

TI *Live!* BATTERY MANAGEMENT SYSTEMS SEMINAR

DAMIAN LEWIS

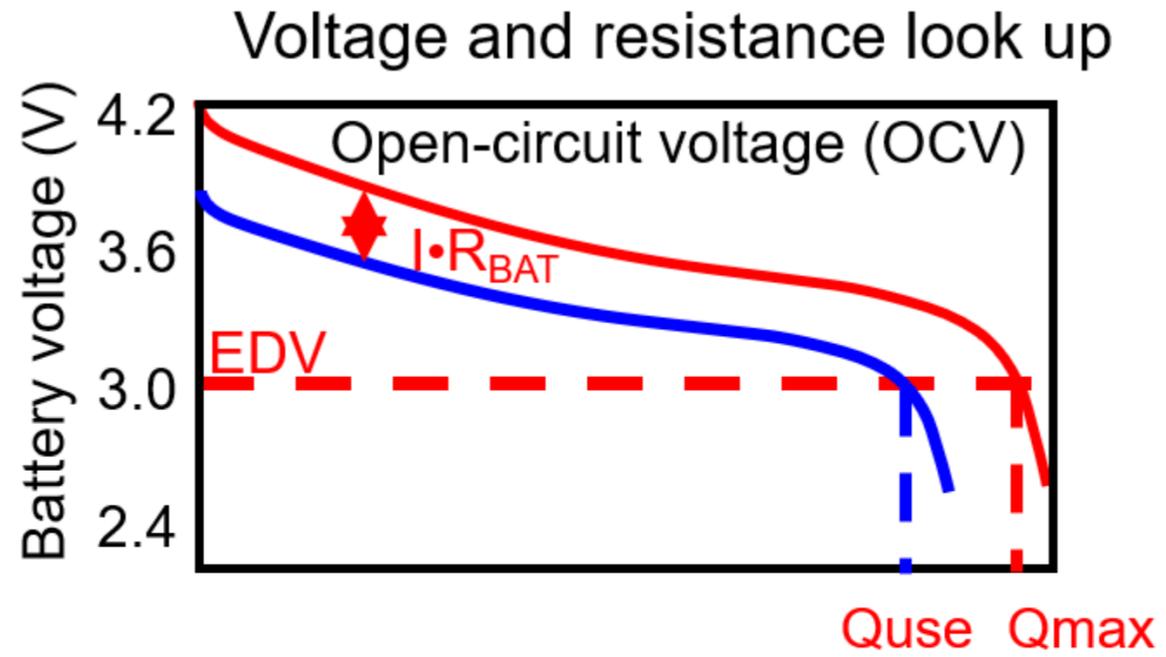
TI GAUGES: A STEP-BY-STEP GUIDE TO
PRODUCTION

Agenda

- What is Impedance Track™ technology?
- High-level overview of Impedance Track gauges.
- Voltage and resistance table (ChemID).
- Design process steps:
 1. Identify product requirements and select Impedance Track gauge.
 2. Identify the ChemID.
 3. Program the ChemID and configure the gauge.
 4. Optimize the gauge for low-temperature performance.
 5. Perform a learning cycle.
 6. Extract a golden file.
 7. Calibrate 20 units.
 8. Mass production.
- Conclusion.
- Questions.

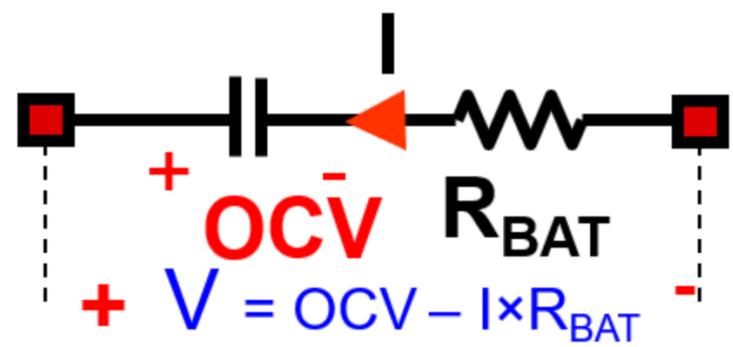
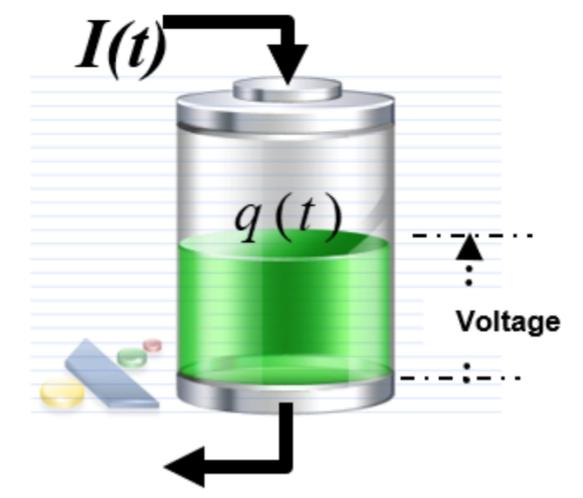
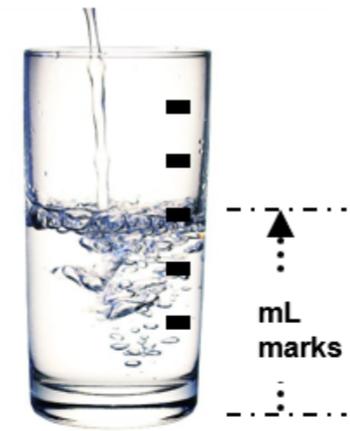
What is Impedance Track technology?

- TI's patented algorithm that combines a voltage and resistance look-up table and Coulomb counting for battery gauging.



Coulomb counting

$$q(t) = \int I dt$$



High-level overview of Impedance Track technology

1. Chemistry table in data flash:

$$\text{OCV} = f(\text{DOD})$$

$$\text{DOD} = g(\text{OCV})$$

DOD = depth of discharge

DOD (%) = 100% state of charge

2. Impedance learning during discharge:

$$R = \frac{\text{OCV} - V}{I}$$

3. Update maximum chemical capacity for each cell:

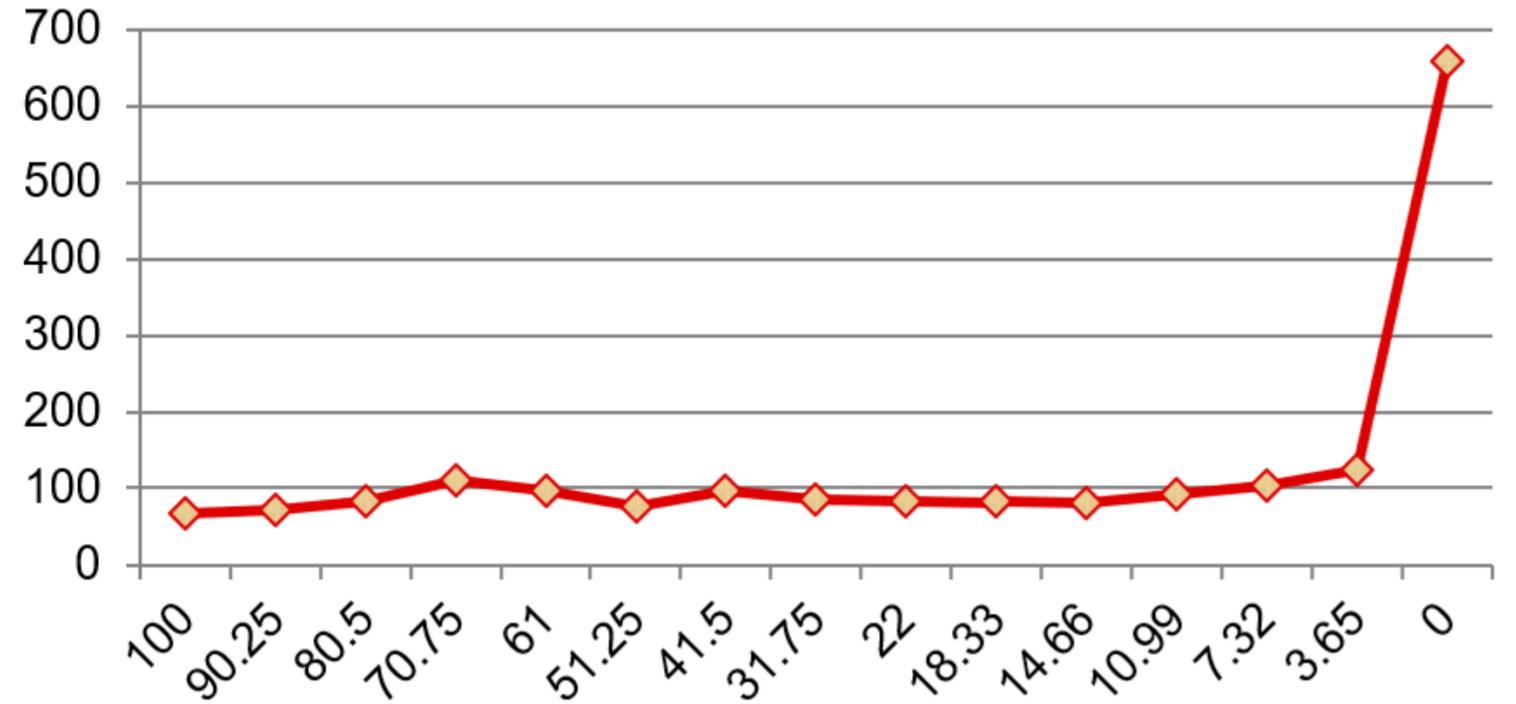
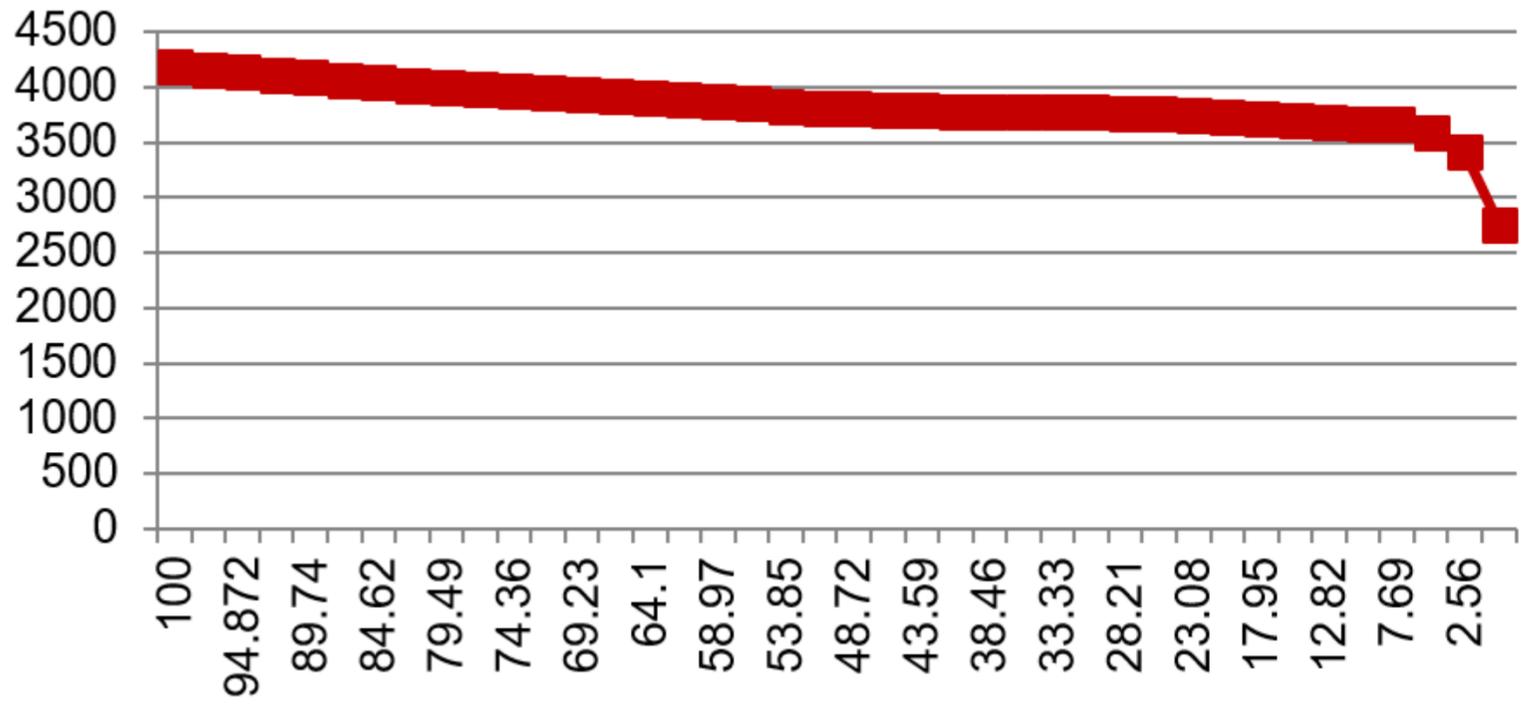
$$Q_{\text{max}} = \text{PassedCharge} / (\text{DOD1} - \text{DOD2})$$

4. Run periodic **simulations** to update predictions of remaining and full capacity.

State of charge = Remcap/FCC

Voltage and resistance table (ChemID)

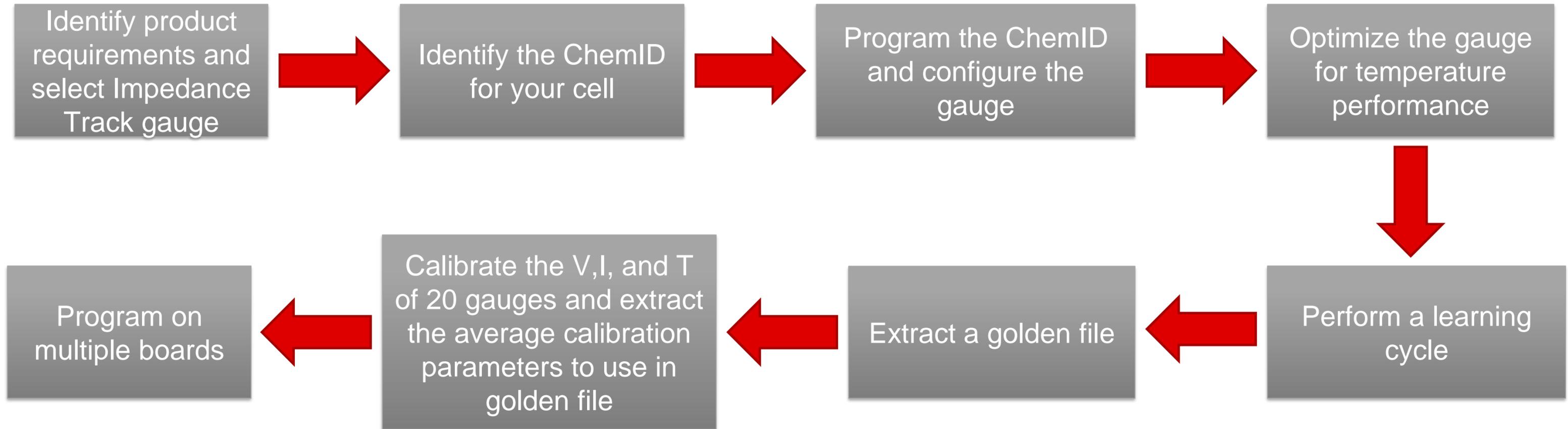
- The ChemID consists of the OCV profile of the battery and the resistance tables.
- There are 40 equally spaced OCV grid points and 15 resistance grid points.



- TI generates a ChemID for most cells.
- The gauging parameter calculator (GPC) GPCCHEM online tool can help determine a close ChemID match for your battery.
- Needs to be programmed in each Impedance Track gauge.
- Used to determine the depth of discharge (DOD) of a relaxed cell.
- Pertinent for high accuracy of the gauge.

Design process

Design process



Step No. 1: Identify product requirements and select the Impedance Track gauge

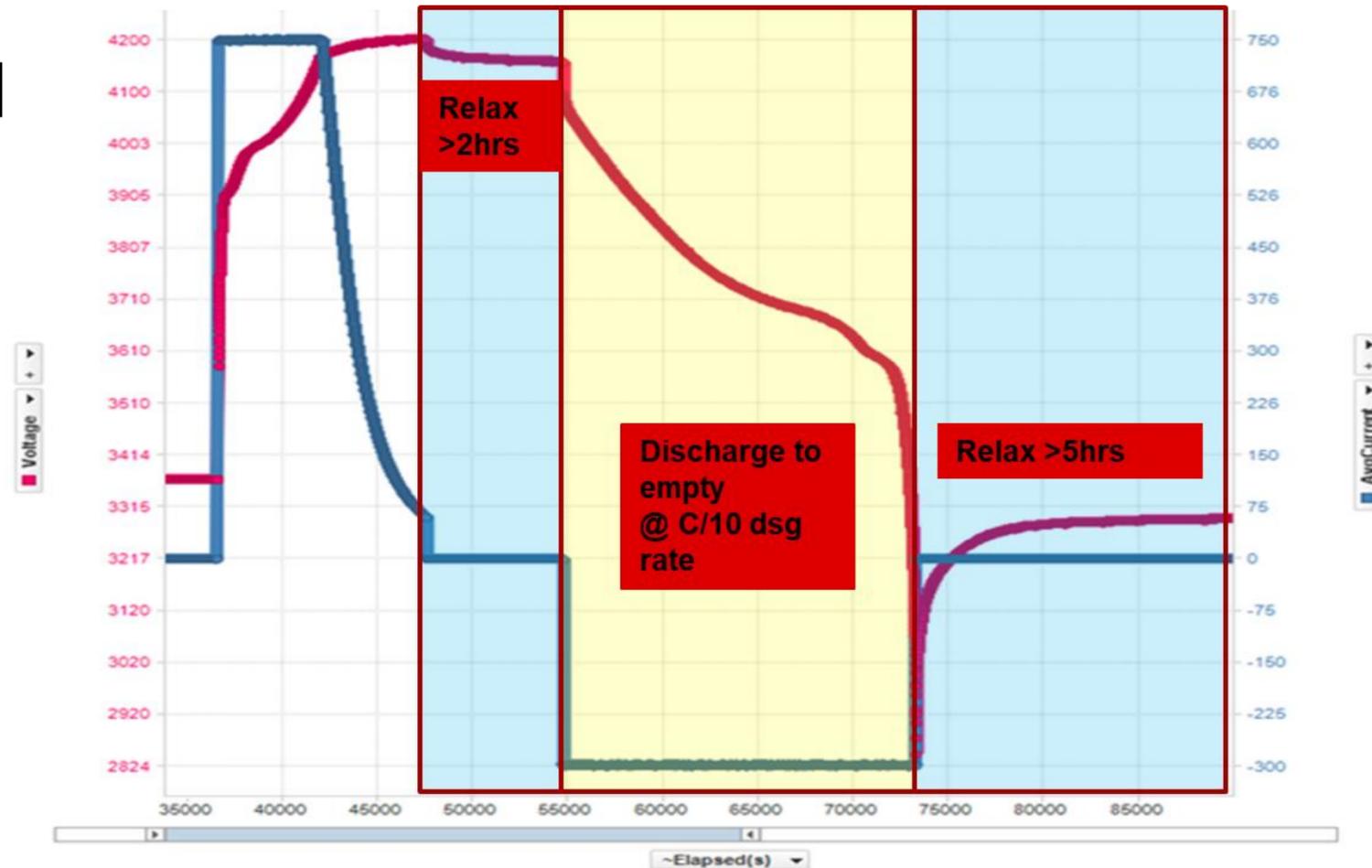
- Number of cells in series.
- Number of cells in parallel.
- Cell balancing.
- Protection.
- Chemistry.
- System or pack side.
- Read-only memory or flash.
- High- or low-side protection field-effect transistors.

Step No. 2: Identify the ChemID

- To ensure high accuracy of Impedance Track gauges, you must program the correct look-up tables (ChemID).
- TI has a large repository of already characterized cells.
- We recommend following the instructions in our GPCCHEM online tool to identify a close-match ChemID for the cell.
- If there is no match, send the cells to TI for characterization.

Step No. 2: Identify the ChemID

- Identify the ChemID of the battery:
 - Perform a relax-discharge-relax test while logging voltage (V), current (I) and temperature (T) with bqStudio or any other logging tool.
 - Upload results to the GPCCHEM online tool.
 - Program the best ChemID returned on the device using bqStudio.



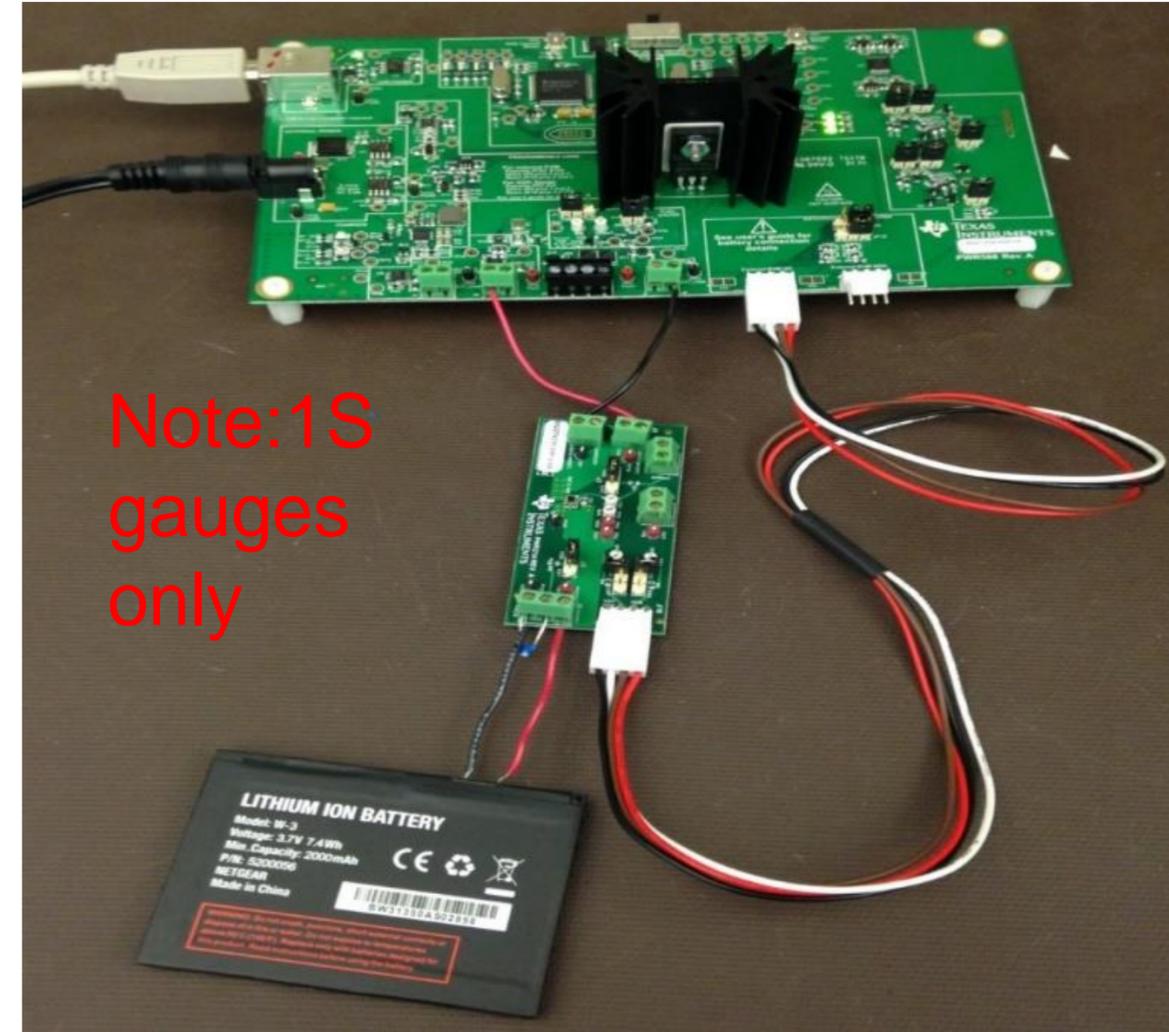
Step No. 2: Identify the ChemID – hardware requirements

- Acquire data files using either one of these systems:
 - A commercial battery cycler such as [Arbin](#) or [Maccor](#), as long as you can satisfy a 1-mV voltage measurement accuracy, a 0.1% current measurement accuracy and a $\pm 1^{\circ}\text{C}$ temperature measurement directly on the cell surface.
 - A power supply or electronic load to perform charging and discharging while logging using any of our calibrated [evaluation modules \(EVM\)](#) plus EV2300 or EV2400, and [bqStudio](#).
 - A power supply or electronic load, logging software as LabView or Python.
 - TI's gauge development kit (GDK).

Step No. 2: Identify the ChemID – hardware requirements (GDK)

Features

- Automated cycling for 1-series cells with customizable profiles:
 - Pulsed loads.
 - Constant current/power loads.
- Programmable load.
- Programmable charger.
- Onboard fuel gauge (bq27421-G1A).
- External EVM connection to evaluate other I²C-compatible single-cell fuel gauges.
- Data logging for evaluation of cycling.



Step 2: Identify the ChemID – software requirements (bqStudio)

- bqStudio enables the logging of V, I and T using a TI gauge EVM.

The screenshot displays the bqStudio software interface. On the left, a dashboard shows a USB icon for 'EV2300 Version:3.1m', an SMB icon with a green double arrow, a bq40z50 chip icon with '4500_0_12 Addr: 0x17 23.0 degC', a battery icon showing '11686 mV 64%', and a gauge icon. The main area is divided into 'Registers' and 'Bit Registers' sections. The 'Registers' section contains two tables of battery parameters. The 'Bit Registers' section contains a table of bit-level status flags.

Name	Value	Units	Log	Scan
Manufacturer Access	0x6100	hex	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Remaining Cap. Alarm	300	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Remaining Time Alarm	10	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
At Rate	0	mA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
At Rate Time To Full	65535	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
At Rate Time To Empty	65535	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
At Rate OK	1	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Voltage	11681	mV	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Current	3	mA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Average Current	0	mA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Max Error	100	%	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Relative State of Charge	64	%	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Absolute State of Charge	57	%	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Remaining Capacity	2475	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Full charge Capacity	3893	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Run time To Empty	65535	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Average Time to Empty	65535	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Name	Value	Units	Log	Scan
Cell 4 Current	0	mA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 2 Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 3 Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 4 Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Average Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Int Temperature	20.3	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TS1 Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TS2 Temperature	22.8	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TS3 Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TS4 Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
FET Temperature	22.8	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Fit Rem Q	2475	mAH	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Fit Rem E	2663	cWH	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Fit Full Chg Q	3893	mAH	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Fit Full Chg E	4317	cWH	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Name	Value	Units	Log	Scan
PackGrid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 Grid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 2 Grid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 3 Grid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 4 Grid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
StateTime	21	s	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 DOD0	6848	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 2 DOD0	6768	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 3 DOD0	6496	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 4 DOD0	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOD0 Passed Q	0	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOD0 Passed E	0	cWh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOD0 Time	0	h/16	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 DODEOC	1216	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 2 DODEOC	1216	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 3 DODEOC	1216	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 4 DODEOC	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 QMax	4400	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Name	Value	Log	Scan	Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Battery Mode	0x6081	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	CapM	ChgM	AM	RSVD	RSVD	RSVD	PB	CC	CF	RSVD	RSVD	RSVD	RSVD	RSVD	PBS	ICC
Battery Status	0x48C0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	OCA	TCA	RSVD	OTA	TDA	RSVD	RCA	RTA	INIT	DSG	FC	FD	EC3	EC2	EC1	ECO
Operation Status A	0x6100	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	SLEEP	XCHG	XDSG	PF	SS	SDV	SEC1	SEC0	BTP_INT	RSVD	FUSE	RSVD	PCHG	CHG	DSG	PRES
Operation Status B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	EMSHUT	CB	SLPCC	SLPAD	SMBLCL	INIT	SLEEPM	XL	CAL_O...	CAL	AUTO...	AUTH	LED	SDM
Temp Range	0x08	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	OT	HT	STH	RT	STL	LT	UT
Charging Status	0x0004	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	CCC	CVR	VCT	MCHG	SU	IN	HV	MV	LV	PV
Gauging Status	0xD0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	CF	DSG	EDV	BAL_EN	TC	TD	FC	FD
IT Status	0x0004	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	OCVFR	LDMD	RX	QMAX	VDQ	NSFM	RSVD	SLPQMAX	QEN	VOK	RDIS	RSVD	REST
Manufacturing Status	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	CAL_EN	LT_TEST	RSVD	RSVD	RSVD	RSVD	LED_EN	FUSE_EN	BRR_EN	PF_EN	LF_EN	FET_EN	GAUGE...	DSG_T...	CHG_T...	PCHG...
Safety Alert A+B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	CUVC	OTD	OTC	ASCDL	RSVD	ASCCL	ASCC	AOLDL	RSVD	OCD2	OCD1	OCC2	OCC1	COV	CUV
Safety Status A+B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	CUVC	OTD	OTC	ASCDL	ASCD	ASCCL	ASCC	AOLDL	AOLD	OCD2	OCD1	OCC2	OCC1	COV	CUV
Safety Alert C+D	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	UTD	UTC	PCHGC	CHGV	CHGC	OC	CTOS	RSVD	PTOS	RSVD	RSVD	OTF
Safety Status C+D	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	UTD	UTC	PCHGC	CHGV	CHGC	OC	RSVD	CTO	RSVD	PTO	HWDF	OTF
PF Alert A+B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	VIMA	VIMR	CD	IMP	CB	QIM	SOTF	RSVD	SOT	SOCD	SOCC	SOV	SUV
PF Status A+B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	VIMA	VIMR	CD	IMP	CB	QIM	SOTF	RSVD	SOT	SOCD	SOCC	SOV	SUV
PF Alert C+D	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	TS4	TS3	TS2	TS1	RSVD	RSVD	OPNCELL	RSVD	RSVD	2VL	AFEC	AFER	FUSE	RSVD	DFETF	CFETF
PF Status C+D	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	TS4	TS3	TS2	TS1	RSVD	DFW	OPNCELL	IFC	PTC	2VL	AFEC	AFER	FUSE	RSVD	DFETF	CFETF
LStatus	0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>													FIELD...	ITEN	CF1	CF0

Step No. 2: Identify the ChemID – GPCCHEM

<http://www.ti.com/tool/gaugeparcal>

Gauging Parameter Calculator

(ACTIVE) GAUGEPARCAL



Description & Features



Technical

Description

GPC variants based on gas gauge types and type of optimization

- A. GPC for Compensated End of Discharge Voltage (CEDV) algorithm gas gauges
- B. GPC for Impedance Track (IT) algorithm gas gauges
 - 1. GPC - Find closest chemistry match (chemID selection) Must be done before (2) or (3).
 - 2. GPC -Optimize room temperature performance (calculate Qmax, Ra, and Thermal coefficients).
 - 3. GPC - Optimize room and low temperature performance. Includes (2).

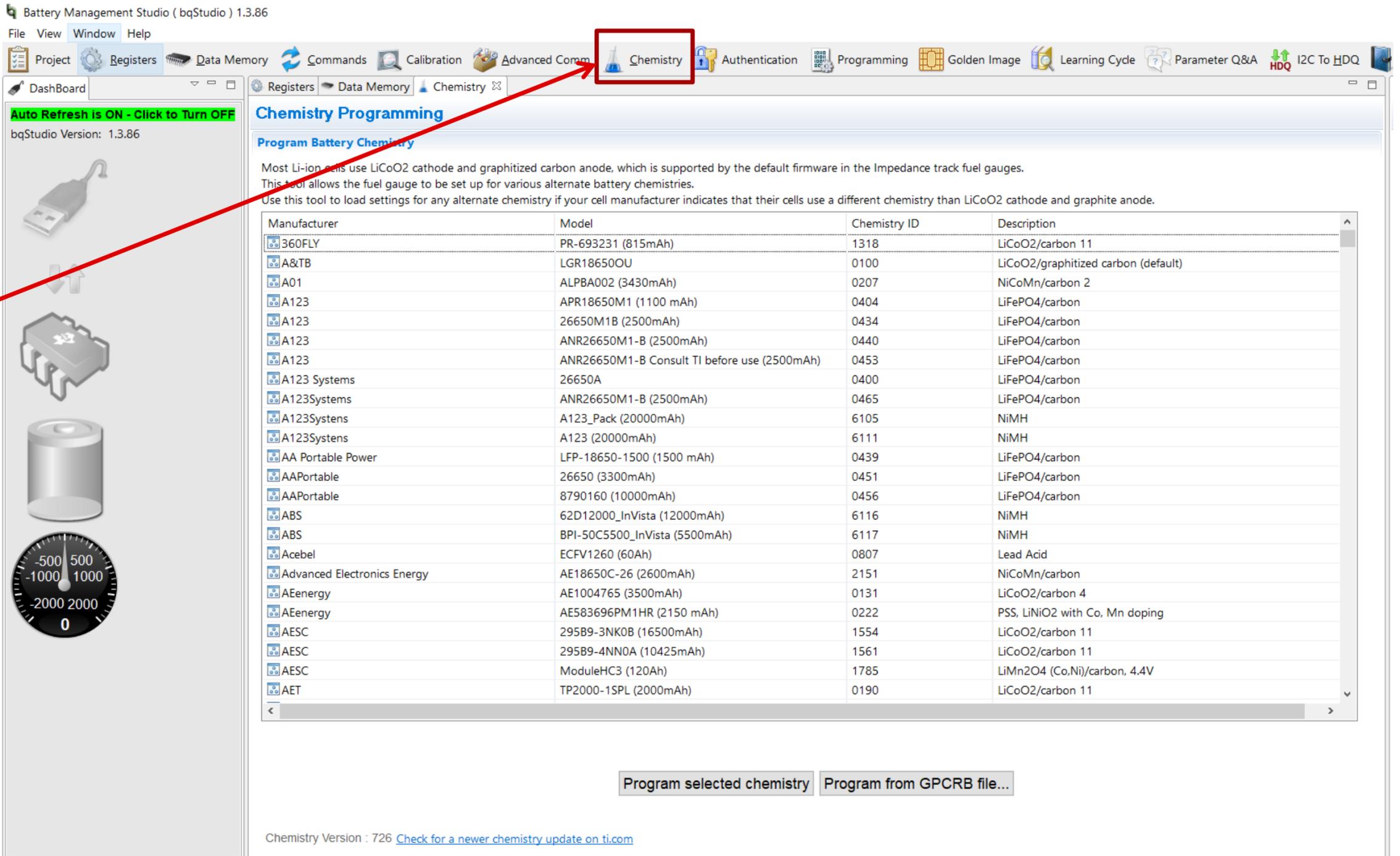
Send
1 room temperature C/10 relaxation /
discharge relaxation file
to get **ChemID selection** by e-mail

Step No. 2: Identify the ChemID – GPCCHEM

- Instruction manual: <http://www.ti.com/lit/an/slva725/slva725.pdf>.
- Files needed:
 - Configuration setup file → config.txt.
 - Cell data file → roomtemp_rel_dis_rel.csv.

Step No. 3: Program the ChemID and configure the gauge

Programming the ChemID can occur within bqStudio because it contains proprietary data.



Battery Management Studio (bqStudio) 1.3.86

File View Window Help

Project Registers Data Memory Commands Calibration Advanced Comm Chemistry Authentication Programming Golden Image Learning Cycle Parameter Q&A HDQ I2C To HDQ

Dashboard

Auto Refresh is ON - Click to Turn OFF
bqStudio Version: 1.3.86

Chemistry Programming

Program Battery Chemistry

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.

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 use (2500mAh)	0453	LiFePO4/carbon
A123 Systems	26650A	0400	LiFePO4/carbon
A123Systems	ANR26650M1-B (2500mAh)	0465	LiFePO4/carbon
A123Systems	A123_Pack (20000mAh)	6105	NiMH
A123Systems	A123 (20000mAh)	6111	NiMH
AA Portable Power	LFP-18650-1500 (1500 mAh)	0439	LiFePO4/carbon
AAPortable	26650 (3300mAh)	0451	LiFePO4/carbon
AAPortable	8790160 (10000mAh)	0456	LiFePO4/carbon
ABS	62D12000_InVista (12000mAh)	6116	NiMH
ABS	BPI-50C5500_InVista (5500mAh)	6117	NiMH
Acebel	ECFV1260 (60Ah)	0807	Lead Acid
Advanced Electronics Energy	AE18650C-26 (2600mAh)	2151	NiCoMn/carbon
AEEnergy	AE1004765 (3500mAh)	0131	LiCoO2/carbon 4
AEEnergy	AE583696PM1HR (2150 mAh)	0222	PSS, LiNiO2 with Co, Mn doping
AESC	295B9-3NK0B (16500mAh)	1554	LiCoO2/carbon 11
AESC	295B9-4NN0A (10425mAh)	1561	LiCoO2/carbon 11
AESC	ModuleHC3 (120Ah)	1785	LiMn2O4 (Co,Ni)/carbon, 4.4V
AET	TP2000-1SPL (2000mAh)	0190	LiCoO2/carbon 11

Program selected chemistry Program from GPCR file...

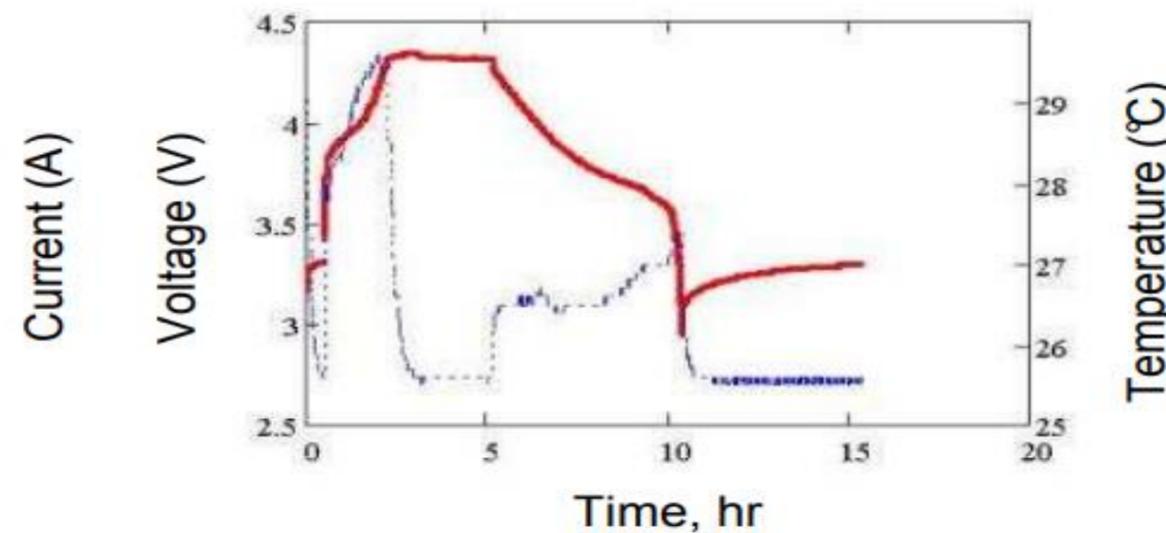
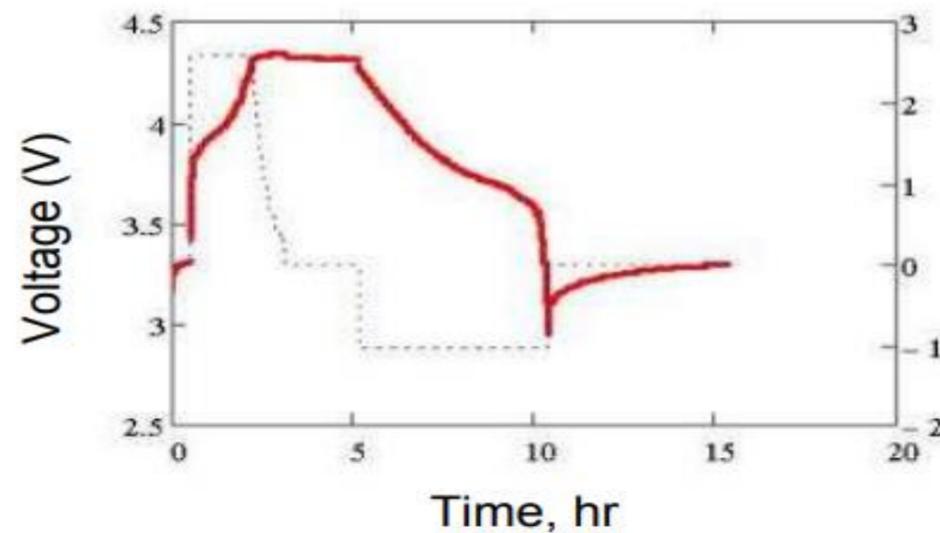
Chemistry Version : 726 [Check for a newer chemistry update on ti.com](#)

Step No. 3: Program the ChemID and configure the gauge

- Configure the data flash. At minimum, configure the:
 - Taper current: use values between C/10 and C/20.
 - Discharge current threshold: should be less than the taper current.
 - Charge current threshold: should be less than the taper current.
 - Quit current: determines the gauge's relaxation state. This value should be less than Dsg and Chg current thresholds and typically less than or equal to C/20.
 - Design capacity: the rated nominal capacity of the cell.
 - Design voltage: the rated nominal voltage of the cell.
 - Charge voltage for the different temperature levels.
 - Terminate voltage: the minimum voltage stated in the cell data sheet to which the cell can be discharged.

Step No. 4: Optimize the gauge for low-temperature performance

- Optimize for low-temperature performance using the EVM and GDK (or your own setup for multicell):
 - Run a charge-relax-discharge profile at room temperature while logging using bqStudio.
 - Run a charge-relax-discharge profile at the lowest temperature at which the application is expected to function.
 - Extract a gg file with the default ChemID values (simply program the ChemID and extract a gg file).
 - Submit the room-temperature log file, a cold-temperature log file, a gg file and a config.txt file to the GPCRB online tool.
 - You will receive a gpcreport via email. Program the returned chemdat12 and gg file using bqStudio.



Step No. 4: Optimize the gauge for low-temperature performance (GPCRB)

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 - 3. GPC - Optimize room and low temperature performance. Includes (2).

Send
room temperature and low
temperature application rate relax /
discharge /relax files with original
GG file to get **learned GG** and
optimized Rb chemdat by e-mail

Step No. 4: Optimize the gauge for low-temperature performance (GPCRB)

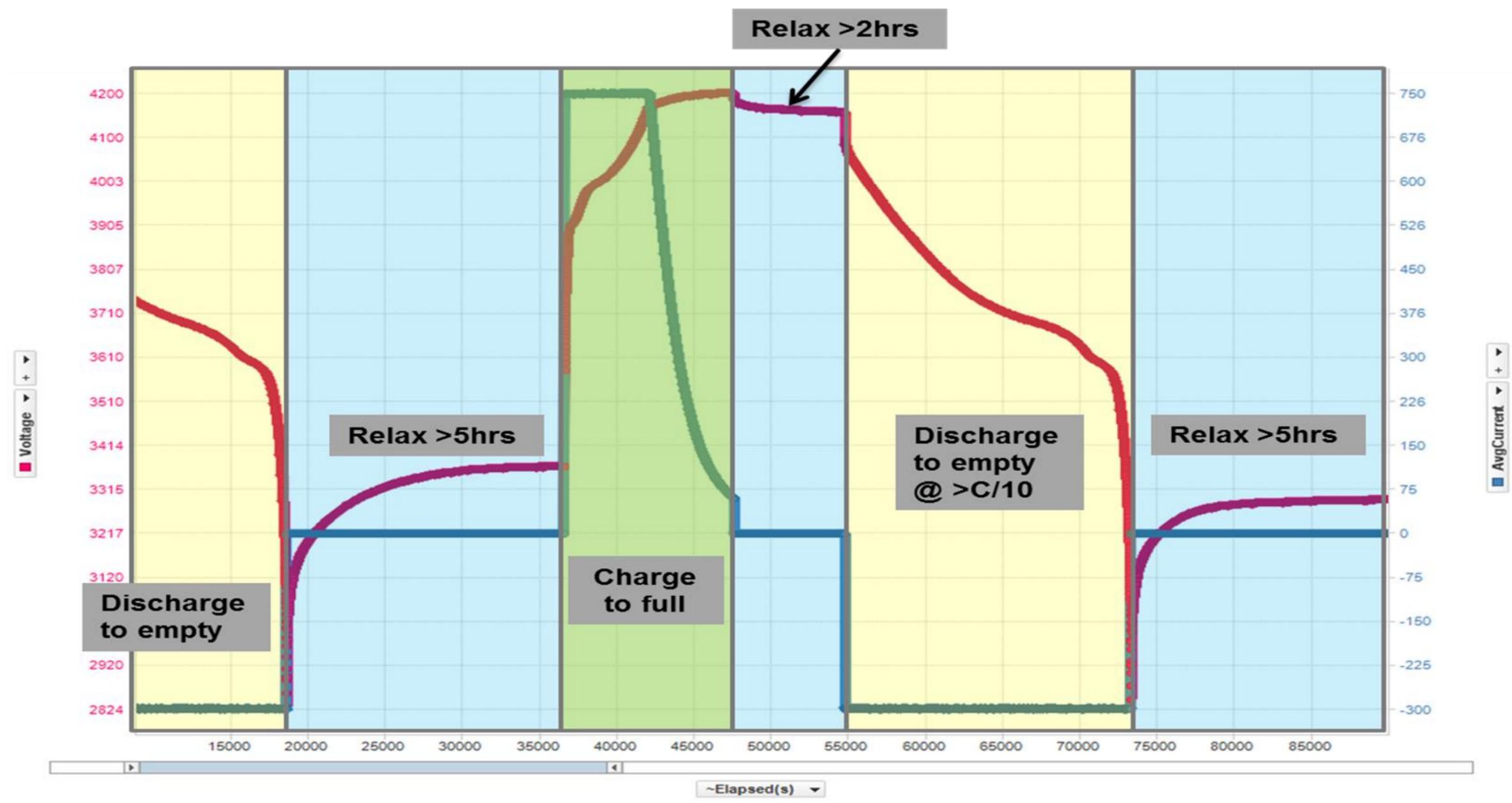
- Instruction manual: <http://www.ti.com/lit/ug/sluubd0/sluubd0.pdf>.
- Files needed:
 - config.txt.
 - gg.csv.
- Data files:
 - roomtemp.csv.
 - lowtemp.csv.

Step No. 5: Perform a learning cycle

- Cell-to-cell capacity variation can be as much 5%.
- Resistance variation exists among cells of the same type from the same manufacturer.
- A matched ChemID could have a vastly different capacity than the cell being used.
GPCCHEM checks for the similarity of the OCV profile.
- The points mentioned above create the need to perform a learning cycle so that the gauge learns the Qmax and resistance tables of the cell.
- The learning cycle involves enabling the algorithm, and then running a discharge-rest-charge-rest-discharge-rest profile.

Step No. 5: Perform a learning cycle

Graphical representation of the learning cycle



Step No. 5: Perform a learning cycle

- Issue an Impedance Track enable command (0x21). Then issue a reset command (0x41).
- Discharge to empty (terminate voltage) using a constant-current value between C/5 and C/10.
- Rest for 5 hours.
- Charge the battery to full (charge voltage specified in DS of cell) and make sure to taper to a value below the taper current programmed in data flash.
- Rest for 2 hours (Qmax should update at this point). Update status will go from 04 to 05 for pack-side gauges, while for system-side gauges it will go from 00 to 01.
- Discharge to empty using the same discharge rate as before.
- Rest for 5 hours.
- At the end of discharge, update status will change to 06 for pack-side gauges and 02 for system-side gauges.

Step No. 6: Extract a golden file

- On pack-side gauges, change update status to 02. This indicates that Qmax and Ra are learned and lifetime data collection is disabled.
- Change the cycle count to 00.
- Extract a golden file with bqStudio, which could be srec, bqfs or dffs.
 - Most devices support flashstream (bqfs, dffs) formats. Write code to parse the flashstream files to the gauge. A bqfs file contains instructions and dataflash. A dffs file contains just data flash. Use dffs if the programming device has the same firmware.
 - An srec is a standard Motorola file format and contains the instruction flash and data flash. Write code to program the srec on the gauge.

Step No. 7: Calibrate 20 units

- If high-measurement accuracy is not required, calibrate the V, I and T measurement of 20 units.
- Take the averaged calibrated parameters and program on a gauge programmed with the golden file.
- Extract a new golden image. This will be the new image that will be programmed on multiple units.
- If high-measurement accuracy is required, then each board requires calibration after programming the golden file.

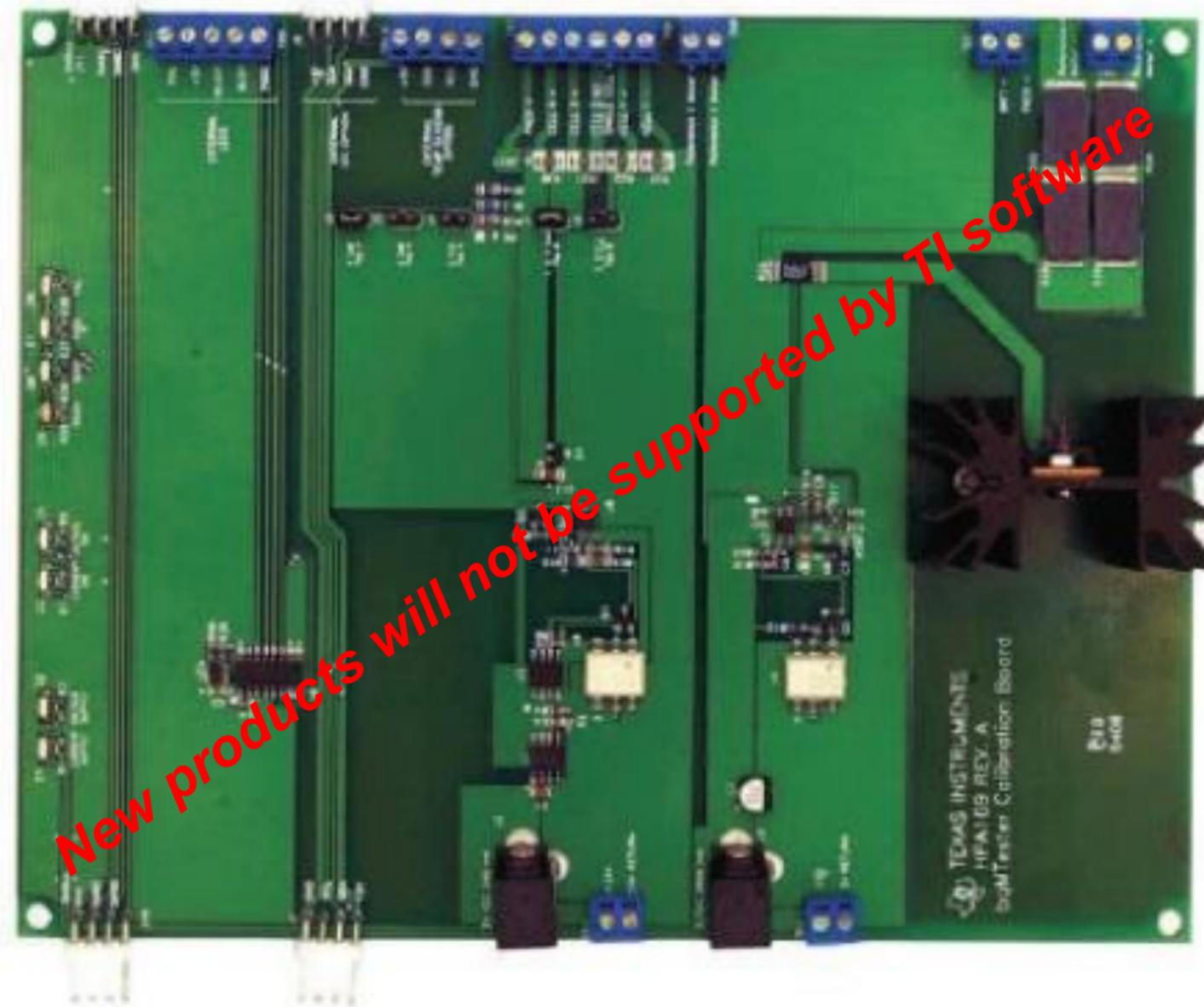
Name	Private	Value	Unit
▲ Voltage			
Cell Gain			-
Pack Gain			-
BAT Gain			-
▲ Current			
CC Gain			mOhm
Capacity Gain			mOhm
▲ Current Offset			
CC Offset			-
Coulomb Counter Offset Samples			-
Board Offset			-
Max CC Auto Offset	Private		-
CC Auto Config			hex
CC Auto Offset			-
▲ Temperature			
Internal Temp Offset			°C
External1 Temp Offset			°C
External2 Temp Offset			°C
External3 Temp Offset			°C
External4 Temp Offset			°C
▲ Internal Temp Model			
Int Gain			-
Int base offset			-

Step No. 8: Mass production – multicell production tools hardware – Advanced BqMTester

- Most customers design their own hardware for mass production (**recommended**).
- TI developed Advanced bqMTester hardware for programming multiple boards.
- TI provides Advanced bqMTester and bqProduction software (**no new product support**).

Advanced BqMTester features:

- Programs and calibrates multicell smart battery modules based on these devices: bq306x and bq28xxx, bq40xx, and Impedance Track devices bq20z4x, bq20z6x, bq20z7x, bq20z80, bq20z9x, bq28zxx and bq40zxx.
- Calibrates Coulomb counter offset, voltage, temperature and current.
- Programs serial number, date and pack lot code.
- Works with bqMTester software and bqProduction.
- No support for new features or new TI devices.



Step No. 8: Mass production – multicell production tools hardware – EV2300

- bqProduction and Advanced bqMTester require the EV2300.
- The EV2300 is obsolete.
- [MKST-3P-ALT-EV2300](https://www.ti.com/tool/MKST-3P-ALT-EV2300) is an EV2300 alternative.
 - Available from third party.
 - Requires additional downloading of software updates from third party.
- Production solutions also available from third parties.

<https://www.ti.com/tool/MKST-3P-ALT-EV2300>



MKST-3P-ALT-EV2300

MKS Technology alternative for EV2300 communications transceiver

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Overview

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This solution, available from MKS Technology, is an alternative for the EV2300 communications transceiver. The solution from MKS Technology has been validated and works with both the BQMTESTER and ADVANCED-BQMTESTER. It has been validated and works with bq Evaluation software ([bqEVS](#)). Using the MKS Technology transceiver, you can communicate from a PC USB port to I2C, SMBus and HDQ products.



Photos courtesy of MKS Technology Inc

Step No. 8: Mass production – multicell production tools software – bqProduction

- Supports bq28z610 and the bq40zxx family of devices, such as the bq40z60 and bq40z50-r1.
- Works with Advanced bqMTester hardware.
- Control multiple stations from a single graphical user interface.
- Run up to 12 stations in parallel from a single computer.
- Calibration and test automation unique serial number assignment/programming.
- Date of manufacture programming calibration limits filter to detect anomalies.
- Uses industry-standard Motorola srec format golden image programmer.



The screenshot displays the MultiStation Tester software interface. The main window is titled "MultiStation Tester" and includes a "VTI Update" button in the top right corner. The "Test Status" section shows a message box with two entries: "Operation executed successfully." with a "Passed" status. A large "Start Test" button is visible on the right. Below the message box, a statistics table shows: Tested 14, Passed 14, Failed 0, and Passed/Hour 314. The "Test Log" section contains a table with the following data:

Test No.	Station ID	TimeStamp	Serial No.	Error Code
1	Station 1	2014-03-26 13:44:17.324	10	0
2	Station 2	2014-03-26 13:44:18.463	11	0
3	Station 1	2014-03-26 13:44:30.146	12	0
4	Station 2	2014-03-26 13:44:31.222	13	0
5	Station 1	2014-03-26 13:44:40.099	14	0
6	Station 2	2014-03-26 13:44:41.018	15	0
7	Station 1	2014-03-26 13:44:50.613	16	0
8	Station 2	2014-03-26 13:44:51.595	17	0
9	Station 1	2014-03-26 13:45:12.109	18	0
10	Station 2	2014-03-26 13:45:12.904	19	0
11	Station 1	2014-03-26 13:45:21.124	20	0
12	Station 2	2014-03-26 13:45:22.107	21	0
13	Station 1	2014-03-26 13:45:30.842	22	0
14	Station 2	2014-03-26 13:45:31.717	23	0

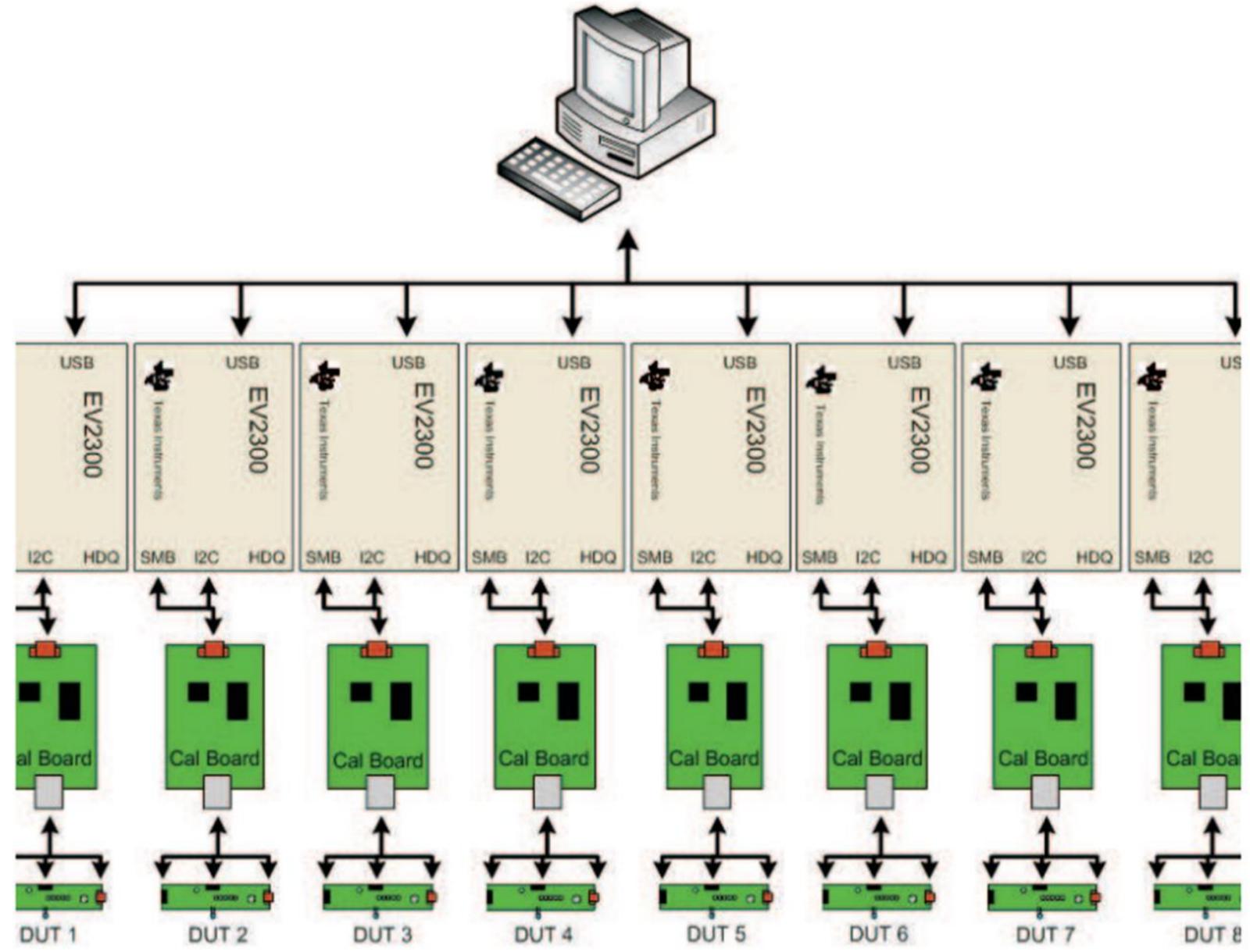
Step No. 8: Mass production – multicell production tools software – Advanced bqMTester

- Supports the bq20zxx, bq30xx and bq30zxx family of devices such as the bq20Z40-R1, bq20Z45-R1, bq3060 and bq30Z554-R1.
- Works with Advanced bqMTester hardware.
- Control multiple stations from a single graphical user interface.
- Run up to 12 stations in parallel from a single computer.
- Calibrates Coulomb counter offset, voltage, temperature and current.
- Programs serial number, date, pack lot code, other defaults obtained from a golden image file.
- Preserves calibration records with its data logging feature.



Step No. 8: Mass production – multicell setup

- bqProduction, bqMTester, and EV2300 can be set up as shown to program multiple units – a maximum of 12 at once.



Conclusion

Conclusion

- **The steps for designing and going to production with an Impedance Track gauge are:**
 - Identify product requirements and select Impedance Track gauge.
 - Identify the ChemID for your cells using the GPCCHEM online tool.
 - Program the ChemID and configure the data flash parameters based on your application.
 - Optimize the gauge for low-temperature performance using GPCRB.
 - Perform a learning cycle.
 - Extract the golden file.
 - Calibrate 20 units; modify the calibration section of the golden file using the averaged calibrated values. Extract a new golden file, **or** –
 - Program each unit with the golden file and calibrate each unit.
 - Use either the srec, bqfs or dffs, through the host or a separate setup, to program each unit.
 - Customers can continue using bqProduction and Advanced bqMTester for mass production with existing production setups, but TI no longer supports customer production tools (evaluation tools only).

Thank you

Questions?



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