

bq27441 EVM: System-Side Impedance Track™ Technology

This evaluation module (EVM) is a complete evaluation system for the bq27441. The EVM includes one bq27441 circuit module with current-sense resistor. A separate orderable EV2300 or EV2400 PC interface board for gas gauge interface along with a PC USB cable, and Windows®-based PC software is needed when using this EVM. The circuit module includes one bq27441 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 bq27441 data registers
- Update the RAM for different configurations
- Log cycling data for further evaluation
- Evaluate the overall functionality of the bq27441 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 bq27441 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

1.1 Kit Contents

- bq27441 circuit module (PWR582)

This EVM is used for the evaluation of the bq27441. Visit the product Web folder at www.ti.com to properly configure the bq27441.

1.2 Ordering Information

Table 1. Ordering Information

Part Number	EVM Part Number	Firmware Version ⁽¹⁾	Chemistry	Chemistry ID ⁽²⁾	Configuration
bq27441-G1A	bq27441EVM-G1A	v1.09 (0x0109)	4.2 V Li-ion	128	1 cell
bq27441-G1B	bq27441EVM-G1B	v1.09 (0x0109)	4.3 V Li-ion	312	1 cell
bq27441-G1C	bq27441EVM-G1C	v1.09 (0x0109)	4.35 V Li-ion	354	1 cell

⁽¹⁾ Using the FW_VERSION (0x0002) *Control()* subcommand returns 0x0109. See [SLUSBH1](#), *bq27441-G1x System-Side Impedance Track™ Fuel Gauge*, data sheet for information on *Control()* subcommands.

⁽²⁾ Using the CHEM_ID (0x0008) *Control()* subcommand helps to differentiate between the bq27441-G1A (returns 0x0128), the bq27441-G1B (returns 0x0312), and the bq27441-G1C (returns 0x0354). See [SLUSBH1](#), *bq27441-G1x System-Side Impedance Track™ Fuel Gauge*, data sheet for information on *Control()* subcommands.

2 bq27441-Based Circuit Module

The bq27441-based circuit module is a complete and compact example solution of a bq27441 circuit for battery management. The circuit module incorporates a bq27441 battery gas gauge integrated circuit (IC) with all other components necessary to accurately predict the capacity of a 1-series Li-ion cell.

2.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct connection to the battery pack (J5): PACK+, PACK–
- To the serial communications port (J10): SDA, SCL, and VSS
- The system load and charger connect across charger and load (J6 and J7): CHARGER+/LOAD+ and CHARGER–/LOAD–.
- Access to signal outputs (J1 and J5): BIN and GPOUT
- External connect to power the IC (J4): EXT VDD and VSS

2.2 Pin Description

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

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

This section contains the board layout, bill of materials, and schematic for the bq27441 circuit module.

3.1 Board Layout

This section shows the printed-circuit board (PCB) layers ([Figure 1](#) through [Figure 5](#)), and assembly drawing for the bq27441 module.

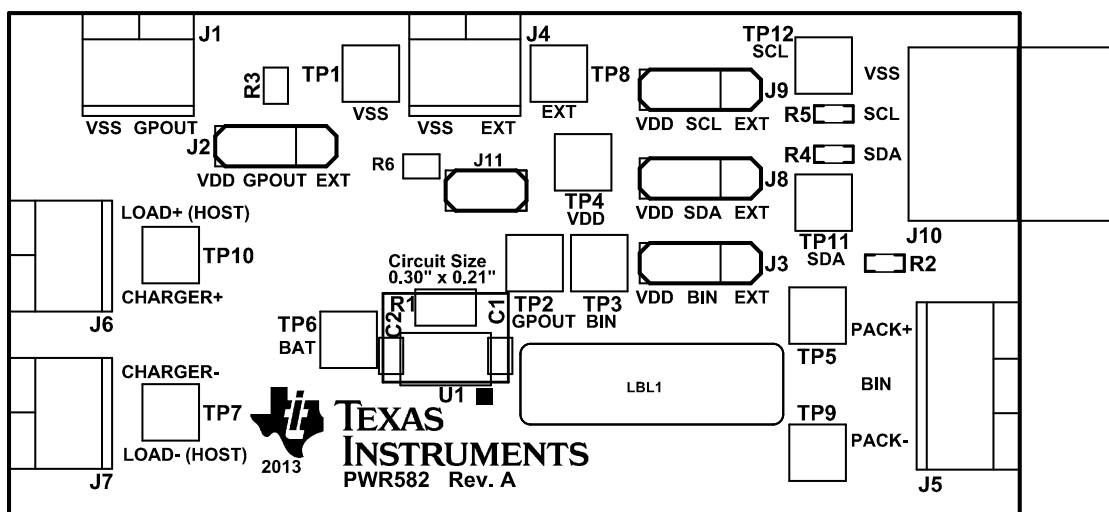


Figure 1. bq27441EVM Layout – Top Silk

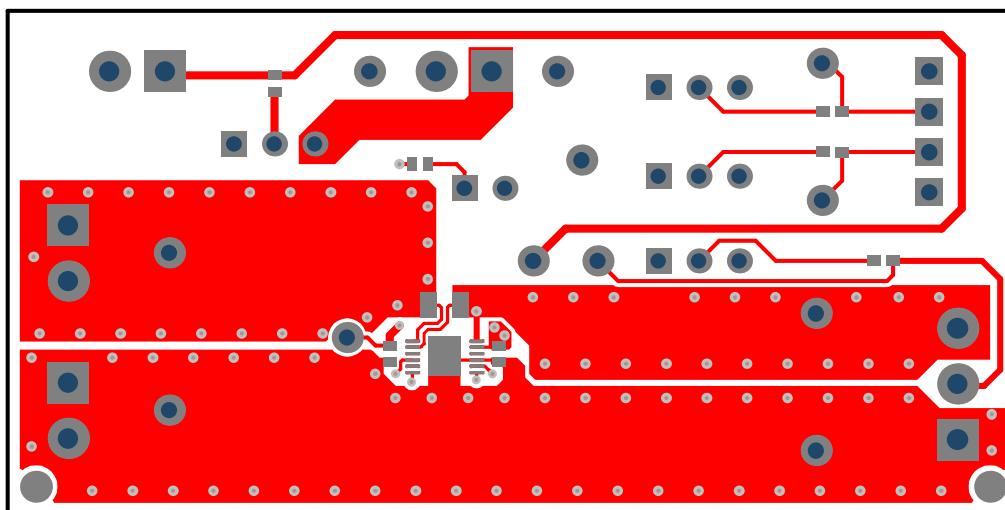


Figure 2. bq27441EVM Layout - Top Layer

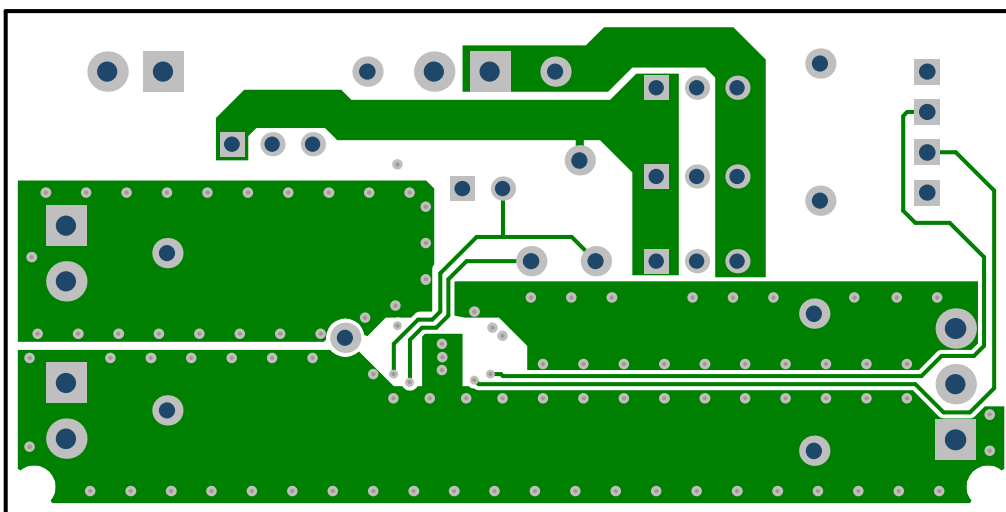


Figure 3. bq27441EVM Layout - Power Layer

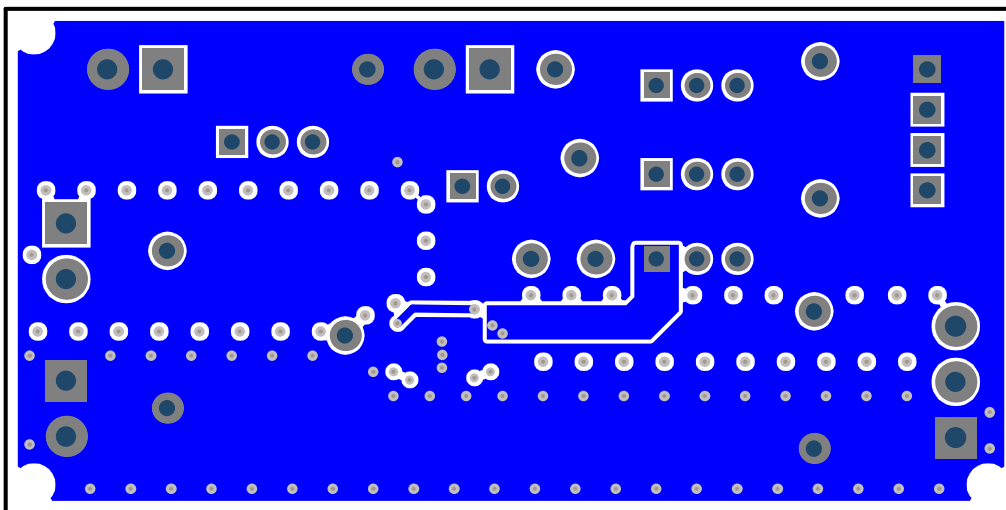


Figure 4. bq27441EVM Layout – Bottom Layer

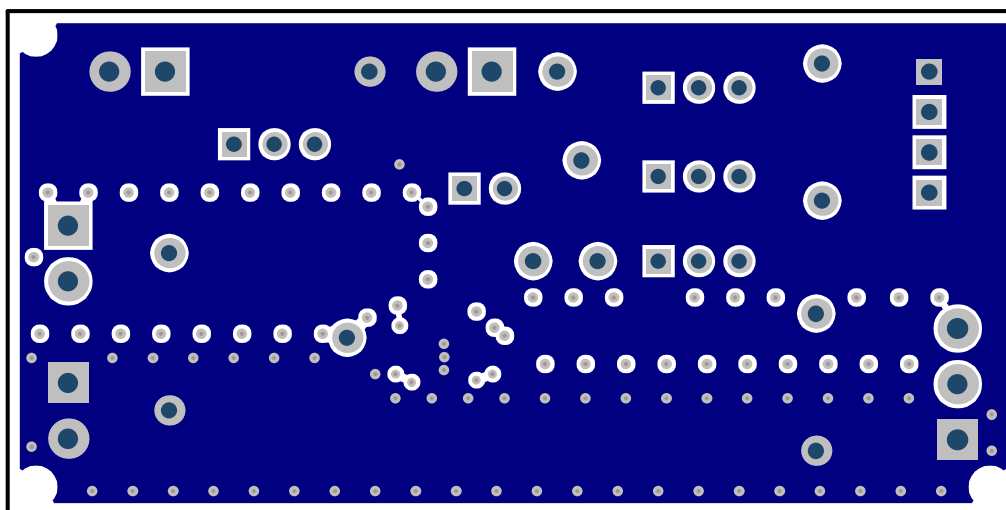


Figure 5. bq27441EVM Layout – Ground Layer

3.2 Bill of Materials

Table 2. Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	Mfr
1	C1	0.47 μ F	Capacitor, Ceramic, 10V, X5R, 10%	0402		
1	C2	1 μ F	Capacitor, Ceramic, 6.3V, X5R, 10%	0402		
4	J1, J4, J6, J7	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED555/2DS	OST
4	J2, J3, J8, J9	PEC36SAAN	Header, Male 3-pin, 100mil spacing	0.100 inch x 3	PEC36SAAN	Sullins
1	J5	ED555/3DS	Terminal Block, 3-pin, 6-A, 3.5mm	0.41 x 0.25 inch	ED555/3DS	OST
1	J10	22-05-3041	Header, Friction Lock Ass'y, 4-pin Right Angle	0.400 x 0.500	22-05-3041	Molex
1	J11	PEC02SAAN	Header, Male 2-pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
1	R1	0.010	Resistor, Power Metal Strip, 5W, 1%	0805	WSL0805R0100FEA1	Vishay
1	R2	1.8 M Ω	Resistor, Chip, 1/16W, 5%	0402	CRCW04021M80JNED	Vishay
3	R3, R4, R5	5.1 k Ω	Resistor, Chip, 1/16W, 5%	0402	CRCW04025K10JNED	Vishay
1	R6	10 k Ω	Resistor, Chip, 1/16W, 5%	0402	CRCW040210K0JNED	Vishay
3	TP1, TP7, TP9	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
4	TP2, TP3, TP11, TP12	5002	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
5	TP4, TP5, TP6, TP8, TP10	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
1	U1	bq27441YZF-G1x	IC, Battery Monitor and Data Logger	DSBGA	bq27441-G1x	TI

4.2 Software Installation

Find the latest software version in the bq27441 tool folder on power.ti.com. Make a search by Part Number for bq27441 to access the tool folder. Use the following steps to install the bq27441 GaugeStudio 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. If EV2300 is connected, wait until system prompt *New Hardware Found* appears. Choose *Select Location Manually*, and use the **Browse** button to point to subdirectory TIUSBWin2K-XP-1.
7. Answer **Continue** to the warning that drivers are not certified with Microsoft®.
8. If the EV2300 is connected and after the previous installation finishes, another system prompt *New Hardware Found* appears. Repeat steps 1 through 5, but specify the directory as TIUSBWin2K-XP-2.
9. Answer **Continue** to the warning that drivers are not certified with Microsoft. Driver installation is now finished.
10. For the EV2400, the driver should be installed along with software installation.

5 Troubleshooting Unexpected Dialog Boxes

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

6 Hardware Connection

The bq27441 evaluation system comprises three hardware components: the bq27441 circuit module, the EV2300 or EV2400 PC interface board, and the PC.

6.1 Connecting the bq27441 Circuit Module to a Battery Pack

Figure 7 shows how to connect the bq27441 circuit module to the cells and system load/charger.

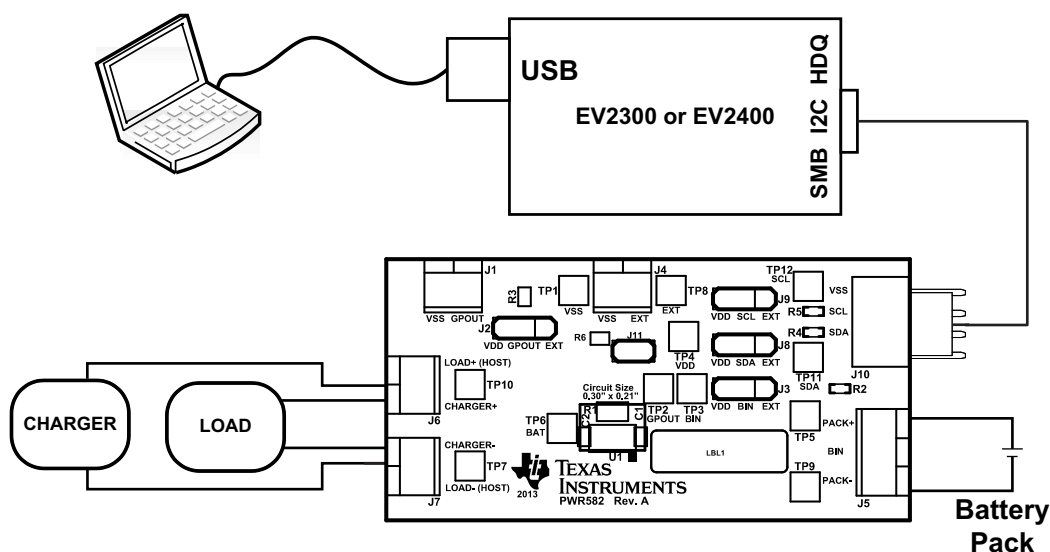


Figure 7. bq27441 Circuit Module Connection to Pack and System Load/Charger

6.2 PC Interface Connection

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

1. Connect the bq27441-based EVM to the EV2300 or EV2400 using wire leads as shown in [Table 4](#).
2. Connect the PC USB cable to the EV2300 or EV2400 and the PC USB port.

Table 4. Circuit Module to EV2300 or EV2400 Connections

bq27441EVM	EV2300 or EV2400
SDA	SDA
SCL	SCL
VSS	GND/VSS

The bq27441EVM is now set up for operation.

7 Operation

This section details the operation of the bq27441 GaugeStudio software.

7.1 Starting the Program

Run GaugeStudio from the Start → Programs → Texas Instruments → GaugeStudio menu sequence. The main GaugeStudio window ([Figure 8](#)) appears. The window consists of a tools panel at the top, and other child windows that can be hidden, docked in various positions, or allowed to float as separate windows. When GaugeStudio first starts up, the *Gauge Dashboard* window, the *Registers* window, and *Data Memory* window should be seen in the main window. *Registers*, *Data Memory*, *Commands*, and other windows can be added to the main window by clicking on the corresponding icon in the tools panel at the top of the main window. Data should appear initially in the *Gauge Dashboard*, *Registers*, and *Data Memory* sections. The **Refresh** (single-time scan) or the **Scan** (continuous scan) buttons can be clicked to update the data in the *Registers* and *Data Memory* windows. The continuous scan is enabled when the *Scan* checkbox is highlighted green and disabled when the *Scan* checkbox is not highlighted.

The continuous scanning interval can be set with the *stopwatch* icon next to the **Scan** button. When the *stopwatch* icon is clicked, a drop-down menu will appear and the desired scanning interval can be selected. The scan interval value will show up next to the *stopwatch* icon.

GaugeStudio provides a logging function which logs selected Data Registers and Data Memory values last received from the bq27441. To enable this function, click the *DataLog* icon in the *Tools* panel. The *DataLog* window will appear below the *Registers* and *Data Memory* windows. Registers and Data Memory parameters can be added to the log by clicking on the *Add Register* and *Add Data Memory Parameter* drop-down menus in the *DataLog* window and then select the desired Registers or Data Memory parameters to be added to the log. After the desired Registers and Data Memory Parameters have been added to the log, click the **Play** button to begin logging. A **Stop** button will replace the **Play** button once logging starts, the **Stop** button can be clicked to stop logging. The log can be saved by clicking on the *Save* icon and specifying a file name.

The logging intervals are specified by the value next to the *stopwatch* icon in the *DataLog* window. To change the logging intervals, click the *stopwatch* icon and choose one of the intervals provided in the menu selections that appear. Logging interval values will show up next to the *stopwatch* icon.

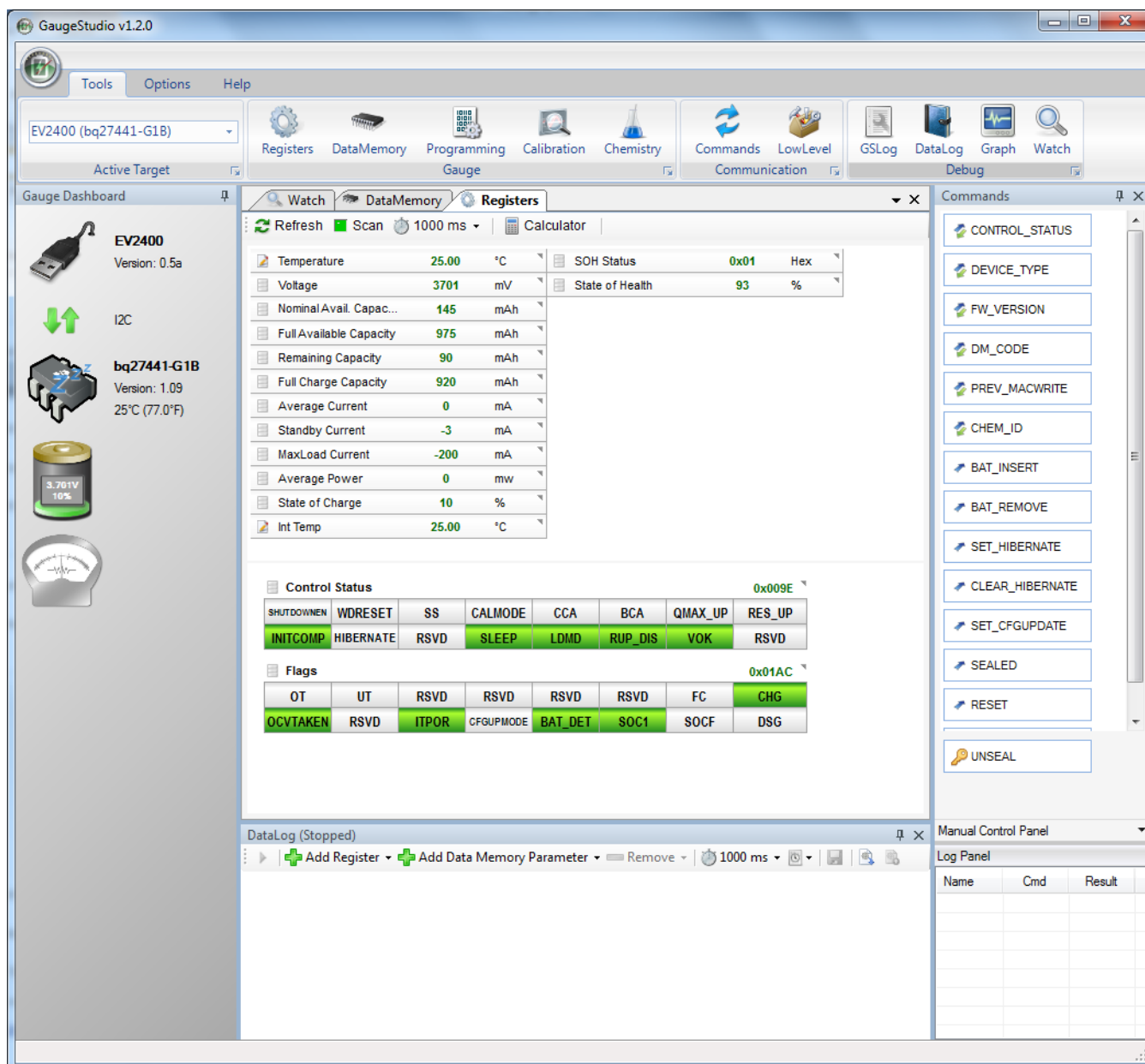


Figure 8. Registers Screen

Figure 8 shows the main GaugeStudio window. Additional Flag and Status data can be viewed at the bottom of the Registers window.

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

7.2 Setting Programmable bq27441 Options

The bq27441 OTP comes configured per the default settings detailed in the bq27441 data sheet (see [SLUSBH1](#)). Ensure that the settings are correctly changed to match the pack and application for the bq27441 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 Memory* window seen in the main *GaugeStudio* window (Figure 9).

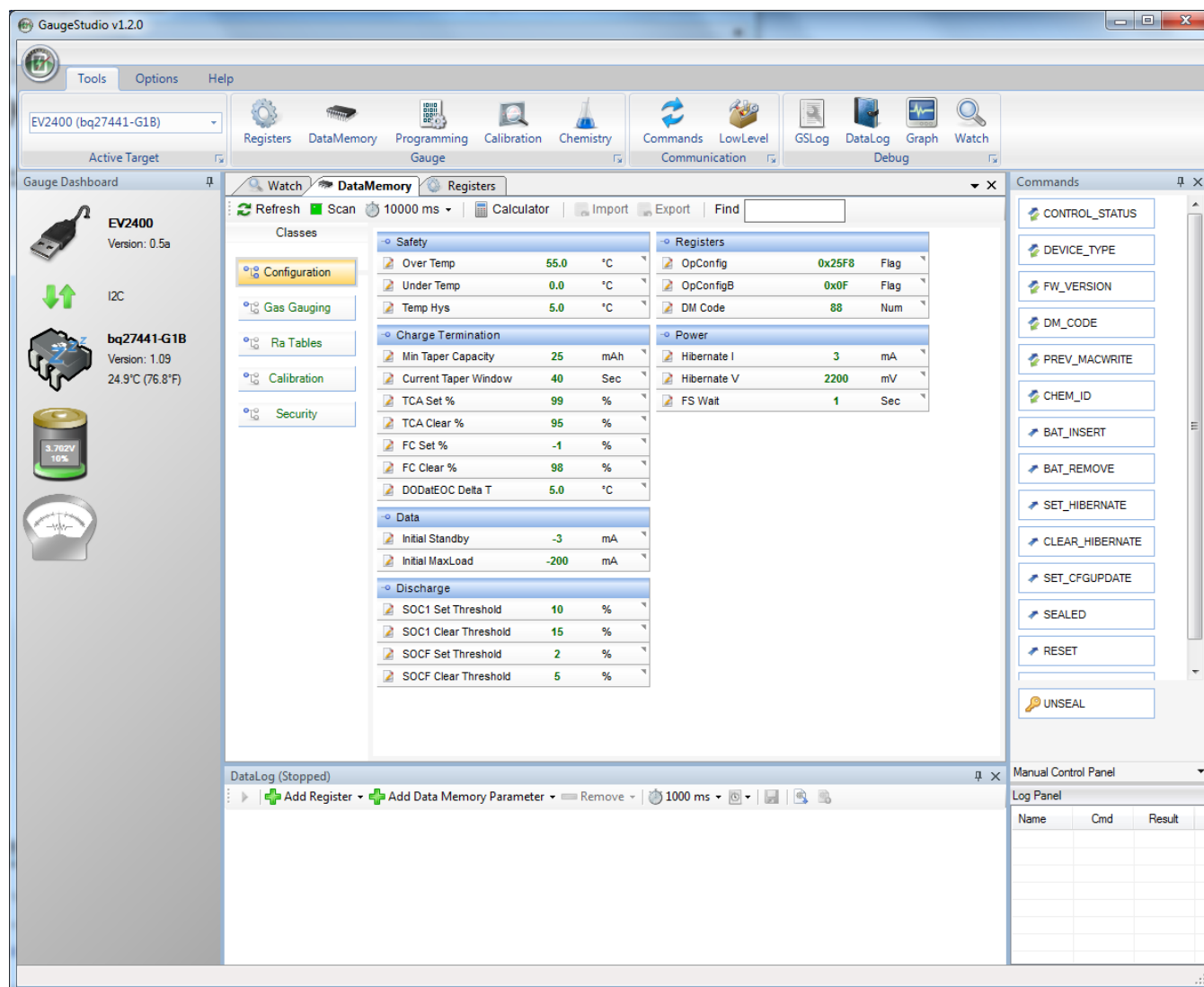


Figure 9. Data Memory Screen

To read the data from the bq27441 OTP, click on the **Refresh** button in the *Data Memory* window.

To update RAM and write to an OTP location, please ensure that the [CFGUPMODE] bit in the Flags register is set by sending the SET_CFGUPDATE subcommand (0x0013). The SET_CFGUPDATE subcommand can be sent to the bq27441 in GaugeStudio by clicking the **SET_CFGUPDATE** button in the Commands window. However, GaugeStudio will handle the update of the OTP parameter(s) automatically so the user will not have to worry about entering and exiting CONFIG UPDATE mode. To update an OTP parameter, click on the desired parameter and a window will pop-up that provides details on the selected OTP parameter. Next, enter the value in the value textbox and press **Enter**. After **Enter** has been pressed, GaugeStudio will update the selected parameter. The OTP updates are stored in RAM and a POR or full RESET subcommand (0x0041) will change the OTP back to the default value.

The **Import** button in the *Data Memory* window can be clicked to import an entire OTP configuration from a specified *.gg file.

The OTP configuration can be saved to a file by clicking the **Export** button in the *Data Memory* window and entering a file name. The OTP configuration will be saved to a *.gg file.

The module calibration data is also held in the bq27441 data memory.

If the Gauge Dashboard is not displaying any information, then the bq27441 may not be supported by the GaugeStudio version that is being used. A GaugeStudio upgrade may be required.

8 Calibrate Screen

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

8.1 To Calibrate the bq27441

1. Select the types of calibration to be performed (see [Figure 10](#)).
2. Enter the measured values for the types selected.
3. Press the button to calibrate.

8.2 Voltage Calibration

Voltage calibration usually is not required. If needed, follow these steps:

1. Measure the voltage across Pack+ and Pack–.
2. Type the voltage value in mV into *Enter measured value*.
3. Press the **Calibrate** button.

8.3 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.

1. Remove load and short PACK– to LOAD–.
2. Press the **Calibrate** button.

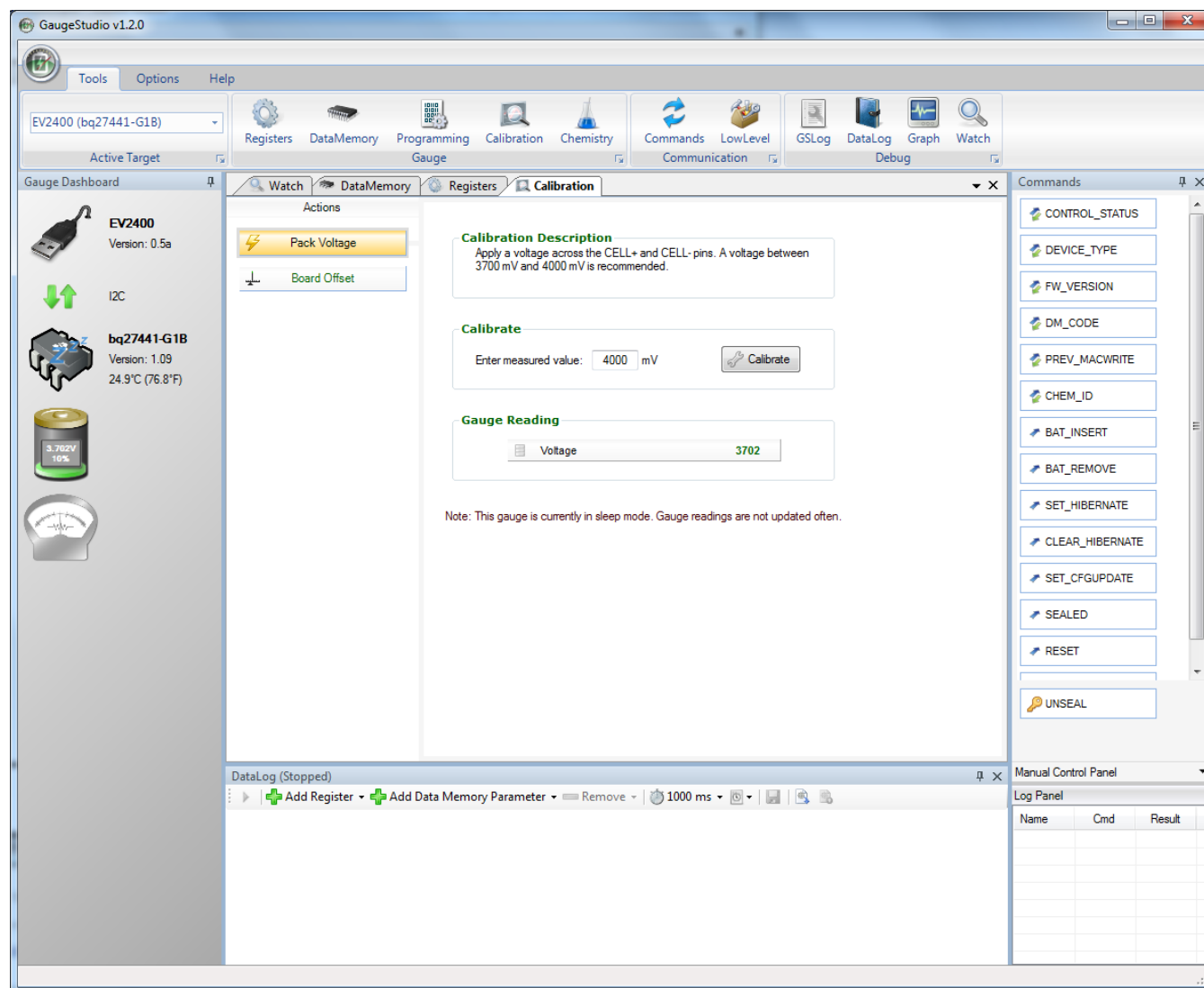


Figure 10. Calibration Screen

9 Related Documentation from Texas Instruments

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

1. *bq27441-G1 System-Side Impedance Track™ Fuel Gauge* data sheet ([SLUSBH1](#))
2. *bq27441-G1 System-Side Impedance Track™ Fuel Gauge* Technical Reference Manual ([SLUUAC9](#))
3. *Quick Start Guide for bq27441-G1* ([SLUUAP7](#))

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