bq4050EVM-561 Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the bq4050. This EVM includes one bq4050 circuit module and an external current-sense resistor. A separate orderable EV2300 or EV2400 PC interface board for gas gauge along with a PC USB cable, and Microsoft® Windows® based PC software is needed when using this EVM. The circuit module includes one bq4050 integrated circuit and all other onboard components necessary to monitor and predict capacity for a system-side or removable battery pack fuel gauge solution. With the EV2300 or EV2400 users can:

- Read the bq4050 data registers
- Program the chipset for different configurations
- Log cycling data for further evaluation
- Evaluate the overall functionality under different charge and discharge conditions

Contents

List of Figures

List of Tables

1 Features

This EVM has the following features:

- Complete evaluation system for the bq4050 CEDV gas gauge
- Populated circuit module for quick setup
- Personal computer (PC) software and interface board for easy evaluation
- Software allows data logging for system analysis

1.1 Kit Contents

The following is a list of the contents included with the EVM:

- bq4050 and BQ296103 circuit module
- Cable to connect the EVM to an EV2300 or EV2400 communications interface adapter
- This EVM is used for the evaluation of bq4050. Visit the product Web folder at www.ti.com to properly configure the bq4050.

1.2 Ordering Information

Table 1 lists the EVM ordering information.

Table 1. Ordering Information

Part Number	EVM Part Number	Configuration	Chemistry
bq4050	bq4050EVM-561	1-, 2-, 3-, or 4-cell	Li-ion

1.3 bq4050 Circuits Module Performance Specification Summary

This section summarizes the performance specifications of the bq4050 circuit module.

Table 2. Performance Specification Summary

Specification	Min	Typ	Max	Units
Input Voltage Pack+ to Pack–	3	15	26	V
Charge and discharge current	0	2	7	A

2 bq4050EVM 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

The following items are required for setup and evaluation:

- bq4050 circuit module
- 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 bqStudio software setup program
- One-to-four battery cells or 1-kΩ resistors to configure a cell simulator
- DC power supply that can supply 16.8 V and 2 A. (Constant current and constant voltage capability is desirable.)

2.2 System Requirements

The bqStudio software requires Windows XP or later. Using later versions of Windows operating system can have issues with the USB driver support. The EV2300 USB drivers have been tested for Windows 98SE, but no assurance is made for problem-free operation with specific system configurations.

2.3 Software Installation

Find the latest software version of bqStudio on http://www.ti.com/tool/bqstudio. Search by part number for bq4050 to access the tool folder for the device. Use the following steps to install bq4050 bqStudio software.

1. Ensure that the EV2300 or EV2400 is not connected to the personal computer (PC) through the USB cable before starting this procedure.
2. Open the archive containing the installation package and copy its contents into a temporary directory.
3. Open the bqStudio installer file that was downloaded from the TI Web site.
4. Follow the on-screen instructions until completing the software installation.
5. Before starting the evaluation software, connect the EV2300 or EV2400 to the computer using the USB cable.
6. If EV2300 is connected, wait until the system prompt *New Hardware Found* appears. Choose *Select Location Manually* and use the **Browse** button to point to subdirectory TIUSBWin2K-XP-1.
7. Answer *Continue* to the warning that drivers are not certified with Microsoft.
8. If the EV2300 is connected, after the previous installation finishes, another system prompt *New Hardware Found* appears. Repeat steps 1 through 5, but specify the directory as TIUSBWin2K-XP-2.
9. Answer *Continue* to the warning that drivers are not certified with Microsoft. Driver installation is now finished.
10. For the EV2400, the driver should be installed along with software installation.

2.4 Troubleshooting Unexpected Dialog Boxes

The user downloading the files must be logged in as the administrator. The driver is not signed, so the administrator must allow installation of unsigned drivers in the operating system. If using Windows 7, install the software with administrator privileges.

2.5 EVM Connections

The bq4050 evaluation system comprises three hardware components: (1) the bq4050 circuit module, (2) the EV2300 or EV2400 PC interface board, and (3) the PC.

2.5.1 Connecting the bq4050 Circuit Module to a Battery Pack

Figure 1 illustrates the circuit module connections.

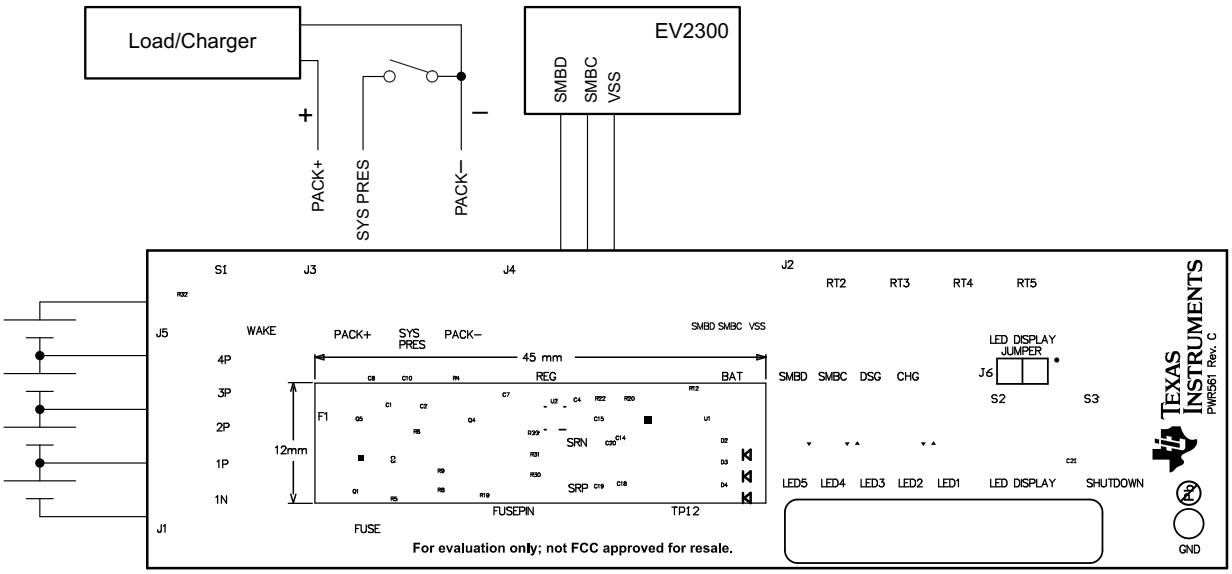

Figure 1. bq4050 Circuit Module Connection to Pack and System Load or Charger

2.5.2 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct connection to the battery pack (J1 and J5): 1N, 1P, 2P, 3P, 4P

  Attach the cells to the J1 and J5 terminal block. A specific cell connection sequence is not required; although, it is good practice to start with lowest cell in the stack (cell 1), then attach cells 2 through 4 in sequence. The U1 and U2 devices should not be damaged by other cell connection sequences, but there is a possibility that the bq296103 could blow the fuse in an application where the fuse is installed. Attaching cells starting with cell 1 should eliminate this risk. A short should be placed across unused voltage sense inputs (see Figure 2).

Number of Cells	J1 and J5 Terminal Block Connections								
	1N		1P		2P		3P		4P
1	⊖	-cell1+	⊖	short	⊖	short	⊖	short	⊖
2	⊖	-cell1+	⊖	-cell2+	⊖	short	⊖	short	⊖
3	⊖	-cell1+	⊖	-cell2+	⊖	-cell3+	⊖	short	⊖
4	⊖	-cell1+	⊖	-cell2+	⊖	-cell3+	⊖	-cell4+	⊖

Figure 2. Cell Connection Configuration

  A resistor cell simulator can be used instead of battery cells. Connect a resistor between each of the contacts on the J1 or J5 connector. For example, from 1N to 1P, from 1P to 2P, and so forth, until the desired number of cells has been achieved. A power supply can provide power to the cell simulator. Set the power supply to the desired cell voltage × the number of cells and attach the ground wire to 1N and the positive wire to 4P. For example, for a 3S configuration with a 3.6-V cell voltage, set the power supply to 3 × 3.6 = 10.8 V.

- Charger/load connection (J3 and J4): PACK+ and PACK–

  Attach the load or power supply to the J3 or J4 terminal block. The positive load or power supply wire should be connected to at least one of the first two terminal block positions labeled PACK+. The ground wire for the load or power supply should be connected to the last terminal block positions labeled PACK–.

- I2C communication port (J2): SMBD, SMBC, and VSS

  Attach the communications interface adapter cable to J2 and to the SMB port on the EV2300.
- Signal outputs (J3): SYS_PRES

  To start charge or discharge test, connect the SYS_PRES position on the J3 terminal block to PACK–. The SYS_PRES can be left open if the non-removable (NR) bit is set to 1 in the *Pack Configuration A* register. To test sleep mode, disconnect the SYS_PRES pin.
- Wake-up the device up from shutdown (WAKE)

  Press the **Wake** pushbutton switch to temporarily connect BAT+ to PACK+. This applies voltage to the PACK pin on the bq4050 to power-up the regulators and start the initialization sequence.
- Parameter setup

  The default data flash settings configure the device for 3-series Li-Ion cells. Change the | *Data Flash* | *Settings* | *DA Configuration* register to set up the number of series cells to match the physical pack configuration. 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 bq4050 technical reference manual (TRM) (SLUSC67) for parameter settings.

2.5.3 Pin Description

Table 3 lists the EVM pin descriptions.

Table 3. EVM Pins Descriptions

Pin Name	Description
PACK+	Pack positive terminal
PACK–	Pack negative terminal
4P	Positive connection to Cell #4
3P	Positive connection to Cell #3
2P	Positive connection to Cell #2
1P	Positive connection to Cell #1
1N	Negative connection to Cell #1
SYS_PRES	Connection to pull SYS_PRES to PACK- to enable the FETs
SMBD	SMBus communication data line
SMBC	SMBus communication clock line
VSS	Ground return for the SMBus signals

2.6 PC Interface Connection

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

1. Connect the bq4050-based EVM to the EV2300 or EV2400 using wire leads as shown in Table 4.
2. Connect the PC USB cable to the EV2300 or EV2400 and the PC USB port.

Table 4. Circuit Module to EV2300 or EV2400 Connections

bq4050EVM	EV2300	EV2400
SMBD	SMBD	PORT1 - SDA
SMBC	SMBC	PORT1 - SCL
VSS	GND	PORT1 - VSS

The bq4050EVM-561 is now set up for operation.

3 Operation

This section details the operation of the bq4050 bqStudio software.

3.1 Starting the Program

With the EV2300 or EV2400 and the bq4050EVM connected to the computer, run bqStudio from the *Desktop* or *installation* directory. The window consists of a tools panel at the top and other child windows that can be hidden, docked in various positions, or allowed to float as separate windows. When bqStudio first starts up the *DashBoard*, the *Registers*, and *Commands* windows should be open. Additional windows can be added by clicking the corresponding icons in the tools panel at the top of the main window.

The **Scan** (continuous scan) or **Refresh** (single time scan) buttons can be clicked in order to update the data in the *Registers* and *Data Memory* windows.

bqStudio provides a logging function which logs selected *Data Registers* last received from the bq4050. To enable this function, click the **Start Log** button. The default elapsed interval is 4000 milliseconds, to change this interval, go to *Windows*, select *Preferences*, choose *Registers*, and change the *Scan/Log Interval* from 4000 to 1000 milliseconds. There is no need to log faster than 1 second as the gauge will not update the registers faster than 1 second.

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.

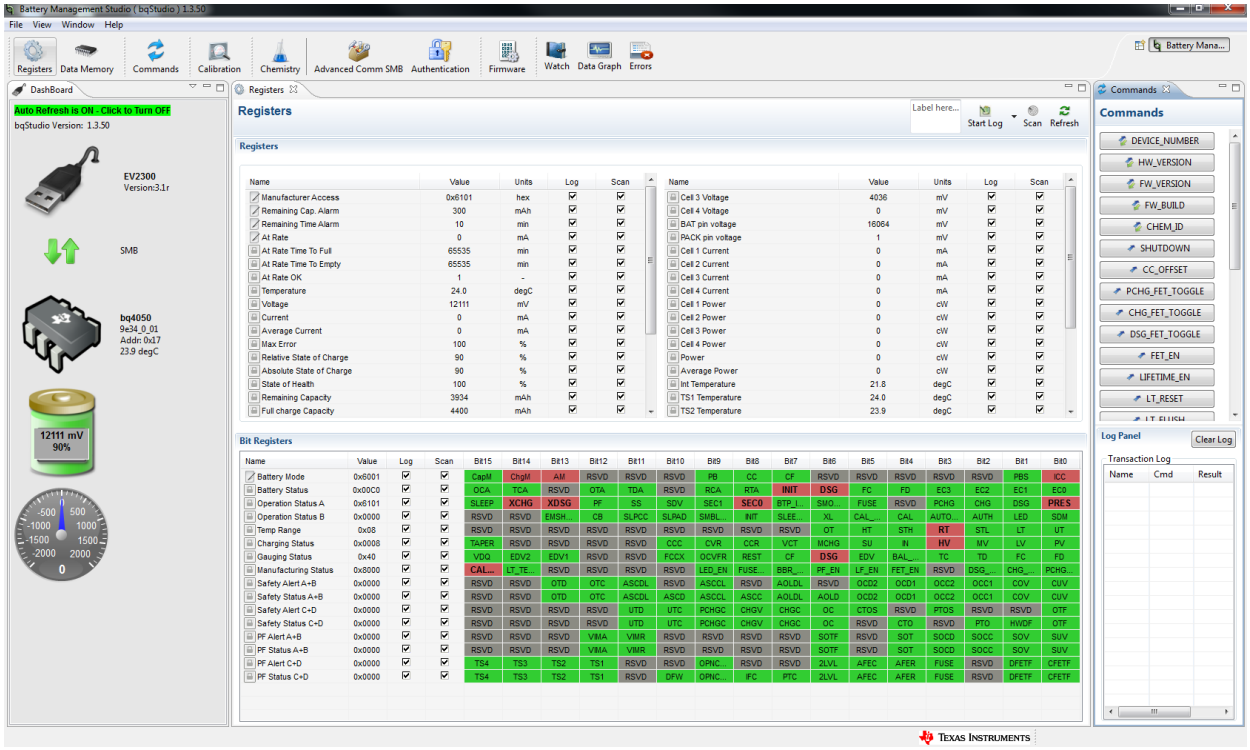

Figure 3. Registers Screen

3.2 Setting Programmable bq4050 Options

The bq4050 comes configured per the default settings detailed in the bq4050 TRM (SLUSC67). Ensure that the settings are correctly changed to match pack and application for the bq4050 solution being evaluated.

IMPORTANT: The bq4050 comes up **UNSEALED** but **not** in **FULL ACCESS**. The keys to enter **FULL ACCESS** must be sent to the device before being able to access the data memory.

IMPORTANT: The correct setting of these options is essential to get the best performance. The settings can be configured using the *Data Memory* window (Figure 4).

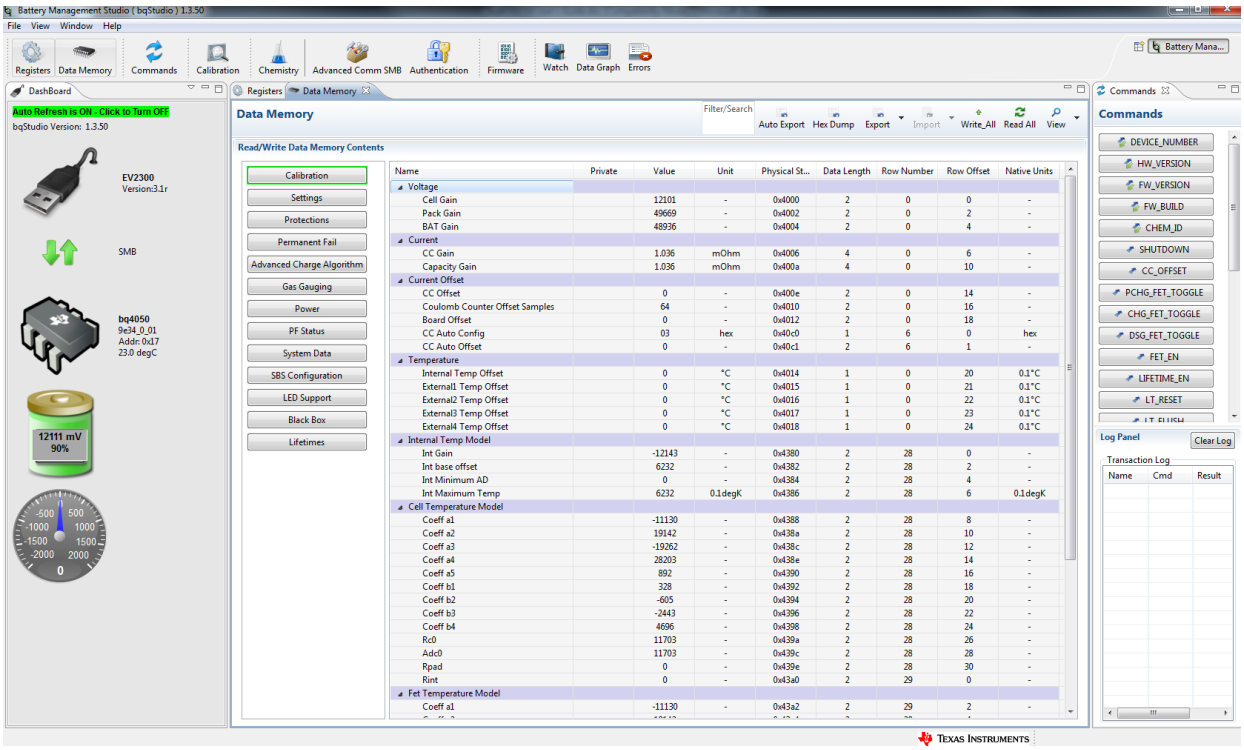

Figure 4. Data Memory Screen

To read all the data from the bq4050 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 bq4050 data memory. If the *Gauge Dashboard* is not displaying any information, then the bq4050 may not be supported by the bqStudio version being used, a bqStudio upgrade may be required.

3.3 Calibration

The bq4050EVM must be calibrated to ensure accurate value reporting. This can be done by going to the *Calibration* window in bqStudio (Figure 5).

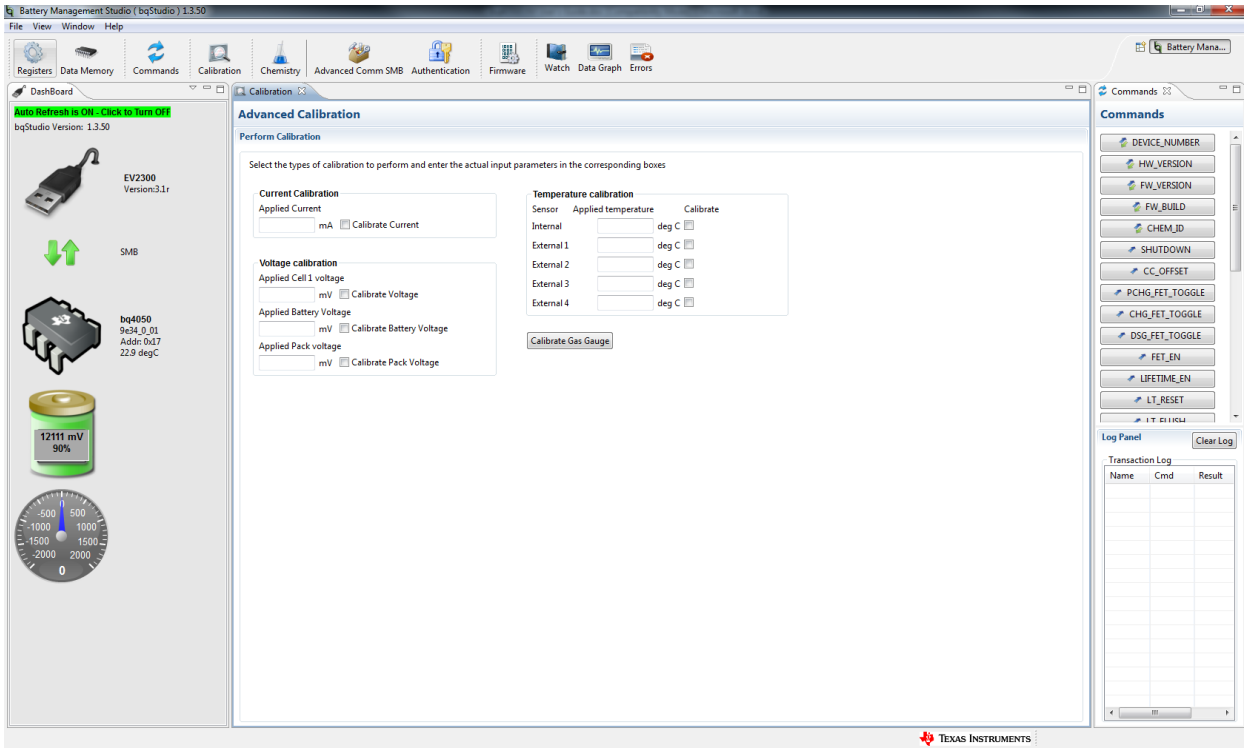

Figure 5. Calibration Screen

3.3.1 Voltage Calibration

The following list provides information about voltage calibration:

- Measure the voltage from Cell 1 to 1N and enter this value in the *Applied Cell 1 Voltage* field and select the *Calibrate Voltage* box.
- Measure the voltage from BAT+ to BAT– and enter this value in the *Applied Battery Voltage* field and select the *Calibrate Battery Voltage* box.
- Measure the voltage from PACK+ to PACK– and enter this value in the *Applied Pack Voltage* field and select the *Calibrate Pack Voltage* box. If the voltage is not present, turn the charge and discharge FETs on by pressing the **FET_EN** button on the *Commands* panel.
- 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

The following list provides information about temperature calibration:

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

3.3.3 Current Calibration

The *Board Offset* calibration option is not offered in *Battery Management Studio*, because it is not required when using the bq4050EVM. The *Board Offset* calibration option is available in bqProduction.

- Connect and measure a 2-A current source from 1N (–) and Pack– (+) to calibrate without using the FETs.
- 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.

NOTE: Current can also be calibrated using the FETs. Measure the current in the discharge path and enter this value in the *Applied Current* field.

3.4 Setting the CEDV Parameters

To ease evaluation of the bq4050, obtain the CEDV parameters from our online gauging parameter calculator (GPC) for CEDV gauges tool (www.ti.com/tool/GPCCEDV). After programming the design parameters to the gauge, the EVM can be used to obtain the experimental data needed to calculate the CEDV coefficients.

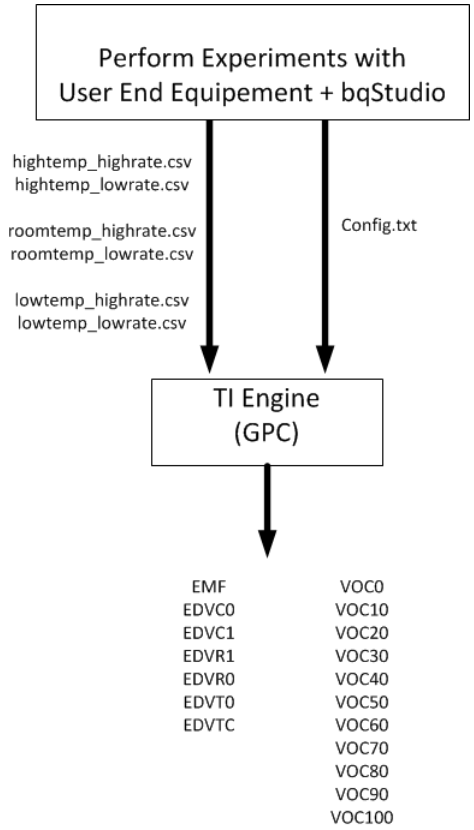

Figure 6. CEDV Coefficients Calculation Flow

The equipment necessary is as follows:

- bqStudio software
- bq4050EVM-561
- Power supply to charge the pack and a load to discharge the pack.

Refer to *CEDV Data Collection for Gauging Parameter Calucalator (GPC)* (SLUUB45) for a detail explanation of the CEDV coefficients data collection process and GPC tool configuration.

3.5 Firmware Screen

Pressing the **Firmware** button selects the *Firmware Update* window. This window allows exporting and importing the device firmware.

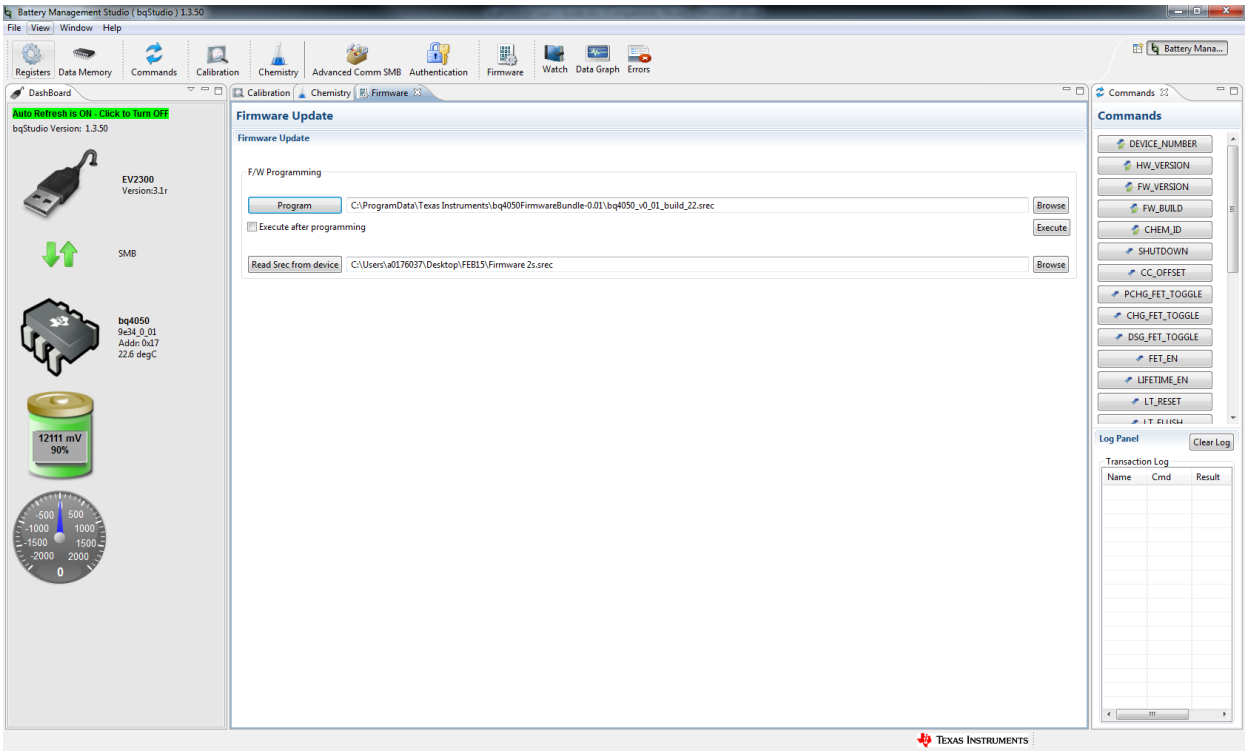

Figure 7. Firmware Screen

The upper section of the **Firmware** *screen is used to initialize the device by loading the default .srec into the flash memory (see Figure 7).*

- Search for the .srec file using the **Browse** button.
- Select the *Execute after programming* box to automatically return the device to Normal mode after programming has completed.
- Press the **Program** button and wait for the download to complete.

3.5.1 Programming the Flash Memory

The lower section of the Firmware screen is used to export all of the flash memory from the device (see Figure 7).

- Press the **Browse** button and enter an .srec filename.
- Pressing the **Read Srec from device** button saves the flash memory contents to the file. Wait for the download to complete.

3.6 Advanced Comm SMB Screen

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

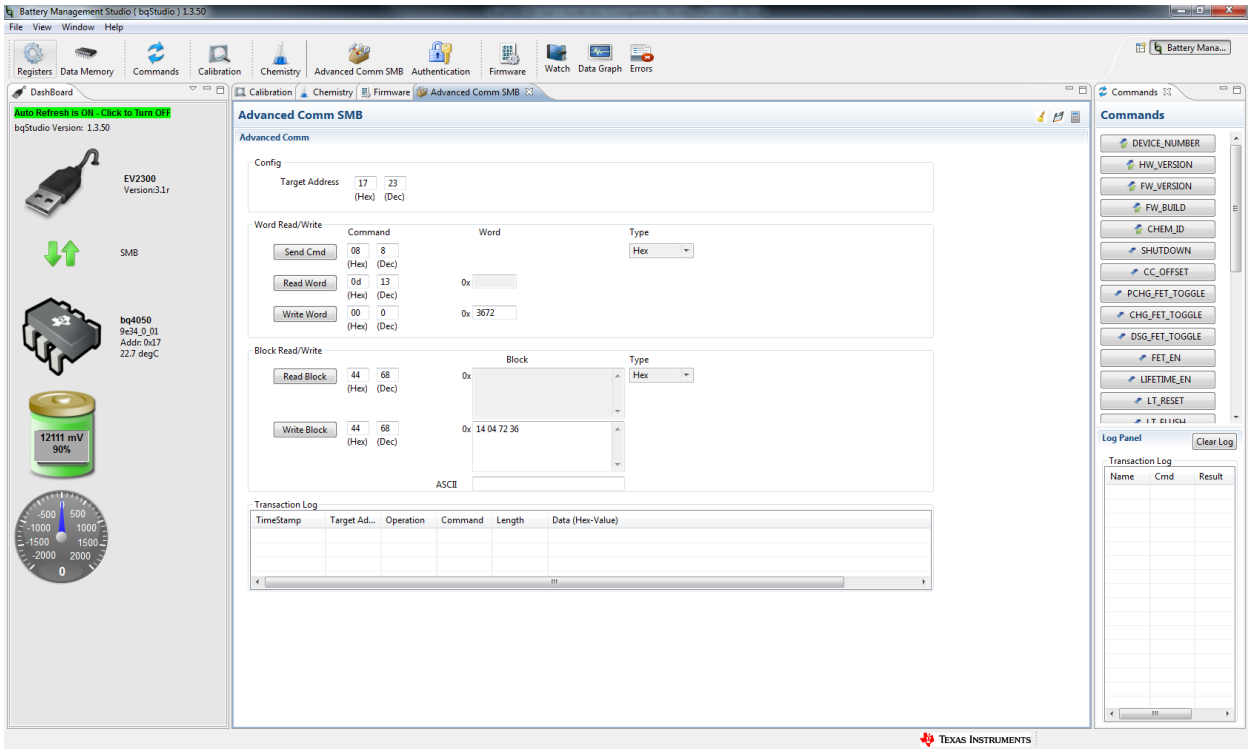

Figure 8. Advanced Comm SMB Screen

Examples:

Reading an SMB Command.

- Read SBData Voltage (0x09)
  - SMBus Read Word. Command = 0x09
  - Word = 0x3A7B, which is hexadecimal for 14971 mV

Sending a MAC Gauging() to enable the FETs via ManufacturerAccess().

- With FETs disabled, send Gauging() (0x0022) to ManufacturerAccess().
  - SMBus Write Word. Command = 0x00. Data = 00 22

Reading Operation Status() (0x0054) via ManufacturerAccess()

- Send the Operation Status() to ManufacturerAccess()
  - SMBus Write Word. Command = 0x00. Data sent = 00 54
- Read the result from ManufacturerData()
  - SMBus Read Block. Command = 0x23. Data read = 81 61 00 00
  - That is 0x6181 for Operation Status A and 0x0000 for Operation Status B.

4 Circuit Module Physical Layout, Bill of Materials and Schematic

This section contains the board layout, bill of materials, and schematic for the bq4050 circuit module.

4.1 Board Layout

This section shows the printed-circuit-board (PCB) layers (Figure 9 through Figure 16), and assembly drawing for the bq4050 module.

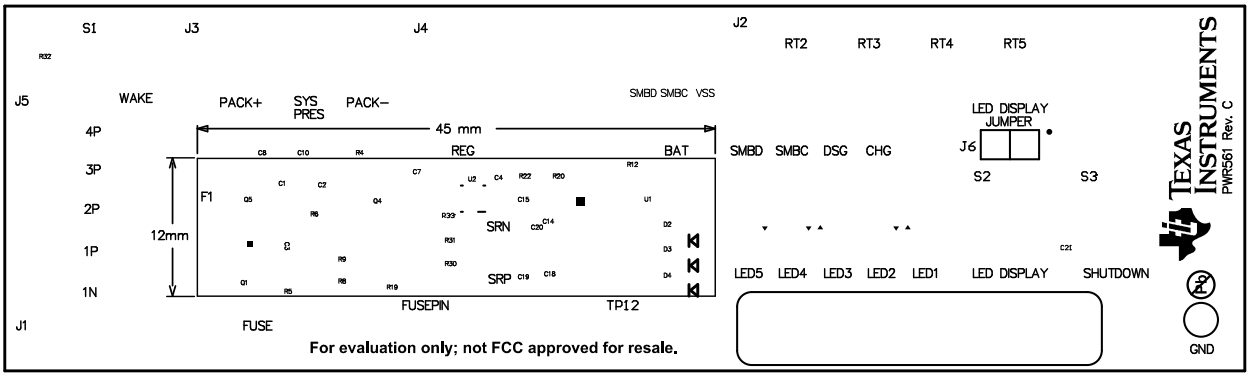

Figure 9. Top Silkscreen

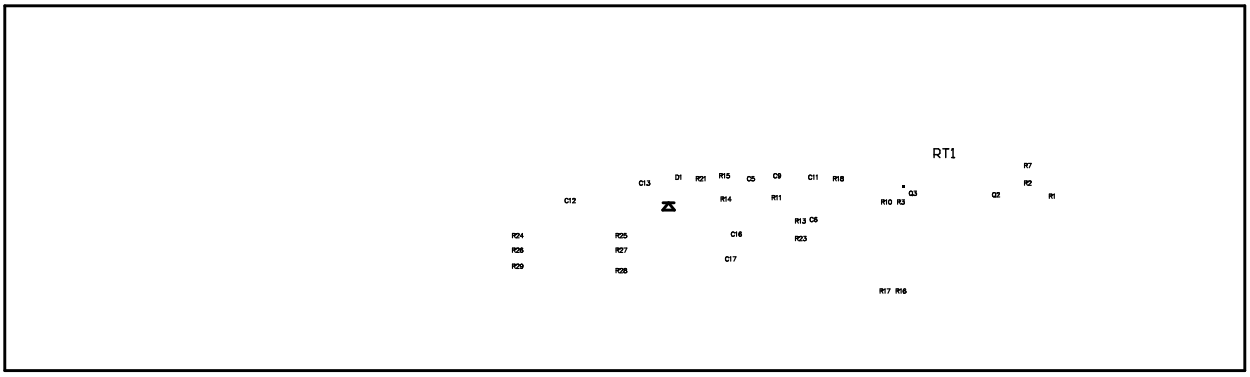

Figure 10. Bottom Silk Screen

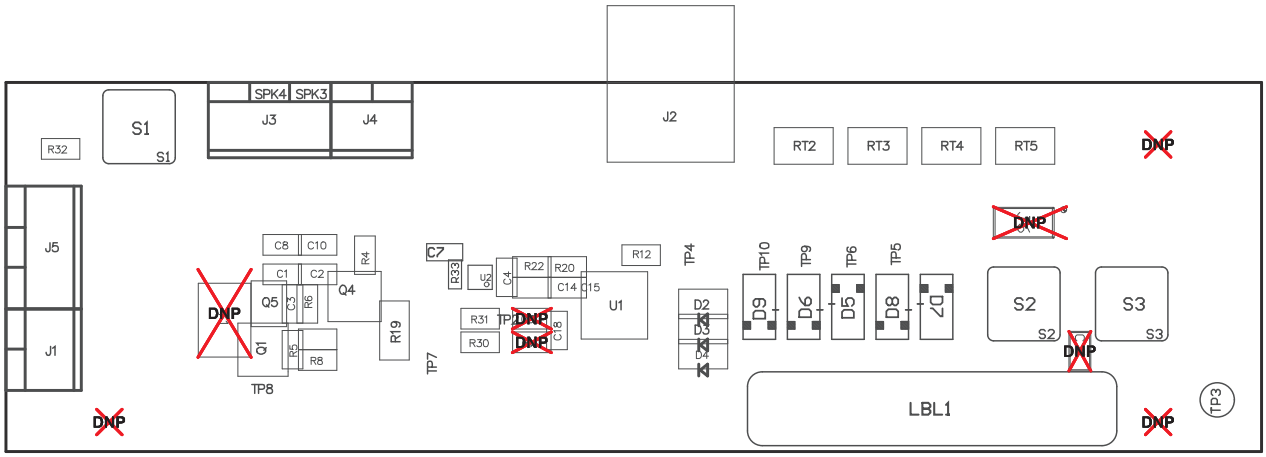

Figure 11. Top Assembly

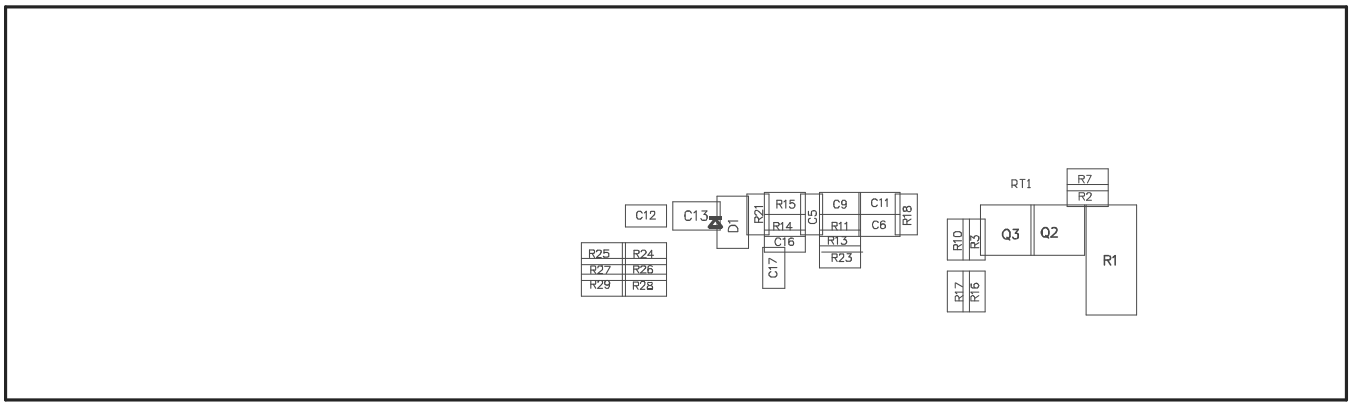

Figure 12. Bottom Assembly

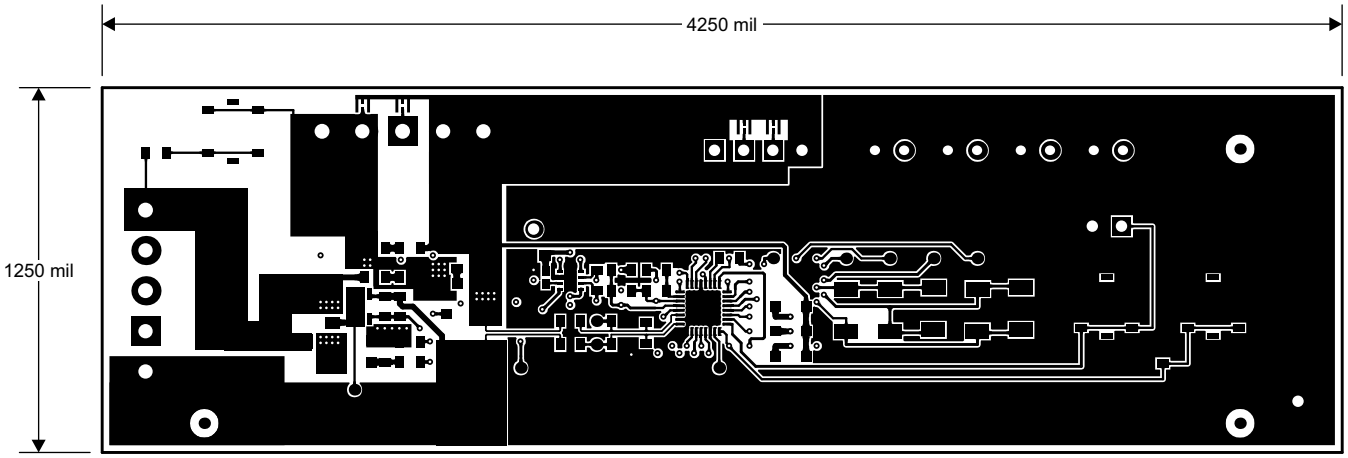

Figure 13. Top Layer

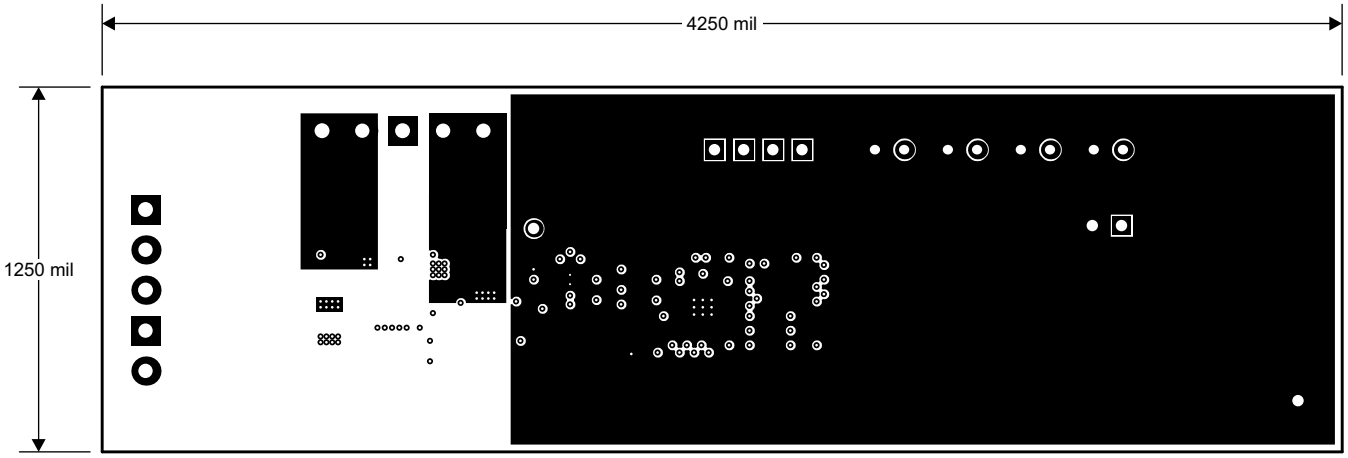

Figure 14. Inner Layer 1

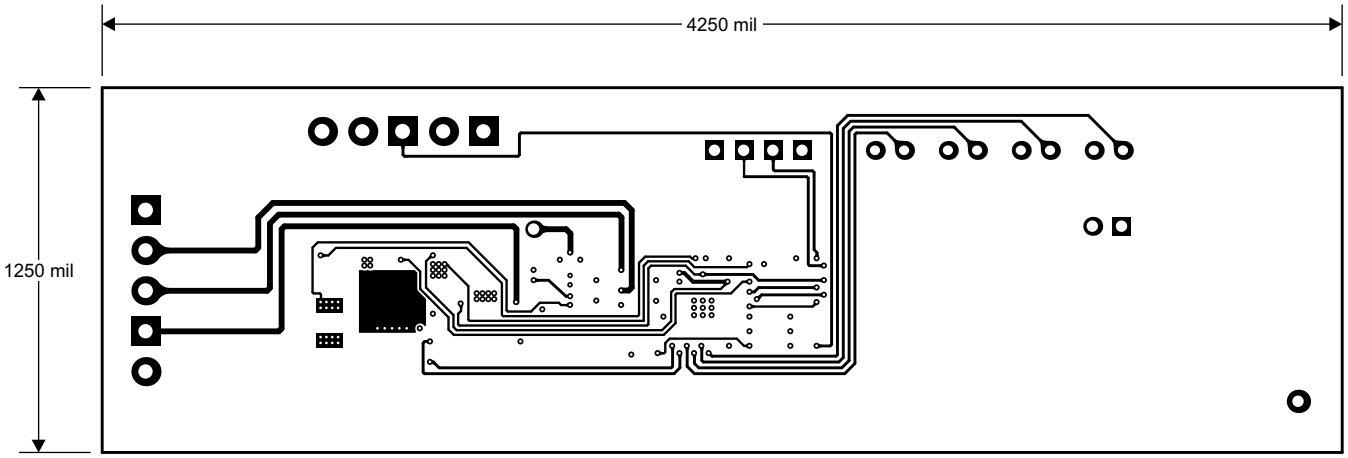

Figure 15. Inner Layer 2

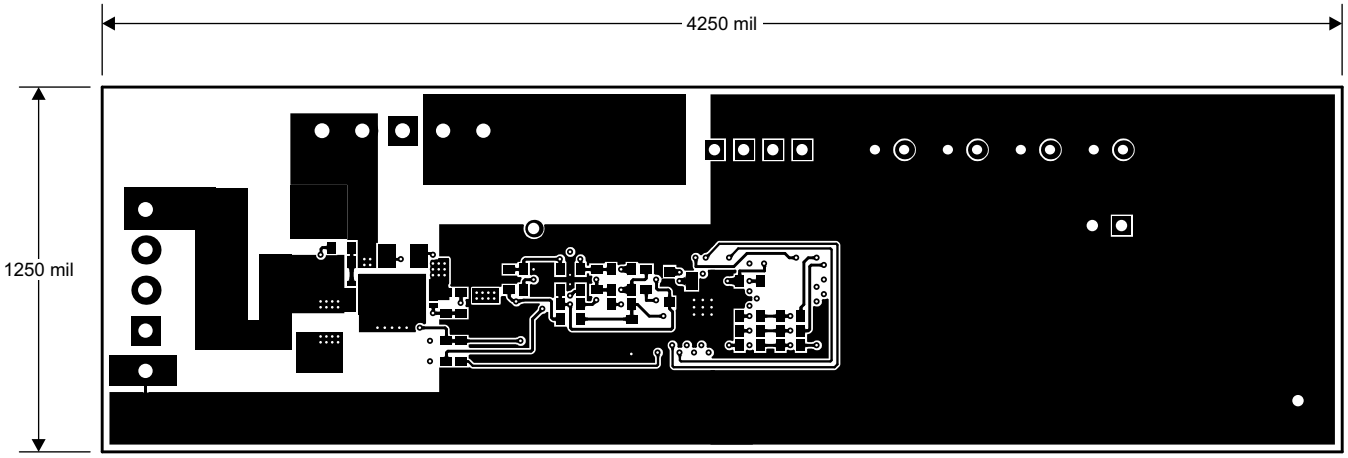

Figure 16. Bottom Layer

4.2 Bill of Materials

Table 5 lists the BOM for this EVM.

Table 5. Bill of Materials

Count	Ref Designator	Value	Description	Size	Part Number	MFR
16	C1-6, C8-12, C14-18	0.1uF	Capacitor, Ceramic, 50 V, X7R, 20%	0603	C0603C104M5RACTU	Kemet
1	C7	0.47uF	Capacitor, Ceramic, 0.47 µF, 10 V, X5R, 10%	0603	C0603C474K8PACTU	Kemet
1	C13	2.2uF	Capacitor, Ceramic, 25 V, X7R, 20%	0805	C2012X7R1E225M085AB	TDK
0	C19-21	DNP	Capacitor, Ceramic, 50 V, X7R, 20%	0603	C0603C104M5RACTU	Kemet
1	D1	BAT54HT1G	Diode, Schottky, 200-mA, 30-V	SOD323	BAT54HT1G	On Semi
3	D2-4	MM3Z5V6C	Diode, Zener, 5.6V, 200mW	SOD323	MM3Z5V6C	Fairchild
5	D5-9	SML-X23GC	LED 2X3MM 565NM GRN WTR CLR SMD	1206	SML-X23GC	Lumex
0	F1	DNP	Fuse, Slo-Blo Ceramic, xxA, yyyV	SFDxxx	SFDxxxx	Sony
1	R1	300	Resistor, Thick Film, 1.5W, 5%	2512	CRCW2512300RJNEGHP	Vishay
3	R2-3 R5	10M	Resistor, Chip, 1/10-W, 5%	0603	CRCW060310M0JNEA	Vishay
3	R4 R12 R32	10K	Resistor, Chip, 1/10-W, 5%	0603	CRCW060310K0JNEA	Vishay
1	R6	51K	Resistor, Chip, 1/10-W, 5%	0603	CRCW060351K0JNEA	Vishay
5	R7-8 R10 R16-17	5.1K	Resistor, Chip, 1/10-W, 5%	0603	CRCW06035K10JNEA	Vishay
10	R9, R11, R20-23, R25, R27, R30-31	100	Resistor, Chip, 1/10-W, 5%	0603	CRCW0603100RJNEAHP	Vishay
5	R13-15 R18 R29	1K	Resistor, Chip, 1/10-W, 5%	0603	CRCW06031K00JNEA	Vishay
1	R19	0.001 50ppm	Resistor, Metal Foil, 1 watt, ± 1%	1206	CSR1206-0R001F1	Riedon
3	R24 R26 R28	200	Resistor, Chip, 1/10-W, 5%	0603	CRCW0603200RJNEA	STD
2	J1 J4	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED555/2DS	OST
1	J2	22-05-3041	Header, Friction Lock Ass'y, 4-pin Right Angle,	0.400 x 0.500 inch	22-05-3041	Molex
2	J3 J5	ED555/3DS	Terminal Block, 3-pin, 6-A, 3.5mm	0.41 x 0.25 inch	ED555/3DS	OST
0	J6	DNP	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
1	RT1	10K	Thermistor, PTC, 5%	1206	TFPT1206L1002JV	Vishay
4	RT2-5	10K	Thermistor, NTC, 3-A	0.095 X 0.150 inch	103AT-2	Semitec
3	S1, S2, S3	EVQ-PLHA15	Switch, Push button, Momentary, 1P1T, 50-mA, 12-V	0.200 x 0.200 inch	EVQ-PLHA15	Panasonic
1	TP3	5001	Test Point, Black, Thru Hole Color Keyed	TH-40	5001	Keystone
1	Q1	FDN358P	MOSFET, Pch, -30V, -1.5A, 125 milliohm	SOT23	FDN358P	Fairchild

4.3 Schematic

Figure 17 illustrates the schematic for the EVM.

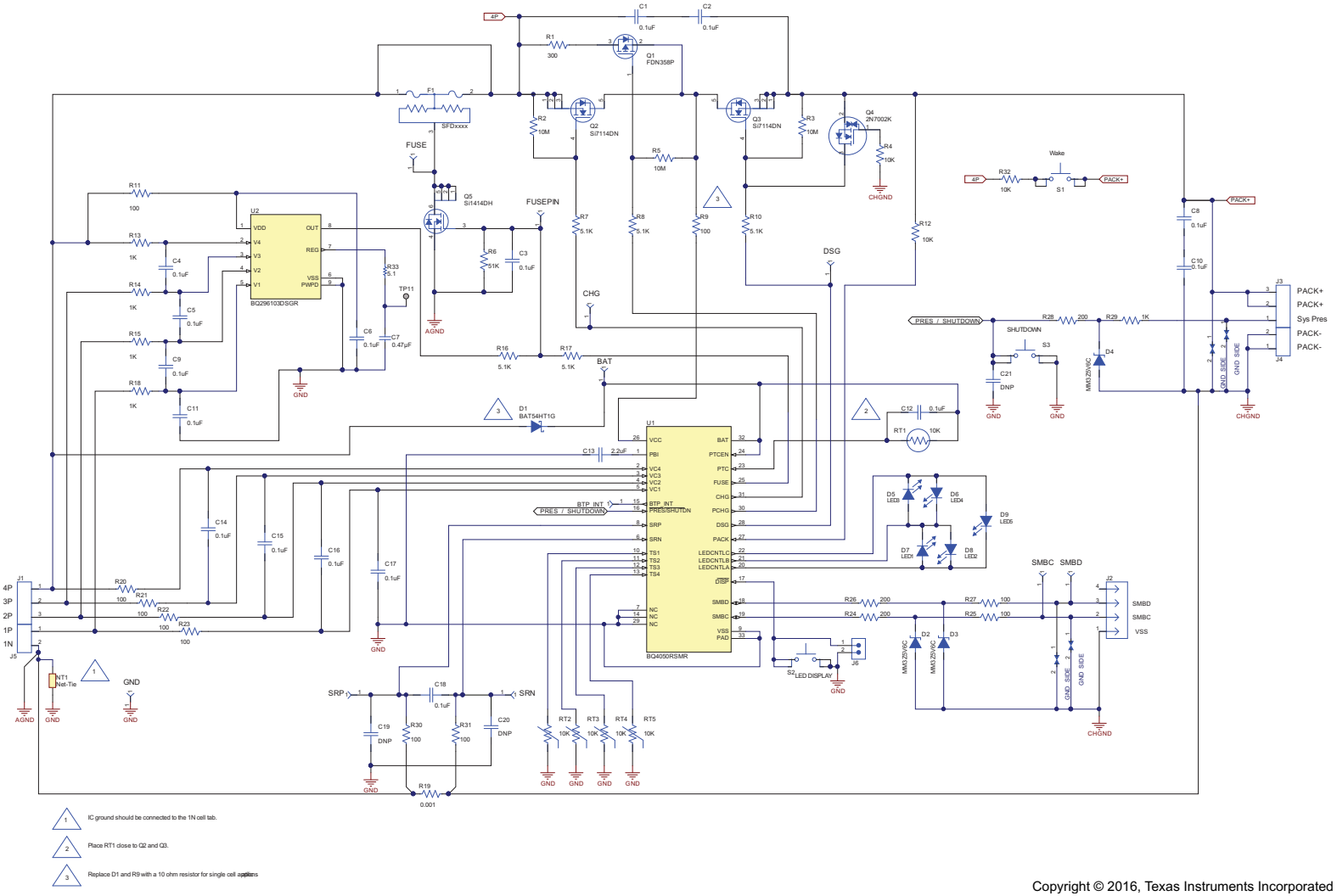

Figure 17. bq4050EVM Schematic

5 Related Documentation from Texas Instruments

Please contact the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center (PIC) at (972) 644-5580 for additional support. 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.

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.

【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】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもの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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

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.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265