# User's Guide BQ28Z620EVM 1- to 2-Series Li-Ion Battery Pack Manager Evaluation Module



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# 1 BQ28Z620EVM 1- to 2-Series Li-Ion Battery Pack Manager Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the BQ28Z620 and BQ294502 battery management system. The EVM includes one BQ28Z620 and BQ294502 circuit module and a link to Windows<sup>®</sup> based PC software. The circuit module includes one BQ28Z620 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-lon or Li-Polymer battery packs. The circuit module connects directly across the cells in a battery. With the EV2400 interface board and software, the user can read the BQ28Z620 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 I2C communication protocol.

## 1.1 Features

- Complete evaluation system for the BQ28Z620EVM 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

#### 1.1.1 Kit Contents

- BQ28Z620 circuit module
- Cable to connect the EVM to an EV2400 Communications Interface adapter

## 1.1.2 Ordering Information

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

#### Table 1-1. Ordering Information

EVM PART NUMBER	CHEMISTRY	CONFIGURATION	MAX CAPACITY
BQ28Z620EVM	Li-Ion	1-, 2-cell	32,000 mAh

#### 1.1.3 Documentation

For information on the BQ28Z620 and BQ294502 device firmware and hardware, see the following documentation:

- BQ28Z620 Impedance Track™ Gas Gauge and Protection Solution for 1-Series to 2-Series Cell Li-Ion Battery Packs (SLUSET3)
- BQ28Z620 Technical Reference Manual (SLUUCO9)
- BQ2945xx Overvoltage Protection For 2-Series and 3-Series Cell Li-Ion Batteries (SLUSAJ3)
- BQ294502 EVM User's Guide (SLUU659)

#### 1.1.4 BQ28Z620 and BQ294502 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the BQ28Z620 EVM.

#### Table 1-2. 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



## 1.2 BQ28Z620EVM 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.

## 1.2.1 Items Needed for EVM Setup and Evaluation

- BQ28Z620 circuit module
- EV2400 communications interface adapter
- · Cable to connect the EVM to an EV2400 communications interface adapter
- USB cable to connect the communications interface adapter to the computer
- Computer setup with Windows® X, 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)

#### 1.2.2 Software Installation

Find the latest software version in the BQ28Z620 tool folder on www.ti.com. Use the following steps to install the BQ28Z620 Battery Management Studio software:

 Download and run the Battery Management Studio setup program from the Development Tools section of the BQ28Z620EVM product folder on www.ti.com. See Section 1.3 for detailed information on using the tools in the Battery Management Studio.

## **1.2.3 EVM Connections Module Connections**

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





• 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	J2 Terminal Block Connections						
of Cells	1N		1P		2P		
1	$\ominus$	-cell1+	$\ominus$	short	$\ominus$		
2	$\ominus$	-cell1+	$\ominus$	–cell2+	$\ominus$		

Figure 1-2. 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  $2 \times 3.6 = 7.2$  V.

• I2C<sup>™</sup> (SDA, SCL)

Attach the communications interface adapter cable to J3 and to the I2C<sup>™</sup> port on the EV2400.

Note

The EV2400 has internal pull-up resistors, P2 and P3 jumpers can be left floating.

· 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 BQ28Z620 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 by clearing the CCO flag for 1-series configuration or setting it for 2-series 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 *BQ28Z620 Technical Reference Manual* for help with setting the parameters.



# 1.3 Battery Management Studio

## 1.3.1 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 1-3. 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 1-4, select any BQ28Z620 variants. 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.

DeshBoard	~	Registers 20																					Cor	mmands 🖂	-
Auto Refresh is ON -Click	to Turn OFF	Registers																		Sta	TLos .	Scan Refres	Con	nmands	
bqStudio Version: 1.3.101		Burkton																				Seatt menta		DEVICE NUMBER	
Δ		nejoteis																						# HW VERSION	
	EV2400	Name		Value	Units.	pg	Scan A	Name			Valu	e Va	ts Loc	o Scan	^ N	ате			Value	Units	Log	Scan A		FW VERSION	
100	Version:0.25	Vanufacturer Access		0x0002	hex.	R	2	BAT pr	votage		3806	i n'	V R	N N	10	PackGrid			Đ	-	R	R			
~		ALRate		0	mA	P	2	H RACK #	in votage		3864	. n	v 🛛	R I	1	Cell 1 Grid			0		P.			FW_BUILD	
-		At Rate Time To Empty		65536	-	F	R	Gel 1 C	trent		65	m	A P	P	E	Cell 2 Grid			D		4	R		CHEM_ID	
		Temperature		23.5	degC	R	2	E Cell 2 C	tearru		54		4 🕅	R		StateTime			27		R	2		a composition	
	12C	Votage		3805	W	R.	ž	Cell 1 P	ower		25	cl	V R	N N	10	Cel 1000	0		9920	-	2	2		- SHUTUOWIN	
		Current		101	104	G		Cell 2 P	ower		0	ci			1	Cel 2 DOD	0		16384		M			CC_OFFSET	
~		Average Correct		81	-	F	2	in Person	orstore.		20.5	i de	c 🛛	R	18	10000 Pas	and F			citta	R	2		CHG FFT TOGGLE	
6 3	ha39+63094	Average Power		30	cW	P.	2	TS1 Te	perature		23.5	de	C 12	P	1	DOD0 Time			0	1/16	P				
	2620_1_00	BTP Dag Set		-1	mAt .	1	2	Li Cell Ter	perature		23.5	de	C P	R I	1	Cel 1 DOD	COC		1216		F	R		DSG_FET_TOGGLE	
Vo V	Addr: 0xAA	BTP Chg Set		-1	mAt	R	₽	E TE Rem	D		a	172	H R	4	16	Cel 2 DOD	eoc		1216		R	₽		CAUGE EN	
YN	23.5 degC	Relative State of Charge		0	5	R	2	E Ft Arm	E		0	si	H R	R		Cell 1 GVa	DK.		4400	mAt	R	2		-	
4		Remaining Capacity		0	nAh	E .	~	FEFUE	thg Q		2338	8 m	H K	N N		Cell 2 QMa	DK.		4400	nAt	N C			FEI_EN	
-		Full charge Capacity		2376	mAx.	-		IN PEPUL	thg E		1774	CH CH			1	Cell 1 QVa	oc DCCO		0		P I			✓ LIFETIME_EN	
		Austrage Time to Empty		1763	-	2	2	E Too B	nu ni							Other Dies	and O			-	12	2		A IT RESET	
		Standby Current		0	mA	P	2	II Interio			2336	1 104	h 🖻	N N	14	QNax Time			0	n/16	E.			- constraint	
3800 mV		Standby Time to Empty		65536	min	F	2	III intal C			1774	E 1	m 🖗	R I	1	Temp k			1.0		F			<ul> <li>LT_FLUSH</li> </ul>	
1%		III Max Load Current		-500	TPA .	F	R v	Trie Pa	Che D		2338	5. TP	h 🖗	P		Term a			1022	-	R	P *		PF_EN	
-		Bit Registers																			British	BILLAW REV		PF_CLEAR	
ALL DE LE DE		Nerre	Value	Log	Log Fields	Sca	1 Bit	5 B814	B#13	Bit12	Bit11	Bit10	889	Bits	Bit7	Bits	Bit5	B164	B#3	B#2	Bitt	Beb		* CAL TOGGLE	
		Battery Status	Dx3050	R	C	R	00	A TCA	RSVD	alla.	184	451/0	ACA.	Rta.	BUT	115/51	HC .	193	BC3	EC2	EC1	EC0		# RESET	
1000 1000		Dperaton Status A	0x6D00	8	5	2	SLE	EP XICHG	Dedix	PF	55	SOV	5801	SECU	RSVD	RSVD	RSVD	RSVD	RSVD	CHG	DSQ	RSVD		· · · · · · · · · · · · · · · · · · ·	
-1500 1500		Deratan Status B	0x2000	P	5	2	RS	D ASVD	ENSHUT	08	SLPCC	SLPAD	SMOL	NT	SLEEPM	XL	a.	CAL	4070	AUTH	RGVD	SOM		* SMOOTH_SYNC	
2000 2000		Temp Range	8290	P.	-		Ban	D RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVG	CT.	-HT	STH	181	571	IT	and the second second		MEC ENABLE A	
76		Gausia Status	04466	P	-	P	I HOA	NH HOVE	HOAN.	HOVE	NO AP.	POVE	North Contraction	Rayo	100	060	ETM.	BL Ph	70	70	20	FD			
-		E T Status	0x1004	F	E	F	RS	D RSVD	ROVD	OCVER	LDND	ax.	ONAX	V50	NOTE	RS\/D	SLPO.	QEN	VOK	ans	85VD	REST		MFC_ENABLE_B	
		Wanufacturing Status	0x8600	F	C	R	CAL	IN REVE	RSVD	RSVD	RSVD	RSVD	RSMD	RSMO	RSVD	27,25	LP EN	TET BA	GAUG	056	CHG	R3V0	LogP	Panel	Charles
		Safety Alert A+B	Dx3000	R	<b>C</b>	R	RS	/B RSVD	016	010	RSVB	RSVD	REND	RSVD	RSVD	REVD	RSVD	0(1)	HSVD	000	C0V	DUN-			Clear LD
		Safety Status A+B	0x0001	6	F	P	RS	D RSVD	OTD	OTC	RSVD	ABCD	RSVD	ASOC	RSVD	AOLD	RSVD	000	RSVD	000	COV	CUV	Tran	naction Log	
		Safety Alert C+D	0x2000	P	E	P	RS	D BSVD	RSVD	REVD	UTD	UTC	RSVD	RSVD	RSVD	RSVD	CTOS	RSVD	PTOIS	RGVD	RSVD	REVE	Nar	me Cmd Result	Read A
		Safety Status C+D	Dx3000	P	5	F	RST	/D 857/D	RSVD	RSVD	UTD .	UTC.	RSVD	RSVD	RSVD	RSVIL	RSVII	CTO	RSVD	PTCI	REVE	RSVD			
		III PF Altri A+8	0x0000	M	-	M	RST	ASVD	RSVD	VMA	VIN	REVO	RSMD	R5VD	RSVD	RSVD	RSVD	REVE	REVO	RSVD	SCV	5.V			
		H PF Status A+B	0000000	6	-		HSI	D HSVD	HOLVD:	PC-A	VINK	001/0	NOVU .	10/00	MSVU	MSVU	HEVU	HSVD	HSVU	RSVD	BUY	DUV CONTR			
		E of Status Call	0x1000	F	-	P	P40	m psym	Provide Provid	E-SVD	25105	CIPIN .	25541	Pr.	255/0	RSID	RSSM	HSMD.	R-SVD_	ESMI	THE TH	CERTE			
		TE L Status	0	F	Ē	R	0.000	Carlo Carlos And	C LOANS	- Contraction			- Harrison		C. State of Contraction of Contracti	- House		-	FE 0	TEN	UF1	CEO			
		B PF Status C+D B LStatus	0 0	1 1	Ē	Dr. Dr.	RS	ND RSVD	RSVD	RSVD	RSND	DFW	RSVD	10	RSVD	RSVD	RSVD	RSVD	RSVD FELD	REVE	CF1	CFO			

Figure 1-3. Registers Screen



a Target Selection Wizard	_		×
Battery Management Studio (bqStudio) Supported Targets			
Please select a target			
1100_0_06-bq78z100.bqz 1561_0_04-bq27z561.bqz 1561_1_03-bq27z561R1.bqz 1561_2_01-bq27z561R2.bqz 1750_0_05-bq78350.bqz 1E9B_0_05-bq78350.bqz 1E9B_0_06-bq78350_R1.bqz 1E9B_1_03-bq78350_R1.bqz 1E9B_1_04-bq78350_R1.bqz 1E9B_2_02-bq78350R2.bqz 2610_0_11-bq28z610.bqz 2610_0_20-bq28z610.bqz 2610_2_00-bq28z610R2.bqz 2620_1_00-bq28z620R1.bqz 4500_1_06-bq40z50R1.bqz 4500_1_06-bq40z50R1.bqz 4500_2_06-bq40z50R2.bqz 4500_2_06-bq40z50R2.bqz			
Auto Detected Device : None			
Advance Address Scanning			
Default $\checkmark$ Select the SMBus target address to use for the remainder of this session ?			
If the type of device is not in the list above, you may download the latest version of bqStudio at <u>http://www</u> (new versions add support for newer devices)	v.ti.com/	/tool/bqs	tudio.
< Back Next > Finish		Cance	

Figure 1-4. Battery Management Studio Supported Targets

#### 1.3.2 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. Please see Register Screen for green and red flags reference.

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.

## 1.3.3 Data Memory Screen

The BQ28Z620 data flash comes configured per the default settings detailed in the BQ28Z620 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 Data Memory Screen 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<sup>®</sup> 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.

	-							
Memory					Filter/Search Auto	Export Hex Dump	Export Import	♥ Write_All Re
Vrite Data Memory Cont	ents							
Calibration	Name	Value	Unit	Physical Start Addr	Data Length	Row Number	Row Offset	Native Units
	<ul> <li>Current Thresholds</li> </ul>							
Settings	Dsg Current Threshold	100	mA	0x46a1	2	53	1	mA
Protections	Chg Current Threshold	50	mA	0x46a3	2	53	3	mA
Trotectiona	Quit Current	10	mA	0x46a5	2	53	5	mA
Permanent Fail	Dsg Relax Time	1	S	0x46a7	1	53	7	S
	Chg Relax Time	60	s	0x46a8	1	53	8	s
anced Charge Algorithm	✓ Standby							
	StandbyCurrent	-10	mA	0x4618	2	48	24	mA
Gas Gauging	✓ Max Load							
Power	Max Load Current	-500	mA	0x461a	2	48	26	mA
101101	Max Load Rsoc	50	%	0x461c	1	48	28	%
PF Status	✓ Design							
	Design Capacity mAh	4400	mAh	0x4625	2	49	5	mAh
System Data	Design Capacity cWh	6336	cWh	0x4627	2	49	7	cWh
	Design Voltage	7200	mV	0x4629	2	49	9	mV
I2C Configuration	✓ Cycle							
Lifetimen	Cycle Count Percentage	90	%	0x462b	1	49	11	%
Enclines	¥ FD							
Ra Table	Set Voltage Threshold	3000	mV	0x4630	2	49	16	mV
	Clear Voltage Threshold	3100	m\/	0x4632	2	49	18	mV
	Set % PSOC Threshold	0	96	0x4634	1	49	20	96
	Clear % RSOC Threshold	5	%	0x4635	1	49	20	%
		5	70	0,4000		43	21	76
	Sat Valtage Threshold	4200	m)/	0×4626	2	40	22	m)/
	Clear Vellage Threshold	4200	m\/	0x4030	2	49	22	mV
	Cited Voltage Threshold	4100	iiiv	0x4030	2	49	24	IIIV
	Set % RSUC Threshold	100	76	0x4638	1	49	20	76
	Clear % RSUC Inreshold	95	%	0X4630	1	49	2/	%
				0.100				
	Set Voltage Inreshold	3200	mv	0x463C	2	49	28	mv
	Clear Voltage Threshold	3300	mV	0x463e	2	49	30	mV
	Set % RSOC Threshold	6	%	0x4640	1	50	0	%
	Clear % RSOC Threshold	8	%	0x4641	1	50	1	%
	✓ TC							
	Set Voltage Threshold	4200	mV	0x4642	2	50	2	mV
	Clear Voltage Threshold	4100	mV	0x4644	2	50	4	mV
	Set % RSOC Threshold	100	%	0x4646	1	50	6	%
	Clear % RSOC Threshold	95	%	0x4647	1	50	7	%
	✓ State							
	Cycle Count	0	-	0x4240	2	18	0	-
	SOH Temp k	1.00	°C/256mW	0x4723	2	57	3	0.1 °C/256
	SOH Temp a	1000	S	0x4725	2	57	5	S
	Qmax Cell 1	4400	mAh	0x4206	2	16	6	mAh
	Qmax Cell 2	4400	mAh	0x4208	2	16	8	mAh
	Qmax Pack	4400	mAh	0x420a	2	16	10	mAh
	Omax Cycle Count	0	-	0x420c	2	16	12	-

## Figure 1-5. Data Memory Screen

#### Note

To see the Data Memory Screen with Physical Start Address, Data Length, Row Number, Row Offset, and Native Units tabs. Please navigate to Window -> Preferences -> All Global Settings -> Show Advanced Views -> Apply -> OK



#### 1.3.4 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 1-6. 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.

#### Note

For best results, please use a power supply with a 1mV and 1mA accuracy.

l input parameters in the corresponding boxes
Temperature calibration
Sensor Applied temperature Calibrate
Internal deg C
External 1 deg C
Calibrate Gas Gauge
la

#### Figure 1-6. Calibration Screen



## 1.3.4.1 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– (1N) 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

## 1.3.4.2 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.

#### 1.3.4.3 Current Calibration

The Board Offset calibration option is not offered in Battery Management Studio, because it is not required when using the BQ28Z620EVM. 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.



## 1.3.5 Authentication Screen

The BQ28Z620 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.

late, Verify, and (	hange Key for SHA-1 Authentica	tion		
SHA-1 Authentic	tion			
data is displaye	d in hexadecimal with most sig	nificant digit first		
HA-1 Calculator				
Key (128 bits):	0123456789ABCDEFFEDCBA98	76543210		🔐 Show Digest
Challenge:	E3A9AC282BA5F63EDF904EA56	51CCA38EBDF26AE3		
Digest:				
auge Authentica	tion by Host			
Key (128 bits):	0123456789ABCDEFFEDCBA	9876543210	🥜 Load De	efault Key
Challenge:	000000000000000000000000000000000000000	000000000000000	🖓 Generat	e Random Challenge
Expected Digest:			Authen	ticate Gauge
Gauge Digest:				
hange Gauge Au	thentication Key			
	;): 0123456789ABCDEFFEDC	BA9876543210		🦪 Change Key
New Key (128 bit				1
New Key (128 bit Challeng	e: 000000000000000000000000000000000000	000000000000000000000000000000000000000		

## Figure 1-7. Authentication Screen



#### **1.3.6 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 1-8).
- Press Update Chemistry from Database to update the chemistry in the device.

Note

In the bottom of the Chemistry Screen, there is a link for chemistry updater. Make sure the latest Chemistries from our database is being used. Please see this FAQ on how to update the chemistry table.

Remember to use our GPCCHEM tool to match the cell chemistry to one of our database.

gisters 🛄 Calibration 🛓 Chemistry 🛿 🔐	Authentication View 🐲 Advanced Comm			
mistry Programming				
im Battery Chemistry				
Li-ion cells use LiCoO2 cathode and graphitiz	ed carbon anode, which is supported by the default firmware in the Impeda	ance track fuel gauges. This tool	allows the fuel gauge to be set up for various alternate battery chemis	stries. Use this to
settings for any alternate chemistry if your cell	manufacturer indicates that their cells use a different chemistry than LiCou	J2 cathode and graphite anode.		
ufacturer	Model	Chemistry ID	Description	
60FLY	PR-693231 (815mAh)	1318	LiCoO2/carbon 11	
&TB	LGR18650OU	0100	LiCoO2/graphitized carbon (default)	
01	ALPBA002 (3430mAh)	0207	NiCoMn/carbon 2	
123	APR18650M1 (1100 mAh)	0404	LiFePO4/carbon	
123	26650M1B (2500mAh)	0434	LiFePO4/carbon	
123	ANR26650M1-B (2500mAh)	0440	LiFePO4/carbon	
123	ANR26650M1-B Consult TI before use (2500mAh)	0453	LiFePO4/carbon	
123 Systems	26650A	0400	LiFePO4/carbon	
123Systems	ANR26650M1-B (2500mAh)	0465	LiFePO4/carbon	
123Systens	A123_Pack (20000mAh)	6105	NiMH	
123Systens	A123 (20000mAh)	6111	NiMH	
A Portable Power	LFP-18650-1500 (1500 mAh)	0439	LiFePO4/carbon	
APortable	26650 (3300mAh)	0451	LiFePO4/carbon	
APortable	8790160 (10000mAh)	0456	LiFePO4/carbon	
BS	62D12000_InVista (12000mAh)	6116	NiMH	
BS	BPI-50C5500_InVista (5500mAh)	6117	NiMH	
cebel	ECFV1260 (60Ah)	0807	Lead Acid	
dvanced Electronics Energy	AE18650C-26 (2600mAh)	2151	NiCoMn/carbon	
EC	Laminate (2350mAh)	2981	LiMn2O4 (Co,Ni)/carbon, 4.35V	
EC	Laminate (600mAh)	0566	LiMn2O4 (Co.Ni)/carbon, 4.4V	
EC	Laminate (600mAh)	5402	LiMn2O4 (Co,Ni)/carbon, 4.4V	
EC	Laminate (600mAh)	5403	LiMn2O4 (Co,Ni)/carbon, 4.4V	
Eenergy	AE1004765 (3500mAh)	0131	LiCoO2/carbon 4	
Eenergy	AE583696PM1HR (2150 mAh)	0222	PSS, LiNiO2 with Co. Mn doping	
ES	635651G (5400mAh)	5836	LiMn2O4 (Co,Ni)/carbon, 4.35V	
ESC	295B9-3NK0B (16500mAh)	1554	LiCoO2/carbon 11	
ESC	295B9-4NN0A (10425mAh)	1561	LiCoO2/carbon 11	
ESC	ModuleHC3 (120Ah)	1785	LiMn2O4 (Co.Ni)/carbon, 4.4V	
ET	TP2000-1SPL (2000mAh)	0190	LiCoO2/carbon 11	
EVPS	ITR26/70-40E (4000mAh)	4130	LiFePO4/carbon	
GM	INR34600K2 (7500mAh)	0210	NiCoMn/carbon	
SIDLI	3872C8 (5100mAb)	1335	LiCoO2/carbon 11	
	SSTECO (STOOTHAIT)	1333	cicose/ carbon m	

Program Selected Chemistry Program from GPCRB file...

Chemistry Version : 975 Check for a newer chemistry update on ti.com

Figure 1-8. Chemistry Screen



#### 1.3.7 Programming Screen

Press the **Programming** button to select the **Programming** window. This window allows the user to import the device firmware.

#### 1.3.7.1 Programming the Flash Memory

The upper section of the Programming screen is used to initialize the device by loading the default .srec into the flash memory (see Figure 1-9).

- Search for the .srec file using the Browse button.
- Press the **Program** button and wait for the download to complete.
  - The updated version should be displayed on the left dashboard window within 2 minutes after programming has been completed. If not, reboot BQStudio.
  - It is recommended to reboot BQStudio after programming the new firmware.

Registers B Programming 12		- 8
Programming		
Perform Programming		
This plug-in will allow you to program image files to a device. Select Programmable File		
C\th\bq28z620R1_v1_00_build_1.srec	~	Browse
		Program

#### Figure 1-9. Programming Screen

#### 1.3.7.2 Generating The Golden Image

The lower section of the Golden Image Screen is used to export all of the flash memory from the device (see Figure 1-10).

- Press the **Browse** button to navigate to where the flash file will be saved.
- Press the Open Directory to rename the flash memory file.
- In the Output Formats sub-tab, check the desired types of flash files to be exported.

olden Image		
olden Image Export		
This plug-in will allow y It will read the data Output Location	rou to export image files. memory contents of the connected gauge and save it to your hard drive in various formats.	Brouse
Output Directory	C: (tr\batterymanagementstudio\Outputriles	browse
Base File Name	2620_1_00-bq28z620R1	Open Director
Output Formats		
SREC File (.srec)	2620_1_00-bq28z620R1.srec	Options
BQFS File (.fs)	2620_1_00-bq28z620R1.bq.fs	Options
	2620 1 00-bn28z620R1;df.fs	Ontions

#### Figure 1-10. Golden Image Screen



## 1.3.8 Advanced Comm I<sup>2</sup>C Screen

Press the **Advanced Comm I2C** button to select the **Advanced Comm I2C** window. This tool provides access to parameters using  $I^2C$  and Manufacturing Access commands. See Figure 1-11. The transaction log screen shows the history of sent commands.

Note

#### I<sup>2</sup>C commands are sent in Little Endian format.

🐊 Registers 🗢 Data Memor	ry 🜆 Dat	a Graph 🍏	Advanced (	Comm 🛛				- 0
Advanced Comm 12	С					Clear Lo	g Save Log	Calculator
I2C Master Control Panel								
Byte Read/Write								
I2C Addr	ess (Hex)	AA						
	[	-						
Start Regis	ter (Hex)	3e						
Bytes to Write (Hex) 06 00								
					~			
Number of Bytes to Read (	Decimal) [	4			Read			
Transaction Log			_					
TimeStamp	Rd/Wr	Address	Register	Length	Data			
2022-11-29 05:37:09 195	Wr	AA	61	1	00			
2022-11-29 05:37:18 618	Wr	AA	3e	2	06 00			
2022-11-29 05:37:19 774	Rd	AA	3e	4	06 00 10 12			

Figure 1-11. Advanced Comm I<sup>2</sup>C Screen

## Examples:

Reading an I<sup>2</sup>C Command.

- Read chemical ID (0x 0006).
  - Make sure the device is unsealed
  - Write 0x00 using BlockDataControl() command (0x61) to enable block data flash control. (wr 0x61 0x00)
  - Write to mac address 0x3e Command 0x06 0x00 (see Figure 1-11).
  - Read 4 bytes.
  - The result returned is 0x10 0x12, which is little endian for chem id 1210.

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

- With Impedance Track<sup>™</sup> disabled, send *Gauging()* (0x0021) to *ManufacturerAccess()*.
  - Write to mac address 0x3e command 0x21 0x00 (see Figure 1-11).

#### 1.3.9 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 1-12. Watch Screen



## 1.4 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 BQ28Z620/BQ294502 circuit modules.

## 1.4.1 Board Layout

This section shows the dimensions, PCB layers (see Figure 1-13 through Figure 1-18), and assembly drawing for the BQ28Z620 modules.



Figure 1-13. Top Silk Screen



Figure 1-14. Bottom Silk Screen





Figure 1-15. Top Assembly



Figure 1-16. Bottom Assembly





Figure 1-17. Top Layer



Figure 1-18. Bottom Layer



## 1.4.2 Bill of Materials

#### Note

The BQ294502 secondary protector used on this evaluation module has a max OVP of 4.35 V. If higher OVP is needed, please check the BQ2945'x family devices.

Qty	Value	Ref Des	Package_Case	Manufacturer	Manufacturer Part No	
1	BMS071	!PCB1	24146	Krypton Solutions	KS 24146	
4	0.1µF	C1, C2, C3, C5	0603	Samsung Electro- Mechanics	CL10B104KB8NNNL	
6	0.1µF	C4, C6, C7, C8, C10, C13	0402	Murata Electronics North America	GRM155R71C104KA 88D	
1	1.0µF	C9	0402	Samsung Electro- Mechanics America, Inc.	CL05A105KO5NNND	
1	2.2µF	C11	0402	TDK Corporation	C1005X5R1E225K05 0BC	
1	Single (Standard) - 75V	D1	SOT-23-3	Diodes Inc	BAS16-7-F	
2	Single (Zener) - 5.6V	D2, D3	SOD-323F	ON Semiconductor	MM3Z5V6C	
2	Black 3 Pin Female R/A	J1, J2	3.5mm 16-28 AWG	On Shore Technology Inc	ED555/3DS	
1	1 X 4 R/A Shrouded - 1 Wall	J3	0.1	Molex Inc	22-05-3041	
3	1 x 2	P1, P2, P3	0.1	Samtec Inc	HTSW-102-07-G-S	
1	MOSFET N-CH 30V	Q1	6-TSSOP	Vishay Siliconix	SI1416EDH-T1-GE3	
2	MOSFET N-Channel	Q2, Q3	8-SON	Texas Instruments	CSD16412Q5A	
1	MOSFET N-Channel, 6pF	Q4	SOT-23-3	Micro Commercial Co	2N7002K-T1-E3	
1	1.00K	R1	0603	Yageo	RC0603FR-071KL	
8	100 Ohm	R2, R15, R16, R18, R19, R20, R22, R23	0402	Yageo	RC0402FR-07100R	
3	1.00k ohm	R3, R4, R12	0402	Vishay Dale	CRCW04021K00FKE D	
2	10.0M	R5, R6	0402	Vishay Dale	CRCW040210M0FKE D	
1	10.0K	R7	0603	Yageo	RC0603FR-0710KL	
1	100k ohm	R8	0402	Yageo	RC0402FR-07100KL	
4	5.10K	R9, R10, R13, R17	0402	Yageo	RC0402FR-075K1L	
1	10.0 Ohm	R11	0402	Yageo	RC0402FR-0710RL	
1	4.99 ohm	R14	0402	KOA Speer Electronics, Inc.	RK73H1ETTP4R99F	
1	0.001	R24	1206	Stackpole	CSNL1206FT1L00	
1	10.0K ohm	RT1	P2.54 3.7 mm W x 17 mm L x 2.4 mm H	Semitec	103AT-2-	



1	PB SPST-NO Off- Mom	S1	4.90mm x 4.90mm	Panasonic Electronic Components	EVQ-PLHA15
10	Test Loop - Black	TP1, TP3, TP4, TP5, TP7, TP8, TP10, TP12, TP13, TP14	0.040	Keystone Electronics	5001
3	Test Loop - Red	TP2, TP6, TP9	0.040	Keystone Electronics	5000
1	BQ294502DRV	U1	6-SON	Texas Instruments	BQ294502DRV
1	BQ28Z620DRZ	U2	DRZ0012A	Texas Instruments	BQ28Z620DRZ
1	4 wire cable(black/ white/brown/red)	W1	L18	Krypton Solutions	I2C_SMB_CABLE CBL002

## 1.4.3 Schematic



## Figure 1-19. Schematic

## 1.4.4 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.

# 2 Revision History

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

Date	Revision	Notes	
March 2023	*	Initial Release	

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