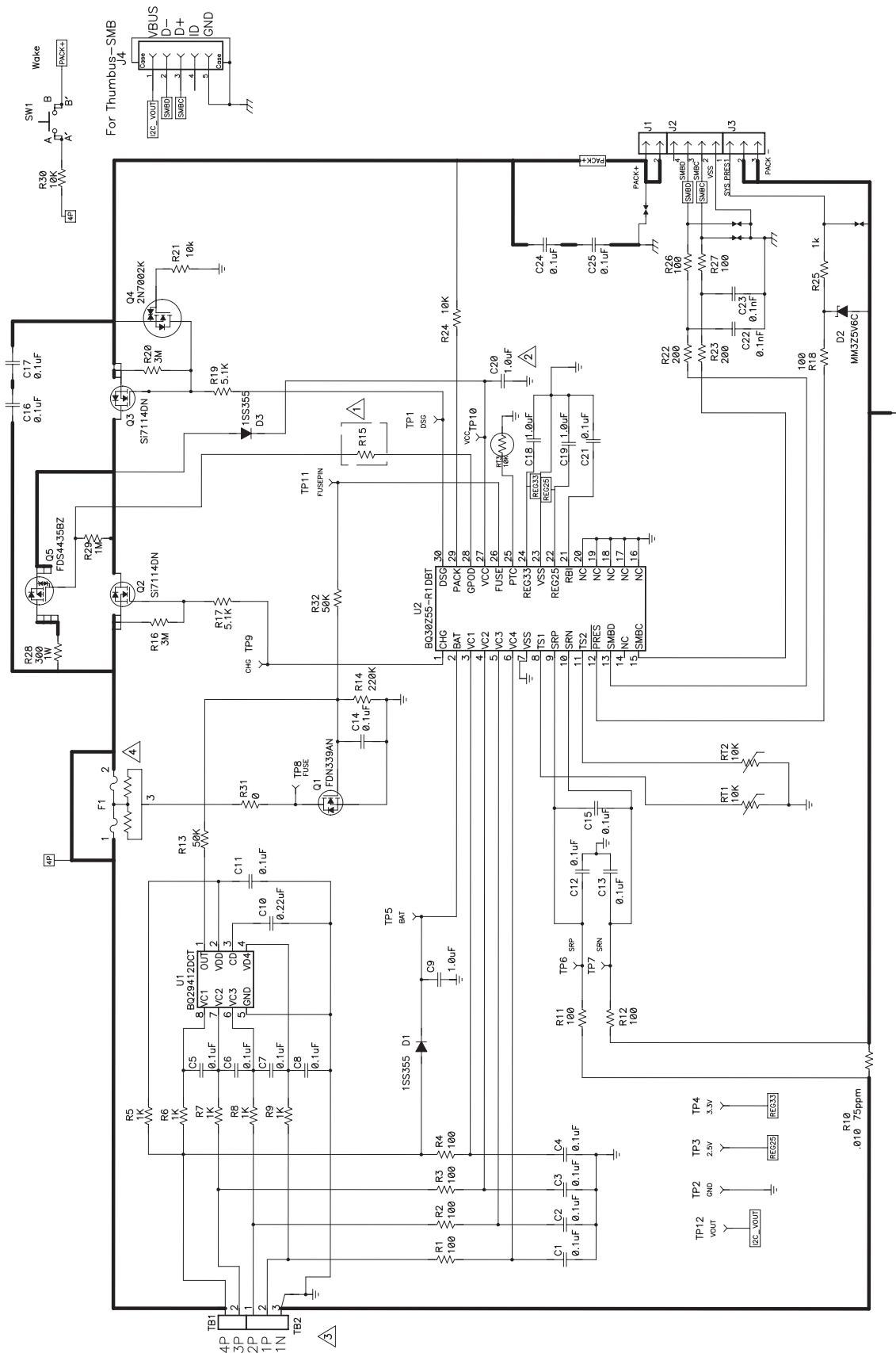


Figure 8. Schematic

4.3 bq30z55-R1/bq29412 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq30z55-R1/bq29412 circuit module.

Table 3. Performance Specification Summary

Specification	Min	Typ	Max	Units
Input voltage Pack+ to Pack-	5	15	25	V
Charge and discharge current	0	2	7	A

5 EVM Hardware and Software Setup

This section describes how to install the bq30z55-R1EVM-001 PC software, and how to connect the different components of the EVM.

5.1 System Requirements

The bq30z55-R1EVSW requires Windows 2000, XP, Vista, or 7.

5.2 Software Installation

NOTE: To get the latest software archive, contact the Texas Instruments field representative assigned to work with this device.

To install the bq30z55-R1EVSW software, do the following:

1. Save the archive to a temporary directory.
2. Double-click on the executable filename, and follow the installer instructions to complete the bq30z55-R1 EVSW installation.

If the EV2300 or EV2400 was not previously installed: After bq30z55-R1 EVSW installation, a TI USB DRIVER INSTALLER pops up. Click **Yes** for the agreement message and follow its instructions.

3. Plug the EV2300 or EV2400 into a USB port.

6 Troubleshooting Unexpected Dialog Boxes

Users downloading the files must be logged in as the administrator, or must have privileges to install new programs.

The driver is not signed, so the administrator must allow installation of unsigned drivers in the operating system policy.

7 Hardware Connection

The bq30z55-R1EVM-001 comprises two hardware components: the bq30z55-R1/bq29412 circuit module and the EV2300 or EV2400 PC interface box.

7.1 Connecting the bq30z55-R1/bq29412 Circuit Module to a Battery Pack

[Figure 9](#) shows how to connect the bq30z55-R1/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, then 4P (see [Section 2.2](#) 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 the SYS PRES pin to the Pack- pin to set SYS PRES state. To test sleep mode, disconnect the SYS PRES pin.

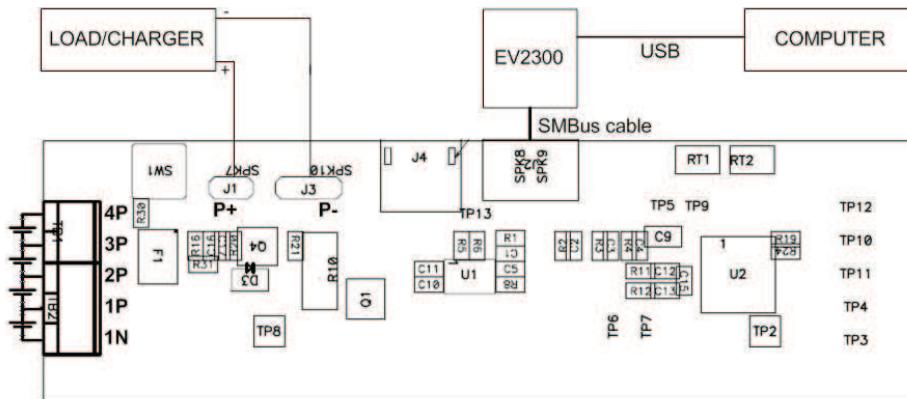


Figure 9. bq30z55-R1 Circuit Module Connection to Cells and System Load/Charger

7.2 PC Interface Connection

To configure the hardware to interface to the PC, do the following:

1. Connect the bq30z55-R1 device-based smart battery to the EV2300 or EV2400 using the provided cable or the connections shown in [Table 4](#).

Table 4. Circuit Module to EV2300 or EV2400 Connections

bq30z55-R1 Device-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 bq30z55-R1EVM-001 is now set up for operation.

8 Operation

This section details the operation of the bq30z55-R1 EVSW software.

NOTE: The EV2300 driver does not support Windows Sleep or Hibernate states. If communicating with the EV2300 or if the EVM presents a problem, unplug the USB cable and then plug it back in. If the problem continues, determine if the EVM is in Shutdown mode. The bq30z55-R1 can be awakened by momentarily pressing SW2 if cell voltage is present.

8.1 Starting the Program

With the EV2300 or EV2400 and the bq30z55-R1EVM connected to the computer, run bq30z55-R1 EVSW from the Desktop Icon or **Start | All Programs | Texas Instruments | bq Evaluation Software** menu sequence. The **SBS Data** screen appears. Data begins to appear once the **Refresh** (single time scan) button is clicked, or when the **Keep Scanning** checkbox 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 bq30z55-R1 EVSW provides a logging function that logs the values that were last scanned by the EVSW. To enable this function, click 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 interval is 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 10. SBS Data Screen

This screen 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 screen.

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

Dragging the splitter bar (the 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 bq30z55-R1 Options

The bq30z55-R1 data flash comes configured per the default settings detailed in the *bq30z50/bq30z55-R1 SBS 1.1-Compliant Gas Gauge With Impedance Track™ Datasheet (SLUSAW6)*. Ensure that the settings are correctly changed to match the pack and application for the bq30z55-R1 solution being evaluated.

IMPORTANT: To get the best performance, it is essential to correctly set these options.

Use the **Data Flash** screen to configure the settings.

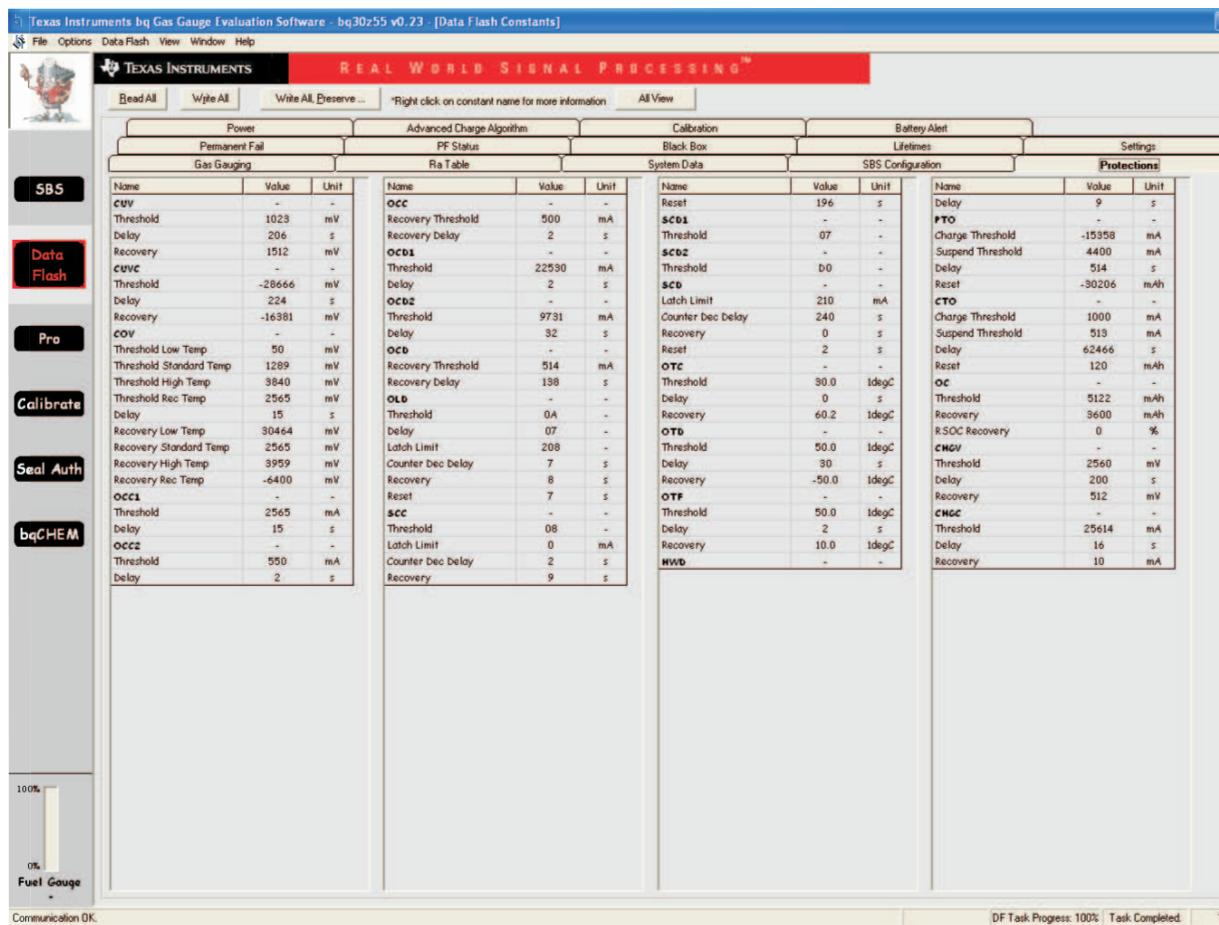


Figure 11. Data Flash Screen, 1st Level Safety Class

To read all of the data from the bq30z55-R1 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 click **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.

The data flash configuration can be saved to a file by selecting | **File | Export** | and entering a file name. In this way, a data flash file also can be retrieved, imported, and written to the bq30z55-R1 using the **Write All** button.

The configuration information of the bq30z55-R1 data is held in the data flash.

The bq30z55-R1 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 seconds. The **AutoExport** filename is set under the | **Options** | menu.

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

If the data flash screen is blank, then the bq30z55-R1 in use may not be supported by the bqEVSW version in use. An upgrade may be required.

9 Calibration Screen

9.1 How to Calibrate

The bq30z55-R1 must be calibrated using power supplies, or a power supply and cell simulation resistors (300 Ω or less) before cells are attached. Before the bq30z55-R1 is calibrated, do the following:

- 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 each cell voltage.
- Measure the temperature of the pack.
- Whether the foregoing steps are necessary depends on the type of calibration being performed.

9.2 To Calibrate the bq30z55-R1

To calibrate the bq30z55-R1, do the following:

- Select the types of calibration to be performed.
- Enter the measured values for the types selected (except for **CC Offset Calibration**).
- If **Temperature Calibration** is selected, select the sensor that is to be calibrated.
- Click the appropriate button to initiate the desired calibration.

9.3 Board Offset Calibration

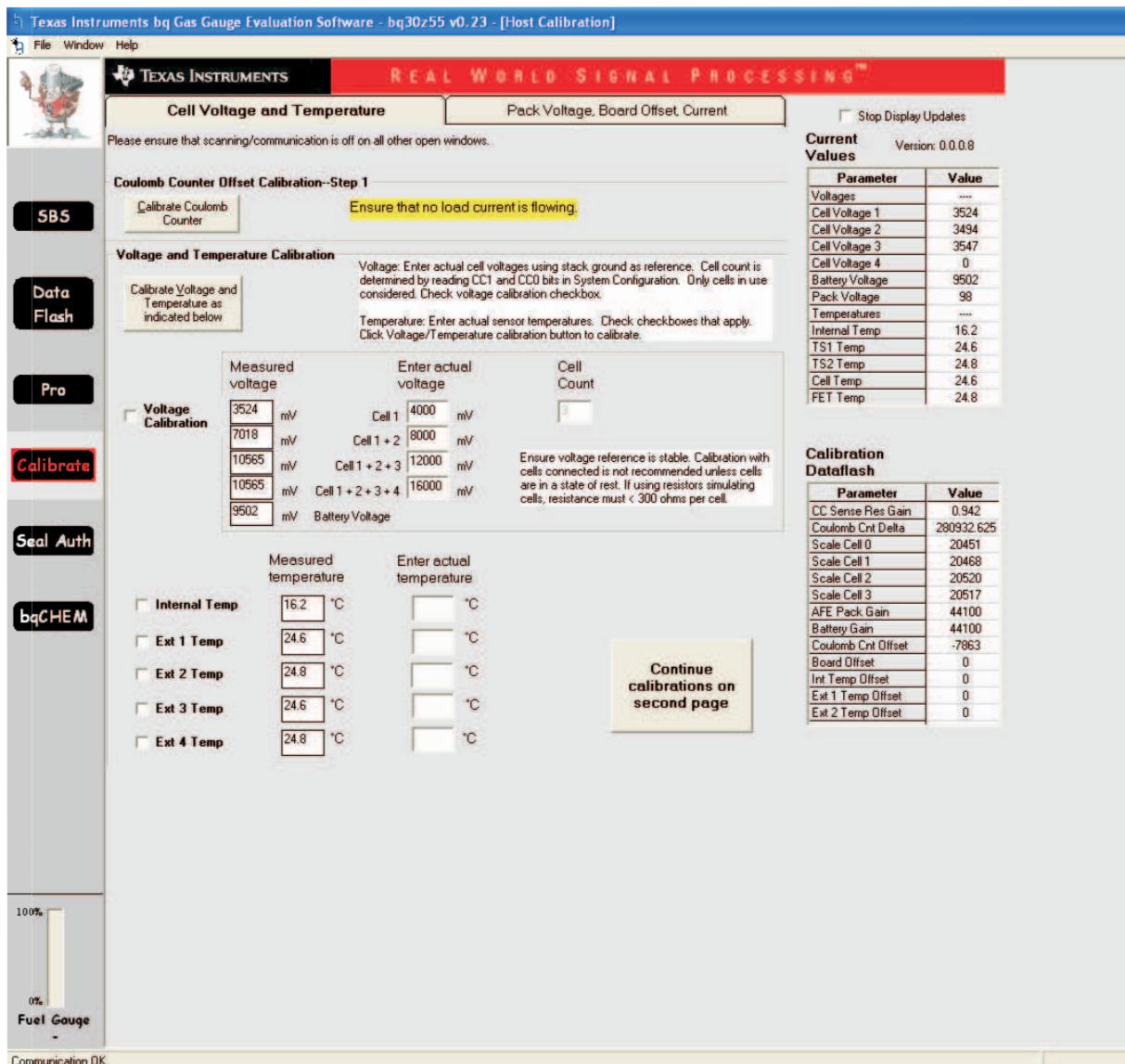
This performs the offset calibration for the current offset of the board.

- Remove any current source, load, or external voltage from the PACK terminals.
- Click the **Software Board Offset Calibration** button.

9.4 Pack Voltage Calibration

This calibrates the voltage at the AFE Pack pin.

- Ensure that **Voltage Calibration** has been performed for the pack. If **Voltage Calibration** is not performed, then **Pack Voltage Calibration** calibrates incorrectly.
- Remove load/external voltage applied between Pack+ and Pack–.
- Click the **Pack Voltage** button to calibrate.


Figure 12. 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.

10.2 Hex/Decimal Converter

The **Hexadecimal Value** and **Decimal Value** boxes convert between hexadecimal (hex) and decimal as soon as values are typed into the boxes. Invalid values can cause erroneous results.

When scaling converted hex 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 Reprogramming

To reprogram the device, do the following:

- Ensure that the gauge is in Full Access mode. To do this, use the **Seal/Authentication** screen (see [Section 11](#)).
- Use the **Write SMB Word** feature to put the gauge into ROM mode (0x0033 to cmd 0x00).
- Use the **Srec** programming feature to browse for the desired .srec or .senc file then click the **Program** button to start the transfer.
- Use the **SMB Command** feature to send 0x08 to execute the program.

If the firmware version was updated, close and re-launch the EVSW to synchronize the tool with the new firmware.



Figure 13. Pro (Advanced) Screen

11 Seal/Authentication Screen

To seal, unseal, or allow full access—which enables users to reprogram the device—select one of these three modes on the **Seal/Authentication** screen and click **Go**.

NOTE: When the device is sealed, users cannot write to the data flash.

The text boxes at the top of the screen are informational and their content loads during the unseal process.

Unsealing the bq30z55-R1 is the reverse procedure from SHA-1 authentication. (For more information on SHA-1 encryption, refer to the *bq30z5x-R1 Technical Reference Manual (SLUU852)*. The gas gauge generates the random number and challenges the EVSW, which must provide a valid key in order to unseal the device. Full access to ROM mode occurs in a similar manner. The **Seal/Authentication** screen shows the default 128-bit key in the **Key (129 bits)** text box.

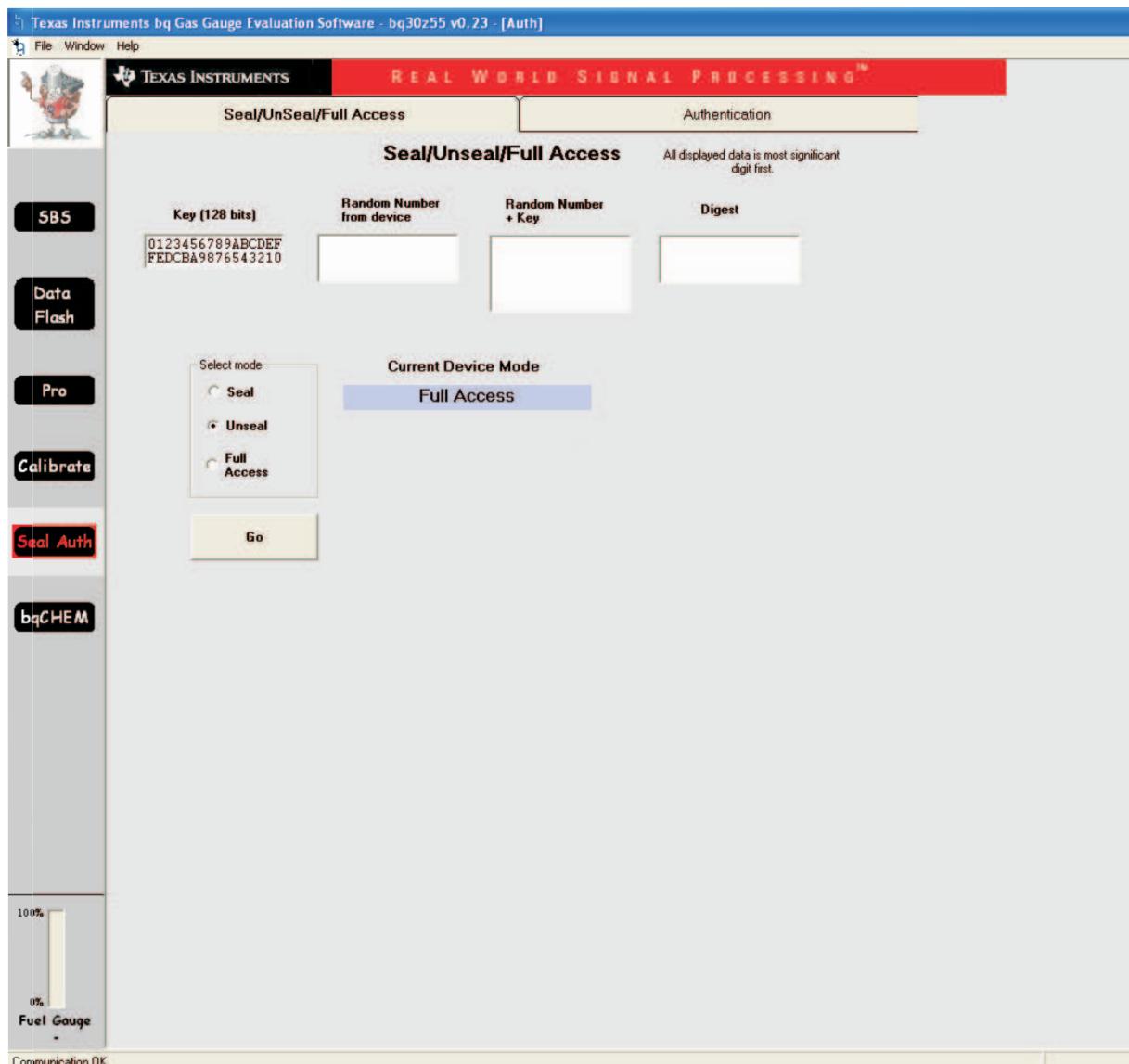


Figure 14. Seal/Authentication Screen

12 bqChem

bqChem enables users to access the library of previously characterized Li-Ion cell chemistries, and program the chemical database into the gauge. Users can sort by chemical ID or by cell manufacturer. For help to identify the chemistry for the cells, contact the Texas Instruments field representative assigned to work with this device.

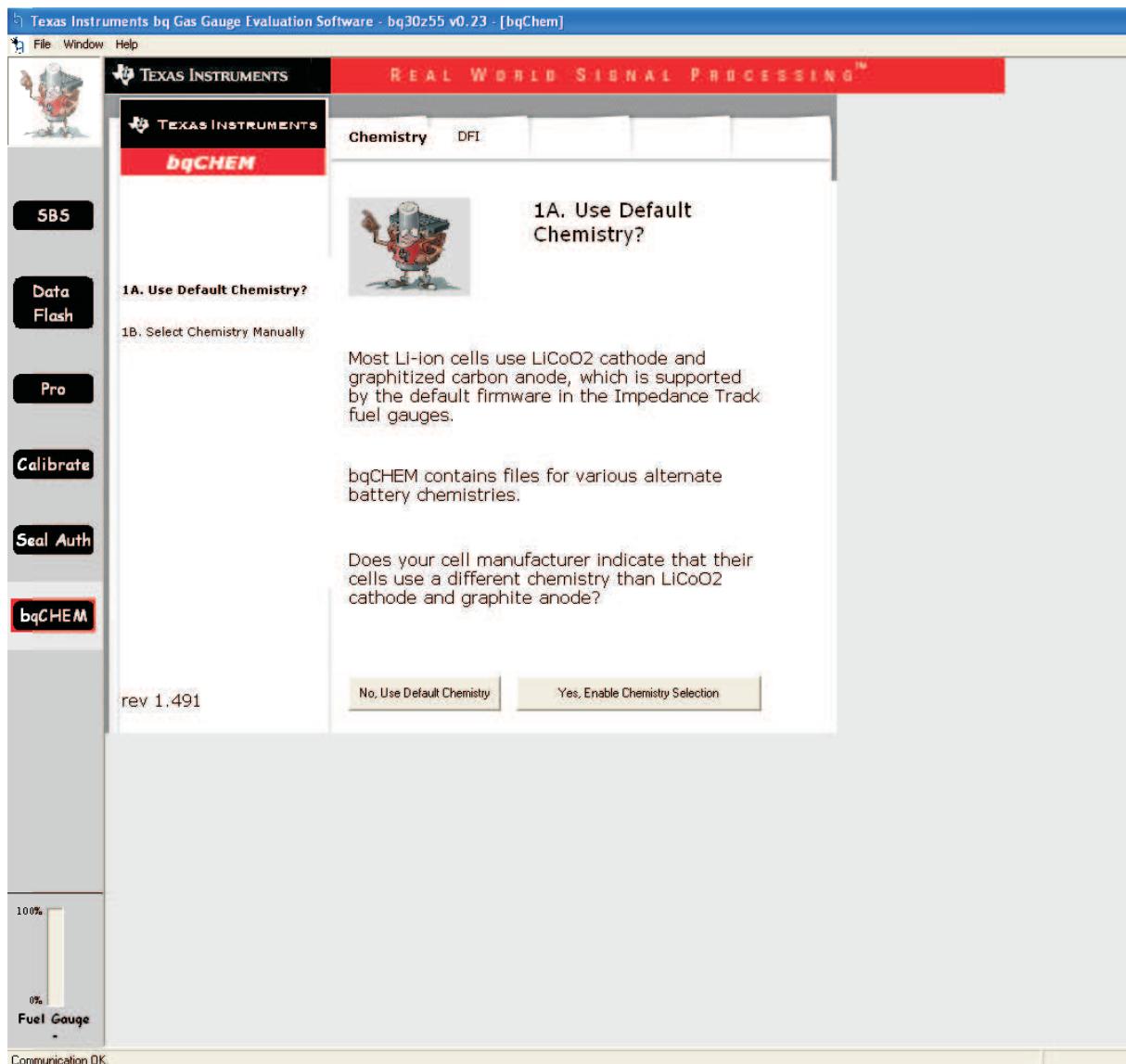


Figure 15. bqChem Screen

The DFI section enables a user to read and write DFI and ROM files. These are complete binary images of the fuel gauge data flash. Once a golden pack is created, the data flash image can be used to quickly program other packs for mass production. The ROM file contains the same data as the DFI file, but adds an additional header for use by the *bqMTester production* tool. These files differ from the .gg files that a user can read and write in the **Data Flash** screen. The .gg files are simply text dictionaries that contain public configuration data. The DFI and ROM files are binary images that contain public, private, and proprietary information necessary for mass production.

13 Related Documentation from Texas Instruments

For related documentation, contact the Texas Instruments field representative assigned to work with this device.

Documents:

*bq30z50-R1/bq30z55-R1 SBS 1.1-Compliant Gas Gauge With
Impedance Track™ Datasheet*

bq30z5x-R1 Technical Reference Manual
EV2300 EVM Interface Board User's Guide
EV2400 EVM Interface Board User's Guide

Literature Number:

[SLUSAW6](#)

[SLUU852](#)

[SLUU159A](#)

[SLUU446](#)

EVALUATION BOARD/KIT IMPORTANT NOTICE

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

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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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