

bq27542-G1 Setup

TI Information – Selective Disclosure

1

Outline

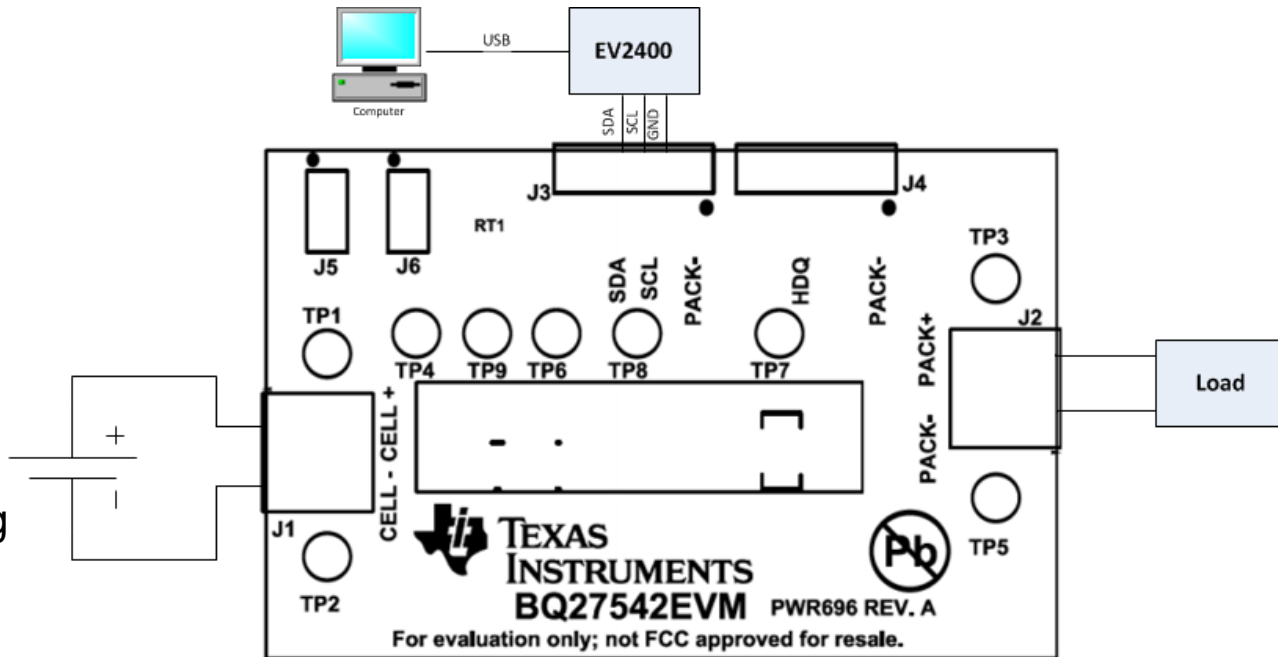
- EVM setup
- How to use bqStudio
- Change chemistry
- Calibration
- Learning cycle

Required Materials

- bq27542-G1 EVM
- bqStudio Evaluation software
- EV2400 HPA500 – Communication box
- Inputs: either a single cell Li-ion battery or a power supply.
- Load able to charge/discharge the input, e.g. Keithley 2400 Sourcemeter

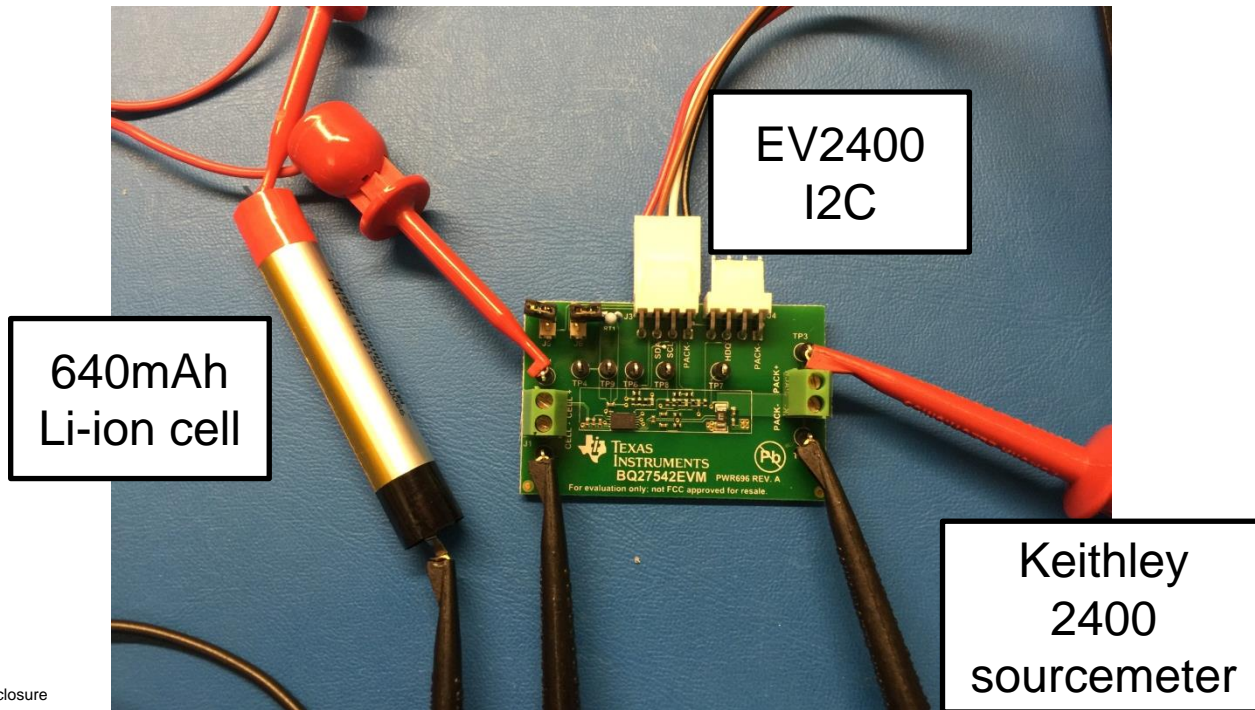
EVM Setup

- **J1** – Connect cell to Cell+/Cell-
- **J2** – Connect your load.
- **J3** – I2C comm port. Connect your EV2400 here.
- **J4** – HDQ comm port.
- **J5 & J6** – I2C external pull-up. Remove if using EV2400.



EVM Setup

For this exercise, a single 4.2V 640mAh cell is used. For the load, a Keithley 2400 Sourcemeter is used.



bqStudio


Battery Management Studio (bqStudio) 1.3.42


File View Window Help


Project Registers Data Memory Commands Calibration Authentication Chemistry Advanced Comm Programming Golden Image Watch Data Graph Errors Goldenizing Learning Cycle Parameter Q&A

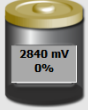
Dashboard


Auto Refresh is ON - Click to Turn Off
bqStudio Version: 1.3.42

 **FV2400**
Version:0.05

 I2C

 **bq27542G1**
0542_2_01
Addr: 0xAA
25.5 °C

 **2840 mV**
0%



Registers

Registers

Name	Value	Units	Name	Value	Units	Name	Value	Units
Control	0x0201	Hex	Full Charge Capacity Unfiltered	971	mAh	Charge Current	800	mA
State Of Charge Unfiltered	0	%	Max Load Current	0	mA	Passed Charge	0	mAh
Temperature	25.5	°C	Remaining Capacity Unfiltered	0	mAh	DOD0	16384	
Voltage	2840	mV	Remaining Capacity Filtered	0	mAh	Self Discharge Current	0	mA
Nominal Available Capacity	20	mAh	BTP SOC1 Set	150	mAh	DoDatEOC	152	Num
Full Available Capacity	991	mAh	BTP SOC1 Clear	175	mAh	Qstart	991	mAh
Remaining Capacity	0	mAh	Internal Temperature	23.7	°C	Fast Qmax	0	mAh
Full Charge Capacity	971	mAh	Cycle Count	0		Qmax	1000	mAh
Average Current	0	mA	State Of Charge	0	%	OCV Current	0	mA
Time to Empty	65535	Min	State Of Health	98		OCV Voltage	2886	mV
Full Charge Capacity Filtered	971	mAh	Charge Voltage	4350	mV	Internal Status	0x2200	Hex
						ResScale	0	Num
						DodFinal	16061	Num

Bit Registers

Name	Value	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Control Status ...	0x009C	SE_EN	FAS	SS	CALMODE	CCA	BCA	QMAXUPDATE	HOSTIE
Control Status ...	0x002A	SE	HIB	FLASLEEP	SLEEP	LDMD	RUP_DIS	YOK	QEN
Flags (high)	0x002A	RSVD	RSVD	BATHI	SYSDOWN	CHG_JNH	RSVD	FC	RSVD
Flags (low)	0x0	CHG_SLSP	8035	8034	IMAXINT	CHG	SOC1	SOCP	DS6
Safety Status (...)	0x0	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD
Safety Status (...)	0x0	RSVD	RSVD	ISO	TDD	OTC	OTD	RSVD	RSVD
Pack Configura...	0x297F	RSVD	INTPOL	INTSEL	HOSTIE	RSOCHOLD99	IWAKE	RSNS1	RSNS0
Pack Configura...	0x297F	GNSEL	RFACTSTEP	SLEEP	RMFCC	RSOCHOLD1	RMHOLD100	RMHOLD0	TEMPS

Commands

CONTROL_STATUS
DEVICE_TYPE
FW_VERSION
HW_VERSION
RESET_DATA
PREV_MACWRITE
CHEM_ID
BOARD_OFFSET
CC_OFFSET
CC_OFFSET_SAVE
DF_VERSION
SET_FULLLSLEEP

Manual Control Panel

Enter Cmd Delay Ms
1000

Read Addr Length

Log Panel Clear Log

Transaction Log

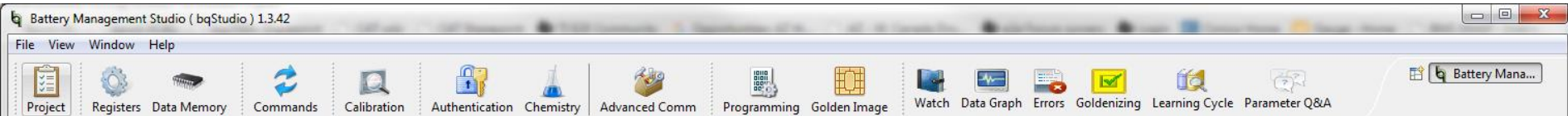
Name	Cmd	Resu

Start Log Scan Refresh

TEXAS INSTRUMENTS

TI Information – Selective Disclosure

bqStudio

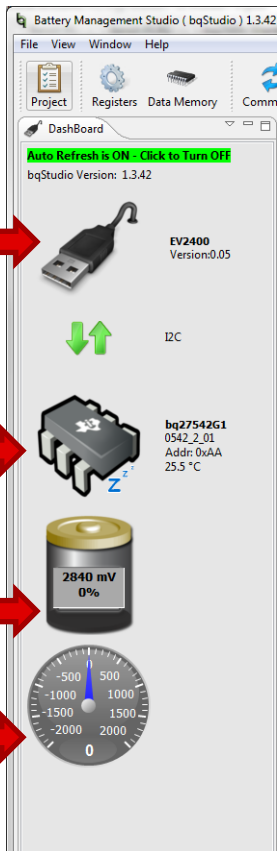


- **Project** – Opens project perspective. Allows to create a new project.
- **Registers** – Opens Registers perspective.
- **Data memory** – Opens data flash perspective. Holds the data flash parameters for the fuel gauge.
- **Commands** – Opens the Commands perspective.
- **Calibration** – Opens the Calibration perspective. Used to calibrate voltage, temperature, board and CC offsets, and current offset.
- **Authentication** – Opens the Authentication perspective. SHA-1 information and security key settings.
- **Chemistry** – Opens the Chemistry perspective. Allows a chemID to be programmed to the gauge that includes the OCV and Impedance tables for a particular chemistry.
- **Advanced Comm** – Allows manual I2C communication to the device.
- **Programming** – Allows to upload firmware files to the gauge (srec, senc).
- **Golden Image** – Allows to export the golden image files.
- **Learning Cycle** – Performs the learning cycle if the required automation hardware is accessible.

bqStudio

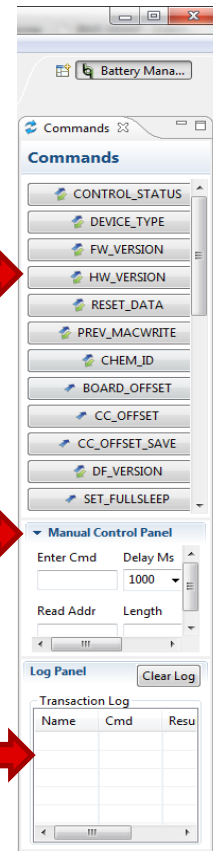
Dashboard

- EV2400 Connection information
- Device
- Quick battery status
- Current



Commands

- Pre-defined commands. These commands are detailed in the device's TRM.
- Send manual commands
- Log of transactions. Commands results will be shown here.



bqStudio

Registers

- Data Registers (voltage, current, SOC, SOH, etc.)



- Single-bit registers (status, flags, etc.)



The screenshot shows the 'Registers' window in bqStudio. It contains two main sections: a list of registers and a bit register table.

Registers List:

Name	Value	Units	Name	Value	Units	Name	Value	Units
Control	0x0201	Hex	Full Charge Capacity Unfiltered	971	mAh	Charge Current	800	mA
State Of Charge Unfiltered	0	%	Max Load Current	0	mA	Passed Charge	0	mAh
Temperature	25.5	°C	Remaining Capacity Unfiltered	0	mAh	DOD0	16384	
Voltage	2840	mV	Remaining Capacity Filtered	0	mAh	Self Discharge Current	0	mA
Nominal Available Capacity	20	mAh	BTP SOC1 Set	150	mAh	DoDataEOC	152	Num
Full Available Capacity	991	mAh	BTP SOC1 Clear	175	mAh	Qstart	991	mAh
Remaining Capacity	0	mAh	Internal Temperature	23.7	°C	Fast Qmax	0	mAh
Full Charge Capacity	971	mAh	Cycle Count	0		Qmax	1000	mAh
Average Current	0	mA	State Of Charge	0	%	OCV Current	0	mA
Time to Empty	65535	Min	State Of Health	98		OCV Voltage	2886	mV
Full Charge Capacity Filtered	971	mAh	Charge Voltage	4350	mV	Internal Status	0x2200	Hex
						ResScale	0	Num
						DodFinal	16061	Num

Bit Registers Table:

Name	Value	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Control Status ...	0x009C	SE_EN	FAS	SS	CALMODE	CCA	BCA	QMAXUPDATE	HOSTIE
Control Status ...		SE	HIB	FULLSLEEP	SLEEP	LDMD	RUP_DIS	VOK	QEN
Flags (high)	0x002A	RSVD	RSVD	BATHI	SYSDOWN	CHG_INH	RSVD	FC	RSVD
Flags (low)		CHG_SUSP	8035	8034	IMAXINT	CHG	SOC1	SOCF	DSG
Safety Status (...)	0x0	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD
Safety Status (...)		RSVD	RSVD	ISD	TDD	OTC	OTD	RSVD	RSVD
Pack Configura...	0x297F	RSVD	INTPOL	INTSEL	HOSTIE	RSOCHOLD99	IWAKE	RSNS1	RSNS0
Pack Configura...		GNDSEL	RFACTSTEP	SLEEP	RMFCC	RSOCHOLD1	RMHOLD100	RMHOLD0	TEMPS

bqStudio - Calibration

The screenshot shows the 'Calibration' window in bqStudio. The window title bar includes 'Advanced Comm', 'Registers', 'Authentication View', 'Chemistry', 'Programming', 'Golden Image', and 'Calibration'. The main content area is titled 'Perform Calibration' and contains the following sections:

- CC Offset:** A text input field with a checkbox labeled 'Calibrate CC Offset'.
- Board Offset:** A text input field with a checkbox labeled 'Calibrate Board Offset'.
- Temperature:** A section with 'Applied Temperature' and a radio button selected for 'Internal Temp'. Below it is a text input field followed by 'deg C', a checkbox for 'Calibrate Temperature', and a radio button for 'External Temp'.
- Current:** A section with 'Applied Current' and a text input field followed by 'mA', and a checkbox for 'Calibrate Current'.
- Voltage:** A section with 'Applied Voltage' and a text input field followed by 'mV', and a checkbox for 'Calibrate Voltage'.

At the bottom center of the form area is a button labeled 'Calibrate Gas Gauge'. The bottom of the window features the Texas Instruments logo and the text 'TEXAS INSTRUMENTS'.

bqStudio - Calibration

- **CC Offset** – Coulomb counter input offset.
- **Board Offset** – Offset calibration for the current offset of the board. **No current** is expected to be flowing through the sense resistor. Remove the load/external voltage and short Pack- to Batt-.
- **Voltage Calibration** – Remove the load applied between Pack+/Pack-. Apply a known voltage across Pack+ and Pack-. Measure it and enter it in the **Applied Voltage** field.
- **Temperature Calibration** – Measure the temperature for PACK. Type the temperature value into the field. Select if the temperature sensor to calibrate is the internal or the external.
- **Pack Current Calibration** - Connect a load to Pack- and Pack+ that draws approximately 1A, or connect a current source to Pack- and Pack+. Measure the current and type value into Enter Actual Current using (-) for current in discharge direction.

bqStudio – Coulomb Counter Calibration

- **CC Offset** – Coulomb counter input offset.

Advanced Comm Registers Authentication View Chemistry Programming Golden Image Calibration

Calibration

Perform Calibration

Select the type of calibration to perform and enter the actual input parameters.

#1 → **CC Offset**
 Calibrate CC Offset

Board Offset
 Calibrate Board Offset

Temperature
Applied Temperature deg C Internal Temp Calibrate Temperature External Temp

Current
Applied Current mA Calibrate Current

Voltage
Applied Voltage mV Calibrate Voltage

#2 → ✓

bqStudio – Board Offset Calibration

- **Board Offset** – Offset calibration for the current offset of the board. **No current** is expected to be flowing through the sense resistor. Remove the load/external voltage and short Pack- to Batt-.

The screenshot shows the bqStudio Calibration window. The 'Board Offset' section is selected, and the 'Calibrate Board Offset' checkbox is checked. A red arrow labeled '#1' points to this checkbox. Below the calibration options, there is a 'Calibrate Gas Gauge' button, with a red arrow labeled '#2' pointing to it. A 'Progress Information' dialog box is overlaid on the screen, displaying a progress bar and the text: 'Calibrating gauge... This process could take up to 1 minute.' and 'Calibrating: [Board Offset]'. The dialog box also has a 'Cancel' button.

bqStudio – Voltage Calibration

- **Voltage Calibration** – Remove the load applied between Pack+/Pack-. Apply a known voltage across Pack+ and Pack-. Measure it and enter it in the **Applied Voltage** field.

The image displays two screenshots of the bqStudio Calibration interface. The left screenshot shows the 'Perform Calibration' form with red arrows and numbers #1, #2, and #3 pointing to the 'Applied Voltage' field, the 'Calibrate Voltage' checkbox, and the 'Calibrate Gas Gauge' button respectively. The right screenshot shows the same form with a 'Progress Information' dialog box overlaid, indicating 'Calibrating gauge... This process could take up to 1 minute.' with a progress bar and a 'Cancel' button.

bqStudio – Current Calibration

- **Pack Current Calibration** - Connect a load to Pack– and Pack+ that draws approximately 1A, or connect a current source to Pack– and Pack-. Measure the current and type value into Enter Actual Current using (-) for current in discharge direction.

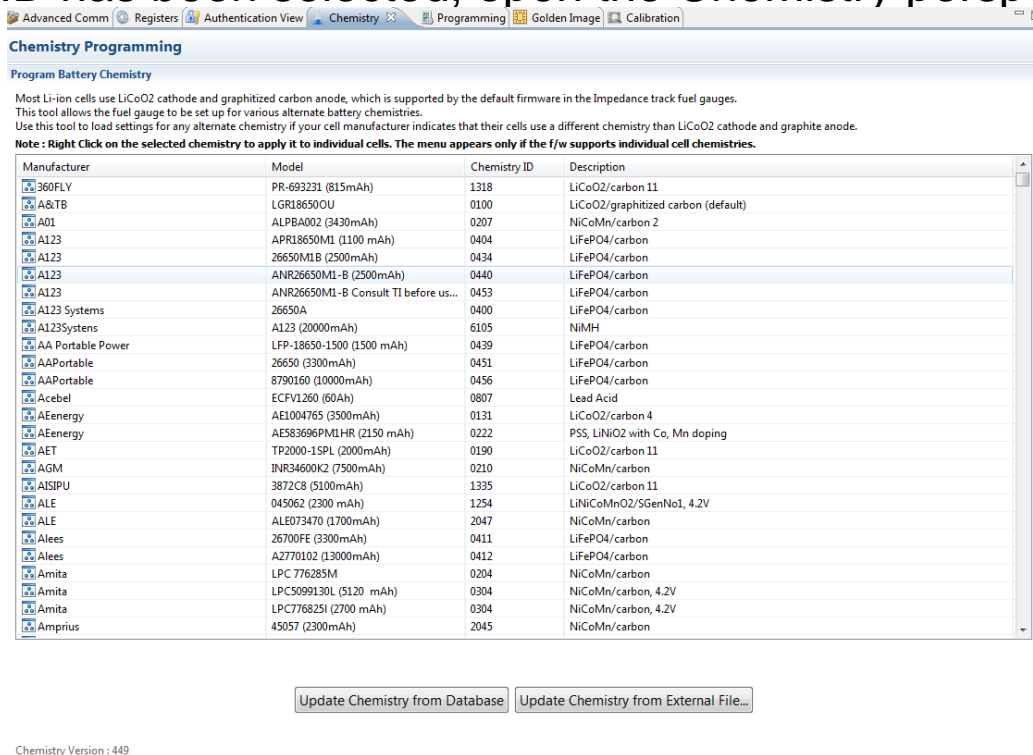
The image shows two side-by-side screenshots of the bqStudio Calibration dialog. The left screenshot shows the 'Perform Calibration' section with the 'Current' calibration step selected. Red arrows and numbers indicate the following steps: #1 points to the 'Applied Current' field, #2 points to the 'Calibrate Current' checkbox, and #3 points to the 'Calibrate Gas Gauge' button. The right screenshot shows the same dialog after the calibration process has started, with a 'Progress Information' popup window overlaid. The popup displays a progress bar and the text 'Calibrating gauge... This process could take up to 1 minute.' and 'Calibrating: [Current]'. A 'Cancel' button is visible in the bottom right of the popup.

bqStudio – Chemistry Selection

- For unknown chemistries, perform a rel-dis-rel cycle to obtain a chemID.
 - Charge cell to the manufacturer specified voltage until taper current reaches $C/100$.
 - Wait 2 hours.
 - Discharge at $C/10$ rate to manufacturer specified termination voltage (use 3V if unknown).
 - Wait 5 hours.
 - Use chemselect_cont.mcd worksheet to find chemical ID (MathCad 11 or higher is needed). After opening worksheet in mathcad, change column assignments for t,V,I,T to match actual data-file column numbers.
- [Link to chemselect tool.](#)

bqStudio – Chemistry Selection

- Once a chemID has been selected, open the Chemistry perspective in bqStudio.



The screenshot shows the 'Chemistry Programming' window in bqStudio. The window title is 'Advanced Comm Registers Authentication View Chemistry Programming Golden Image Calibration'. The main content area is titled 'Program Battery Chemistry' and contains the following text:

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
360FLY	PR-693231 (815mAh)	1318	LiCoO2/carbon 11
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 us...	0453	LiFePO4/carbon
A123 Systems	26650A	0400	LiFePO4/carbon
A123Systems	A123 (20000mAh)	6105	NiMH
AA Portable Power	LFP-18650-1500 (1500 mAh)	0439	LiFePO4/carbon
AAPortable	26650 (3300mAh)	0451	LiFePO4/carbon
AAPortable	8790160 (10000mAh)	0456	LiFePO4/carbon
Acebel	ECFV1260 (50Ah)	0807	Lead Acid
AEnergy	AE1004765 (3500mAh)	0131	LiCoO2/carbon 4
AEnergy	AE583696PM1HR (2150 mAh)	0222	PSS, LiNiO2 with Co, Mn doping
AET	TP2000-1SPL (2000mAh)	0190	LiCoO2/carbon 11
AGM	JNR34600K2 (7500mAh)	0210	NiCoMn/carbon
AISIPU	3872C8 (5100mAh)	1335	LiCoO2/carbon 11
ALE	045062 (2300 mAh)	1254	LiNiCoMnO2/SGenNo1, 4.2V
ALE	ALE073470 (1700mAh)	2047	NiCoMn/carbon
Alees	26700FE (3300mAh)	0411	LiFePO4/carbon
Alees	A2771012 (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
Amprius	45057 (2300mAh)	2045	NiCoMn/carbon

At the bottom of the window, there are two buttons: 'Update Chemistry from Database' and 'Update Chemistry from External File...'.

bqStudio – Chemistry Selection

- Scroll down to find the corresponding ChemID, then select **Update Chemistry from Database.**
- If the user already has the file for the chemistry being used, select **Update Chemistry from External File.**

The screenshot shows the 'Chemistry Programming' window in bqStudio. The window title is 'Chemistry Programming' and the subtitle is 'Program Battery Chemistry'. Below the subtitle, there is a note: '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
360FLY	PR-693231 (815mAh)	1318	LiCoO2/carbon 11
A8,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 us...	0453	LiFePO4/carbon
A123 Systems	26650A	0400	LiFePO4/carbon
A123Systems	A123 (20000mAh)	6105	NiMH
AA Portable Power	LFP-18650-1500 (1500 mAh)	0439	LiFePO4/carbon
AAPortable	26650 (3300mAh)	0451	LiFePO4/carbon
AAPortable	8790160 (10000mAh)	0456	LiFePO4/carbon
Acebel	ECFV1260 (60Ah)	0807	Lead Acid
AEnergy	AE1004765 (3500mAh)	0131	LiCoO2/carbon 4
AEnergy	AE583696PMLHR (2150 mAh)	0222	PSS, LiNiO2 with Co, Mn doping
AET	TP2000-15PL (2000mAh)	0190	LiCoO2/carbon 11
AGM	INR34600K2 (7500mAh)	0210	NiCoMn/carbon
AISIPU	3872C8 (5100mAh)	1335	LiCoO2/carbon 11
ALE	045062 (2300 mAh)	1254	LiNiCoMnO2/SGenNo1, 4.2V
ALE	ALE073470 (1700mAh)	2047	NiCoMn/carbon
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
Amprius	45057 (2300mAh)	2045	NiCoMn/carbon

At the bottom of the window, there are two buttons: 'Update Chemistry from Database' and 'Update Chemistry from External File...'. A red arrow points to the 'Update Chemistry from Database' button. The text 'Chemistry Version : 449' is visible at the bottom left of the window.

bqStudio – Learning Cycle

- Application note discussing how to achieve the successful learning cycle can be found [here](#).
- Process to set up the learning cycle:
 1. Discharge to empty.
 2. Relax for 5 hours.
 3. After relaxation is done, send IT_Enable command (0x0021) to the bq27542.
 4. Charge to full and relax for 2 hours.
 5. Discharge to empty at a C/10 rate then relax for 5 hours.
- **Update Status** indicates the status of the gauge during the learning cycle:
 - **0X00** – IT is disabled.
 - **0X04** – IT is enabled but the gauge hasn't updated QMAX or the RA tables.
 - **0x05** – IT is enabled and QMAX has been updated, but not the RA tables.
 - **0x06** – IT is enabled and both QMAX and RA table have been updated successfully.