TEXAS INSTRUMENTS

User's Guide

SLUU426B–June 2010–Revised July 2016

bq27520EVM With System-Side, Single-Cell Impedance Track™ Technology

This evaluation module (EVM) is a complete evaluation system for the bq27520. The EVM includes one bq27520 circuit module, a current sense resistor, and one thermistor. An EV2300 board is required to interface this EVM with the PC and can be purchased separately. The circuit module includes one bq27520 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 interface board and software, the user can read the bq27520 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the bq27520 solution under different charge and discharge conditions. The latest Microsoft® Windows® based PC software can be downloaded from the product folder on the Texas Instruments Web site.

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Microsoft, Windows are registered trademarks of Microsoft Corporation.

1 Features

- Complete evaluation system for the bq27520 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
- Ability to upgrade to the latest firmware version by flash reprogramming

1.1 Kit Contents

- bq27520 circuit module (HPA568)
- NTC103AT thermistor

This EVM is used for the evaluation of different bq27520-based products. Ensure that you visit the product Web folder at www.ti.com to download the latest firmware version, evaluation software, and documentation for the associated product to be evaluated.

1.2 Ordering Information

Table 1. Ordering Information

EVM PART NUMBER	CHEMISTRY	CONFIGURATION	CAPACITY
bq27520EVM	Li-ion	1 cell	Any

2 bq27520-Based Circuit Module

The bq27520-based circuit module is a complete and compact example solution of a bq27520 circuit for battery management. The circuit module incorporates a bq27520 battery gas gauge integrated circuit (IC) and all other components necessary to accurately predict the capacity of 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 (J2 or J3): PACK+, PACK–, and TS
- To the serial communications port (J8): 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 (J5): SOC_INT, BAT_GD, and BAT_LOW

2.2 Pin Descriptions

PIN NAME	DESCRIPTION
PACK+	Pack positive terminal
PACK–	Pack negative terminal
TS	Pack thermistor input that leads to IC TS pin
SDA	I^2C communication data line
SCL	I^2C communication clock line
VSS	Signal return for communication line, shared with charger and ground

PIN NAME	DESCRIPTION
CHG+/LOAD+	High potential of load or charger connection
CHG–/LOAD–	Low potential of load or charger connection (system VSS)
BAT_GD	Access to push-pull output that indicates that pack is ready to be connected to system
BAT_LOW	Access to push-pull output that signals low State-of-Charge (SOC)
SOC_INT	Access to open-drain output that signals interrupt for changes in SOC

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

This section contains the board layout, bill of materials, assembly drawings, and schematic for the bq27520 circuit module.

3.1 Board Layout

This section shows the printed-circuit board (PCB) layers (Figure 1 through Figure 4), assembly drawing, and schematic for the bq27520 module.

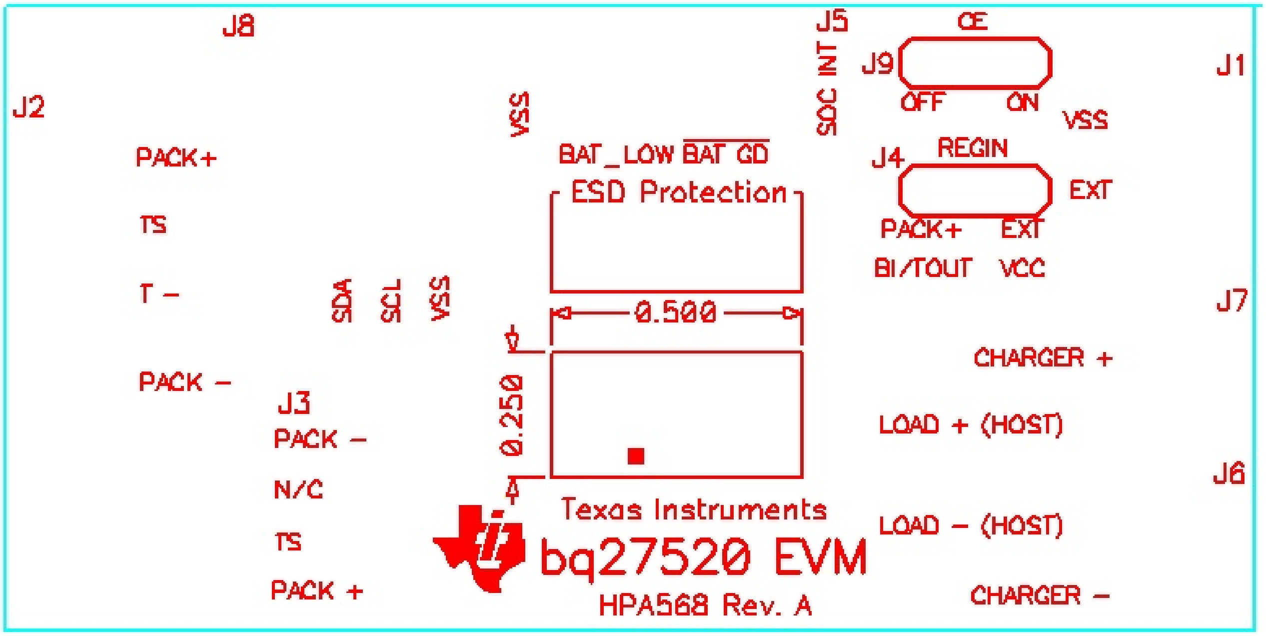


Figure 1. bq27520EVM-001 Layout – Silk Screen

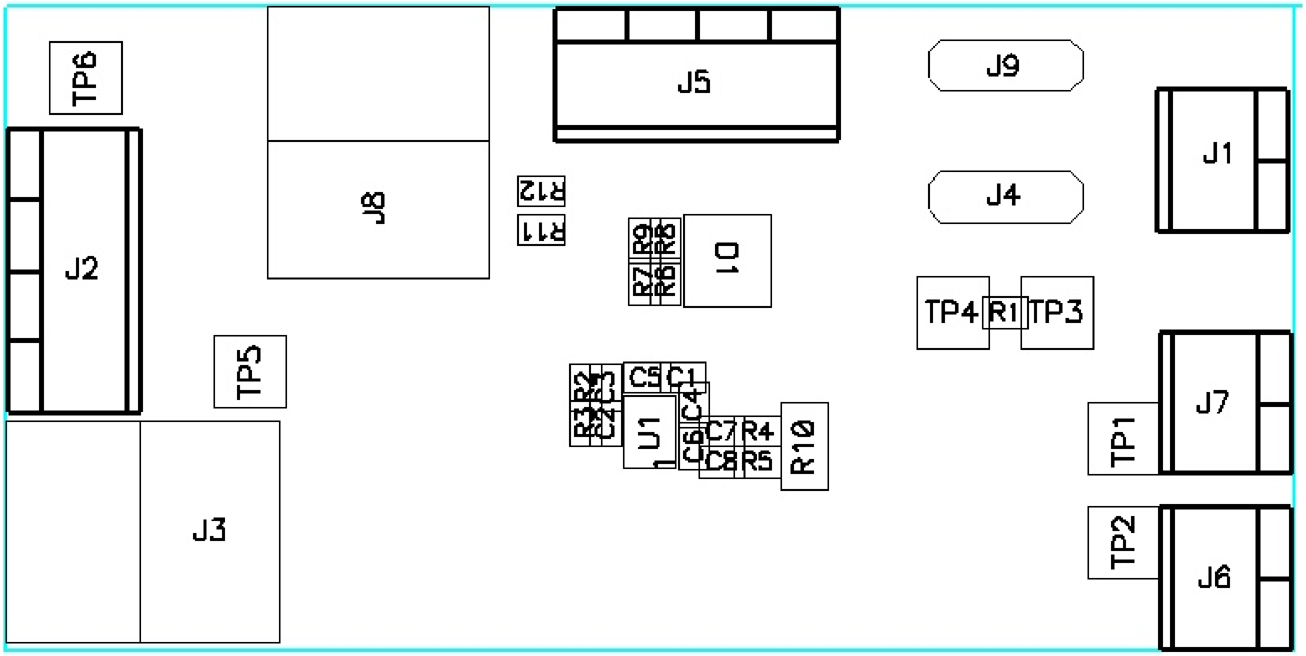


Figure 2. Top Assembly

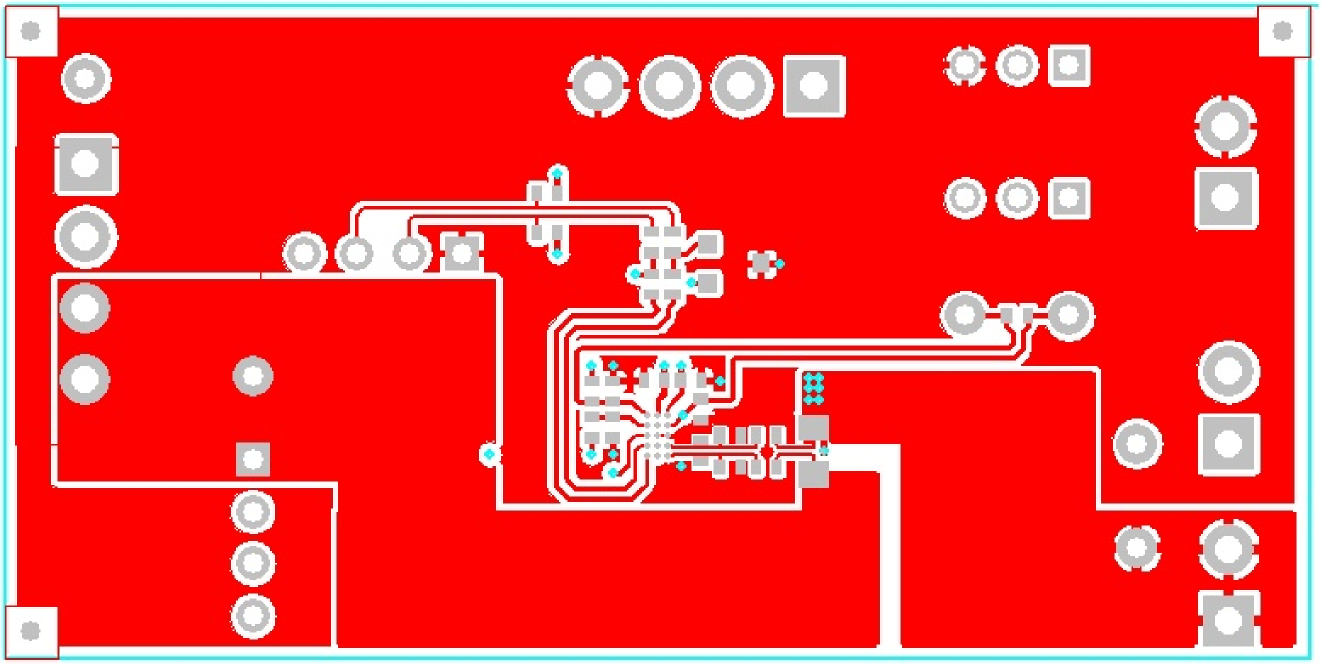


Figure 3. Top Layer

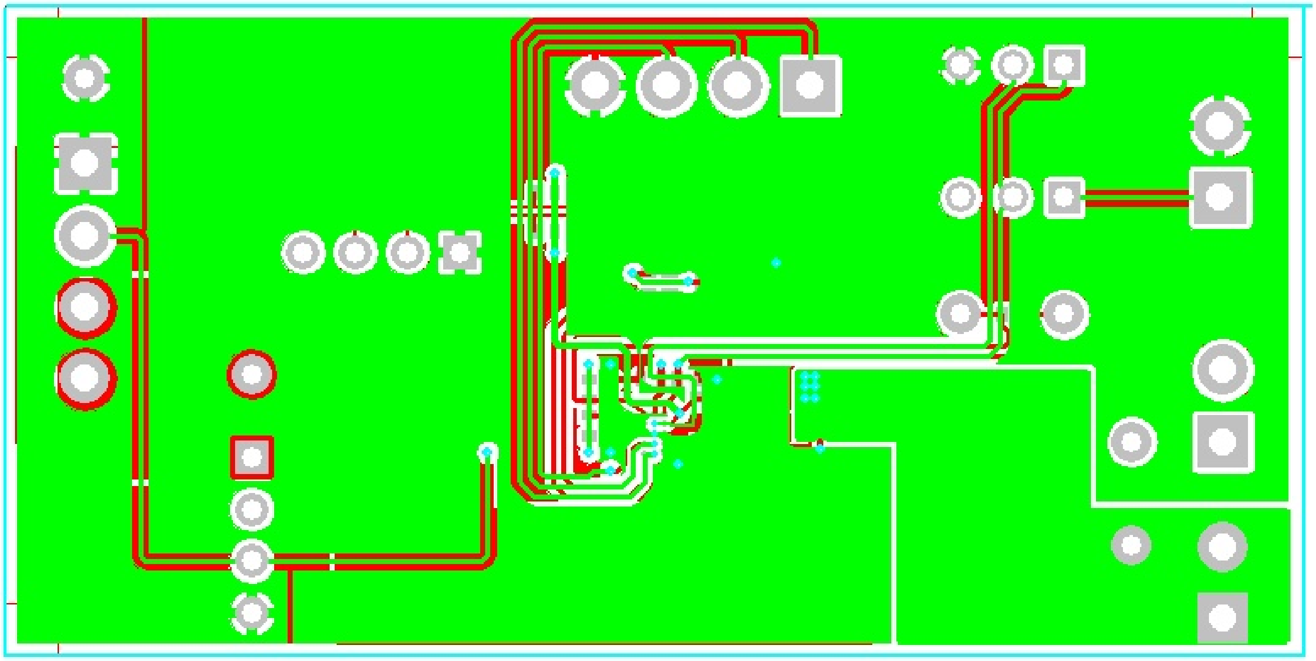


Figure 4. Bottom Layer

3.2 Bill of Materials and Schematic

Table 2. Bill of Materials

Count	Ref Des	Description	Size	MFG	Part Number
6	C1, C2, C5–C8	Capacitor, Ceramic, 0.1 µF, 10 V, X5R	0402	Murata	GRM155R61A104KA01D
1	C3	Capacitor, Ceramic, 33 nF, 10 V, X7R, +/-10%	0402	Murata	GRM155R71A333KA01D
1	C4	Capacitor, Ceramic, 1 µF, 6.3V, X5R	0402	Murata	GRM155R60J105KE19D
1	D1	Diode, Dual, Zener, 5.6 V, 300 mW	SOT23	Diodes	AZ23C5V6-7
3	J1, J6, J7	Terminal Block, 2-pin, 6 A, 3.5 mm	0.27 x 0.25 inch	OST	ED555/2DS
2	J2, J5	Terminal Block, 4-pin, 6 A, 3.5 mm	0.55 x 0.25 inch	OST	ED555/4DS
2	J3, J8	Header, Friction Lock Assy, 4-pin Right Angle,	0.400 x 0.500	Molex	22-05-3041
2	J4, J9	Header, Male 3-pin, 100-mil spacing, (36-pin strip)	0.100 inch x 3	Sullins	PEC36SAAN
1	R1	Resistor, Chip, 1.80 MΩ, 1/16 W, 5%	0402	Std	Std
1	R10	Resistor, Chip, 0.01 Ω, 1/4 W, 1%	0805	Vishay	WSL0805R0100FEA18
2	R11, R12	Resistor, Chip, 10 kΩ, 1/16 W, 5%	0402	Std	Std
1	R2	Resistor, Chip, 18.2 kΩ, 1/16 W, 5%	0402	Std	Std
1	R3	Resistor, Chip, 1 kΩ, 1/16 W, 5%	0402	Std	Std
6	R4–R9	Resistor, Chip, 100 Ω, 1/16 W, 5%	0402	Std	Std
3	TP1, TP3, TP6	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	Keystone	5000
2	TP2, TP5	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	Keystone	5001
1	TP4	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	Keystone	5002
1	U1	IC, System-Side Impedance-Track Fuel Gauge	BGA	Texas Instruments	BQ27520YZF

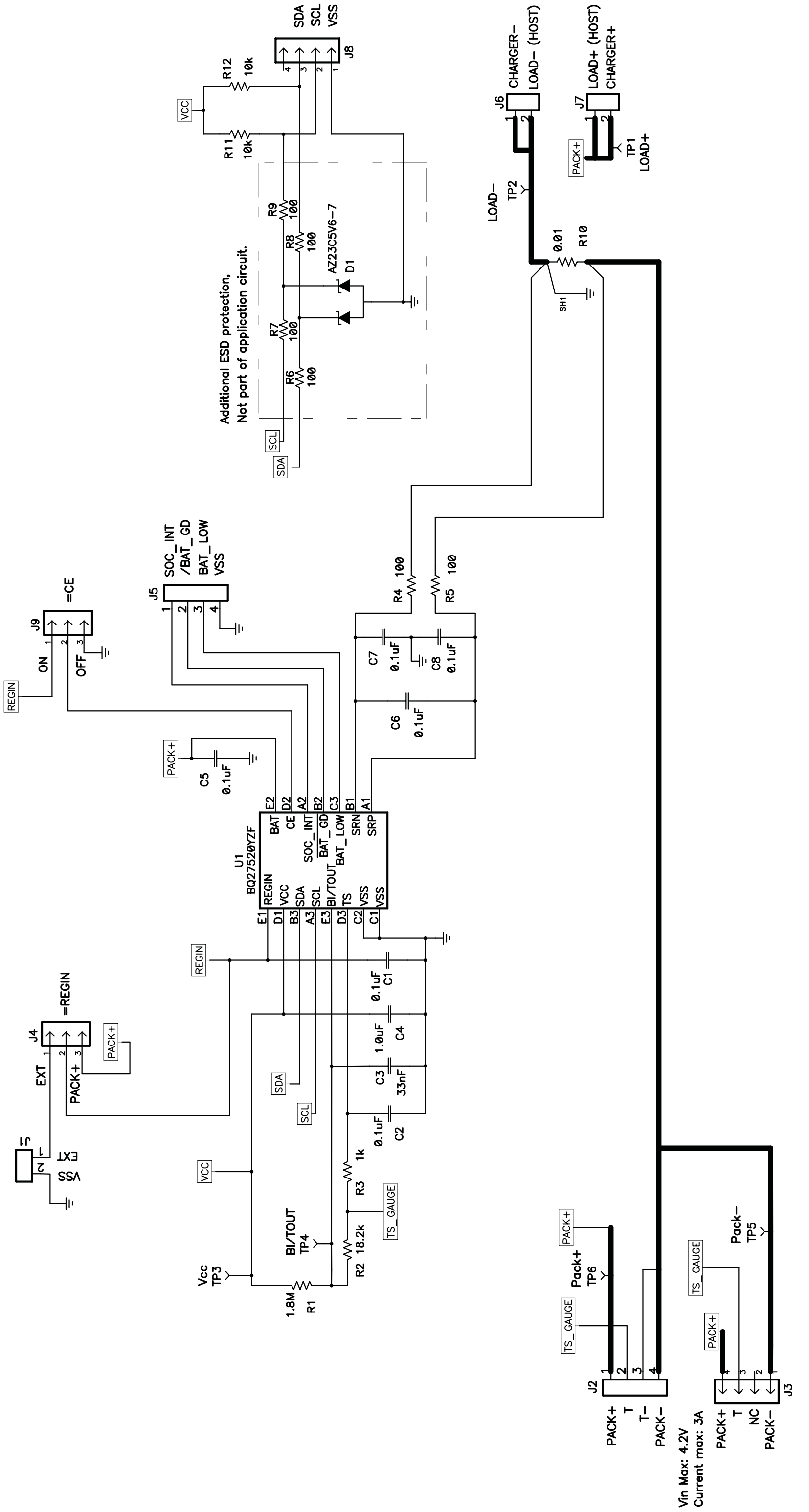


Figure 5. Schematic

3.3 bq27520 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq27520 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	1	2	A

4 EVM Hardware and Software Setup

This section describes how to install the bq27520EVM PC software and how to connect the different components of the EVM.

4.1 Software Installation

Find the latest software version at http://www.ti.com/tool/bqStudio. Use the following steps to install Battery Management Studio:

1. Ensure that the EV2300 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.

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

6 Hardware Connection

The bq27520EVM-001 comprises three hardware components: the bq27520 circuit module, the EV2300 PC interface board, and the PC.

6.1 Connecting the bq27520 Circuit Module to a Battery Pack

Figure 6 shows how to connect the bq27520 circuit module to the cells and system load/charger.

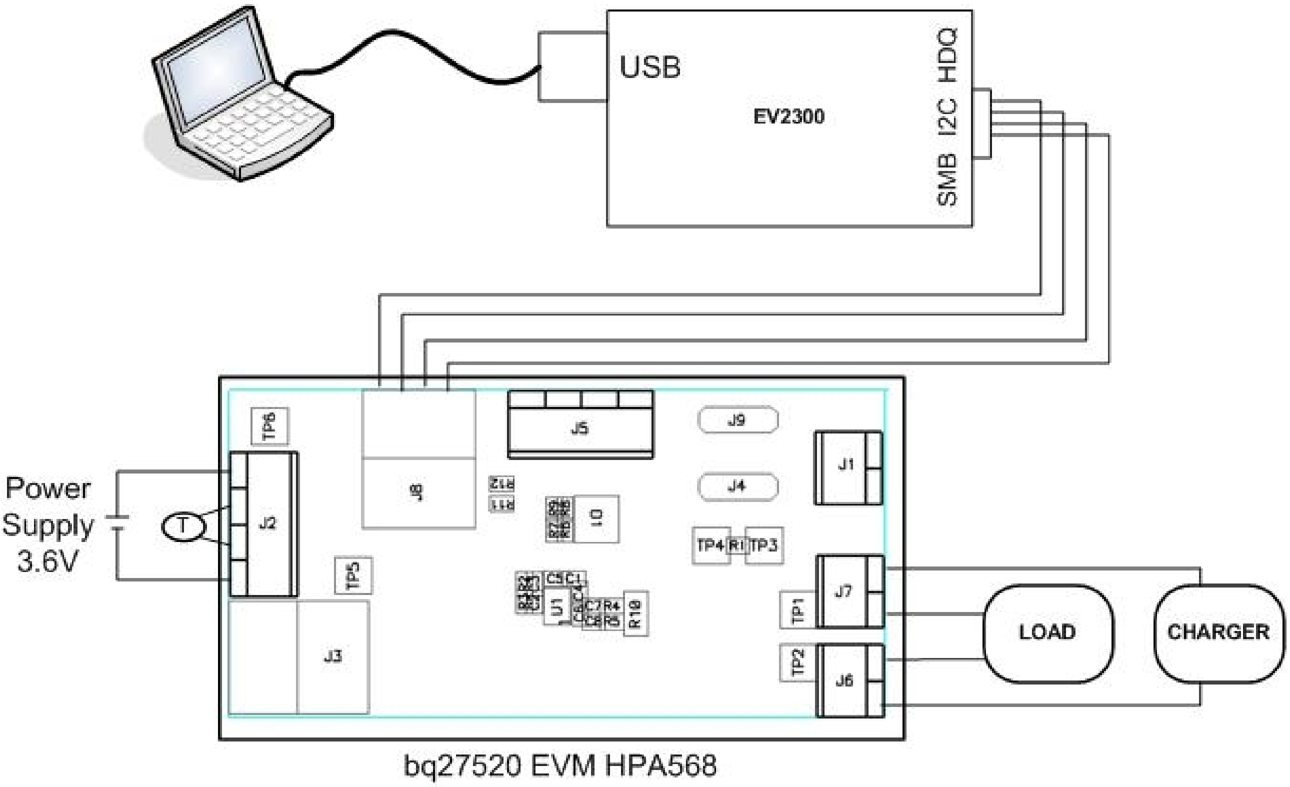


Figure 6. bq27520 Circuit Module Connection to Cell and System Load/Charger

6.2 PC Interface Connection

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

1. Connect the bq27520-based EVM to the EV2300 using wire leads as shown in Table 4.

Table 4. Circuit Module to EV2300 Connections

bq27520-Based Battery	EV2300
SDA	SDA
SCL	SCL
VSS	GND

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

The bq27520EVM-001 is now set up for operation.

7 Operation

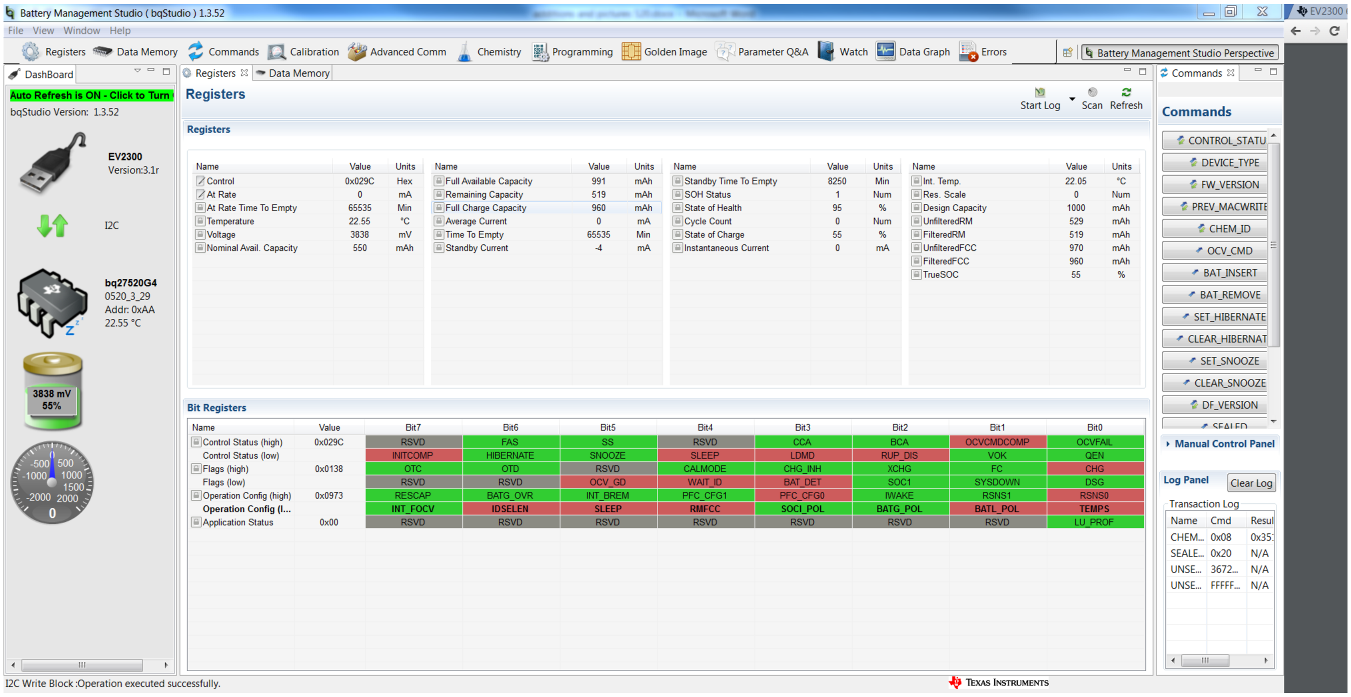
This section details the operation of the bqStudio software.

7.1 Starting the Program

Run bqStudio from the Start | All Programs | Texas Instruments | Battery Management Studio. The main screen (Figure 7) appears. If instead of Figure 7 appearing, Figure 8 appears, it may mean that the EVM is not connected to the computer correctly. Make sure that the USB interface (EV2300 or EV2400 or GDK) and the bq27520 are connected and restart bqStudio. If this still does not resolve the issue, check if the I^{2}C pull-up resistors are connected. 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.



Registers

Name	Value	Units
Control	0x029C	Hex
At Rate	0	mA
At Rate Time To Empty	65535	Min
Temperature	22.55	°C
Voltage	3838	mV
Nominal Avail. Capacity	550	mAh

Name	Value	Units
Full Available Capacity	991	mAh
Remaining Capacity	519	mAh
Full Charge Capacity	960	mAh
Average Current	0	mA
Time To Empty	65535	Min
Standby Current	-4	mA

Name	Value	Units
Standby Time To Empty	8250	Min
SOH Status	1	Num
State of Health	95	%
Cycle Count	0	Num
State of Charge	55	%
Instantaneous Current	0	mA

Name	Value	Units
Int. Temp.	22.05	°C
Res. Scale	0	Num
Design Capacity	1000	mAh
UnfilteredRM	529	mAh
FilteredRM	519	mAh
UnfilteredFCC	970	mAh
FilteredFCC	960	mAh
TrueSOC	55	%

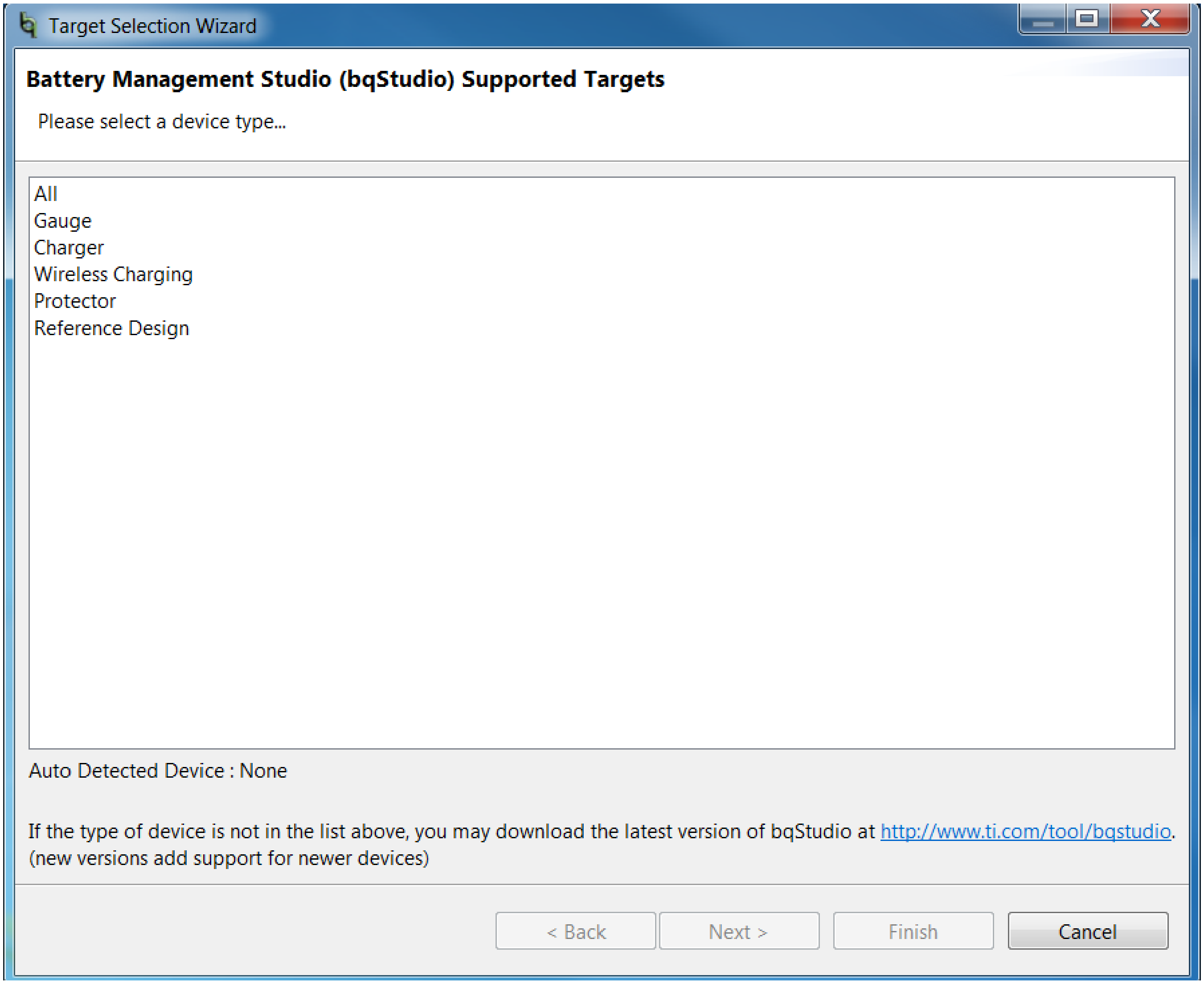
Bit Registers

Name	Value	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Control Status (high)	0x029C	RSVD	FAS	SS	RSVD	CCA	BCA	OCVCMDCOMP	OCVFAIL
Control Status (low)		INITCOMP	HIBERNATE	SNOOZE	SLEEP	LDMD	RUP_DIS	VOK	QEN
Flags (high)	0x0138	OTC	OTD	RSVD	CALMODE	CHG_INH	XCHG	FC	CHG
Flags (low)		RSVD	RSVD	OCV_GD	WAIT_ID	BAT_DET	SOC1	SYSDOWN	DSG
Operation Config (high)	0x0973	RESCAP	BATG_OVR	INT_BREM	PFC_CFG1	PFC_CFG0	IWAKE	RSNS1	RSNS0
Operation Config (l...		**INT_FOCV**	**IDSELEN**	**SLEEP**	**RMFCC**	**SOCI_POL**	**BATG_POL**	**BATL_POL**	**TEMPS**
Application Status	0x00	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	LU_PROF

I2C Write Block :Operation executed successfully.

Figure 7. Registers Screen

This screen (Figure 7) shows the RAM data in the bq27520 device. Additional *Flags* and *Status* data can be viewed at the bottom of the *Registers* screen.



Battery Management Studio (bqStudio) Supported Targets

Please select a device type...

All
Gauge
Charger
Wireless Charging
Protector
Reference Design

Auto Detected Device : None

If the type of device is not in the list above, you may download the latest version of bqStudio at http://www.ti.com/tool/bqstudio.
(new versions add support for newer devices)

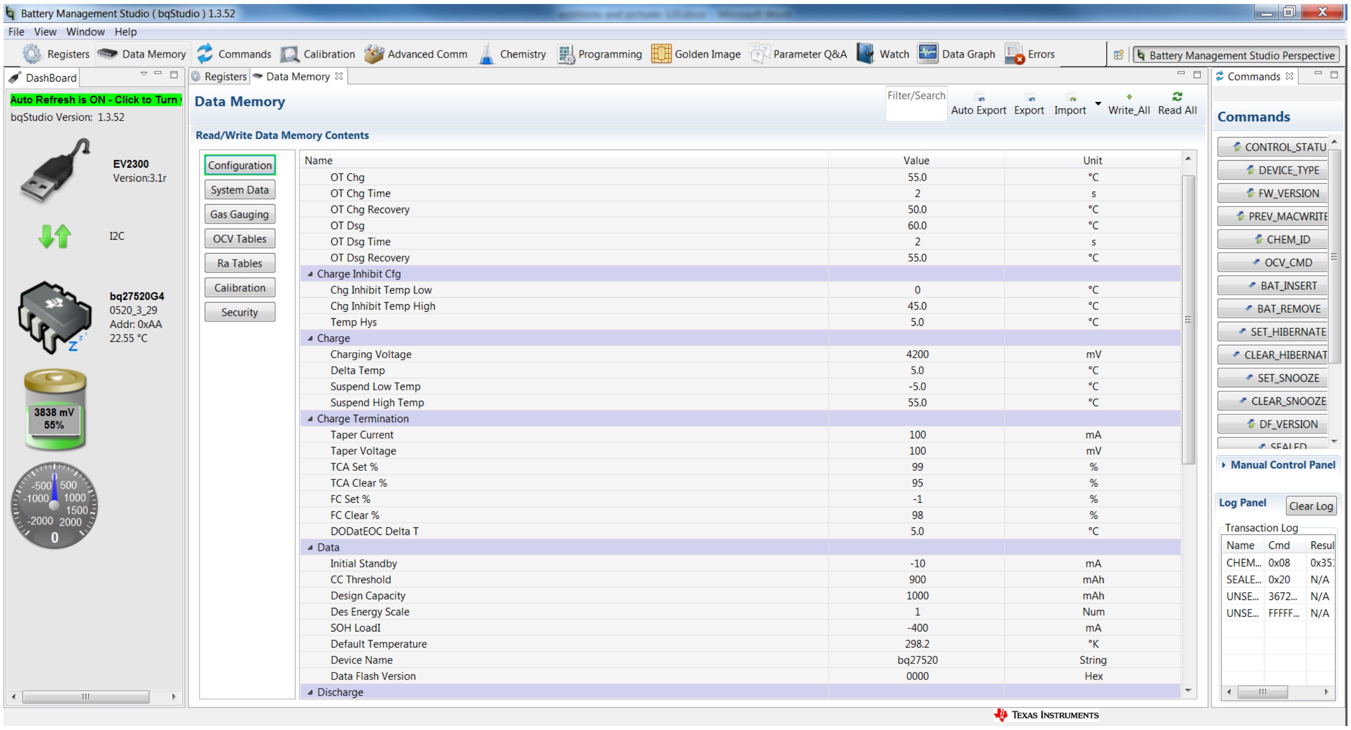
Figure 8. bqStudio Default Page

7.2 Setting Programmable bq27520 Options

The bq27520 data memory comes configured per the default settings detailed in the bq27520 technical reference manual (SLUUA35). Ensure that the settings are correctly changed to match the pack and application for the bq27520 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 9).



Name	Value	Unit
OT Chg	55.0	°C
OT Chg Time	2	s
OT Chg Recovery	50.0	°C
OT Dsg	60.0	°C
OT Dsg Time	2	s
OT Dsg Recovery	55.0	°C
Charge Inhibit Cfg		
Chg Inhibit Temp Low	0	°C
Chg Inhibit Temp High	45.0	°C
Temp Hys	5.0	°C
Charge		
Charging Voltage	4200	mV
Delta Temp	5.0	°C
Suspend Low Temp	-5.0	°C
Suspend High Temp	55.0	°C
Charge Termination		
Taper Current	100	mA
Taper Voltage	100	mV
TCA Set %	99	%
TCA Clear %	95	%
FC Set %	-1	%
FC Clear %	98	%
DODatEOC Delta T	5.0	°C
Data		
Initial Standby	-10	mA
CC Threshold	900	mAh
Design Capacity	1000	mAh
Des Energy Scale	1	Num
SOH LoadI	-400	mA
Default Temperature	298.2	°K
Device Name	bq27520	String
Data Flash Version	0000	Hex
Discharge		

Name	Cmd	Resul
CHEM...	0x08	0x35:
SEALE...	0x20	N/A
UNSE...	3672...	N/A
UNSE...	FFFF...	N/A

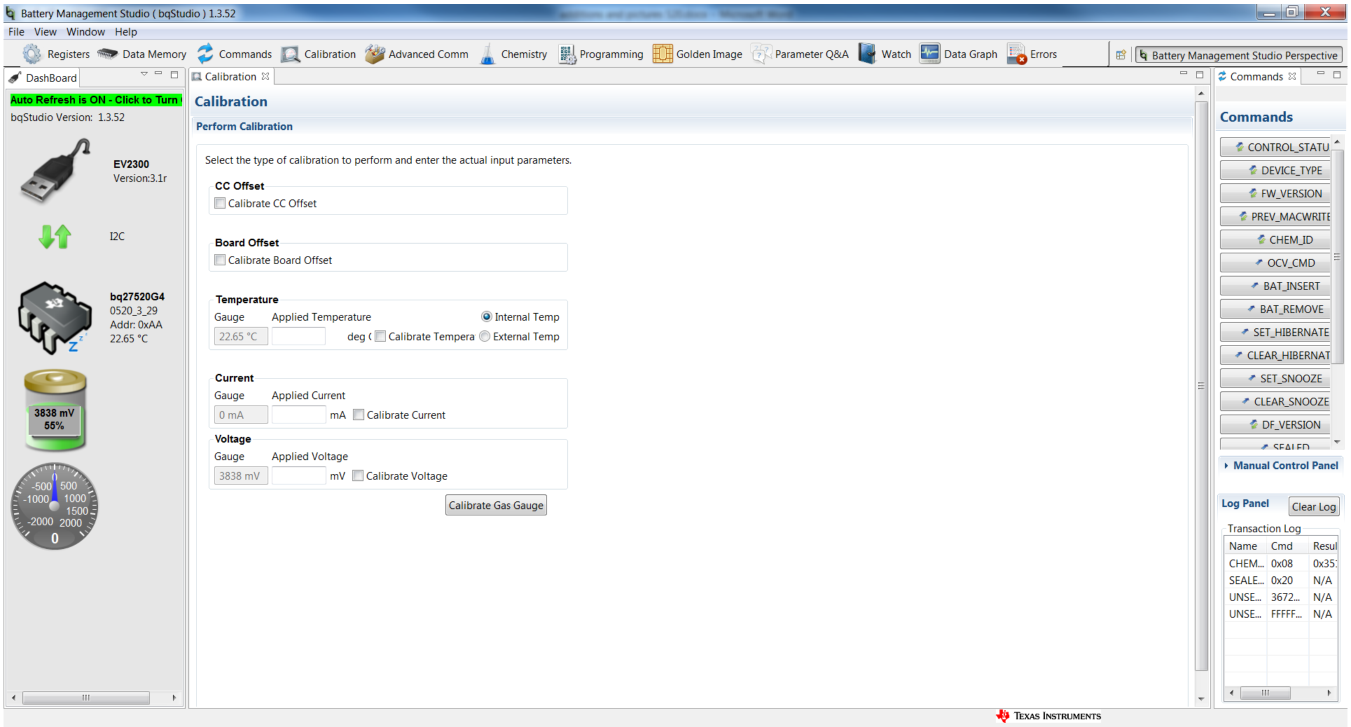
Figure 9. Data Memory Screen

To read all the data from the bq27520 non-volatile flash memory, click on the **Read All** button on the *Data Memory* window. Make sure the device is not sealed and in full access to read or write to the data memory. To update a parameter, click on the desired parameter and a window pops-up that provides details on the selected parameter. Next, enter the value in the value textbox and press **Enter**. After pressing **Enter**, bqStudio updates the selected parameter. The **Import** button in the *Data Memory* window can be clicked in order to import an entire configuration from a specified *.gg.csv file.

Save the configuration to a file by clicking the **Export** button in the *Data Memory* window and entering a file name. The configuration is saved to a *.gg.csv file. The module calibration data is also held in the bq27520 data memory. If the Gauge Dashboard is not displaying any information, then the bq27520 may not be supported by the bqStudio version being used, a bqStudio upgrade may be required.

8 Calibration

The bq27520EVM must be calibrated to ensure accurate value reporting. This can be done by going to the *Calibration* window in bqStudio (Figure 10).


Battery Management Studio (bqStudio) 1.3.52

Calibration

Perform Calibration

Select the type of calibration to perform and enter the actual input parameters.

CC Offset
☐ Calibrate CC Offset

Board Offset
☐ Calibrate Board Offset

Temperature
Gauge: 22.65 °C
Applied Temperature: deg C ☐ Calibrate Tempera
● Internal Temp ○ External Temp

Current
Gauge: 0 mA
Applied Current: mA ☐ Calibrate Current

Voltage
Gauge: 3838 mV
Applied Voltage: mV ☐ Calibrate Voltage

Auto Refresh is ON - Click to Turn
bqStudio Version: 1.3.52
EV2300 Version:3.1r
bq27520G4 0520_3_29 Addr: 0xAA 22.65 °C

Transaction Log

Name	Cmd	Resul
CHEM...	0x08	0x35
SEALE...	0x20	N/A
UNSE...	3672...	N/A
UNSE...	FFFF...	N/A

Figure 10. Calibration Window

8.1 *Calibrating the bq27520*

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 10).

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 you proceed with configuration or testing.

8.2 *CC Offset Calibration*

This performs the internal calibration of the coulomb counter input offset. Press the *Calibrate Gas Gauge as indicated below* 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.

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

8.4 Voltage Calibration

Use the following procedures to calibrate voltage:

- 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.

8.5 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 external.
- Press the *Calibrate Gas Gauge as indicated below* button.

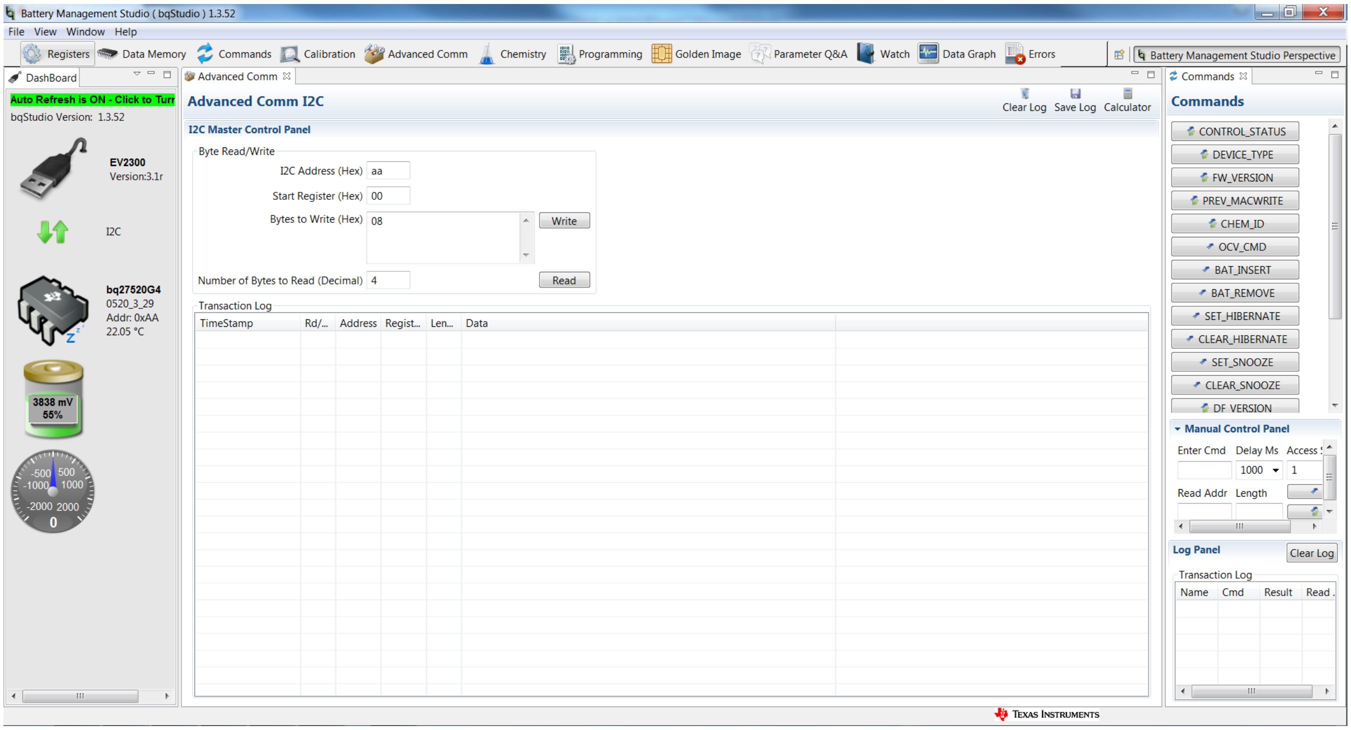
8.6 Pack Current Calibration

- Connect a load to LOAD– and LOAD+ that draws approximately 1 A, or connect a current source to LOAD– 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 Gas Gauge as indicated below* button.

9 Advanced Communication I^{2}C

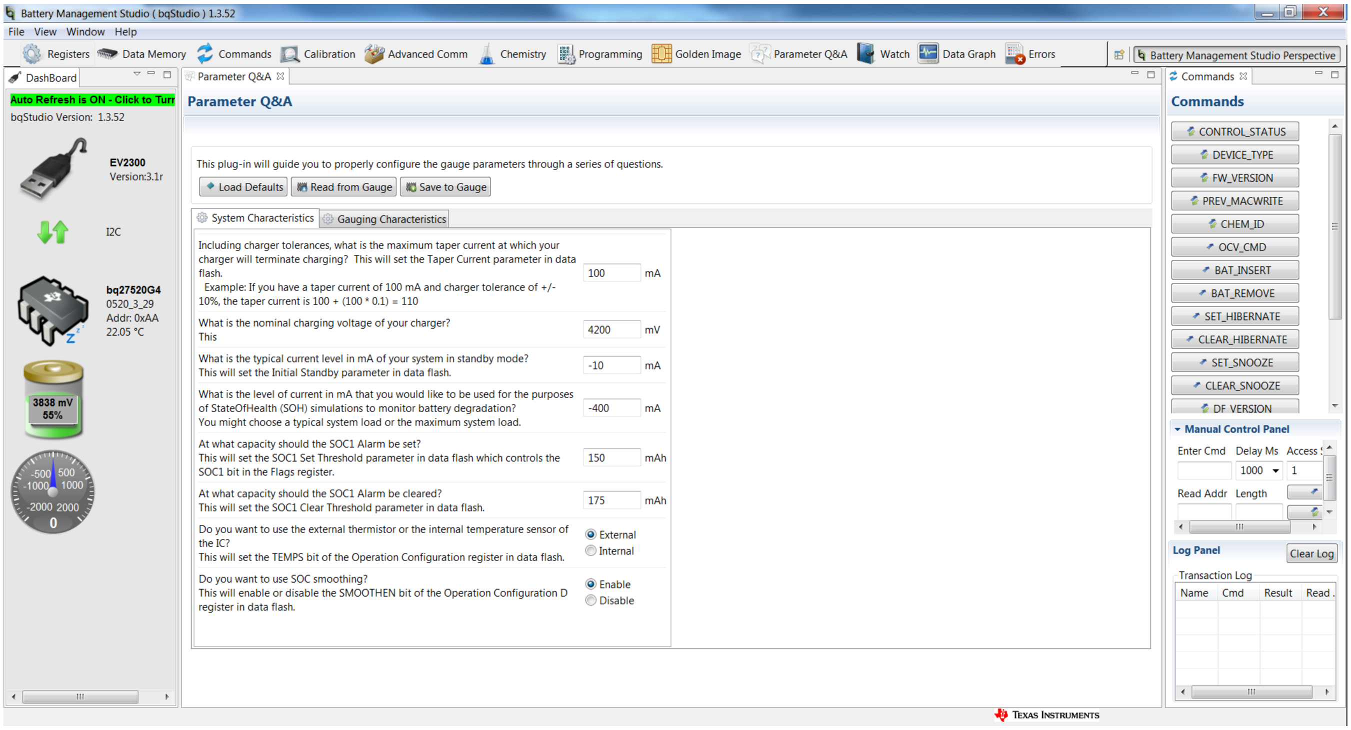
9.1 I^{2}C Communication

I^{2}C read/write operations are not specific to any gas gauge. These operations serve as general-purpose communication tools (Figure 11).



I2C Address (Hex) aa
Start Register (Hex) 00
Bytes to Write (Hex) 08
Number of Bytes to Read (Decimal) 4
Delay Ms 1000
Access 1

Figure 11. Advanced Communication I^{2}C



Parameter Q&A

This plug-in will guide you to properly configure the gauge parameters through a series of questions.

Including charger tolerances, what is the maximum taper current at which your charger will terminate charging? This will set the Taper Current parameter in data flash.
Example: If you have a taper current of 100 mA and charger tolerance of +/- 10%, the taper current is 100 + (100 * 0.1) = 110 — 100 mA

What is the nominal charging voltage of your charger?
This — 4200 mV

What is the typical current level in mA of your system in standby mode?
This will set the Initial Standby parameter in data flash. — -10 mA

What is the level of current in mA that you would like to be used for the purposes of StateOfHealth (SOH) simulations to monitor battery degradation?
You might choose a typical system load or the maximum system load. — -400 mA

At what capacity should the SOC1 Alarm be set?
This will set the SOC1 Set Threshold parameter in data flash which controls the SOC1 bit in the Flags register. — 150 mAh

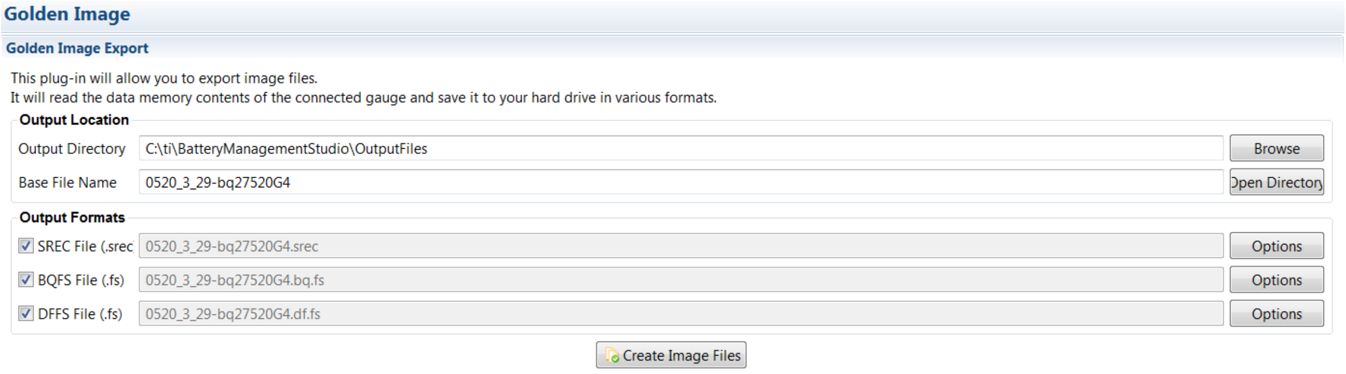
At what capacity should the SOC1 Alarm be cleared?
This will set the SOC1 Clear Threshold parameter in data flash. — 175 mAh

Do you want to use the external thermistor or the internal temperature sensor of the IC?
This will set the TEMPS bit of the Operation Configuration register in data flash. — ● External ○ Internal

Do you want to use SOC smoothing?
This will enable or disable the SMOOTHEN bit of the Operation Configuration D register in data flash. — ● Enable ○ Disable

Delay Ms: 1000
Access: 1

Figure 12. Parameter Q&A Screen

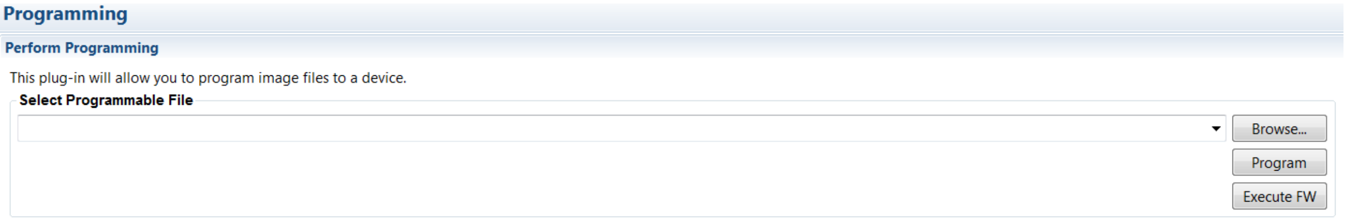


This plug-in will allow you to export image files.
It will read the data memory contents of the connected gauge and save it to your hard drive in various formats.

Output Directory: C:\ti\BatteryManagementStudio\OutputFiles
Base File Name: 0520_3_29-bq27520G4

☑ SREC File (.srec: 0520_3_29-bq27520G4.srec
☑ BQFS File (.fs): 0520_3_29-bq27520G4.bq.fs
☑ DFFS File (.fs): 0520_3_29-bq27520G4.df.fs

Figure 13. Golden Image Output Screen



This plug-in will allow you to program image files to a device.

Figure 14. Perform Programming Screen

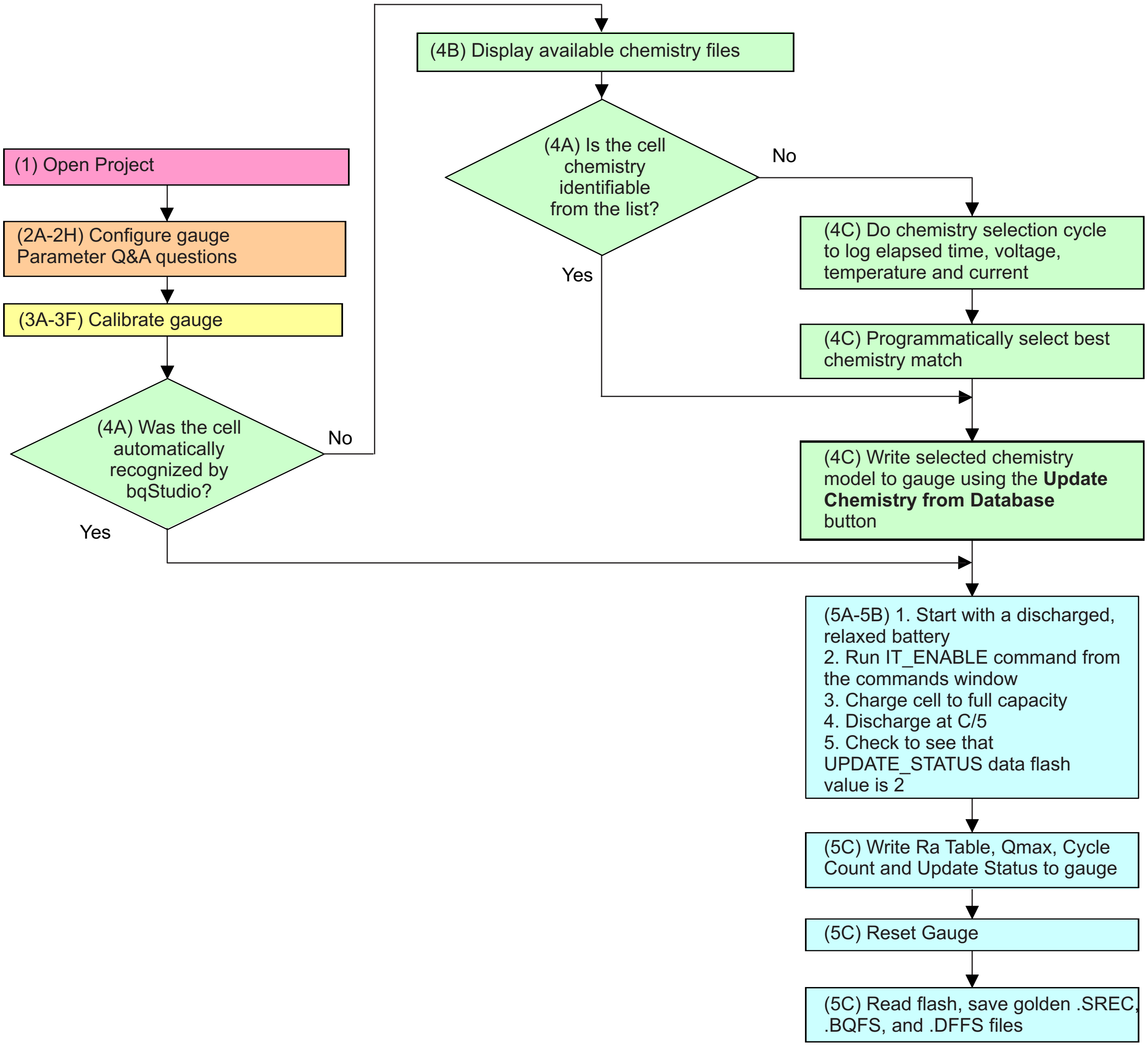
10 bqStudio™ Software

10.1 Introduction

Texas Instruments fuel gauges, employing the Impedance Track algorithm, offer an unmatched array of features and benefits. Sometimes, however, the wide range of configuration settings can seem challenging to get started with the evaluation process. In addition, determining the correct chemistry model and producing the 'golden image' file can be time consuming. The bqStudio program is designed to greatly simplify the process of configuring, calibrating, selecting chemistry, and performing learning cycles through the step-by-step use of a wizard program.

10.2 Program Navigation and Flowchart

The sequence of operation of the bqStudio program can be understood by reviewing the basic flowchart in Figure 15 . Using the program is simple – just start a new project and follow the steps sequentially from 1A to 5C. You can use the Next button, or click on the top tabs and left subsection labels to move to any desired page. Some operations must be completed in sequence due to data dependencies, or to implement the proper flow. Therefore, it is recommended that the prescribed sequence be followed, at least at first.



There is not a **Learning Cycle** button in the bq27520EVM bqStudio display.

Figure 15. bqStudio Flowchart

11 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.

- *bq27520, System-Side Impedance Track Fuel Gauge With Integrated LDO* data sheet (SLUS955)

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from A Revision (October 2013) to B Revision	Page
• Deleted *System Requirements* and reworded *Software Installation* sections in *EVM Hardware and Software Setup*.	7
• Changed the entire *Operation* section, text and images.	9
• Changed *Calibrate Screen* section to *Calibration* section, and changed much of the text in the section.	12
• Changed *I²C Pro Screen* section to *Advanced Communication I²C*, changed some text and the images in this section.	14
• Changed bqEASY to bqStudio globally in the document. Removed all images and content related to bqEASY.	16
• Changed the *Flowchart* image.	17
• Deleted *Simplified Configuration Procedures*, *Files*, *Completion Checkmarks*, and *Device Detection* sections.	17

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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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
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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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*
    6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
    6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS AND CONDITIONS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL 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 HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*
    8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.
    8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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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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