User's Guide
SLUUBD6–September 2015

bq78z100EVM 1- to 2-Series Li-Ion Battery Pack Manager Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the bq78z100 or bq294502 battery management system. The EVM includes one bq78z100 and bq294502 circuit module and a link to Windows® based PC software. The circuit module includes one bq78z100 integrated circuit (IC), one bq294502 IC, 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 over-current in 1- or 2-series cell Li-Ion or Li-Polymer battery packs. The circuit module connects directly across the cells in a battery. With the EV2300 or EV2400 interface board and software, the user can read the bq78z100 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the solution under different charge and discharge conditions using HDQ communication protocol.

Contents

List of Figures

1 Features

- Complete evaluation system for the bq78z100EVM 1- to 2-Series Battery Pack Manager Evaluation Module and bq294502 independent overvoltage protection IC
- Populated circuit module for quick setup
- Software that allows data logging for system analysis

1.1 Kit Contents

- bq78z100 and bq294502 circuit module
- Cable to connect the EVM to an EV2300 or EV2400 Communications Interface adapter

1.2 Ordering Information

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

Table 1. Ordering Information

EVM PART NUMBER	CHEMISTRY	CONFIGURATION	CAPACITY
bq78z100EVM	Li-Ion	1-, 2-cell	Any

1.3 Documentation

For information on the bq78z100 and bq294502 device firmware and hardware, see the following documentation:

- *bq78z100 Impedance Track™ Gas Gauge for 1-Series to 2-Series Li-Ion/Li-Polymer Battery Packs* (SLUSC23)
- *bq78z100 Technical Reference Manual* (SLUUB63)
- *bq2945xx Overvoltage Protection For 2-Series and 3-Series Cell Li-Ion Batteries* (SLUSAJ3)
- *bq294502 EVM User's Guide* (SLUU659)

1.4 bq78z100 and bq294502 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq78z100 and bq294502 EVM.

Table 2. Performance Specification Summary

SPECIFICATION	MINIMUM	TYPICAL	MAXIMUM	UNITS
Input voltage Pack+ to Pack–	3	7	25	V
Charge and discharge current	0	2	7	A

2 bq78z100EVM Quick Start Guide

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

2.1 Items Needed for EVM Setup and Evaluation

- bq78z100 and bq294502 circuit module
- EV2300 or EV2400 communications interface adapter
- Cable to connect the EVM to an EV2300 or EV2400 communications interface adapter
- USB cable to connect the communications interface adapter to the computer
- Computer setup with Windows® XP, or higher, operating system
- Access to the Internet to download the Battery Management Studio software setup program
- One or two battery cells or 1-kΩ resistors to configure a cell simulator
- A DC power supply that can supply 8.4 V and 2 A (constant current and constant voltage capability is desirable)

2.2 Software Installation

Find the latest software version in the bq78z100 tool folder on www.ti.com. Use the following steps to install the bq78z100 Battery Management Studio software:

1. Download and run the Battery Management Studio setup program from the Development Tools section of the bq78z100EVM product folder on www.ti.com. See Section 3 for detailed information on using the tools in the Battery Management Studio.
2. If the Communications Interface Adapter was not previously installed, after the bqStudio installation, a TI USB DRIVER INSTALLER pops up. Click **Yes** for the agreement message and follow its instructions. Two drivers are associated with the EV2300 and an additional file may be required for the EV2400. Follow the instructions to install both. Do not reboot the computer, even if asked to do so.
3. Plug the communications interface adapter into a USB port using the USB cable. The Windows® system may show a prompt that new hardware has been found. When asked, "Can Windows connect to Windows Update to search for software?", select "No, not this time", and click **Next**. In the next dialog window, it indicates "This wizard helps you install software for: TI USB Firmware Updater". Select "Install the software automatically (Recommended)" and click **Next**. It is common for the next screen to be the Confirm File Replace screen. Click **No** to continue. If this screen does not appear, then go to the next step. After Windows® indicates that the installation was finished, a similar dialog window pops up to install the second driver. Proceed with the same installation preference as the first one. The second driver is TI USB bq80xx Driver.

2.3 EVM Connections Module Connections

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

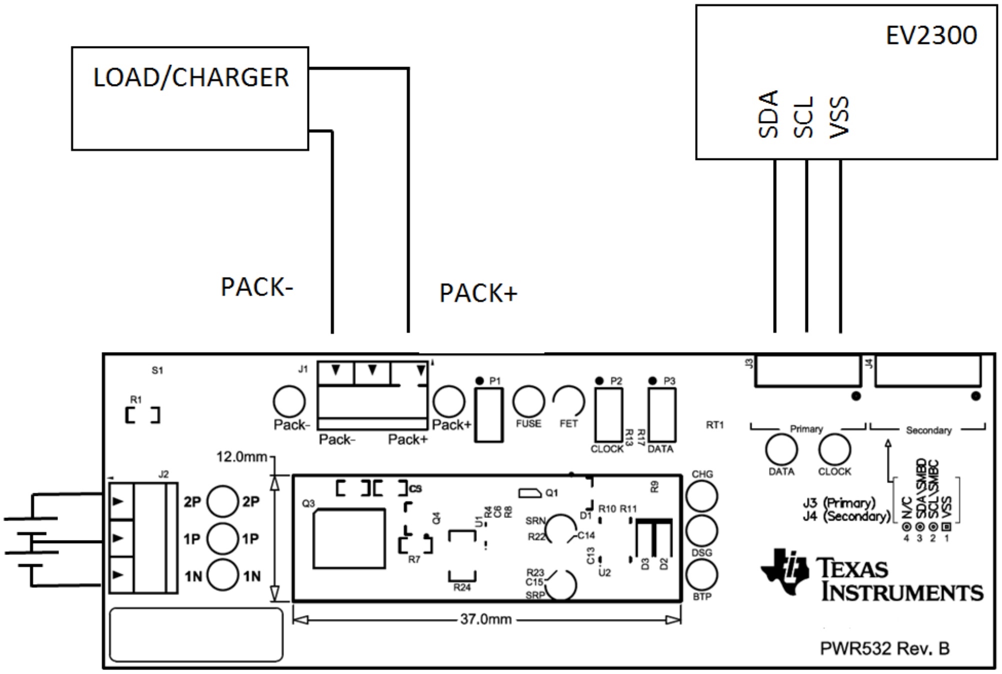
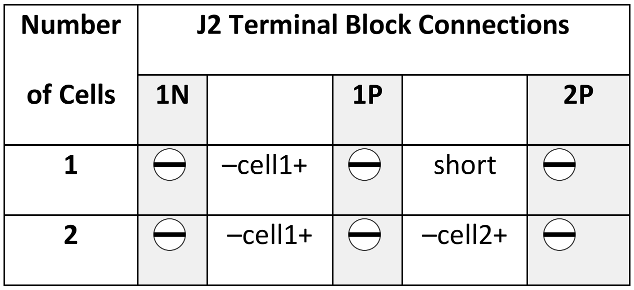


Figure 1. bq78z100 Circuit Module Connection to Cells and System Load or Charger

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

  Attach the cells to the J2 terminal block. A specific cell connection sequence is not required, although it is a good practice to start with lowest cell in the stack (cell1) and then add cell 2. The U1 and U2 devices should not get damaged by other cell connection sequences, but there is a possibility that the bq294502 could blow the fuse in a module that has one. Attaching cells starting with cell 1 should eliminate this risk.



Number of Cells	J2 Terminal Block Connections				
	1N		1P		2P
1	⊖	–cell1+	⊖	short	⊖
2	⊖	–cell1+	⊖	–cell2+	⊖

Figure 2. Cell Connection Configuration

A resistor cell simulator can be used instead of battery cells. Connect a resistor between each of the contacts on the J2 connector; that is, from 1N to 1P and from 1P to 2P. If being used for a 1-series configuration no resistor is needed, simply short 1P and 2P. A power supply can provide power to the cell simulator. Set the power supply to the desired cell voltage x the number of cells and attach the ground wire to 1N and the positive wire to 2P. For example, for a 2-series configuration with a 3.6-V cell voltage, set the power supply to 2 × 3.6 = 7.2 V.

- I^{2}C™ (SDA, SCL) and HDQ port

  Attach the communications interface adapter cable to J3 and to the I^{2}C™ port on the EV2300.

NOTE: The bq78z100 ships with the firmware in I^{2}C mode for faster programming of the data flash. When programming is done, the device can be switched to HDQ mode using the GO_TO HDQ command. After the device is switched to HDQ, the connecting cable on the EV2300 should be switched to the HDQ port; otherwise, the user will not be able to communicate with the device. The user can also switch back from HDQ to I^{2}C using the GO_TO I^{2}C command.

- System load and charger connections across PACK+ and PACK–

  Attach the load or power supply to the J1 terminal block. The positive terminal of the load or power supply wire should be connected to the terminal block position labeled PACK+. The ground wire for the load or power supply should be connected to the other terminal block position labeled PACK–.

- Wake-up the device up from SHUTDOWN (WAKE)

  Press the **Wake** pushbutton switch S1 to temporarily connect BAT+ to PACK+. This applies voltage to the PACK pin on the bq78z100 to power-up the regulators and start the initialization sequence.

- Parameter setup

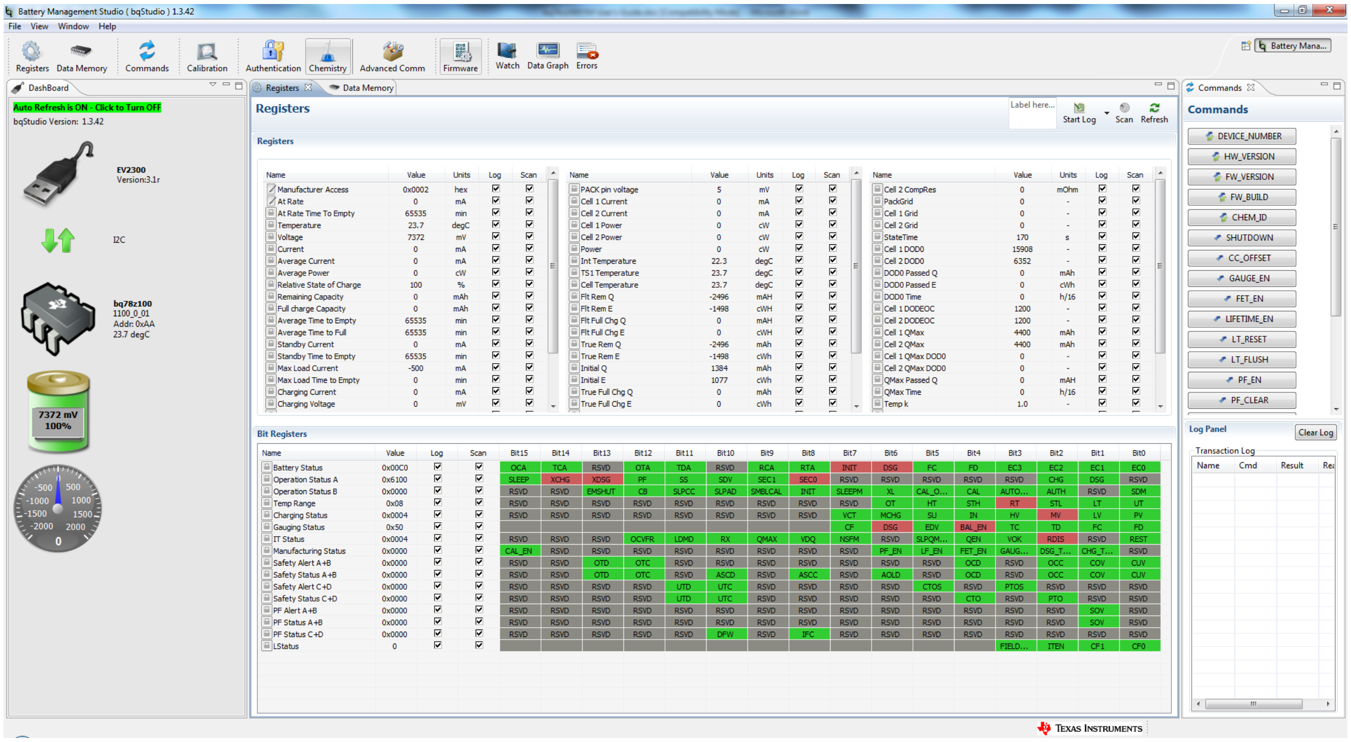
  The default data flash default settings is configured for 2-series Li-Ion cells. The user should change the | Data Memory | Settings | DA Configuration register to set up the number of series cells to match the physical pack configuration. This provides basic functionality to the setup. Other data flash parameters should also be updated to fine tune the gauge to the pack. See the *bq78z100 Technical Reference Manual* (SLUUB63) for help with setting the parameters.

NOTE: If using a 1-series configuration: To avoid an undervoltage safety condition, the device should be initially powered up with a 2-series configuration to allow the user to go into the | Data Memory | Settings | DA Configuration and modify the CC0 bit for 1-series configuration.

3 Battery Management Studio

3.1 Starting the Program

Run Battery Management Studio from the Start | Programs | Texas Instruments | Battery Management Studio sequence or the Battery Management Studio shortcut. As long as the device has been woken up from shutdown mode by momentarily pressing button **S1** or applying a charger voltage, the gauge will be automatically detected and the register screen will appear as seen in Figure 3. If your device contains an earlier firmware version, then auto detection of the device may not occur. If that happens, on the window that pops up as shown in Figure 4, select any bq78z100 .bqz file. This action will enable the program to get started and the user can update the firmware using the latest .srec file for the device downloadable from the product folder of the gauge at www.ti.com.



Registers

Name	Value	Units	Log	Scan
Manufacturer Access	0x0002	hex	☑	☑
At Rate	0	mA	☑	☑
At Rate Time To Empty	65535	min	☑	☑
Temperature	23.7	degC	☑	☑
Voltage	7372	mV	☑	☑
Current	0	mA	☑	☑
Average Current	0	mA	☑	☑
Average Power	0	cW	☑	☑
Relative State of Charge	100	%	☑	☑
Remaining Capacity	0	mAh	☑	☑
Full charge Capacity	0	mAh	☑	☑
Average Time to Empty	65535	min	☑	☑
Average Time to Full	65535	min	☑	☑
Standby Current	0	mA	☑	☑
Standby Time to Empty	65535	min	☑	☑
Max Load Current	-500	mA	☑	☑
Max Load Time to Empty	0	min	☑	☑
Charging Current	0	mA	☑	☑
Charging Voltage	0	mV	☑	☑

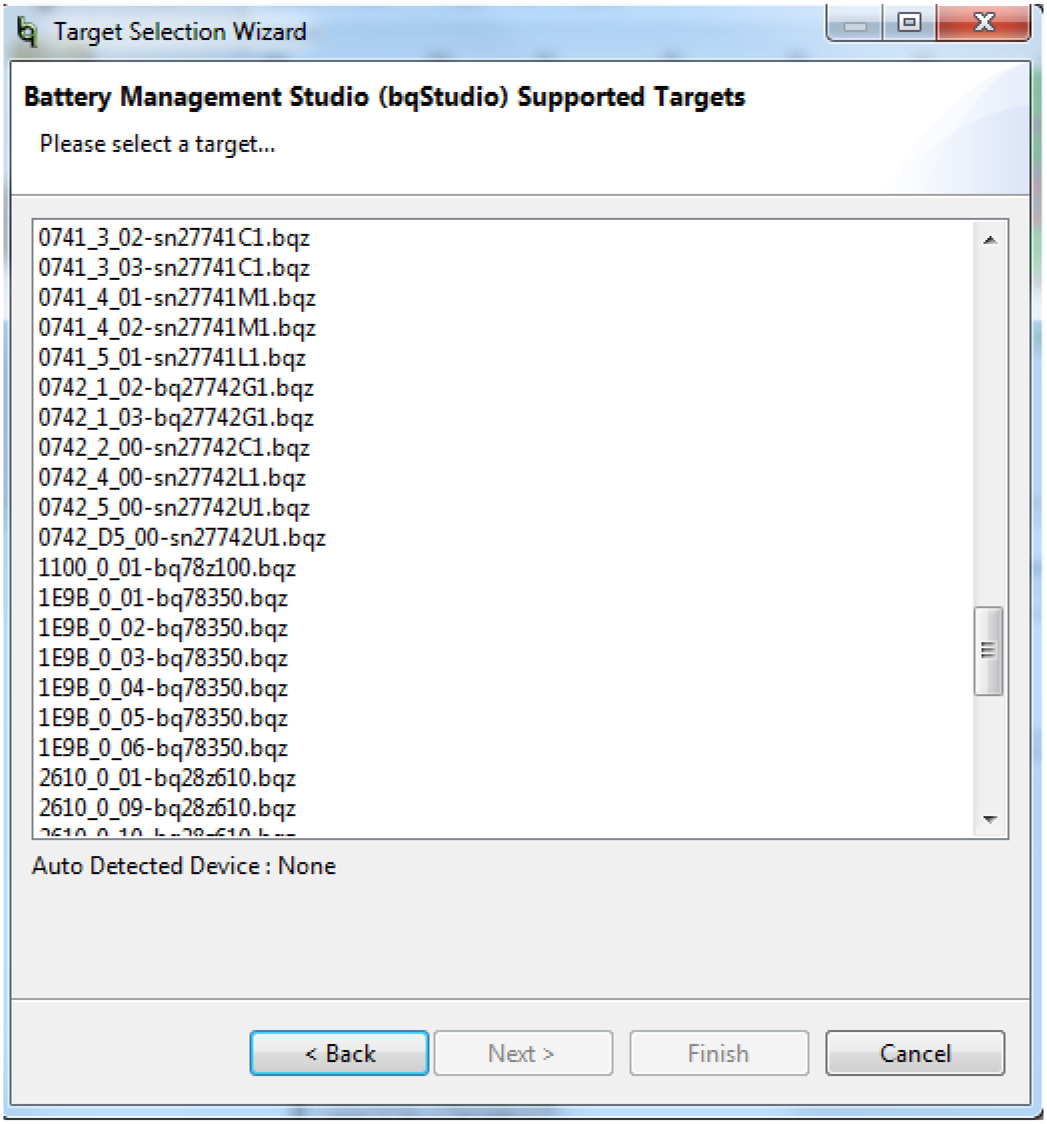
Name	Value	Units	Log	Scan
PACK pin voltage	5	mV	☑	☑
Cell 1 Current	0	mA	☑	☑
Cell 2 Current	0	mA	☑	☑
Cell 1 Power	0	cW	☑	☑
Cell 2 Power	0	cW	☑	☑
Power	0	cW	☑	☑
Int Temperature	22.3	degC	☑	☑
TS1 Temperature	23.7	degC	☑	☑
Cell Temperature	23.7	degC	☑	☑
Flt Rem Q	-2496	mAH	☑	☑
Flt Rem E	-1498	cWH	☑	☑
Flt Full Chg Q	0	mAH	☑	☑
Flt Full Chg E	0	cWH	☑	☑
True Rem Q	-2496	mAh	☑	☑
True Rem E	-1498	cWh	☑	☑
Initial Q	1384	mAh	☑	☑
Initial E	1077	cWh	☑	☑
True Full Chg Q	0	mAh	☑	☑
True Full Chg E	0	cWh	☑	☑

Name	Value	Units	Log	Scan
Cell 2 CompRes	0	mOhm	☑	☑
PackGrid	0	-	☑	☑
Cell 1 Grid	0	-	☑	☑
Cell 2 Grid	0	-	☑	☑
StateTime	170	s	☑	☑
Cell 1 DOD0	15908	-	☑	☑
Cell 2 DOD0	6352	-	☑	☑
DOD0 Passed Q	0	mAh	☑	☑
DOD0 Passed E	0	cWh	☑	☑
DOD0 Time	0	h/16	☑	☑
Cell 1 DODEOC	1200	-	☑	☑
Cell 2 DODEOC	1200	-	☑	☑
Cell 1 QMax	4400	mAh	☑	☑
Cell 2 QMax	4400	mAh	☑	☑
Cell 1 QMax DOD0	0	-	☑	☑
Cell 2 QMax DOD0	0	-	☑	☑
QMax Passed Q	0	mAH	☑	☑
QMax Time	0	h/16	☑	☑
Temp k	1.0	-	☑	☑

Bit Registers

Name	Value	Log	Scan	Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Battery Status	0x00C0	☑	☑	OCA	TCA	RSVD	OTA	TDA	RSVD	RCA	RTA	INIT	DSG	FC	FD	EC3	EC2	EC1	EC0
Operation Status A	0x6100	☑	☑	SLEEP	XCHG	XDSG	PF	SS	SDV	SEC1	SEC0	RSVD	RSVD	RSVD	RSVD	RSVD	CHG	DSG	RSVD
Operation Status B	0x0000	☑	☑	RSVD	RSVD	EMSHUT	CB	SLPCC	SLPAD	SMBLCAL	INIT	SLEEPM	XL	CAL_O...	CAL	AUTO...	AUTH	RSVD	SDM
Temp Range	0x08	☑	☑	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	OT	HT	STH	RT	STL	LT	UT
Charging Status	0x0004	☑	☑	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	VCT	MCHG	SU	IN	HV	MV	LV	PV
Gauging Status	0x50	☑	☑									CF	DSG	EDV	BAL_EN	TC	TD	FC	FD
IT Status	0x0004	☑	☑	RSVD	RSVD	RSVD	OCVFR	LDMD	RX	QMAX	VDQ	NSFM	RSVD	SLPQM...	QEN	VOK	RDIS	RSVD	REST
Manufacturing Status	0x0000	☑	☑	CAL_EN	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	PF_EN	LF_EN	FET_EN	GAUG...	DSG_T...	CHG_T...	RSVD
Safety Alert A+B	0x0000	☑	☑	RSVD	RSVD	OTD	OTC	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	OCD	RSVD	OCC	COV	CUV
Safety Status A+B	0x0000	☑	☑	RSVD	RSVD	OTD	OTC	RSVD	ASCD	RSVD	ASCC	RSVD	AOLD	RSVD	OCD	RSVD	OCC	COV	CUV
Safety Alert C+D	0x0000	☑	☑	RSVD	RSVD	RSVD	RSVD	UTD	UTC	RSVD	RSVD	RSVD	RSVD	CTOS	RSVD	PTOS	RSVD	RSVD	RSVD
Safety Status C+D	0x0000	☑	☑	RSVD	RSVD	RSVD	RSVD	UTD	UTC	RSVD	RSVD	RSVD	RSVD	RSVD	CTO	RSVD	PTO	RSVD	RSVD
PF Alert A+B	0x0000	☑	☑	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	SOV	RSVD
PF Status A+B	0x0000	☑	☑	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	SOV	RSVD
PF Status C+D	0x0000	☑	☑	RSVD	RSVD	RSVD	RSVD	RSVD	DFW	RSVD	IFC	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD
LStatus	0	☑	☑													FIELD...	ITEN	CF1	CF0

Figure 3. Registers Screen



Target Selection Wizard

Battery Management Studio (bqStudio) Supported Targets

Please select a target...

0741_3_02-sn27741C1.bqz
0741_3_03-sn27741C1.bqz
0741_4_01-sn27741M1.bqz
0741_4_02-sn27741M1.bqz
0741_5_01-sn27741L1.bqz
0742_1_02-bq27742G1.bqz
0742_1_03-bq27742G1.bqz
0742_2_00-sn27742C1.bqz
0742_4_00-sn27742L1.bqz
0742_5_00-sn27742U1.bqz
0742_D5_00-sn27742U1.bqz
1100_0_01-bq78z100.bqz
1E9B_0_01-bq78350.bqz
1E9B_0_02-bq78350.bqz
1E9B_0_03-bq78350.bqz
1E9B_0_04-bq78350.bqz
1E9B_0_05-bq78350.bqz
1E9B_0_06-bq78350.bqz
2610_0_01-bq28z610.bqz
2610_0_09-bq28z610.bqz

Auto Detected Device : None

Figure 4. Battery Management Studio Supported Targets

3.2 Registers Screen

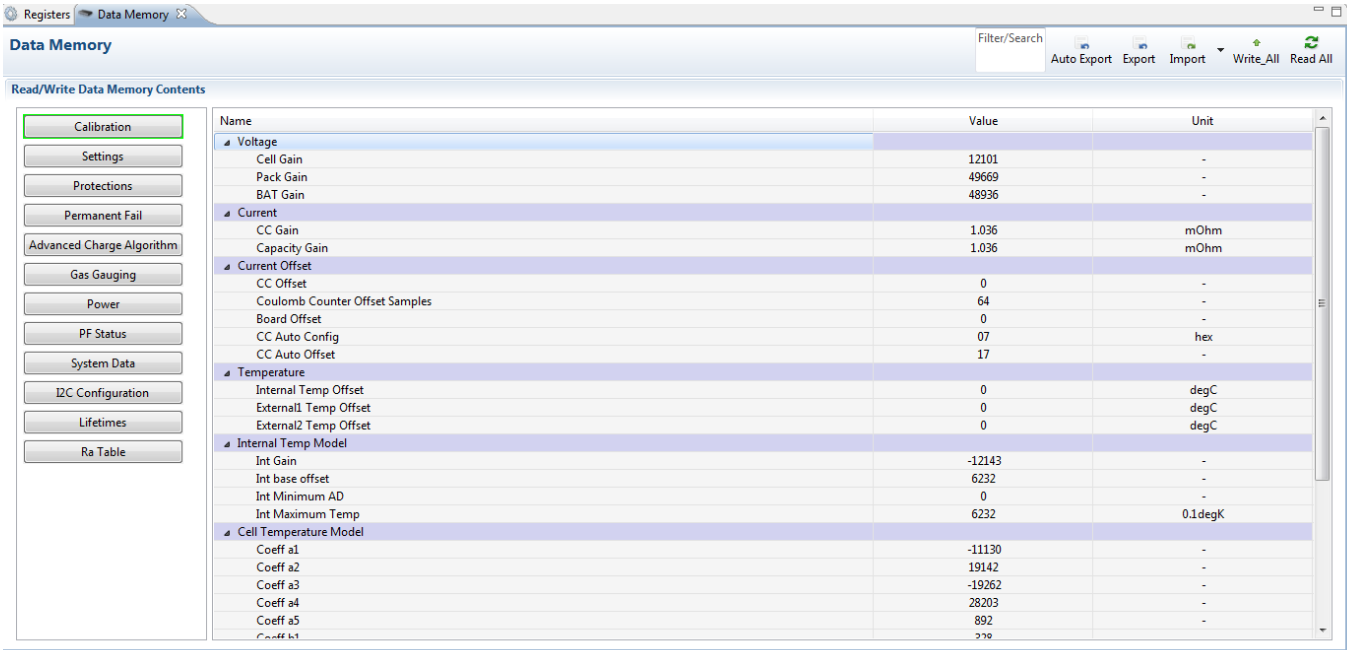
The Registers section contains parameters used to monitor gauging. The Bit Registers section provides bit level picture of status and fault registers. A green flag indicates that the bit is 0 (low state) and a red flag indicates that the bit is 1 (high state). A greyed out bit indicated that bit is reserved. Data begins to appear once the **Refresh** (single-time scan) button is selected, or it scans continuously if the **Scan** button is selected. The continuous scanning period can be set via the | Windows |preferences| register selections.

The battery management Studio program provides a logging function which logs all the values of the parameters in the Register section if running the program in “Show basic view mode”. In order to selectively choose the parameters of Register section that are scanned and logged, the user needs to set Battery Management Studio to “Show Advanced view mode”. This mode can be set via | Windows |preferences| All Global Settings| Show Advanced Views. Uncheck the fields that are not needed to be scanned or logged. To enable logging, select the **Log** button; this causes the **Scan** button to be selected. When logging is stopped, the **Scan** button is still selected and has to be manually deselected.

3.3 Data Memory Screen

The bq78z100 data flash comes configured per the default settings detailed in the bq78z100 TRM. Ensure that the settings are correctly changed to match the pack and application for the solution being evaluated. For ease of configuration, a text file with a gg.csv extension can be extracted, modified and imported back on the device. Use the export and import buttons as seen in Figure 5 to export and import gg.csv files. The auto export button enables gg files to be exported periodically at intervals. This is useful when debugging issues with the gauge. A write all command is necessary if a gg.csv file is imported to ensure that all the changes made on the gg.csv file are effected on the gauge. The read all command is used to read back all of the data written to the gauge so that the changes made can be verified. The filter/search field enables the user to search for a particular parameter in the data memory content.

NOTE: Do not make modifications to the gg.csv file using Microsoft Excel® as it makes changes to file, which bqStudio rejects. Make sure to use a text editor like notepad or similar to edit a gg.csv file.

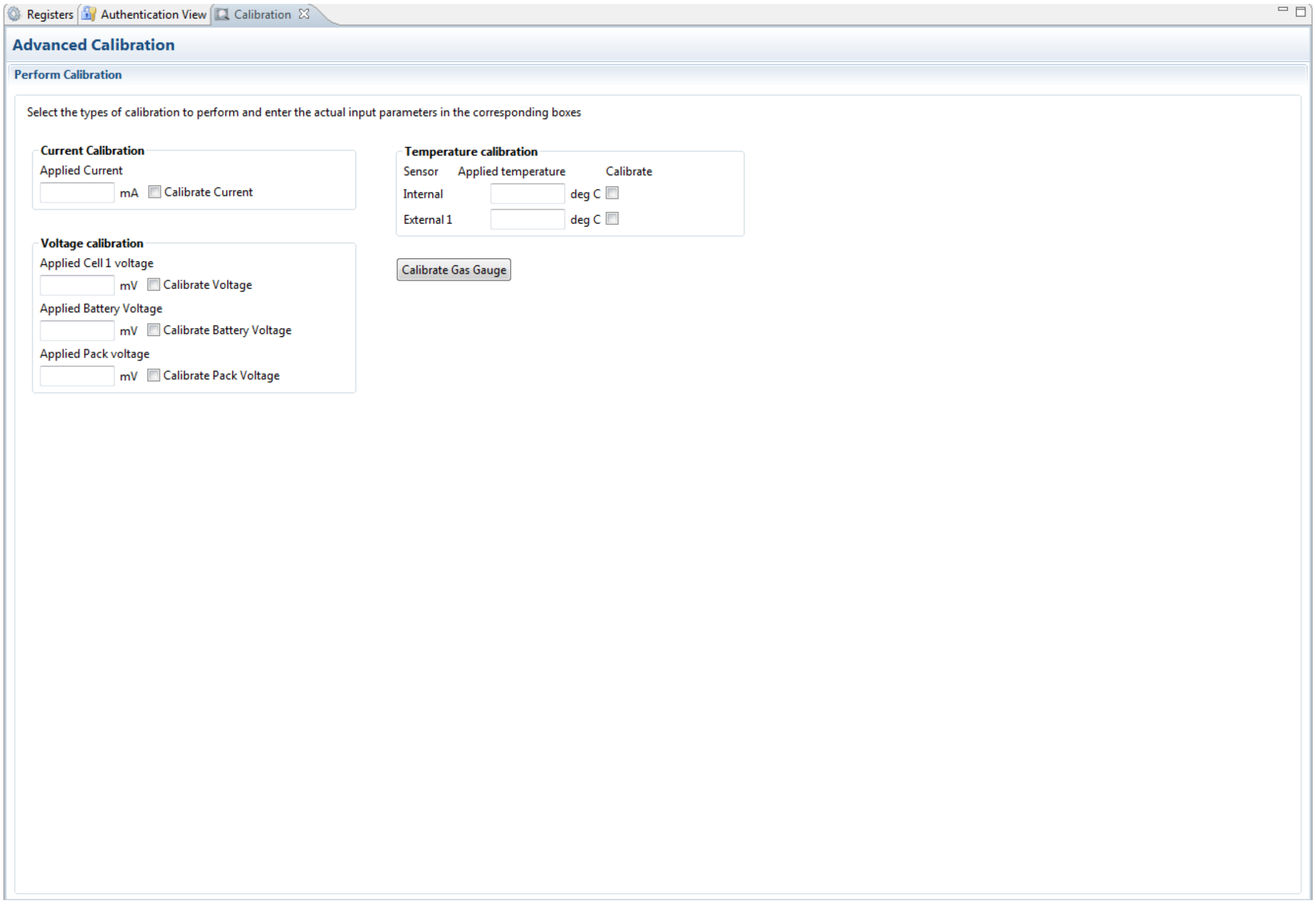


Name	Value	Unit
Voltage		
Cell Gain	12101	-
Pack Gain	49669	-
BAT Gain	48936	-
Current		
CC Gain	1.036	mOhm
Capacity Gain	1.036	mOhm
Current Offset		
CC Offset	0	-
Coulomb Counter Offset Samples	64	-
Board Offset	0	-
CC Auto Config	07	hex
CC Auto Offset	17	-
Temperature		
Internal Temp Offset	0	degC
External1 Temp Offset	0	degC
External2 Temp Offset	0	degC
Internal Temp Model		
Int Gain	-12143	-
Int base offset	6232	-
Int Minimum AD	0	-
Int Maximum Temp	6232	0.1degK
Cell Temperature Model		
Coeff a1	-11130	-
Coeff a2	19142	-
Coeff a3	-19262	-
Coeff a4	28203	-
Coeff a5	892	-

Figure 5. Data Memory Screen

3.4 Calibration Screen

The voltages, temperatures, and currents should be calibrated to provide good gauging performance. Press the **Calibration** button while in the “Show Advanced view mode” to select the **Advanced Calibration** window. See Figure 6. If in the “Show basic view mode”, the basic calibration window shows when the **Calibration** button is clicked. The **Advanced Calibration** window enables the internal temperature sensor as well as the external thermistor to be calibrated.



Advanced Calibration

Perform Calibration

Select the types of calibration to perform and enter the actual input parameters in the corresponding boxes

Current Calibration
Applied Current
mA ☐ Calibrate Current

Voltage calibration
Applied Cell 1 voltage
mV ☐ Calibrate Voltage
Applied Battery Voltage
mV ☐ Calibrate Battery Voltage
Applied Pack voltage
mV ☐ Calibrate Pack Voltage

Temperature calibration

Sensor	Applied temperature	Calibrate
Internal	deg C	☐
External 1	deg C	☐

Figure 6. Calibration Screen

3.4.1 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+ (2P) to Bat– (2N) 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 0x22 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.

3.4.2 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.

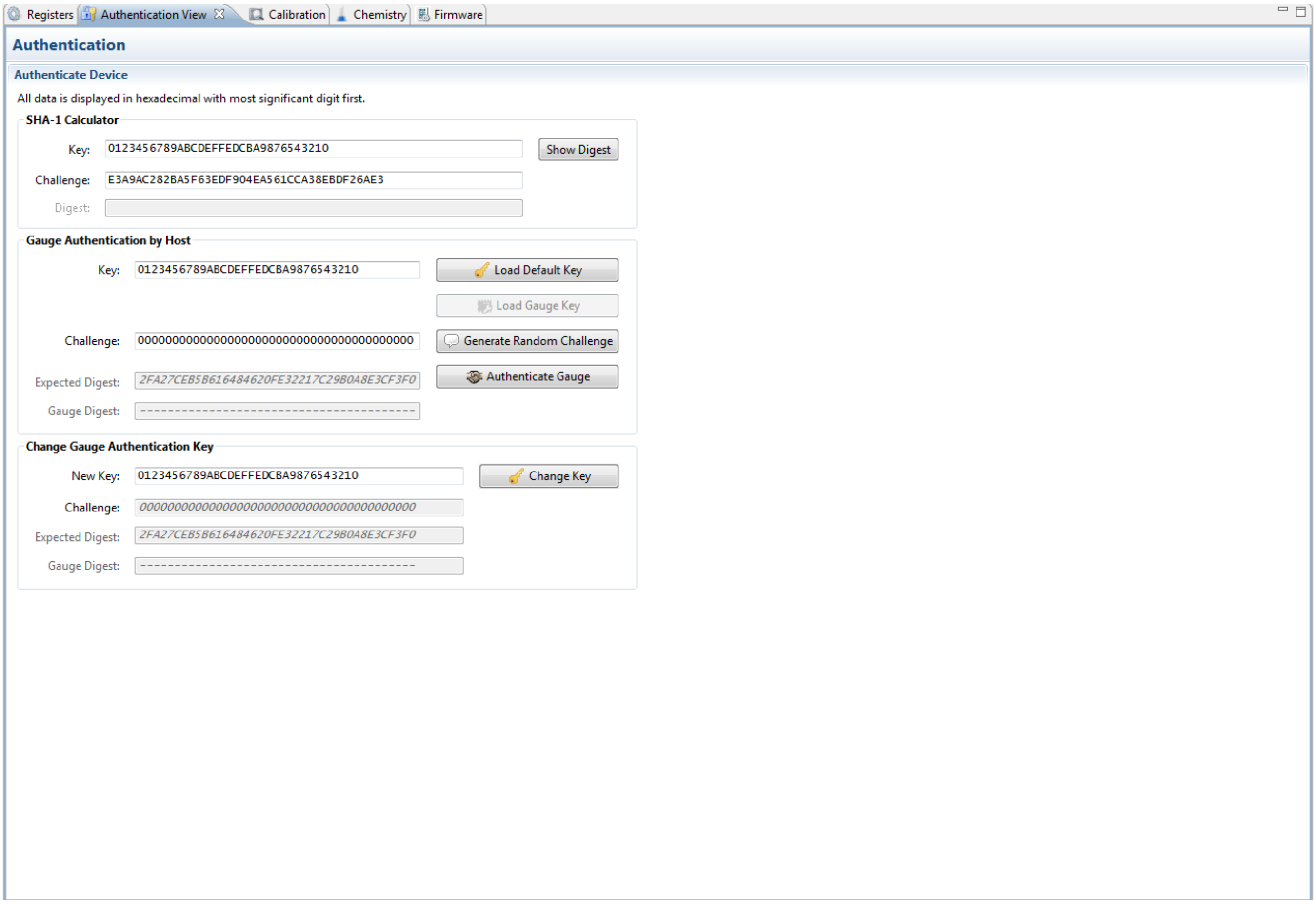
3.4.3 Current Calibration

The Board Offset calibration option is not offered in Battery Management Studio, because it is not required when using the bq78z100EVM. The Board Offset calibration option is available in bqProduction.

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

3.5 Authentication Screen

The bq78z100 supports SHA-1 HMAC authentication with the host system. The authentication screen of bqStudio allows for the SHA-1 calculator to be tested, perform gauge authentication by the host and change the gauge authentication key.



All data is displayed in hexadecimal with most significant digit first.

SHA-1 Calculator

Key: 0123456789ABCDEFFEDCBA9876543210
Challenge: E3A9AC282BA5F63EDF904EA561CCA38EBDF26AE3
Digest:

Gauge Authentication by Host

Key: 0123456789ABCDEFFEDCBA9876543210
Challenge: 0000000000000000000000000000000000000000
Expected Digest: 2FA27CEB5B616484620FE32217C29B0A8E3CF3F0
Gauge Digest: --

Change Gauge Authentication Key

New Key: 0123456789ABCDEFFEDCBA9876543210
Challenge: 0000000000000000000000000000000000000000
Expected Digest: 2FA27CEB5B616484620FE32217C29B0A8E3CF3F0
Gauge Digest: --

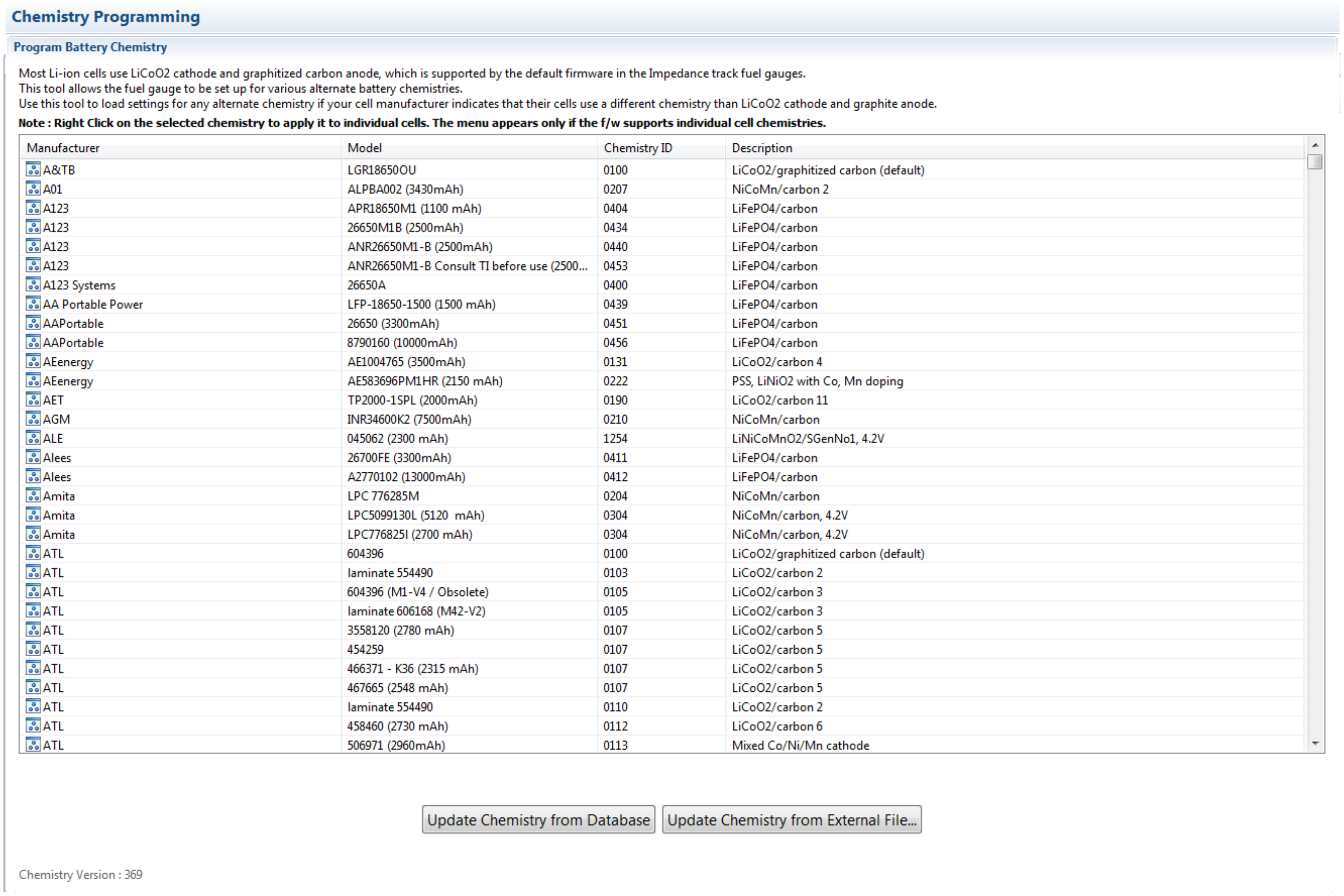
Figure 7. Authentication Screen

3.6 Chemistry Selection

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

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

- The table can be sorted by clicking the desired column. For example: Click the *Chemistry ID* column header.
- Select the ChemID that matches your cell from the table (see Figure 8).
- Press **Update Chemistry from Database** to update the chemistry in the device.



Most Li-ion cells use LiCoO2 cathode and graphitized carbon anode, which is supported by the default firmware in the Impedance track fuel gauges.
This tool allows the fuel gauge to be set up for various alternate battery chemistries.
Use this tool to load settings for any alternate chemistry if your cell manufacturer indicates that their cells use a different chemistry than LiCoO2 cathode and graphite anode.

Note : Right Click on the selected chemistry to apply it to individual cells. The menu appears only if the f/w supports individual cell chemistries.

Manufacturer	Model	Chemistry ID	Description
A&TB	LGR18650OU	0100	LiCoO2/graphitized carbon (default)
A01	ALPBA002 (3430mAh)	0207	NiCoMn/carbon 2
A123	APR18650M1 (1100 mAh)	0404	LiFePO4/carbon
A123	26650M1B (2500mAh)	0434	LiFePO4/carbon
A123	ANR26650M1-B (2500mAh)	0440	LiFePO4/carbon
A123	ANR26650M1-B Consult TI before use (2500...	0453	LiFePO4/carbon
A123 Systems	26650A	0400	LiFePO4/carbon
AA Portable Power	LFP-18650-1500 (1500 mAh)	0439	LiFePO4/carbon
AAPortable	26650 (3300mAh)	0451	LiFePO4/carbon
AAPortable	8790160 (10000mAh)	0456	LiFePO4/carbon
AEenergy	AE1004765 (3500mAh)	0131	LiCoO2/carbon 4
AEenergy	AE583696PM1HR (2150 mAh)	0222	PSS, LiNiO2 with Co, Mn doping
AET	TP2000-1SPL (2000mAh)	0190	LiCoO2/carbon 11
AGM	INR34600K2 (7500mAh)	0210	NiCoMn/carbon
ALE	045062 (2300 mAh)	1254	LiNiCoMnO2/SGenNo1, 4.2V
Alees	26700FE (3300mAh)	0411	LiFePO4/carbon
Alees	A2770102 (13000mAh)	0412	LiFePO4/carbon
Amita	LPC 776285M	0204	NiCoMn/carbon
Amita	LPC5099130L (5120 mAh)	0304	NiCoMn/carbon, 4.2V
Amita	LPC776825I (2700 mAh)	0304	NiCoMn/carbon, 4.2V
ATL	604396	0100	LiCoO2/graphitized carbon (default)
ATL	laminate 554490	0103	LiCoO2/carbon 2
ATL	604396 (M1-V4 / Obsolete)	0105	LiCoO2/carbon 3
ATL	laminate 606168 (M42-V2)	0105	LiCoO2/carbon 3
ATL	3558120 (2780 mAh)	0107	LiCoO2/carbon 5
ATL	454259	0107	LiCoO2/carbon 5
ATL	466371 - K36 (2315 mAh)	0107	LiCoO2/carbon 5
ATL	467665 (2548 mAh)	0107	LiCoO2/carbon 5
ATL	laminate 554490	0110	LiCoO2/carbon 2
ATL	458460 (2730 mAh)	0112	LiCoO2/carbon 6
ATL	506971 (2960mAh)	0113	Mixed Co/Ni/Mn cathode

Chemistry Version : 369

Figure 8. Chemistry Screen

3.7 Firmware Screen

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

3.7.1 Programming the Flash Memory

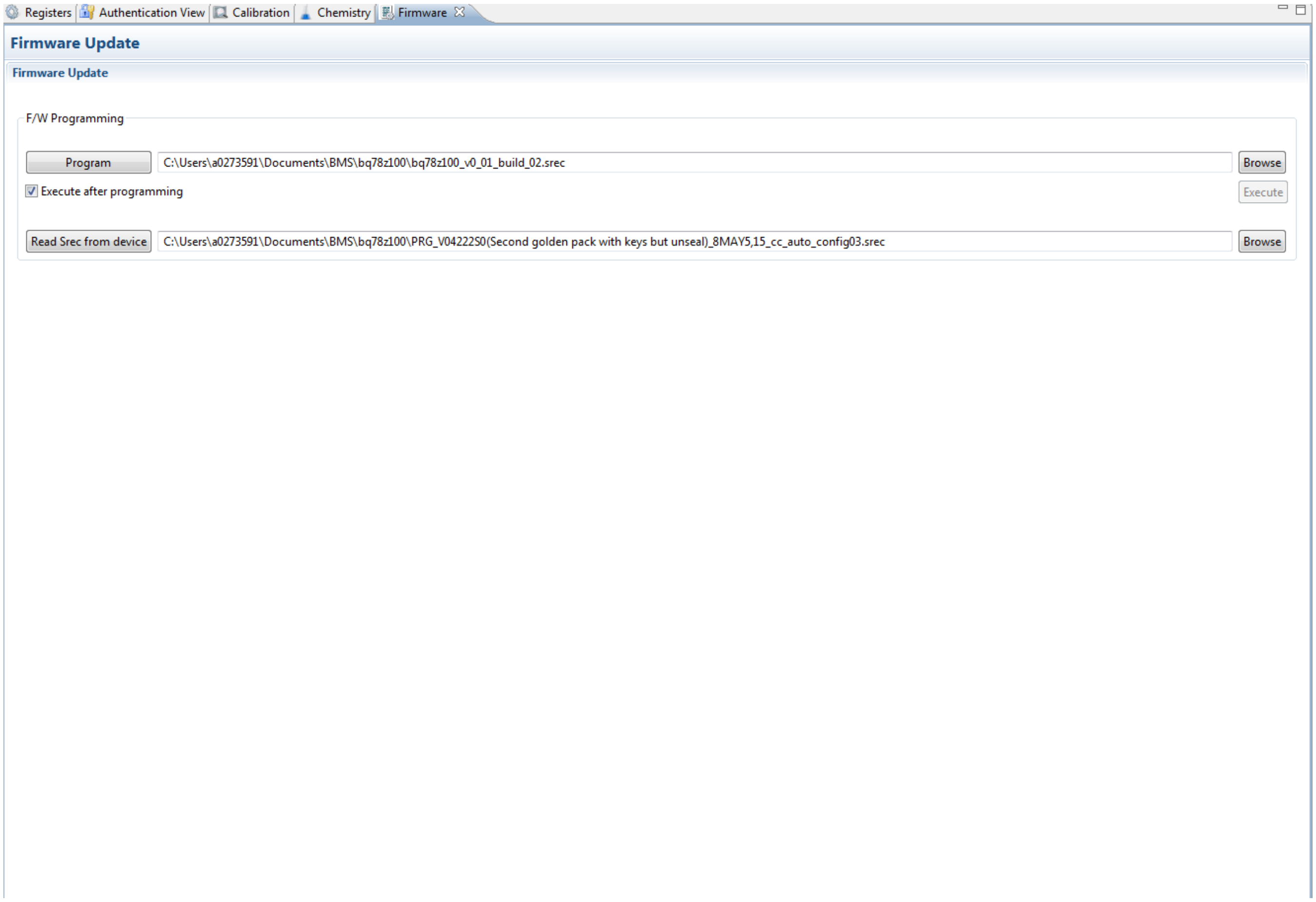
The upper section of the Firmware screen is used to initialize the device by loading the default .srec into the flash memory (see Figure 9).

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

3.7.2 Exporting the Flash Memory

The lower section of the Firmware screen is used to export all of the flash memory from the device (see Figure 9).

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



Program: C:\Users\a0273591\Documents\BMS\bq78z100\bq78z100_v0_01_build_02.srec

☑ Execute after programming

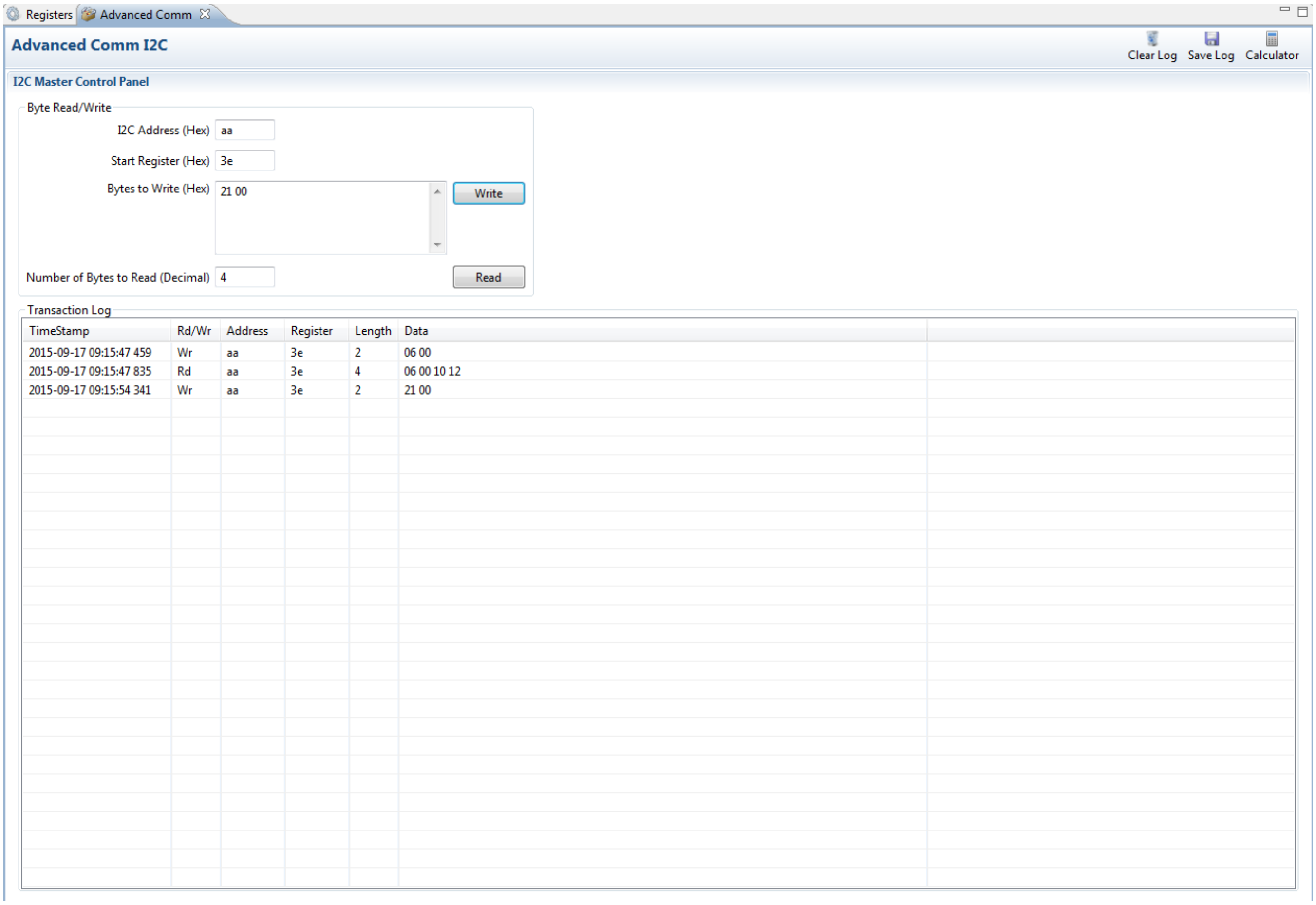
Read Srec from device: C:\Users\a0273591\Documents\BMS\bq78z100\PRG_V04222S0(Second golden pack with keys but unseal)_8MAY5,15_cc_auto_config03.srec

Figure 9. Firmware Screen

3.8 Advanced Comm I^{2}C Screen

Press the **Advanced Comm I2C** button to select the **Advanced Comm I2C** window. This tool provides access to parameters using I^{2}C and Manufacturing Access commands. See Figure 10. The transaction log screen shows the history of sent commands.

NOTE: I^{2}C commands are sent in Little Endian format.



I2C Address (Hex) aa

Start Register (Hex) 3e

Bytes to Write (Hex) 21 00

Number of Bytes to Read (Decimal) 4

TimeStamp	Rd/Wr	Address	Register	Length	Data
2015-09-17 09:15:47 459	Wr	aa	3e	2	06 00
2015-09-17 09:15:47 835	Rd	aa	3e	4	06 00 10 12
2015-09-17 09:15:54 341	Wr	aa	3e	2	21 00

Figure 10. Advanced Comm I^{2}C Screen

Examples:

Reading an I^{2}C Command.

- Read chemical ID (0x 0006).
  - Write to mac address 3e Command 06 00 (see Figure 10).
  - Read 4 bytes.
  - The result returned is 10 12, which is little endian for chem id 1210.

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

- With Impedance Track™ disabled, send *Gauging()* (0x0021) to *ManufacturerAccess()*.
  - Write to mac address 3e command 21 00 (see Figure 10).

3.9 Watch Screen

This enables monitoring of specific registers and data memory items at user specified time intervals. By clicking the add register or add data memory item, these will be added to the table of values to be tracked.

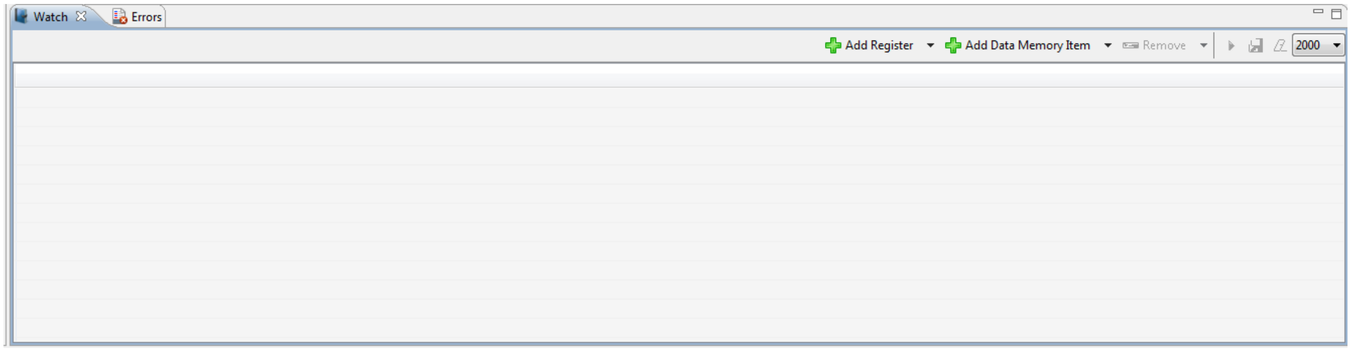


Figure 11. Watch Screen

3.10 Data Graph Screen

This enables specified registers and data memory items to be plotted in a graph real time based on a specific time interval chosen as shown in Figure 12.

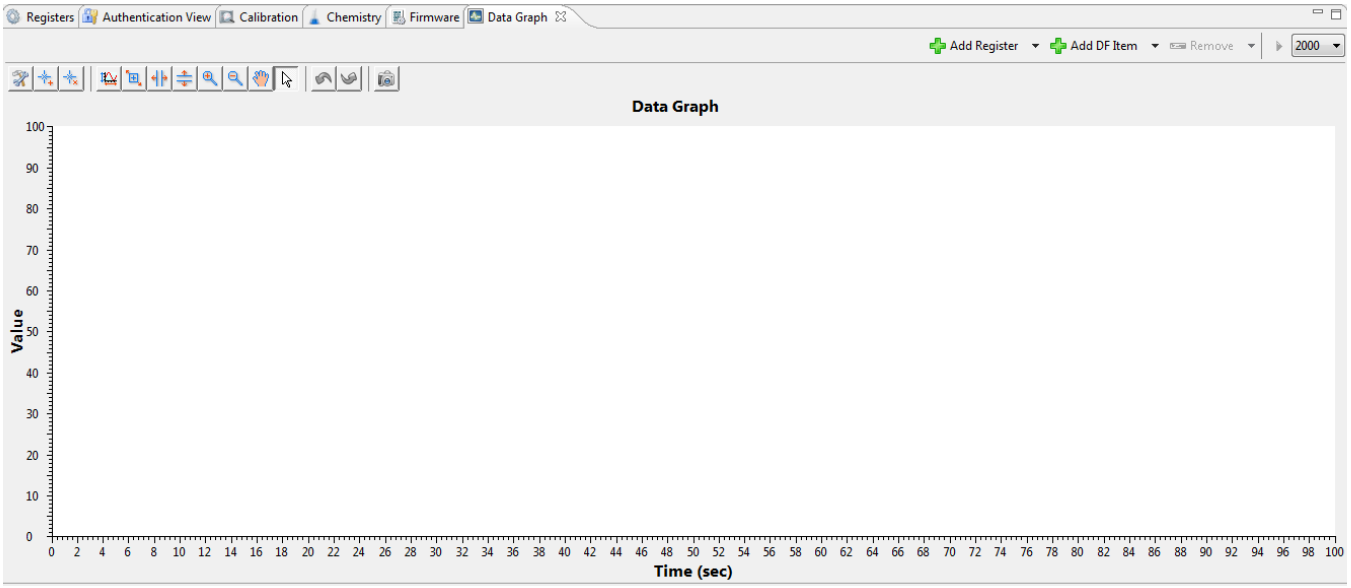


Figure 12. Data Graph Screen

3.11 Error Screen

This keeps track of any error that may occur with bqStudio during usage.

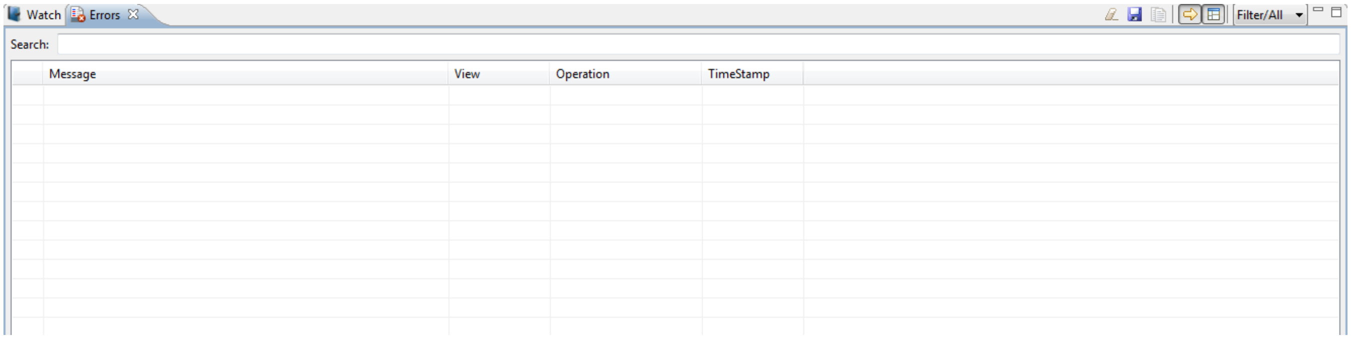


Figure 13. Error Screen

4 Circuit Module Physical Layouts and Bill of Materials

This section contains the printed-circuit board (PCB) layout, bill of materials, and assembly drawings for the bq78z100/bq294502 circuit modules.

4.1 Board Layout

This section shows the dimensions, PCB layers (see Figure 14 through Figure 19), and assembly drawing for the bq78z100 modules.

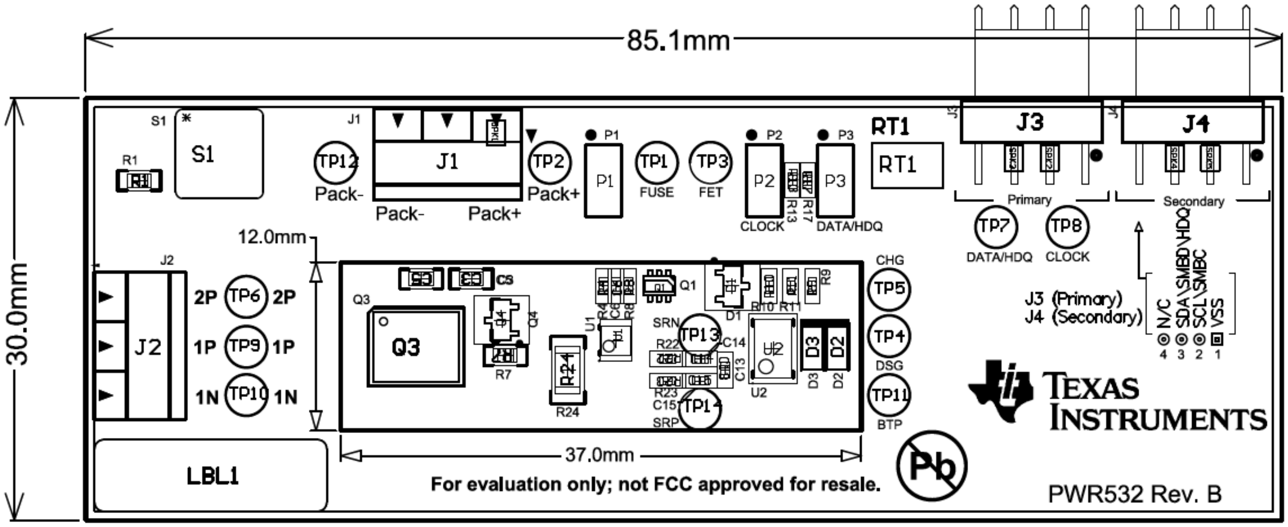


Figure 14. Top Silk Screen

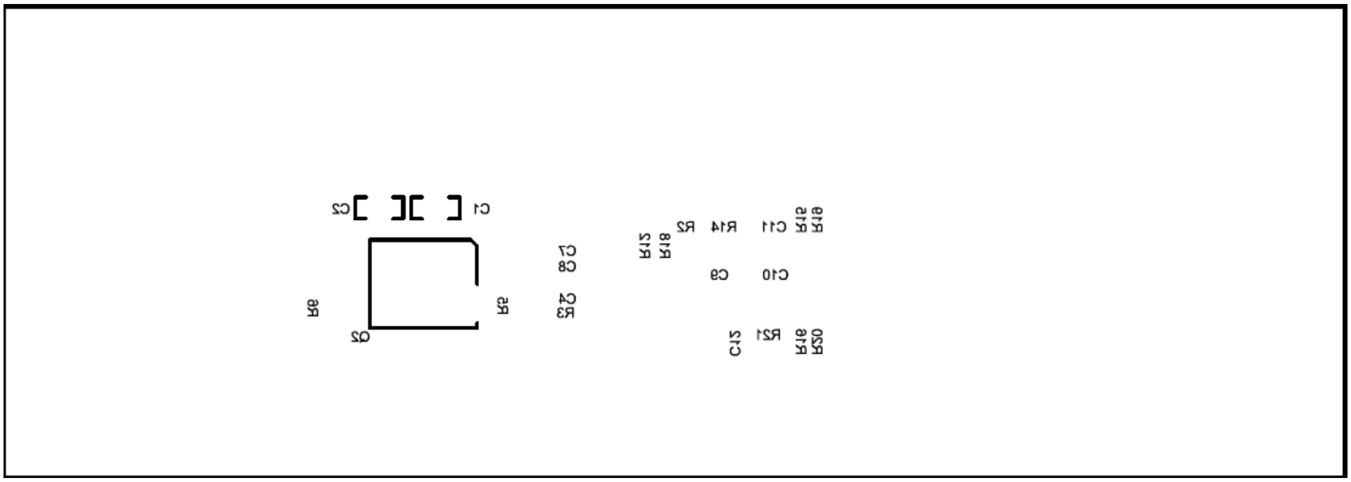


Figure 15. Bottom Silk Screen

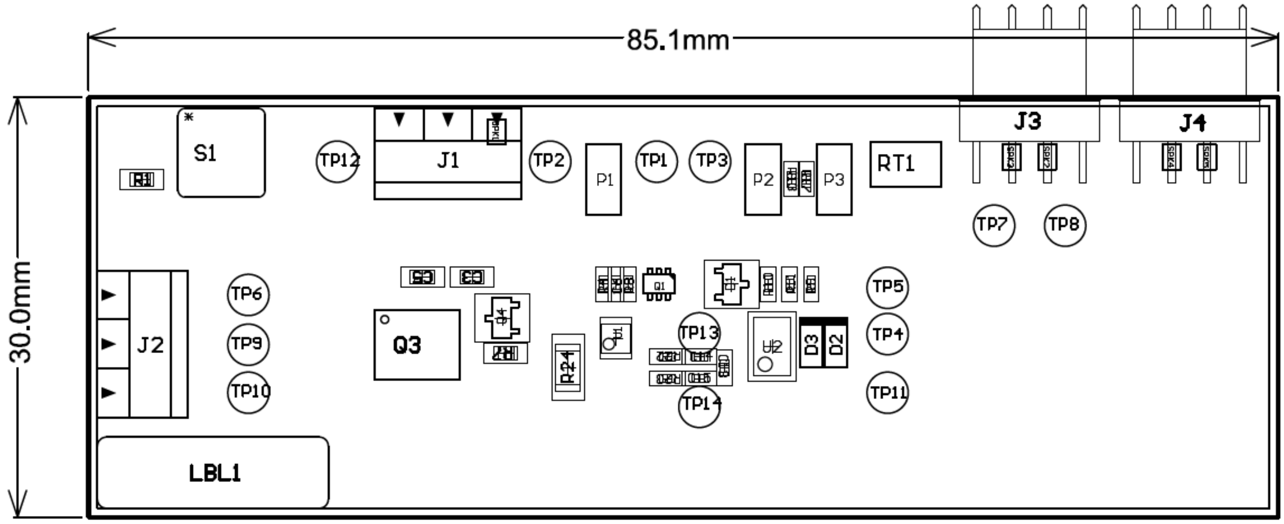


Figure 16. Top Assembly

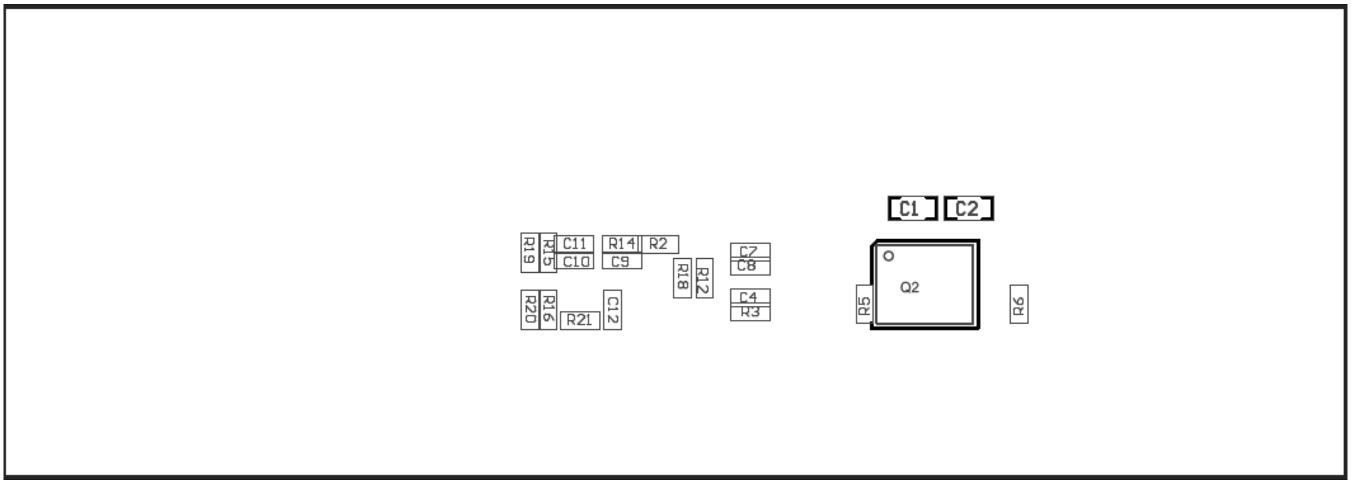


Figure 17. Bottom Assembly

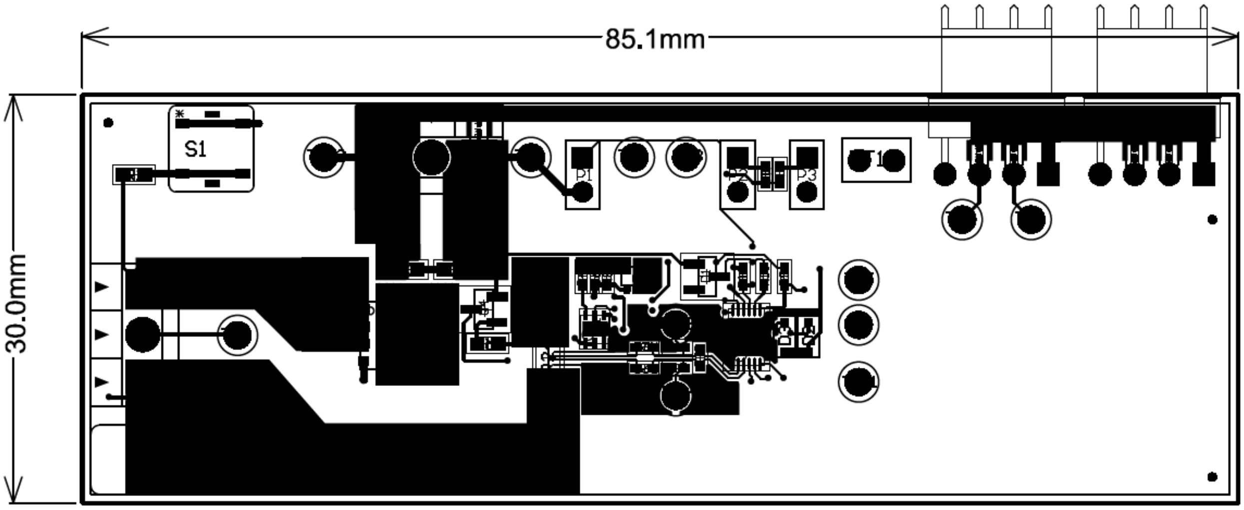


Figure 18. Top Layer

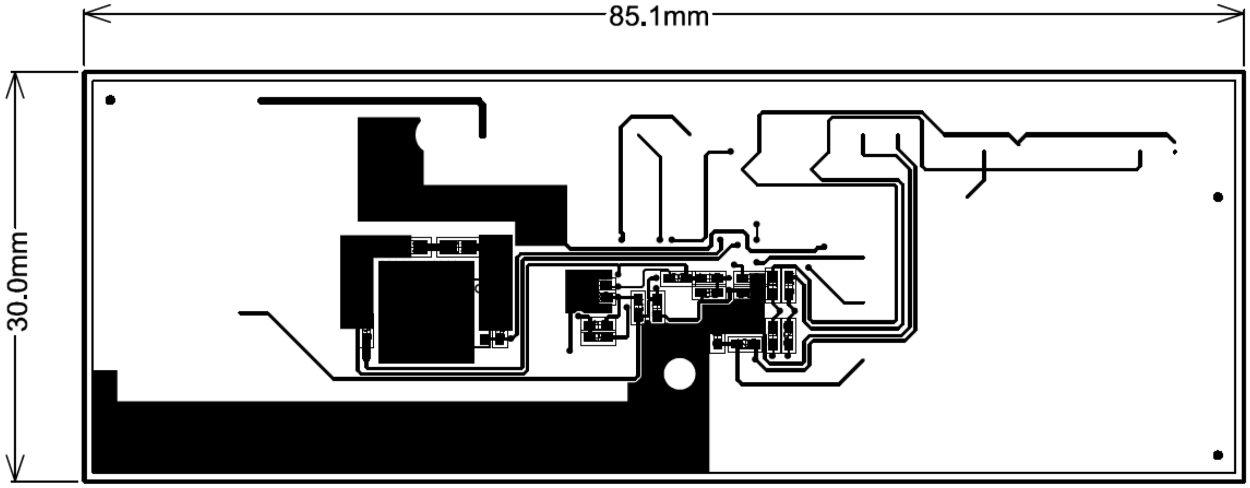


Figure 19. Bottom Layer

4.2 Bill of Materials and Schematic

Table 3. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	PartNumber	Manufacturer
C1, C2, C3, C5	4	0.1 µF	Capacitor, Ceramic, 50 V, X7R, 10%	0603	CL10B104KB8SFNC	Samsung Electromechanics
C4, C6, C7, C8, C10, C13	6	0.1 µF	Capacitor, Ceramic Chip, 16 V, X7R, 10%	0402	CL05B104KO5NNNC	Samsung Electromechanics
C9	1	1 µF	Capacitor, Ceramic Chip, 16 V, X5R, 10%	0402	CL05A105KO5NNNC	Samsung Electromechanics
C11	1	2.2 µF	Capacitor, Ceramic Chip, 16 V, X5R, 20%	0402	C1005X5R1C225M050 BC	TDK Corporation
D1	1	BAS16-7-F	Diode, Ultrafast, 75V, 0.3A, SOT-23	SOT-23	BAS16-7-F	Diodes Inc.
D2, D3	2	MM3Z5V6C	Diode, Zener, 5.6V, 200 mW	SOD323	MM3Z5V6C	Fairchild
J1, J2	2	ED555/3DS	Terminal Block, 3-pin, 6-A, 3.5 mm	0.41 x 0.25 inch	ED555/3DS	OST
J3	1		Header (friction lock), 100 mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex
P1, P2, P3	3	PEC02SAAN	Header, male 2-Pin, 100-mil spacing	0.100 x 2	PEC02SAAN	Sullins
Q1	1	SI1414DH-T1-GE3	MOSFET, Nch, 30 V, 4 A, 46 mΩ	SC-70	SI1414DH-T1-GE3	Vishay
Q2, Q3	2	25 V	MOSFET, N-CH, 25 V, 52 A, SON 5x6 mm	SON 5x6mm	CSD16412Q5A	Texas Instruments
Q4	1	2N7002K-T1-E3	MOSFET, Nch, 60 V, 300 mA, 2 Ω	SOT23	2N7002K-T1-E3	Vishay
R1	1	1K	Resistor, Chip, 1/10-W, 5%	0603	RC1608J102CS	Samsung Electromechanics
R2, R15, R16, R18, R19, R20, R22, R23	8	100	Resistor, Chip, 1/16W, 5%	0402	RC1005J101CS	Samsung Electromechanics
R3, R4, R12	3	1k	Resistor, Chip, 1/16W, 5%	0402	RC1005J102CS	Samsung Electromechanics
R5, R6	2	10M	Resistor, Chip, 1/16W,5%	0402	RC1005J106CS	Samsung Electromechanics
R7	1	10K	Resistor, Chip, 1/10-W, 5%	0603	RC1608J103CS	Samsung Electromechanics
R8	1	100k	Resistor, Chip, 1/16W, 5%	0402	RC1005J104CS	Samsung Electromechanics
R9, R10, R13, R17	4	5.1k	Resistor, Chip, 1/16W, 5%	0402	RC1005J512CS	Samsung Electromechanics
R11	1	10	Resistor, Chip, 1/16W, 5%	0402	RC1005J100CS	Samsung Electromechanics
R14	1	4.99	Resistor, Chip, 1/16W, 5%	0402	CRCW04024R99FKED	Vishay Dale
R24	1	0.001 50 ppm	Resistor, Metal Foil, 1 watt, ± 1%	1206	CSNL1206FT1L00	Vishay
RT1	1	10 K	Thermistor, NTC, 3 A	0.095 X 0.150 inch	103AT-2	Semitec
S1	1	EVQ-PLHA15	Switch, Push button, Momentary, 1P1T, 50 mA, 12 V	0.200 x 0.200 inch	EVQ-PLHA15	Panasonic
SPK1, SPK2, SPK3, SPK4, SPK5	5		Gap, 0.010" space	0.020 x 0.020 inch		
TP1, TP3, TP4, TP5, TP7, TP8, TP10, TP12, TP13, TP14	10	Black	Test Point, TH, Miniature, Black	0.100 x 0.100 inch	5001	Keystone
TP2, TP6, TP9	3	Red	Test Point, TH, Miniature, Red	0.100 x 0.100 inch	5000	Keystone

Table 3. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	PartNumber	Manufacturer
U1	1	BQ294502DRVR	Overvoltage Protection Device for 2 to 3 Cell Li-Ion Batteries, with 4.35 V OVP, -40 to 85 °C, 6-pin SON (DRV), Green (RoHS & no Sb/Br)	DRV0006A	BQ294502DRVR	Texas Instruments
U2	1	bq78z610DRZ	1-Cell to 2-Series Cell Programmable Battery Manager, DRZ0012A	DRZ0012A	bq78z100DRZ	Texas Instruments
C12	0	1 µF	Capacitor, Ceramic Chip, 16 V, X5R, 10%	0402	CL05A105KO5NNNC	Samsung Electromechanics
C14, C15	0	0.1 µF	Capacitor, Ceramic Chip, 16 V, X7R, 10%	0402	CL05B104KO5NNNC	Samsung Electromechanics
J4	0		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex
R21	0	330k	Resistor, Chip, 1/16W, 5%	0402	RC1005J334CS	Samsung Electromechanics
TP11	0	Black	Test Point, TH, Miniature, Black	0.100 x 0.100 inch	5001	Keystone

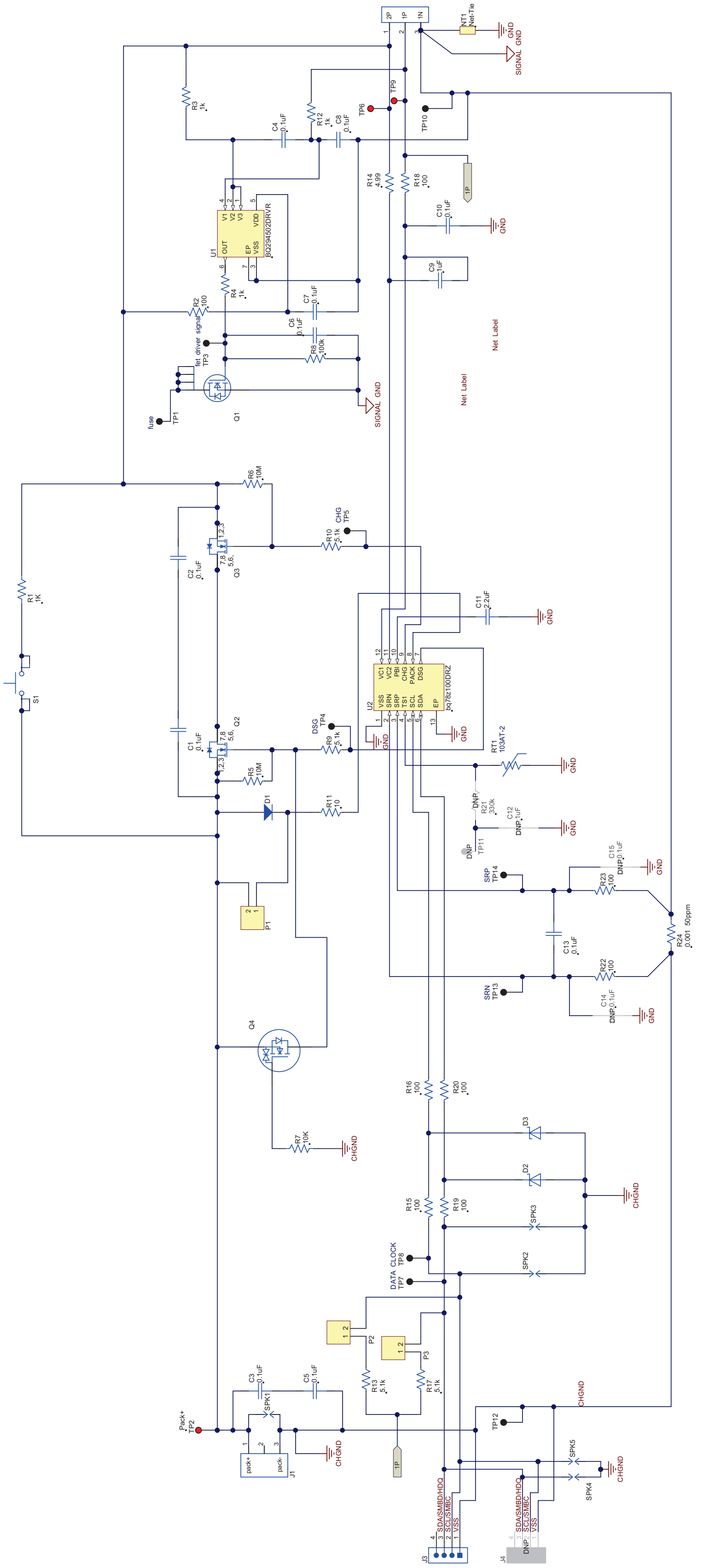


Figure 20. Schematic

4.3 Testing Fuse-Blowing Circuit

To prevent the loss of board functionality during the fuse-blowing test, the actual chemical fuse is not provided in the circuit. FET Q1 drives TP1 low if a fuse-blow condition occurs; thus, monitoring TP1 can be used to test this condition.

Revision History

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

Date	Revision	Notes
September 2015	*	Initial Release

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