

# ***bq27421 EVM: Single-Cell Impedance Track Technology***

This evaluation module (EVM) is a complete evaluation system for the bq27421. The EVM includes one bq27421 circuit module with an integrated current-sense resistor. A separated 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 bq27421 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 bq27421 data registers
- Update the RAM for different configurations
- Log cycling data for further evaluation
- Evaluate the overall functionality of the bq27421 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 bq27421 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

- bq27421 circuit module (PWR214)

This EVM is used for the evaluation of bq27421. Visit the product Web folder at [www.ti.com](http://www.ti.com) to properly configure the bq27421.

### 1.2 Ordering Information

**Table 1. Ordering Information**

Part Number	EVM Part Number	Firmware Version <sup>(1)</sup>	Chemistry	Chemistry ID <sup>(2)</sup>	Configuration
bq27421-G1A	bq27421EVM-G1A	v1.08 (0x0108)	4.2 V Li-ion	128	1 cell
bq27421-G1B	bq27421EVM-G1B	v1.08 (0x0108)	4.3/4.35 V Li-ion	312	1 cell

<sup>(1)</sup> Using the FW\_VERSION (0x0002) Control() Subcommand returns 0x0108. See the bq27421-G1x data sheet for information on Control() Subcommands.

<sup>(2)</sup> Using the CHEM\_ID (0x0008) Control() Subcommand helps differentiate between the bq27425-G1A (returns 0x0128) and the bq27421-G1B (returns 0x0312). Please refer to the bq27421-G1x data sheet for information on Control() Subcommands.

## 2 bq27421-Based Circuit Module

The bq27421-based circuit module is a complete and compact example solution of a bq27421 circuit for battery management. The circuit module incorporates a bq27421 battery gas gauge integrated circuit (IC) with integrated sense resistor and 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 <sup>2</sup> C™ communication data line
EXT VDD	External supply connection
SCL	I <sup>2</sup> 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 bq27421 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 bq27421 module.

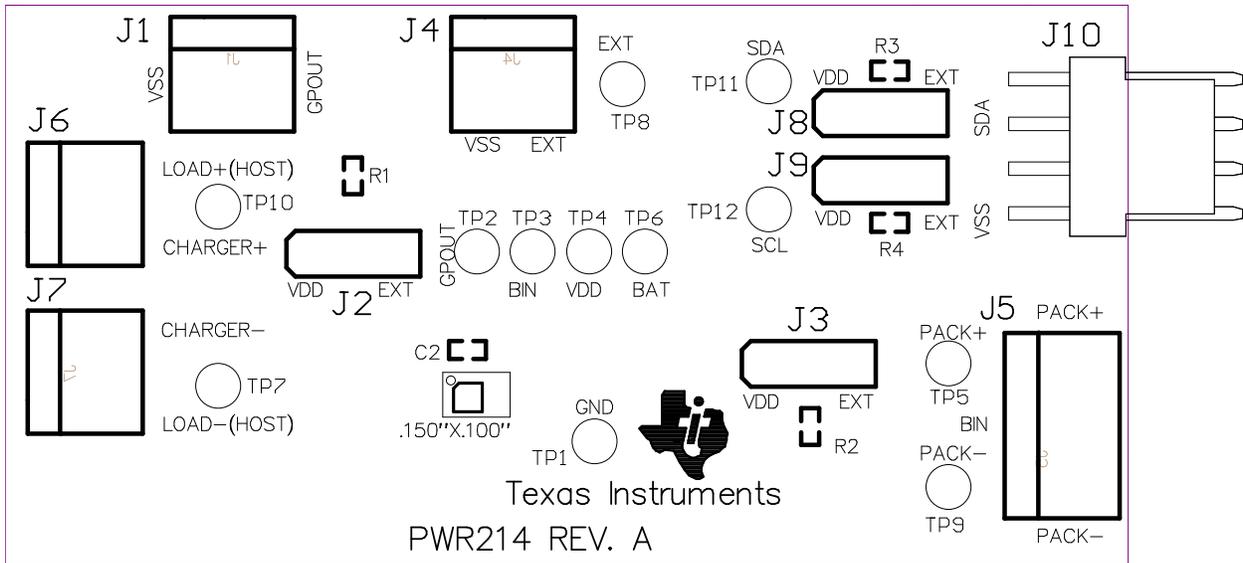


Figure 1. bq27421EVM Layout – Top Silk

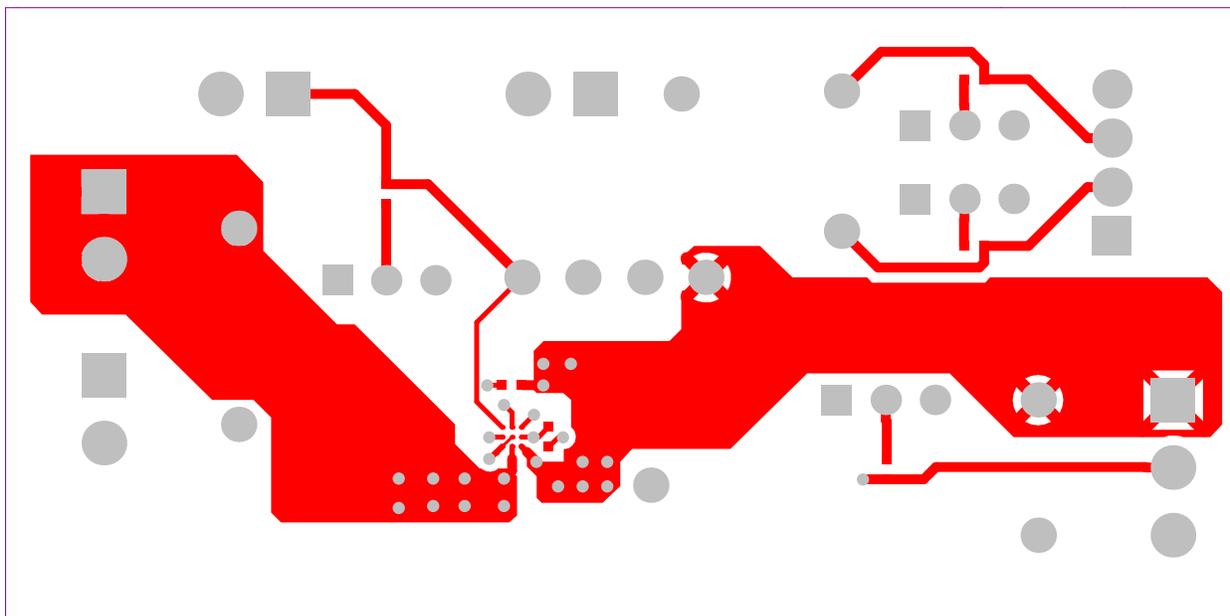


Figure 2. bq27421EVM Layout - Top Layer

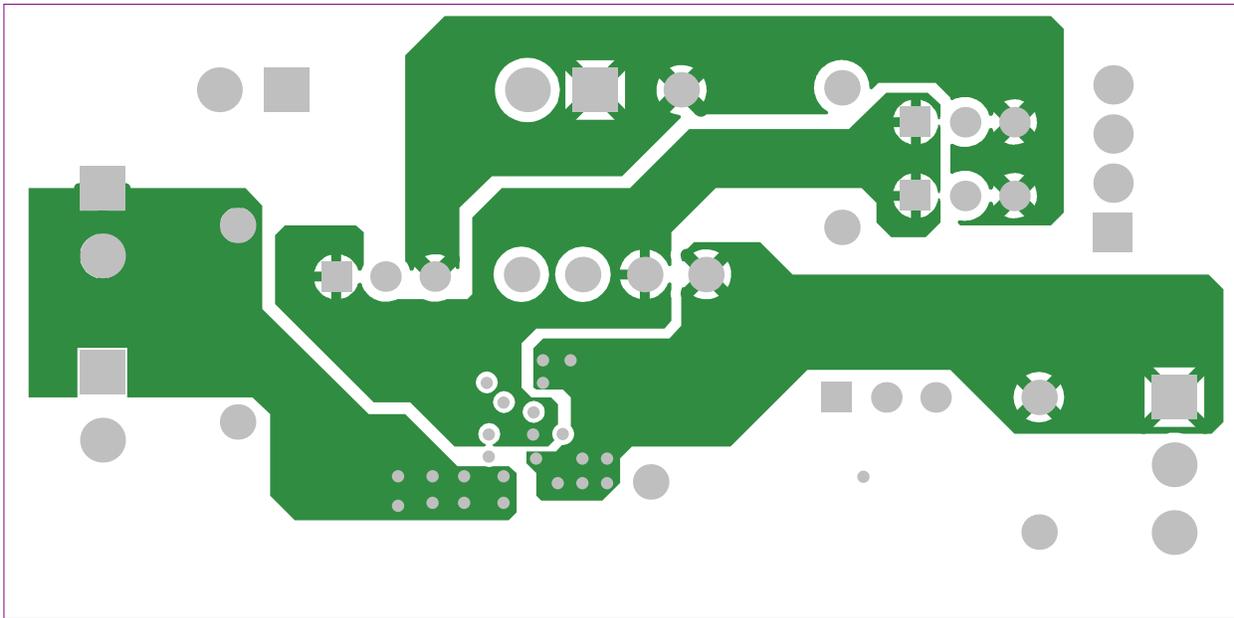


Figure 3. bq27421EVM Layout - Power Layer

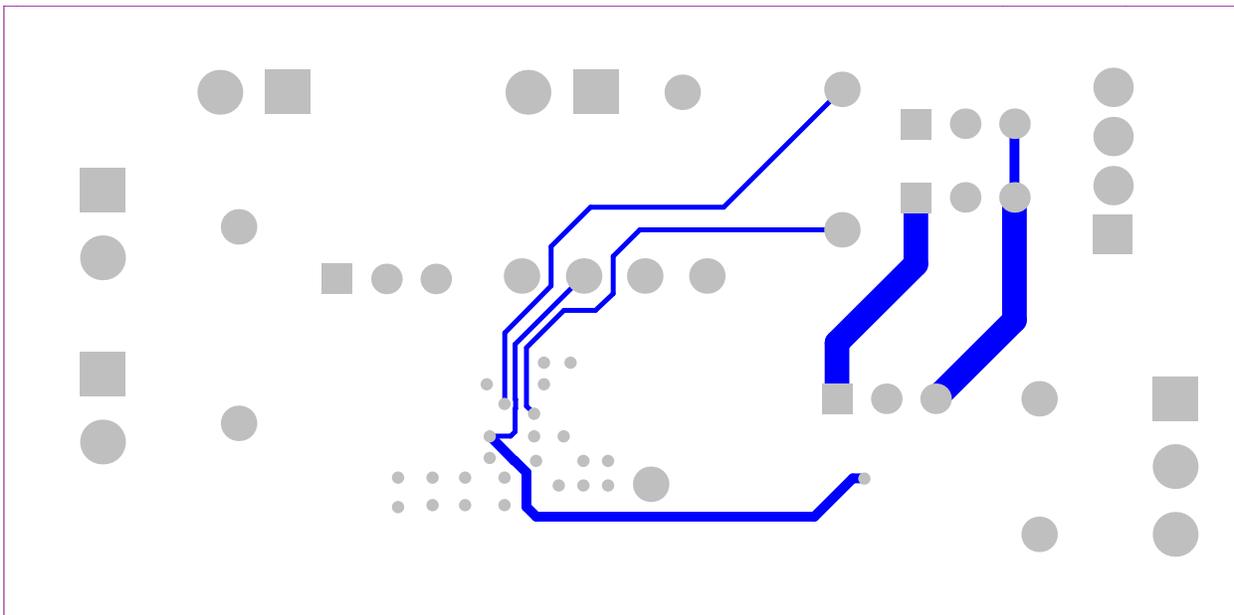


Figure 4. bq27421EVM Layout – Bottom Layer

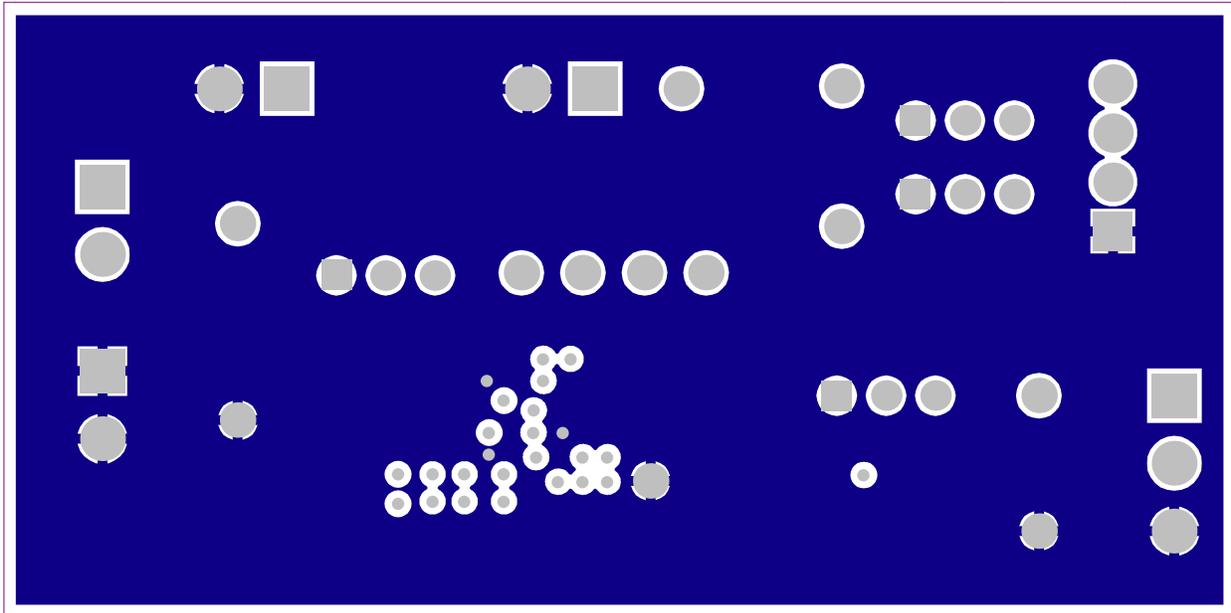


Figure 5. bq27421EVM Layout – Ground Layer



**Table 3. Performance Specification Summary**

Specification	Min	Typ	Max	Units
Input voltage Pack+ to Pack-	2.7	3.6	4.3	V
Charge and discharge current	0	1	2.5	A

## 4 EVM Hardware and Software Setup

This section describes how to install the bq27421EVM PC software and how to connect the different components of the EVM.

### 4.1 System Requirements

The GaugeStudio software requires Windows XP or later. Using later versions of Windows operating system can have issues with the USB driver support. The EV2300 USB drivers have been tested for Windows 98SE, but no assurance is made for problem-free operation with specific system configurations.

### 4.2 Software Installation

Find the latest software version in the bq27421 tool folder on [power.ti.com](http://power.ti.com). Make a search by Part Number for bq27421 to access the tool folder. Use the following steps to install the bq27421 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, 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 bq27421 evaluation system comprises three hardware components: the bq27421 circuit module, the EV2300 or EV2400 PC interface board, and the PC.

### 6.1 Connecting the bq27421 Circuit Module to a Battery Pack

[Figure 7](#) shows how to connect the bq27421 circuit module to the cells and system load/charger.

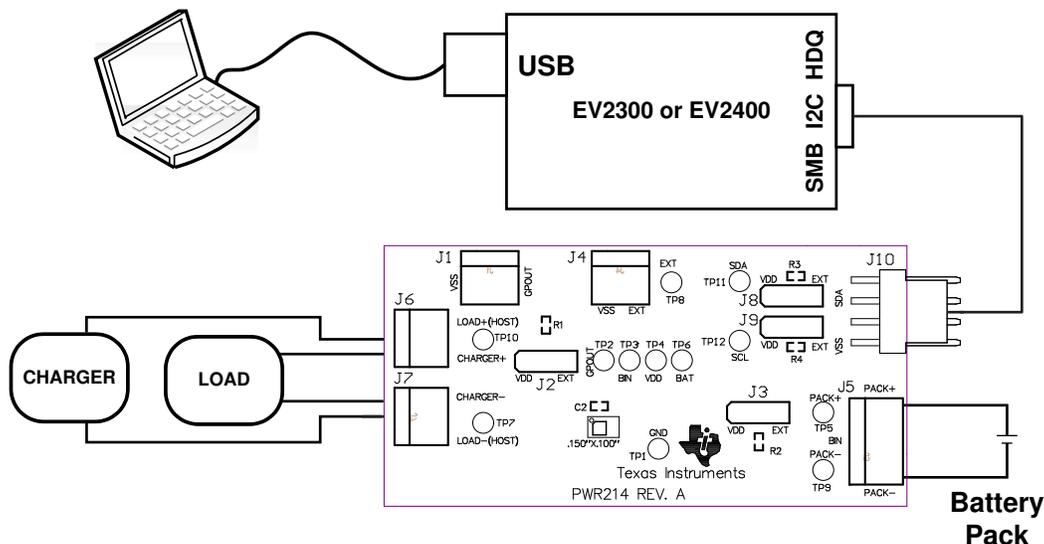


Figure 7. bq27421 Circuit Module Connection to Pack and System Load/Charger

## 6.2 PC Interface Connection

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

1. Connect the bq27421-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

bq27421EVM	EV2300 or EV2400
SDA	SDA
SCL	SCL
VSS	GND/VSS

The bq27421EVM is now set up for operation.

## 7 Operation

This section details the operation of the bq27421 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 in order 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 bq27421. 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 selected the desired Registers or Data Memory parameters to be added to the log. After all the desired Registers and Data Memory Parameters have been added to the log, click the **Play** button in order 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. In order 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.

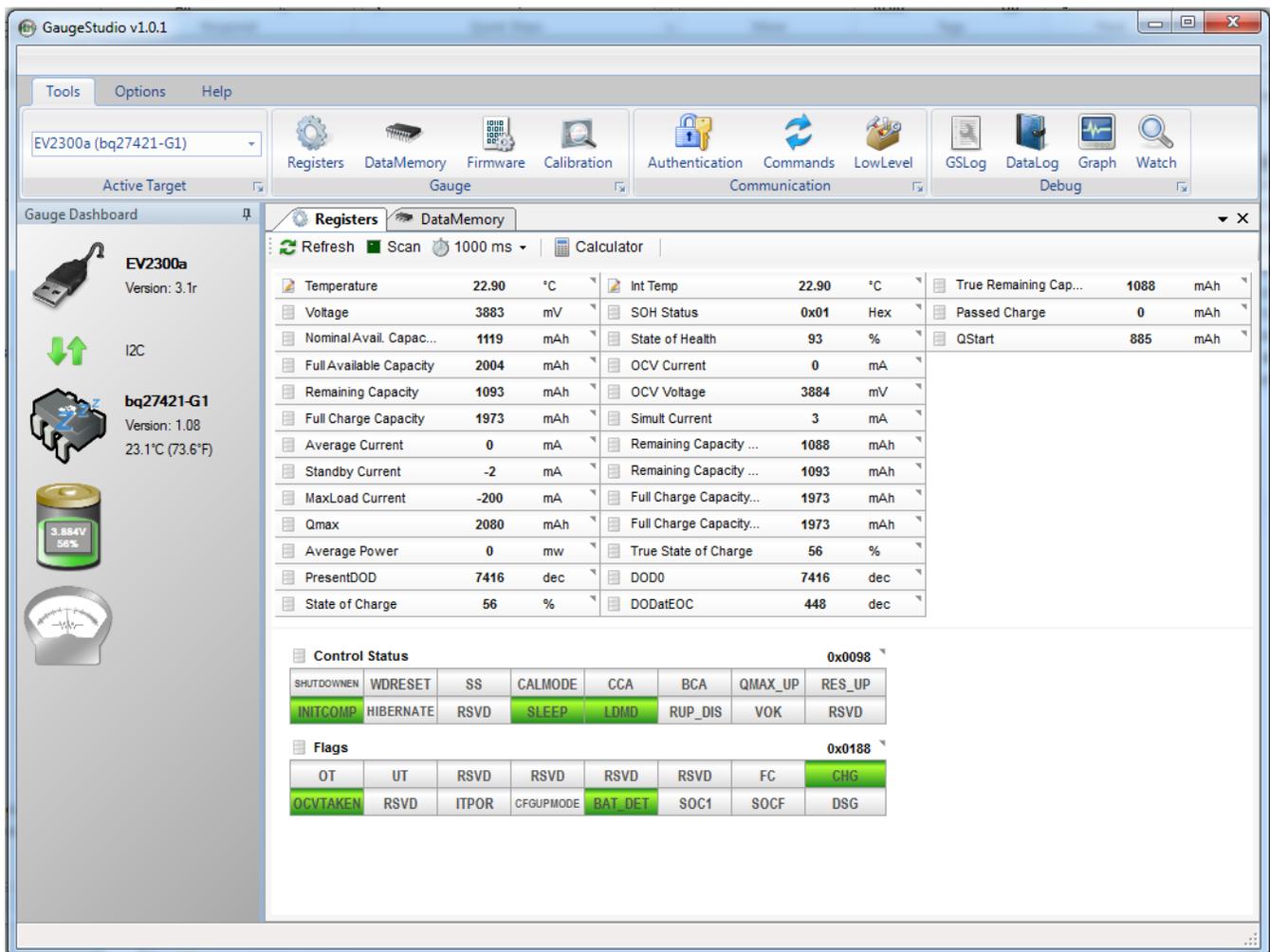


Figure 8. Registers Screen

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 bq27421 Options

The bq27421 OTP comes configured per the default settings detailed in the bq27421 data sheet. Ensure that the settings are correctly changed to match the pack and application for the bq27421 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).

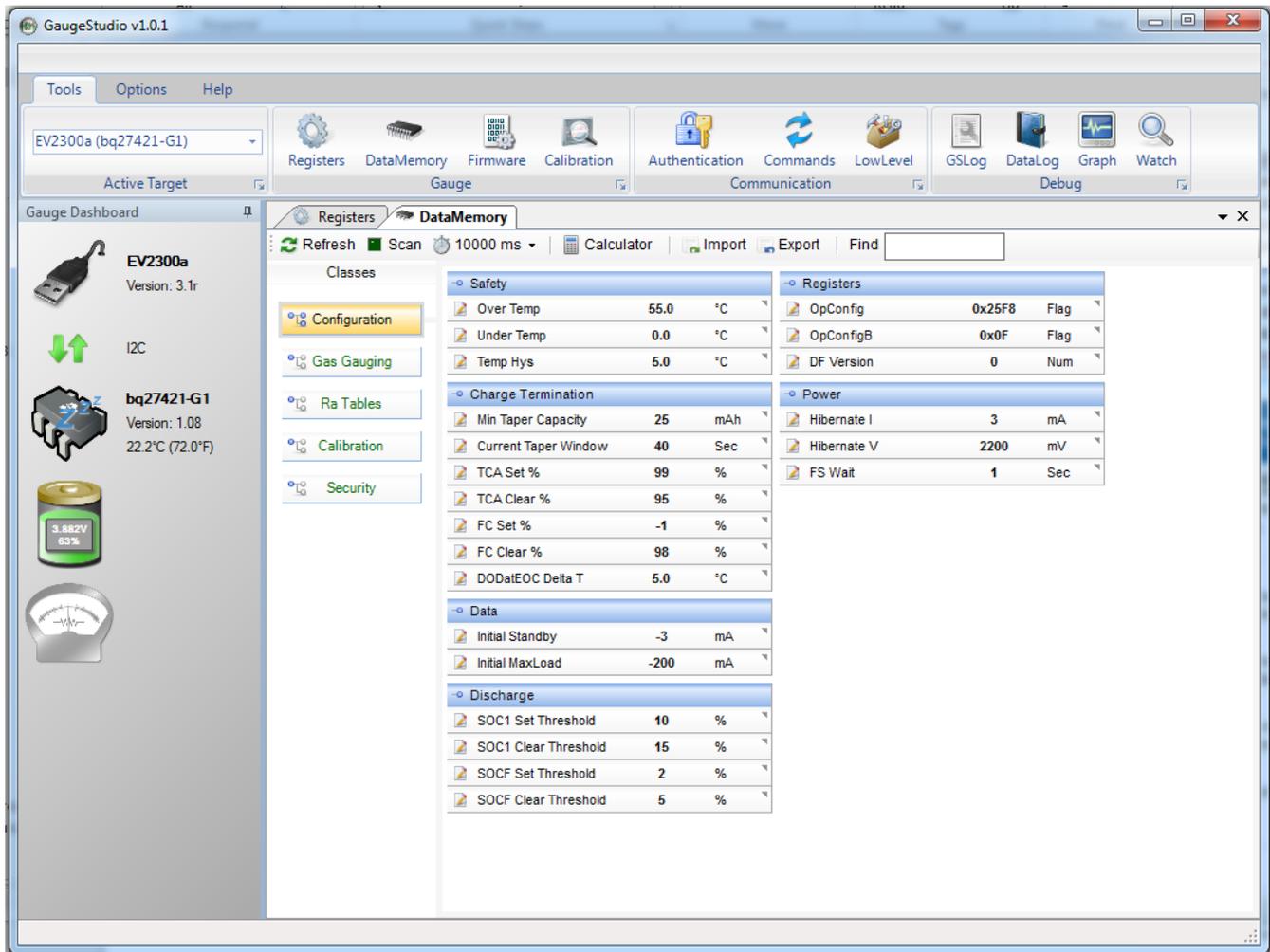


Figure 9. Data Memory Screen

To read all the data from the bq27421 OTP, click on the **Refresh** button in the *Data Memory* window.

To make a RAM update and write to an OTP location, please make sure 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 bq27421 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. Please note that 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 in order 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 bq27421 data Memory.

If the Gauge Dashboard is not displaying any information, then the bq27421 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 bq27421

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:

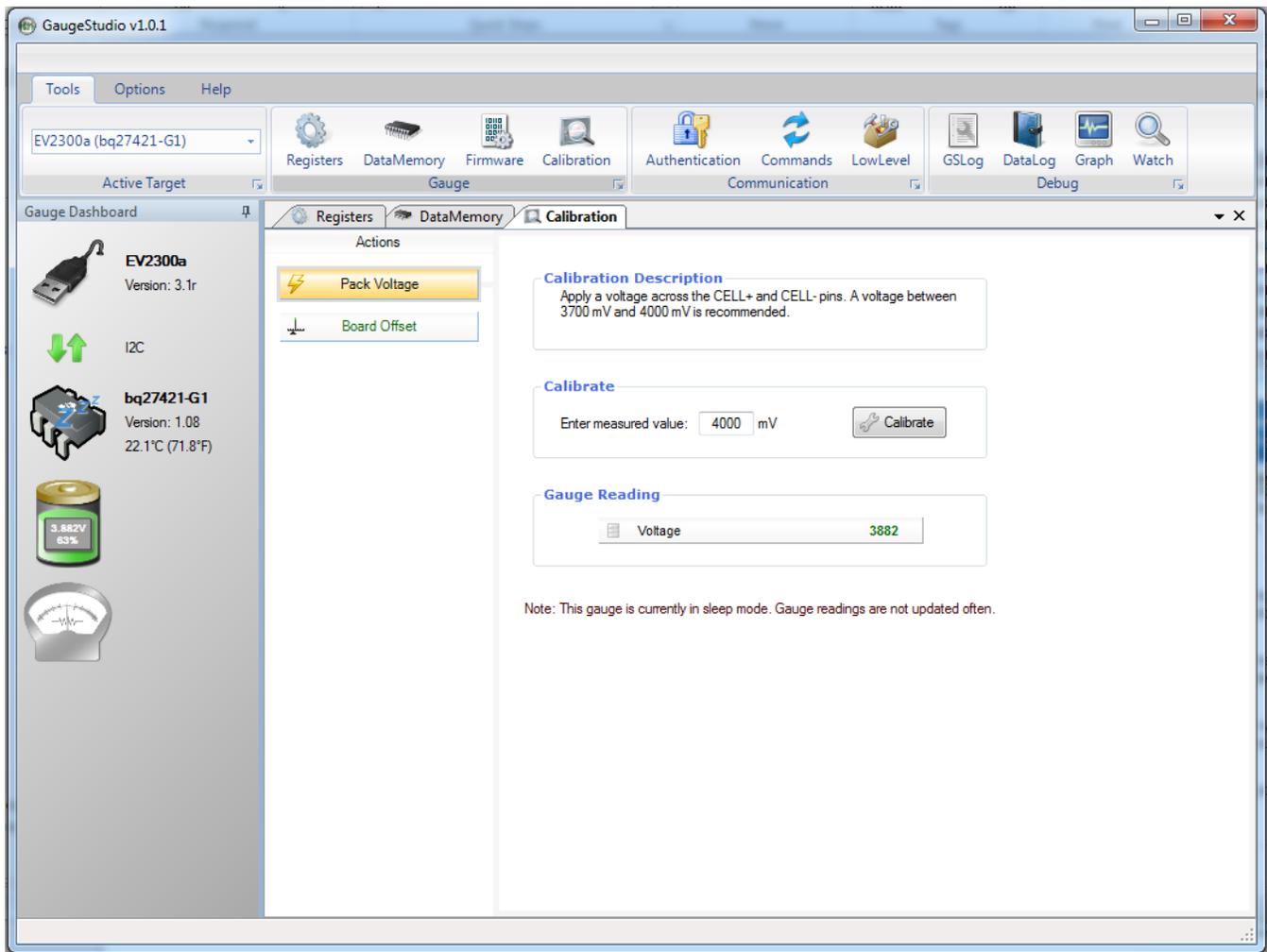
1. Measure the voltage across Pack+ and Pack-.
2. Type the voltage value in mV into *Enter measured value*.
3. Press the **Calibrate** button.

### 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](http://www.ti.com).

1. *bq27421-G1, System-Side Impedance Track™ Fuel Gauge with Integrated Sense Resistor* data sheet ([SLUSB85](#))

## EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

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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.

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 LIMITED 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. 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.

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As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module 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 or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment 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.

### General Statement for EVMs including a radio

*User Power/Frequency Use Obligations:* This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

### 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

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**

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.

### **For EVMs annotated as IC – INDUSTRY CANADA Compliant**

This Class A or B digital apparatus complies with Canadian ICES-003.

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

### **Concerning EVMs including radio transmitters**

This device complies with Industry Canada licence-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.

### **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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

### **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.

### **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.

## **【Important Notice for Users of this Product in Japan】**

### **This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan**

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

**Texas Instruments Japan Limited**  
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## **EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS**

**For Feasibility Evaluation Only, in Laboratory/Development Environments.** Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

**Certain Instructions.** It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. 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 as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

**Agreement to Defend, Indemnify and Hold Harmless.** You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

**Safety-Critical or Life-Critical Applications.** If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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