EVM User's Guide: BQ41Z50EVM

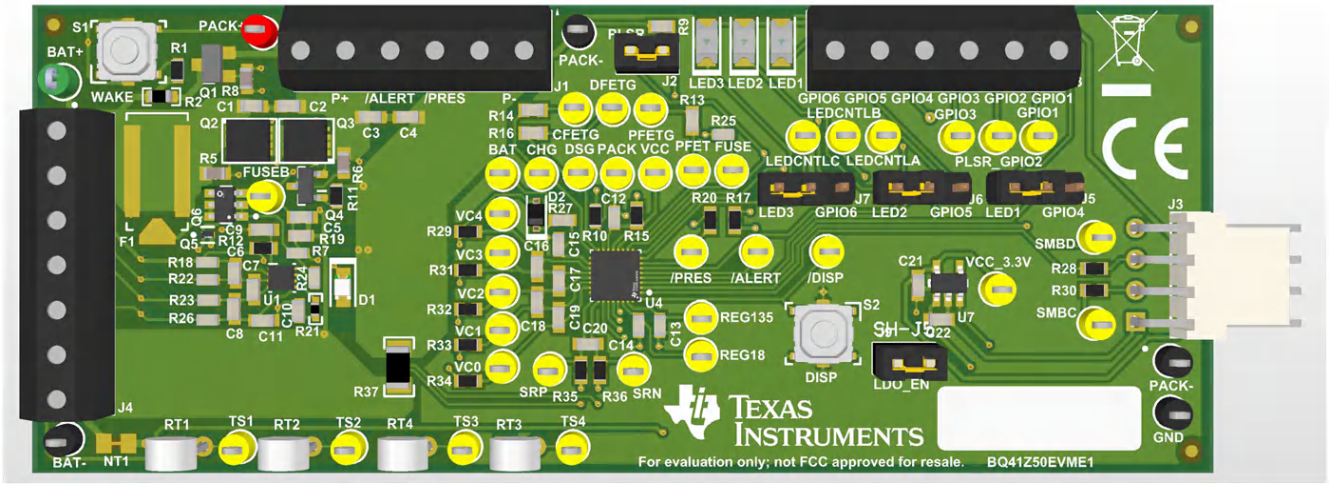
BQ41Z50 Li-Ion Battery Pack Manager Evaluation Module

Description

The BQ41Z50EVM is a complete system useful for evaluating the functionality of the BQ41Z50 fuel gauge. This gauge is appropriate for applications powered by multi-cell battery systems. The EVM includes one BQ41Z50 circuit module, a current sense resistor, and four thermistors. This evaluation module (EVM) is a complete evaluation system for the BQ41Z50 battery management system.

Features

- Complete evaluation system for the BQ41Z50EVM Li-Ion Battery Pack Manager Evaluation Module and BQ296103 independent overvoltage protection IC
- Populated circuit module for quick setup
- Software that allows data logging for system analysis



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1 Evaluation Module Overview

1.1 Introduction

The EVM includes one BQ41Z50 and BQ296xxx circuit module and a link to Microsoft® Windows® based PC software. The circuit module includes one BQ41Z50 integrated circuit, one BQ296103, and all other onboard components necessary to monitor and predict capacity, perform cell balancing, monitor critical parameters, protect the cells from overcharge, over-discharge, short-circuit, and overcurrent in 2-, 3-, or 4-series cell Li-ion or Li-polymer battery packs. The circuit module connects directly across the cells in a battery. With the EV2400 interface board and software, the user can read the BQ41Z50 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the design under different charge and discharge conditions.

1.2 Kit Contents

- BQ41Z50 and BQ296103 circuit module
- Cable to connect the EVM to an EV2400 communications interface adapter

1.3 Specification

This section summarizes the performance specifications of the BQ41Z50EVM and BQ296103EVM.

Table 1-1. BQ41Z50 and BQ296103 Circuit Module Performance Specification Summary

Specification	Min	Typ	Max	Unit
Input voltage Pack+ to Pack–	6	15	26	V
Charge and discharge current	0	2	7	A

1.4 Device Information

For complete ordering information, see the product page at www.ti.com.

Table 1-2. Ordering Information

EVM Part Number	Chemistry	Configuration	Capacity
BQ41Z50EVM	Li-ion	2-, 3-, or 4-cell	Any

For information on device firmware and hardware, see the *BQ41Z50 2-Series, 3-Series, and 4-Series Cell Li-Ion Battery Pack Manager with Dynamic Z-Track™* data sheet and the *BQ41Z50 Technical Reference Manual* on www.ti.com.

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2 BQ41Z50EVM Quick Start Guide

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

2.1 Items Needed for EVM Setup and Evaluation

- BQ41Z50 or BQ296103 circuit module
- EV2400 communications interface adapter
- Cable to connect the EVM to an EV2400 communications interface adapter
- USB cable to connect the communications interface adapter to the computer
- Computer setup with Windows 7, or higher, operating system
- Access to the Internet to download the Battery Management Studio software setup program.
- Two-to-four battery cells or 1kΩ resistor divider.
- A DC power supply that can supply 16.8V and 2A (constant current and constant voltage capability is desirable)

2.2 Software Installation

Find the latest software version in the BQ41Z50 tool folder on www.ti.com. Use the following steps to install the BQ41Z50 Battery Management Studio software:

1. Download and run the Battery Management Studio setup program from the Development Tools section of the BQ41Z50EVM product folder on www.ti.com. See Section 4.1 for detailed information on using the tools in the Battery Management Studio.

2.3 EVM Connections

This section covers the hardware connections for the EVM. See Figure 2-1.

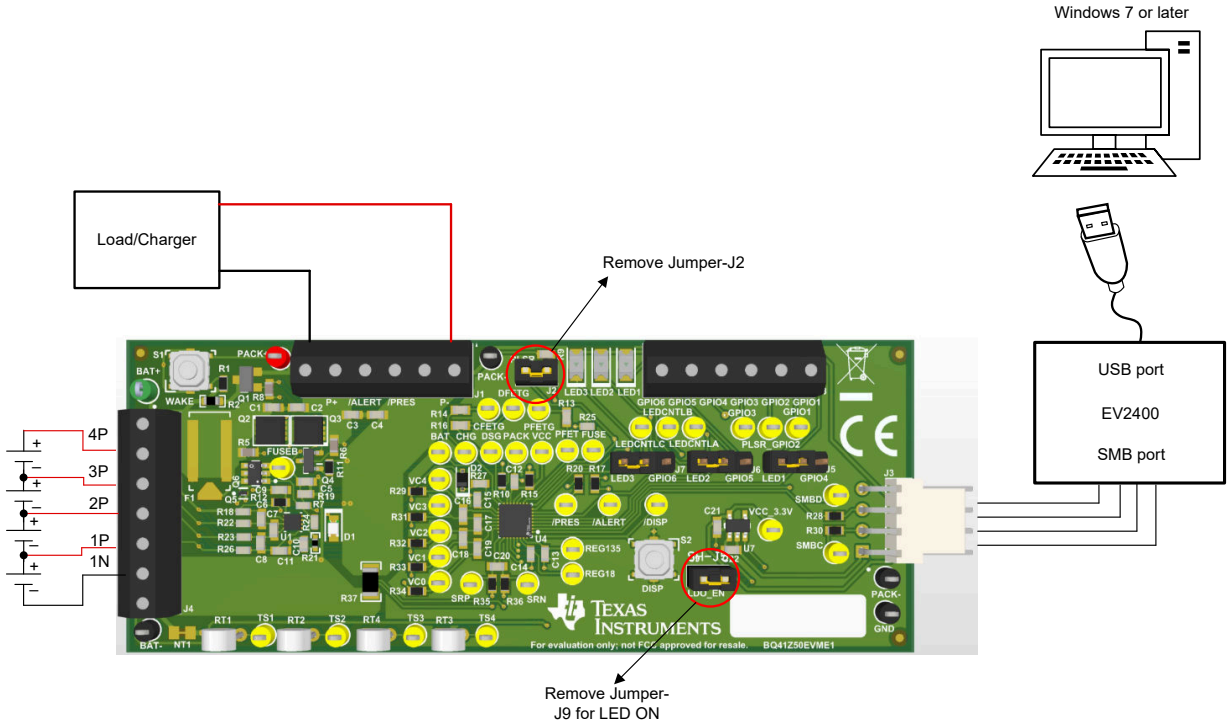

Figure 2-1. BQ41Z50 Circuit Module Connection to Cells and System Load or Charger

Note

Make sure to remove J2 before programming. If J2 is installed while programming, then this can damage the device and the passive components around.

- Direct connection to the cells: 1N (BAT–), 1P, 2P, 3P, 4P (BAT+)

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Attach the cells as shown above in Figure 2-1. A specific cell connection sequence is not required; although, a good practice is to start with lowest cell in the stack (cell 1), then attach cells 2 through 4 in sequence. The U1 and U4 devices must not be damaged by other cell connection sequences, but there is a possibility that the BQ296103(U1) can blow the fuse. Attaching cells starting with cell 1 eliminates this risk. A short must be placed across unused voltage sense inputs. See Figure 2-2.

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

Figure 2-2. Cell Connection Configuration

Note

Notice how BQ41Z50 needs at least 2 cells attached for proper configuration.

A resistor cell simulator can be used instead of battery cells. Connect a resistor between each of the contacts on the J4 Jumper. 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 3.6V cell voltage, set the power supply to 3 × 3.6 = 10.8V.

- Serial communications port (SMBC, SMBD)

  Attach the communications interface adapter cable to J3 and to the SMB port on the EV2400.
- System load and charger connections across PACK+ and PACK–

  Attach the load or power supply to the J1 terminal block. The positive load or power supply wire must be connected to at least one of the first two terminal block positions labeled PACK+. The ground wire for the load or power supply must be connected to the last terminal block positions labeled PACK–. See Figure 2-1
- System-present pin ($\overline{\text{PRES}}$/$\overline{\text{SHUTDN}}$)

  To start charge or discharge test, connect the $\overline{\text{PRES}}$/$\overline{\text{SHUTDN}}$ position on the J 1 terminal block to PACK–. The $\overline{\text{PRES}}$/$\overline{\text{SHUTDN}}$ can be left open if the non-removable (NR) bit is set to 1 in the ***Settings:Configuration:DA Configuration*** register. To test sleep mode, disconnect the $\overline{\text{PRES}}$/$\overline{\text{SHUTDN}}$ 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 BQ41Z50 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. The user must change the ***Settings:Configuration: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 must also be updated to fine tune the gauge to the pack. For help with setting the parameters, see *BQ41Z50 Technical Reference Manual*.

2.4 Update Firmware

Find the latest firmware version in the appropriate BQ41Z50 folder on www.ti.com. Use the following steps to install the BQ41Z50 *Battery Management Studio* software:

1. Run *Battery Management Studio* from the **Start** | **Programs** | **Texas Instruments** | **Battery Management Studio** menu sequence, or the *Battery Management Studio* shortcut.
2. Follow the directions in Programming Screen, select the firmware .bq.fs file downloaded from www.ti.com, and click the **Program** button.
3. Once programming is finished, the EVM is ready to use with the latest firmware.

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3 Hardware

3.1 BQ41Z50 Production Calibration Guide

Please refer to the BQ41xxx Production Calibration Guide.

4 Software

4.1 Battery Management Studio

4.1.1 Registers Screen

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 4-1) appears. The Registers section contains parameters used to monitor gauging. The Bit Registers section provides 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 scans continuously if the *Scan* button is selected.

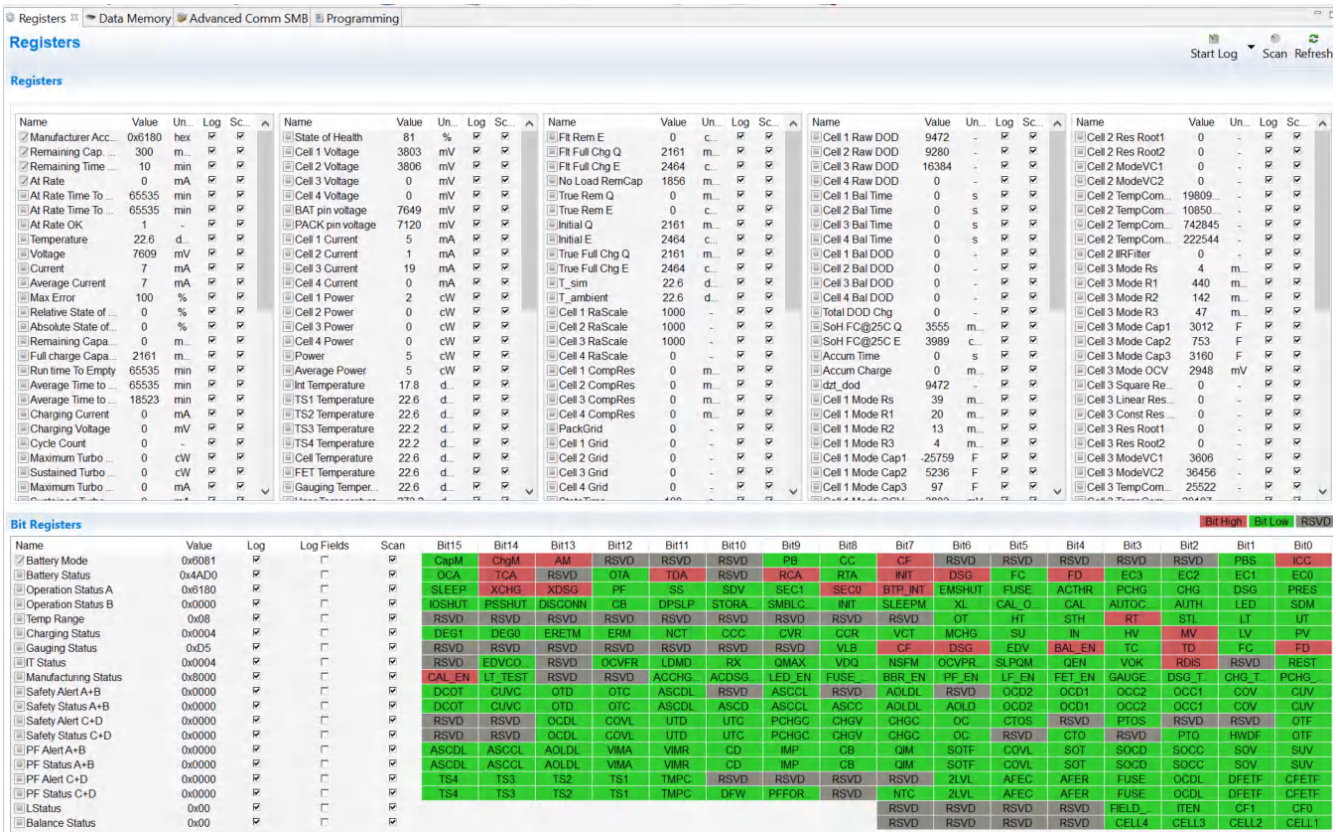

Figure 4-1. Registers Screen

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

The Battery Management Studio program provides a logging function which logs the values that are selected by the Log check boxes located beside each parameter in the Register 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.

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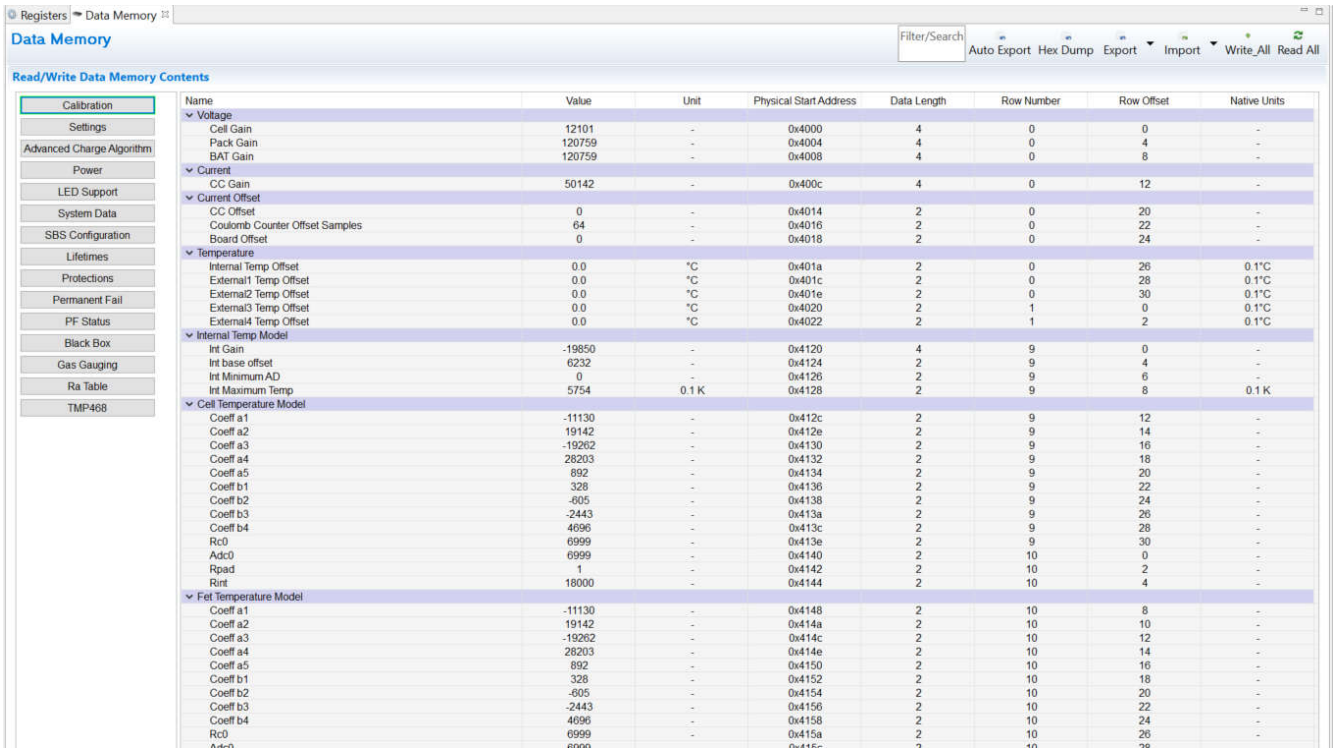
4.1.2 Setting Programmable BQ41Z50 Options

The BQ41Z50 data flash comes configured per the default settings detailed in the BQ41Z50 TRM. Make sure that the settings are correctly changed to match the pack and application for the design 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 4-2).



Name	Value	Unit	Physical Start Address	Data Length	Row Number	Row Offset	Native Units
Voltage							
Cell Gain	12101	-	0x4000	4	0	0	-
Pack Gain	120759	-	0x4004	4	0	4	-
BAT Gain	120759	-	0x4008	4	0	8	-
Current							
CC Gain	50142	-	0x400c	4	0	12	-
Current Offset							
CC Offset	0	-	0x4014	2	0	20	-
Coulomb Counter Offset Samples	64	-	0x4016	2	0	22	-
Board Offset	0	-	0x4018	2	0	24	-
Temperature							
Internal Temp Offset	0.0	°C	0x401a	2	0	26	0.1°C
External1 Temp Offset	0.0	°C	0x401c	2	0	28	0.1°C
External2 Temp Offset	0.0	°C	0x401e	2	0	30	0.1°C
External3 Temp Offset	0.0	°C	0x4020	2	1	0	0.1°C
External4 Temp Offset	0.0	°C	0x4022	2	1	2	0.1°C
Internal Temp Model							
Int Gain	-19850	-	0x4120	4	9	0	-
Int base offset	6232	-	0x4124	2	9	4	-
Int Minimum AD	0	-	0x4126	2	9	6	-
Int Maximum Temp	5754	0.1 K	0x4128	2	9	8	0.1 K
Cell Temperature Model							
Coeff a1	-11130	-	0x412c	2	9	12	-
Coeff a2	19142	-	0x412e	2	9	14	-
Coeff a3	-19262	-	0x4130	2	9	16	-
Coeff a4	28203	-	0x4132	2	9	18	-
Coeff a5	892	-	0x4134	2	9	20	-
Coeff b1	328	-	0x4136	2	9	22	-
Coeff b2	-605	-	0x4138	2	9	24	-
Coeff b3	-2443	-	0x413a	2	9	26	-
Coeff b4	4696	-	0x413c	2	9	28	-
Rc0	6999	-	0x413e	2	9	30	-
Adc0	6999	-	0x4140	2	10	0	-
Rpad	1	-	0x4142	2	10	2	-
Rint	18000	-	0x4144	2	10	4	-
Fet Temperature Model							
Coeff a1	-11130	-	0x4148	2	10	8	-
Coeff a2	19142	-	0x414a	2	10	10	-
Coeff a3	-19262	-	0x414c	2	10	12	-
Coeff a4	28203	-	0x414e	2	10	14	-
Coeff a5	892	-	0x4150	2	10	16	-
Coeff b1	328	-	0x4152	2	10	18	-
Coeff b2	-605	-	0x4154	2	10	20	-
Coeff b3	-2443	-	0x4156	2	10	22	-
Coeff b4	4696	-	0x4158	2	10	24	-
Rc0	6999	-	0x415a	2	10	26	-

Figure 4-2. Data Memory Screen

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4.1.3 Calibration Screen

The voltages, temperatures, and currents must be calibrated to provide good gauging performance.

Press the *Calibration* button to select the Advanced Calibration window. See Figure 4-3.

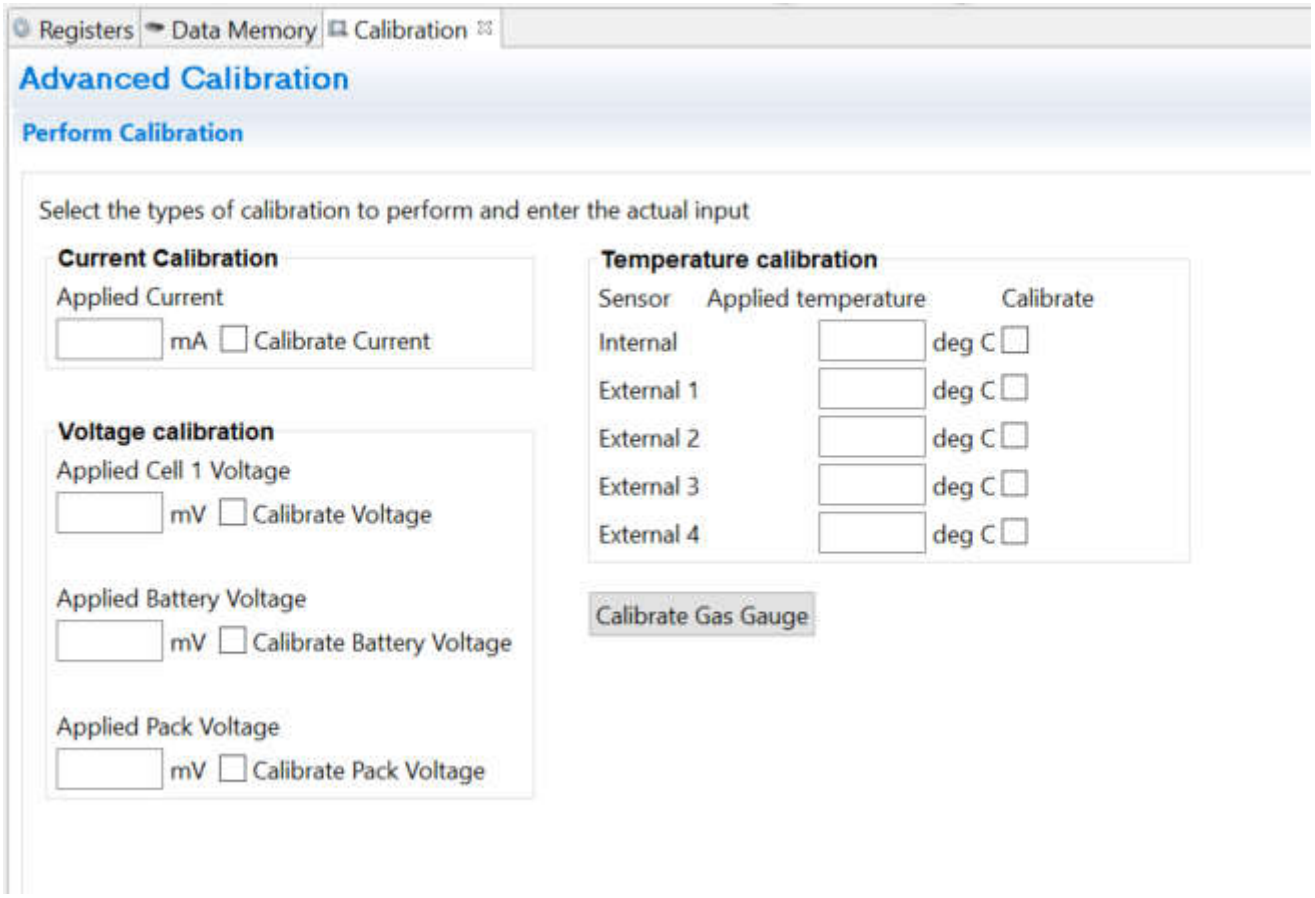

Figure 4-3. Calibration Screen

4.1.3.1 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, then turn the charge and discharge FETs on by entering a 0x0022 command in the Manufacturer Access register on the Register screen.
- Press the *Calibrate Gas Gauge* button to calibrate the voltage measurement system.
- Deselect the Calibrate Voltage boxes after voltage calibration has completed.

4.1.3.2 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.

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4.1.3.3 Current Calibration

The Board Offset calibration option is not offered in Battery Management Studio, because the Board Offset calibration is not required when using the BQ41Z50EVM.

- Connect and measure a -2A current source from 1N (–) and Pack– (+) to calibrate without using the FETs. (TI does not recommend calibration 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.

4.1.4 Chemistry Screen

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

1. Press the *Chemistry* button to select the Chemistry window.

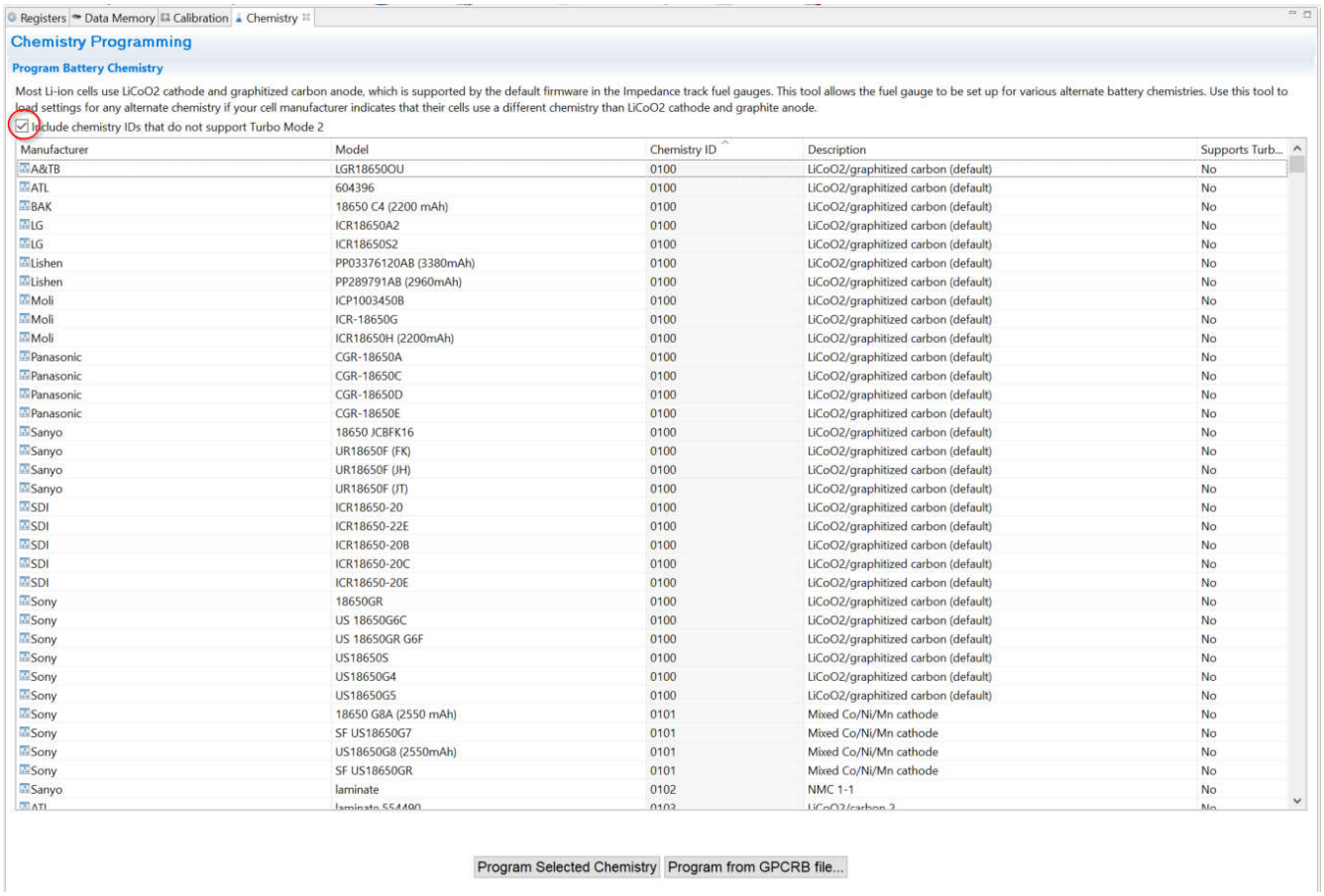

Figure 4-4. Chemistry Screen

2. The table can be sorted by clicking the desired column. for example: Click the Chemistry ID column header.
3. Select the ChemID that matches your cell from the table (see Figure 4-4).
4. Press the *Program Selected Chemistry* button to update the chemistry in the device.
5. Press *Program from GPCRB file* button to program the Chemdat file exported from the GPCRB tool (low temperature optimization tool).

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4.1.5 Firmware Screen

Press the *Programming* button to select the Firmware Programming window. This window allows the user to export and import the device firmware.

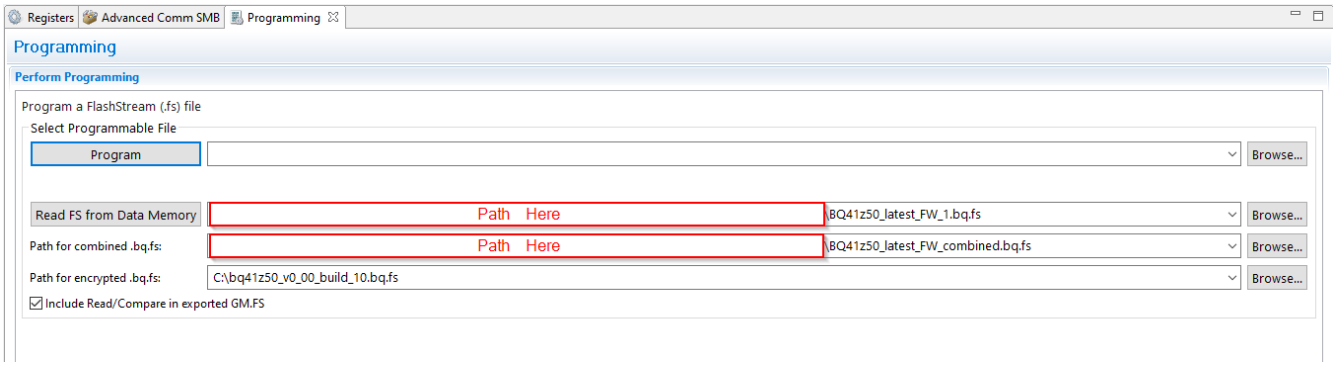

Figure 4-5. Programming Screen

4.1.5.1 Programming the Flash Memory

The upper section of the Programming screen is used to initialize the device by loading the .bq.fs file into the flash memory (see Figure 4-5).

- Search for the .bq.fs file using the *Browse* button.
- Press the *Program* button and wait for the download to complete.

4.1.5.2 Exporting the Flash Memory

The lower section of the Programming screen is used to export all of the flash memory from the device (see Figure 4-5).

1. In the first lower box, press the *Browse* button and enter a .bq.fs filename. This contains the encrypted firmware changes and updates.
2. In the *Path for combined .bq.fs*, press the *Browse* button and enter a .bq.fs filename that defers from the name above (for example, filename_combined), see example Figure 4-5. The combined .fs file contains the encrypted FW and user specific settings to be uploaded in production.
3. In the *Path for encrypted .bq.fs*, press the *Browse* button and upload the encrypted bq.fs file provided from ti.com. This encrypted file is the default .bq.fs that the user can download from ti.com.
4. Press the *Read FS from Data Memory* to save the Flash memory contents to the file. Wait for the *Operation executed successfully* message at the left bottom corner of the BQStudio screen.

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4.1.6 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 4-6.

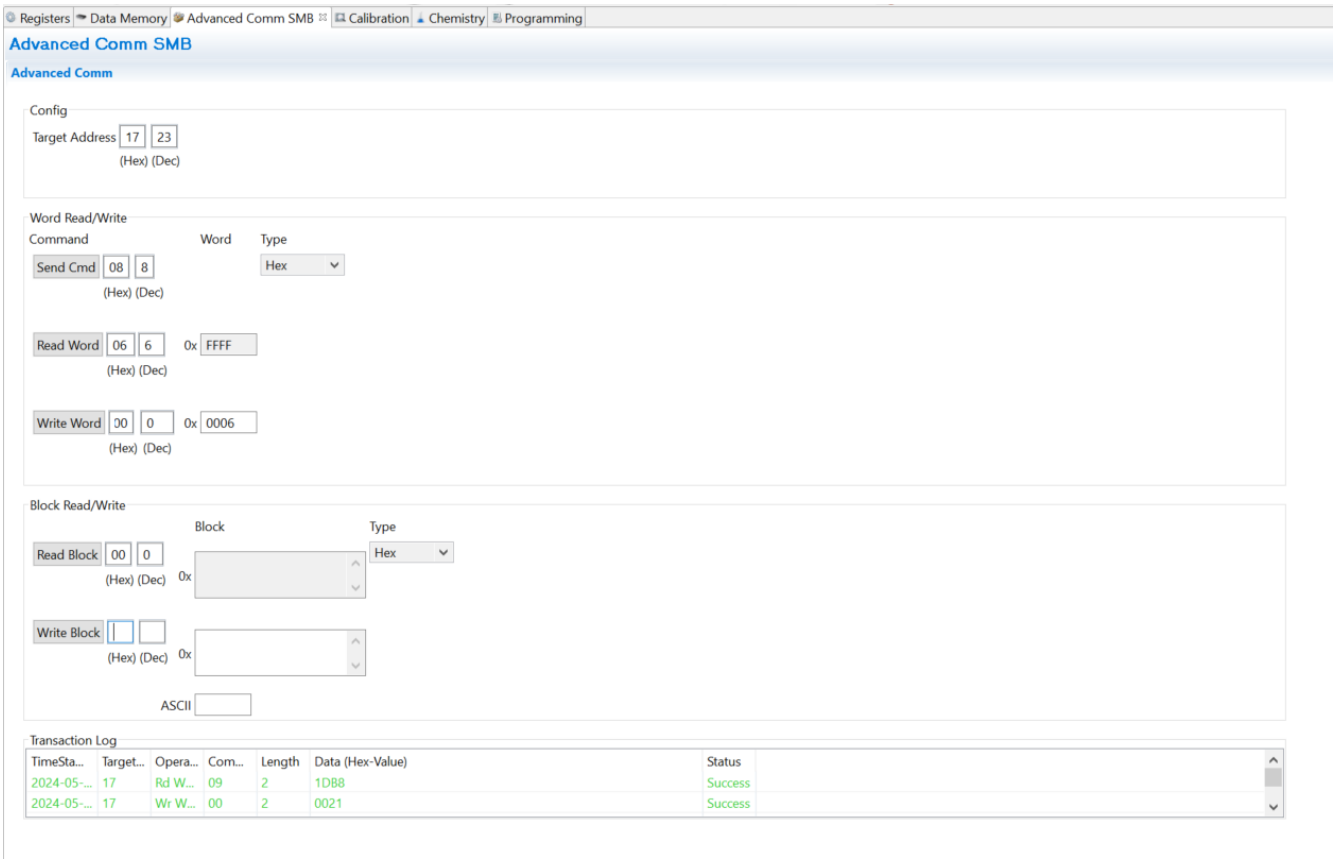

Figure 4-6. Advanced Comm SMB Screen

Examples:

Reading an SMB Command.

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

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

- With Impedance Track™ disabled, send Gauging() (0x0021) to ManufacturerAccess().
  - SMBus Write Word. Command = 0x00. Data = 00 21

Reading Chemical ID() (0x0006) via ManufacturerAccess()

- Send Chemical ID() to ManufacturerAccess()
  - SMBus Write Block. Command = 0x44. Data sent = 00 06
- Read the result from ManufacturerData()
  - SMBus Read Block. Command = 0x44. Data read = 06 00 10 12
  - That is 0x1210, chem ID 1210

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5 Hardware Design Files

5.1 BQ41Z50EVM Circuit Module Schematic

This section contains information on modifying the EVM and using various features on the reference design.

5.1.1 LED Control

The EVM is configured to support three LEDs to provide state-of-charge information for the cells. Press the *LED DISPLAY* button to illuminate the LEDs for approximately 5 seconds.

Note

Notice how LEDs are powered from the external LDO device. Make sure the LDO_EN jumper-J9 is removed. LEDs are no longer charlieplexed together as LEDs used to be in the BQ40z50 family devices. The EVM requires an external LDO to power LEDs.

5.2 Circuit Module Physical Layouts

This section contains the printed-circuit board (PCB) layout, assembly drawings, and schematic for the BQ41Z50 and BQ296103 circuit modules.

5.2.1 Board Layout

This section shows the dimensions, PCB layers, and assembly drawing for the BQ41Z50 modules.

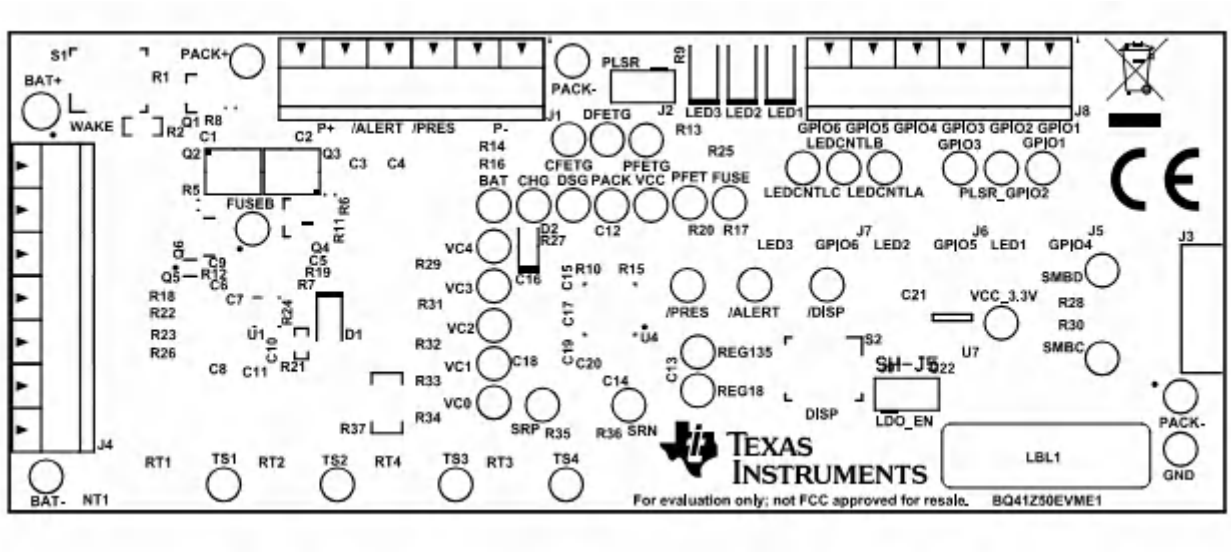

Figure 5-1. Top Silk Screen

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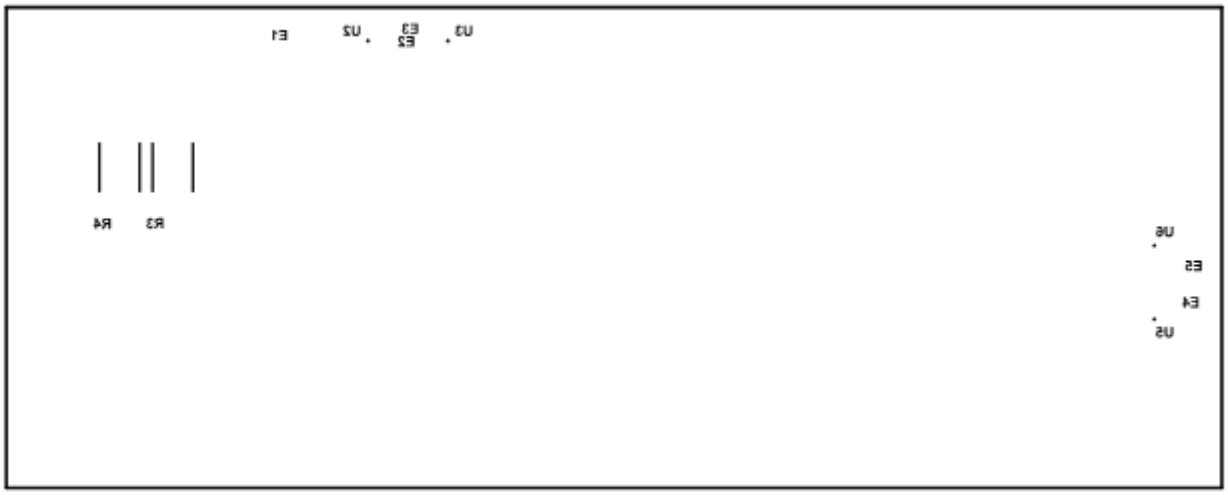

Figure 5-2. Bottom Silk Screen

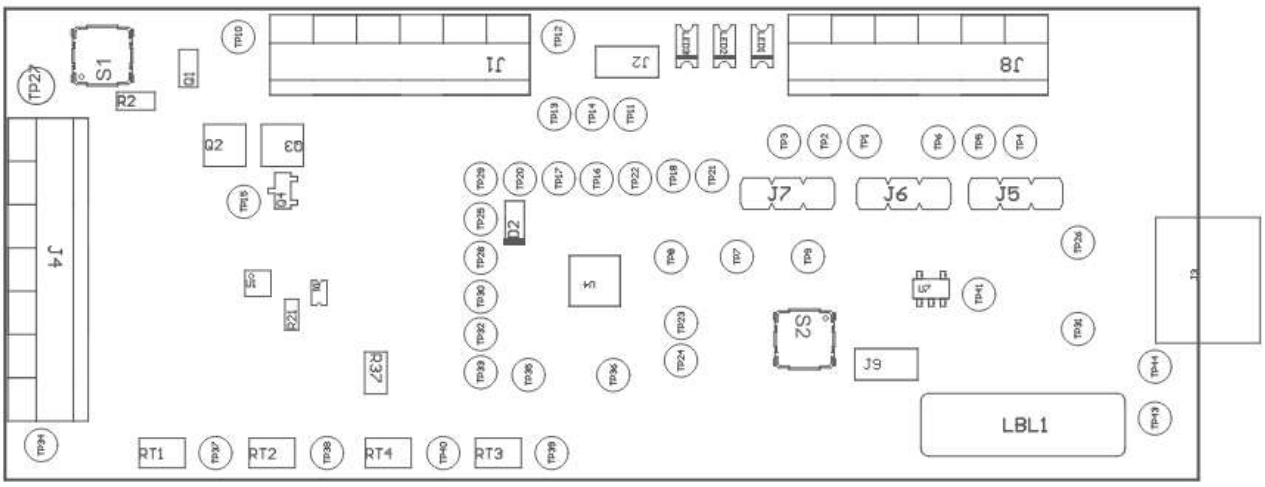

Figure 5-3. Top Assembly

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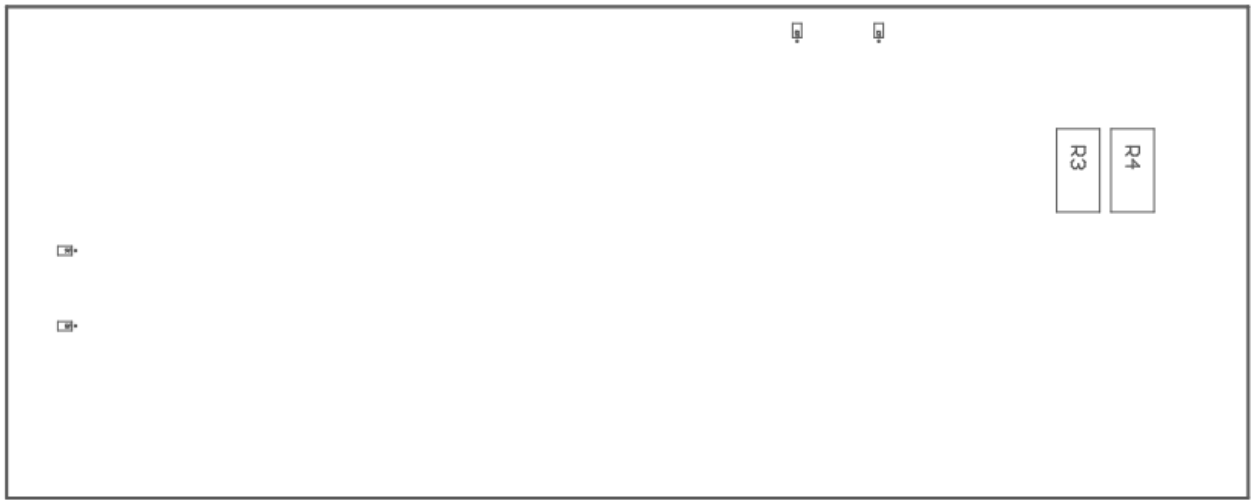

Figure 5-4. Bottom Assembly

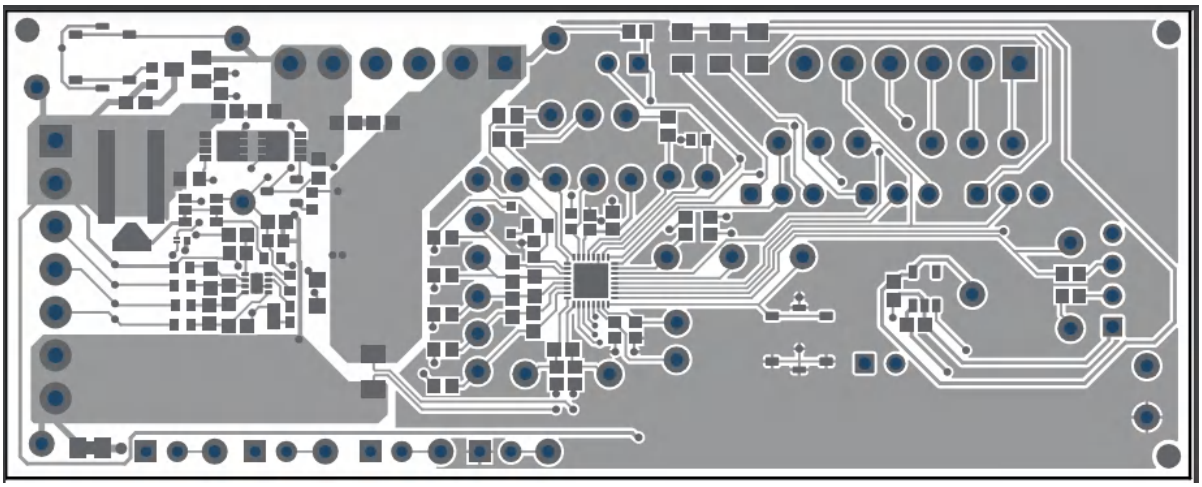

Figure 5-5. Top Layer

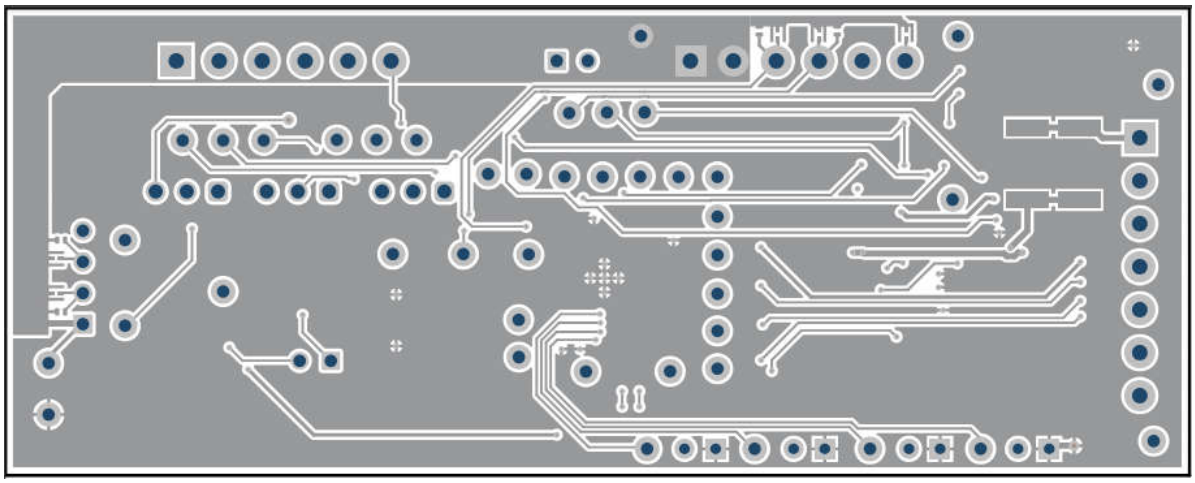

Figure 5-6. Bottom Layer

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5.2.2 Schematic

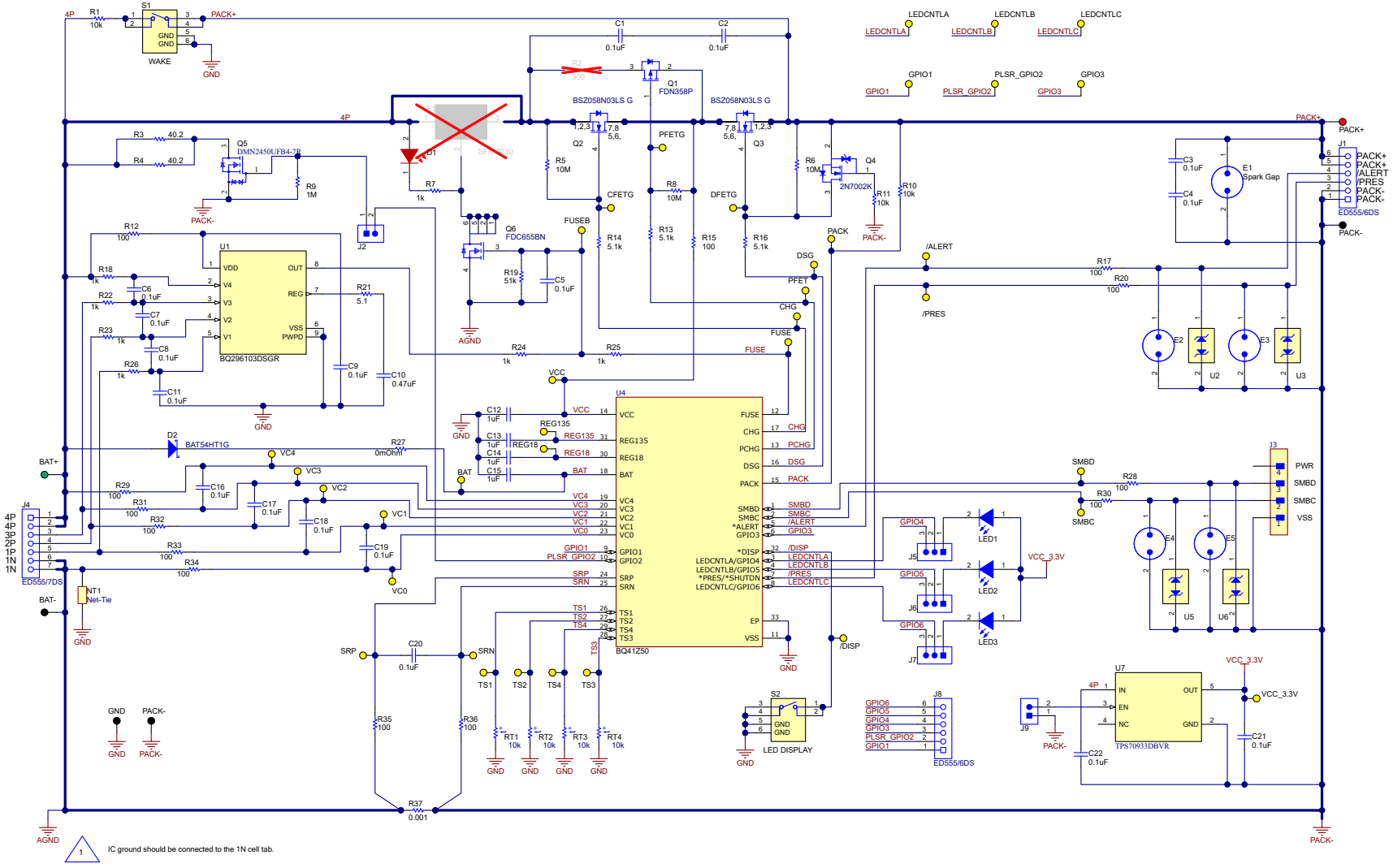

Figure 5-7. BQ41Z50 Schematic

Note

The precharge function is currently unavailable on the initial EVM revision. R2 was unpopulated for this reason.

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5.3 Bill of Materials

Table 5-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB	1		Printed Circuit Board		BQ41Z50EVM	Any		
C1, C2, C3, C4, C5, C6, C7, C8, C9, C11, C16, C17, C18, C19, C20, C21, C22	17	0.1uF				AVX Interconnect / Elco		
C10	1	0.47uF	Multilayer Ceramic Capacitors MLCC - SMD/SMT 16V 0.47uF X7R 0603 10% Flex Soft			Kemet		
C12, C13, C14, C15	4	1uF	Multilayer Ceramic Capacitors MLCC - SMD/SMT 25V 1uF X7R 0603 10%			Kemet		
D1	1	Red	LED, Red, SMD	LED_0805	150080RS75000	Wurth Elektronik		
D2	1	30V	Diode, Schottky, 30V, 0.2A, SOD-323	SOD-323	BAT54HT1G	ON Semiconductor		
J1, J8	2		Terminal Block, 3.5mm Pitch, 6x1, TH	20.5x8.2x6.5mm	ED555/6DS	On-Shore Technology		
J2, J9	2		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
J3	1			HDR4	22-05-3041	Molex		
J4	1		Terminal Block, 3.5mm Pitch, 7x1, TH	24x.5x8.2x6.5mm	ED555/7DS	On-Shore Technology		
J5, J6, J7	3		Header, 2.54mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	61300311121	Wurth Elektronik		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady		
LED1, LED2, LED3	3		LED, Green, SMD	1206	SML-LX1206GC-TR	Lumex		
Q1	1	-30V	MOSFET, P-CH, -30V, -1.5A, SSOT-3	SSOT-3	FDN358P	Fairchild Semiconductor		None
Q2, Q3	2	30V	MOSFET, N-CH, 30V, 40A, PG-TSDSON-8	PG-TSDSON-8	BSZ058N03LS G	Infineon Technologies		None
Q4	1	60V	MOSFET, N-CH, 60V, 0.3A, SOT-23	SOT-23	2N7002K-T1-E3	Vishay-Siliconix		None
Q5	1		DMN2450UFB4-7R Trans Mosfet N-ch 20V 1A 3-PIN Dfn SMD T/r					
Q6	1		MOSFET N-CH 30V 6.3A SSOT-6			ON Semiconductor		

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Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R1, R10, R11	3	10k	Chip Resistor, 10 KOhm, ±1%, 0.1 W, -55 to 155 deg°C, 0603 (1608 Metric), RoHS, Tape and Reel			Panasonic		
R2	1	300	RES, 300, 5%, 0.1W, 0603	0603	RC0603JR-07300RL	Yageo		
R3, R4	2	40.2	RES, 40.2, 1%, 1W, AEC-Q200 Grade 0, 2512	2512	CRCW251240R2FKEG	Vishay-Dale		
R5, R6, R8	3	10M	10M 0.1W 1% 0603 (1608 Metric) SMD					
R7, R18, R22, R23, R24, R25, R26	7	1k	SMD Chip Resistor, 1 kOhm, ± 1%, 100mW, 0603 [1608 Metric], Thick Film, General Purpose			Yageo		
R9	1	1M	SMD Chip Resistor, 1 MOhm, ± 1%, 100mW, 0603 [1608 Metric], Thick Film, General Purpose			Vishay Dale		
R12, R15, R17, R20, R28, R29, R30, R31, R32, R33, R34, R35, R36	13	100	Chip Resistor, 100 Ohm, ± 1%, 100mW,-55 to 155 deg°C, 0603 (1608 Metric), RoHS, Tape and Ree	0603		Vishay Semiconductor		
R13, R14, R16	3	5.1k	Res 5.1K Ohm 1% 1/3W 0603			KOA Speer		
R19	1	51k	Res Thick Film 0603 51K Ohm 1% 0.1W ±100ppm/°C Molded SMD Punched Carrier T/R			Panasonic		
R21	1	5.1	RES, 5.1, 5%, 0.063 W, 0402	0402	CRCW04025R10JNED	Vishay-Dale		
R27	1		Chip Resistor, 0 Ohm,± 5%, 0.1W, -55 to 155 deg°C, 0603 (1608 Metric), RoHS, Tape and Reel			Yageo		
R37	1	0.001	RES, 0.001, 1%, 1W, AEC-Q200 Grade 0, 1206	1206	CSNL1206FT1L00	Stackpole Electronics Inc		
RT1, RT2, RT3, RT4	4	10k	Thermistor NTC, 10.0k ohm, 1%, Disc, 5x8.4mm	Disc, 5x8.4 mm	103AT-2	SEMITEC Corporation		
S1, S2	2		Switch, SPST-NO, Off-Mom, 0.02A, 15 VDC, SMD	4.9x4.9mm	EVQ-PLHA15	Panasonic		
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5	5	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M

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Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP11, TP13, TP14, TP15, TP16, TP17, TP18, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP28, TP29, TP30, TP31, TP32, TP33, TP35, TP36, TP37, TP38, TP39, TP40, TP41	36		Test Point, Miniature, Yellow, TH	Yellow Miniature Test point	5004	Keystone		
TP10	1		Test Point, Miniature, Red, TH	Red Miniature Test point	5000	Keystone		
TP12, TP34, TP43, TP44	4		Test Point, Miniature, Black, TH	Black Miniature Test point	5001	Keystone		
TP27	1		Test Point, Miniature, Green, TH	Green Miniature Test point	5116	Keystone		
U1	1		2-4S Overvoltage Protector with LDO Output, DSG0008A (WSON-8)	DSG0008A	BQ296103DSGR	Texas Instruments	BQ296103DSGT	Texas Instruments
U2, U3, U5, U6	4		Single-Channel ESD in 0402 Package With 10pF Capacitance and 6V Breakdown, DPY0002A (X1SON-2)	DPY0002A		Texas Instruments	TPD1E10B06DPYT	Texas Instruments
U4	1		Battery Management Platform, WQFN32	WQFN32	BQ41Z50	Texas Instruments		
U7	1		150mA, 30V, Ultra-Low IQ, Wide Input Low-Dropout Regulator with Reverse Current Protection, DBV0005A (SOT-23-5)	DBV0005A	TPS70933DBVR	Texas Instruments	TPS70933DBVT	Texas Instruments
F1	0		Fuse, 30A, 62VDC, SMD	9.5x2x5mm	SFK-3030	Dexerials Corporation		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		

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6 Additional Information

6.1 Trademarks

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7 Related Documentation from Texas Instruments

- *BQ41Z50 2-Series, 3-Series, and 4-Series Cell Li-Ion Battery Pack Manager with Dynamic Z-Track™* data sheet
- *BQ41Z50 Technical Reference Manual*
- *BQ296xxx Overvoltage Protection for 2-Series, 3-Series, and 4-Series Cell Li-Ion Batteries with Regulated Output Supply* data sheet

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   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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: 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 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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 to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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

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2. 実験局の免許を取得後ご使用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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:*

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   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM 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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