

bq27621 EVM: Single-Cell Rechargeable Lithium Battery Gauge Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the bq27621 fuel gauge. The circuit module includes one bq27621 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 to a rechargeable lithium-ion battery pack. Without any configuration, the battery voltage, temperature, and State of Charge (SOC in %) can be immediately read from the gauge with confidence. By quickly configuring a few parameters like battery capacity (***Design Capacity*** and ***Design Energy***), full charge condition (***Taper Rate***), and empty condition (***Terminate Voltage***), more accurate values of estimated current (in mA) and remaining capacity (in mAh) can be read from the gauge. The bq27621-G1 IC contains three battery profiles for typical rechargeable lithium cells that can be selected based on the maximum charging voltage (4.2 V, 4.3 V, and 4.35 V).

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. With the EV2300 or EV2400 interface board and Battery Management Studio (bqStudio) software, the user can:

- Read the bq27621 data registers
- Update the RAM for different configurations
- Log cycling data for further evaluation
- Evaluate the overall functionality of the bq27621 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 bq27621 fuel gauge
- 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

- bq27621 circuit module (PWR582)

This EVM is used for the evaluation of the bq27621. Visit the product Web folder at www.ti.com to properly configure the bq27621.

1.2 Ordering Information

Table 1. Ordering Information

Part Number	EVM Part Number	Firmware Version ⁽¹⁾	Battery Type	Chemistry ID	Configuration
bq27621-G1	bq27621EVM-G1	v1.05 (0x0105)	4.2 V Li-ion	0x1202	1 cell
			4.3 V Li-ion	0x1210	
			4.35 V Li-ion	0x354	

⁽¹⁾ Using the *FW_VERSION* (0x0002) *Control()* subcommand returns 0x0105. See the bq27621-G1 data sheet for information on *Control()* subcommands.

2 bq27621-Based Circuit Module

The bq27621-based circuit module is a complete and compact example solution of a bq27621 circuit for battery management.

2.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct connection to the battery pack (J5): PACK+/LOAD+/CHARGER+, PACK-/LOAD-/CHARGER-
- To the serial communications port (J10): SDA, SCL, and V_{SS}
- Access to signal outputs (J1 and J5): BIN and GPOUT
- External connect to power the IC (J4): EXT V_{DD} and V_{SS}

2.2 Pin Description

Pin Name	Description
PACK+/CHARGER+/LOAD+	Pack positive pin
PACK-/CHARGER-/LOAD-	Pack negative pin
SDA	I ² C communication data line
EXT V _{DD}	External supply connection
SCL	I ² C communication clock line
V _{SS}	Signal return for communication line, shared with charger and ground
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 bq27621 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 bq27621 module.

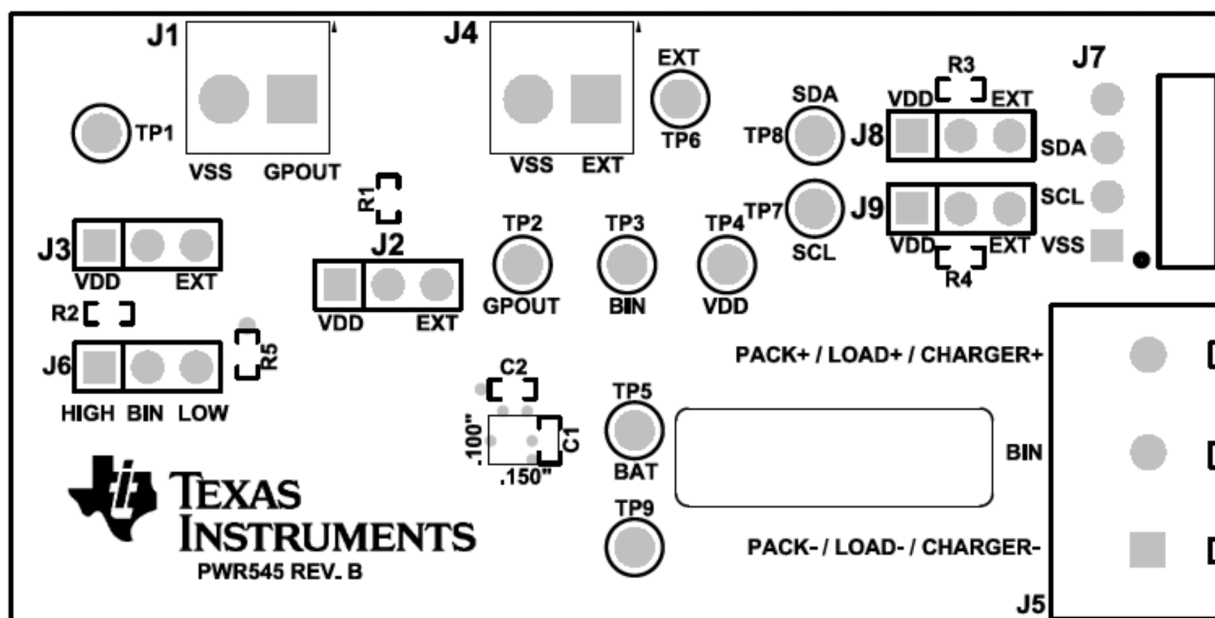


Figure 1. bq27621EVM Layout – Top Silk

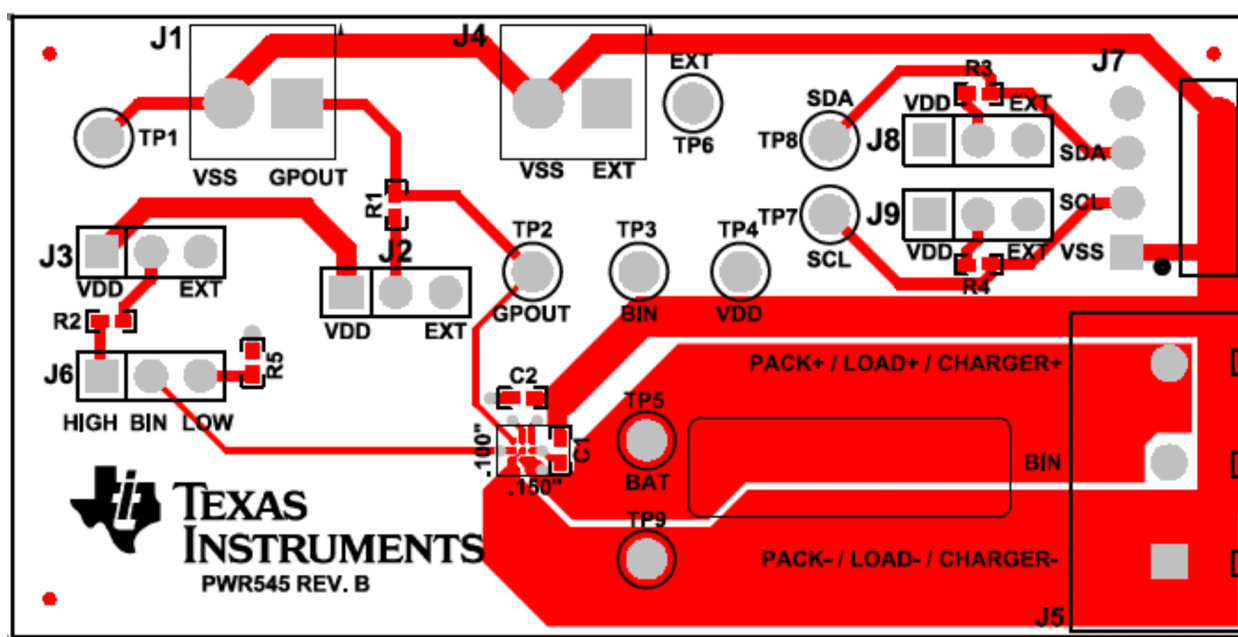


Figure 2. bq27621EVM Layout – Top Layer

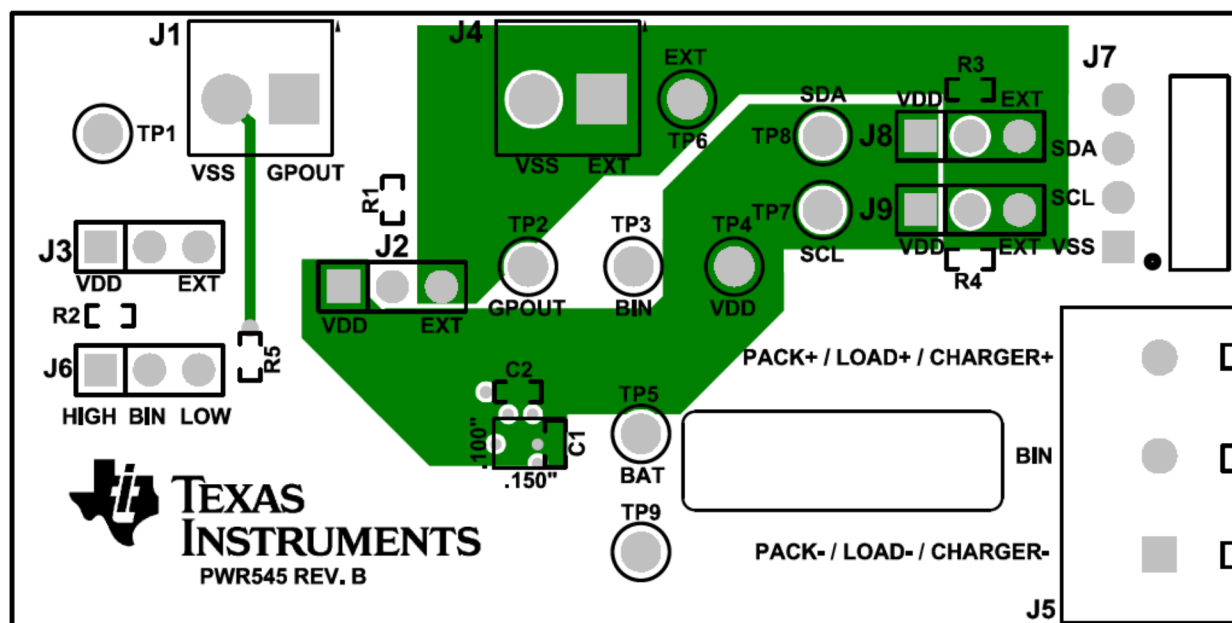


Figure 3. bq27621EVM Layout – Power Layer

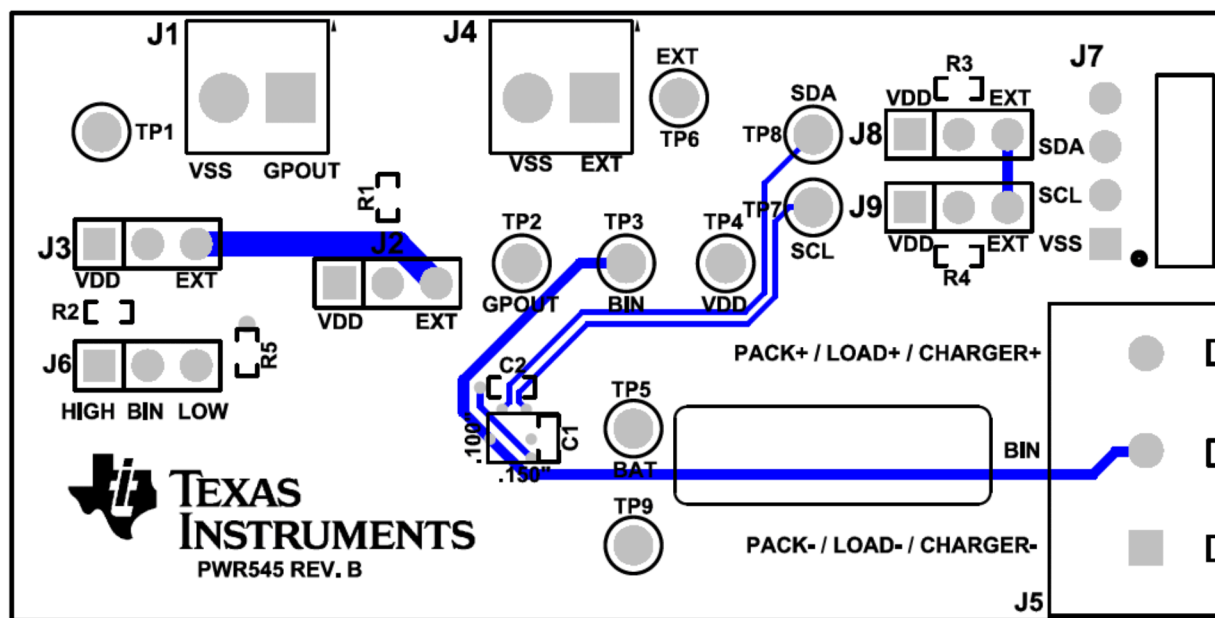


Figure 4. bq27621EVM Layout – Bottom Layer

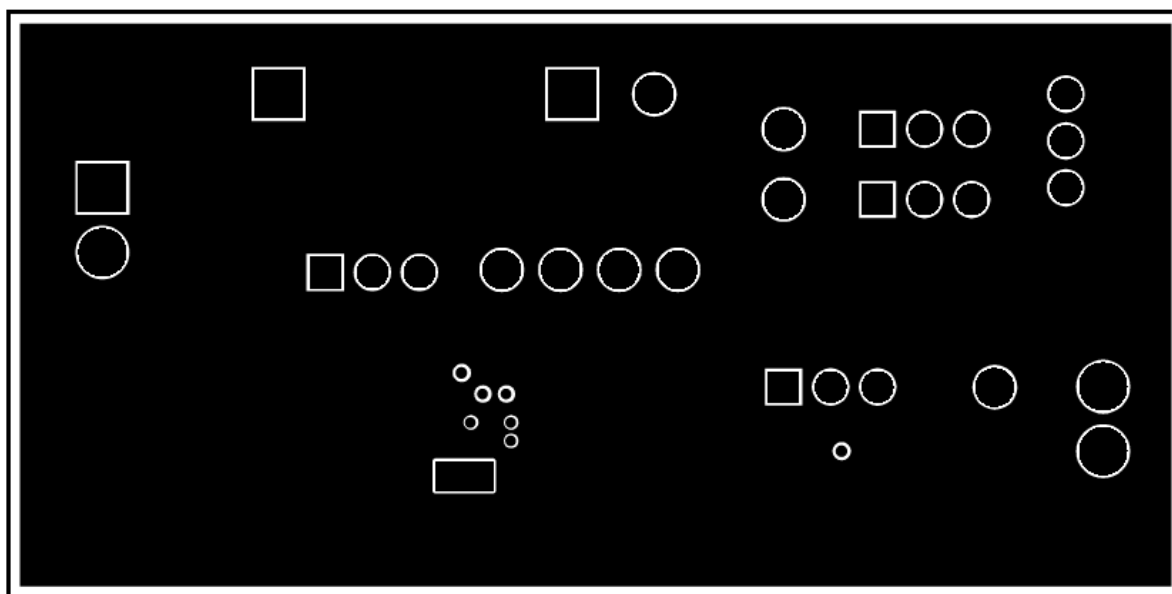


Figure 5. bq27621EVM Layout – Ground Layer

3.2 Bill of Materials

Table 2. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1	1	0.47 μ F	CAP, CERM, 0.47 μ F, 10 V, $\pm$ 10%, X5R	0402	GRM155R61A474KE15D	MuRata
C2	1	1 μ F	CAP, CERM, 1 μ F, 10 V, $\pm$ 10%, X5R	0402	GRM155R61A105KE15D	MuRata
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	Fiducial	NA	NA
J1, J4, J6, J7	4		Terminal Block, 6 A, 3.5-mm Pitch, 2-Pos, TH	7.0 x 8.2 x 6.5mm	ED555/2DS	On-Shore Technology
J2, J3, J8, J9	4	1x3	Header, TH, 100 mil, 1x3, Gold plated, 230 mil above insulator	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
J5	1		Terminal Block, 6 A, 3.5-mm Pitch, 3-Pos, TH	10.5 x 8.2 x 6.5mm	ED555/3DS	On-Shore Technology
J10	1		Header, 100 mil, 4x1, R/A, TH	4 x 1 R/A Header	22-05-3041	Molex
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady
R1	1	10 k Ω	RES, 10 k Ω , 5%, 0.063 W	0402	CRCW040210K0JNED	Vishay-Dale
R2	1	4.7 M Ω	RES, 4.7 M Ω , 5%, 0.063 W	0402	CRCW04024M70FKED	Vishay-Dale
R3, R4	2	5.1 k Ω	RES, 5.1 k Ω , 5%, 0.063 W	0402	CRCW04025K10JNED	Vishay-Dale
TP1, TP7, TP9	3	Black	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
TP2, TP3, TP10, TP11	4	White	Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
TP4, TP5, TP6, TP8	4	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
U1	1		System-Side Fuel Gauge With Dynamic Voltage Correlation	YZF0009AGAH	bq27621YZF-G1	Texas Instruments

3.3 Schematic

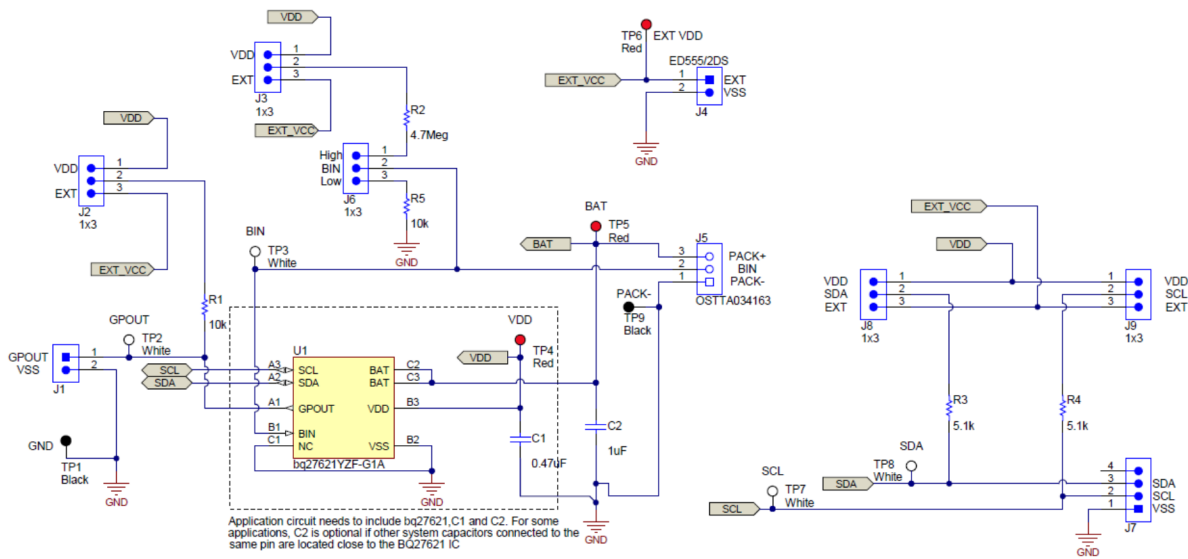


Figure 6. bq27621EVM Schematic

NOTE: Add 10-kΩ pull-down resistor on BIN pin for proper operation.

3.4 bq27621 Circuit Module Performance Specification Summary

Table 3 summarizes the performance specifications of the bq27621 circuit module.

Table 3. Performance Specification Summary

Specification	Min	Typ	Max	Unit
Input voltage Pack+ to Pack–	2.7	3.6	4.5	V

4 EVM Hardware and Software Setup

This section describes how to install the bq27621EVM PC software and how to connect the different components of the EVM.

4.1 System Requirements

The software requires Windows XP or later. EV2300 is not officially supported for 64-bit Windows, such as Windows 7 or later. EV2400 is recommended.

4.2 Software Installation

Find the latest software version of Battery Management Studio (bqStudio) in the bq27621 tool folder on power.ti.com. Make a search by Part Number for bq27621 to access the tool folder. Use the following steps to install the bq27621 bqStudio 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, 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 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. If using Windows 7, install the software with administrator privileges.

6 Hardware Connection

The bq27621 evaluation system comprises three hardware components: the bq27621 circuit module, the EV2300 or EV2400 PC interface board, and the PC.

6.1 Connecting the bq27621 Circuit Module to a Battery Pack

[Figure 7](#) shows how to connect the bq27621 circuit module to the cells and system load/charger.

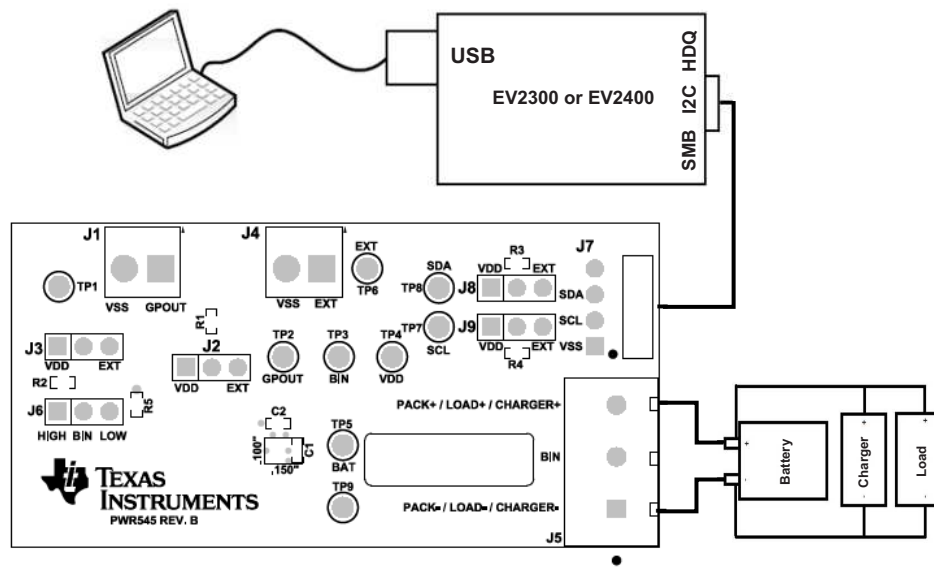


Figure 7. bq27621 Circuit Module Connection to Pack and System Load/Charger

NOTE: If you have the PWR545 REV. A EVM board, connect the battery, charger, and load to the PACK+ and PACK– connections on J5 as shown in [Figure 7](#). Do not connect the charger and load to J6 and J7 as shown in the initial release of this EVM User's Guide.

Ensure that the battery is closest to the EVM board followed by the charger and the load when these are connected to J5.

6.2 PC Interface Connection

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

1. Connect the bq27621-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

bq27621EVM	EV2300 or EV2400
SDA	SDA
SCL	SCL
VSS	GND/VSS

The bq27621EVM is now set up for operation.

7 Operation

This section details the operation of the bq27621 bqStudio software.

7.1 Starting the Program

Run bqStudio from the Start → Programs → Texas Instruments → Battery Management Studio menu sequence. When bqStudio starts up, the main perspective ([Figure 8](#)) should appear. The main perspective shows the plug-ins panel at the top, the Gauge Dashboard and the Registers and Commands plug-in windows. The plug-in windows are allowed to be hidden, docked in various positions, or allowed to float as separate windows. If bqStudio is starting for the first time, only the welcome screen will be seen. To get to the main perspective, simply close the welcome screen tab. *Registers, Data Memory, Commands, and*

other plug-ins can be added to the main window by clicking on the corresponding icon in the plug-ins panel at the top of the main window. Data should appear initially in the *Gauge Dashboard* and *Registers* sections. The **Refresh** (single time scan) or the **Scan** (continuous scan) buttons can be clicked to update the data in the *Registers* window. The Log button can be used to save scanned values to a file for later analyses.

The logging and continuous scanning interval can be set in the Preferences option found under the *Window* menu.

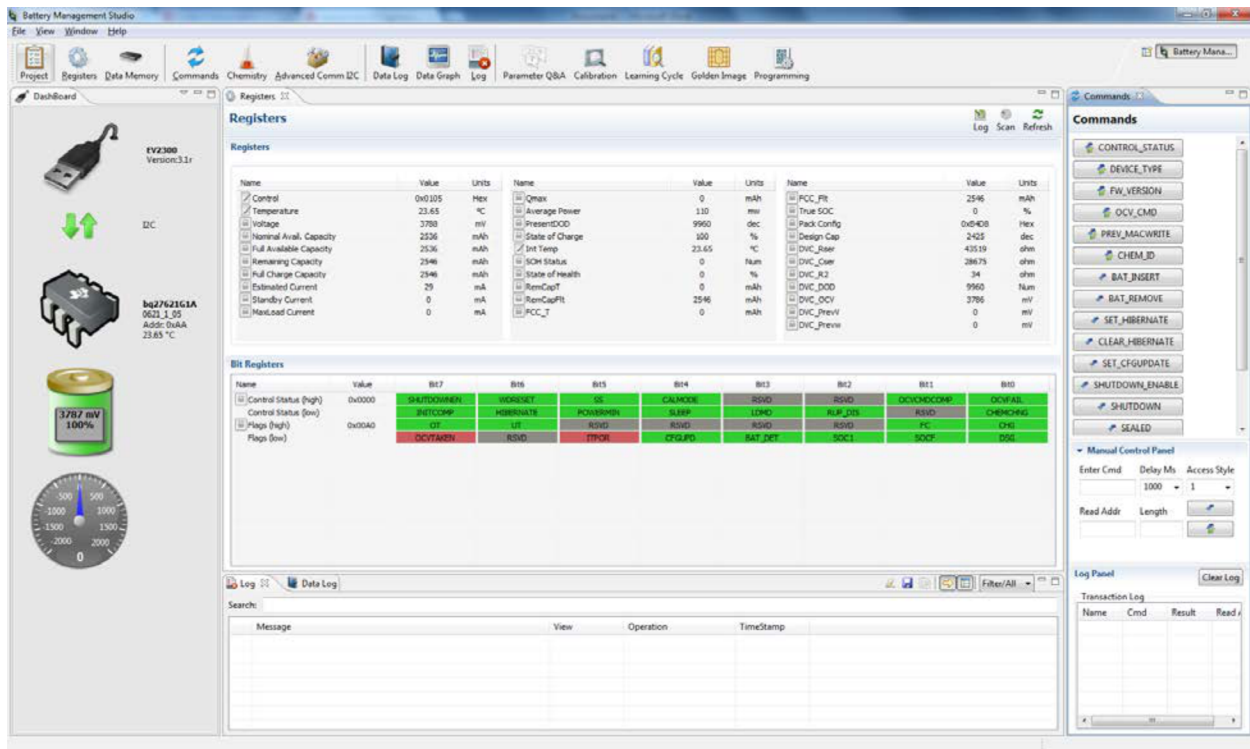


Figure 8. Registers Screen

Figure 8 shows the main *bqStudio* perspective. Additional Flag and Status data can be viewed at the bottom of the *Registers* plug-in window.

Each plug-in window can be resized and docked in various positions within the main *bqStudio* window. Each plug-in window can also be pulled out from the main window and allowed its own floating window.

7.2 Setting Programmable bq27621 Options

The bq27621 EVM comes configured per the default settings detailed in the bq27621 technical reference manual. Ensure that the settings are correctly changed to match the pack and application for the bq27621 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 Plug-in* *bqStudio* Figure 9).

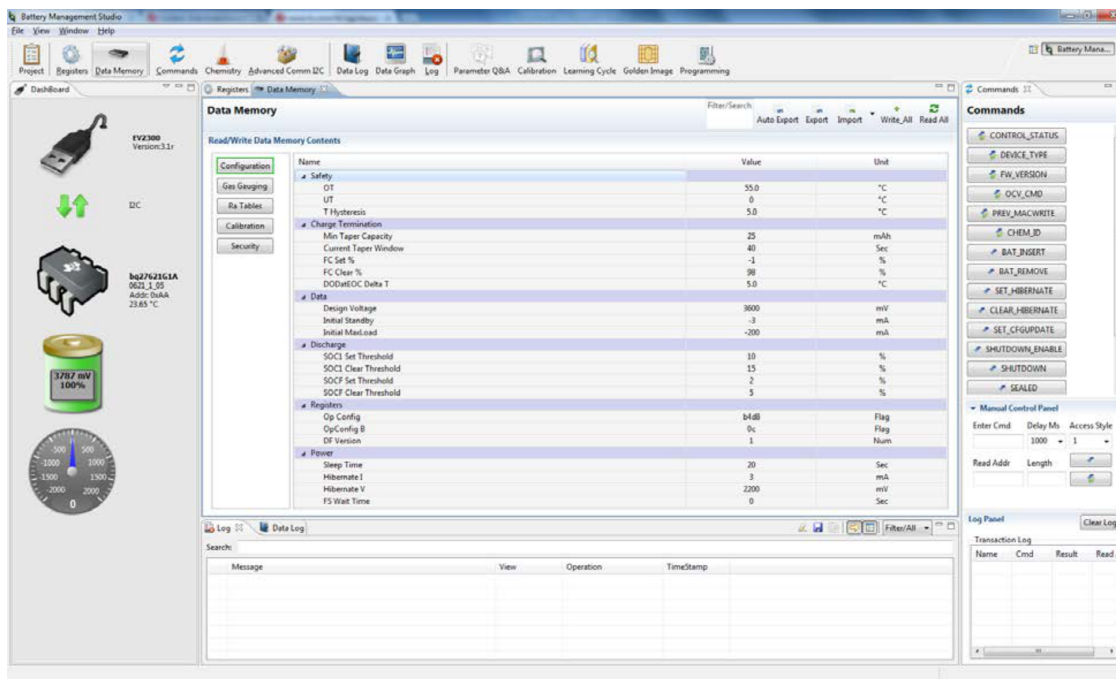


Figure 9. Data Memory Screen

When the *Data Memory* plug-in is first opened, bqStudio will read the configuration values from the connected bq27621EVM. If the EVM has been reset as indicated by the *[ITPOR]* bit being set in the *Flags()* register, these values will be the defaults.

To change these values in the *Data Memory* plug-in, double-click on the desired parameter and enter the new value. After the new value has been entered, press the Enter key. After Enter has been pressed, bqStudio will update the selected parameter. Please note that the RAM updates will revert back to the defaults when there is a POR or full RESET (indicated by the *[ITPOR]* bit being set in the *Flags()* register).

The **Import** button in the *Data Memory* plug-in can be clicked to import the configuration from an entire *.gg.csv file into RAM.

The RAM configuration can be saved to a file by clicking the **Export** button in the *Data Memory* plug-in and entering a file name. The RAM configuration will be saved to a *.gg.csv file.

8 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. bq27621-G1, System-Side Fuel Gauge with Dynamic Voltage Correlation data sheet ([SLUSB85](#))
2. Quickstart Guide for bq27621-G1 ([SLUUAP5](#))
3. bq27621-G1, Technical Reference Manual ([SLUUAD4](#))

9 Revision History

Version	Date	Description
—	November 2013	Initial release
A	February 2014	Figure 1 through Figure 4 , Figure 6 , and Figure 7 are updated with the PWR545, Rev B EVM board. Figure 8 and Figure 9 are updated with the bq27621-G1A device. Added the Note following Figure 7 . Added Revision History section.
B	April 2014	Deleted Section 8, <i>Calibrate Screen</i> Streamlined instructions.

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

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- 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

- 2 *Limited Warranty and Related Remedies/Disclaimers:*

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- 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
- 2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

- 3 *Regulatory Notices:*

- 3.1 *United States*

- 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

- 3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

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