EVM User's Guide: BQ41Z90

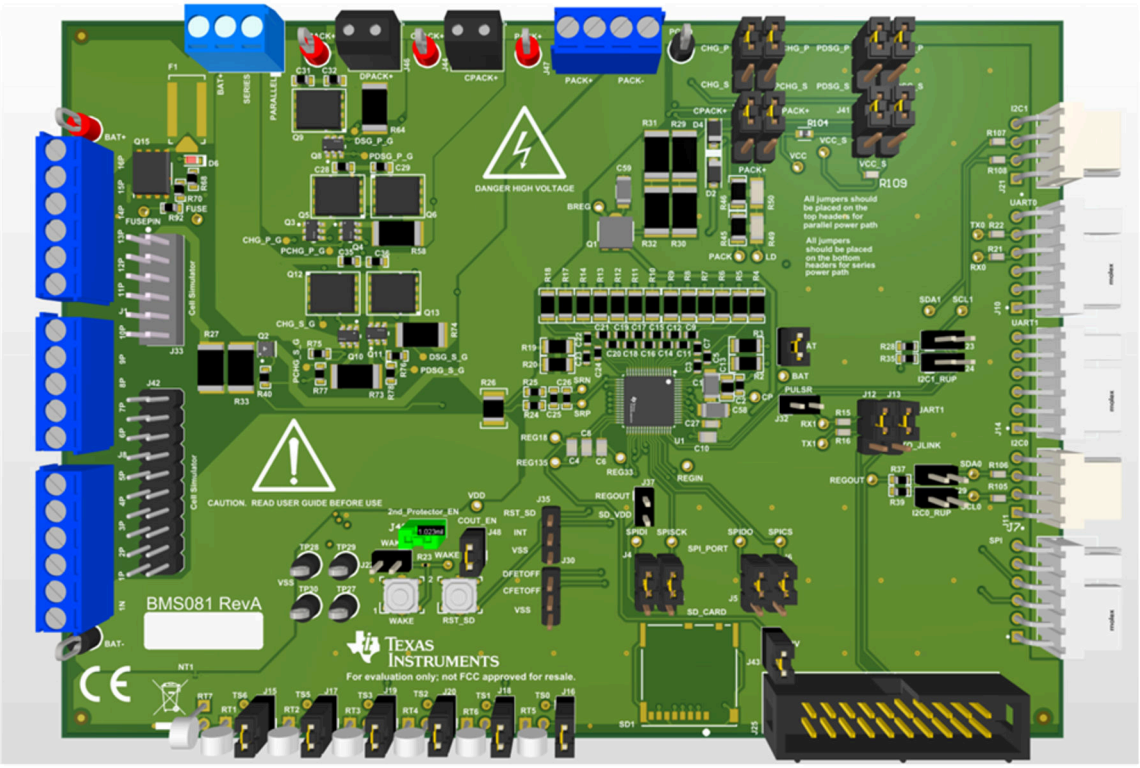
BQ41Z90 Li-Ion Battery Pack Manager Evaluation Module

Description

The BQ41Z90EVM is a complete system useful for evaluating the functionality of the BQ41Z90 fuel gauge. This gauge is appropriate for applications powered by multi-cell battery systems up to 16 cells in series. The EVM includes one BQ41Z90 circuit module, a current sense resistor, and six thermistors. This evaluation module (EVM) is a complete evaluation system for the BQ41Z90 battery management system.

Features

- Complete evaluation system for the BQ41Z90EVM Li-Ion Battery Pack Manager Evaluation Module and BQ77216 independent overvoltage protection IC
- Populated circuit module for quick setup
- Software that allows data logging for system analysis



Note

This EVM is intended for basic product functionality evaluation, and does not reflect the full performance capacity of the device. This EVM is not designed to be included in part of the manufacturing cycle.

1 Evaluation Module Overview

1.1 Introduction

The EVM includes one BQ41Z90 and BQ77216 circuit module and a link to Microsoft® Windows® based PC software. The circuit module includes one BQ41Z90 integrated circuit, one BQ77216, 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 3- to 16-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 BQ41Z90 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

- BQ41Z90 and BQ77216 circuit module
- Cable to connect the EVM to an EV2400 communications interface adapter

1.3 Specification

This section summarizes the performance specifications of the BQ41Z90EVM and BQ77216EVM.

Table 1-1. BQ41Z90 and BQ77216 Circuit Module Performance Specification Summary

Specification	Min	Typ	Max	Unit
Input voltage Pack+ to Pack–	4.9	20	85	V
Charge and discharge current	0	2	10	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
BQ41Z90EVM	Li-ion	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16 cells	Any

For information on device firmware and hardware, see the *BQ41Z90 2-Series, 3-Series, and 4-Series Cell Li-Ion Battery Pack Manager with Dynamic Z-Track™* data sheet and the *BQ41Z90 Technical Reference Manual* on www.ti.com.

1.4.1 Before You Begin

The following warnings and cautions are noted for the safety of anyone using or working close to the BQ41Z90 EVM. Observe all safety precautions.

	**Warning**	The BQ41Z90EVM circuit module can become hot during operation due to dissipation of heat. Avoid contact with the board. Follow all applicable safety procedures applicable to your laboratory.
	**Warning**	The BQ41Z90EVM is not rated as a high voltage EVM, has smaller clearances than normally used on high voltage boards and does not have an isolation boundary. If you apply high voltage to this board, all terminals should be considered high voltage. Electric shock is possible when connecting the board to live wire. The board should be handled with care by a professional. For safety, use of isolated test equipment with overvoltage and overcurrent protection is highly recommended.
	**Caution**	Do not leave the EVM powered when unattended.

CAUTION

The default settings of the BQ41Z90 do not limit performance to the ratings of the EVM. Set all protections appropriately and limit current for safe operation.

CAUTION

The circuit module has signal traces, components, and component leads on the bottom of the board. This can result in exposed voltages, hot surfaces or sharp edges. Do not reach under the board during operation.

CAUTION

The circuit module can be damaged by over temperature. To avoid damage, monitor the temperature during evaluation and provide cooling, as needed, for your system environment. Do not operate beyond the current and voltage limits in the Specification Table.

CAUTION

Some power supplies can be damaged by application of external voltages. If using more than 1 power supply, check your equipment requirements and use blocking diodes or other isolation techniques, as needed, to prevent damage to your equipment.

CAUTION

The communication interface is not isolated on the EVM. Be sure no ground potential exists between the computer and the EVM. Also be aware that the computer is referenced to the Battery- potential of the EVM.

CAUTION

Connections for rated current must be made at the terminal block. Test points are not rated for the board current.

2 BQ41Z90EVM 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

- BQ41Z90 or BQ77216 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.
- 3 to 16 battery cells or 1kΩ resistor divider.
- A DC power supply that can supply 85V and 2A (constant current and constant voltage capability is desirable)

2.2 Software Installation

Find the latest software version in the BQ41Z90 tool folder on www.ti.com. Use the following steps to install the BQ41Z90 Battery Management Studio software:

1. Download and run the Battery Management Studio setup program from the Development Tools section of the BQ41Z90EVM product folder on www.ti.com. See Battery Management Studio 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 and Figure 2-2.

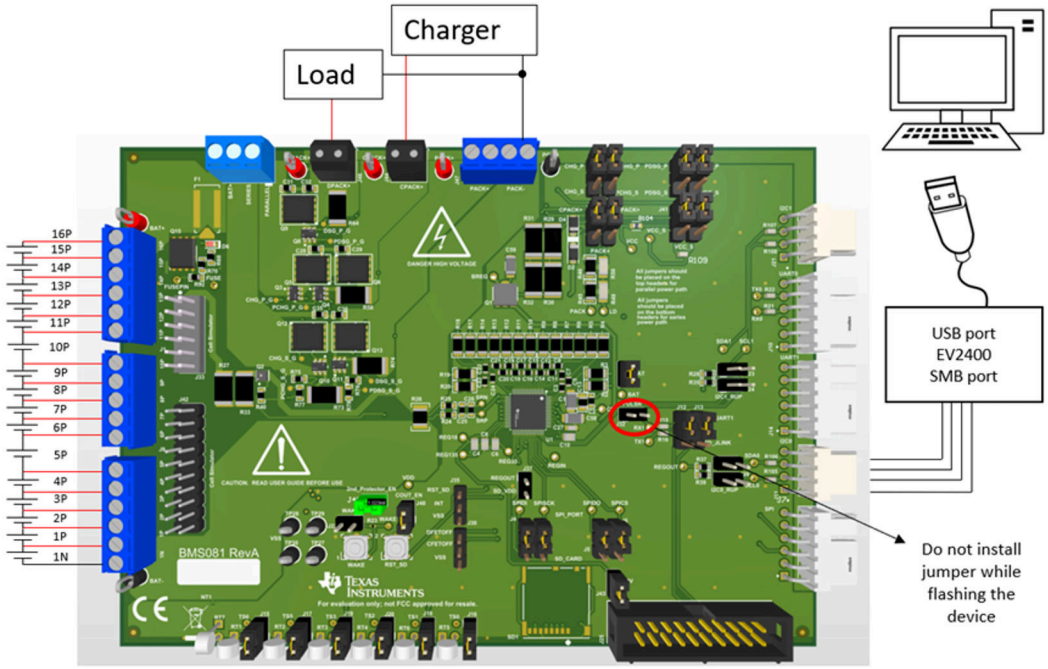


Figure 2-1. BQ41Z90 Circuit Module Connection to Cells and System Load or Charger, Parallel Configuration

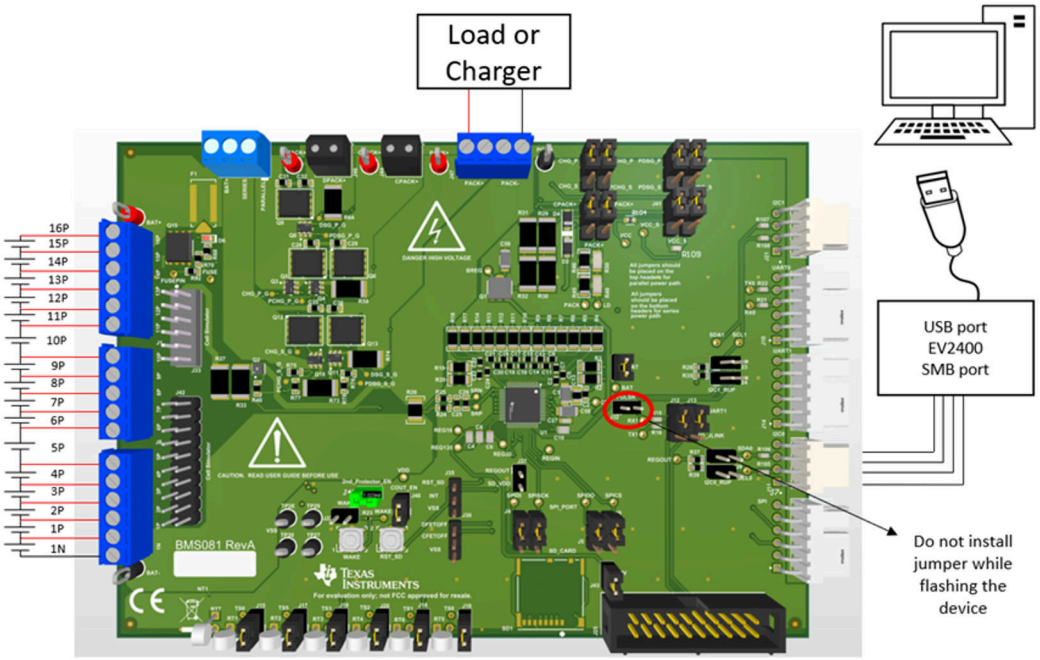


Figure 2-2. BQ41Z90 Circuit Module Connection to Cells and System Load or Charger, Series Configuration

Direct connection to the cells: 1N (BAT–), 1P, 2P, 3P, 4P, 5P, 6P, 7P, 8P, 9P, 10P, 11P, 12P, 13P, 14P, 15P, 16P (BAT+).

Attach the cells as shown in Figure 2-1. A specific cell connection sequence is required along with shorts across unused voltage sense inputs. See Figure 2-3.

	Cell Connections																																							
Number of cells in series	VC0		VC1		VC2		VC3		VC4		VC5		VC6		VC7		VC8		VC9		VC10		VC11		VC12		VC13		VC14		VC15		VC16	
3		Cell1		Cell2		Short		Short		Short		Short		Short		Short		Short		Short		Short		Short		Short		Short		Short		Cell3	
4		Cell1		Cell2		Short		Short		Cell3		Short		Short		Short		Short		Short		Short		Short		Short		Short		Short		Cell4	
5		Cell1		Cell2		Short		Short		Cell3		Short		Short		Cell4		Short		Short		Short		Short		Short		Short		Short		Cell5	
6		Cell1		Cell2		Short		Short		Cell3		Short		Short		Cell4		Short		Short		Cell5		Short		Short		Short		Short		Cell6	
7		Cell1		Cell2		Short		Short		Cell3		Short		Short		Cell4		Short		Short		Cell5		Short		Short		Cell6		Short		Cell7	
8		Cell1		Cell2		Short		Short		Cell3		Short		Short		Cell4		Short		Short		Cell5		Short		Short		Cell6		Cell7		Cell8	
9		Cell1		Cell2		Short		Short		Cell3		Short		Short		Cell4		Short		Short		Cell5		Short		Cell6		Cell7		Cell8		Cell9	
10		Cell1		Cell2		Short		Short		Cell3		Short		Short		Cell4		Short		Short		Cell5		Cell6		Cell7		Cell8		Cell9		Cell10	
11		Cell1		Cell2		Short		Short		Cell3		Short		Short		Cell4		Short		Cell5		Cell6		Cell7		Cell8		Cell9		Cell10		Cell11	
12		Cell1		Cell2		Short		Short		Cell3		Short		Short		Cell4		Cell5		Cell6		Cell7		Cell8		Cell9		Cell10		Cell11		Cell12	
13		Cell1		Cell2		Short		Short		Cell3		Short		Cell4		Cell5		Cell6		Cell7		Cell8		Cell9		Cell10		Cell11		Cell12		Cell13	
14		Cell1		Cell2		Short		Short		Cell3		Cell4		Cell5		Cell6		Cell7		Cell8		Cell9		Cell10		Cell11		Cell12		Cell13		Cell14	
15		Cell1		Cell2		Short		Cell3		Cell4		Cell5		Cell6		Cell7		Cell8		Cell9		Cell10		Cell11		Cell12		Cell13		Cell14		Cell15	
16		Cell1		Cell2		Cell3		Cell4		Cell5		Cell6		Cell7		Cell8		Cell9		Cell10		Cell11		Cell12		Cell13		Cell14		Cell15		Cell16	

Figure 2-3. Cell Connection Configuration

Note

The BQ41Z90 needs at least 3 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 J1, J8, and J9 Jumper. For example, following the connections in Figure 2-3 place resistors where cells are to be connected and place external shorts in the remaining terminal slots until the desired number of slots is 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 16P. For example, for a 3S configuration with a 3.6V cell voltage, set the power supply to 10.8V (3 × 3.6 = 10.8V).

- **Communications ports**

  For SMB attach the communications interface adapter cable to J11 and to the SMB port on the EV2400.

  For I2C attach the communications interface adapter cable to J21 and to the I2C port on the EV2400.
- **System load and charger connections across PACK+ and PACK–**

  For Parallel configuration, attach the positive load wire to the J46 terminal block, labeled DPACK+. The ground wires for the load must be connected to the J47 terminal block, labeled PACK-. Connect the positive charger wire to the J44 terminal block, labeled CPACK+. The ground wire for the charger must be connected to the J47 terminal block, labeled PACK-. See Figure 2-1.

  For Series configuration, attach the positive load or charger wire to the PACK+ end of the J47 terminal block. Attach the ground wires for the load or charger to the PACK- end of the J47 terminal block. See Figure 2-2.
- **System-present pin (PRES/SHUTDN)**

  To start charge or discharge test, connect the PRES/SHUTDN position on the J 1 terminal block to PACK–. The PRES/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 PRES/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 BQ41Z90 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 the BQ41Z90 Technical Reference Manual.

2.3.1 Jumper Description

- **J42 and J33**

  Cell Simulator: Install a jumper for the series cell needed.

  For instance, if 3S configuration is needed. See Figure 2-4.

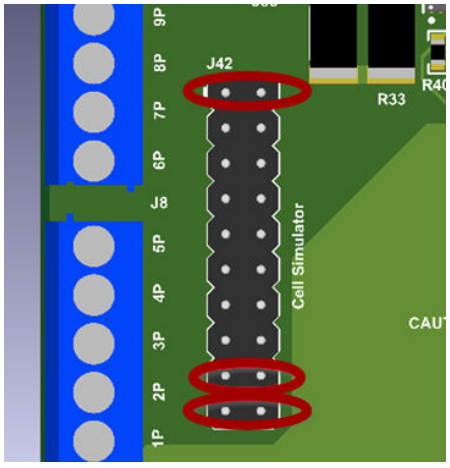


Figure 2-4. Cell Simulator Jumper Connections

- **J15, J17, J19, J20, J18, and J16**

  Install these jumpers for thermistors as needed.
- **J30**

  DFETOFF and CFETOFF are intended to be left floating unless user wants to manually turn off the FETs.

- **J35**

  If **RST_SD** switch is installed, **do not** press the button for more than 5 seconds. This action can cause device to permanently lock up on initial units. See Figure 2-5.

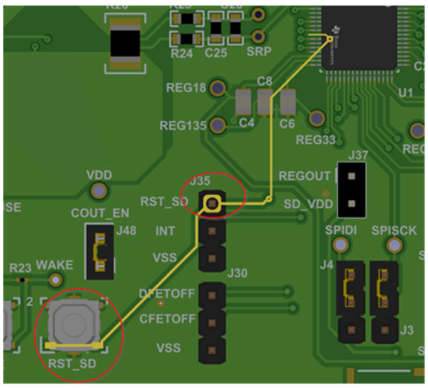


Figure 2-5. RST_SD Button and Jumper

- **J22**

  Installing a jumper here means the device constantly wakes up, preventing entry to shutdown mode.

- **J48**

  Enables the output of secondary protector (U14). U14 is not installed on board in version BMS081-*E1*.

- **J3, J4, J5, J6**

  For SPI, connect jumper as shown below. For SDK, please connect in the lower two. See Figure 2-6.

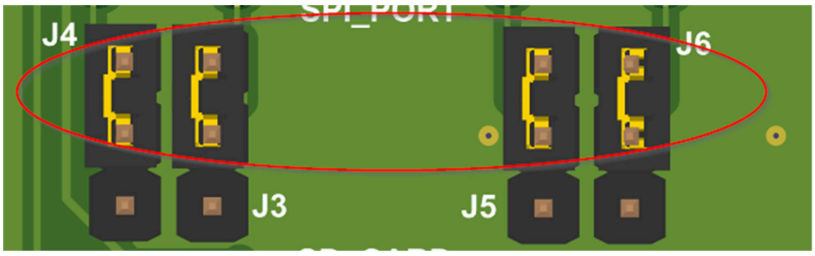


Figure 2-6. SPI Jumper Connection

- **J43**

  Install jumper when using J-link.

- **J12 and J13**

  Upper two are for UART. Lower two are for J-link.

- **J29, J28, J24, J23**

  I2C pull-ps. These are not needed if using EV2400. EV2400 has integrated pull-ups.

- **J2**

  Needed for Device power-up. Keep the jumper installed. The jumper is useful for measuring power consumption.

- **J32**

  Do not install this jumper while flashing the device.

- **J26, J41, J39, J27, J34, J36, J31**

  All of these jumpers are needed to determine series or parallel FET configuration. See Figure 2-7 and Figure 2-8.

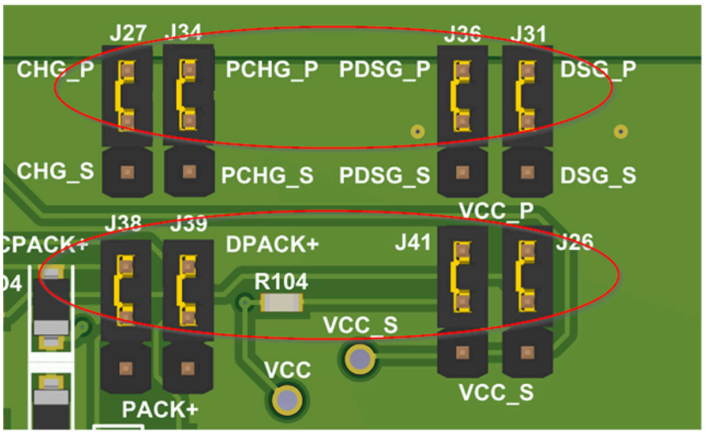


Figure 2-7. Parallel FET Configuration

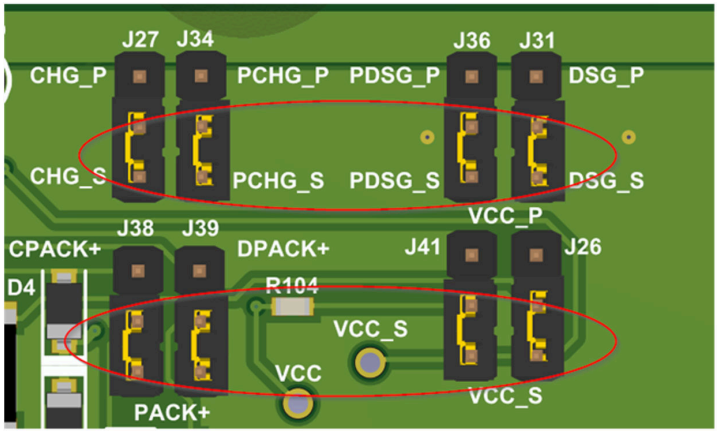


Figure 2-8. Series FET Configuration

- **J45**

  Used to determines Series or Parallel FET configuration. See Figure 2-9 and Figure 2-10.

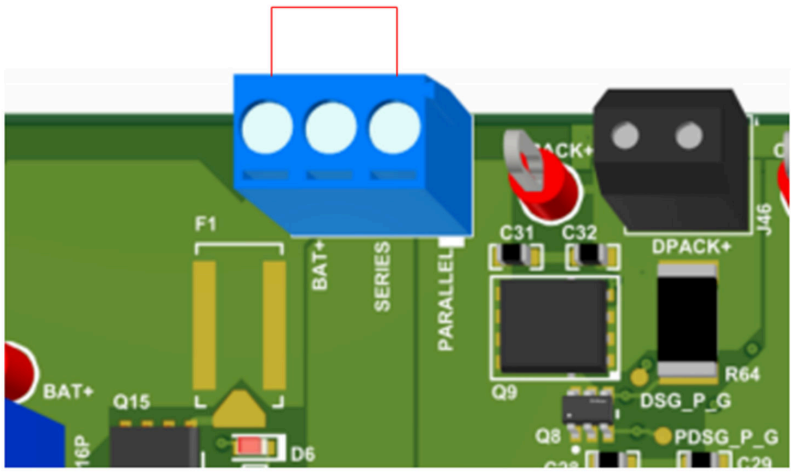


Figure 2-9. Parallel FET Configuration

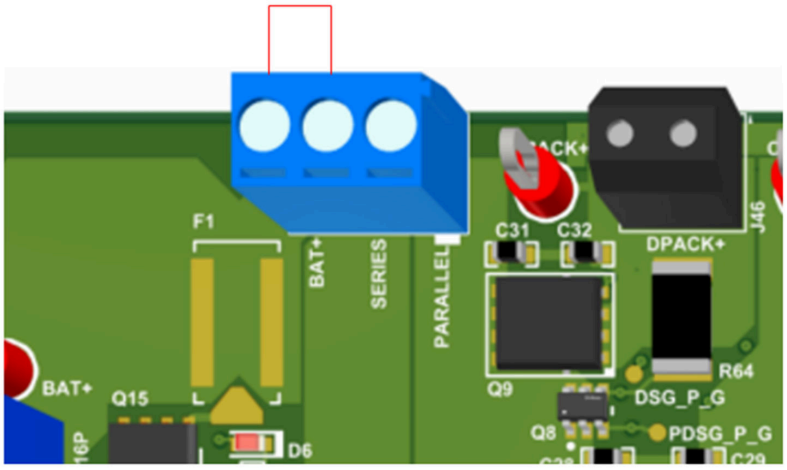


Figure 2-10. Series FET Configuration

Note

SDK is DNP on board version BMS081-*E1*.

2.4 Update Firmware

Flashing FW on initial units.

1. Download and install BQstudio, BQstudio appears as BatteryManagementStudio in the computers directory.
2. Inside the BatteryManagementStudio folder there is a folder labeled "config". Place the "4190_0_01-bq41z90.bqz" file inside the config folder.
3. Connect the communication cable to the SMBus port on the EV2400 and J7 on the BQ41z90EVM. The Jumpers on J28 and J29 need to be uninstalled.
4. Launch BQstudio, the device does not automatically detect. Force open the 4190_0_01-bq41z90.bqz by selecting gauges and then selecting 4190_0_01-bq41z90.bqz and pressing Finish. A warning appears, press "ok".
5. Go to the "Programming" tab on BQstudio, select "bq41z90_v0_01_build_1.sig.enc.bq.fs" and press program.
6. The device is now programmed with the BQ41z90FW, the next time BQstudio is opened the device is automatically detected.

Find the latest firmware version in the appropriate BQ41Z90 folder on www.ti.com. Use the following steps to install the BQ41Z90 *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.

3 Hardware

3.1 BQ41Z90 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.

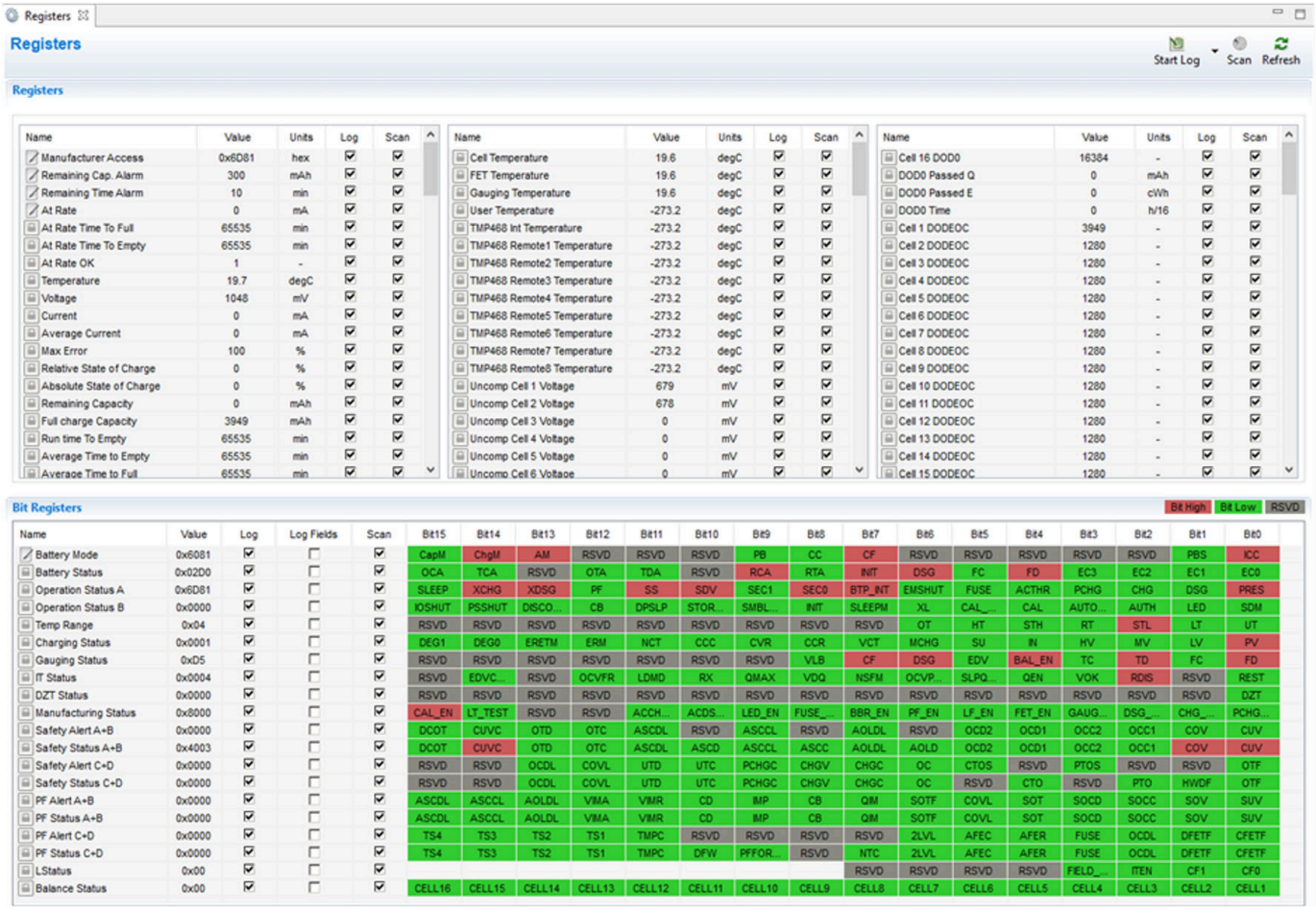


Figure 4-1. Registers Screen

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

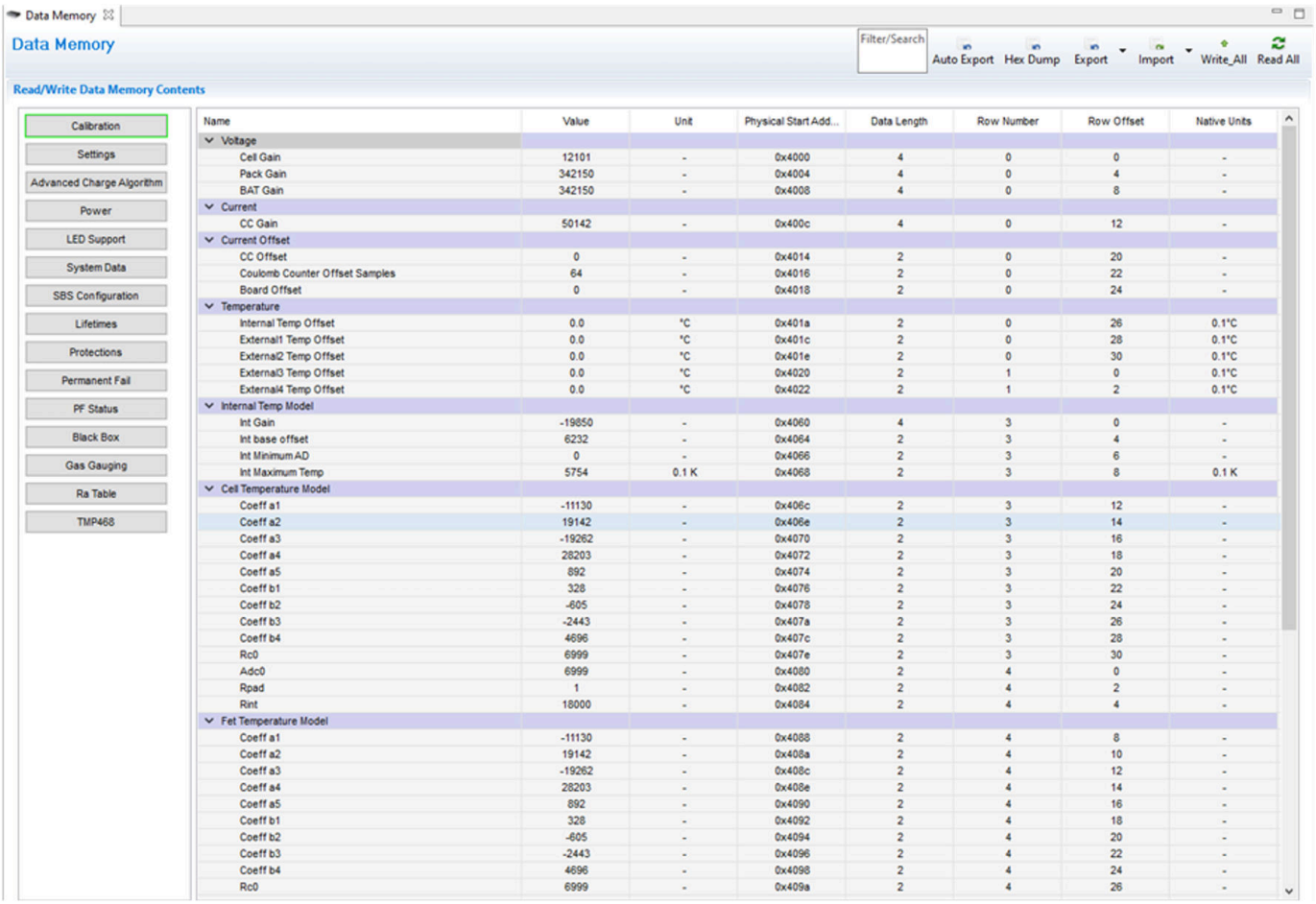
The Battery Management Studio program provides a logging function which logs the values that are selected by the Log check boxes located beside each parameter in the Register section. To enable this function, select the *Start Log* button; this causes the *Scan* button to be selected. When logging is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

4.1.2 Setting Programmable BQ41Z90 Options

The BQ41Z90 data flash comes configured per the default settings detailed in the BQ41Z90 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 Add...	Data Length	Row Number	Row Offset	Native Units
Voltage							
Cell Gain	12101	-	0x4000	4	0	0	-
Pack Gain	342150	-	0x4004	4	0	4	-
BAT Gain	342150	-	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	-	0x4060	4	3	0	-
Int base offset	6232	-	0x4064	2	3	4	-
Int Minimum AD	0	-	0x4066	2	3	6	-
Int Maximum Temp	5754	0.1 K	0x4068	2	3	8	0.1 K
Cell Temperature Model							
Coeff a1	-11130	-	0x406c	2	3	12	-
Coeff a2	19142	-	0x406e	2	3	14	-
Coeff a3	-19262	-	0x4070	2	3	16	-
Coeff a4	28203	-	0x4072	2	3	18	-
Coeff a5	892	-	0x4074	2	3	20	-
Coeff b1	328	-	0x4076	2	3	22	-
Coeff b2	-605	-	0x4078	2	3	24	-
Coeff b3	-2443	-	0x407a	2	3	26	-
Coeff b4	4696	-	0x407c	2	3	28	-
Rc0	6999	-	0x407e	2	3	30	-
Adc0	6999	-	0x4080	2	4	0	-
Rpad	1	-	0x4082	2	4	2	-
Rint	18000	-	0x4084	2	4	4	-
Fet Temperature Model							
Coeff a1	-11130	-	0x4088	2	4	8	-
Coeff a2	19142	-	0x408a	2	4	10	-
Coeff a3	-19262	-	0x408c	2	4	12	-
Coeff a4	28203	-	0x408e	2	4	14	-
Coeff a5	892	-	0x4090	2	4	16	-
Coeff b1	328	-	0x4092	2	4	18	-
Coeff b2	-605	-	0x4094	2	4	20	-
Coeff b3	-2443	-	0x4096	2	4	22	-
Coeff b4	4696	-	0x4098	2	4	24	-
Rc0	6999	-	0x409a	2	4	26	-

Figure 4-2. Data Memory Screen

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.

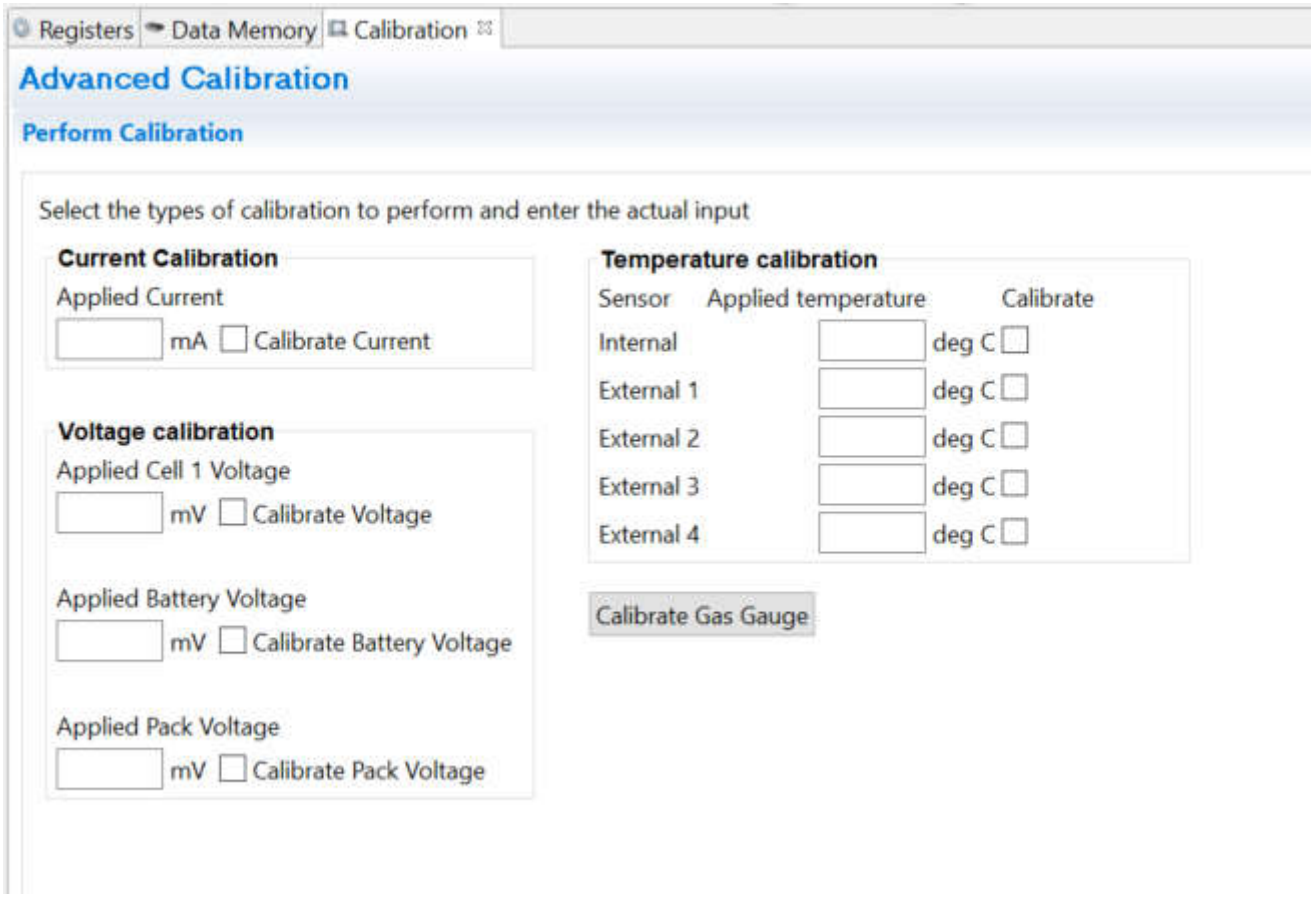


Figure 4-3. Calibration Screen

4.1.3.1 Voltage Calibration

1. 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.
2. Measure the voltage from Bat+ to Bat– and enter this value in the Applied Battery Voltage field and select the Calibrate Battery Voltage box.
3. 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.
4. Press the *Calibrate Gas Gauge* button to calibrate the voltage measurement system.
5. Deselect the Calibrate Voltage boxes after voltage calibration has completed.

4.1.3.2 Temperature Calibration

1. 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.
2. Press the *Calibrate Gas Gauge* button to calibrate the temperature measurement system.
3. Deselect the Calibrate boxes after temperature calibration has completed.

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 BQ41Z90EVM.

1. 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).
2. Enter –2000 in the Applied Current field and select the Calibrate Current box.
3. Press the *Calibrate Gas Gauge* button to calibrate.
4. Deselect the Calibrate Current box after current calibration has completed.

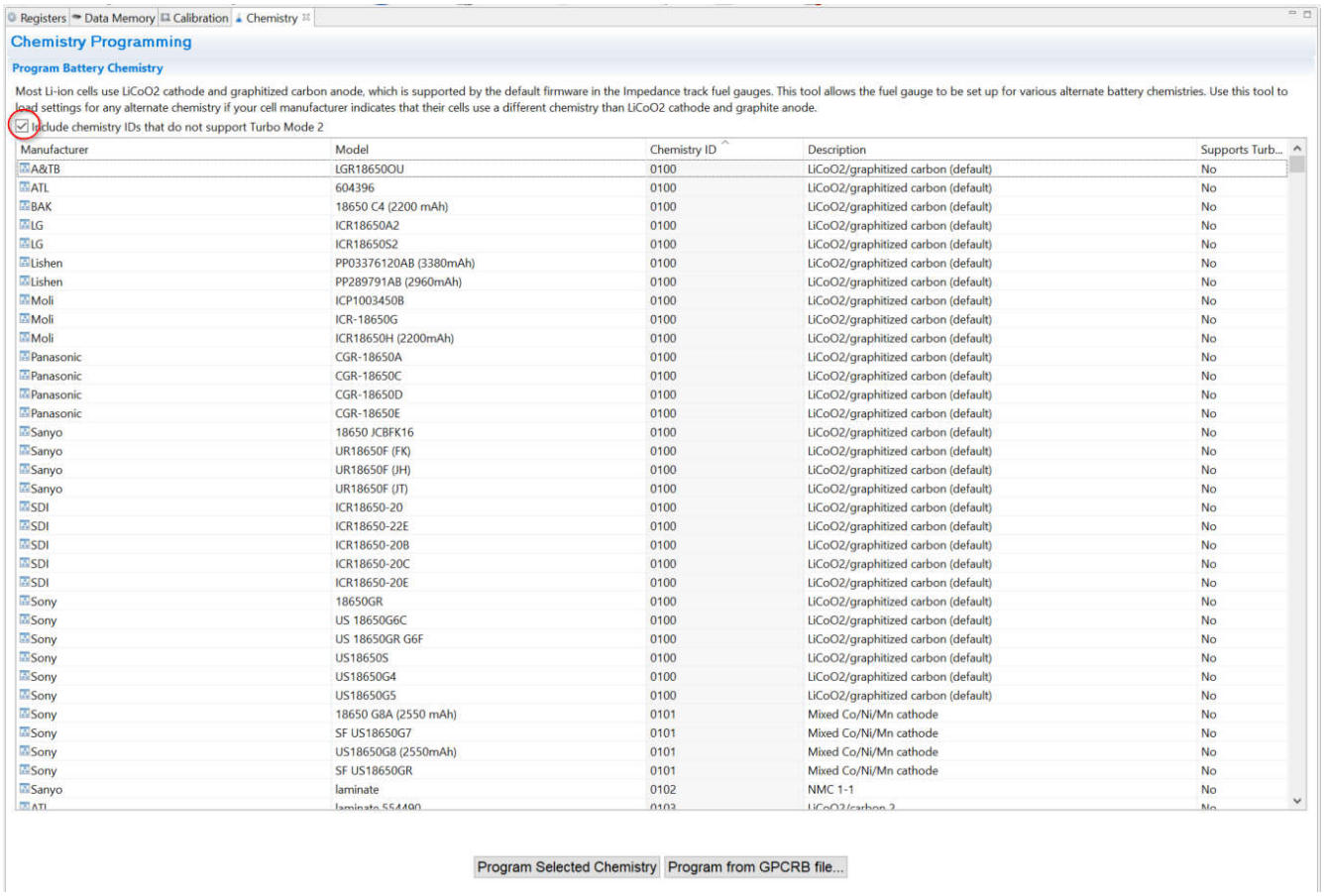
Note

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. Download the most recent Chem Updater available here GASGAUGECHEM-SW Design tool | TI.com Place all Chemdat files into the Chemistry Folder inside the BatteryManagementStudio folder.
2. Press the *Chemistry* button to select the Chemistry window.



Manufacturer	Model	Chemistry ID	Description	Supports Turb...
A&TB	LGR18650OU	0100	LiCoO2/graphitized carbon (default)	No
ATL	604396	0100	LiCoO2/graphitized carbon (default)	No
BAK	18650 C4 (2200 mAh)	0100	LiCoO2/graphitized carbon (default)	No
LG	ICR18650A2	0100	LiCoO2/graphitized carbon (default)	No
LG	ICR18650S2	0100	LiCoO2/graphitized carbon (default)	No
Lishen	PP03376120AB (3380mAh)	0100	LiCoO2/graphitized carbon (default)	No
Lishen	PP289791AB (2960mAh)	0100	LiCoO2/graphitized carbon (default)	No
Moli	ICP1003450B	0100	LiCoO2/graphitized carbon (default)	No
Moli	ICR-18650G	0100	LiCoO2/graphitized carbon (default)	No
Moli	ICR18650H (2200mAh)	0100	LiCoO2/graphitized carbon (default)	No
Panasonic	CGR-18650A	0100	LiCoO2/graphitized carbon (default)	No
Panasonic	CGR-18650C	0100	LiCoO2/graphitized carbon (default)	No
Panasonic	CGR-18650D	0100	LiCoO2/graphitized carbon (default)	No
Panasonic	CGR-18650E	0100	LiCoO2/graphitized carbon (default)	No
Sanyo	18650 JCBFK16	0100	LiCoO2/graphitized carbon (default)	No
Sanyo	UR18650F (FK)	0100	LiCoO2/graphitized carbon (default)	No
Sanyo	UR18650F (JH)	0100	LiCoO2/graphitized carbon (default)	No
Sanyo	UR18650F (JT)	0100	LiCoO2/graphitized carbon (default)	No
SDI	ICR18650-20	0100	LiCoO2/graphitized carbon (default)	No
SDI	ICR18650-22E	0100	LiCoO2/graphitized carbon (default)	No
SDI	ICR18650-20B	0100	LiCoO2/graphitized carbon (default)	No
SDI	ICR18650-20C	0100	LiCoO2/graphitized carbon (default)	No
SDI	ICR18650-20E	0100	LiCoO2/graphitized carbon (default)	No
Sony	18650GR	0100	LiCoO2/graphitized carbon (default)	No
Sony	US 18650G6C	0100	LiCoO2/graphitized carbon (default)	No
Sony	US 18650GR G6F	0100	LiCoO2/graphitized carbon (default)	No
Sony	US18650S	0100	LiCoO2/graphitized carbon (default)	No
Sony	US18650G4	0100	LiCoO2/graphitized carbon (default)	No
Sony	US18650G5	0100	LiCoO2/graphitized carbon (default)	No
Sony	18650 G8A (2550 mAh)	0101	Mixed Co/Ni/Mn cathode	No
Sony	SF US18650G7	0101	Mixed Co/Ni/Mn cathode	No
Sony	US18650G8 (2550mAh)	0101	Mixed Co/Ni/Mn cathode	No
Sony	SF US18650GR	0101	Mixed Co/Ni/Mn cathode	No
Sanyo	laminate	0102	NMC 1-1	No

Figure 4-4. Chemistry Screen

3. The table can be sorted by clicking the desired column for example: Click the Chemistry ID column header.
4. Select the ChemID that matches the cells used from the table (see Figure 4-4).
5. Press the *Program Selected Chemistry* button to update the chemistry in the device.

6. (Optional) Press *Program from GPCRB file* button to program the Chemdat file exported from the GPCRB tool (low temperature optimization tool).

Note

To find which ChemIDs support IT-DZT, please contact a local TI representative.

Note

New ChemIDs are required for BQ41Z90, previously made ChemIDs needs to be recreated.

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.

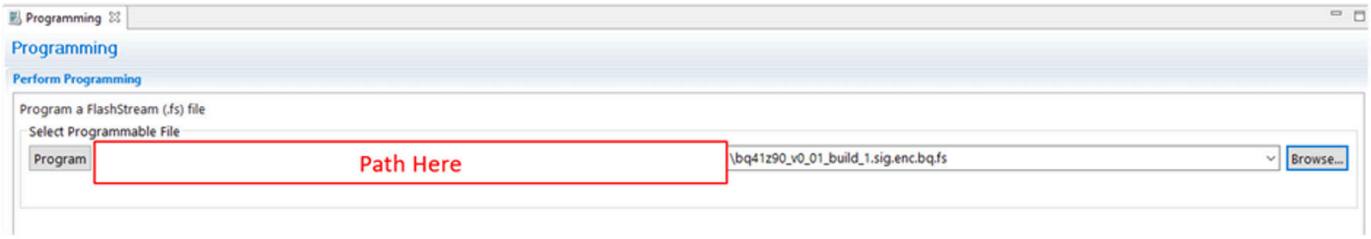


Figure 4-5. Programming Screen

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.

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.

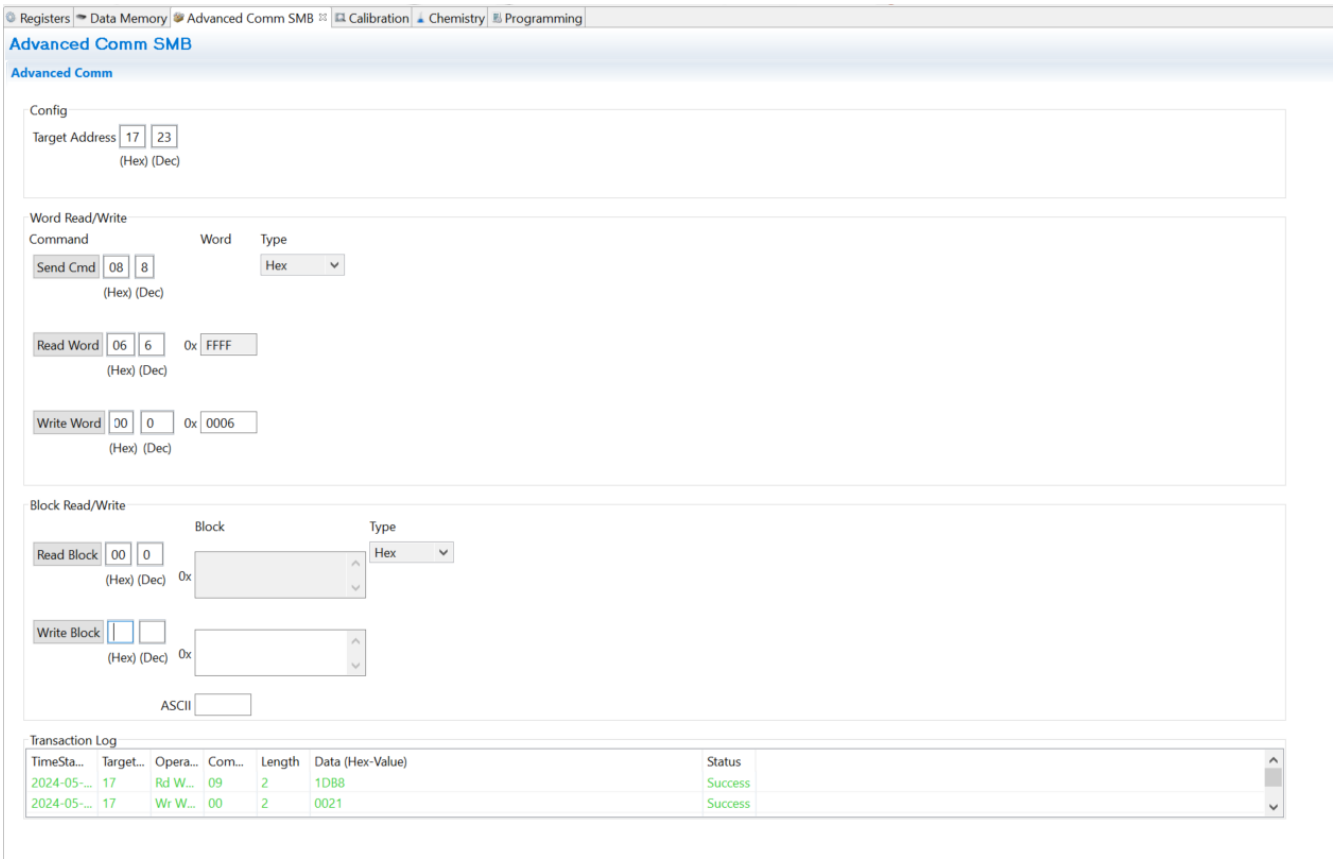


Figure 4-6. Advanced Comm SMB Screen

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 using ManufacturerAccess().

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

Reading Chemical ID() (0x0006) using 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

5 Hardware Design Files

5.1 BQ41Z90EVM Circuit Module Schematic

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

5.2 Circuit Module Physical Layouts

This section contains the printed-circuit board (PCB) layout, assembly drawings, and schematic for the BQ41Z90 and BQ77216 circuit modules.

5.2.1 Board Layout

This section shows the dimensions, PCB layers, and assembly drawing for the BQ41Z90 modules.

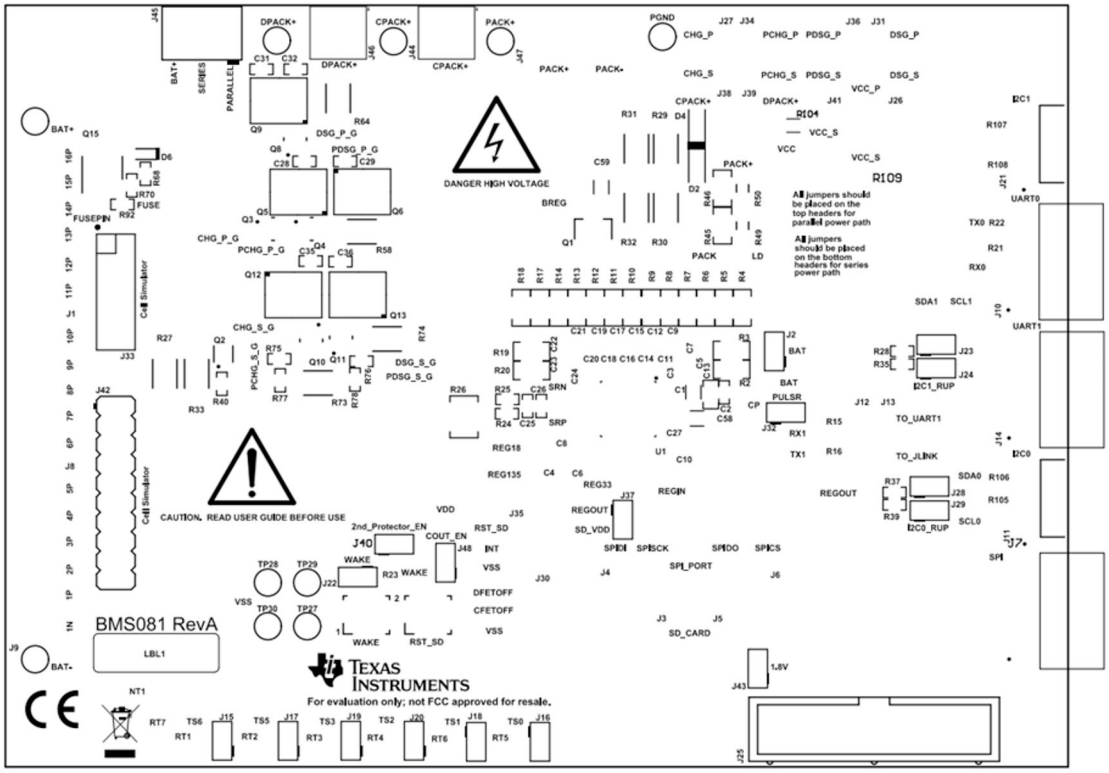


Figure 5-1. Top Silk Screen

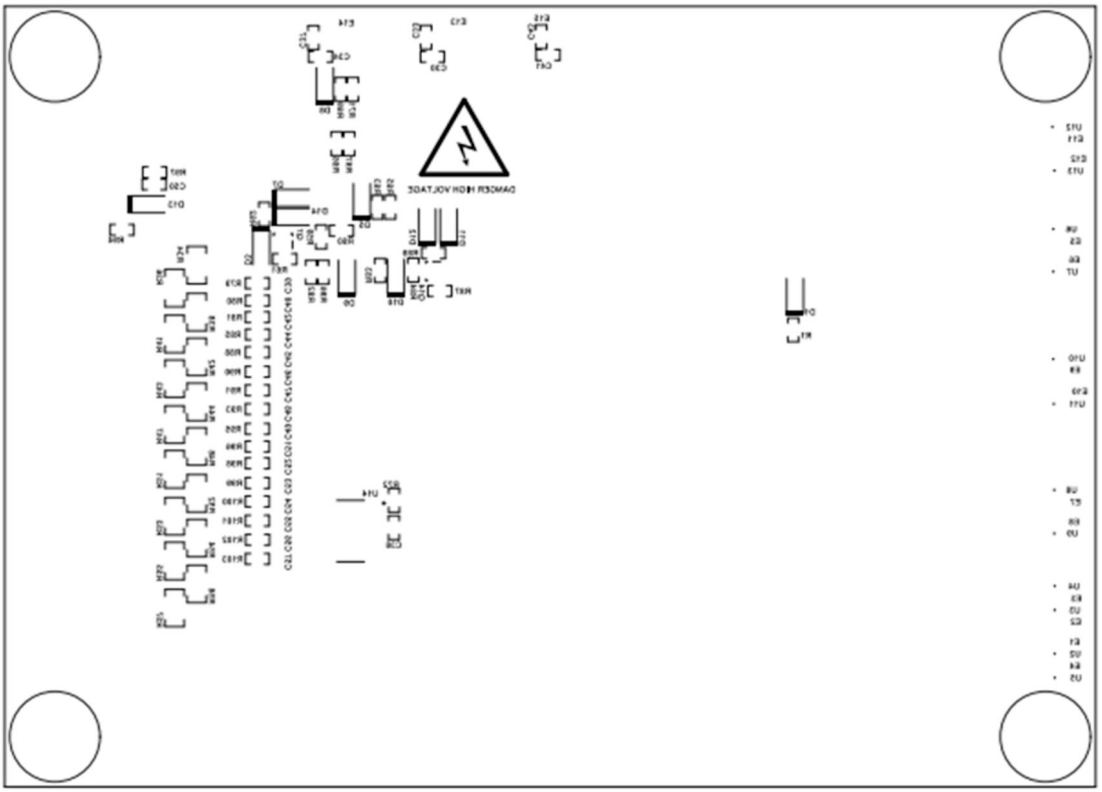


Figure 5-2. Bottom Silk Screen

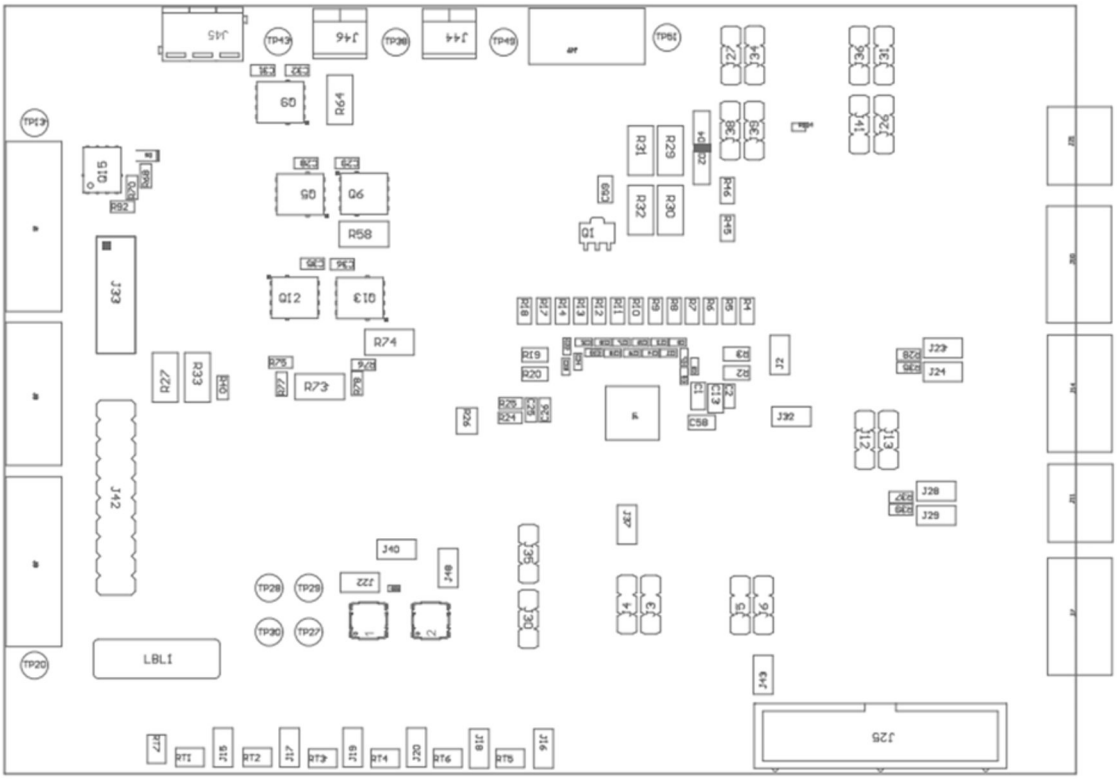


Figure 5-3. Top Assembly

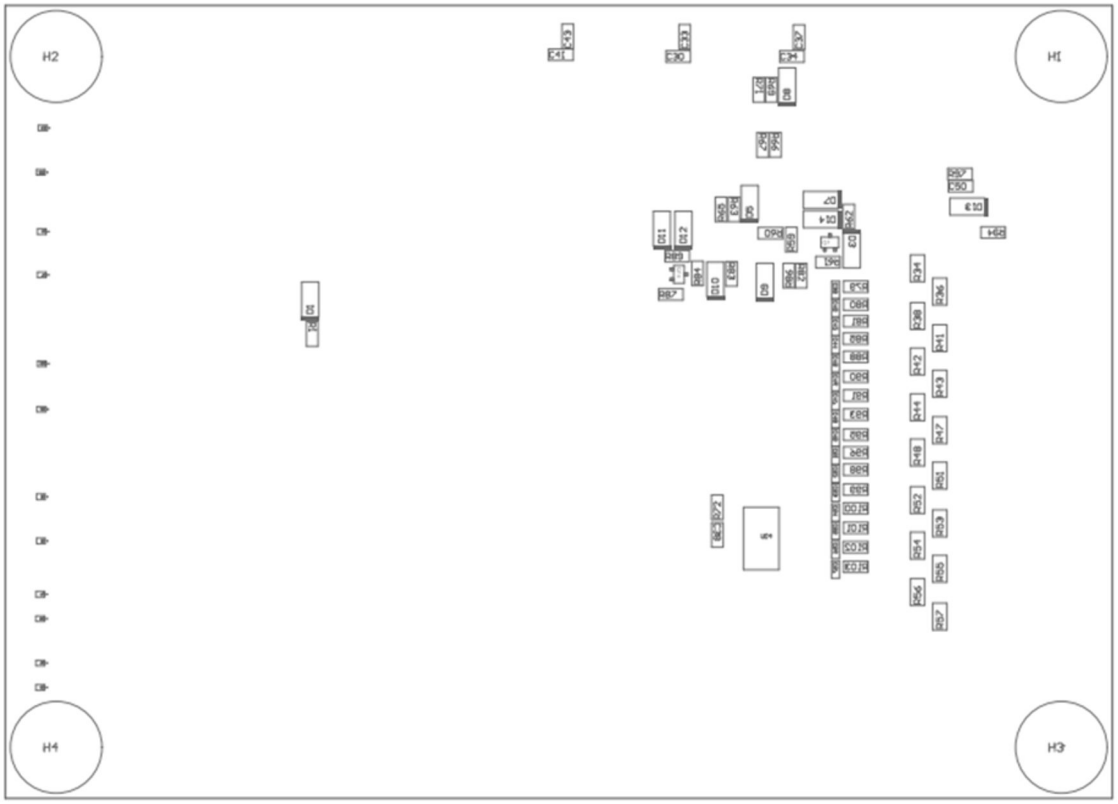


Figure 5-4. Bottom Assembly

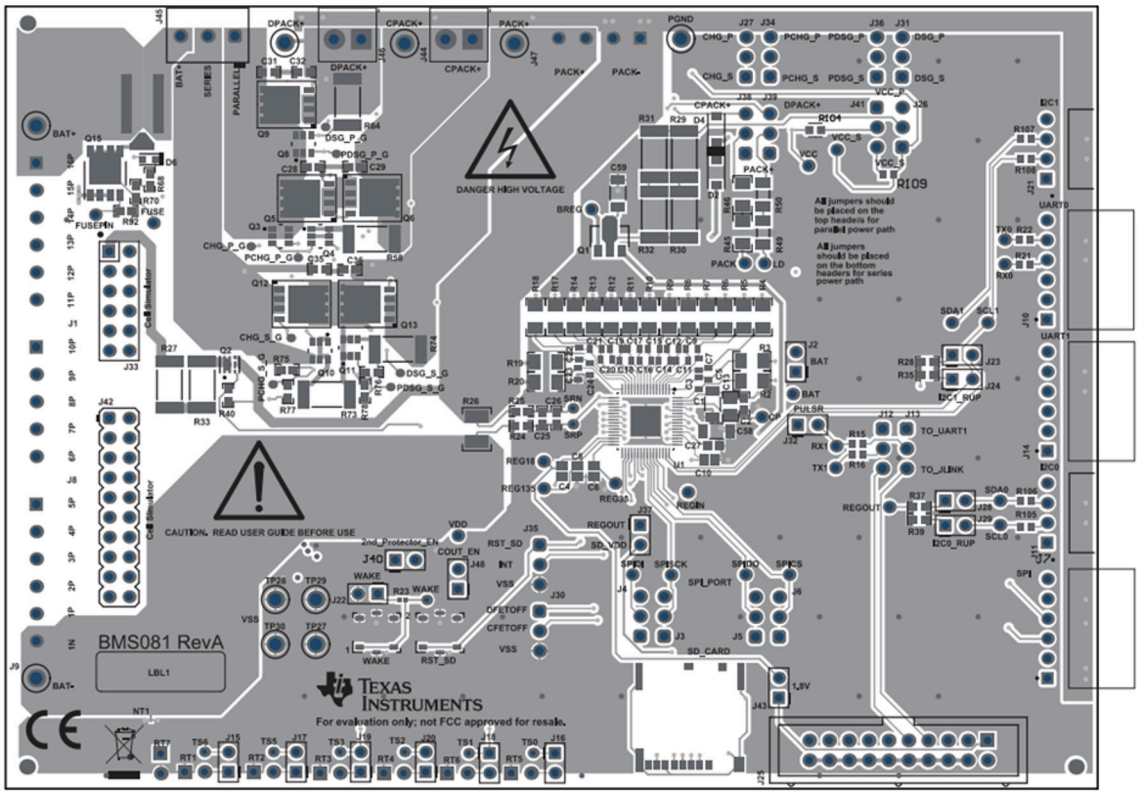


Figure 5-5. Top Layer

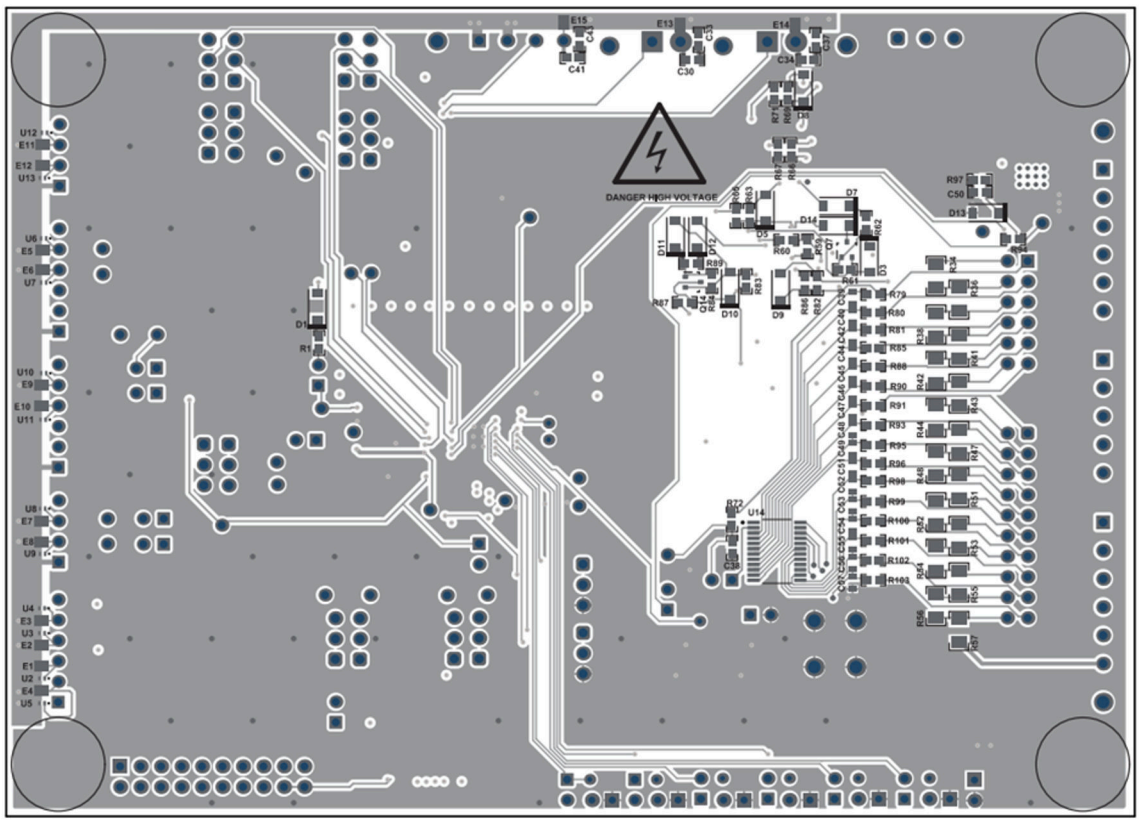


Figure 5-6. Bottom Layer

5.2.2 Schematic

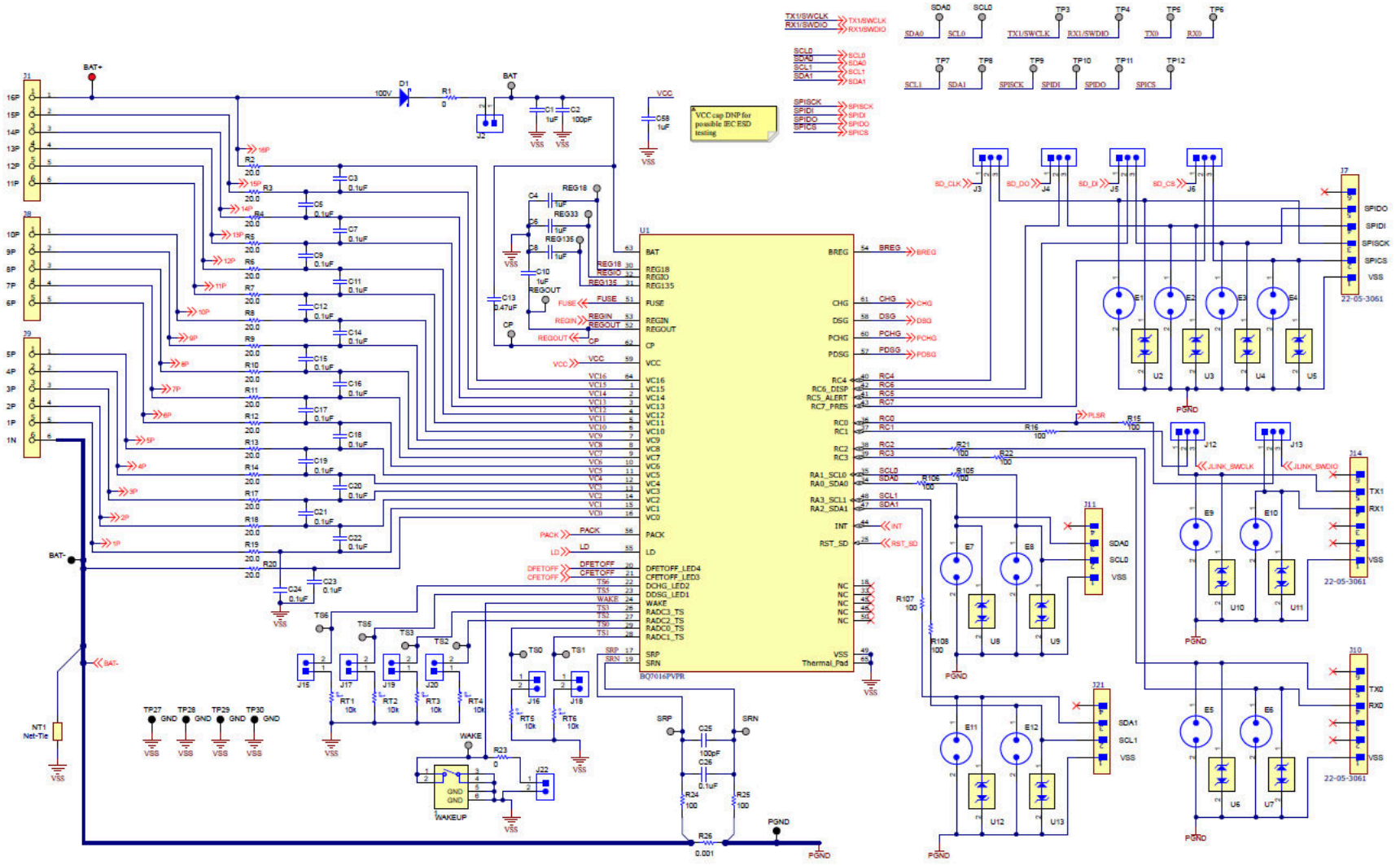
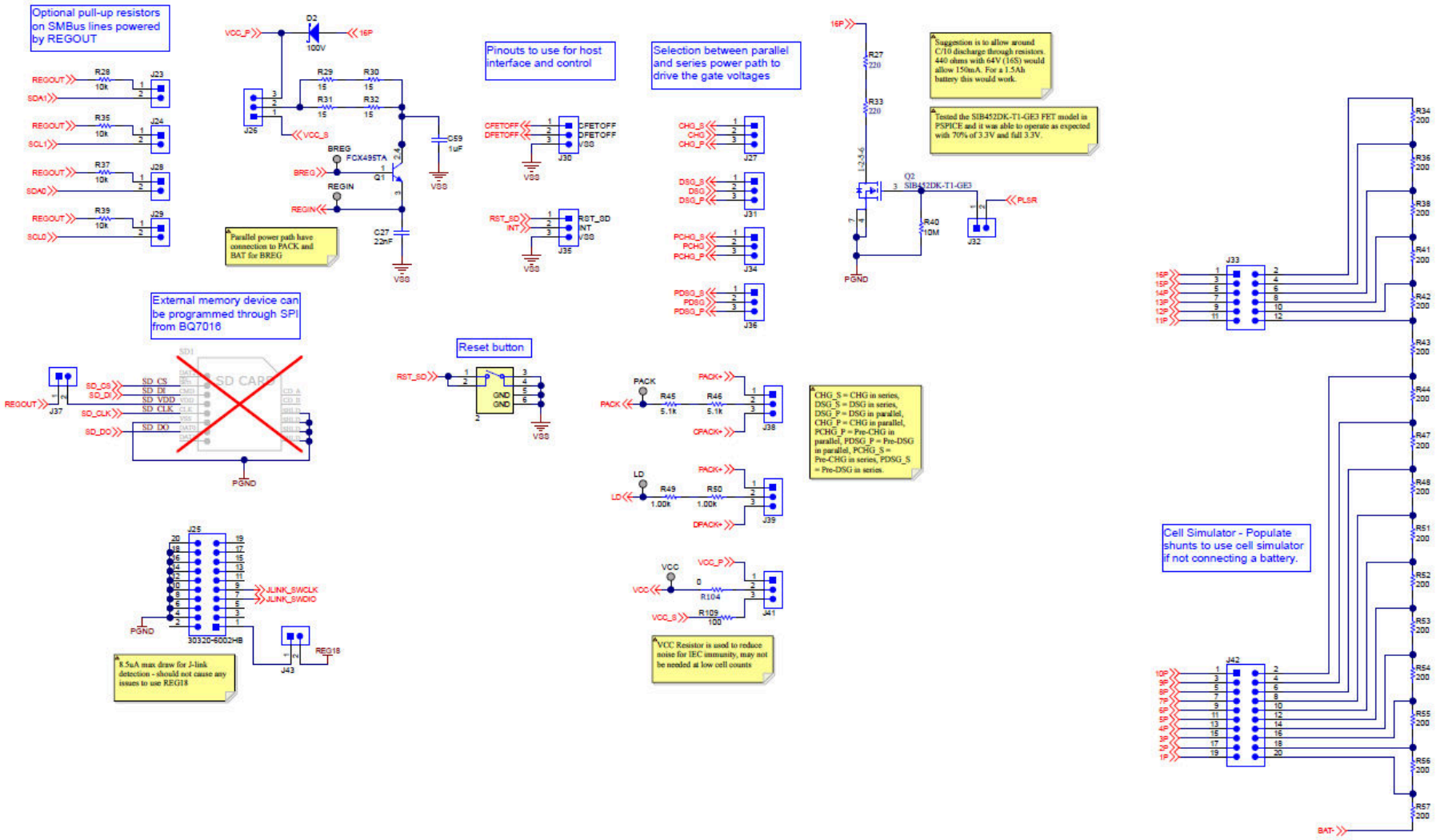
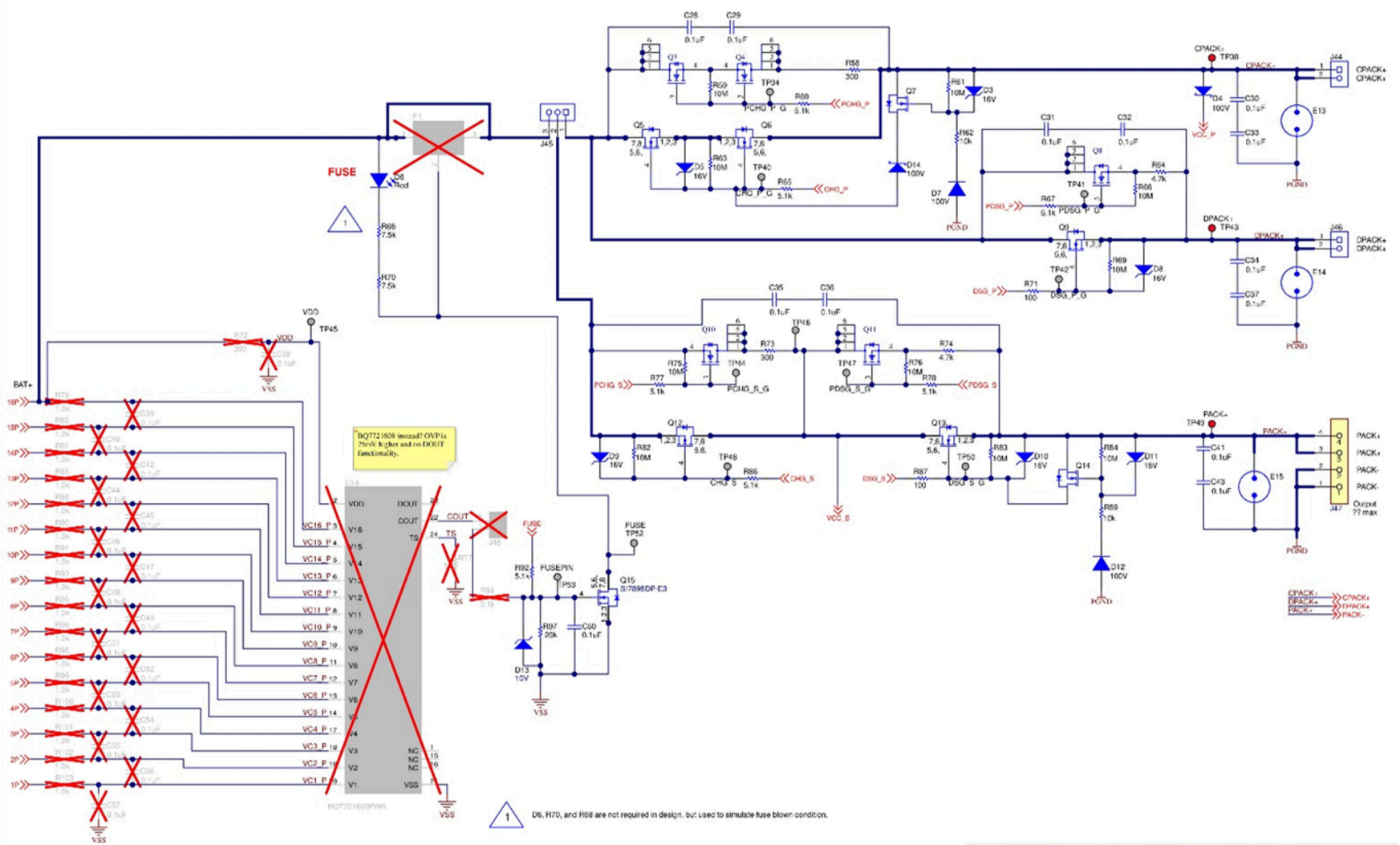
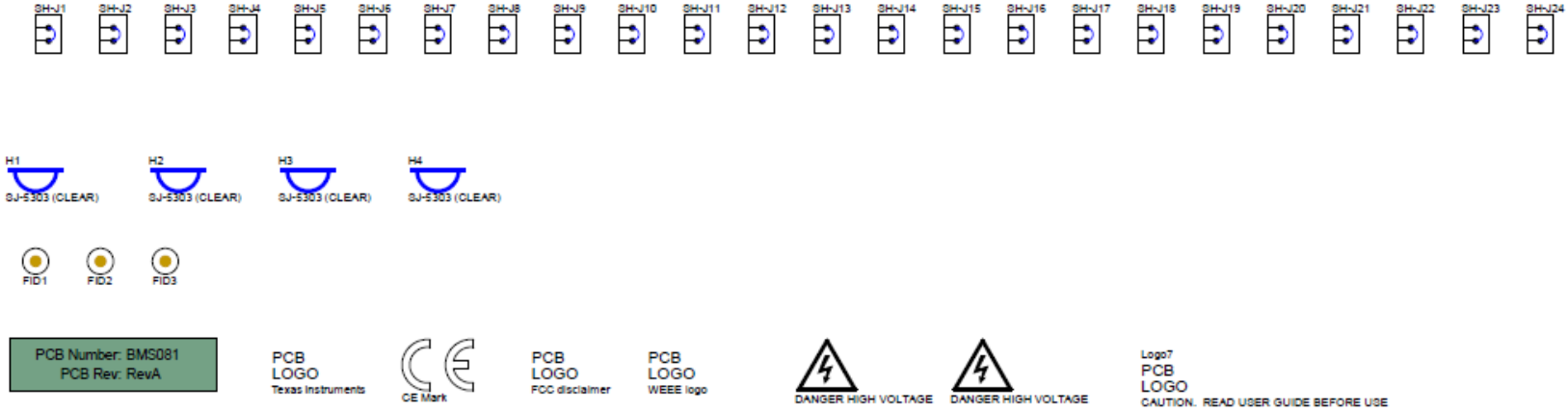


Figure 5-7. BQ41Z90 Schematic







Variant/Label Table	
Variant	Label Text
001	BQ7016EVM_E2

LBL1
PCB Label
THT-14-423-10
Size: 0.65" x 0.20 "

ZZ1
Label Assembly Note
This Assembly Note is for PCB labels only

ZZ2
Assembly Note
These assemblies are ESD sensitive, ESD precautions shall be observed.

ZZ3
Assembly Note
These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

ZZ4
Assembly Note
These assemblies must comply with workmanship standards IPC-A-610 Class 2, unless otherwise specified.

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
!PCB1	1		Printed Circuit Board		BMS081	Any		
1, 2	2		Switch, SPST-NO, Off-Mom, 0.02 A, 15 VDC, SMD	4.9x4.9mm	EVQ-PLHA15	Panasonic		
C1, C58, C59	3	1uF	CAP, CERM, 1 uF, 100 V, +/- 10%, X7R, 1206	1206	C3216X7R2A105K160AA	TDK		
C2	1	100pF	CAP, CERM, 100 pF, 100 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	603	GCM1885C2A101JA16D	MuRata		
C3, C5, C7, C9, C11, C12, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C26, C39, C40, C42, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57	35	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	603	8.85E+11	Wurth Elektronik		
C4, C6, C8, C10	4	1uF				Kemet		
C13	1	0.47uF	CAP, CERM, 0.47 uF, 25 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	805	GCM219R71E474KA55D	MuRata		
C25	1	100pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0603	603	C0603C101J5GACTU	Kemet		
C27	1	22nF	0603 22 nF 16 V ±5 % Tolerance X7R Surface Mount Multilayer Ceramic Capacitor Ceramic Capacitors 0.0416 0603 Surface Mount 16V 5% 22nF			AVX Interconnect / Elco		
C28, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C41, C43	13	0.1uF	CAP, CERM, 0.1 uF, 100 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	GCJ188R72A104KA01D	MuRata		
D1, D2, D4, D14	4	100V	Diode, Schottky, 100 V, 0.15 A, SOD-123	SOD-123	BAT46W-7-F	Diodes Inc.		
D3, D5, D8, D9, D10, D11	6	16V	Diode, Zener, 16 V, 500 mW, SOD-123	SOD-123	MMSZ5246B-7-F	Diodes Inc.		

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
D6	1	Red	LED, Red, SMD	LED_0603	150060RS75000	Wurth Elektronik		
D7, D12	2	100V	Diode, Ultrafast, 100 V, 0.15 A, SOD-123	SOD-123	1N4148W-7-F	Diodes Inc.		
D13	1	10V	Diode, Zener, 10 V, 500 mW, SOD-123	SOD-123	MMSZ4697T1G	ON Semiconductor		
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M		
J1, J9	2		TERM BLOCK 3.5MM VERT 6POS PCB	HDR6	OSTTE060161	On Shore Technology		
J2, J15, J16, J17, J18, J19, J20, J22, J23, J24, J28, J29, J32, J37, J40, J43, J48	17		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
J3, J4, J5, J6, J12, J13, J26, J27, J30, J31, J34, J35, J36, J38, J39, J41	16		Header, 2.54 mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	61300311121	Wurth Elektronik		
J7, J10, J14	3		Connector Header Through Hole, Right Angle 6 position 0.100" (2.54mm)	HDR6	22-05-3061	Molex		
J8	1		TERM BLOCK 3.5MM VERT 5POS PCB	HDR5	OSTTE050161	On Shore Technology		
J11, J21	2			HDR4	22-05-3041	Molex		
J25	1		Straight Low Profile Header, 10x2 Position, 2.54 mm Pitch, TH	Male Header, 10x2 Position, 2.54 mm Pitch, Straight, TH	30320-6002HB	3M		
J33	1		Header, 100mil, 6x2, Tin, TH	Header, 6x2, 100mil, Tin	PEC06DAAN	Sullins Connector Solutions		
J42	1		Header, 2.54mm, 10x2, Tin, TH	Header, 10x2, 2.54mm, TH	PEC10DAAN	Sullins Connector Solutions		
J44, J46	2		Terminal Block, 3.5mm Pitch, 2x1, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology		
J45	1		Terminal Block, 3.5mm, 3x1, Tin, R/A, TH	Terminal Block, 3.5mm, 3x1, TH	OSTTE030161	On-Shore Technology		

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
J47	1		TERM BLOCK 3.5MM VERT 4POS PCB	HDR4	OSTTE040161	On Shore Technology		
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		
Q1	1	150 V	Transistor, NPN, 150 V, 1 A, AEC-Q101, SOT-89	SOT-89	FCX495TA	Diodes Inc.		
Q2	1		MOSFET N-CH 190V 1.5A PPAK SC75					
Q3, Q4, Q8, Q10, Q11	5		MOSFET N-CH 150V 900MA MICRO6					
Q5, Q6, Q9, Q12, Q13	5	150V	MOSFET, N-CH, 150 V, 56 A, PG-TDSON-8	PG-TDSON-8	BSC160N15NS5ATMA1	Infineon Technologies		None
Q7, Q14	2	60V	MOSFET, N-CH, 60 V, 0.31 A, SOT-323	SOT-323	2N7002KW	Fairchild Semiconductor		None
Q15	1	150V	MOSFET, N-CH, 150 V, 3 A, PowerPAK SO-8	PowerPAK SO-8	SI7898DP-E3	Vishay-Siliconix		None
R1	1	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06030000Z0EA	Vishay-Dale		
R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R17, R18, R19, R20	17	20	RES, 20.0, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW120620R0FKEA	Vishay-Dale		
R15, R16, R21, R22, R105, R106, R107, R108, R109	9		Chip Resistor, 100 Ohm, ± 1%, 100 mW, 0603 [1608 Metric], Thick Film, General Purpose Chip SMD Resistors 0.0419 0603 50V 1% 100ppm/°C 100mW 100R			Yageo		
R23	1	0	RES, 0, 5%, 0.05 W, 0201	201	CRCW02010000Z0ED	Vishay-Dale		
R24, R25	2	100	RES, 100, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603100RJNEA	Vishay-Dale		
R26	1	0.001	RES, 0.001, 1%, 1 W, 1210	1210	PMR25HZPFV1L00	Rohm		
R27, R33	2	220	RES, 220, 5%, 3 W, 2512	2512	3522220RJT	TE Connectivity		
R28, R35, R37, R39, R62, R89	6	10k	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060310K0JNEA	Vishay-Dale		
R29, R30, R31, R32	4	15	RES, 15, 5%, 1 W, AEC-Q200 Grade 0, 2512	2512	CRCW251215R0JNEG	Vishay-Dale		

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R34, R36, R38, R41, R42, R43, R44, R47, R48, R51, R52, R53, R54, R55, R56, R57	16	200	RES, 200, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW1206200RFKEA	Vishay-Dale		
R40, R59, R61, R63, R66, R69, R75, R76, R82, R83, R84	11	10Meg	RES, 10 M, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060310M0JNEA	Vishay-Dale		
R45, R46	2	5.1k	RES, 5.1 k, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW12065K10JNEA	Vishay-Dale		
R49, R50	2	1.00k	Chip Resistor, 1 KOhm, +/- 1%, 0.25 W, -55 to 155 degC, 1206 (3216 Metric), RoHS, Tape and Reel			Yageo		
R58, R73	2	300	RES, 300, 5%, 1 W, AEC-Q200 Grade 0, 2512	2512	CRCW2512300RJNEG	Vishay-Dale		
R60, R65, R67, R77, R78, R86, R92, R94	8	5.1k	RES, 5.1 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06035K10JNEA	Vishay-Dale		
R64, R74	2	4.7k	RES, 4.7 k, 5%, 1 W, AEC-Q200 Grade 0, 2512	2512	CRCW25124K70JNEG	Vishay-Dale		
R68, R70	2	7.5k	RES, 7.5 k, 5%, 0.1 W, 0603	603	RC0603JR-077K5L	Yageo		
R71, R87	2	1.0k	RES, 1.0 k, 5%, 0.25 W, AEC-Q200 Grade 0, 0603	603	ESR03EZPJ102	Rohm		
R72	1	300	RES, 300, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603300RJNEA	Vishay-Dale		
R79, R80, R81, R85, R88, R90, R91, R93, R95, R96, R98, R99, R100, R101, R102, R103	16	1.0k	RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06031K00JNEA	Vishay-Dale		
R97	1	20k	RES, 20 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060320K0JNEA	Vishay-Dale		
R104	1	0	0 Ohms Jumper Chip Resistor 0603 (1608 Metric) Metal Element	603	WSL060300000ZEA9	Vishay		
RT1, RT2, RT3, RT4, RT5, RT6, RT7	7	10k	Thermistor NTC, 10.0k ohm, 1%, Disc, 5x8.4 mm	Disc, 5x8.4 mm	103AT-2	SEMITEC Corporation		

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13, SH-J14, SH-J15, SH-J16, SH-J17, SH-J18, SH-J19, SH-J20, SH-J21, SH-J22, SH-J23, SH-J24	24	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M
TP13, TP38, TP43, TP49	4		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone		
TP20, TP51	2		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone		
TP27, TP28, TP29, TP30	4		Test Point, Compact, Black, TH	Black Compact Testpoint	5006	Keystone		
U1	1		Highly Integrated 3-16 Cell Battery Fuel Gauge with Ultra Low IQ	HTQFP64	BQ7016PVPR	Texas Instruments		
U2, U3, U4, U5, U6, U7, U8, U9, U10, U11, U12, U13	12		Single-Channel ESD in 0402 Package With 10pF Capacitance and 6V Breakdown, DPY0002A (X1SON-2)	DPY0002A		Texas Instruments	TPD1E10B06DPYT	Texas Instruments
U14	1		Voltage and Temperature Protection for 3-Series to 16-Series Cell Li-Ion Batteries with Internal Delay Timer	TSSOP24	BQ7721602PWR	Texas Instruments		
F1	0		Fuse, 30 A, 62 VDC, SMD	9.5x2x5mm	SFK-3030	Dexerials Corporation		
SD1	0		Micro SD Connector, Pitch 1.1 mm, 8 Position, Height 1.4 mm, -25 to 85 degC, RoHS, Tape and Reel			Molex		

6 Additional Information

6.1 Trademarks

Impedance Track™ is a trademark of Texas Instruments.
Microsoft® and Windows® are registered trademarks of Microsoft Corporation.
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7 Related Documentation from Texas Instruments

- Texas Instruments, *BQ41Z90 2-Series, 3-Series, and 4-Series Cell Li-Ion Battery Pack Manager with Dynamic Z-Track™*, data sheet
- Texas Instruments, *BQ41Z90 Technical Reference Manual*
- Texas Instruments, *BQ77216 Voltage and Temperature Protection for 3-Series to 16-Series Cell Li-Ion Batteries with Internal Delay Timer* data sheet

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   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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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。

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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

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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:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS 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 EPIDEMIC FAILURE WARRANTY OR 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 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, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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. 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 OR THE USE OF THE EVMS , 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 TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   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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