bq27530EVM with bq27530 Battery Management Unit Impedance Track™ Fuel Gauge and bq24161 2.5-A, Dual-Input, Switch-Mode Battery Charger for Single-Cell Applications

This evaluation module (EVM) is a complete evaluation system for the Battery Management Unit (BMU) chipset consisting of the bq27530-G1 fuel gauge and bq24161 battery charger. The EVM includes one bq27530 circuit, including a current sense resistor and one thermistor. In addition, the fuel gauge controls the bq24161 battery charger's settings and monitors its status via I²C communication lines. Together, the chipset provides all necessary components to monitor and predict capacity for a system-side fuel gauge solution as well as to charge the battery from either an adapter or USB input with up to 2.5-A of charge current. The circuit module connects directly across the battery pack. With the EV2300 interface board and software, the user can read the bq27530-G1 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the battery management unit 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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List of Tables

1 Features

- Complete evaluation system for the Battery Management Unit chipset consisting of the bq27530-G1 Impedance Track fuel gauge and bq24161 2.5-A Dual Input Battery Charger.
- 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

- bq27530-G1 and bq24161 chipset circuit module (HPA763)
- NTC103AT thermistor

This EVM is used for the evaluation of the bq27530-G1 and bq24161 BMU chipset. 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
bq27530EVM	Li-ion	1 cell	Any

2 bq27530-Based Circuit Module

The bq27530-based circuit module is a complete and compact example solution of a bq27530 circuit for battery management. The circuit module incorporates a bq27530 battery gas gauge integrated circuit (IC) and all other components necessary to accurately predict the capacity of 1-series Li-ion cell.

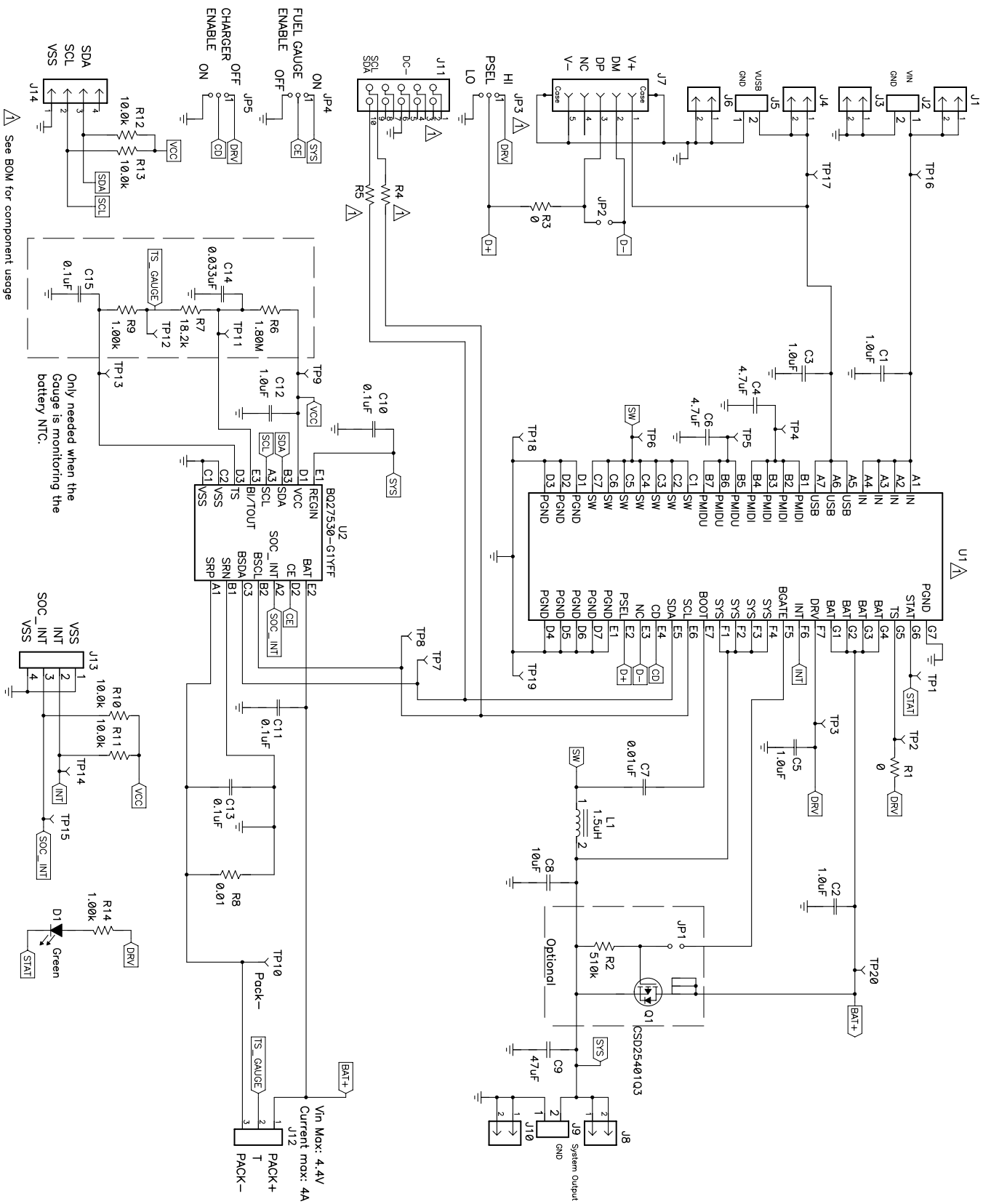

Figure 1. Schematic

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 I/O Description

Header/Terminal Block	Description
J1–VIN	Adapter positive terminal
J2–VIN	Adapter positive terminal
J2–GND	Adapter negative terminal
J3-GND	Adapter negative header
J4-USB	USB positive header
J5-USB	USB positive terminal
J5-GND	USB negative terminal
J6-GND	USB negative header
J7	USB Miniconnector
J8-SYS	System positive header
J9-SYS	System positive terminal
J9-GND	System negative terminal
J10-GND	System ground header
J10-SYS	System output positive header
J11	USBTOGPIO 10-pin connector (not installed)
J12-PACK+	Battery positive terminal
J12-T	Pack thermistor input that leads to IC TS pin
J12-PACK-	Battery negative terminal
J13	I2C SDA/SCL/VSS - I2C communication header
J14	EV2300 connector for using bq27530 software to communicate with bq27530 IC

2.3 Test Points

Test Point	Description
TP1	bq24161 STAT pin
TP2	bq24161 TS pin
TP3	bq24161 DRV pin
TP4	bq24161 PMIDI pin
TP5	bq24161 PMIDU pin
TP6	bq24161 SW pin
TP7	bq24161 SDA = bq27530 BSDA - I2C communication data line
TP8	bq24161 SCL = bq27530 BSCL - I2C communication clock line
TP9	bq27530 VCC
TP10	bq27530 PACK-
TP11	bq27530 BI/TOUT
TP12	Battery pack NTC positive side
TP13	bq27530 TS pin
TP14	bq24161 INT pin

Test Point	Description
TP15	bq27530 SOC_INT pin - Access to open-drain output that signals interrupt for changes in SOC.
TP16	bq24161 IN voltage
TP17	bq24161 USB voltage

2.4 Control and Key Parameters Setting

Jumper	Description	Default Factory Setting
JP1 BGATE	When installed, connects the bq24161's BGATE output to the gate of Q1, thereby enabling the external battery FET.	INSTALLED
JP2 USB D+/D-	Shorting jumper for USB data lines DM (D-) and DP (D+). When shorted, USB input current limit defaults to 1.5 A. Otherwise, USB100 mode is selected.	NOT INSTALLED
JP3 PSEL	2-3 (PSEL = LO): Indicates that an ac adapter is connected to the USB input and sets the USB input current limit to 1.5 A. 1-2 (PSEL = HI): Indicates that a USB source is connected to the USB input and sets the input current limit to 500 mA. (DEFAULT)	1-2 (PSEL = HI)
JP4 CHARGE ENABLE	2-3 ON: Charge disable (CD) pin low for normal operation 1-2 OFF: Charge disable (CD) pin high to disable charge and enter Hi-Z mode	1-2 OFF
JP5 FUEL GAUGE ENABLE	1-2 ON: Charge enable (CE) pin high for normal operation 2-3 OFF: Charge enable (CE) pin low to disable charge and gauging	2-3 OFF

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 bq27530 circuit module.

3.1 Board Layout

This section shows the printed-circuit board (PCB) layers (Figure 2 through Figure 5), assembly drawing, and schematic for the bq27530 module.

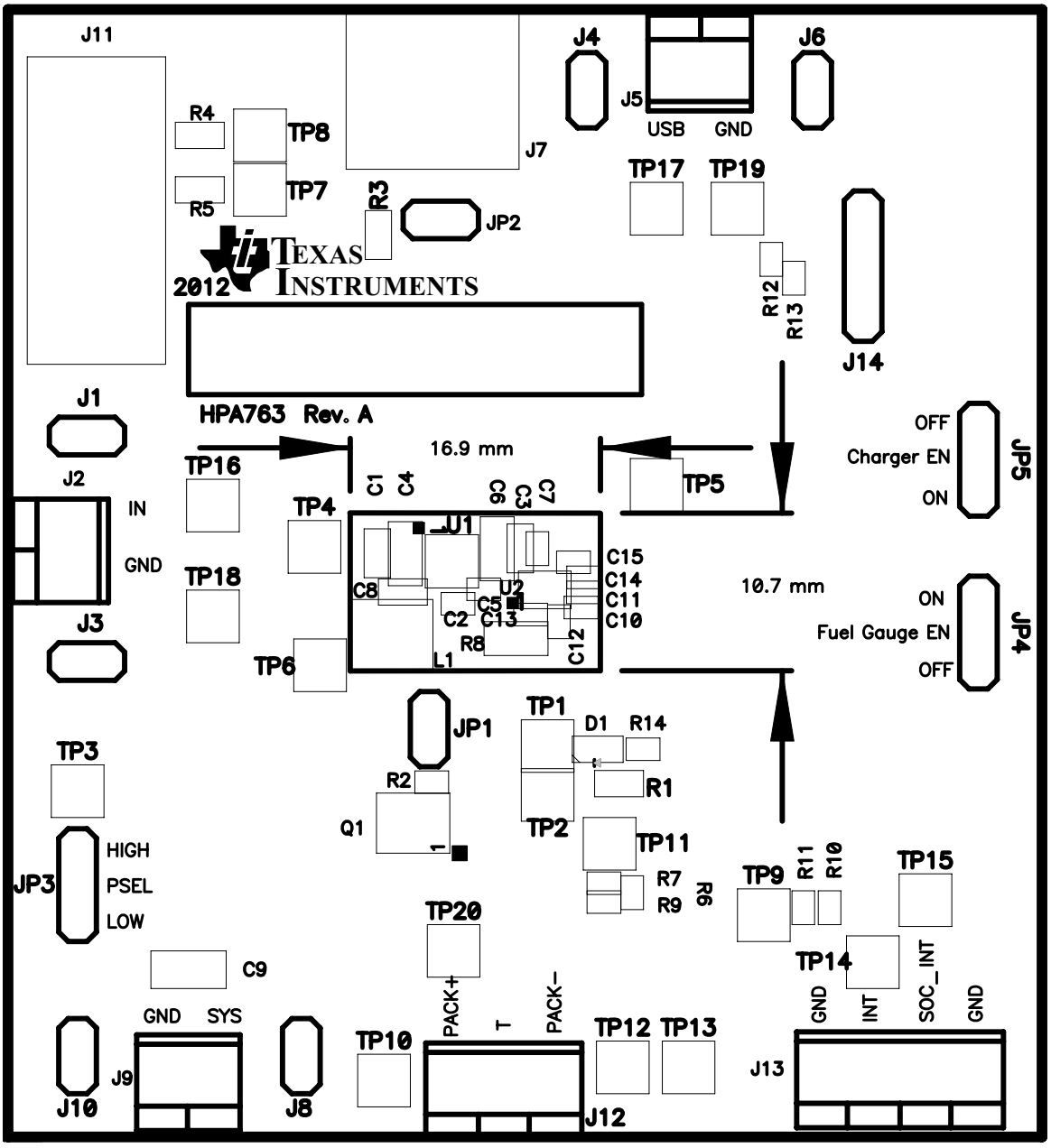

Figure 2. bq27530EVM-001 Layout – Layer 1 Silk Screen

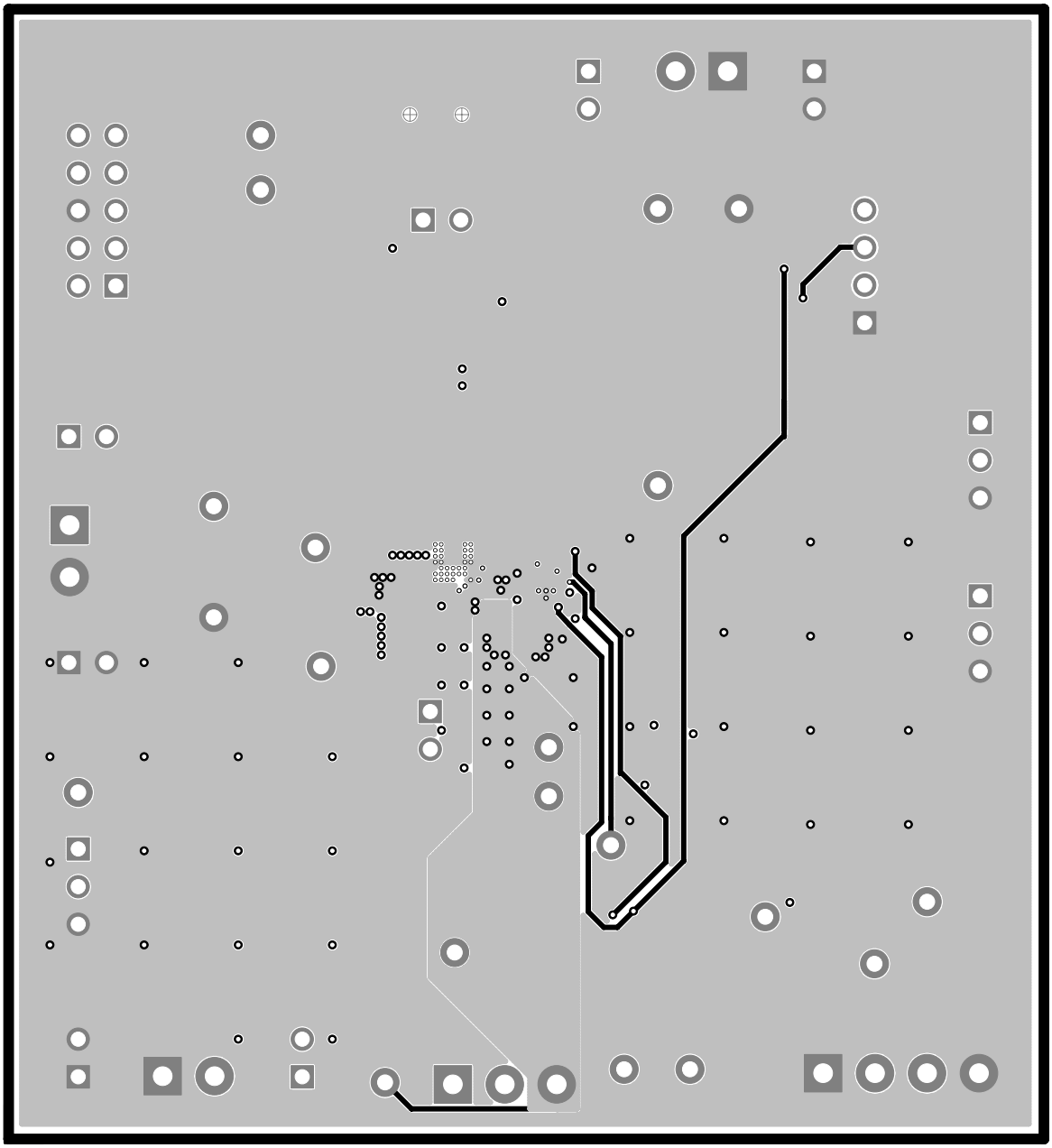

Figure 3. Layer 2

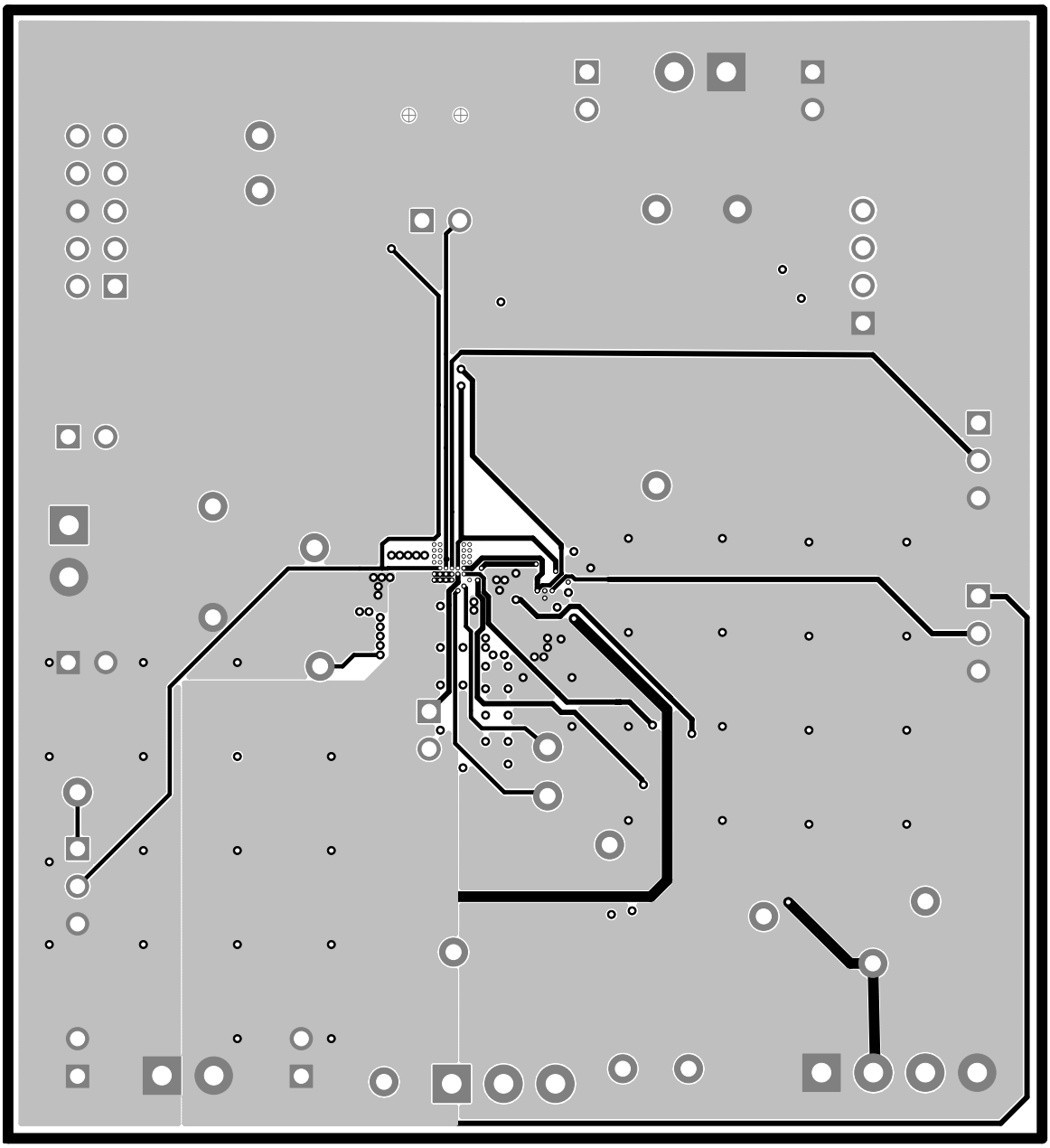

Figure 4. Layer 3

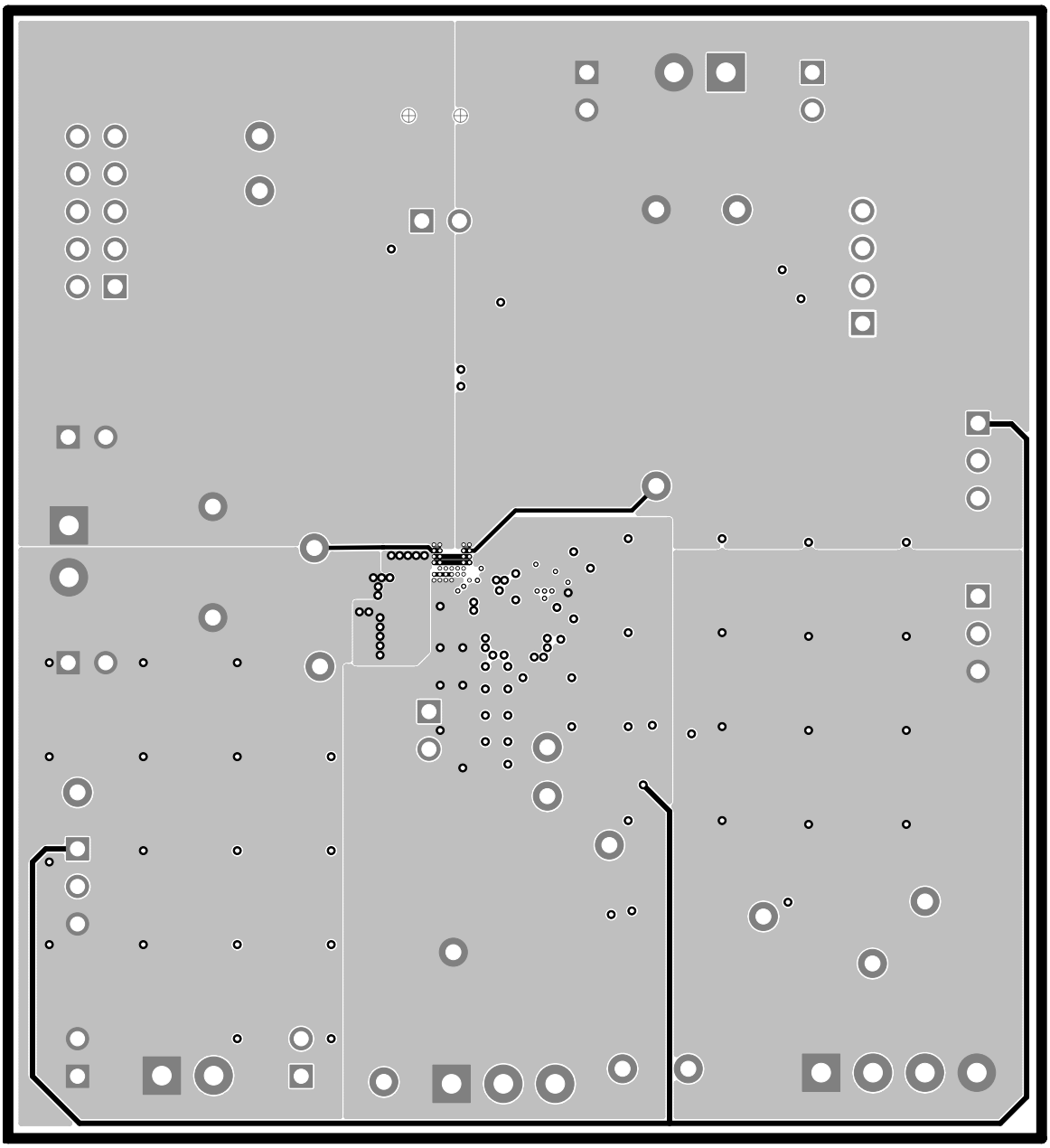

Figure 5. Layer 4

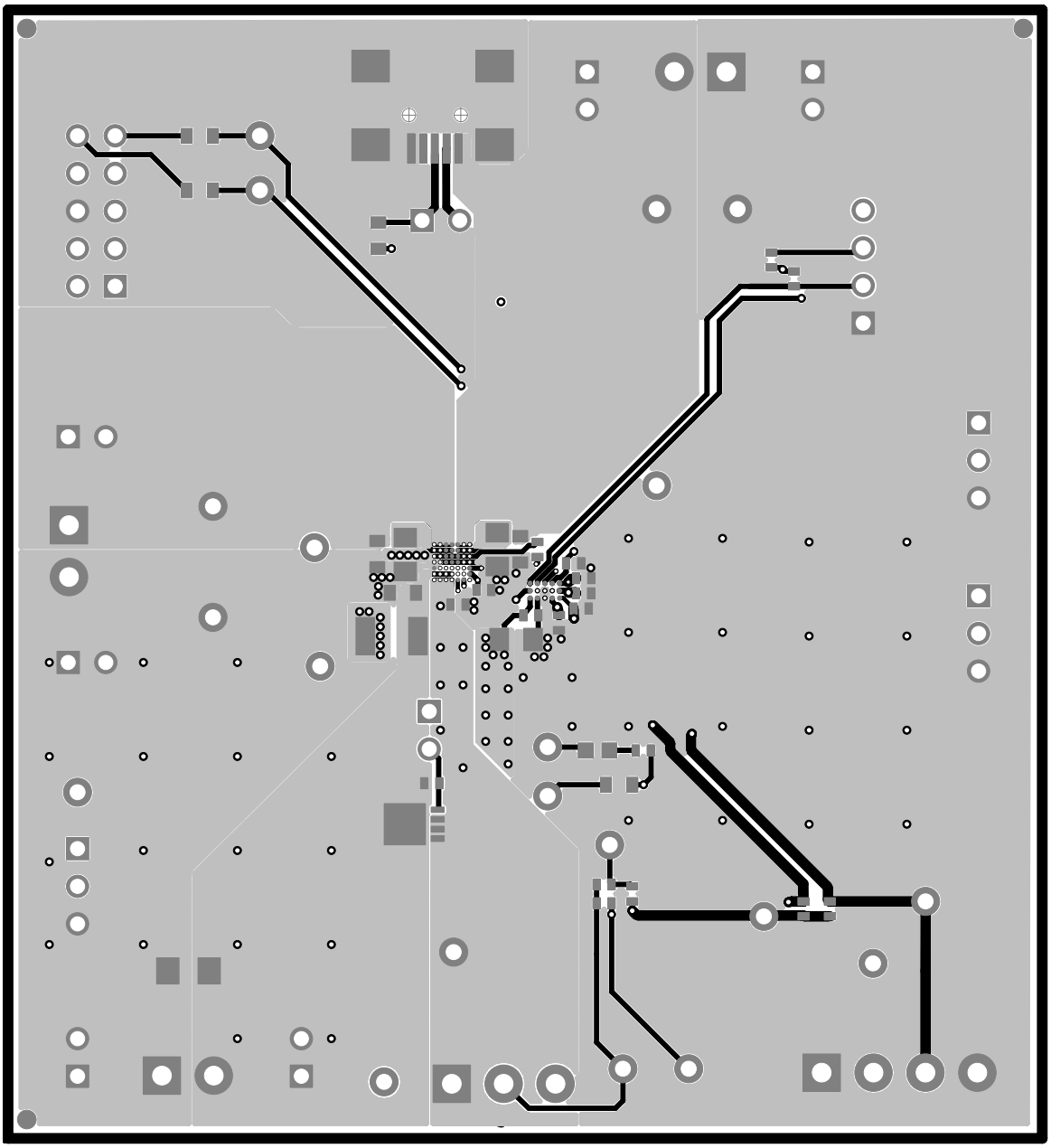

Figure 6. Layer 5

3.2 Bill of Materials and Schematic

Table 2. Bill of Materials

Count	Reference Designator	Value	Description	Size	Part Number	MFR
2	C1, C3	1.0uF	Capacitor, Ceramic, 25V, X5R, 10%	0603	Std	Std
3	C2, C5, C12	1.0uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0402	Std	Std
2	C4, C6	4.7uF	Capacitor, Ceramic, 25V, X5R, 10%	0805	Std	Std
1	C7	0.01uF	Capacitor, Ceramic, 16V, X7R, 10%	0402	Std	Std
1	C8	10uF	Capacitor, Ceramic, 10V, X5R, 10%	0603	Std	Std
1	C9	47uF	Capacitor, Ceramic, 10V, X5R, 20%	1206	Std	Std
4	C10, C11, C13, C15	0.1uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0402	Std	Std
1	C14	0.033uF	Capacitor, Ceramic, 16V, X7R, 10%	0402	Std	Std
1	D1	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	0603	LTST-C190GKT	Liteon
6	J1, J3, J4, J6, J8, J10	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
0	J11	Open	Connector, Male Straight 2x5 pin, 100mil spacing, 4 Wall	0.338 x 0.788 inch	N2510-6002-RB	3M
1	J12	ED555/3DS	Terminal Block, 3-pin, 6-A, 3.5mm	0.41 x 0.25 inch	ED555/3DS	OST
1	J13	ED555/4DS	Terminal Block, 4-pin, 6-A, 3.5mm	0.55 x 0.25 inch	ED555/4DS	OST
1	J14	22-05-3041	Header, Friction Lock Ass'y, 4-pin Right Angle	0.400 x 0.500	22-05-3041	Molex
3	J2, J5, J9	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25	ED555/2DS	OST
1	J7	UX60-MB-5ST	Connector, Recpt, USB-B, Mini, 5-pins, SMT	0.354 X 0.303 Inches	UX60-MB-5ST	Hiroise
2	JP1, JP2	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
2	JP4, JP5	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	PEC03SAAN	Sullins
1	JP3	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	PEC03SAAN	Sullins
1	L1	1.5uH	Inductor, SMT, 3.5A, 70 milliohm	4.1x4.4 mm	SPM4012T-1R5M Alternate: FDSD0415-H-1R5M	TDK Alternate: Toko
1	Q1	CSD25401Q3	MOSFET, PChan, -20V, 60A, 8.7 milliOhm	QFN3.3X3.3mm	CSD25401Q3	TI
1	R1	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R3	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	R10, R11, R12, R13	10.0k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R2	510k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
0	R4, R5	Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R6	1.80M	Resistor, Chip, 1/16W, 1%	0402	Std	Std

Table 2. Bill of Materials (continued)

Count	Reference Designator	Value	Description	Size	Part Number	MFR
1	R7	18.2k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R8	0.01	Resistor, Chip, 1/4W, 1%	0805	WSL0805R0100FEA18	Vishay
2	R9, R14	1.00k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
20	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20	5002	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	U1	BQ24161YFF	IC, 2.5A, Dual-Input, Single Cell SwitchmodeLi-Ion BATTERY CHARGER with Power Path Management	BGA	BQ24161YFF	TI
1	U2	BQ27530-G1YZF	IC, Battery Monitor and Data Logger	DSBGA	BQ27530-G1YZF	TI
4	--		Shunt, 100-mil, Black	0.100	929950-00	3M
1	--		PCB		HPA763	Any
1	--		Label (See note 5)	1.25 x 0.25 inch	THT-13-457-10	Brady
2	J5 mate		Connector, Female, 0.100 Centers		22-01-3047	Molex
8	N/A		Terminals, Crimp, Tin		08-50-0114	Molex
	N/A		Wire, Insulated 24 Awg, Red, 18 Inches (+/- 3 inches)(USB_5V)		1854-3	Alpha
	N/A		Wire, Insulated 24 Awg, White, 18 Inches (+/- 3 inches)(SCL)		1854-1	Alpha
	N/A		Wire, Insulated 24 Awg, Black, 18 Inches (+/- 3 inches)(GND)		1854-2	Alpha
	N/A		Wire, Insulated 24 Awg, Brown, 18 Inches (+/- 3 inches) (SDA)		1854-7	Alpha
1	N/A		Heatshrink 1" placed at middle of wire set		Any	Any

3.3 bq27530 Circuit Module Performance Specification Summary

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

3.4 Recommended Operating Conditions

		Min	Typ	Max	Unit
Supply voltage, V_{IN}	Input voltage from ac adapter	4.2		10	V
USB voltage, V_{USB}	Input voltage from USB or equivalent supply	4.2		6	V
System voltage, V_{SYS}	Voltage output at SYS terminal (depends on VBAT voltage and status of V_{INDPM} and input current limit circuits)	3.3		VBATREG+4.17%	V
Battery voltage, V_{BAT}	Voltage output at VBAT terminal (registers set via bq27530 software)	3	4.2	4.44	V
Supply current, $I_{IN(MAX)}$	Maximum input current from ac adapter input (registers set via bq27530 software)	1.5		2.5	A
Supply current, $I_{USB(MAX)}$	Maximum input current from USB input (registers set via bq27530 software)	0.1	0.5	1.5	A
Fast charge current, $I_{CHRG(MAX)}$	Battery charge current (registers set via bq27530 software)	0.550		2.5	A
Operating junction temperature range, T_J		-40		125	°C

4 EVM Hardware and Software Setup

This section describes how to connect the different components of the EVM how to install the bq27530EVM PC software and.

4.1 Recommended Test Equipment

4.1.1 Power Supplies

1. Power Supply #1 (PS #1) capable of supplying 6 V at 3 A is required.
2. If not using a battery as the load, then power supply #2 (PS #2) capable of supplying up to 5 V at 5 A is required to power the circuit shown in Figure 7.

4.1.2 Load #1 Between BAT and GND

Testing with an actual battery is the best way to verify operation in the system. If a battery is not available, then a circuit similar to the one shown inFigure 7 can simulate a battery when connected to a power supply.

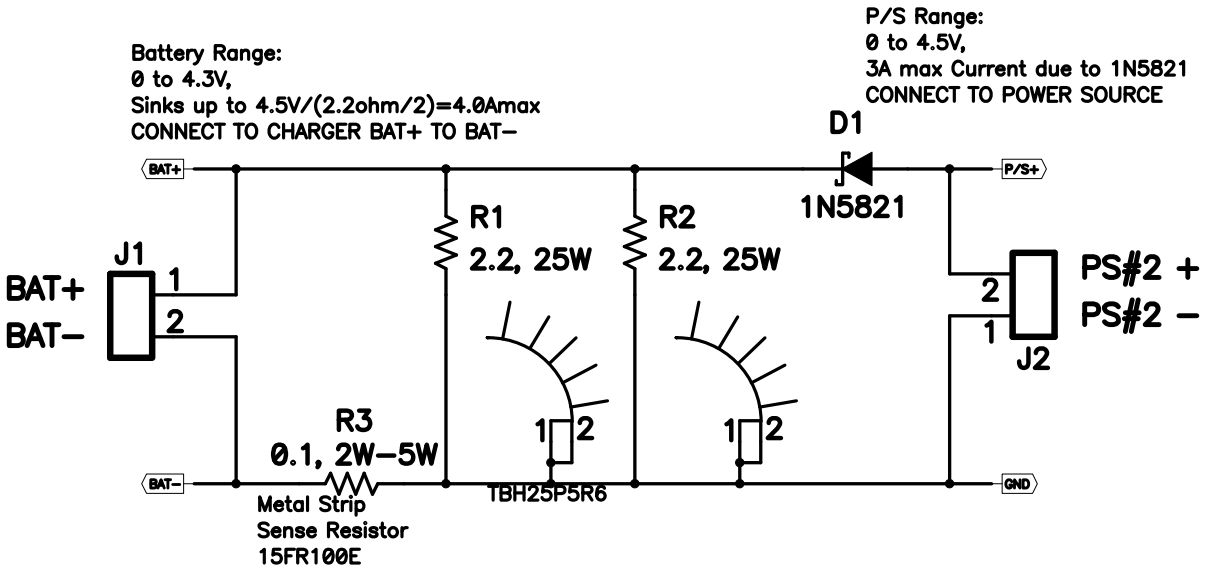

Figure 7. BAT_Load (PR1010) Schematic

4.1.3 Load #2 Between SYS and GND

Although not required, a resistive load capable of sinking up to 3 A can be used.

4.1.4 Meters

Four equivalent voltage meters (VM #) and two equivalent current meters (CM #) are required. The current meters must be able to measure 3-A current.

4.1.5 Test Equipment Setup

1. For all power connections, use short, twisted-pair wires of appropriate gauge wire for the amount of the current.
2. Set Power Supply #1 (PS #1) for 6-V, 3-A current limit and then turn off supply.
3. If BAT_Load as shown in Figure 8 is used, connect Power Supply #2 (PS #2) set to approximately 3.6 V to the input side (PS #2+/-) of BAT_Load, then turn off PS #2.
4. Connect the output side of the battery or BAT_Load in series with current meter (multimeter) #2 (CM #2) to J2 and J6 or J3 (BAT, GND). Ensure that a voltage meter is connected across J2 or TP3 and J6 or TP9 (BAT, GND).
5. Connect VM #3 across J10 or TP7 and J14 or TP9 (SYS, GND).
6. Connect VM #4 across J15 or TP5 and J14 or TP9 (DRV, GND).
7. Ensure jumpers are at the default factory settings per Section 2.4
8. Connect I^2C port of EV2300 with J14 board using the assembled 4 colored-wire connector included with EV2300 kit (GND / BLACK at the bottom).
9. After the preceding steps have been performed, the test setup for HPA721 is configured as is shown in Figure 8

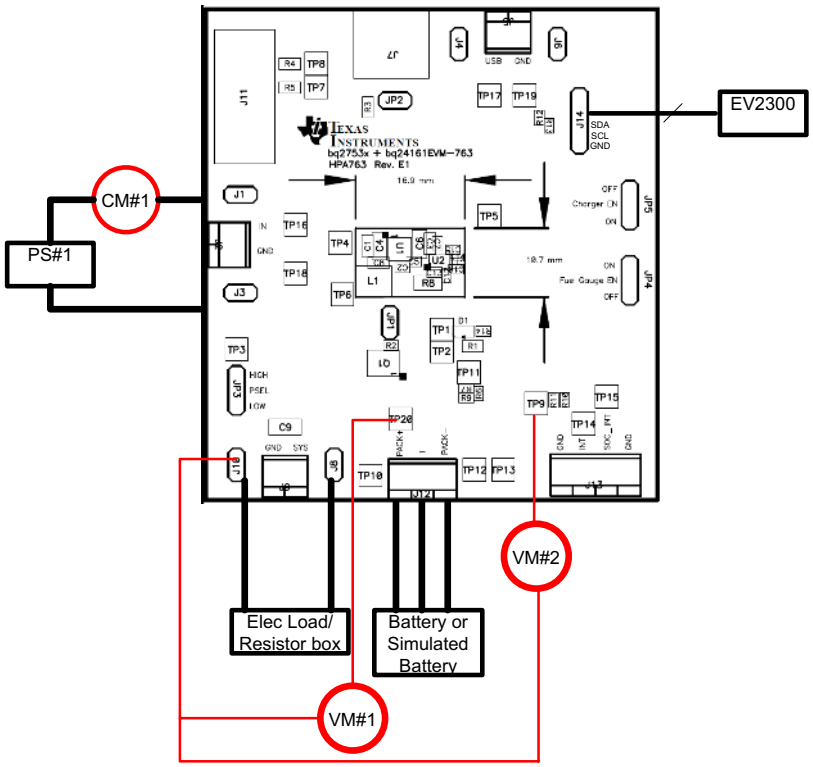

Figure 8. Original Test Setup for bq24160/161/163/168EVM (HPA721)

10. Turn on the computer. Open the bq27530 evaluation software. The main window of the software is shown in Figure 9 (DataRAM Screen)

4.2 Software Installation

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

4.2.1 Using EV2300

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.

4.2.2 Using EV2400:

1. Ensure that the EV2400 is not connected to the PC through a USB cable before starting this procedure.
2. Browse for the supported software link within the bq27530 TI web site product folder to find the downloadable EVSW installation files.
3. Open the software file that was downloaded from the TI web site.
4. Follow the instructions on screen until the software installation is completed.

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 Operation

This section details the operation of the bqStudio software.

6.1 Starting the Program

Run bqStudio from the Start | All Programs | Texas Instruments | Battery Management Studio. The main screen (Figure 9) appears. If instead of Figure 9 appearing, Figure 10 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 bq27530 are connected and restart bqStudio. If this still does not resolve the issue, check if the I2C pullup 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.

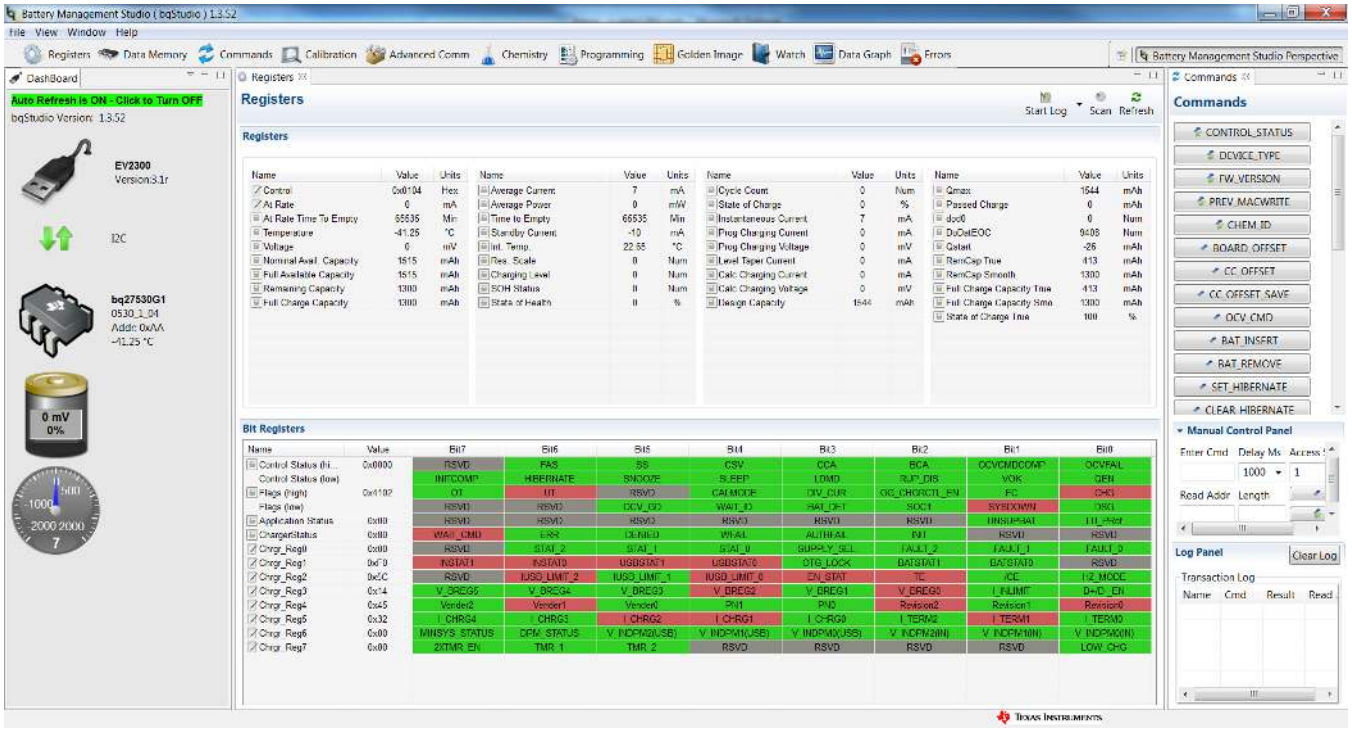

Figure 9. Registers Screen

This screen (Figure 9) shows the RAM data in the bq27530 device. Additional Flags and Status data can be viewed at the bottom of the Registers screen.

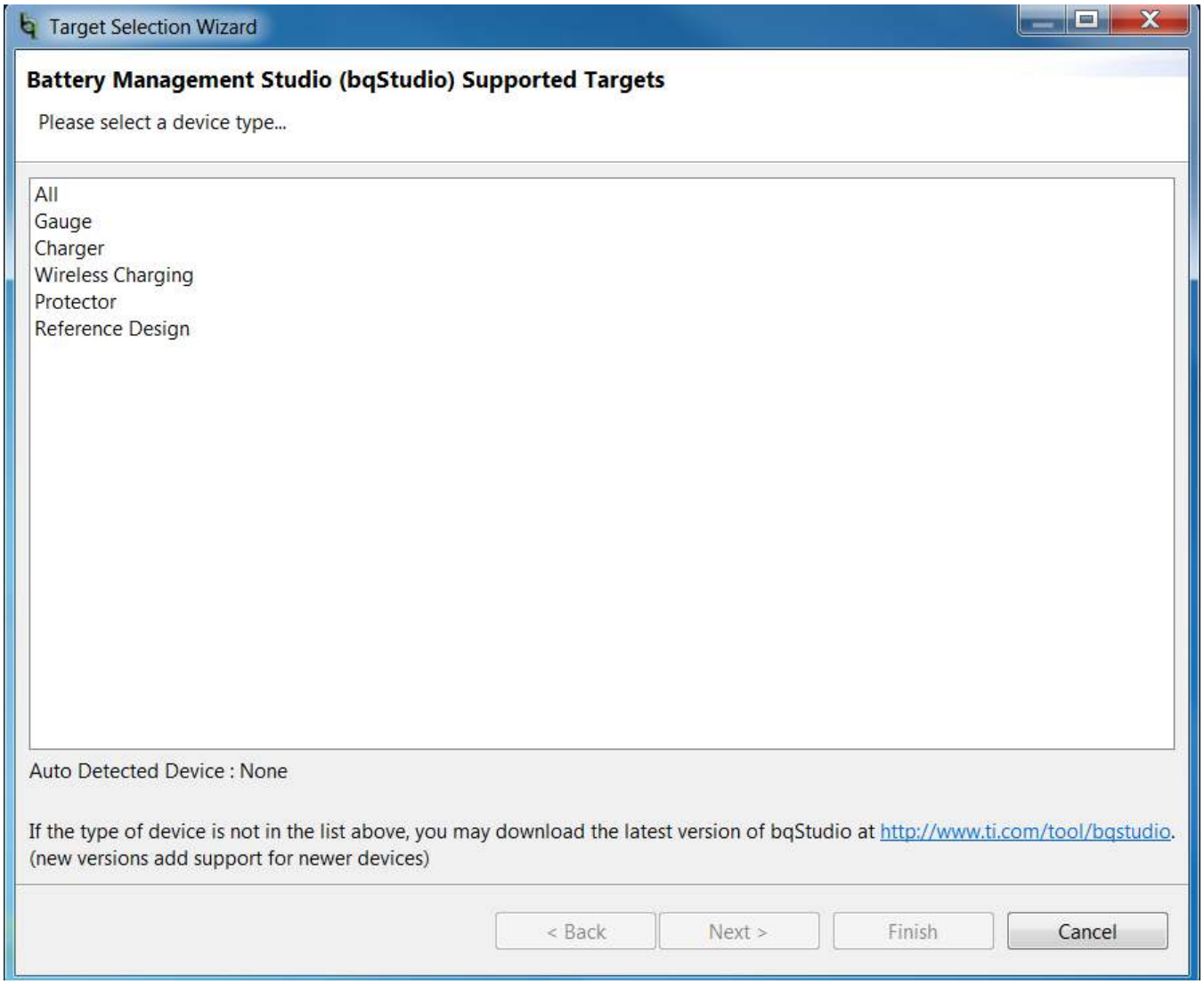

Figure 10. bqStudio Default Page

6.2 Setting Programmable bq27530 Options

The bq27530 data memory comes configured per the default settings detailed in the bq27530 technical reference manual. Ensure that the settings are correctly changed to match the pack and application for the bq27530 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 11).

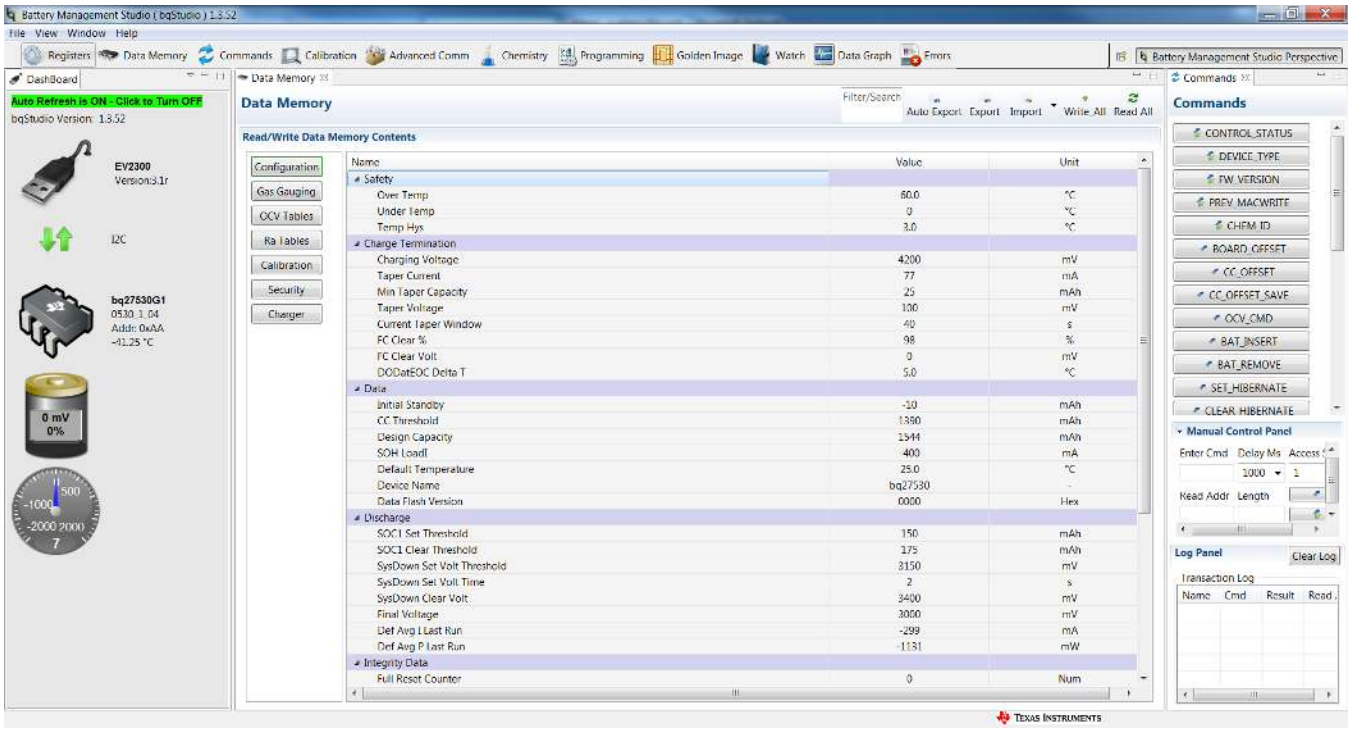

Figure 11. Data Memory Screen

To read all the data from the bq27530 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 bq27530 data memory. If the Gauge Dashboard is not displaying any information, then the bq27530 may not be supported by the bqStudio version being used, a bqStudio upgrade may be required.

7 Calibration

The bq27530EVM must be calibrated to ensure accurate value reporting. This can be done by going to the Calibration window in bqStudio (Figure 12).

7.1 Calibrating the bq27530

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 12).

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.

7.2 CC Offset Calibration

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

7.3 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.

7.4 Board Offset Calibration

This performs the offset calibration for the current offset of the board. It takes approximately 35 seconds to complete.

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.

7.5 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 Gas Gauge* button.

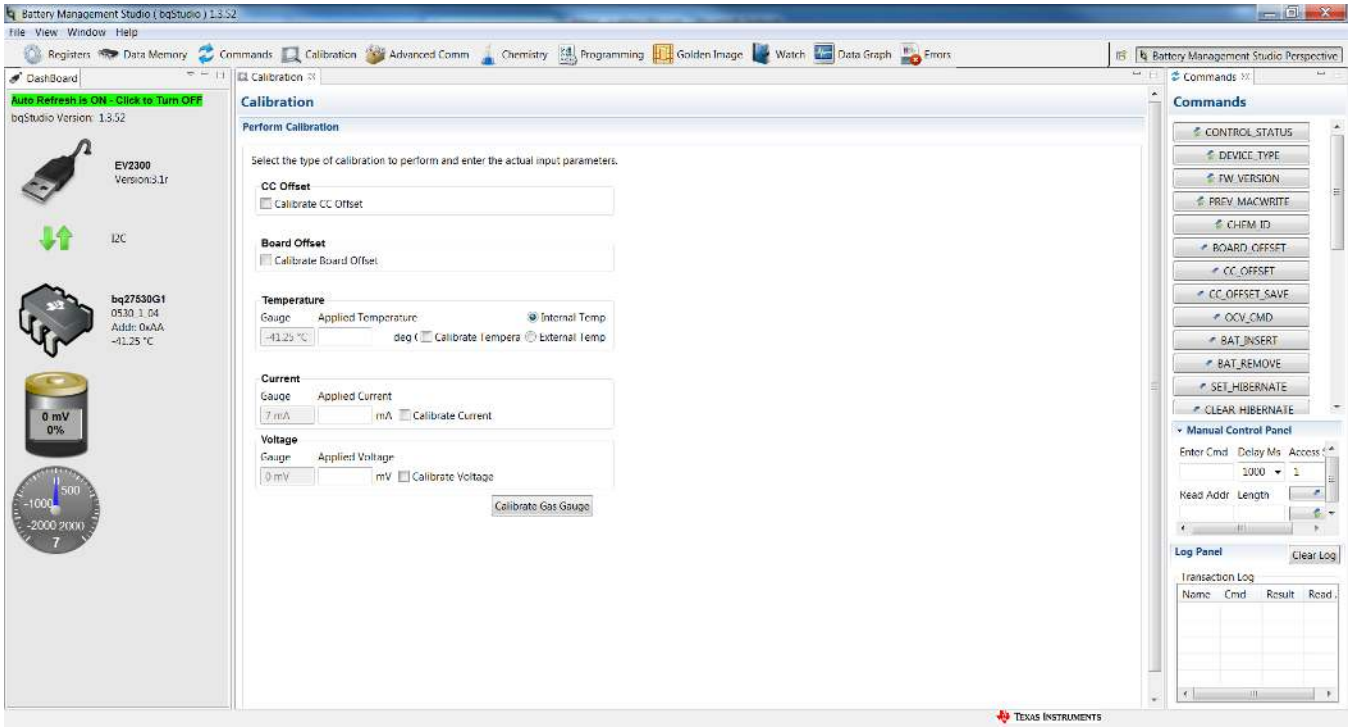

Figure 12. Calibration Screen

8 Advanced Communication I2C

8.1 I²C Communication

I²C read/write operations are not specific to any gas gauge. These operations serve as general-purpose communication tools (Figure 13).

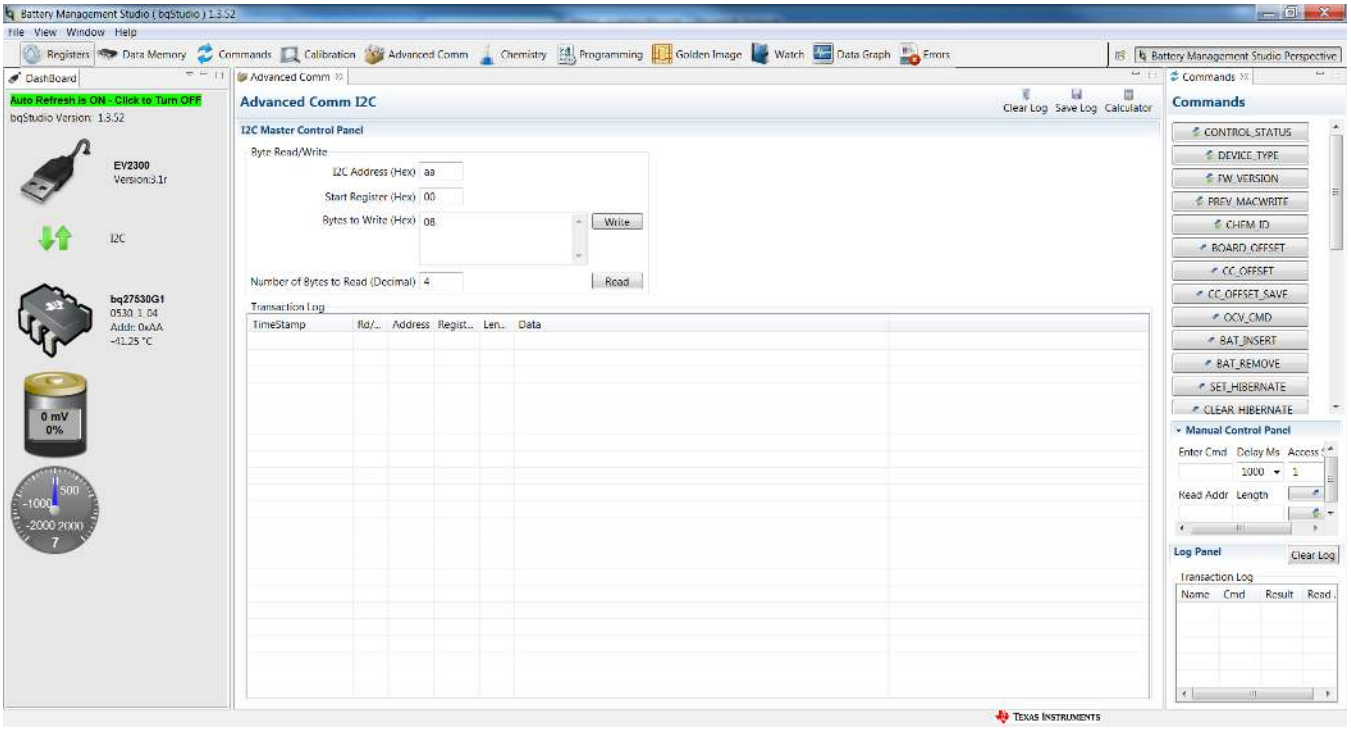

Figure 13. Advanced Communication I²C

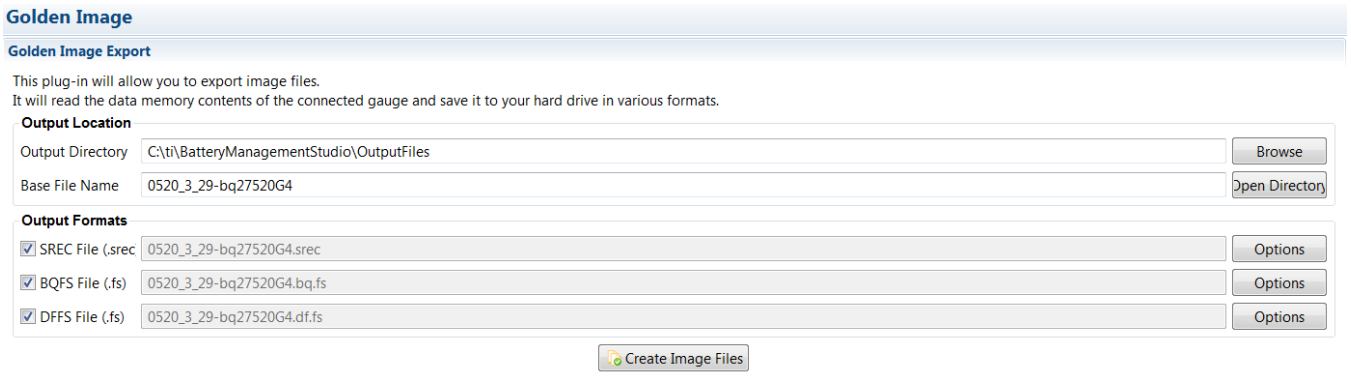

Figure 14. Golden Image Output Screen

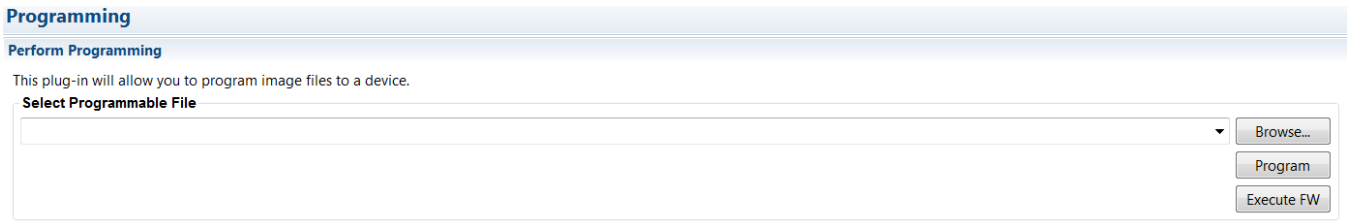

Figure 15. Perform Programming Screen

9 Related Documentation From Texas Instruments

To obtain a copy of any of the following TI documents, call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center (PIC) at (972) 644-5580. When ordering, identify this document by its title and literature number. Updated documents also can be obtained through the TI Web site at www.ti.com.

- *bq27530, 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 (August 2013) to B Revision	Page
• Deleted *System Requirements* and reworded *Software Installation* sections in *EVM Hardware and Software Setup*.	15
• Changed the entire *Operation* section, text and images.	16
• Changed *Calibrate Screen* section to *Calibration* section, and changed much of the text in the section.	18
• Changed *I2C Pro Screen* section to *Advanced Communication I2C*, changed some text and the images in this section.	20

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

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

2 *Limited Warranty and Related Remedies/Disclaimers*:

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

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

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4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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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