User's Guide
SLUUB79–May 2015

bq27542-G1 Single-Cell Impedance Track™ Technology Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the bq27542. The EVM includes one bq27542 circuit module, a current sense resistor, and one thermistor. The circuit module includes one bq27542 integrated circuit (IC), and all other onboard components necessary to monitor and predict capacity. The circuit module connects directly across the cell in a battery. With the EV2400 interface board and software, the user can read the bq27542 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the bq27542 solution under different charge and discharge conditions.

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1 Features

- Complete evaluation system for the bq27542 gas gauge with Impedance Track™ Technology
- Populated circuit module for quick setup
- PC software and interface board for easy evaluation
- Software that allows data logging for system analysis

1.1 Kit Contents

- bq27542 circuit module
- bq27542EVM-696 tool folder for support documentation and evaluation software

1.2 Ordering Information

Table 1. Ordering Information

EVM Part Number	Chemistry	Configuration	Capacity
bq27542EVM-696	Li-ion	1 cell	14500 mAh or less

2 bq27542-Based Circuit Module

The bq27542-based circuit module is a complete and compact example solution of a bq27542 circuit for battery management. The circuit module incorporates a bq27542 battery gas gauge IC, 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 cells: CELL+ and CELL–
- To the serial communications ports (SDA, SCL) or HDQ
- The system load and charger connect across PACK+ and PACK–

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2.2 Pin Descriptions

PIN NAME	DESCRIPTION
PACK+	Pack positive terminal
PACK-	Pack negative terminal
CELL+	Cell positive terminal
CELL-	Cell negative terminal
SDA	I2C communication data line
SCL	I2C communication clock line
HDQ	Single wire communication line

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

This section contains the printed-circuit board (PCB) layouts, schematic, and bill of materials for the bq27542 circuit module.

3.1 Board Layout

This section shows the PCB layers (Figure 1 through Figure 4) for the bq27542 module.

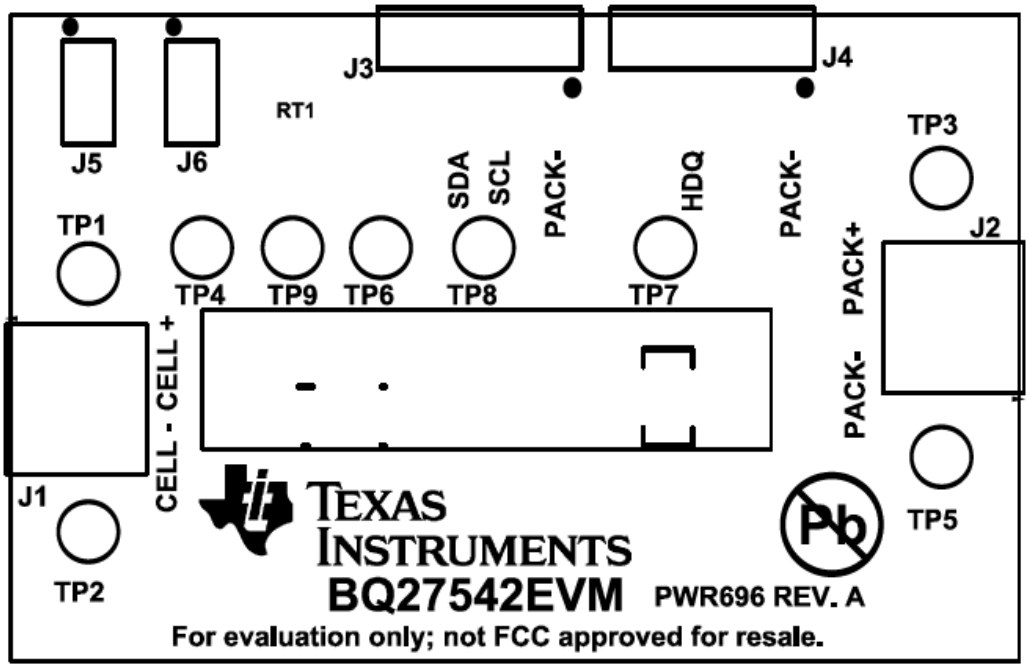


Figure 1. bq27542EVM-696 Layout, Silk Screen

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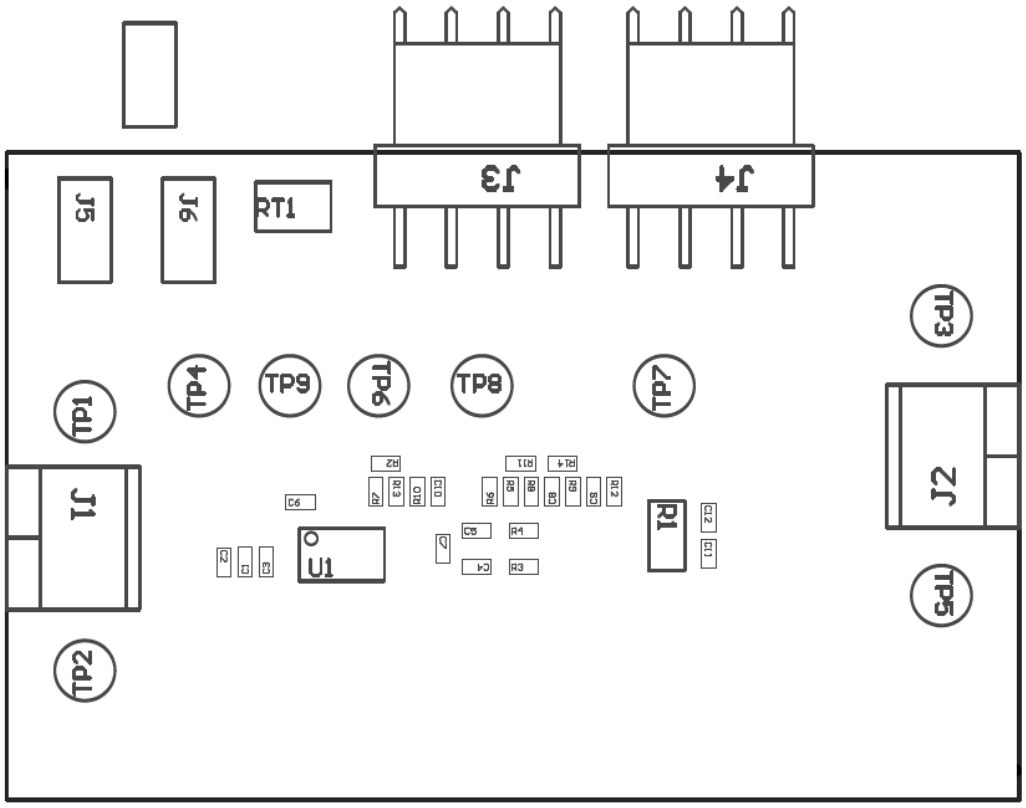


Figure 2. Top Assembly

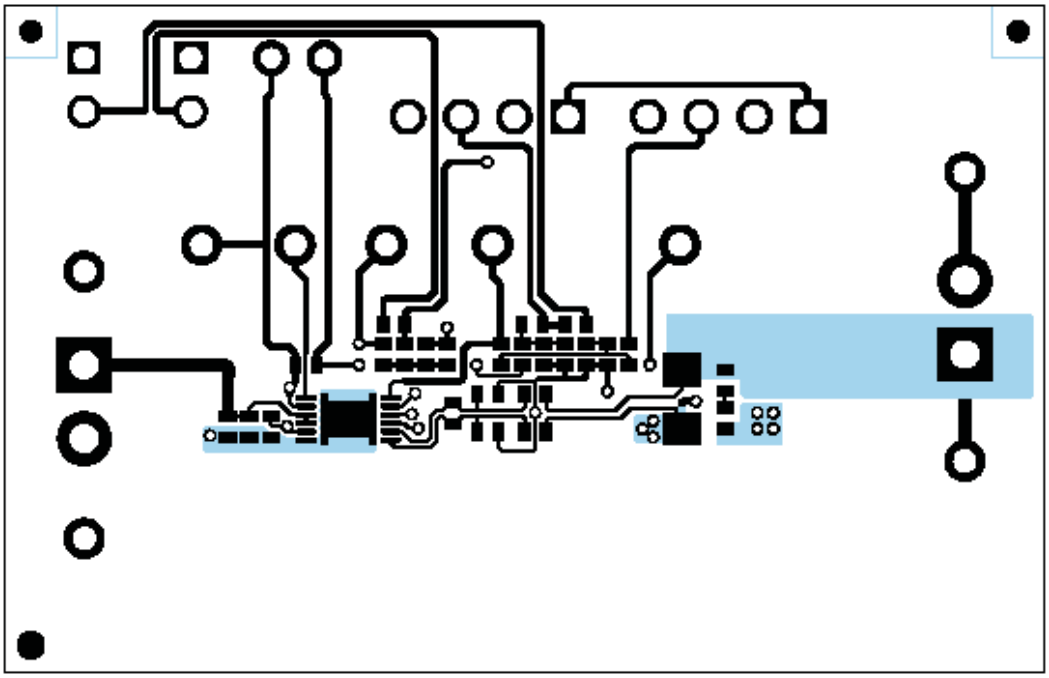


Figure 3. Top Layer

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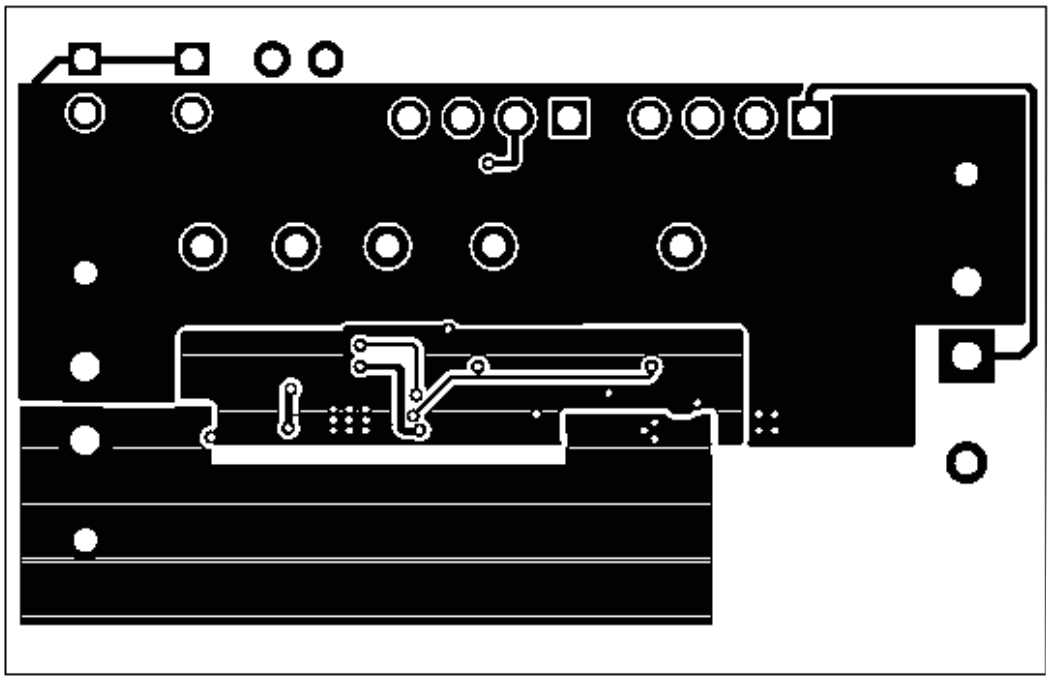


Figure 4. Bottom Layer

3.2 Bill of Materials

Table 2 lists the bq24572 bill of materials.

Table 2. Bill of Materials(1)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
C1, C2, C4, C5, C7, C11, C12	7	0.1 µF	CAP, CERM, 0.1 µF, 10 V, ±10%, X5R, 0402	0402	GRM155R61A104KA01D	Murata		
C3, C6	2	0.47 µF	CAP, CERM, 0.47 µF, 6.3 V, ±10%, X5R, 0402	0402	GRM155R60J474KE19D	Murata		
C8–C10	3	150 pF	CAP, CERM, 150 pF, 50 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1H151JA01D	Murata		
J1, J2	2		Terminal Block, 6A, 3.5mm Pitch, 2-Pos, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology		
J3, J4	2		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex		
J5, J6	2		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
R1	1	0.01	RES, 0.01, 1%, 1 W, 1206	1206	WSLP1206R0100FEA	Vishay-Dale		
R2, R14	2	10k	RES, 10 k, 5%, 0.063 W, 0402	0402	CRCW040210K0JNED	Vishay-Dale		
R3, R4, R11–R13	5	100	RES, 100, 5%, 0.063 W, 0402	0402	CRCW0402100RJNED	Vishay-Dale		
R5–R7	3	300	RES, 300, 5%, 0.063 W, 0402	0402	CRCW0402300RJNED	Vishay-Dale		
R8–R10	3	1.00Meg	RES, 1.00 M, 1%, 0.063 W, 0402	0402	CRCW04021M00FKED	Vishay-Dale		
RT1	1	10.0 kΩ	Thermistor NTC, 10.0 kΩ, 1%, Disc, 5x8.4 mm	Disc, 5x8.4 mm	103AT-2	SEMITEC Corporation		
TP1–TP9	9	Black	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone		
U1	1		Single Cell Li-Ion Battery Fuel Gauge for Battery Pack Integration, DRZ0012A	DRZ0012A	BQ27542DRZR-G1	Texas Instruments	bq27542DRZT-G1	Texas Instruments

(1) Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.

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3.3 Schematic

Figure 5 shows the bq27542 schematic.

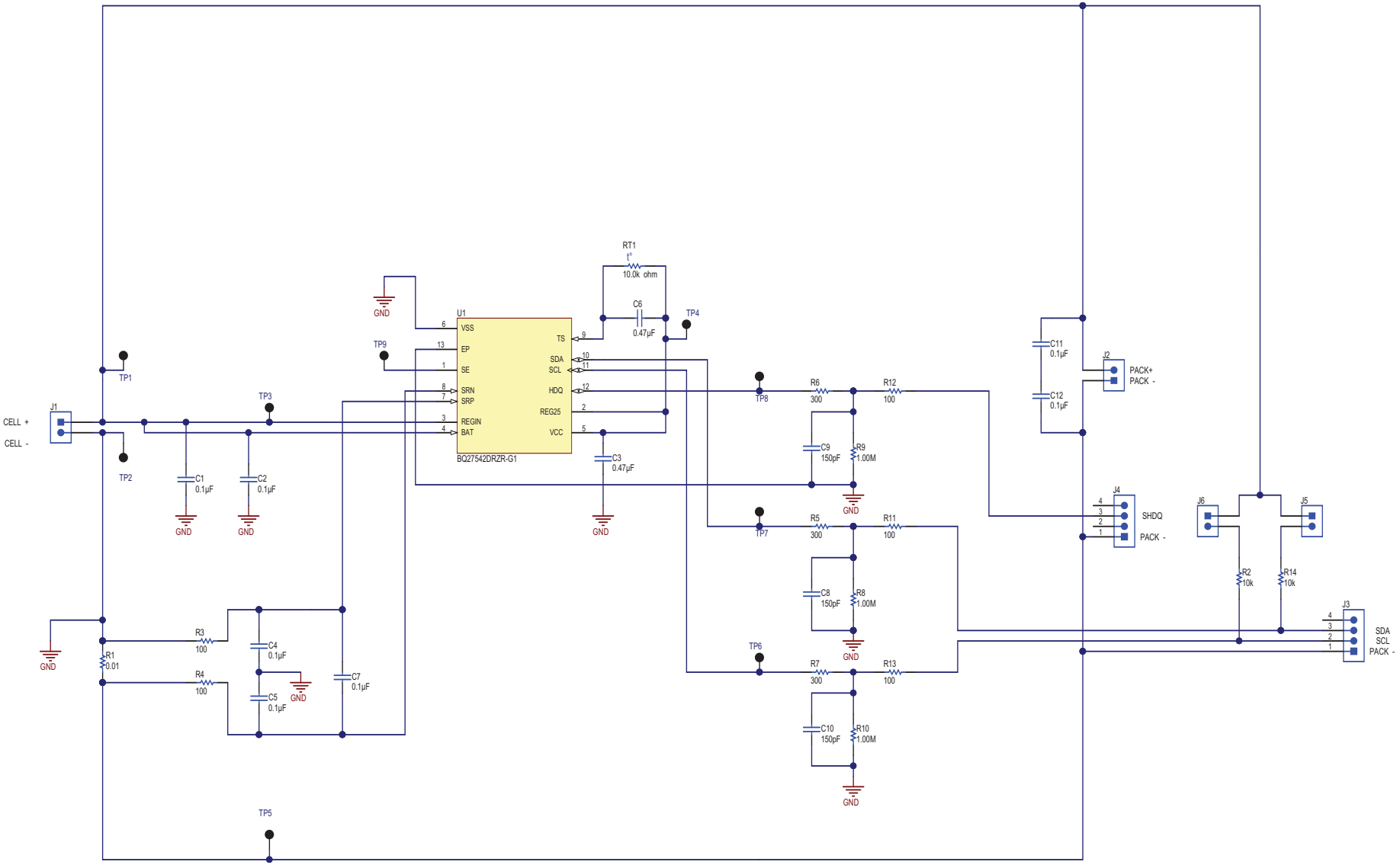


Figure 5. Schematic

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3.4 bq27542 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq27542 circuit module.

Table 3. Performance Specification Summary

Specification	Min	Typ	Max	Unit
Input voltage Pack+ to Pack–	2.7	3.6	5	V
Input voltage CELL+ to CELL–	2.7	3.6	5	
Charge and discharge current	0	1	2	A

4 EVM Hardware and Software Setup

This section describes how to install the bq27542EVM-696 PC software, and how to connect the different components of the EVM.

4.1 Software Installation

Find the latest software version in the bq27542 product folder on http://www.ti.com/. Search by product for bq27542 to access the product folder. Use the following steps to install Battery Management Studio:

1. Ensure that the EV2400 is not connected to the PC through a USB cable before starting this procedure.
2. Select the Tool and Software tab in the product folder.
3. Under the Software section, click on Battery Management Studio (bqStudio) Software Suite.
4. Click the **Download** button to download the software.
5. Download software to hard drive.
6. Double-click the software executable and follow all instructions and prompts.

5 Troubleshooting Unexpected Dialog Boxes

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

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6 Hardware Connection

The bq27542EVM-696 comprises three hardware components: the bq27542 circuit module, the EV2400 PC interface board, and the PC.

6.1 Connecting the bq27542 Circuit Module to a Battery Cell

The bq27542EVM-696 should be connected to a battery cell or power supply with a voltage not to exceed the maximum voltage specified in Table 3. The connection should be made between the CELL+ and CELL– terminals on the EVM. The Load/Charger should connect between the PACK+/PACK– terminals on the EVM.

6.2 PC Interface Connection

The bq27542 can be configured as an HDQ communication device or left in default as an I2C device. Once the bq27542 is configured for HDQ communication, it cannot be reverted to I2C mode.

The following steps configure the hardware for interfacing to the PC:

1. Connect the bq27542-based pack to the EV2400 using wire leads as shown in Table 4.

Table 4. Circuit Module to EV2400 Connections – I2C

bq27542-Based Battery (I2C mode)	EV2400 (I2C port)
SDA	SDA
SCL	SCL
PACK-	VSS

Table 5. Circuit Module to EV2400 Connections – HDQ

bq27542-Based Battery (HDQ mode)	EV2400 (HDQ port)
HDQ	SDA
PACK–	VSS

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

The bq27542EVM-696 is now set up for operation.

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7 Operation

This section details the operation of the bq27542 evaluation software.

7.1 Starting the Program

Run bqStudio from the Start | All Programs | Texas Instruments | Battery Management Studio. The main screen (Figure 6) appears. Data begins to appear once the <Refresh> (single-time scan) button is clicked, or when the Scan button is clicked. To disable the scan feature, simply click the *Scan* button again.

The continuous scanning period can be set by opening Window | Preferences → Registers section. The range for this interval is 0 ms to 65,535 ms. Only items that are selected for scanning are scanned within this period.

Battery Management Studio provides a logging function which logs the values that were last scanned. To enable this function, select the *Start Log* button; this causes the *Scan* button to be pressed. When logging is *Stopped*, the *Scan* button will still be selected and has to be manually clicked again.

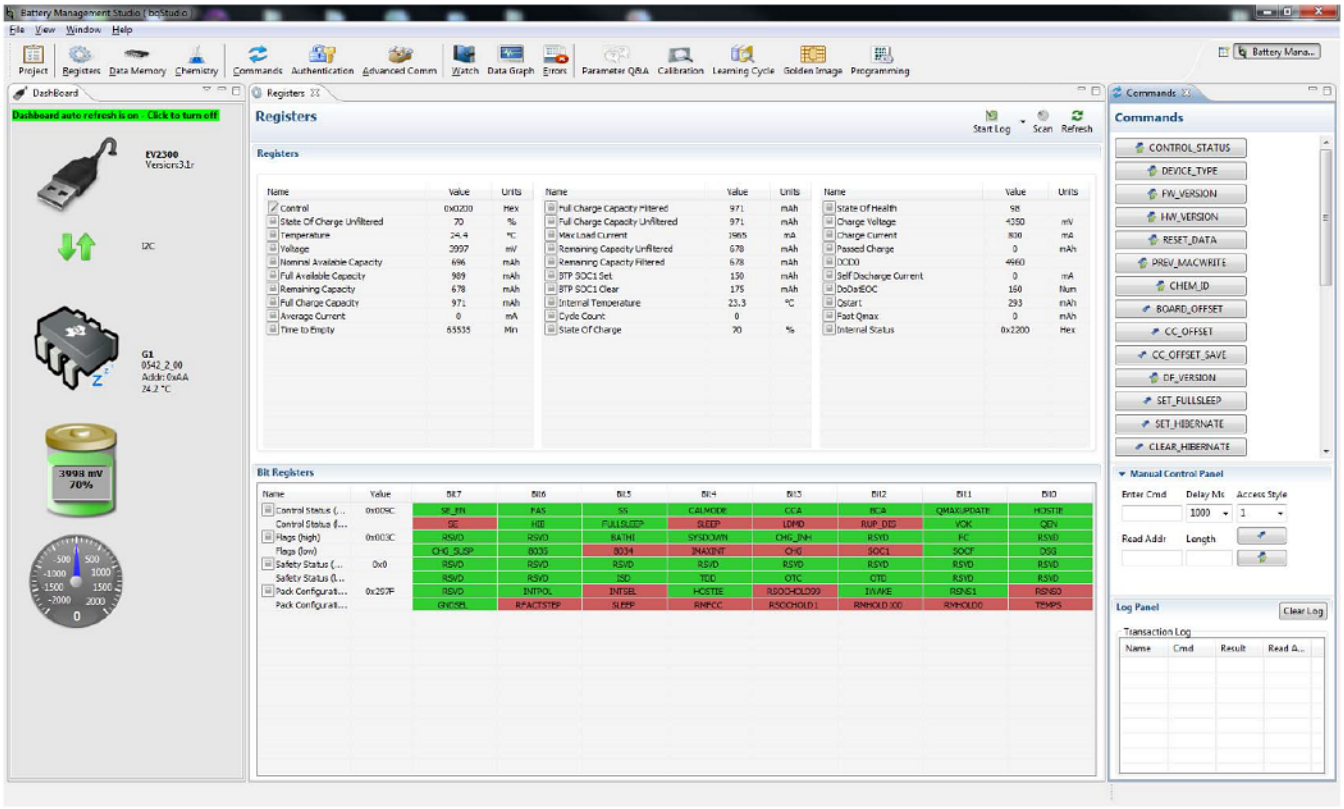


Figure 6. Registers Screen

This screen (Figure 6) shows the RAM data in the bq27542 device. Additional *Flags* and *Status* data can be viewed at the bottom of the Registers screen.

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7.2 Setting Programmable bq27542 Options

The bq27542 data memory comes configured per the default settings detailed in the bq27542 technical reference manual (SLUUB65). Ensure that the settings are correctly changed to match the pack and application for the bq27542 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 screen (Figure 7).

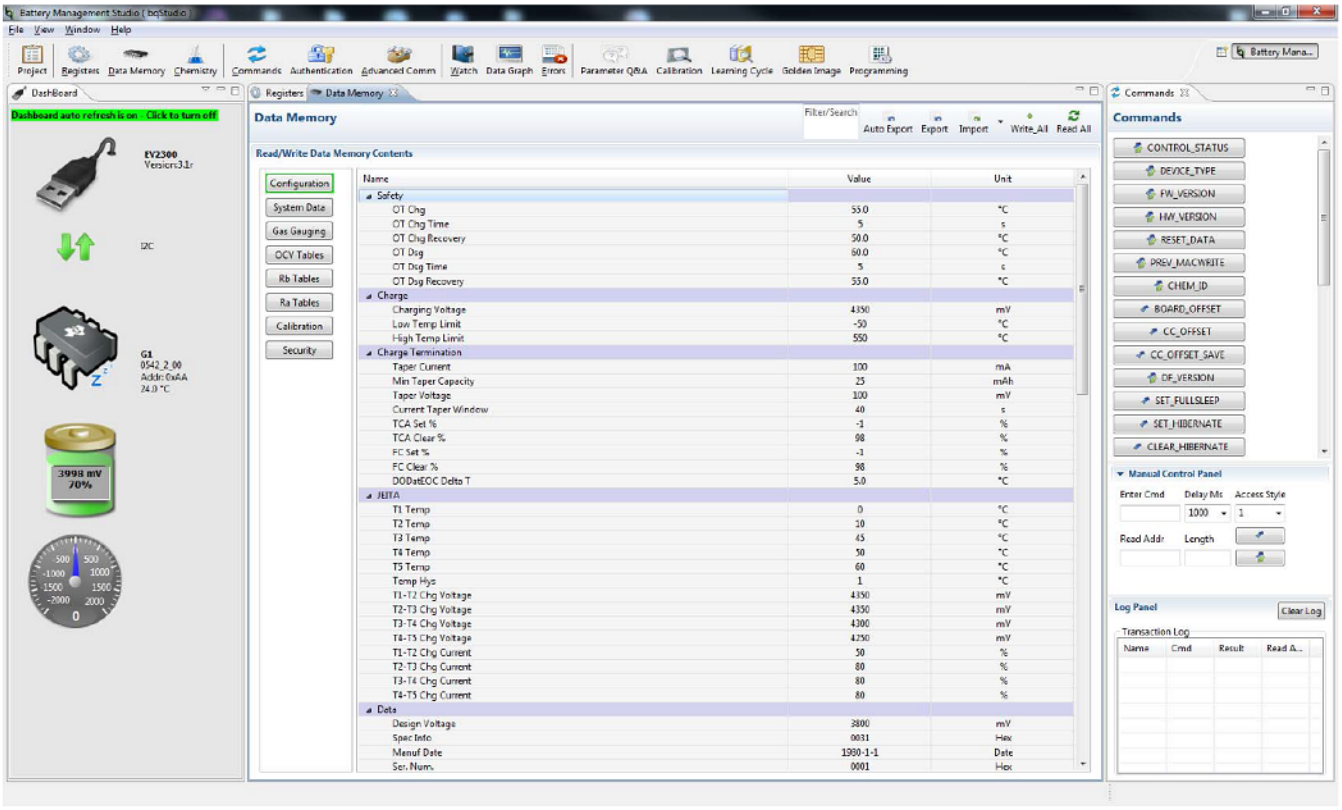


Figure 7. Data Memory Screen

To read all the data from the bq27542 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 press <Enter>, which writes the entire tab of flash data, or select menu option | Data Flash | Write All |. The data flash must be read before any writes are performed to avoid any incorrect data being written to the device.

The | File | Special Export | menu options allows the data flash to be exported, 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 can also be retrieved in this way, imported, and written to the bq27542 using the | Write All | button.

The module calibration data is also held in the bq27542 data flash.

Battery Management Studio allows for an automatic data flash export function, similar to the Registers logging function. This feature, when selected via | Auto Export |, exports Data Flash to a sequential series of files named as *FilenameNNNNN.gg.csv* where N = a decimal number from 0 to 9.

The AutoExport interval is set under the | Window | Preferences → Data Memory | window with a default value of 1800 seconds. There is also the ability to select Classic or Default style. Classic is the standard .gg file that can be opened with typical notepad editors. Default style is the gg.csv which is a comma delimited file.

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When AutoExport is pressed, the Auto Export is in progress. The same button is used to turn on/off AutoExport. AutoExport is typically used for troubleshooting experiments, but is highly recommended for any experiment. The standard AutoExport interval is typically 30 minutes.

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 bq27542

Calibrate each item one at a time in the order presented in this document. Select the types of calibration to be performed by selecting the corresponding checkbox (see Figure 8).

Enter the measured values for the types selected, if necessary.

Then press the *Calibrate Part as indicated below* button. After all calibration is complete, close the Calibrate subwindow. While the Calibrate subwindow is open, even in the background, the calibration routines are running in firmware. Close the subwindow to ensure that they are stopped before proceeding with configuration or testing.

8.2 CC Offset Calibration

This performs the internal calibration of the coulomb counter input offset. Press the *Calibrate Coulomb Counter* button.

8.3 Voltage Calibration

- Measure the voltage across Pack+ and Pack– with a calibrated meter.
- Type the voltage value in mV into *Enter Actual Voltage*.
- Measure the temperature for PACK.
- Type the temperature value into Enter Actual Temperature.
- Press the *Calibrate Voltage and Temperature as indicated below* button.

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 and short Pack– to GND.
- Press the *Calibration Board Offset* button.

8.5 Temperature Calibration

Measure the temperature for PACK. Type the temperature value into Enter Actual Temperature. Select if the temperature sensor to calibrate is the internal or the external.

Press the *Calibrate Part as indicated below* button.

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8.6 Pack Current Calibration

- Connect a load to GND and SYS that draws approximately 1 A, or connect a current source to GND and Pack–. Ensure that the Measured Current reported is negative, or else reverse the connections.
- Measure the current with a calibrated meter, and type the value into *Enter Actual Current* using (–) for current in discharge direction.
- Press the *Calibrate Pack Current* button.

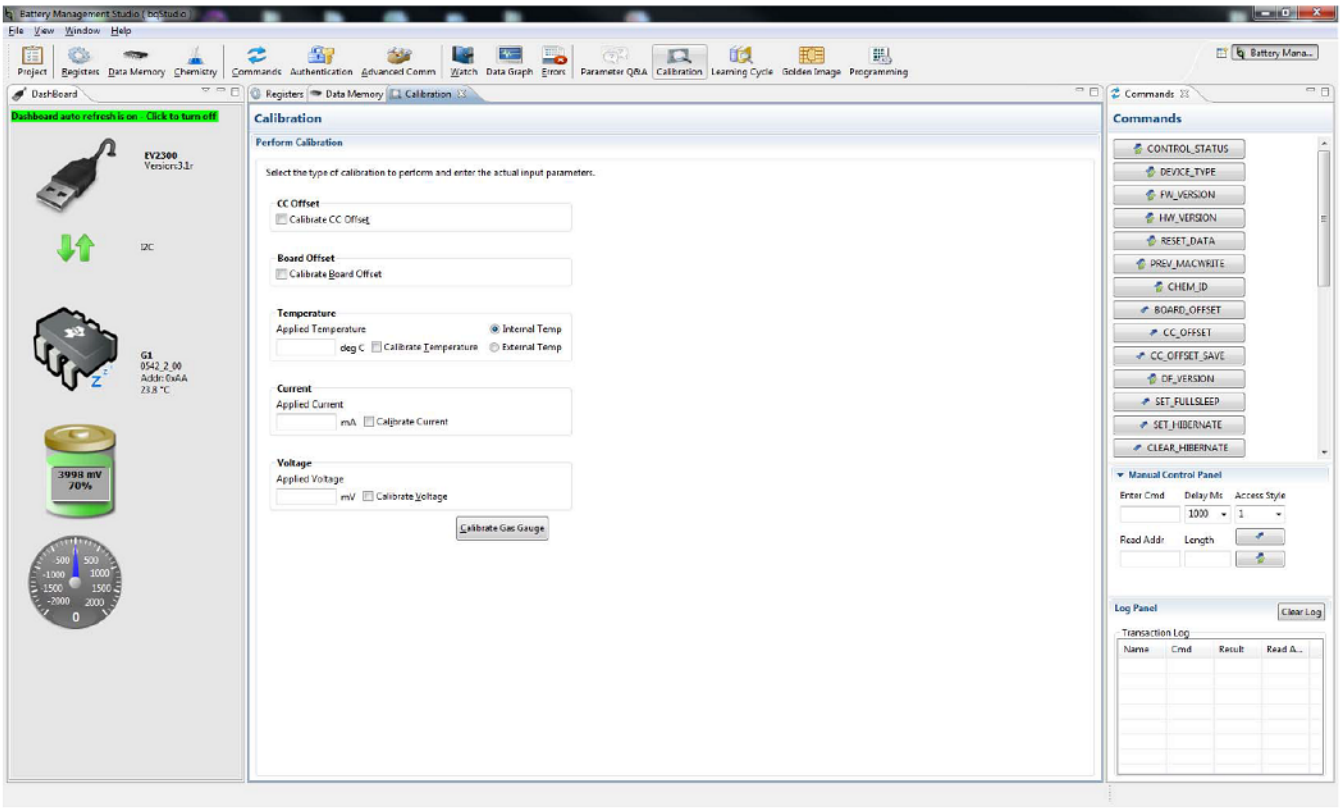


Figure 8. Calibration Screen

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9 Advanced Communication I2C

I²C Communication

The set of read/write operations over I2C are not specific to any gas gauge. These operations serve as general-purpose communication tools (Figure 9).

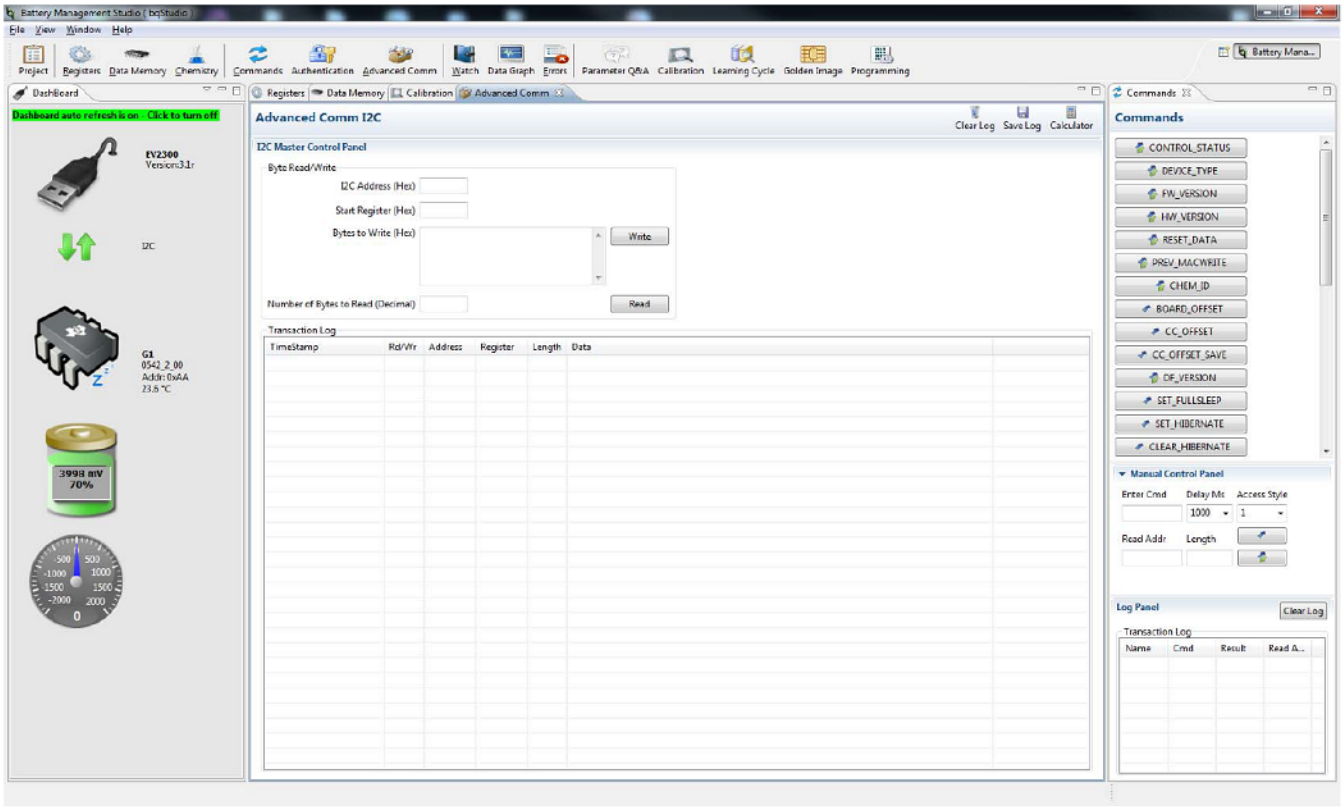


Figure 9. Advanced Comm I2C

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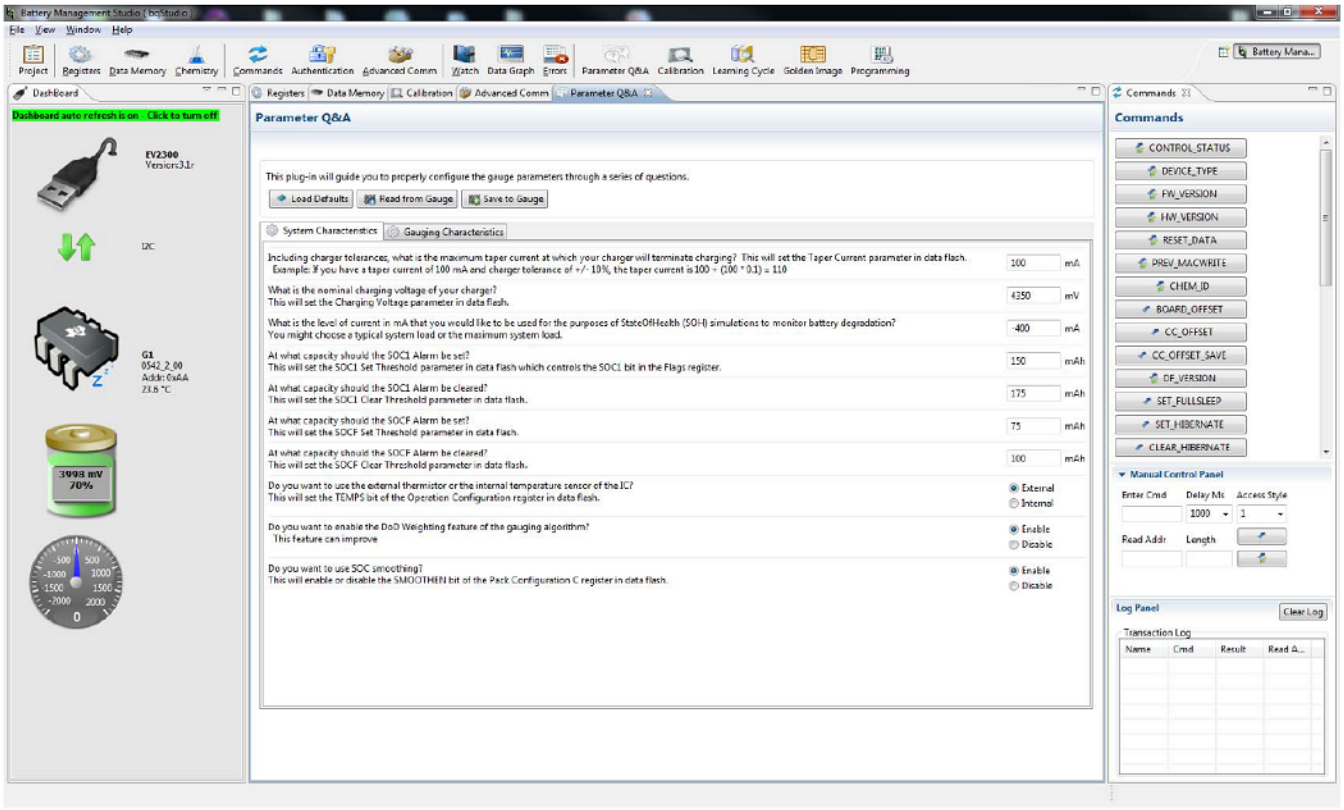


Figure 10. Parameter Q&A Screen

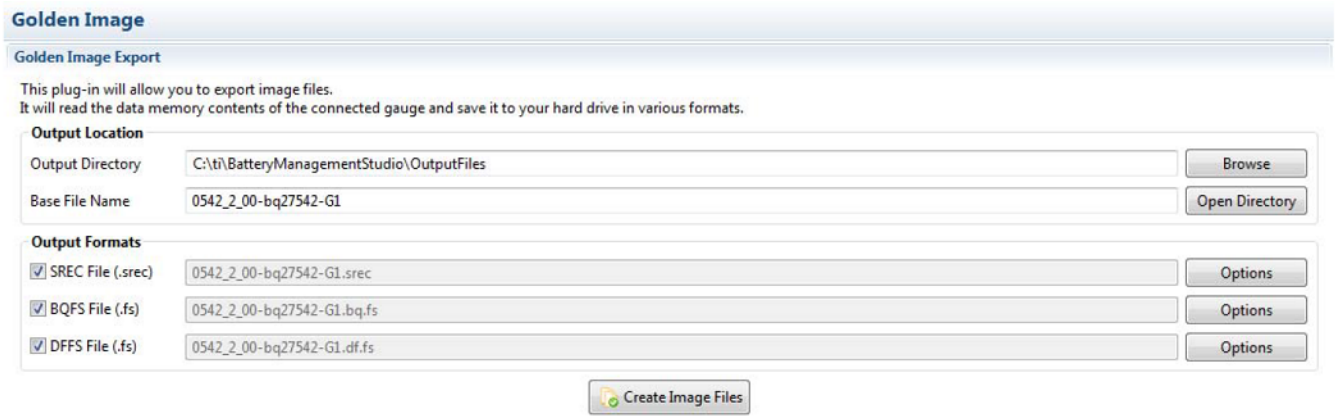


Figure 11. Golden Image Output Screen

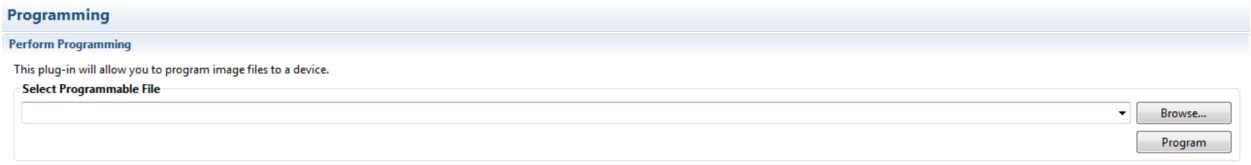


Figure 12. Perform Programming Screen

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10 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 Support Center at (512) 434-1560. 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.

- *bq27542, Single Cell Li-Ion Battery Fuel Gauge for Battery Pack Integration* data sheet (SLUSC33)

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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.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software

   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*:

   2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   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/lsds/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/lsds/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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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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:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should 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 also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure 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. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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