Application Report

Start Guide for BQ Products

ABSTRACT

Battery management devices at TI use the prefix BQ as the identifier. In particular, gas gauge products are divided into single cell, multi-cell, and specialized products. In nonmenclature, BQ27xxx are for CEDV and legacy single cell products, and BQ27Zxx are for current single cell products. BQ20Z, 30Z, and 40Z are multi-cell products using impedance track and BQ20xx, 30xx, 40xx are multicell products using CEDV. Multi-cell products are used in notebook, medical, applications and Industrial applications. Examples are computers, drones and appliances.

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Trademarks

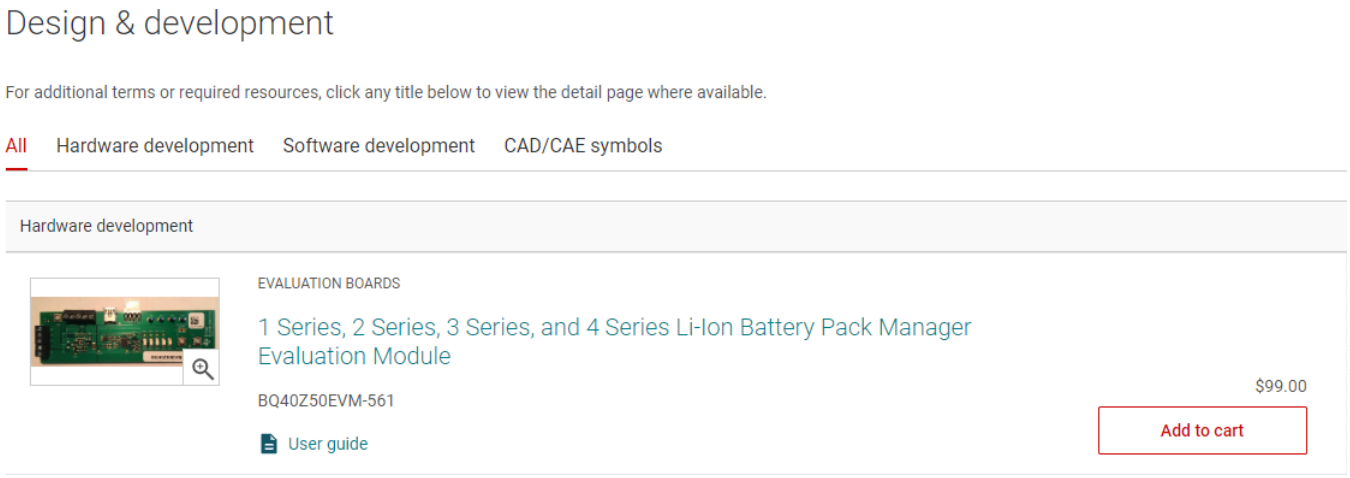
1 How to Get Started with BQ Gas Gauge Products

1.1 Items Required to Get Started

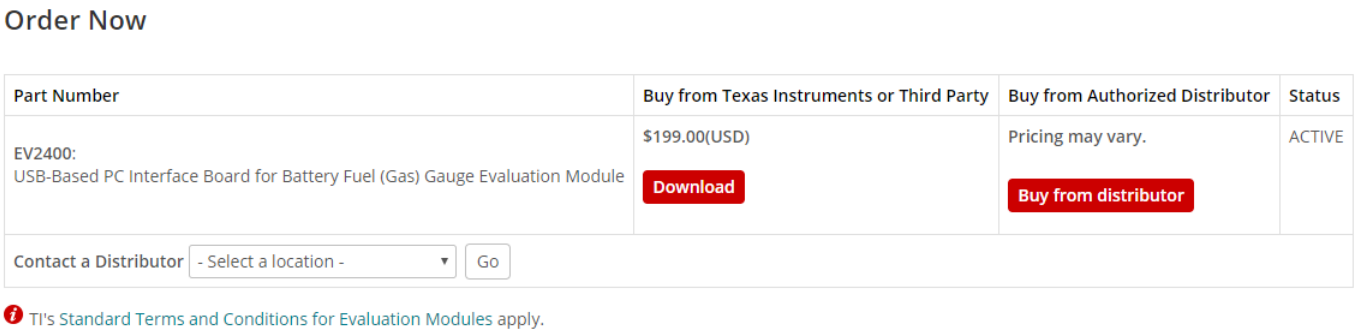
- EVM of Gas Gauge
- EV2400 communications interface adapter
- Cables to connect EVM to an EV2400 communication interface adapter
- USB cable to connect the communication interface adapter to the computer.
- Computer setup with Windows XP, or higher, operating system.
- Battery cells, or if using cell simulator, 1-kΩ resistors to match the number of cells of the chosen EVM
- A DC power supply that can supply the EVM's required voltage and current (constant current and constant voltage capability is desirable)

1.1.1 Selecting Gauge and Ordering EV2400

1. Select the right gauge for your application using https://www.ti.com/power-management/battery-management/fuel-gauges/overview.html.
2. Order the desired EVM for your application. To order the EVM, go to the product page of the device and click "Design & Development".



3. Order an EV2400. Please refer to the EVM user's guide on the product page to see if EV2400 is supported. If it is not supported, use what is recommended in the EVM user's guide. For a list of supported devices, please go to the EV2400 product page. The EV2400 is a HID device that converts data from BQSTUDIO to I2C /HDQ/SDQ/SMBus/SPI commands to the bq EVM (https://www.ti.com/tool/EV2400).

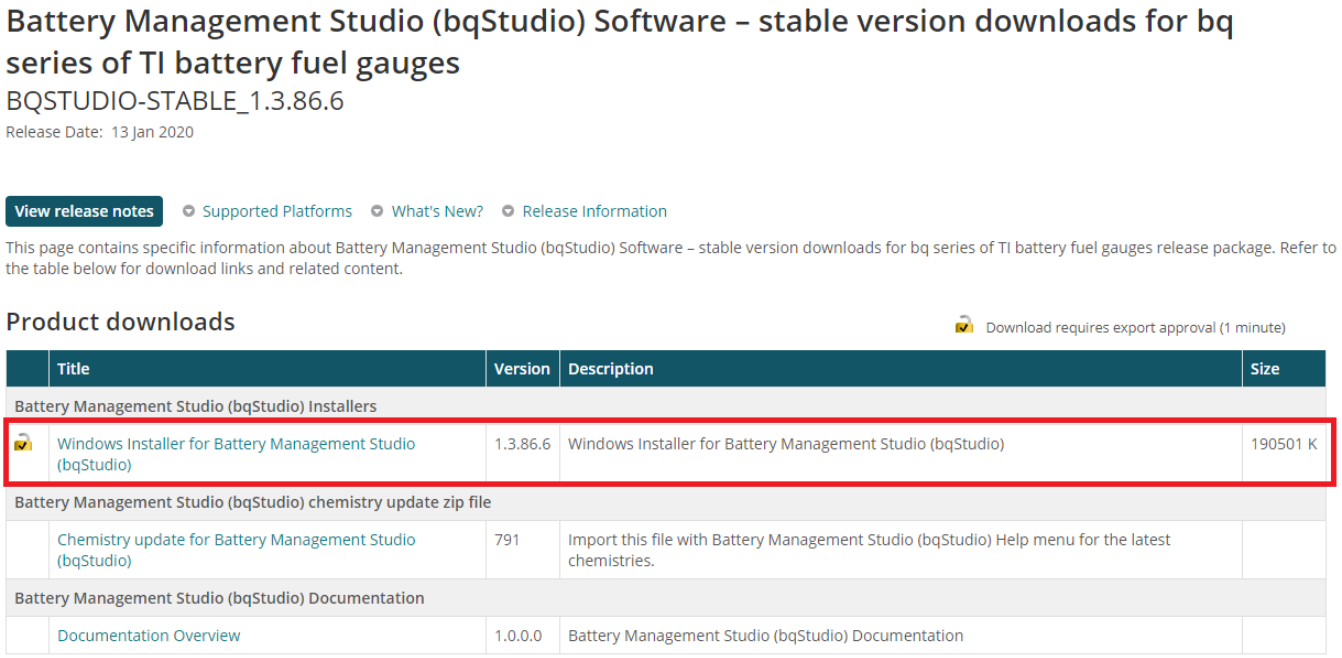


4. The EV2400 might need to have its firmware updated, the steps to update it can be found in the EV2400's user guide (https://www.ti.com/lit/ug/sluu446d/sluu446d.pdf).

1.2 Getting Started with BQSTUDIO

1. Download the latest stable version of BQSTUDIO (https://www.ti.com/tool/download/BQSTUDIO-STABLE). There are two versions of BQSTUDIO, the stable version and the test version which is kept up to date with

the latest releases. For most development and released devices, TI recommends the stable version of BQSTUDIO. If the device is in PREVIEW phase or it is not supported by the stable version, try downloading the latest test version from https://www.ti.com/tool/download/BQSTUDIO-TEST to see if the gauge is supported.



Battery Management Studio (bqStudio) Software – stable version downloads for bq series of TI battery fuel gauges

BQSTUDIO-STABLE_1.3.86.6

Release Date: 13 Jan 2020

View release notes | Supported Platforms | What's New? | Release Information

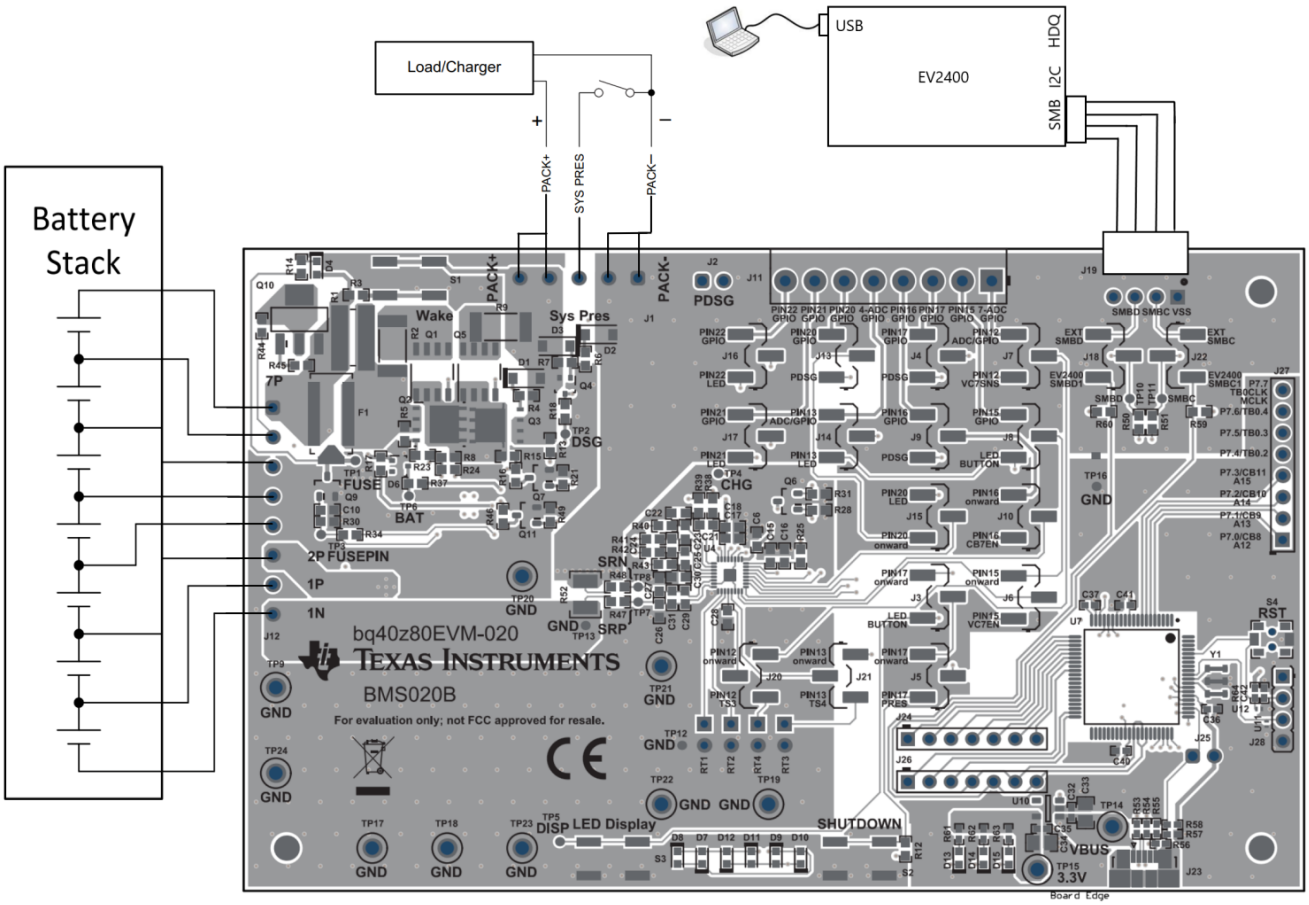
This page contains specific information about Battery Management Studio (bqStudio) Software – stable version downloads for bq series of TI battery fuel gauges release package. Refer to the table below for download links and related content.

Product downloads

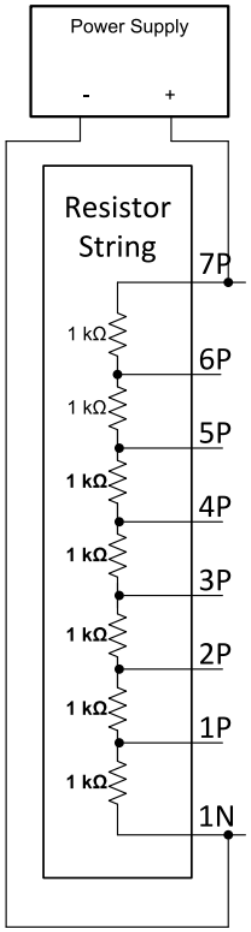
Download requires export approval (1 minute)

	Title	Version	Description	Size
Battery Management Studio (bqStudio) Installers				
	Windows Installer for Battery Management Studio (bqStudio)	1.3.86.6	Windows Installer for Battery Management Studio (bqStudio)	190501 K
Battery Management Studio (bqStudio) chemistry update zip file				
	Chemistry update for Battery Management Studio (bqStudio)	791	Import this file with Battery Management Studio (bqStudio) Help menu for the latest chemistries.	
Battery Management Studio (bqStudio) Documentation				
	Documentation Overview	1.0.0.0	Battery Management Studio (bqStudio) Documentation	

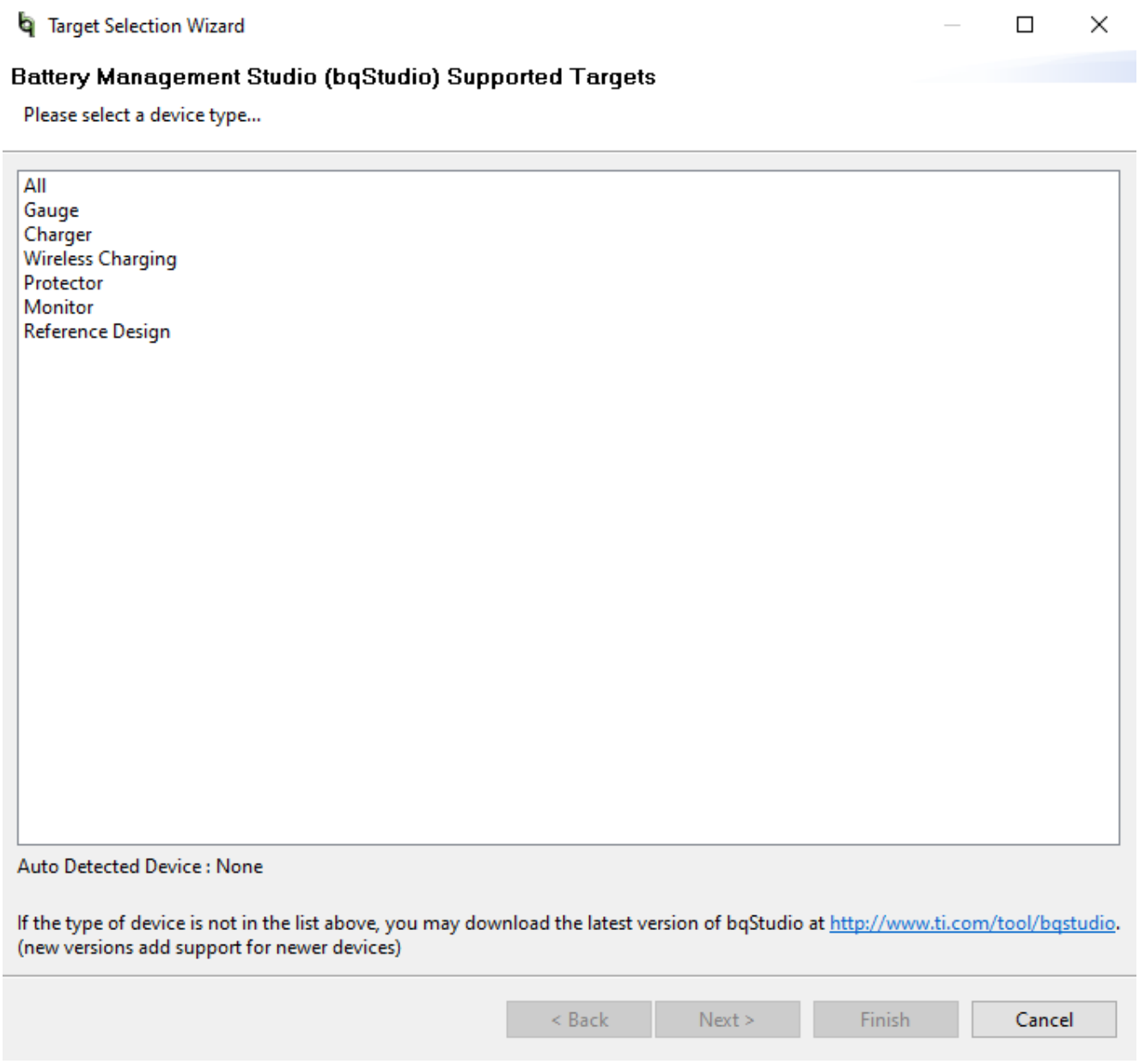
2. Make the necessary connections from battery to pack or battery terminals on the EVM based on the general setup guidelines on the selected EVM user's guide.
3. Generally, you will want to connect your battery cells starting from the lowest cell in the stack(cell 1) to ground, then attach the remaining cells in sequence, cell 2, cell 3, etc. This would be done up to the top of the stack or after you've reached the desired number of cells. If there are any empty battery cell slots in your gauge, short the empty cells from the bottom up to the positive terminal. For some EVMs, Sys Press might need to be shorted to PACK- in order for the device to start-up. You will also need to connect the thermistor if it is not connected already, the battery or power supply at the recommended voltage, the I2C or SMBus connections from the gauge to the EV2400, and USB from the EV2400 to PC as explained in your EVM User Guide. If discharge or charge current needs to be applied, connect a load or charger to the appropriate terminals.
4. A sample connection is shown below.



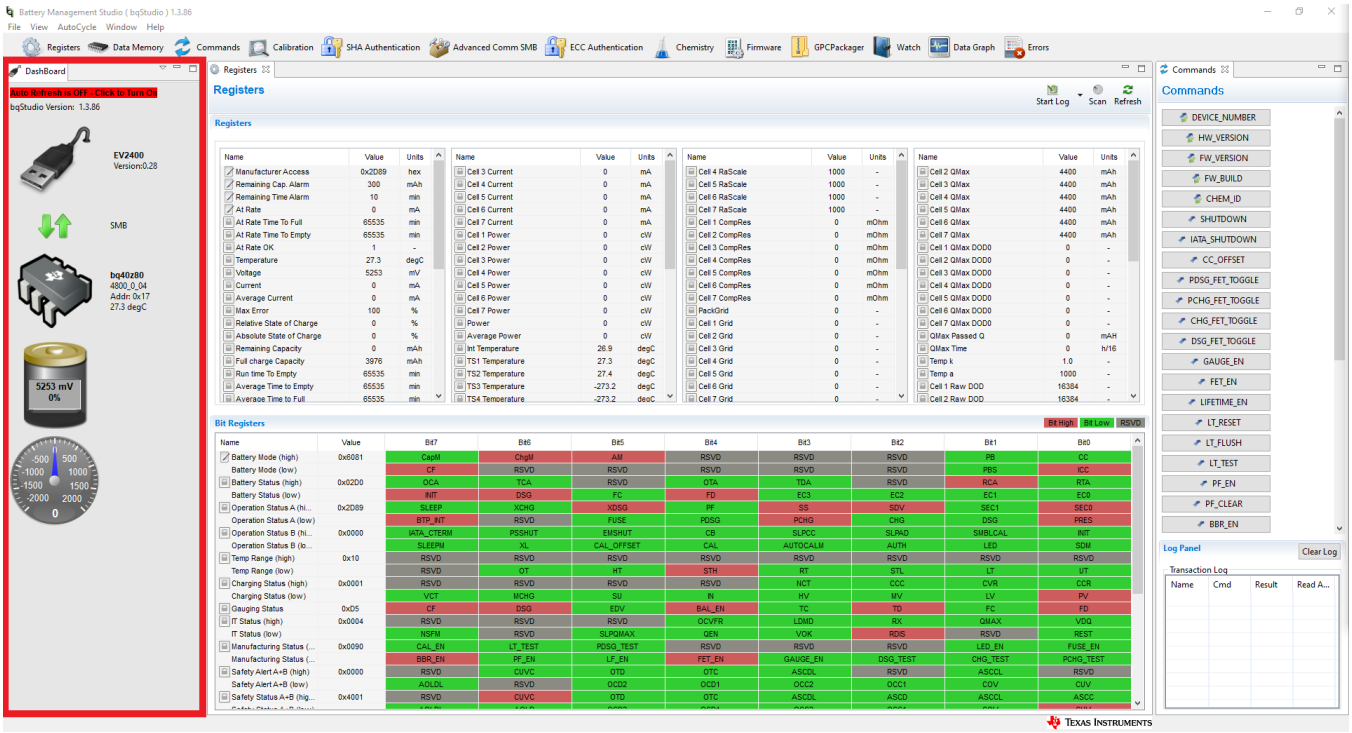
5. A cell simulation can be used instead of battery cells. Connect a 1-kΩ resistor between each of the contacts of the input cell slots up to the desired number of cells is achieved. Short any empty cell slots. A power supply can provide power to the cell simulator. Set the power supply to the desired cell voltage × the number of cells and attach the ground wire to the bottom of the cell stack and the positive wire to the top of the stack. For example, for a 6 cell in series(6s) configuration with a 3.6-V cell voltage, set the power supply to 6 × 3.6 = 21.6-V.
6. A sample connection of a cell simulator is shown below.



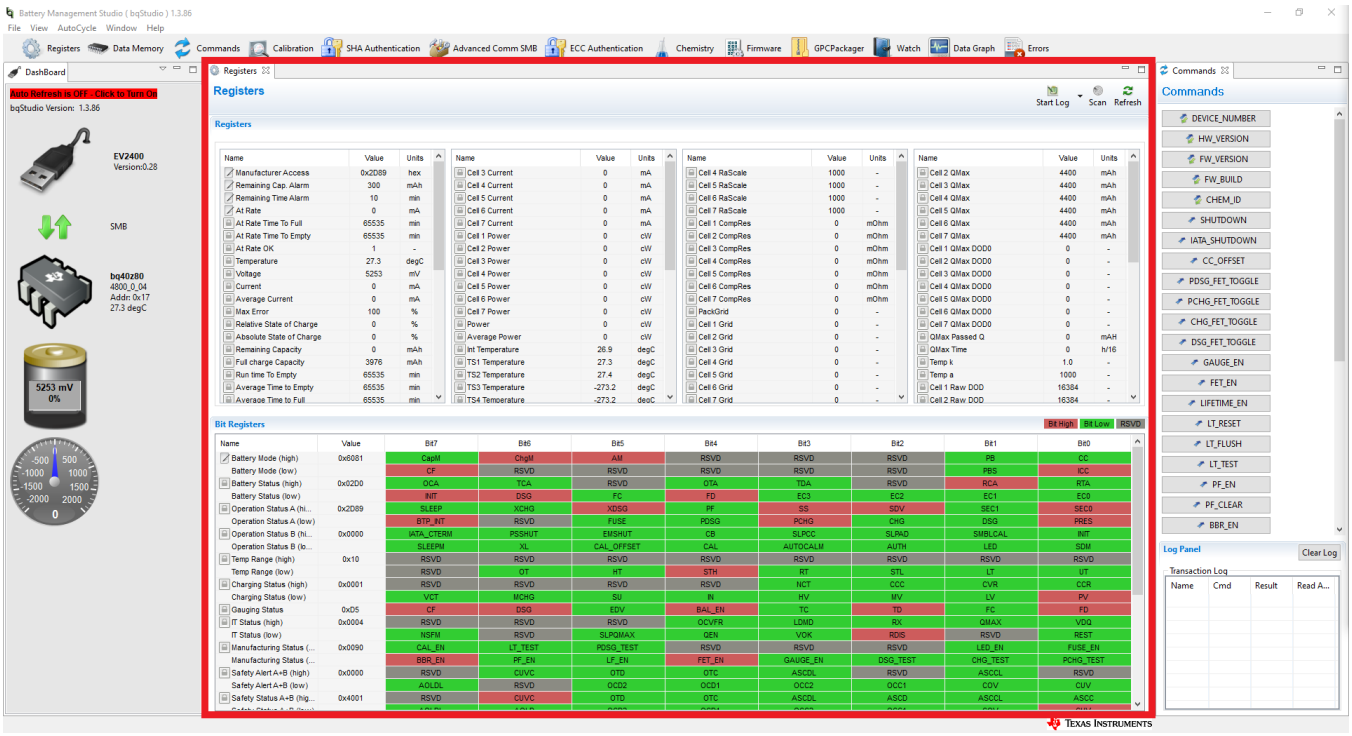
7. After the necessary connections, wake your device according to your EVM User Guide and launch BQSTUDIO to make sure your device can be auto-detected with BQSTUDIO and the bqz container file.
8. If it does not automatically connect, you will see a selection dialog with many product lines, as shown below.



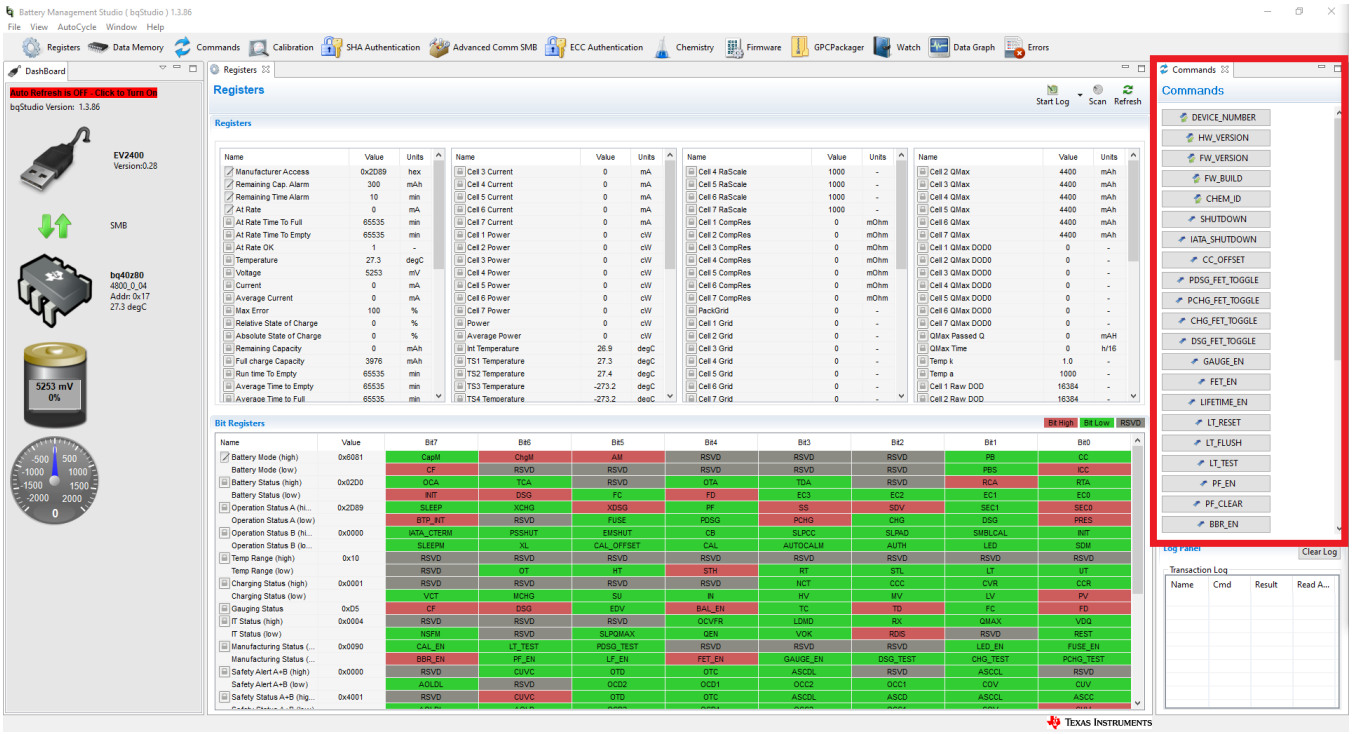
9. After successful connection, you will see that the dashboard on left half of screen displays values for Voltage, Temp, and Current. It will also display the protocol used for communication. If no information is displayed, then there is an error in communication. Check connections and make sure to wake your device.



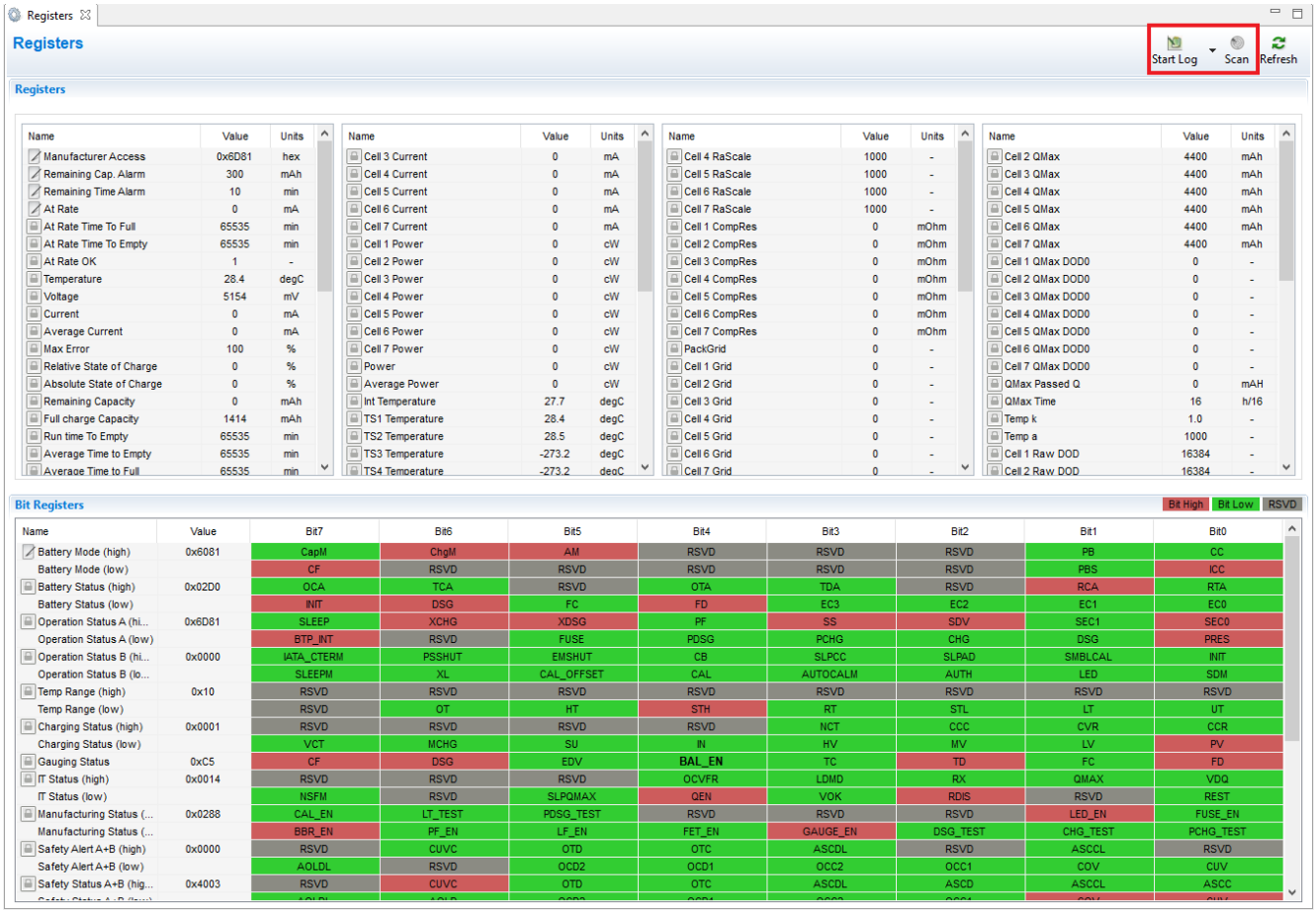
10. Default Register window in the middle reports data from the gauge.



11. Commands window on the right side of the screen can be used to send commands to the gauge. You can use these commands to obtain gauge information such as the programmed Chemistry ID, and the hardware or firmware version. Many of the gauge's functions such as protection FETs can also be controlled using these commands. You can also unseal or seal your device with these commands. Refer to your gauge's Technical Reference Manual for descriptions of each Command function.



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

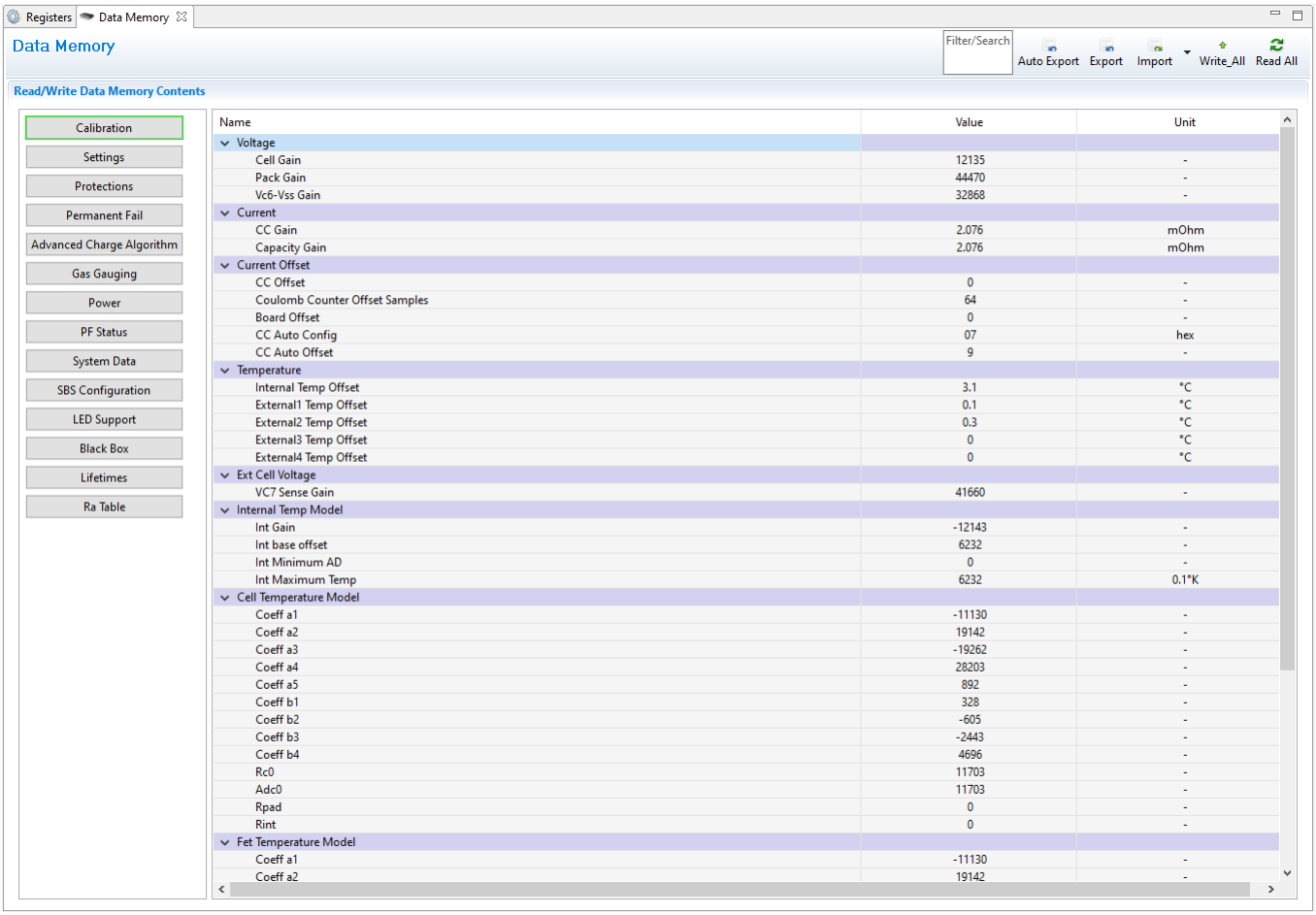


13. The Log Interval can be adjusted by opening the Windows tab, then Preferences>Registers. Anything below 1000-milliseconds will not provide any useful information, because most of this data gets updated only once a second. Do not set this to more than 10-seconds, because then useful information can be lost. Ideally, you'd keep this between 2000-milliseconds and 8000-milliseconds, between 2 and 8 seconds. We recommend to leave the log interval at the default value of 4000-ms.

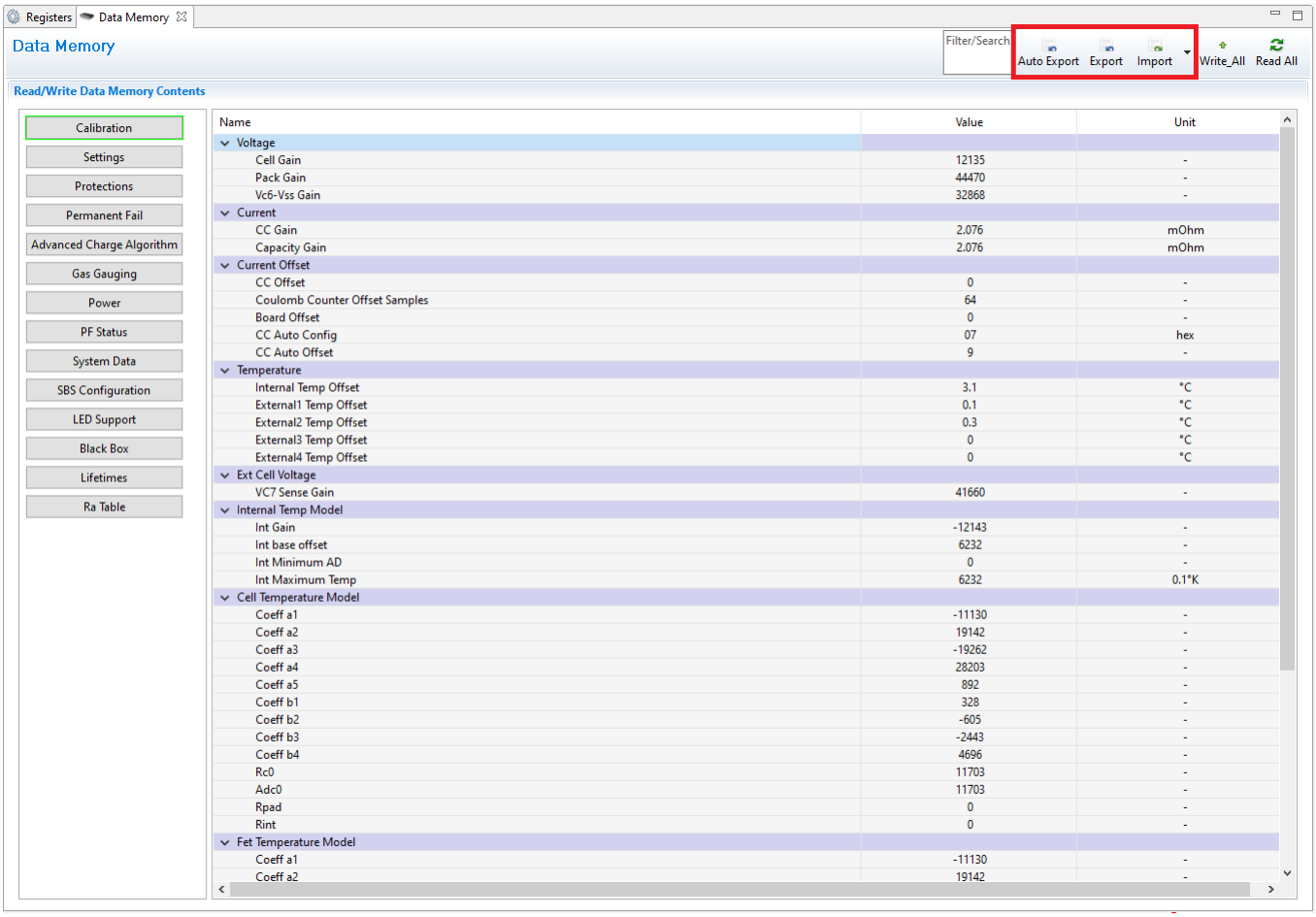
1.2.1 Gauge Configurations Using BQSTUDIO

1. Navigate to “Data Memory”.

2. This is where you configure the gauge parameters.



3. To read all the data from the gauge non-volatile flash memory, click on the **Read All** button on the Data Memory window. The device must not be sealed and must be in full access in order to read or write to the data memory.
4. Calibrate your gauge as shown in your EVM's user guide and configure all values for your application. Remember to change the *DA Configuration* to set up the number of series cells to match the physical pack configuration. This is done in | *Data Memory* | *Settings* | *DA Configuration* register. This provides basic functionality to the setup.
5. For Learning Cycle purposes in TI's Impedance Tracking gauges, you will want to adjust Design Capacity, Design Voltage, Charge Term Taper Current, Discharge Current Threshold, Charge Current threshold, Quit Current and Term Voltage. For other parameters, please refer to your gauge's Technical Reference Manual and EVM User Guide for detailed descriptions.
6. To save or review the configuration settings, you can export a .GG.CSV file by using the export button on the top-right corner of Data Memory.
7. You can also import any existing .GG.CSV file by using the import button on the top-right corner of Data Memory; you must then write it to memory by using the Write All button on the top-right corner of Data Memory. This will write all imported configurations into the data flash memory of the gauge.

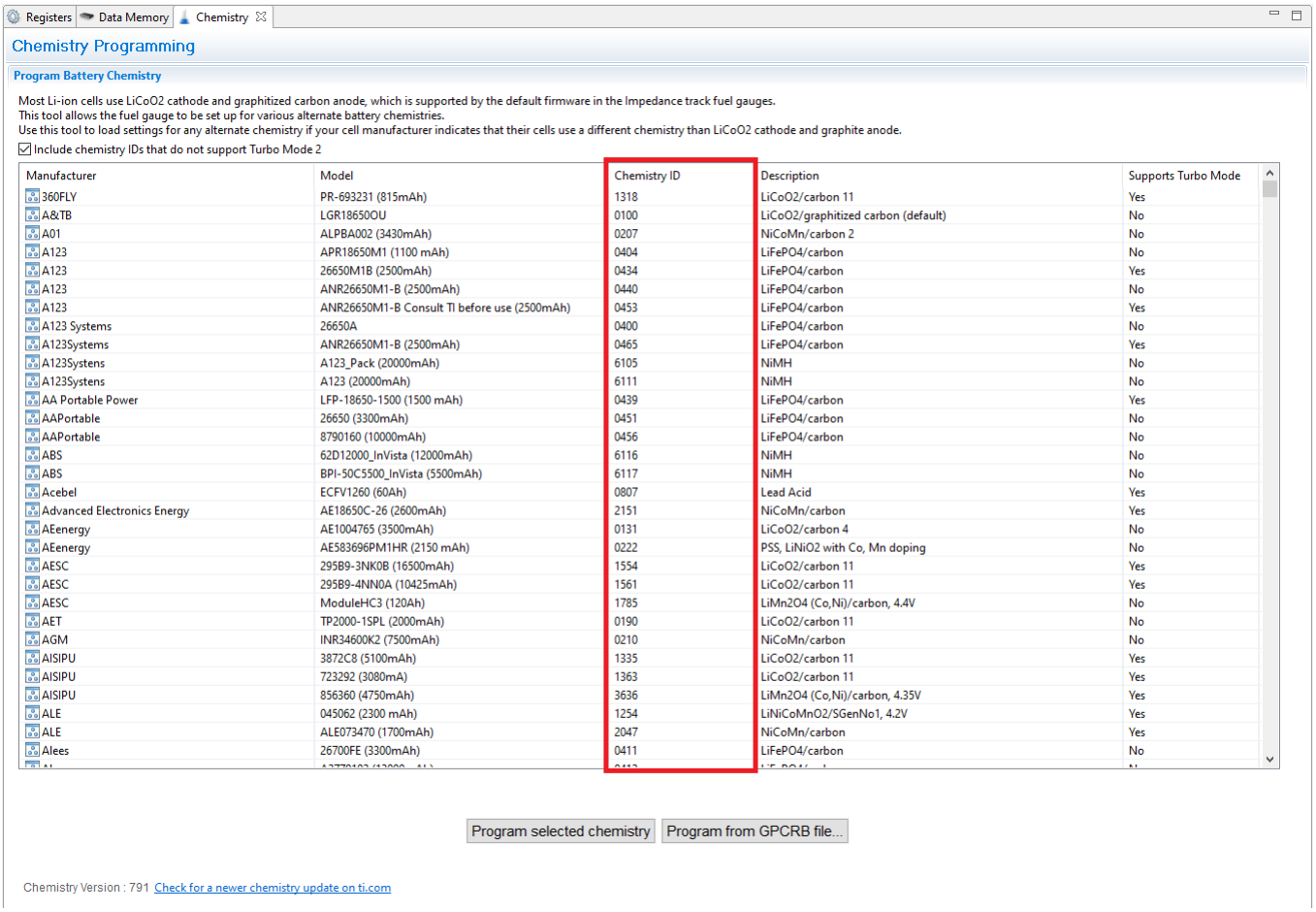


1.3 Chemistry ID

When using Impedance Track™ gauges, choosing the proper Chemistry ID is critical to achieving good performance. Chemistry ID refers to a set of tables containing information about the cell's characteristics and behaviors. BQSTUDIO offers a large portfolio of Chemistry IDs that have been created by Texas Instruments for a vast variety of cells.

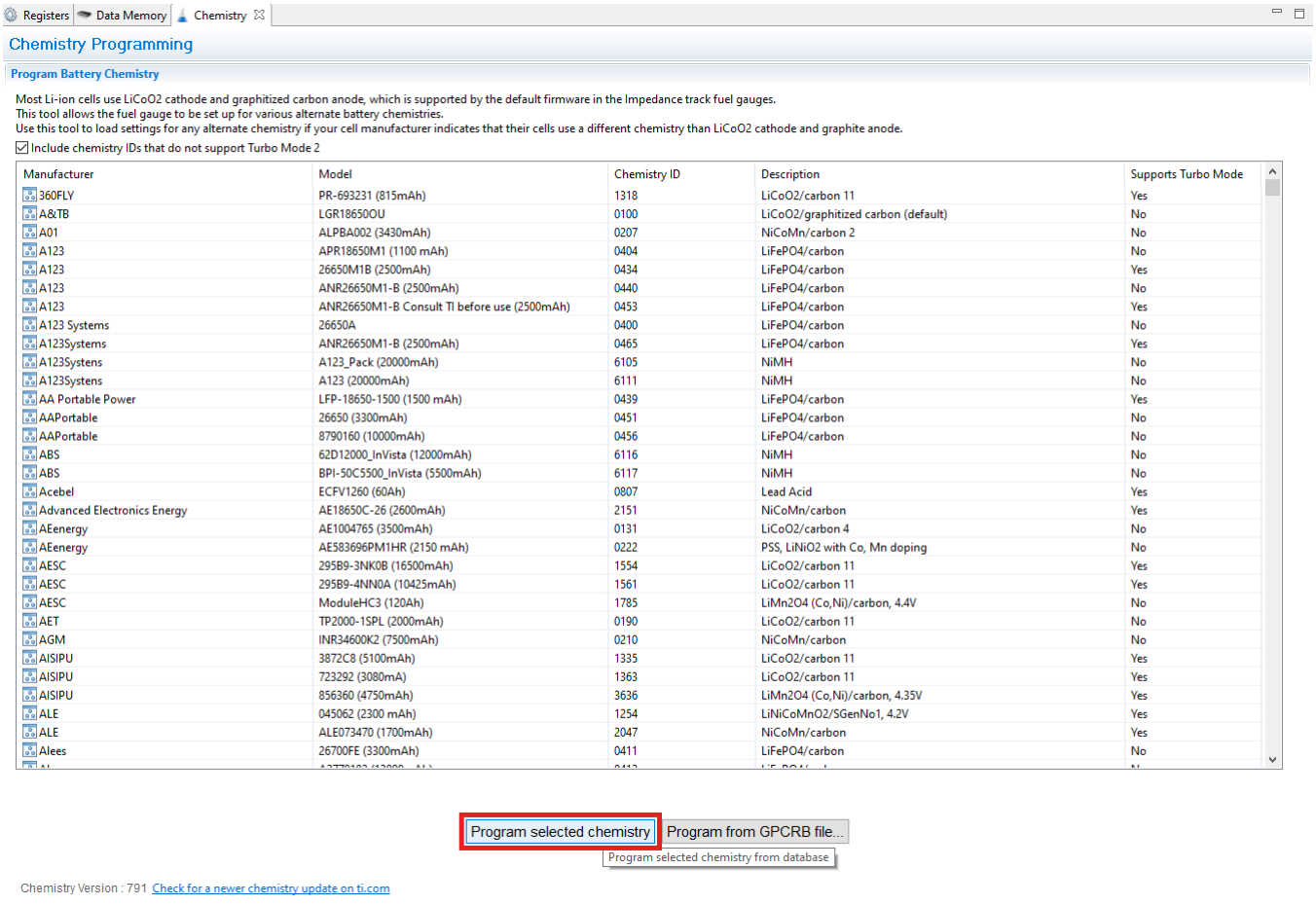
1. Navigate to "Chemistry"

2. Match the model of the desired cell to one in the table if available and select the matching Chemistry ID.



Manufacturer	Model	Chemistry ID	Description	Supports Turbo Mode
360FLY	PR-693231 (815mAh)	1318	LiCoO2/carbon 11	Yes
A&TB	LGR18650OU	0100	LiCoO2/graphitized carbon (default)	No
A01	ALPBA002 (3430mAh)	0207	NiCoMn/carbon 2	No
A123	APR18650M1 (1100 mAh)	0404	LiFePO4/carbon	No
A123	26650M1B (2500mAh)	0434	LiFePO4/carbon	Yes
A123	ANR26650M1-B (2500mAh)	0440	LiFePO4/carbon	No
A123	ANR26650M1-B Consult TI before use (2500mAh)	0453	LiFePO4/carbon	Yes
A123 Systems	26650A	0400	LiFePO4/carbon	No
A123Systems	ANR26650M1-B (2500mAh)	0465	LiFePO4/carbon	Yes
A123Systens	A123_Pack (20000mAh)	6105	NiMH	No
A123Systens	A123 (20000mAh)	6111	NiMH	No
AA Portable Power	LFP-18650-1500 (1500 mAh)	0439	LiFePO4/carbon	Yes
AAPortable	26650 (3300mAh)	0451	LiFePO4/carbon	No
AAPortable	8790160 (10000mAh)	0456	LiFePO4/carbon	No
ABS	62D12000_InVista (12000mAh)	6116	NiMH	No
ABS	BPI-50C5500_InVista (5500mAh)	6117	NiMH	No
Acebel	ECFV1260 (60Ah)	0807	Lead Acid	Yes
Advanced Electronics Energy	AE18650C-26 (2600mAh)	2151	NiCoMn/carbon	Yes
AEenergy	AE1004765 (3500mAh)	0131	LiCoO2/carbon 4	No
AEenergy	AE583696PM1HR (2150 mAh)	0222	PSS, LiNiO2 with Co, Mn doping	No
AESC	295B9-3NK0B (16500mAh)	1554	LiCoO2/carbon 11	Yes
AESC	295B9-4NN0A (10425mAh)	1561	LiCoO2/carbon 11	Yes
AESC	ModuleHC3 (120Ah)	1785	LiMn2O4 (Co,Ni)/carbon, 4.4V	No
AET	TP2000-1SPL (2000mAh)	0190	LiCoO2/carbon 11	No
AGM	INR34600K2 (7500mAh)	0210	NiCoMn/carbon	No
AISIPU	3872C8 (5100mAh)	1335	LiCoO2/carbon 11	Yes
AISIPU	723292 (3080mA)	1363	LiCoO2/carbon 11	Yes
AISIPU	856360 (4750mAh)	3636	LiMn2O4 (Co,Ni)/carbon, 4.35V	Yes
ALE	045062 (2300 mAh)	1254	LiNiCoMnO2/SGenNo1, 4.2V	Yes
ALE	ALE073470 (1700mAh)	2047	NiCoMn/carbon	Yes
Alees	26700FE (3300mAh)	0411	LiFePO4/carbon	No

3. If no model in the table matches the cell, create a log based on the GPCCHEM tool (http://www.ti.com/tool/GPCCHEM) and obtain a GPCCHEM report. Select the Chemistry ID with the lowest error based on the GPCCHEM report. This will ensure that the learning cycle does not fail. Running the GPCCHEM test is the best method to determine a good chemistry ID for the gas gauge.
4. If no appropriate ID exists, contact your local TI representative or post the GPCCHEM log and your gauge setup to e2e.ti.com.
5. After the proper Chemistry ID is obtained, program the selected Chemistry ID



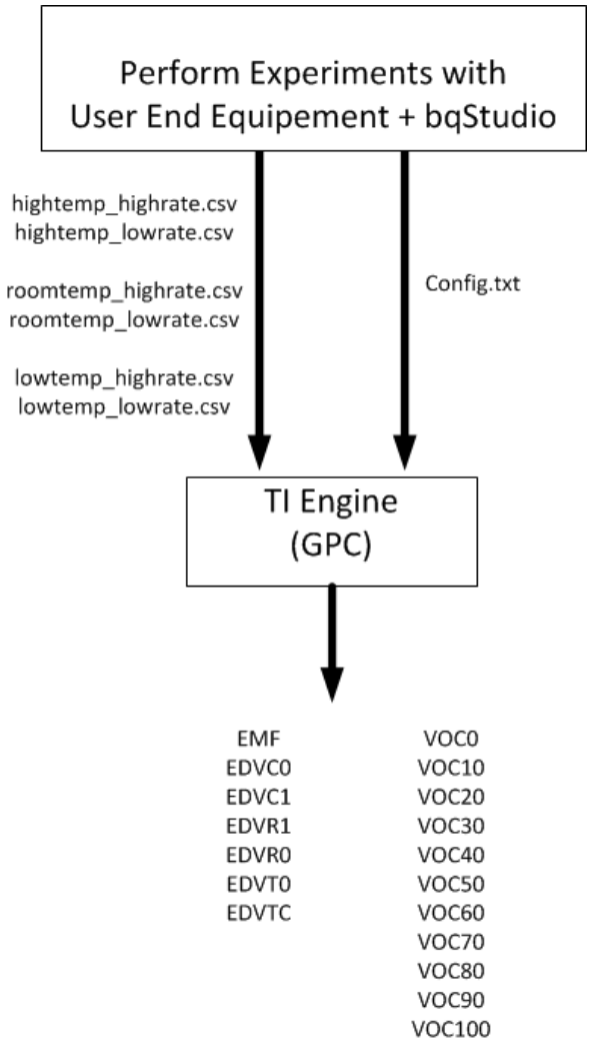
1.4 Learning Cycle

During the golden file creation process, Impedance Tracking gauges must undergo a learning cycle process. The learning cycle requires the user to carry out a few cycles on the pack to make sure that possible variation in cell manufacturer processes is accounted for in the learned resistance, as well to account for board contact and trace resistances which could impact the gauges state of charge reporting and accuracy.

1. Prior to starting the learning cycle, a matching Chemistry ID must be selected.
2. Perform the learning cycle on the device. There are multiple learning cycle guidelines, please refer to the learning cycle application notes(Achieving A Successful Learning Cycle) below for single cell and multi-cell gauges. (https://www.ti.com/lit/slua903).
3. Run accuracy cycle and determine if learning cycle/chemistry is successful (https://e2e.ti.com/blogs_/archives/b/fullycharged/archive/2016/11/04/how-accurate-is-your-battery-fuel-gauge-part-2-2).

1.5 Compensated End of Discharge Voltage (CEDV) Gauges

When using TI's CEDV algorithm-based gauges, you must obtain CEDV coefficients for your specific battery profile. These coefficients allow the user to increase the accuracy of the fuel gauge IC over temperature. You can obtain CEDV parameters from our online gauging parameter calculator(GPC) for CEDV gauges tool (http://www.ti.com/tool/GPCCEDV). After programming the design parameters to the gauge, the EVM can be used to obtain the experimental data needed to calculate the CEDV coefficients.



Refer to *Simple Guide to CEDV Data Collection for Gauging Parameter Calculator (GPC)* (http://www.ti.com/lit/pdf/SLUUB45) for a detail explanation of the CEDV coefficients data collection process and GPC tool configuration.

2 Example BQ40Z50-R3 Evaluation

1. Please use samples.ti.com to place an order for the BQ40Z50-R3 EVM. In the EVM user's guide discusses the options for connecting the board (http://www.ti.com/lit/ug/sluuav7b/sluuav7b.pdf).
2. Use samples.ti.com to place an order for the EV2400 board
3. Install BQSTUDIO: http://www.ti.com/tool/BQSTUDIO, there are two options, stable and test version can be used. TI recommends using the stable version for first time users.
4. Once you have installed BQSTUDIO, make sure you can log the SBS registers by clicking start log. Make sure you know how to export a gg.csv file using the data memory tab.
5. Follow instructions for GPCCHEM tool. Once you have submitted the input log files to GPCCHEM, use the chemistry plug-in and program the chemID in the BQ40Z50-R3.
6. Perform learning cycle.

3 Linux and Windows Drivers

TI gas gauges that support the SMBus communication protocol adhere to the Smart Battery Specification(SBS) standard. Windows and Linux have built in drivers to read data from SBS compliant battery gas gauges.

Most TI gas gauges that use the I2C communication protocol have drivers integrated into the Linux kernel. TI regularly pushes updates to add support for new I2C gas gauges in the Linux Kernel.

An operating system + gas gauge combination that is not described above may require custom driver development.

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