

bq28550-R1 Single Cell Li-Ion Battery Gas Gauge and Protection EVM

NOTE: Before starting: Download the latest revision of the device firmware and the evaluation software from the TI bq28550-R1 product page at <http://www.ti.com>. Go to the Tools and Software section. For step-by-step instructions on reprogramming the device firmware, refer to [Section 10.3](#) of this document.

This evaluation module (EVM) is a complete evaluation system for the bq28550-R1 battery management solution. The EVM includes one bq28550-R1 circuit module, a current sense resistor, and one thermistor. An EV2300 or EV2400 PC interface board is required to interface to the gas gauge, and a PC USB cable is required for communication with a PC. Both can be ordered online at <http://power.ti.com>. Windows®-based PC software is available online as well. The circuit module includes one bq28550-R1 IC, and all other onboard components necessary to monitor and predict capacity, monitor critical parameters, and protect the cell from overcharge, overdischarge, short circuit, and overcurrent in single-cell Li-Ion or Li-Polymer battery packs. With the EV2300 or EV2400 interface board and software, the user can read the bq28550-R1 data registers, program the chipset for different configurations, log cycling data for further evaluation, and evaluate the overall functionality of the bq28550-R1 solution under different charge and discharge conditions.

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1 Features

- Complete evaluation system for the bq28550-R1 battery management IC
- Populated circuit module for quick setup
- Software allowing data logging for system analysis

1.1 Kit Contents

- bq28550-R1EVM-001 circuit module
- Links to support documentation

1.2 Ordering Information

Table 1. Ordering Information

EVM PART NUMBER	CHEMISTRY	CONFIGURATION	CAPACITY
bq28550-R1EVM-001	Li-Ion, Li-Polymer	1 Cell	Any

2 bq28550-R1EVM-001 Circuit Module

The bq28550-R1EVM-001 circuit module is a complete and compact example solution of a bq28550-R1 circuit for battery management and protection of Li-Ion or Li-Polymer packs. The circuit module incorporates a bq28550-R1 battery monitor IC and all other components necessary to accurately predict the capacity of single-cell batteries.

2.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Directly to the cells: CELL+ and CELL–
- To the serial communication ports: SDA, SCL, HDQ, GND
- The system load and charger connect across PACK+/LOAD+ and PACK–/LOAD–

PIN NAME	DESCRIPTION
CELL–	Negative connection of the cell
CELL+	Positive connection of the cell
SDA	Serial communication data port
SCL	Serial communication clock port
HDQ	Serial single wire data port
GND	Pack negative terminal
PACK– or LOAD–	Pack negative terminal
PACK+ or LOAD+	Pack positive terminal

3 bq28550-R1EVM-001 Circuit Module Schematic

This section contains the board layout, bill of materials, assembly drawings, and schematic for the bq28550-R1EVM-001 circuit module.

3.1 Schematic

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

3.2 Configuring the Board for SMBus or I²C™ Communication

For successful SMBus or I²C communication, jumpers J3 and J4 must be shunted.

3.3 Configuring the Board for HDQ Communication

For successful HDQ communication, jumper J2 must be shunted and the device must be converted to HDQ mode.

3.4 Board Layout

This section shows the printed-circuit board (PCB) layers (Figure 1 through Figure 4), assembly drawing, and schematic for the bq28550-R1 module.

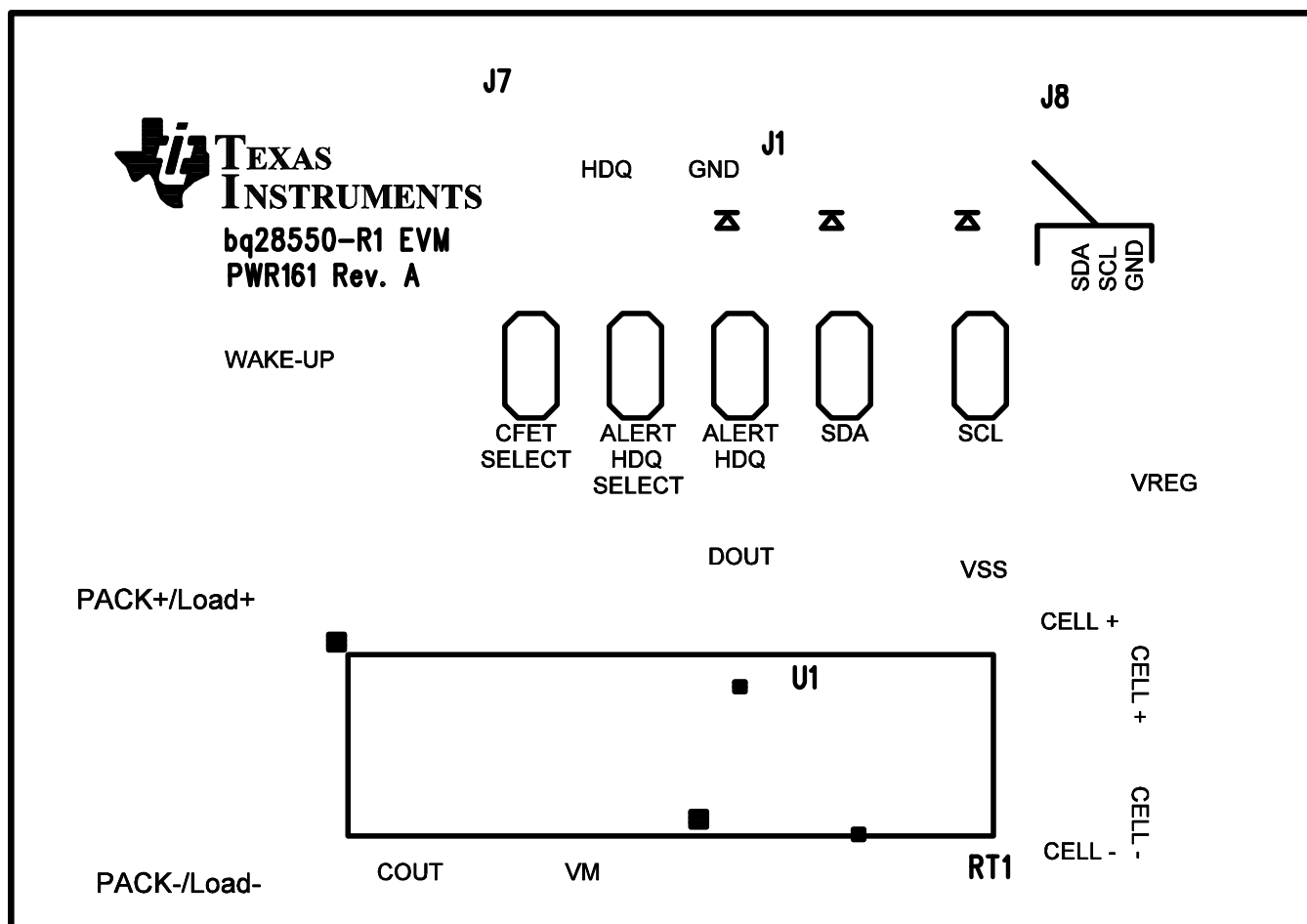


Figure 1. bq28550-R1EVM-001 Layout (Silkscreen)

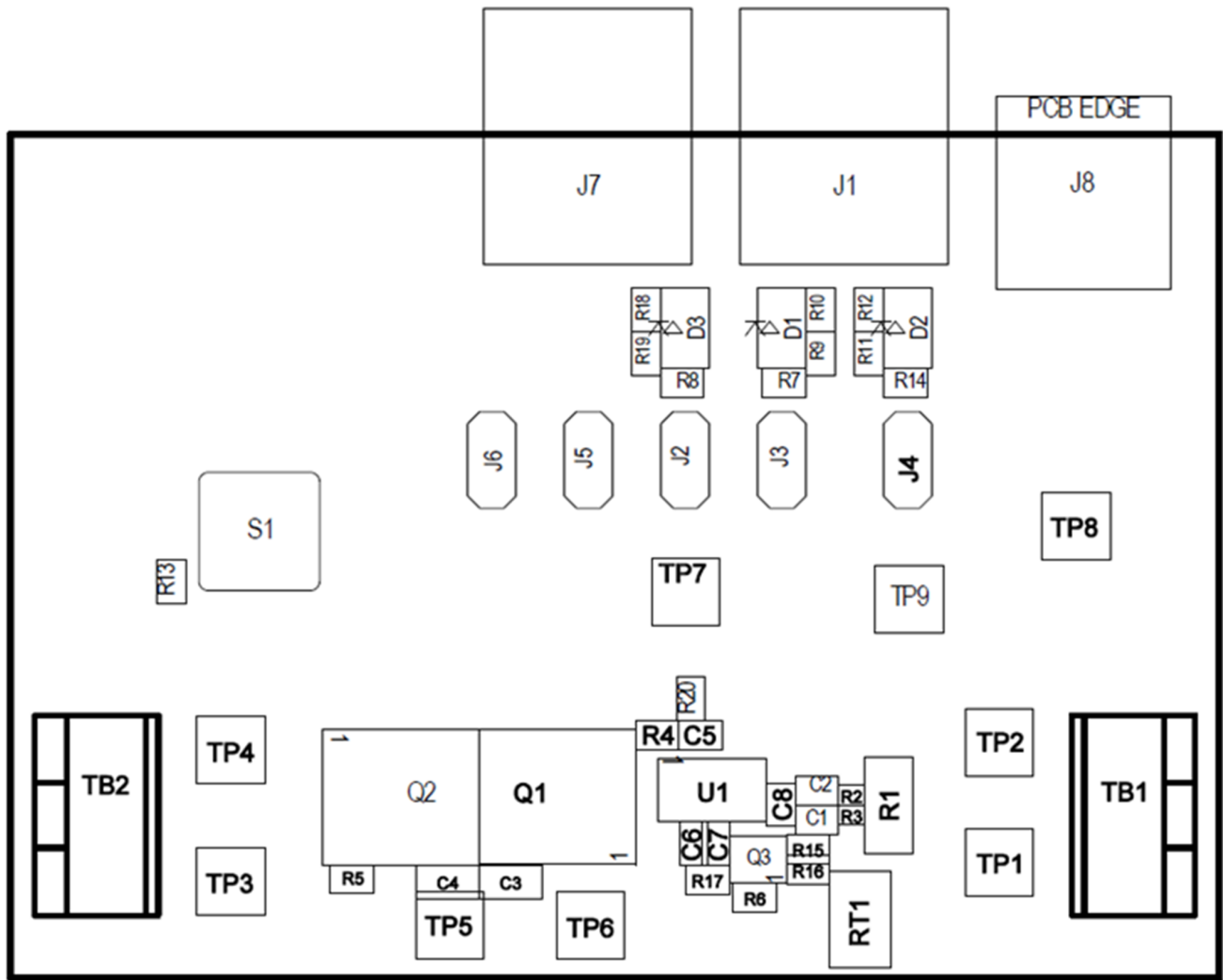


Figure 2. Top Assembly

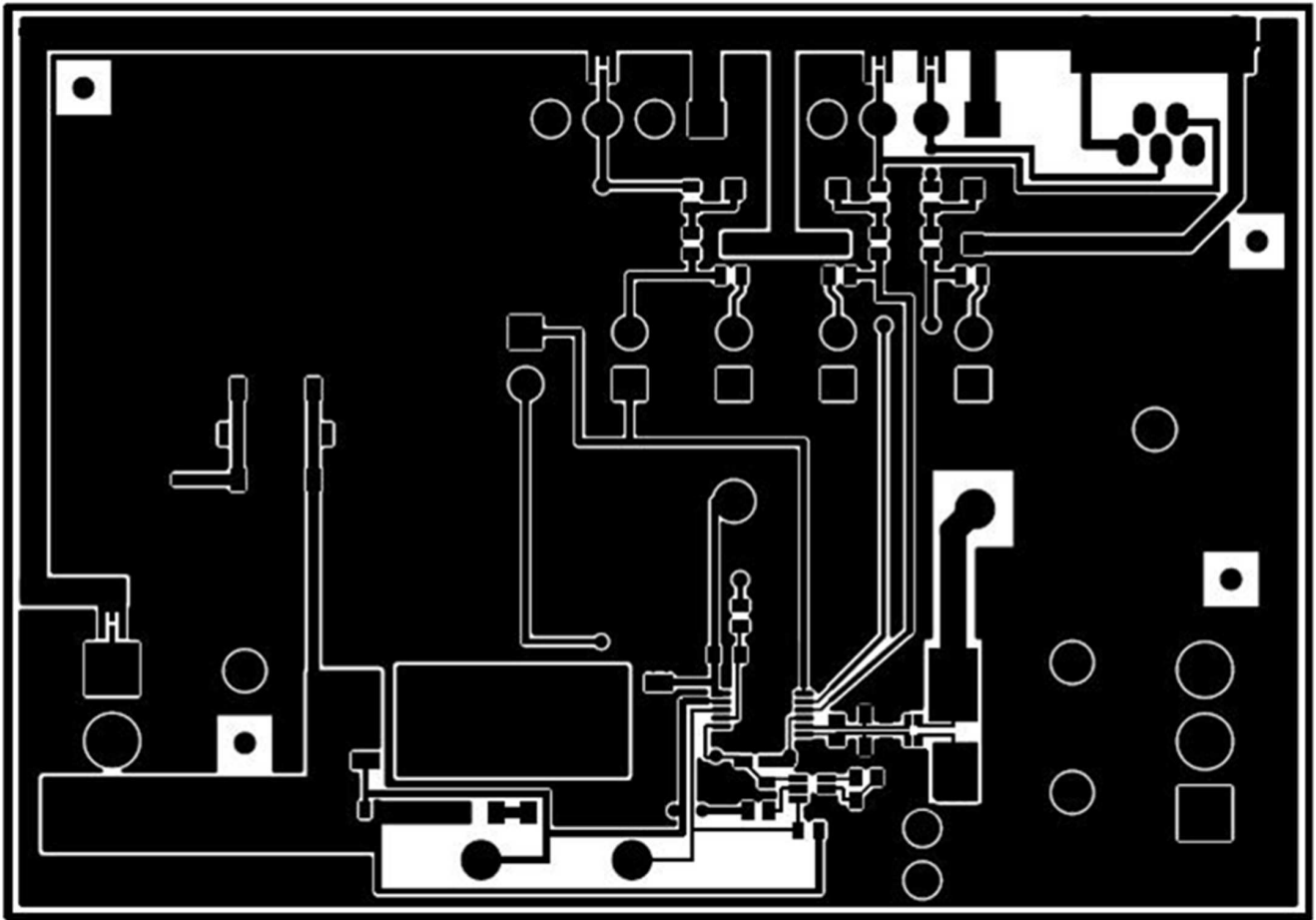


Figure 3. Top Layer

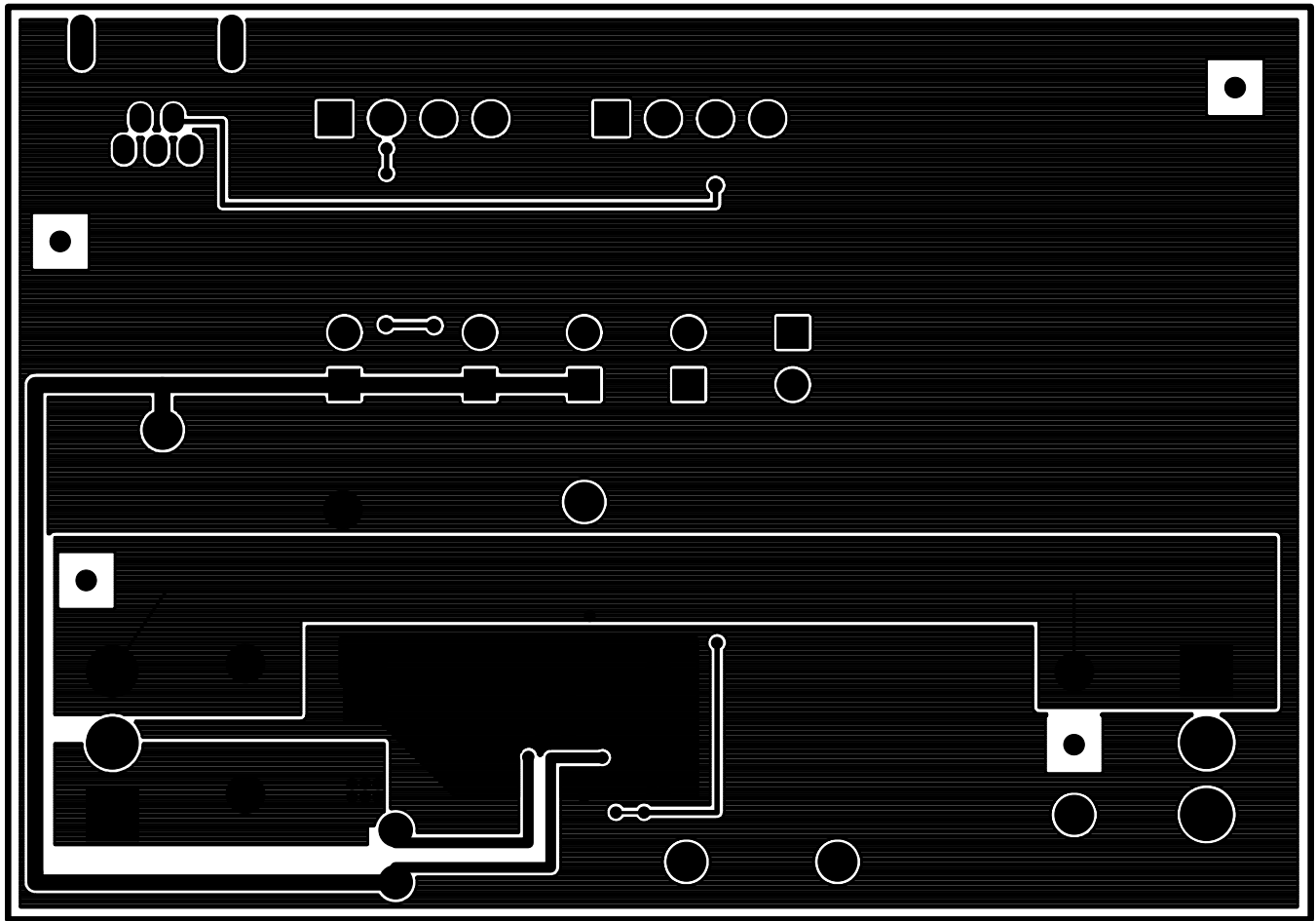


Figure 4. Bottom Layer

3.5 Schematic and Bill of Materials

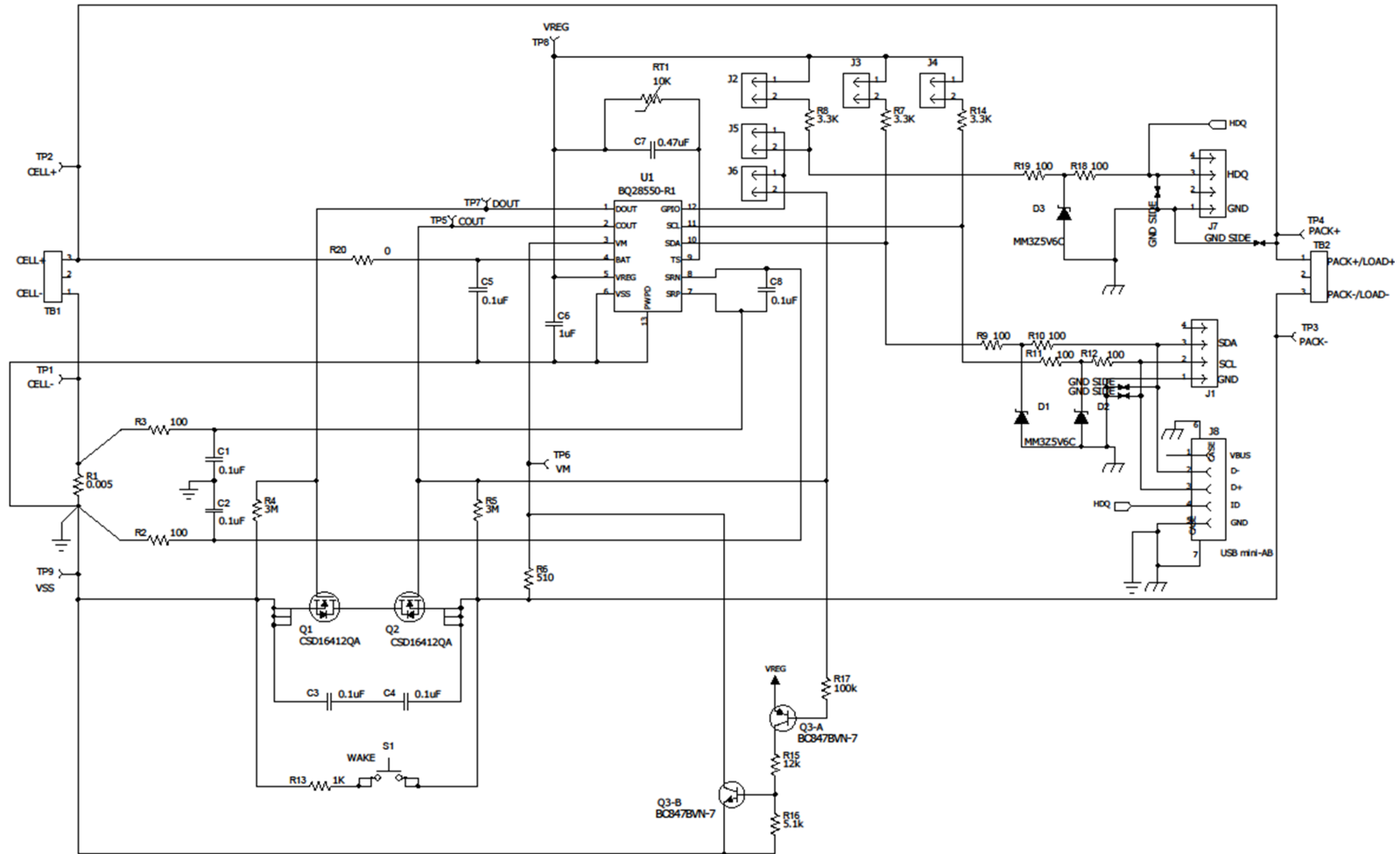


Figure 5. Schematic

Table 2. Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
2	C1-2	0.1 μ F	Capacitor, ceramic, 16 V, X7R, 20%	0402	STD	Any
2	C3-4	0.1 μ F	Capacitor, ceramic, 16 V, X7R, 20%	0603	STD	Any
2	C5 C8	0.1 μ F	Capacitor, ceramic, 6.3 V, X5R, 20%	0402	STD	Any
1	C6	1 μ F	Capacitor, ceramic, 16 V, X5R, 20%	0402	STD	Any
1	C7	0.47 μ F	Capacitor, ceramic, 16 V, X5R, 20%	0402	STD	Any
3	D1-3	MM3Z5V6C	Diode, Zener, 5.6 V, 200 mW	SOD323	MM3Z5V6C	Fairchild
2	J1 J7	22-05-3041	Header, friction lock assembly, 4-pin right angle	0.400 x 0.500 in	22-05-3041	Molex
5	J2-6	PEC02SAAN	Header, male 2-pin, 100-mil spacing	0.100 in x 2	PEC02SAAN	Sullins
1	J8	USB mini-AB	Connector, USB, mini AB, 5-pins	0.354 x 0.307 in	56579-0519	Molex
5	J2-6	SPC02SYAN	Connector jumper, shorting, 100-mil spacing	0.100 in x 2	SPC02SYAN	Sullins
2	Q1-2	CSD16412QA	MOSFET, N-Channel, 25 V, 52 A, 11 m Ω	QFN-8 POWER	CSD16412Q5A	TI
1	Q3	BC847BVN-7	Trans, G.P. Dual N/P-ch, 50/-50V, 100 mA,	SOT-563	BC847BVN-7	On Semi
1	R1	0.005 Ω	Resistor, metal film, 1 watt, \pm 1%	1206	WSLP12065L000FEA	Vishay/Dale
2	R2-3	100 Ω	Resistor, chip, 1/16W, 5%	0201	STD	Any
2	R4-5	3 M Ω	Resistor, chip, 1/16W, 5%	0402	STD	Any
1	R6	510 Ω	Resistor, chip, 1/16W, 5%	0402	STD	Any
3	R7-8 R14	3.3 k Ω	Resistor, chip, 1/16W, 5%	0402	STD	Any
6	R10-12 R9 R18-19	100 Ω	Resistor, chip, 1/16W, 5%	0402	STD	Any
1	R13	1 k Ω	Resistor, chip, 1/16W, 5%	0402	STD	Any
1	R15	12 k Ω	Resistor, chip, 1/16W, 5%	0402	STD	Any
1	R16	5.1 k Ω	Resistor, chip, 1/16W, 5%	0402	STD	Any
1	R17	100 k Ω	Resistor, chip, 1/16W, 5%	0402	STD	Any
1	R20	0 Ω	Resistor, chip, 1/16W, 5%	0603	STD	Any
1	RT1	10 k Ω	Thermistor, NTC, 3-A	0.095 x 0.150 in	103AT-2	Semitec
1	S1	EVQ-PLHA15	Switch, 1P1T, 50 mA, 12 V, 160 g	0.200 x 0.200 in	EVQ-PLHA15	Panasonic
2	TB1-2	ED555/3DS	Terminal block, 3 pin, 6 A, 3.5 mm	0.41 x 0.25 in	ED555/3DS	OST
7	TP1 TP3 TP5-9	5001	Test point, black, thru hole color keyed	0.100 x 0.100 in	5001	Keystone
2	TP2 TP4	5000	Test point, red, thru hole color keyed	0.100 x 0.100 in	5000	Keystone
1	U1	BQ28550-R1	IC, single-cell battery management controllers	QFN12	BQ28550-R1DRZ	TI
1	--		PCB	2.5 in x 1.75 in	PWR161	Any
Notes:	1. These assemblies are ESD sensitive, observe ESD precautions. 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)	White - Pin # 2 (Signal SCL)				
	Brown - Pin # 3 (Signal SDA)	Black - Pin # 1 (GND)				

3.6 **bq28550-R1EVM-001 Circuit Module Performance Specification Summary**

This section summarizes the performance specifications of the bq28550-R1EVM-001 circuit module.

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	2	4	A

4 **EVM Hardware and Software Setup**

This section describes how to install the bq28550-R1EVM-001 evaluation software (EVSU), and how to connect the different components of the EVM.

4.1 **System Requirements**

The EVSU requires Windows 2000 or Windows XP.

4.2 **Software Installation**

Get the latest software version in the bq28550-R1 tool folder on www.ti.com, and follow these steps to install the EVSU:

1. Save the archive to a temporary directory. Open the archive containing the installation package, and copy its contents to a temporary directory. The executable filename can consist of several component names and versions. Double-click on the executable filename, and follow the installer instructions to complete the EVSU installation.
2. If an EV2300 or EV2400 was not previously installed, after EVSU installation, a TI USB DRIVER INSTALLER pops up. Click **Yes** for the agreement message and follow its instructions.
3. Plug the EV2300/EV2400 into a USB port.

5 **Troubleshooting Unexpected Dialog Boxes**

1. Ensure that the files were extracted from the zip file using the **Preserve Folder names** option.
2. Ensure that all the files were extracted from the zip file.

The user downloading the files must be logged in as the administrator.

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

6 Hardware Connection

The EVM comprises three hardware components: the bq28550-R1 circuit module, the EV2300 or EV2400 PC interface board, and the PC.

6.1 Connecting bq28550-R1 Circuit Module to the Cell

Figure 6 shows an overview of how the EVM circuit module connects to the cells and system load/charger.

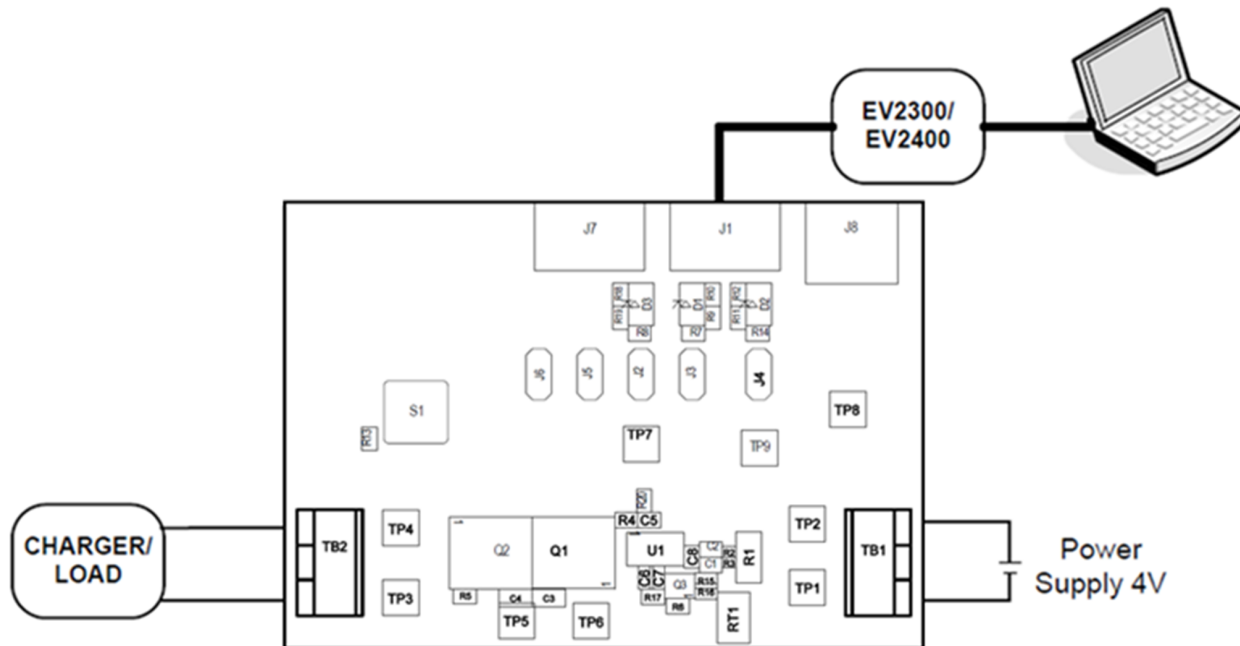


Figure 6. bq28550-R1EVM-001 Circuit Module Connection to Cell and System Charger/Load

6.2 PC Interface Connection

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

1. Connect the EVM circuit module to the EV2300 or EV2400 using wire leads as shown in Table 4.

Table 4. Circuit Module to EV2300 or EV2400 Connections

bq28550-R1 Circuit Module	EV2300 or EV2400
SDA	SMBD
SCL	SMBC
GND	GND

2. Connect the PC USB cable to the EV2300 or EV2400 and the PC USB port.

The EVM is now set up for operation.

7 Operation

This section details the operation of the EVSW.

7.1 Starting the Program

Run bq Evaluation Software from the **Start | Programs | Texas Instruments | bq Evaluation Software** menu sequence. The **SBS Data** screen (Figure 7) 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 bq Evaluation Software provides a logging function that logs the values that were last scanned by the EVSW. To enable this function, select the **Start Logging** button, which causes the selection of the **Keep Scanning** button. When logging is *Stopped*, the **Keep Scanning** button is still selected and has to be manually unchecked.

The logging intervals are specified under the **Options |** menu with the maximum value of 65535 ms. The *Log* interval cannot be smaller than the *Scan* interval because this results in the same value being logged at least twice.



Figure 7. SBS Data Screen

This screen (Figure 7) 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 available 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.

7.2 Setting Programmable bq28550-R1 Options

The bq28550-R1 data flash comes configured per the default settings as detailed in the *bq28550-R1 Single Cell Li-Ion Battery Gas Gauge and Protection Datasheet (SLUSAJ2)*. Ensure that the settings are correctly changed to match the capacitor stack and application for the bq28550-R1 solution being evaluated.

IMPORTANT: The correct setting of these options is essential to get the best performance.

The settings can be configured using the **Data Flash** screen (Figure 8).

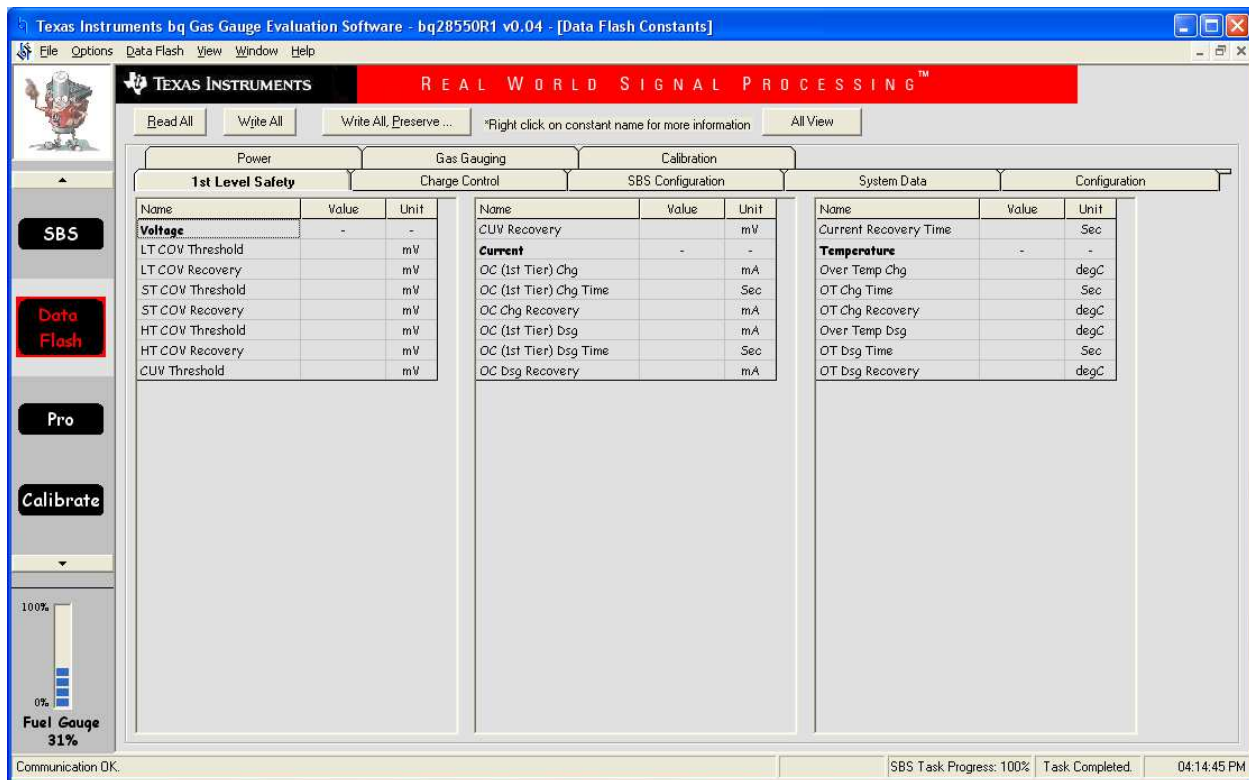


Figure 8. Data Flash Screen, Safety Class

To read all the data from the bq28550-R1 data flash, click on the 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 the 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, but it configures the exported data flash to a learned state ready for mass production use.

The data flash configuration can be saved to a file by selecting | **File** | **Export** | and entering a file name. A data flash file also can be retrieved in this way, imported, and written to the bq28550-R1 using the | **Write All** | button.

The configuration information of the bq28550-R1 and module calibration data are also held in the bq28550-R1 data flash.

The bq28550-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 s. The *AutoExport* filename also is set under the | **Options** | menu.

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

If the data flash screen is blank, then the bq28550-R1 in use may not be supported by the bqEVSW version in use. An upgrade may be required.

8 Calibration Screen

To ensure proper calibration, proceed in the order that follows. These steps may or may not be required, depending on the type of calibration being performed.

8.1 To Calibrate the bq28550-R1

1. Select the types of calibration to be performed (see [Figure 9](#) and [Figure 10](#)).
2. Enter the measured values for the types selected.

The calibration routine consists of two tabs. The first tab is for **Voltage and Temperature**. The second tab is for **CC Offset, Board Offset, and Current** calibration.

3. Ensure that the **Keep Scanning** checkbox in the SBS screen is unchecked.
4. If **Temperature Calibration** is selected, then select the sensor that is to be calibrated.

8.2 Voltage and Temperature Calibration

1. Select the **Voltage and Temperature** tab.
2. Remove the load applied between Pack+/Load+ and Pack-/Load-.
3. Ensure that voltage is stable before performing voltage calibration. Measure the voltage across Cell+ and Cell-. Type the voltage value in mV into **Enter Actual Voltage**.
4. Measure the temperature near the sensor to be calibrated. Type the temperature value into **Enter Actual Temperature**. Select if the temperature sensor to calibrate is the internal or the external sensor.
5. Click the **Calibrate Voltage and Temperature as indicated below** button.

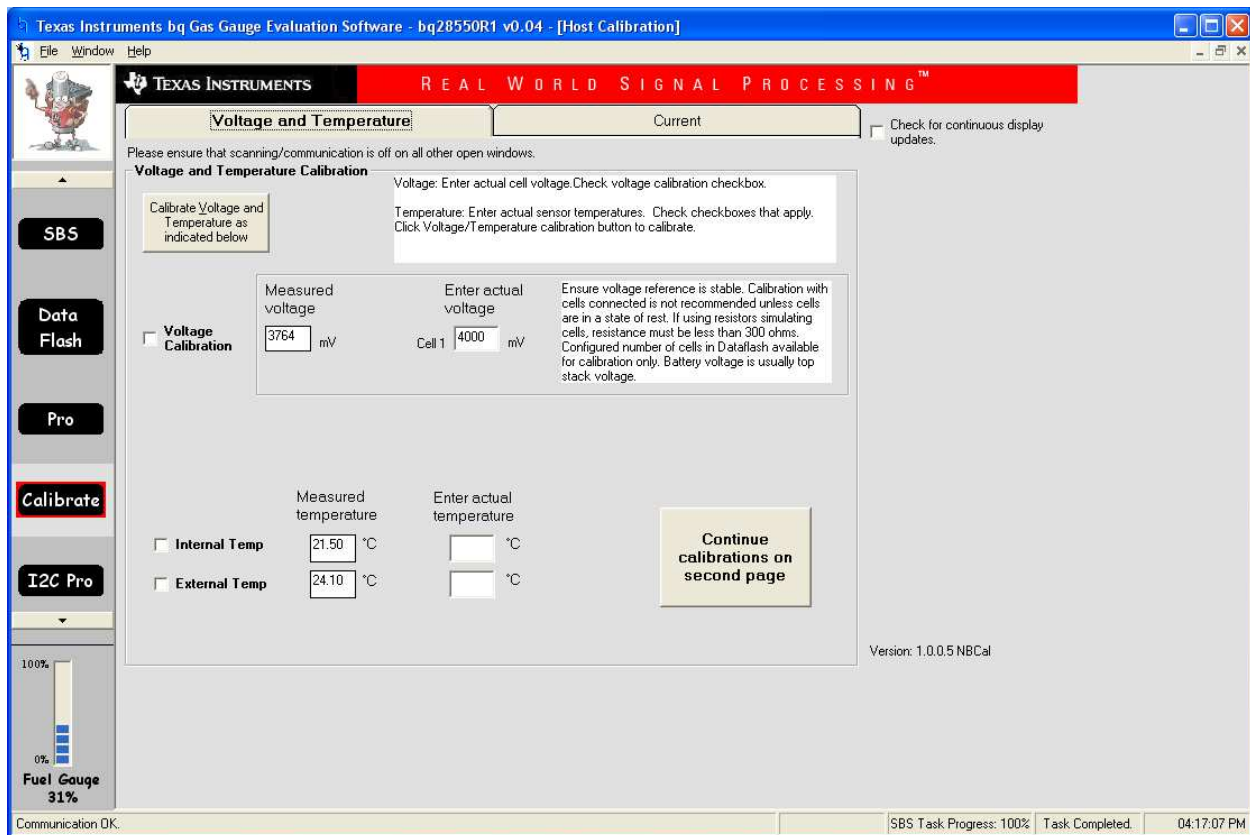


Figure 9. Voltage and Temperature Calibration Screen

8.3 CC Offset Calibration

Select the **Current** tab. **CC Offset Calibration** performs the internal calibration of the coulomb counter input offset.

8.4 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. Remove load/external voltage and short Pack- to Batt-.

Click the **Calibrate Board Offset** button.

8.5 Pack Current Calibration

Connect a load to Pack+/Load+ and Pack-/Load- that draws approximately 2 A. Measure the current and type the value into Enter Actual Current using (-) for current in discharge direction.

Click the **Calibrate Pack Current** button.

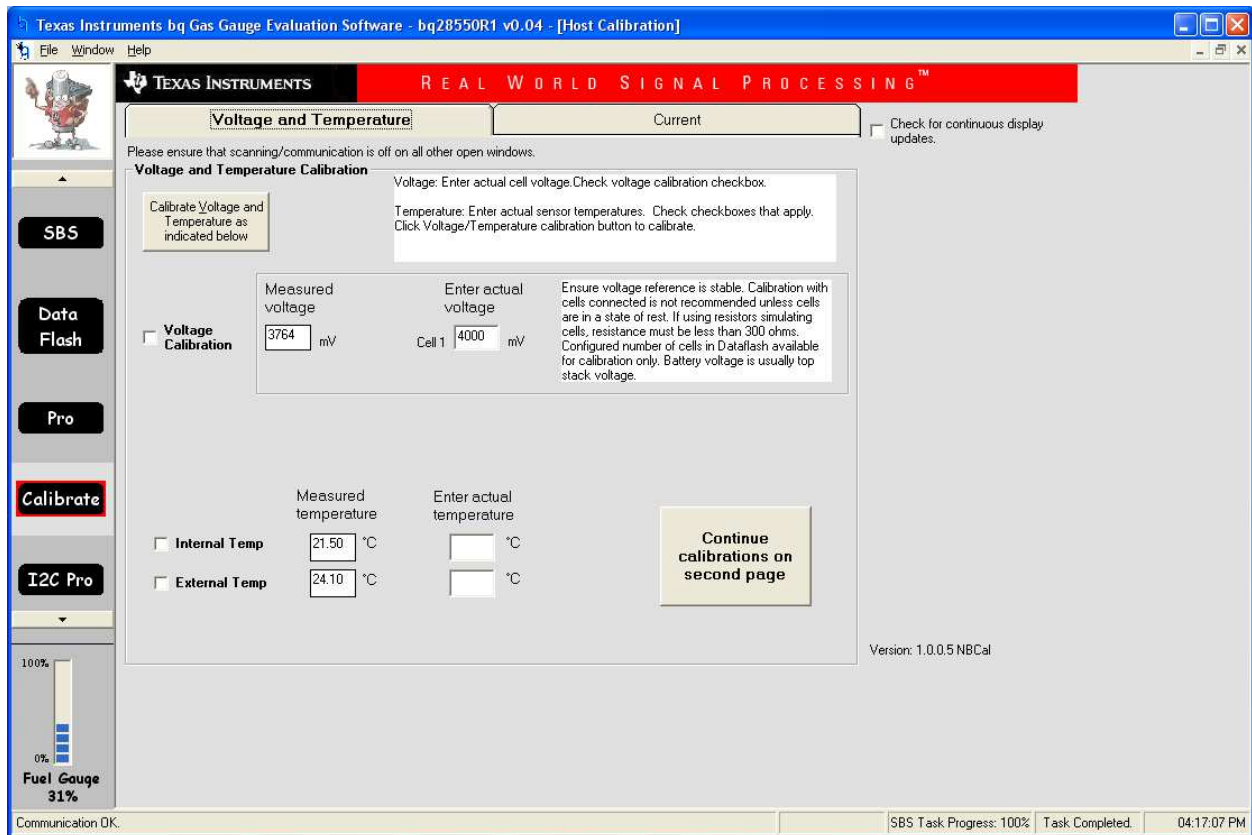


Figure 10. Current Calibration Screen

9 Pro (Advanced) Screen

9.1 SMB Communication

The set of read/write operations over the SMBus are not specific to any gas gauge. These are provided as general-purpose communication tools (Figure 11).

9.2 Hexadecimal/Decimal Converter

These two boxes convert between hexadecimal and decimal as soon as values are typed into the boxes. Invalid values may cause erroneous results.

When scaling converted hexadecimal values to a higher number of bytes, follow these rules:

- When **Unsigned** is selected, the left pad contains zeroes.
- When **Signed** is selected, the left pad contains zeroes for a positive number, or the left pad contains *F* for negative numbers.

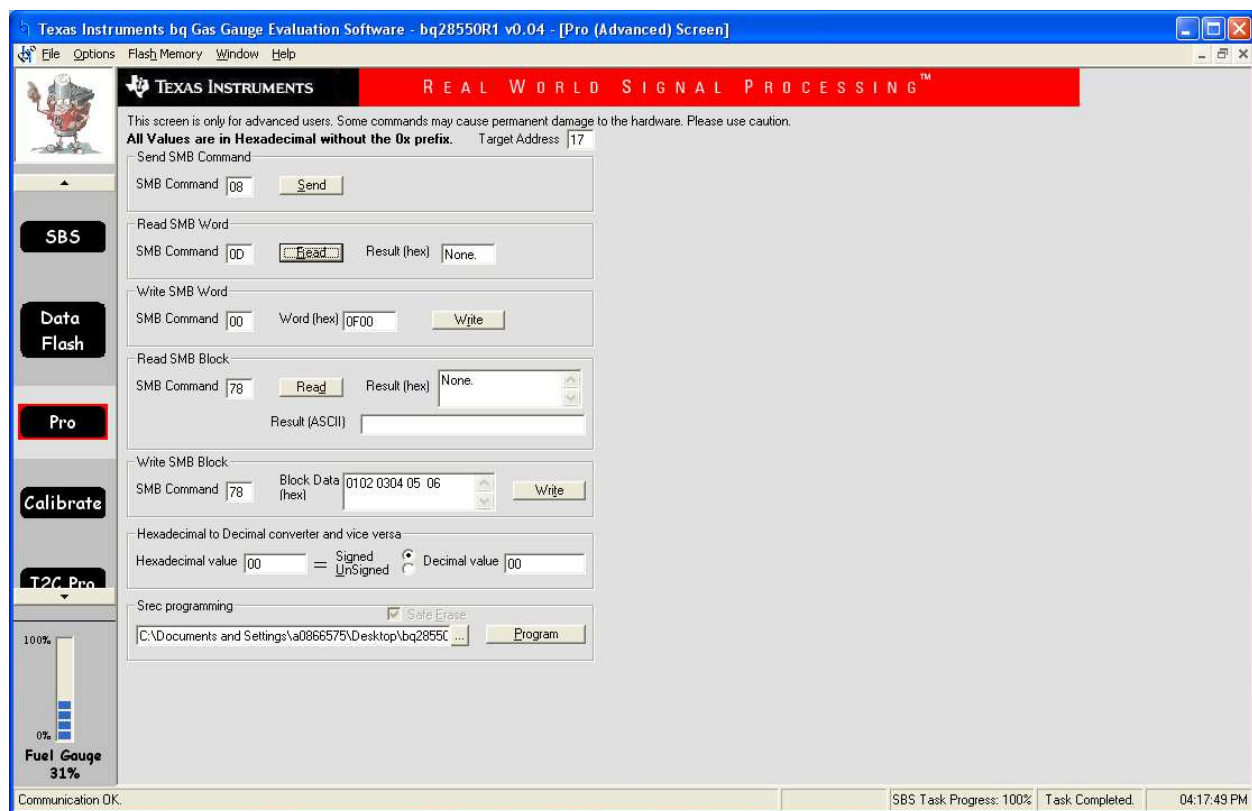


Figure 11. Pro (Advanced) Screen

10 I²C Pro (Advanced) Screen

10.1 I²C Communication

The read/write operations of the I²C Pro function is not specific to any gas gauge. These operations serve as general-purpose communication tools (Figure 12).

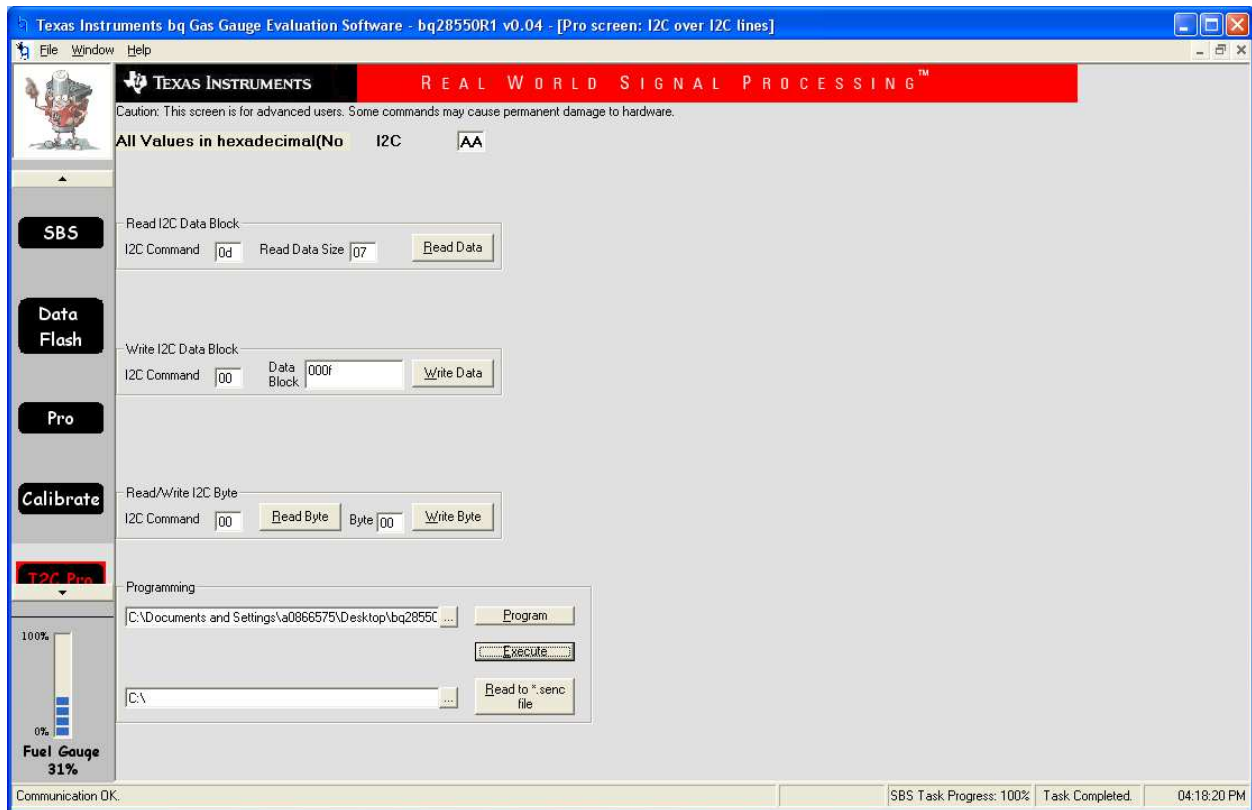


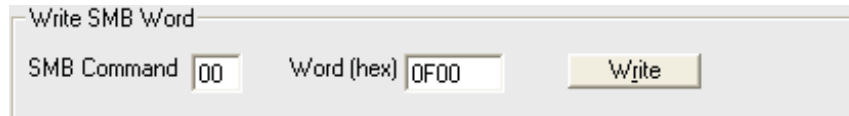
Figure 12. I²C Pro (Advanced) Screen

10.2 bq28550-R1 Programming

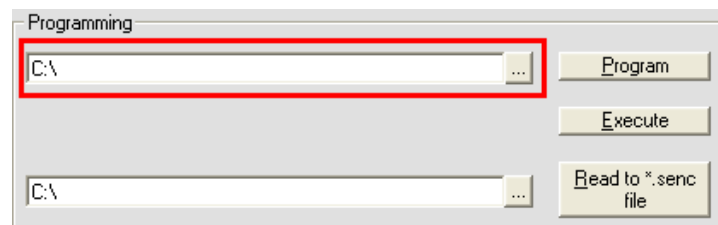
This screen allows device reprogramming from unencrypted and encrypted files.

10.3 Firmware Programming Procedure

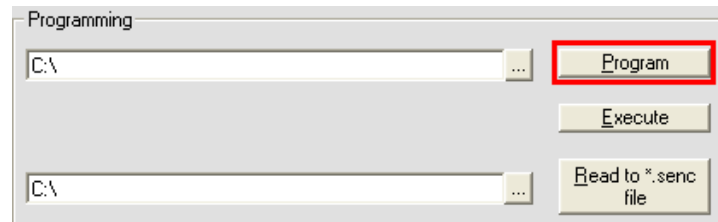
1. Ensure that jumpers J3 and J4 are shunted.
2. Connect J1 (EVM bus communication) to the SMBus connector of the EV2300 or EV2400.
3. Send command 0x0f00 to MAC (0x00) using **SMBus Pro** screen on EVSW.



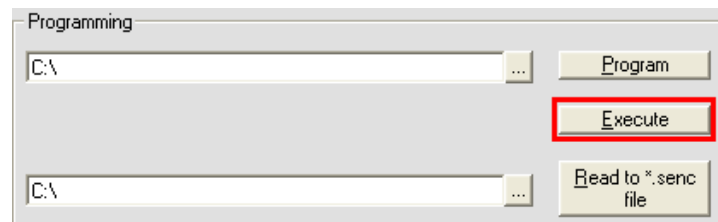
4. Disconnect J1 from the SMBus connector of the EV2300/EV2400, and connect to the I²C connector of EV2300/EV2400.
5. Click on the **I²C Pro** button on the EVSW to change to the **I²C Pro** screen.
6. Using the browse function, select the firmware for programming.



7. Click on the **Program** button to program the firmware.



8. Click **Execute Program** button on **I²C Pro** to bring the gauge to firmware mode.



9. Disconnect J1 from the I²C connector of the EV2300/EV2400 interface board, and connect to the SMBus connector of the EV2300/EV2400.
10. Click on the **SBS** tab to monitor the device. The device is now running in firmware mode.

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

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.

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

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REGULATORY COMPLIANCE INFORMATION

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.

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2. 実験局の免許を取得後ご使用いただく。
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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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EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

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.

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

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REGULATORY COMPLIANCE INFORMATION

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.

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Concernant les EVMs avec appareils radio

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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.

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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.

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2. 実験局の免許を取得後ご使用いただく。
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EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS

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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.
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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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In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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