bq34z100EVM Wide Range Impedance Track™ Enabled Battery Fuel Gauge Solution

This evaluation module (EVM) is a complete evaluation system for the bq34z100 wide-range fuel gauge for lithium ion, Nickel metal hydride (NiMH) and Nickel Cadmium (NiCd) chemistries when combined with an EV2300 USB adapter and Microsoft® Windows® based PC software downloadable from the TI.com website. The circuit module includes one bq34z100 integrated circuit (IC) and all other components necessary to monitor and predict capacity in one or more series cell Li-ion, Li-polymer, or LiFePO4 battery packs. The minimum series cell count for PbA, NiMH, and NiCd chemistries must exceed 3.3-V stack voltage. The circuit module connects directly across the battery stack. With the EV2300 interface adapter and software, it is possible to read the bq34z100 data registers, program the chip for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the bq34z100 solution under different charge and discharge conditions.

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1 Features

- Complete evaluation system for the bq34z100 advanced gas gauge with Impedance Track™ technology.
- Populated circuit module for quick setup
- Link to software allowing data logging for system analysis

1.1 Kit Contents

- bq34z100 circuit module
- Cable to connect the EVM to an EV2300 or EV2400 Communications Interface Adapter.

1.2 Ordering Information

Table 1. Ordering Information

EVM Part Number	Chemistry	Configuration	Capacity
bq34z100EVM	Li-Ion, Li-Polymer, LiFePO4, PbA, NiMH, NiCd	3 V–48 V	Any

1.3 Documentation

See the device data sheet for bq34z100-G1 (SLUSBZ5) on www.ti.com for information on device firmware and hardware.

1.4 bq34z100 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq34z100 circuit module.

Specification	Min	Typ	Max	Unit
Input voltage BAT+ to BAT– in 1S mode	3	4	5	V
Input voltage BAT+ to BAT– in MultiCell	6	28	48	V
Charge and discharge current	0	2	7	A

2 bq34z100 Quick Start Guide

This section provides the step-by-step procedures required to take a new EVM and configure it for operation in a laboratory environment.

2.1 Items Needed for EVM Setup and Evaluation

- bq34z100 circuit module
- EV2300 or EV2400 Communications Interface Adapter
- Cable to connect the EVM to an EV2300 or EV2400 Communications Interface Adapter
- USB cable to the Communications Interface Adapter to the computer
- Computer setup with Windows XP, or higher, operating system
- Access to the internet to download the Battery Management Studio software setup program
- Battery cells or 1-kΩ resistors to configure a cell simulator
- A DC power supply that can supply 50 V and 3 A (Constant current/constant voltage capability is desirable)

2.2 Software Installation

Find the latest software version in the bq34z100 tool folder on www.ti.com. Use the following steps to install the bq34z100-G1 Battery Management Studio software:

1. Download and run the Battery Management Studio setup program from the bqStudio product folder on www.ti.com. See Section 3 for detailed information on using the tools in the Battery Management Studio.
2. If the Communications Interface Adapter was not previously installed, after the Battery Management Studio installation, a TI USB driver installer pops up. Click “Yes” for the agreement message and follow the instructions. Two drivers are associated with the EV2300 and an additional file may be required for the EV2400. Follow the instructions to install both. Do not reboot the computer, even if asked to do so.
3. Plug the Communications Interface Adapter into a USB port using the USB cable. The Windows system may show a prompt that new hardware has been found. When asked, "Can Windows connect to Windows Update to search for software?", select "No, not this time", and click "Next". In the next dialog window, it indicates "This wizard helps you install software for: TI USB Firmware Updater". Select "Install the software automatically (Recommended)" and click "Next". It is common for the next screen to be the Confirm File Replace screen. Click "No" to continue. If this screen does not appear, then go to the next step. After Windows indicates that the installation was finished, a similar dialog window pops up to install the second driver. Proceed with the same installation preference as the first one. The second driver is the TI USB bq80xx Driver.

2.3 EVM Connections

This section covers the hardware connections for the EVM (see Figure 1).

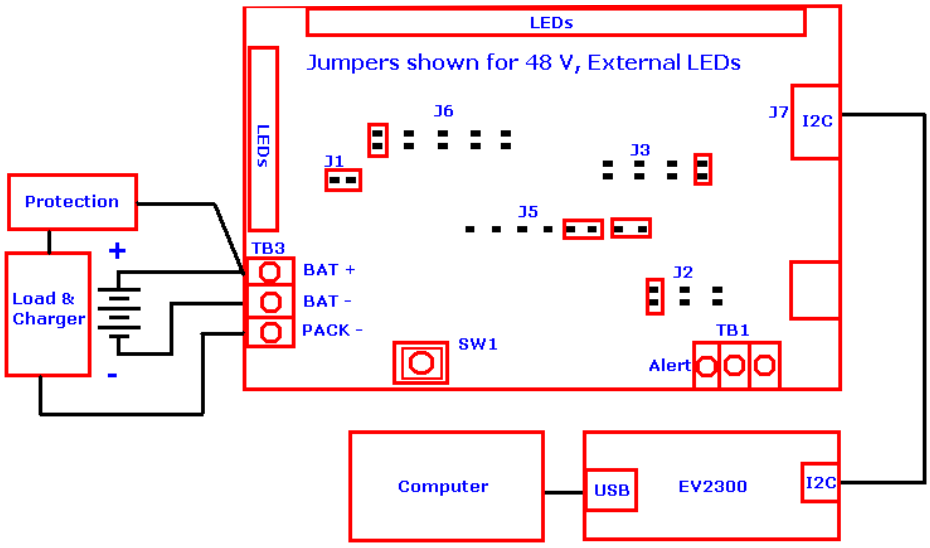

Figure 1. bq34z100 Circuit Module Connection to Cells and System Load and Charger

- Direct connection to the cells: BAT–, BAT+

  The bq34z100 monitors the cell stack voltage. Connect the bottom of the stack to BAT– and the top of the stack to BAT+. The stack voltage can range from 3 V to 48 V (see Figure 1).

STACK VOLTAGE	J5 HEADER	J2 HEADER
Less than 5 V	< 5-V jumpers	N/A
Greater than 5 V	> 5-V jumpers	16 V, 32 V or 48 V

WARNING

Applying a voltage greater than 5 V when jumpers are configured to < 5-V operation will damage the IC. Do not apply power until you have completed the *EVM Connections* section.

- To the serial communications port (SCL, SDA)

  Attach the Communications Interface Adapter cable to the J7 terminal block and to an EV2300 or EV2400 adapter box. Connect the PC USB cable to the EV2300 or EV2400 and the PC USB port (see Figure 1).
- The charger and system load connection across BAT+ and PACK–

  Attach the charger or load to the TB3 terminal block. Connect the positive load wire to BAT+ and the ground wire for the load to PACK– (see Figure 1).
- The ALERT output

  The ALERT output is an active low interrupt. The ALERT Configuration register selects the Control Status bits that will activate the interrupt. The ALERT pin is an open drain output and a pull-up resistor must be attached to the TB1 to use the feature.

- The LED Configuration

  When configuring the data flash registers, choose one of five LED/Comm configuration codes (refer to Table 21 in the bq34z100-G1 datasheet SLUSBZ5). After reviewing those possibilities, select the jumper pattern desired for the J6 header on the EVM. For single LED mode, place a jumper on the pair marked A. For four direct LED mode, place jumpers on A, B, C, and D. (Note: This configuration is only available when using HDQ communications mode.) For external LEDs using the shift register option, place a single jumper on EXT. In all cases, where one or more LED's are used, place a jumper across the J1 header to provide power to the LED (see Figure 1).

- Parameter setup

  The default data flash settings configure the device for 1-series Li-Ion cell. The user must update the data to set up the number of series cells to match the physical pack configuration (see Cell Configuration in Section 3.2). This provides basic functionality to the setup. Other data flash parameters should also be updated to fine tune the gauge to the pack. See the bq34z100 datasheet for help with setting the parameters.

3 Battery Management Studio

3.1 Registers Screen

Apply power to the EVM after you have completed the EVM Connections section. Run Battery Management Studio from the Start | Programs | Texas Instruments | Battery Management Studio menu sequence, or the Battery Management Studio shortcut. The Registers screen (see Figure 2) appears. The *Registers* section contains parameters used to monitor gauging. The *Bit Registers* section provides a bit-level picture of status and fault registers. A green flag indicates that the bit is 0 (low state) and a red flag indicates that the bit is 1 (high state). Data begins to appear once the *Refresh* (single-time scan) button is selected, or it scans continuously, if the *Scan* button is selected.

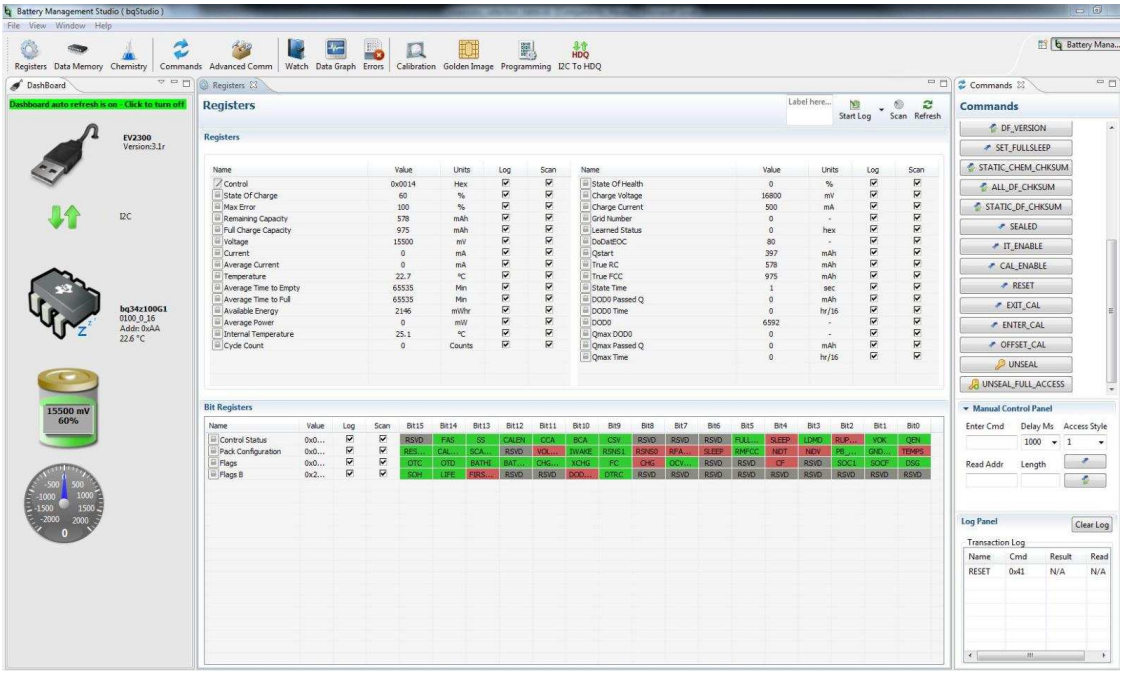

Figure 2. Registers Screen

The continuous scanning period can be set via the | Window | Preferences | SBS | Scan Interval | menu selection.

The Battery Management Studio program provides a logging function which logs the values selected by the *Log* check boxes located beside each parameter in the *Registers* section. To enable this function, select the *Log* button; this causes the *Scan* button to be selected. When logging is stopped, the *Scan* button is still selected and has to be manually deselected.

3.2 Setting Programmable bq34z100 Options

The bq34z100 data flash comes configured per the default settings detailed in the bq34z100 datasheet. Ensure that the settings are correctly changed to match the pack and application for the solution being evaluated.

NOTE: The correct setting of these options is essential to get the best performance. The settings can be configured using the *Data Memory* screen (see Figure 3)

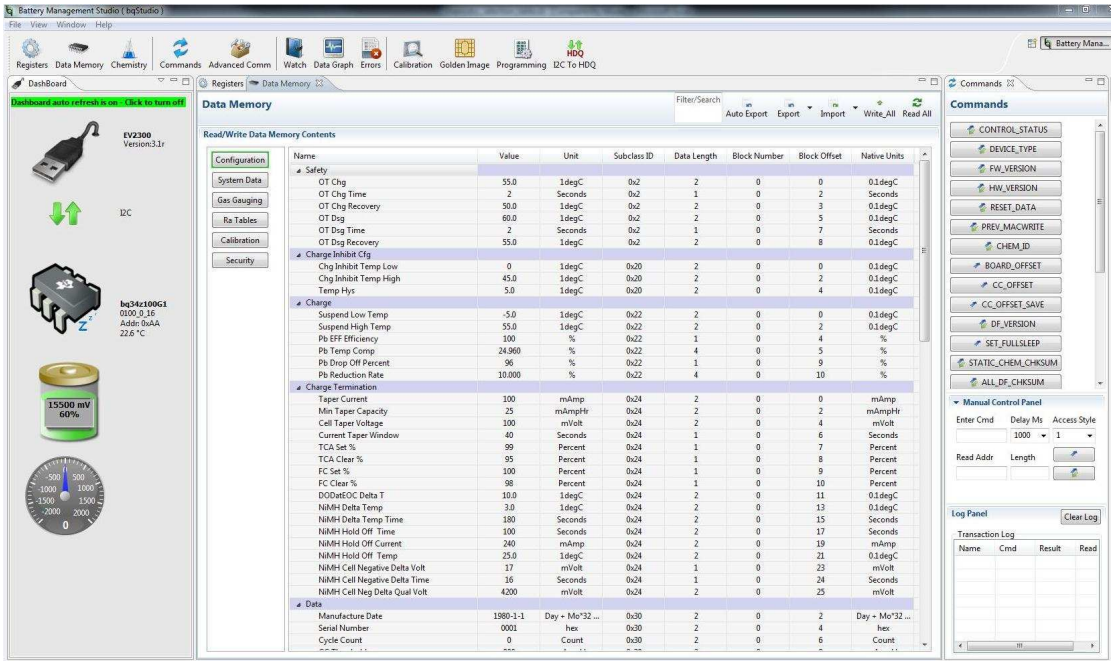

Figure 3. Data Memory Screen

3.2.1 Cell Configuration

The bq34z100 operates in one of two modes for measuring battery voltage. Place two jumpers on header J5 to select the mode of operation. Refer to the Section 2.3.

For packs where the stack voltage is less than 5 V:

- Set the *Number of Series Cells* parameter field to the appropriate value
- Reset the gauge using the *RESET* button on the ***Commands*** panel
- Calibrate the stack voltage. Reference the ***Calibration Screen*** section

For packs where the stack voltage is less than 5 V:

- Set the *Number of Series Cells* parameter field to the appropriate value
- Set the *VOLTSEL* bit in the *Pack Cfg A* register
- Reset the gauge using the *RESET* button on the ***Commands*** panel
- Calibrate the stack voltage. Reference the ***Calibration Screen***section

3.3 Calibration Screen

Calibrate the voltages, temperatures, and currents to provide good gauging performance. Press the *Calibration* button to select the *Advanced Calibration* window. See Figure 4.

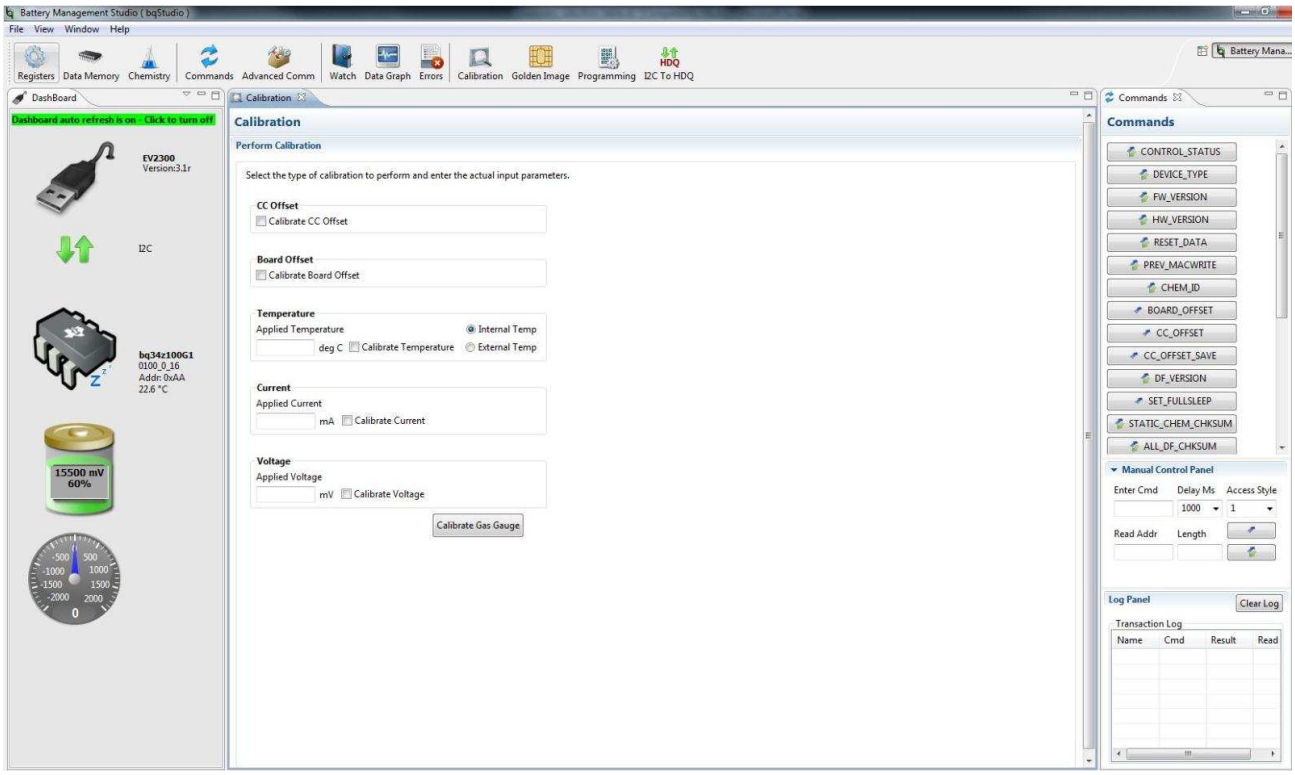

Figure 4. Calibration Screen

3.3.1 Voltage Calibration

- Measure the voltage from BAT+ to BAT– and enter this value in the *Applied Voltage* field and select the *Calibrate Voltage* box.
- Press the *Calibrate Gas Gauge* button to calibrate the voltage measurement system.
- Deselect the Calibrate Voltage boxes after voltage calibration has completed.

3.3.2 Temperature Calibration

- Enter the room temperature in the *Applied Temperature* field and select the *Calibrate Temperature* box and select the thermistor to be calibrated. The temperature value must be entered in degrees Celsius.
- Press the *Calibrate Gas Gauge* button to calibrate the temperature measurement system.
- Deselect the *Calibrate Temperature* box after temperature calibration has completed.

3.3.3 Current Calibration

- Select the *Calibrate CC Offset* and *Calibrate Board Offset* boxes and insure that there is no current flow.
- Press the *Calibrate Gas Gauge* button to calibrate.
- Deselect the *Calibrate CC Offset* and *Calibrate Board Offset* boxes after current calibration has completed.
- Connect and measure a 2-A load from BAT+ and PACK– to calibrate the current gain.
- Enter –2000 in the Applied Current field and select the Calibrate Current box.
- Press the *Calibrate Gas Gauge* button to calibrate.
- Deselect the Calibrate Current box after current calibration has completed.

3.4 Chemistry Screen

The chemistry file contains parameters that the simulations use to model the cell and its operating profile. It is critical to program a Chemistry ID that matches the cell into the device. Some of these parameters can be viewed in the Data Flash section of the Battery Management Studio.

Press the *Chemistry* button to select the Chemistry window. See Figure 5.

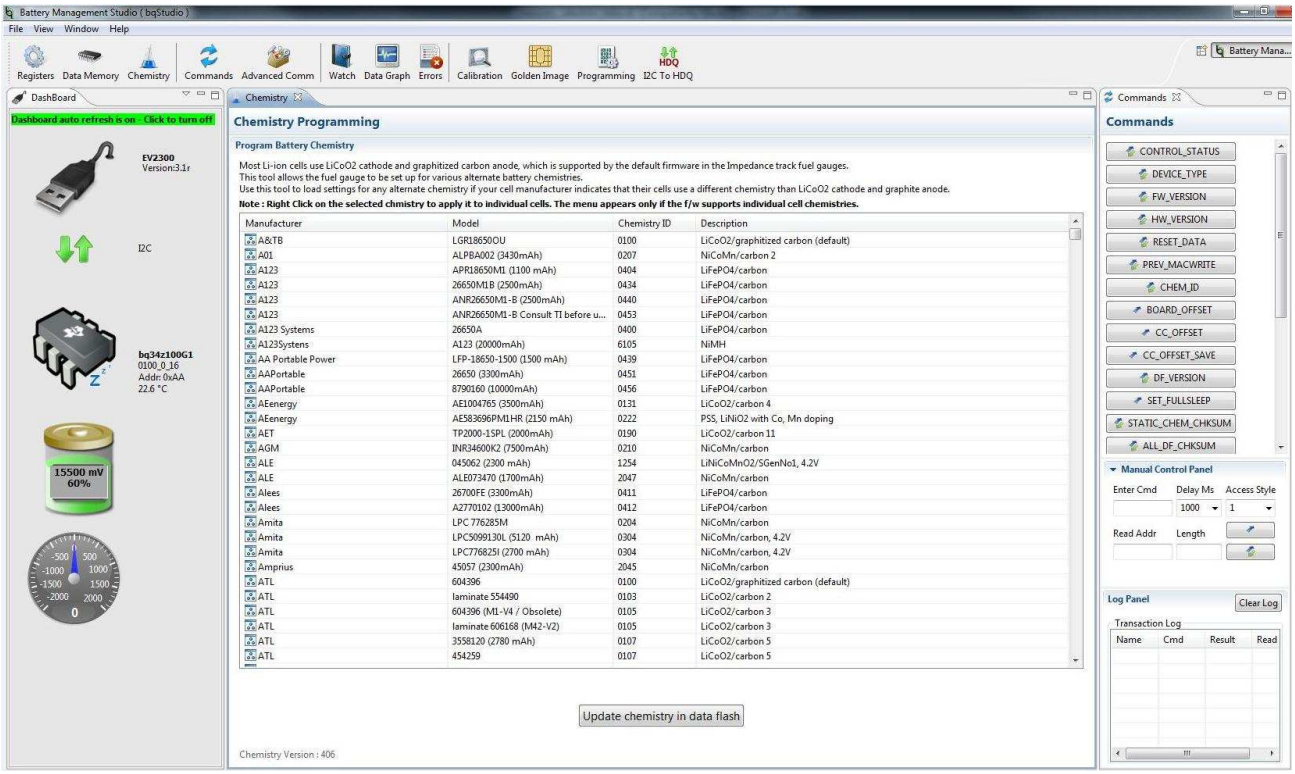

Figure 5. Chemistry Screen

- The table can be sorted by clicking the desired column. For example: Click the Chemistry ID column header.
- Select the ChemID that matches your cell from the table (Figure 5).
- Press the *Update chemistry in the data flash* button to update the chemistry in the device.

3.5 Programming Screen

Press the *Programming* button to select the Programming Update window. This window allows the user to program the device to a new version of firmware.

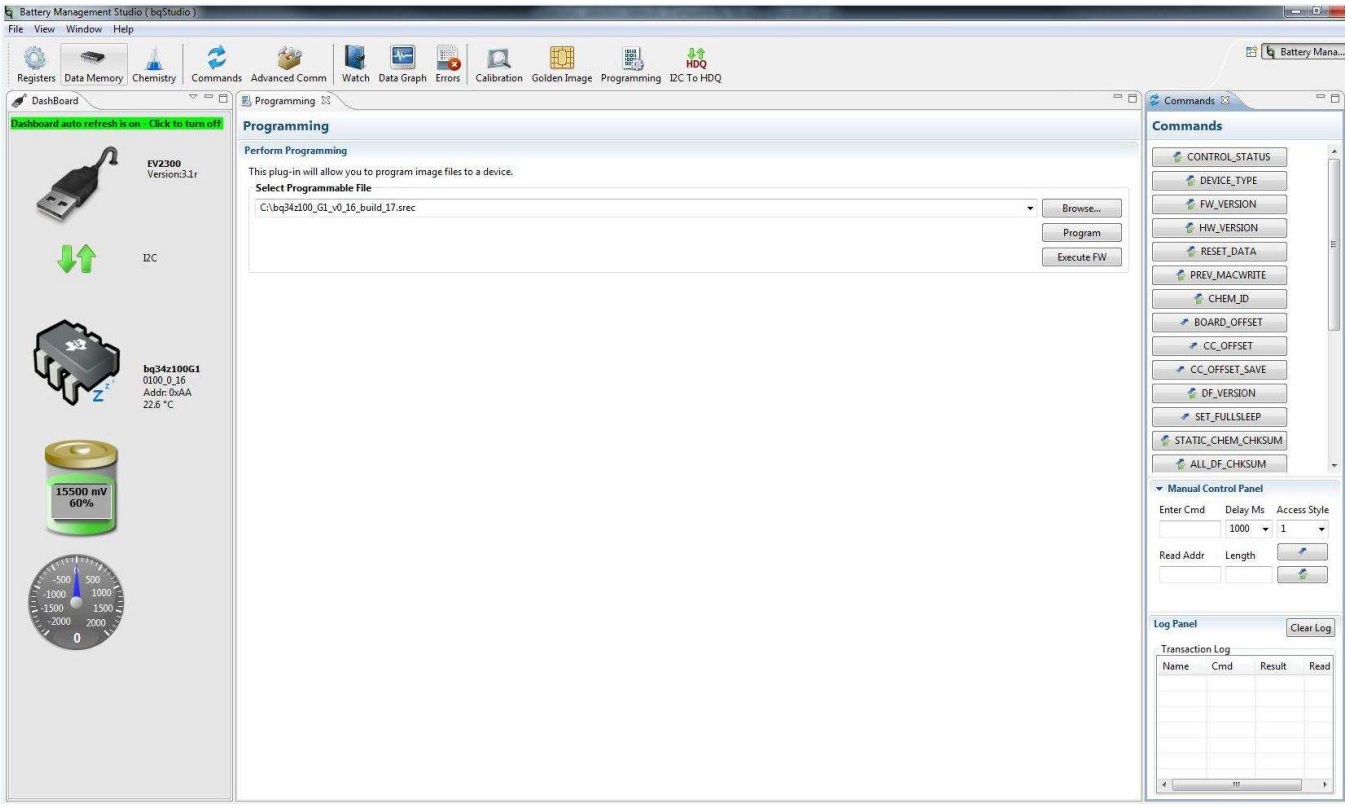

Figure 6. Programming Screen

3.5.1 Programming the Flash Memory

The upper section of the Programming screen is used to initialize the device by loading the default .srec into the flash memory (see Figure 6).

- Search for the .srec file using the *Browse* button.
- Press the *Program* button and wait for the download to complete.
- Press the *Execute FW* button after the download has completed.
- Select File | Restart to initialize bqStudio to the new firmware.

3.6 Golden Image Screen

Press the *Golden Image* button to select the Golden Image window. This window allows the user to export the device firmware as an .srec, .bq.fs, and .df.fs files.

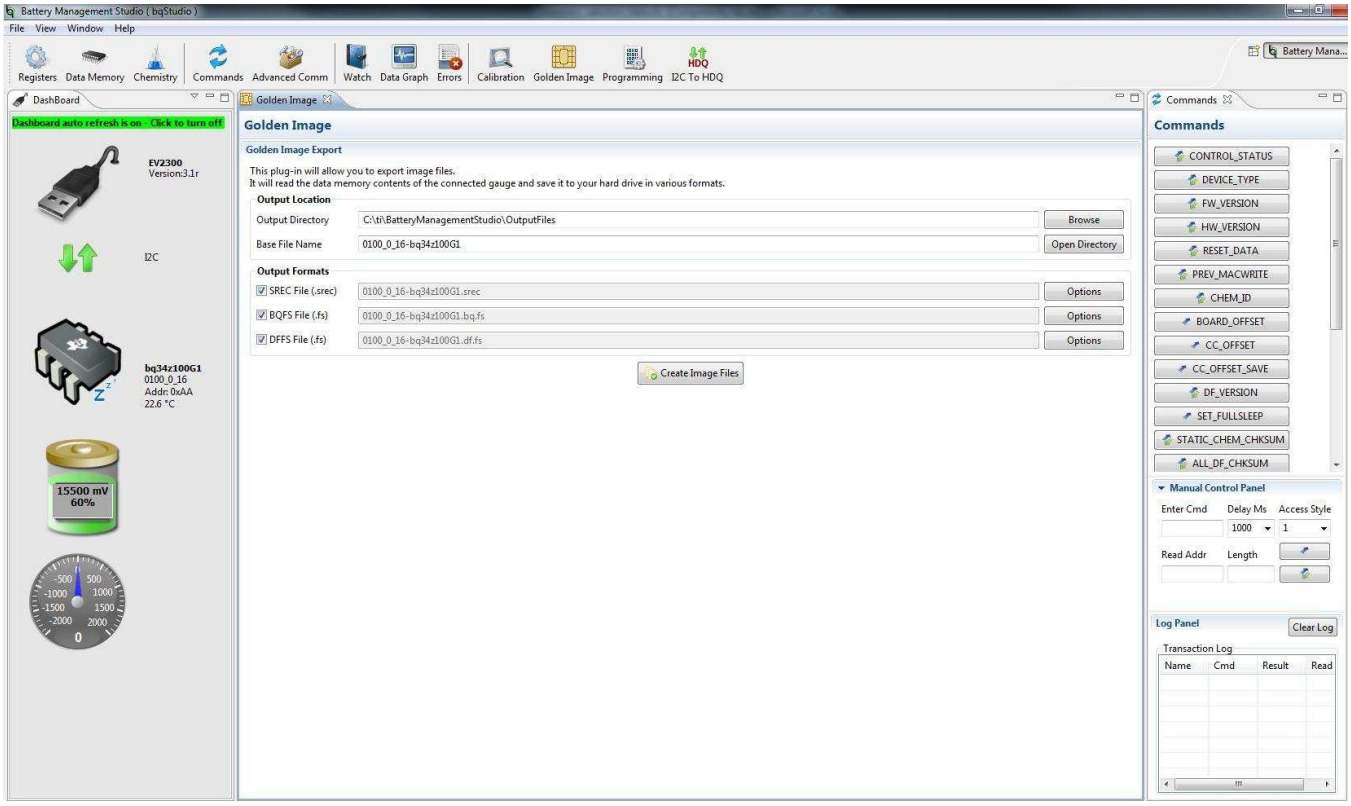

Figure 7. Golden Image Screen

3.6.1 Exporting the Flash Memory

The .srec file contains the full flash memory. The .bq.fs contains the program memory portion for the flash memory and the .df.fs contains the data flash portion of the flash memory (see Figure 7).

- Select the directory location to export the files.
- Enter the file name for the files.
- Select the files types to export.
- Press the *Create Image File* button to export the memory and create the files.

3.7 Advanced Comm I2C Screen

Press the *Advanced Comm I2C* button to select the Advanced I2C Comm window. This tool provides access to parameters using I2C and Manufacturing Access commands (see Figure 8).

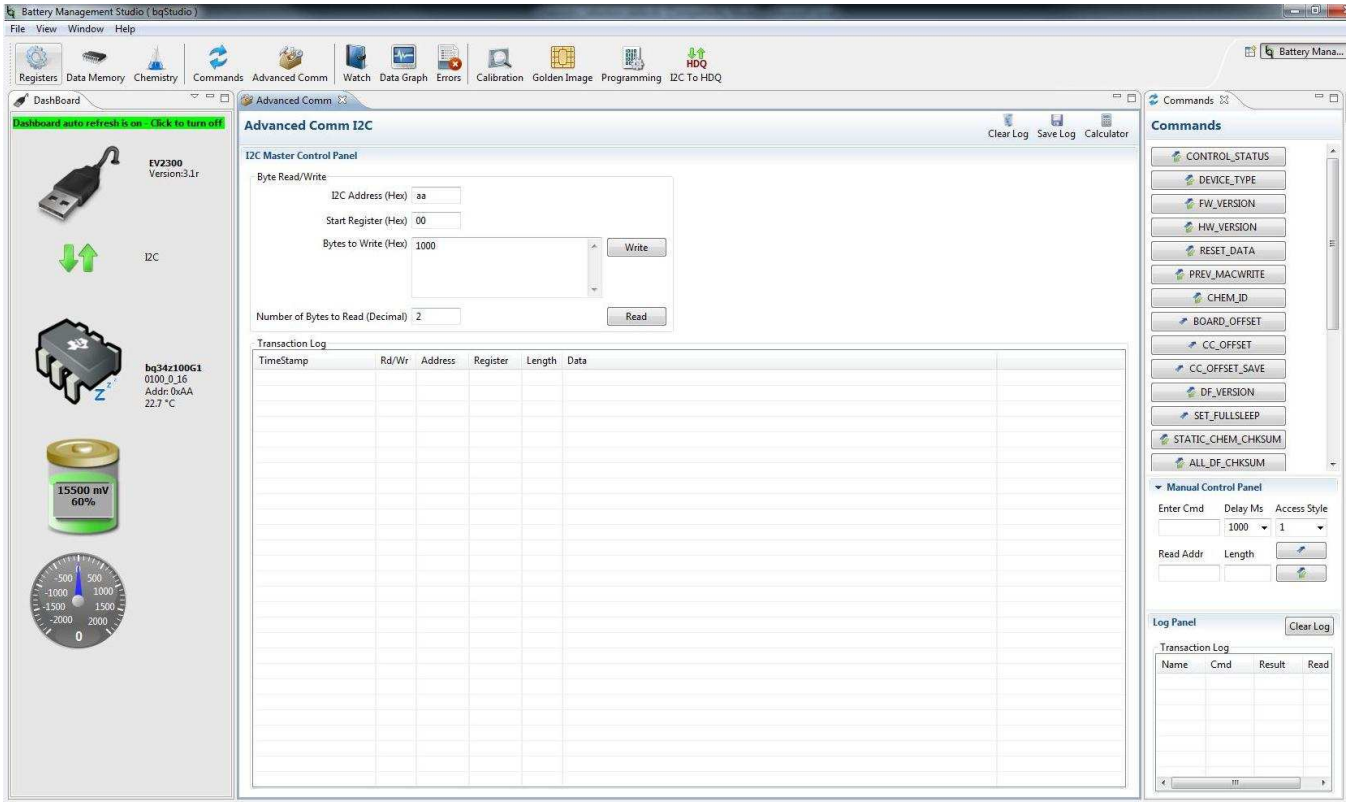

Figure 8. Advanced Comm Screen

3.7.1 Examples

Reading Standard Data Commands.

- Read SBData Voltage (0x08)
  - Start Register = 0x08
  - Number of Bytes to Read = 2
  - Press the *Read* button
  - Date returned =8C 3C, which a byte swapped
  - 0x3C8C = 15500mV, when converted to decimal

Sending a MAC Gauging() to enable IT via ManufacturerAccess().

- With Impedance Track™ disabled, send Gauging() (0x0021) to ManufacturerAccess().
  - Start Register = 0x00
  - Bytes to Write = 21 00
  - Press the Write button
  - The QEN flag should set in the Control Status register to indicate that Impedance Track is enabled

Reading Control Subcommands. Chemical ID() (0x0008) via ManufacturerAccess()

- Send Chemical ID() to ManufacturerAccess()
  - Start Register = 0x00
  - Bytes to Write = 08 00
  - Press the Write button
  - Start Register = 0x00
  - Number of Bytes to Read = 2
  - Press the *Read* button
  - Date returned =07 01, which a byte swapped
  - That is 0x0107, chem ID 107

3.8 Send HDQ Screen

When using the HDQ single wire serial communication feature, the mode of the gauge must be changed with a special command. This screen provides a button for this purpose. Note the warning message. The process is not reversible. Once in HDQ mode, the HDQ pro screen is available for testing commands and reprogramming the device. For register scanning and data flash access, use the companion evaluation program for HDQ (see Figure 9).

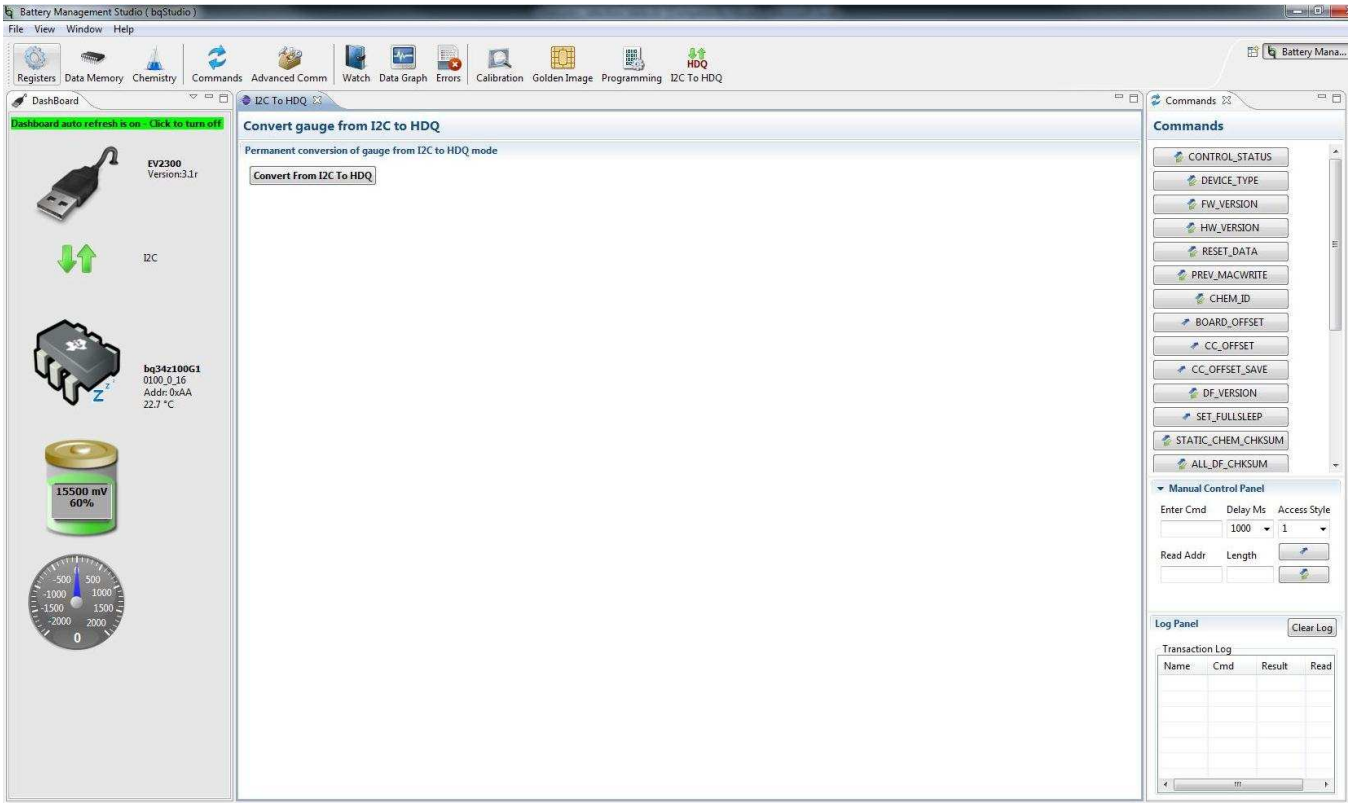

Figure 9. Send HDQ Screen

- To the HDQ communications port (HDQ, GND)
  - Attach the Communications Interface Adapter cable to the J7 terminal block (I2C Interface) to the I2C port on the EV2300..
  - Press the Convert From I2C to HDQ button
  - Power cycle the voltage to the device
  - Attach the Communications Interface Adapter cable to the J4 terminal block (HDQ Interface) to the HDQ port on the EV2300
  - Select File | Restart to reload the bqStudio program

WARNING

The conversion to HDQ mode is permanent. TI recommends using the I2C interface to setup, calibrate, and run the optimization cycle.

3.9 Dashboard Panel

The Dashboard panel displays the device type and firmware version. It also provides updates to the Voltage, SOC, Current and Temperature in one location. The Dashboard uses automatic polling, which can cause problems when sending some MAC commands. Dashboard polling can be disabled by clicking the auto refresh field at the top of the panel (see Figure 2).

3.10 Commands Panel

The Commands panel provides a quick and easy access to frequently used I2C and MAC commands. They are mapped to buttons that can be pressed to execute the function. The I2C transaction is logged in the Log Panel (see Figure 2).

4 Circuit Module Physical Layouts

This section contains the printed-circuit board (PCB) layout, assembly drawings, and schematic for the bq34z100 circuit module.

4.1 Board Layout

This section shows the dimensions, PCB layers (Figure 10 through Figure 15), and assembly drawing for the bq34z100 module.

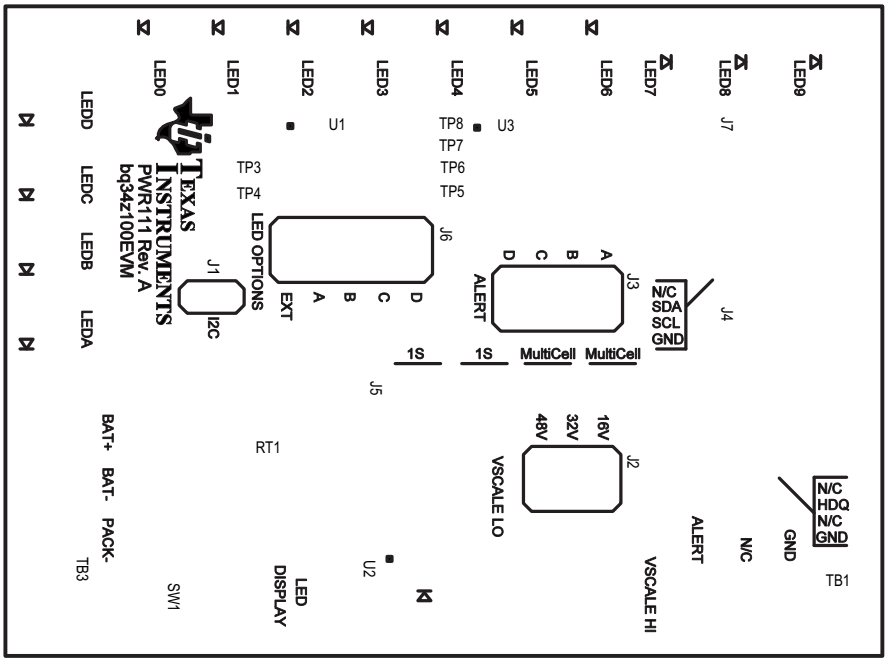

Figure 10. Top Silk Screen

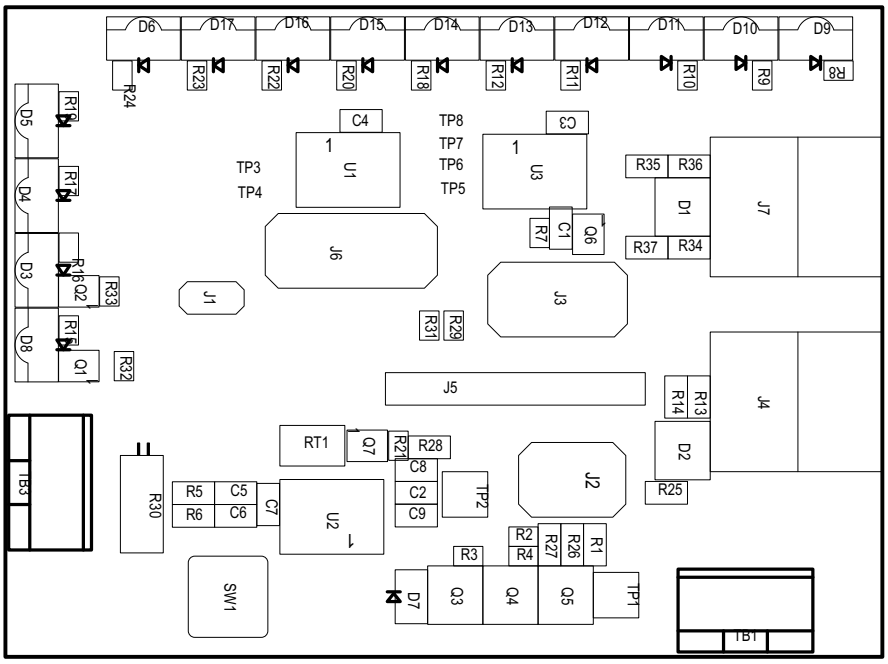

Figure 11. Top Assembly

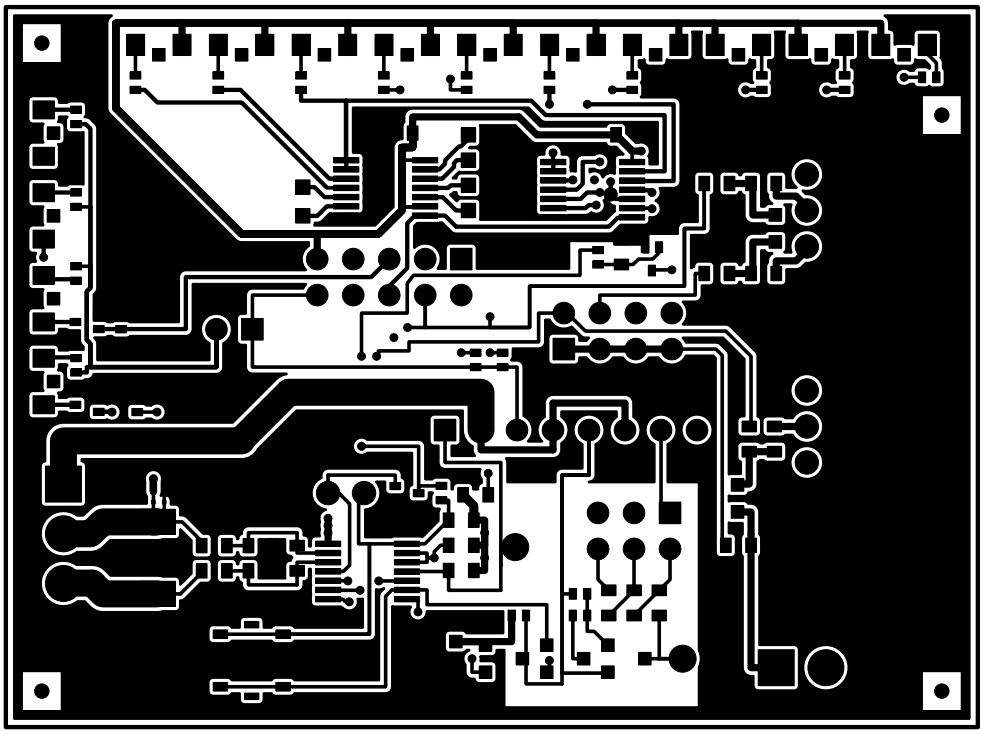

Figure 12. Top Layer

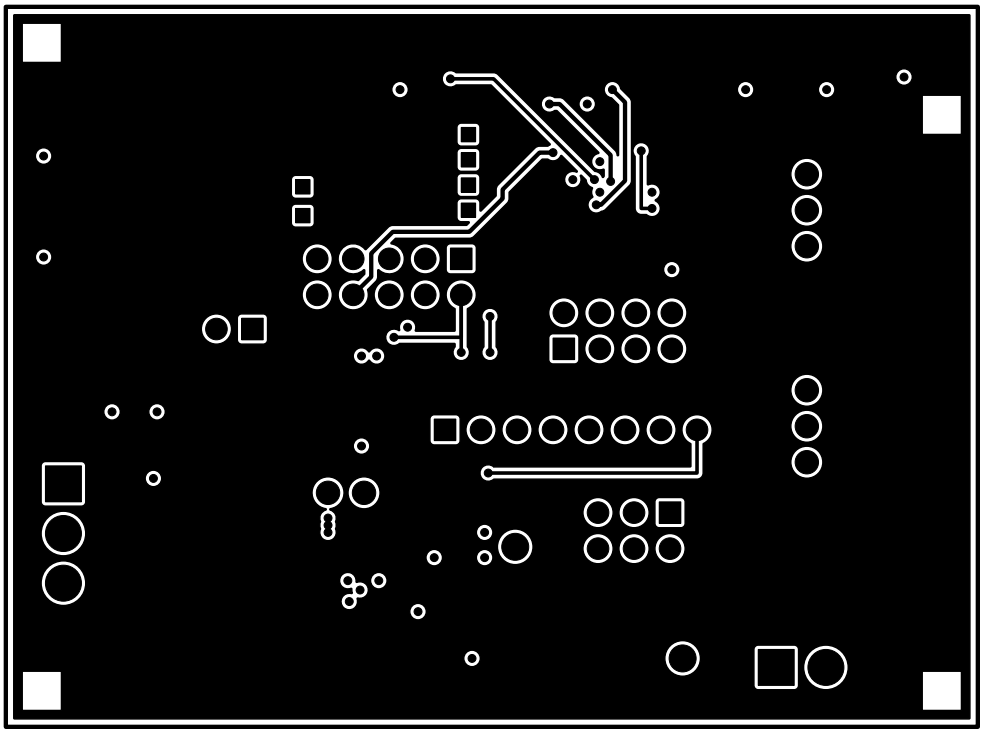

Figure 13. Internal Layer 1

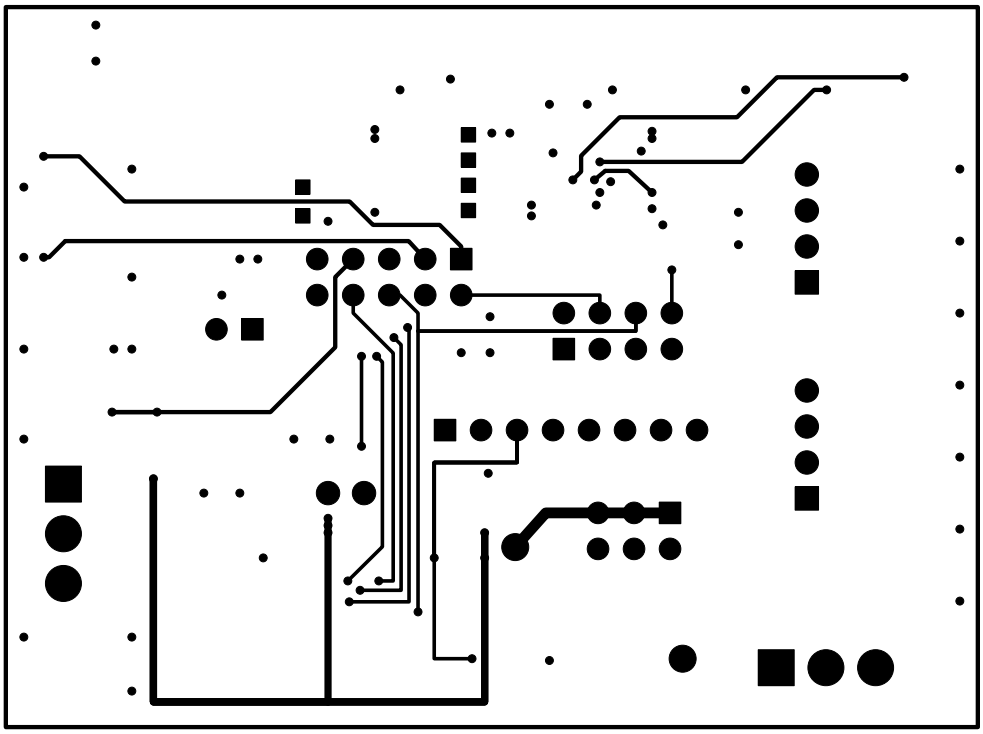

Figure 14. Internal Layer 2

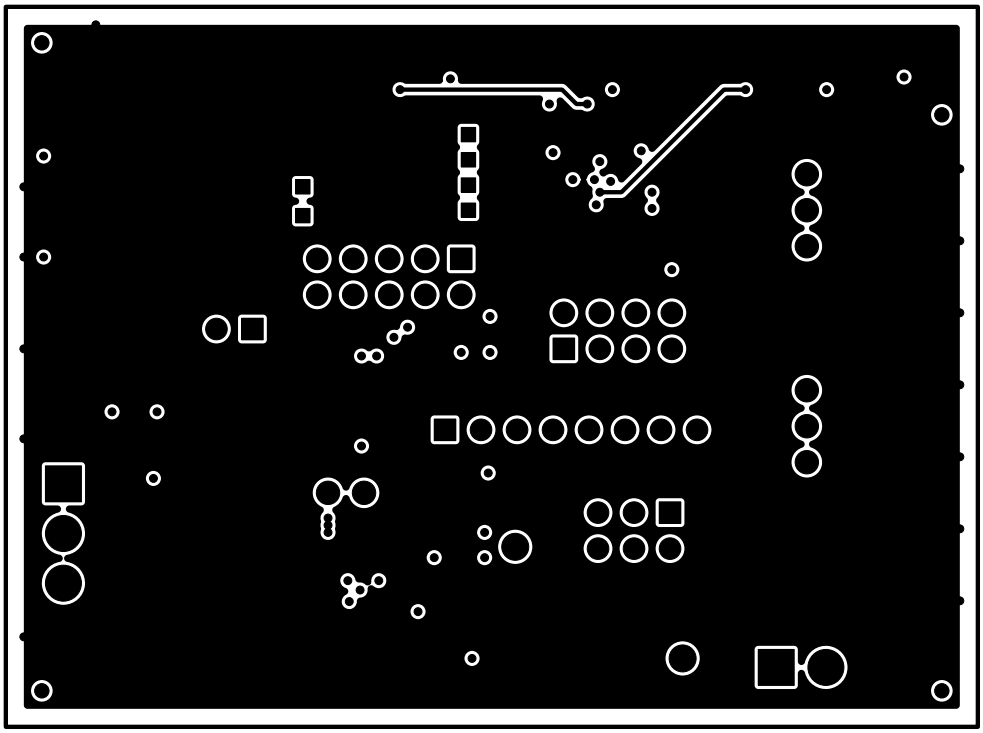

Figure 15. Bottom Layer

4.2 Schematic

Figure 16 shows the schematic for this EVM.

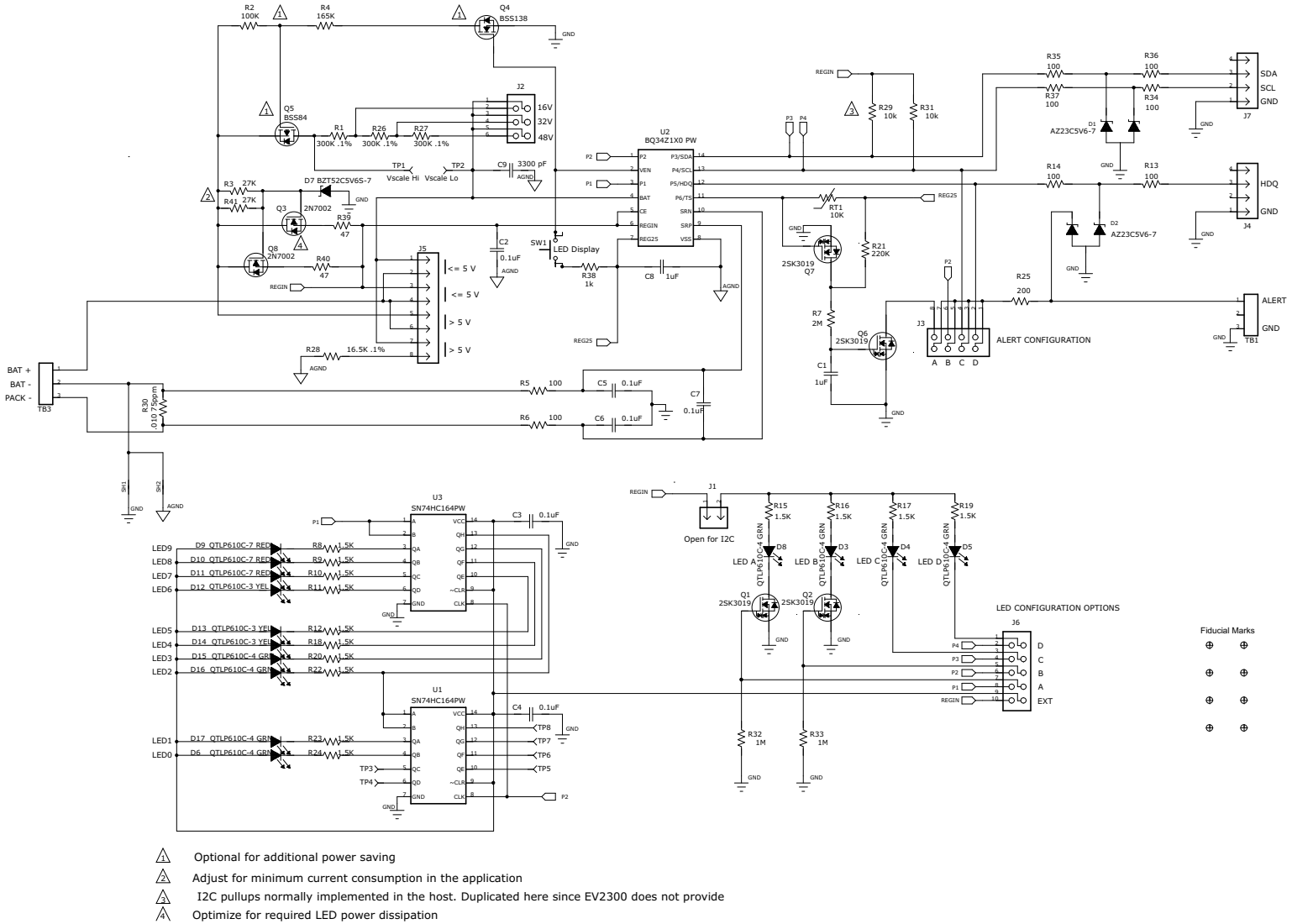

Figure 16. bq34z100EVM-003 Schematic

4.3 Bill of Materials

Table 2 lists the bill of materials (BOM) for this EVM.

Table 2. Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
2	C1, C8	1 µF	Capacitor, ceramic, 6.3 V, X7R, 20%	0603	Std	Any
6	C2–C7	0.1 µF	Capacitor, ceramic, 50 V, X7R, 20%	0603	Std	Any
1	C9	3300 pF	Capacitor, ceramic, 50 V, X7R, 20%	0603	Std	Any
2	D1, D2	AZ23C5V6-7	Diode, dual, Zener, 5.6 V, 300 mW	SOT23	AZ23C5V6-7	Diodes
3	D12–D14	QTLP610C-3 YEL	Diode, LED yellow, 30 mA	0.126 × 0.087 in	QTLP610C-3	Fairchild
8	D3–D6, D8, D15–D17	QTLP610C-4 GRN	Diode, LED green, 30 mA	0.126 × 0.087 in	QTLP610C-4	Fairchild
1	D7	BZT52C5V6S-7	Diode, Zener, 200 mW, 5.6 V	SOD-323	BZT52C5V6S-7	Diodes Inc
3	D9–D11	QTLP610C-7 RED	Diode, LED red, 30 mA	0.126 × 0.087 in	QTLP610C-7	Fairchild
1	J1	PEC02SAAN	Header, male 2-pin, 100 mil spacing,	0.100 in × 2	PEC02SAAN	Sullins
1	J2	PEC03DAAN	Header, male 2 × 3-pin, 100 mil spacing	0.20 in × 0.30	PEC03DAAN	Sullins
1	J3	PEC04DAAN	Header, male 2 × 4-pin, 100 mil spacing	0.20 × 0.40 in	PEC04DAAN	Sullins
2	J4, J7	22-05-3041	Header, friction lock assembly, 4-pin right angle	0.400 × 0.500	22-05-3041	Molex
1	J5	PEC08SAAN	Header, male 8-pin, 100 mil spacing,	0.100 in × 8	PEC08SAAN	Sullins
1	J6	PEC05DAAN	Header, male 2 × 5-pin, 100 mil spacing	0.100 in × 5 × 2	PEC05DAAN	Sullins
4	Q1, Q2, Q6, Q7	2SK3019	MOSFET, N ch, 30V, 100 mA, 8 Ω	SC-75A	2SK3019	Rohm
2	Q3, Q8	2N7002	MOSFET, N ch, 60 V, 115 mA, 1.2 Ω	SOT23	2N7000-7-F	Diodes Inc
1	Q4	BSS138	MOSFET, N ch, 50 V, 0.22 A, 3.5 Ω	SOT23	BSS138	Fairchild
1	Q5	BSS84	MOSFET, P ch, 50 V, 130mA, 10 Ω	SOT23	BSS84	Fairchild
3	R1, R26, R27	300 kΩ	Resistor, chip, 0.1W, 0.1%, ±25 ppm/C°	0603	RG1608P-304-B-T5	SSM
1	R2	100 kΩ	Resistor, chip, 1/16W, 1%	0402	Std	Std
2	R3, R41	27 kΩ	Resistor, chip, 1/16-W, 5%	0402	Std	Std
1	R21	220 kΩ	Resistor, chip, 1/16W, 5%	0402	Std	Std
1	R25	200 Ω	Resistor, chip, 1/16W, 5%	0603	Std	Any
1	R28	16.5 kΩ	Resistor, chip, 0.1W, 0.1%, ±25 ppm/C°	0603	RG1608P-1652-B-T5	SSM
2	R29, R31	10 kΩ	Resistor, chip, 1/16W, 5%	0402	Std	Std
1	R30	.010 Ω	Resistor, chip, 1/2W, 1%, ±75 ppm/C°	2010	WSL2010R0100FEA	Dale
2	R32, R33	1 MΩ	Resistor, chip, 1/16W, 5%	0402	Std	Std
1	R4	165 kΩ	Resistor, chip, 1/16W, 1%	0402	Std	Std
8	R5, R6, R13, R14, R34–R37	100 Ω	Resistor, chip, 1/16W, 5%	0603	STD	Any
1	R7	2 MΩ	Resistor, chip, 1/16W, 5%	0402	Std	Std
14	R8–R12, R15–R20, R22–R24	1 kΩ	Resistor, chip, 1/16W, 5%	0402	Std	Std
1	RT1	10 kΩ	Thermistor, NTC, 3 A	0.095 × 0.150 in	103AT-2	Semitec
1	SW1	EVQ-PLHA15	Switch, push button, momentary, N.O. low profile	0.200 × 0.200 in	EVQ-PLHA15	Panasonic
2	TB1, TB3	ED555/3DS	Terminal block, 3 pin, 6 A, 3.5 mm	0.41 × 0.25 in	ED555/3DS	OST
1	TP1	Vscale Hi	Test point, black, thru hole color keyed	0.100 × 0.100 in	5001	Keystone
1	TP2	Vscale Lo	Test point, black, thru hole color keyed	0.100 × 0.100 in	5001	Keystone
0	TP3–TP8	STD	Test point, 0.020 Hole		STD	STD
2	U1, U3	SN74HC164PW	IC, 8-Bit Parallel-Out Serial Shift Registers	TSSOP-14	SN74HC164PW	TI
1	U2	BQ34100PW-G1	IC, Gas gauge	TSSOP	BQ34Z100PW-G1	
1	–		PCB, 68 mm × 50 mm × 1 mm		PWR111	Any

5 Related Documentation from Texas Instruments

For related documentation, contact the TI field representative.

1. *bq34z100-G1 Wide Range Fuel Gauge with Impedance Track™ Technology* datasheet, SLUSBZ5

Revision History

Changes from Original (April 2012) to A Revision	Page
• Deleted the paragraphs in the Abstract and replace with new one.	1
• Deleted the second Itemized List from Kit Contents and replaced with new text	2
• Changed the text in the second and third column of the Ordering information	2
• Added Documentation and subheadings to the first section.	2
• Changed or rearranged most of this User Guide with new text, tables, and graphics.	3
• Changed Schematic.	19
• Changed *Bill of Materials.*	20

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

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 are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in 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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】

本開発キットは技術基準適合証明を受けておりません。

本製品のご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

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。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。

日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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

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

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

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

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