

bq27750EVM 1-Series Li-Ion Battery Pack Manager Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the bq27750 battery management system. The EVM includes one bq27750 circuit module and a link to the Microsoft® Windows® based PC software. The circuit module includes one bq27750 integrated circuit (IC) and all other onboard components necessary to monitor and predict capacity, monitor critical parameters, protect the battery from overcharge, over-discharge, short-circuit, and overcurrent in 1-series cell Li-Ion or Li-Polymer battery packs. The circuit module connects directly across the battery. With the EV2300 or EV2400 interface board and software, the user can read the bq27750 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.

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Features

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1 Features

The EVM supports the following features:

- Complete evaluation system for the bq27750EVM 1-series battery pack manager evaluation module
- Populated circuit module for quick setup
- Software that allows data logging for system analysis

1.1 Kit Contents

The following items are supplied with the EVM kit:

- bq27750 circuit module
- Cable to connect the EVM to an EV2300 or EV2400 Communications Interface adapter

1.2 Ordering Information

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

Table 1. Ordering Information

EVM Part Number	Chemistry	Configuration	Capacity
bq27750EVM	Li-Ion	1-cell	Any

1.3 Documentation

For information on the bq27750 and bq294502 device firmware and hardware, see the following documentation:

- bq27750 data sheet (SLUSCM7)
- bq27750 Technical Reference Manual (TRM) (SLUUBI6)

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1.4 bq27750 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq27750 EVM.

Table 2. Performance Specification Summary

Specification	MIN	TYP	MAX	Units
Input voltage 1P+ to 1N-	2.5	3.5	25	V
Charge and discharge current	0	2	7	А

2 bq27750EVM Quick Start Guide

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

2.1 Items Needed for EVM Setup and Evaluation

The following items are needed for EVM setup and evaluation:

- bq27750 circuit module
- EV2300 or EV2400 communications interface adapter
- Cable to connect the EVM to an EV2300 or EV2400 communications interface adapter
- USB cable to connect the communications interface adapter to the computer
- Computer setup with Microsoft Windows XP, or higher, operating system
- Access to the Internet to download the Battery Management Studio software setup program
- One battery cell
- A DC power supply that can supply 5 V

2.2 Software Installation

Find the latest software version in the bq27750 tool folder on www.ti.com. Use the following steps to install the bq27750 Battery Management Studio software:

- 1. Download and run the *Battery Management Studio* setup program from the *Development Tools* section of the bq27750EVM product folder on www.ti.com. See Section 3 for detailed information on using the tools in the *Battery Management Studio*.
- 2. If the Communications Interface Adapter was not previously installed, after the bqStudio installation, a TI USB DRIVER INSTALLER pops up. Click Yes for the agreement message and follow its instructions. Two drivers are associated with the EV2300 and an additional file may be required for the EV2400. Follow the instructions to install both. Do not reboot the computer, even if asked to do so.
- 3. Plug the communications interface adapter into a USB port using the USB cable. The Windows system may show a prompt that new hardware has been found. When asked, "Can Windows connect to Windows Update to search for software?", select "No, not this time", and click Next. In the next dialog window, it indicates "This wizard helps you install software for: TI USB Firmware Updater". Select "Install the software automatically (Recommended)" and click Next. It is common for the next screen to be the *Confirm File Replace* screen. Click No to continue. If this screen does not appear, then go to the next step. After Windows indicates that the installation was finished, a similar dialog window pops up to install the second driver. Proceed with the same installation preference as the first one. The second driver is TI USB bq80xx Driver.

2.3 EVM Connections Module Connections

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



Figure 1. bq27750 Circuit Module Connection to Cells and System Load or Charger

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

Attach the cells to the J2 terminal block. A specific connection sequence is not required, but it is a good practice to start with the BAT– of the battery before the BAT+. A power supply set at 4 V can be used instead of a battery for evaluation purposes.

I²C[™] (SDA, SCL)
 Attach the communications interface adapter cable to J3 and to the I²C port on the EV2300.

NOTE: If the EVM board is an E1 revision, it will only work with an EV2400. If it is an A revision, the EV2300 can be used. Ensure that shunts are placed on P2 and P3 jumpers to enable the onboard pullup resistors. If the EV2400 is used, there will be no need for shunts on P2 and P3 because it has internal pullup resistors.

• System load and charger connections across Charger+/Load+ and Charger-/Load-

Attach the load to the J1 terminal block. The positive terminal of the load should be connected to the terminal block position labeled PACK+. The ground wire for the load should be connected to the other terminal block position labeled Charger-/Load-.

Wake-up the device up from SHUTDOWN (WAKE)

Press the **Wake** pushbutton switch S1 to temporarily connect 1P to Charger+/Load+. This applies voltage to the PACK pin on the bq27750 to power-up the regulators and start the initialization sequence.

Parameter setup

Data flash parameters should be updated to fine tune the gauge to the pack. See the *bq27750 Technical Reference Manual* (SLUUBI6) for help with setting the parameters.



3 Battery Management Studio

3.1 Starting the Program

Run *Battery Management Studio* from the Start | Programs | Texas Instruments | Battery Management Studio sequence or the *Battery Management Studio* shortcut. As long as the device has been woken up from shutdown mode by momentarily pressing button **S1** or applying a charger voltage, the gauge will be automatically detected and the register screen will appear as seen in Figure 2. 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 3, select any bq27750.bqz file. This action will enable the program to get started and the user can update the firmware using the latest .srec file for the device downloadable from the product folder of the gauge at www.ti.com.

ashBoard		🗅 🛛 🕲 Registers 🕮 🔣 Programm	ning 🧱 Go	Iden Imag	e 🔢 GPC	Packager															
Refresh is ON - C	lick to Turn OFF	Registers																Label	here	12	0
dio Version: 1.3.61																			S	art Log	Scan I
0		Registers																			
-	EV/2300	New		V Aller	11282	1.22					1000	11-11-	l via il	C	News			Victor	er Ka		
	Version:3.1m	The second second		value	Units	Log	scal N	ame			value	Units	Log	Scal	Ivame			valu	e	Jines L	og s
~/		Manufacturer Access		1x0002	nex	R.		Cell 1 Volta	ge		3937	mv	N.		I I_SIM			24.2		legc I	-
		At Rate		U	mA	R.		BAI pin voi	tage		3937	mv	N.		i _ambi	ient		24.0		Jegc I	y
		At Rate Time to Empty	U 8	65535	min			HACK PIN V	onage		2	mv	12 12		Cell 1 P	(aScale		1000	·		×.
		iemperature		24.0	degu			Cell 1 Curre	int.		0	mA	12 12		Cellin	ompices		0	n	Unm i	2
	12C	w vokage		3937	my	R.		Demos	ar -		0	CVV	(*) (2)		Packo			0		-	*
•		Current		0	mA	R		The Terrar			22.0	deeC	17. 17.		Centro	3110		74		-	7
		Average Current		0	mA			Int lempera	ture		23.6	degu	N.		Staten	me		/1		3	×.
~ .		Balative State of Charge		60	ev.			Coll Tompo	atura		24.0	degC	100 100			Dagged O		010-	•	- i	5
2		Developer Charge		2000	70	R.			ature		24.0	ueyc				rasseu w		0	1.8	-14/6	
22	bq27750	Cut shares Casacity		5000	mAn	R		Cell I Raw	voitage		3937	mv	17. 17.		00000	Passed c		0	2	Luc I	7
1	1/50_0_04	Capacity		0000	IDAUI			Ek Oam C			0000	-MAR		5		ODEOC		252	40	10	2
P.	23.7 degC	Average Time to Emply		000000	min			EN EUR Cha	0		E104	mAH	100 100		Cell 1	Max		552		-	2
1	Lon dege	Average Time to Full	10	500	min	R.		FR FUE Chg	u r		5104	mAn	(*) (2)		Cento	Awax		0,000	9	nAn i	-
~		Max Load Current		-500	mA	R		True Dame	-		2004	CWH	19. 19.		To other	IMax DODU		0		-	7
		Character Contract		510				True Rein C			0000	-10ACH			Coldan 7	Passed Q		0		LUIC I	2
677		Charging Corrent		0	mire and f			laikel O			2104	máh	100 100		Tamp	I MINE		2.0		1010	2
		May Current		2500	mà	E.		I siluar u			2104	oM/h		2	Tomp o			1000		-	
2027 1/		in max current		6300	1104			i initial c			002	Civil		1	i remp a			1000	·	-	
60%				_											× [
		Bit Registers																			
		Name	Value	Log	Scan	Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	BitS	Bit4	Bit3	Bit2	Bit1	Bit
1		Battery Status	0x00C0	V	V	OCA	TCA	RSVD	GTA	TDA	RSVD	RCA	RTA	INIT	DSG	FC	FD	EC3	EC2	EC1	EC
00 500		Operation Status A	0xE100			SLEEP	XCHG	XDSG	PF.	\$5	SOV	SEC1	SECO	RSVD	RSVD	RSVD	RSVD	RSVD	CHG	DSG	RS
0 📕 1000-1		Operation Status B	0x0640			RSVD	RSVD	RSVD	RSVD	SUPCC	SLPAD	SMBLC	INIT	SLEEPM	XL	CAL_O	CAL	AUTOC.	AUTH	RSVD	SE
1500 -		Temp Range	0x08		R	RSVD	RSVD	RSVD.	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	TO	HT	STH	RT	STL	UT	Ų
0 2000 📝		Charging Status	0x0004		R	RSVD	RSVD	RSVD	RSVD	NCT	RSVD	RSVD	RSVD	VCT	MCHG	SU	N	HV	MV	LV	p
0		Gauging Status	0x40	V					1				1	CF	DSG	EDV	RSVD	TC	TD	FC	F
		III Status	0x0804			RSVD	RSVD	RSVD	OCVFR	LDMD	RX	QMAX	VDQ	NSFM	RSVD	SLPQM.	QEN	VOK	RDIS	RSVD	RE
		Manufacturing Status	0x8000	•	R	CAL_EN	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	PF_EN	LF_EN	FET_EN	GAUGE.	DSG_T.	CHG_T	RS
		Safety Alert A+B	0x0000	V	R	RSVD	RSVD	OTD	OTC	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	000	RSVD	000	COV	CL.
		Safety Status A+B	0x0000			RSVD	RSVD	OTD	OTC	RSVD	ASCD	RSVD	ASCC	RSVD	AOLD	RSVD	OCD	RSVD	000	COV	CU
		Safety Alert C+D	0x0000			RSVD	RSVD	RSVD	RSVD	UTD	UTC	RSVD	RSVD	RSVD	RSVD	CTOS	RSVD	PTOS	RSVD	RSVD	RS
		Safety Status C+D	0x0000		R	RSVD	RSVD	RSVD	RSVD	UTD	UTC	RSVD	RSVD	RSVD	RSVD	RSVD	CTO	RSVD	PTO	RSVD	RS
		PF Alert A+B	0x0000	R	R	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	SOV	RS
		PF Status A+B	0x0000			RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	SOV	RS
		PF Alert C+D	0x0000			RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	DFETF	CFE
		PF Status C+D	0x0000		R	RSVD	RSVD	RSVD	RSVD	RSVD	DFW	RSVD	FC	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	DFETF	CFE
		LStatus	0	V	R													FELD	ITEN	CF1	CF

Figure 2. Registers Screen



Battery Management Studio

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a Target Selection Wizard	
Battery Management Studio (bqStudio) Supported Targets	
Please select a target	
0741_1_08-bq27741G1.bqz	
0741_2_01-sn27741B1.bqz	
0741_2_02-sn27741B1.bqz	
0/41_3_02-sn2//41C1.bqz	
0/41_3_03-sn2//41C1.bqz	
0/41_4_01-sn2//41M1.bdz	
0741_4_02-sn2774114_bra	
0742_1_02_ks27742C1_ksz	
0742_1_05-0d2774201.0d2	
0742_2_00-sh27742C1.0q2	
0742_5_00-sh27742L1.bqz	
0742 6 01 sp2774201.5q2	1.00
0742 D5 00-sp27742U1.bgz	1
0750 0 01-ba27750.baz	
0750 0 02-ba27750.baz	
1100 0 01-ba78z100.baz	
1100 0 02-bg78z100.bgz	
1100_0_03-bq78z100.bqz	
1100_0_04-bq78z100.bqz	
1100 0 05 L-70-100 L-	
Auto Detected Device : None	
Advance Address Scanning	
Default 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 http://www.ti. (new versions add support for newer devices)	com/tool/bqstudio.
< Back	Cancel

Figure 3. Battery Management Studio Supported Targets

3.2 Registers Screen

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



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

3.3 Data Memory Screen

The bq27750 data flash comes configured per the default settings detailed in the bq27750 TRM. Ensure that the settings are correctly changed to match the pack and application for the solution being evaluated. For ease of configuration, a text file with a gg.csv extension can be extracted, modified, and imported back on the device. Use the export and import buttons as seen in Figure 4 to export and import gg.csv files. The auto export button enables gg files to be exported periodically at intervals. This is useful when debugging issues with the gauge. A *Write All* command is necessary if a gg.csv file is imported to ensure that all the changes made on the gg.csv file are effected on the gauge. The *Read All* command is used to read back all of the data written to the gauge so that the changes made can be verified. The *Filter/Search* field enables the user to search for a particular parameter in the data memory content.

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

ata Memory		Filter/Search	unt Event Import Write All Pord A
		Autoex	for Export import write_Air Read A
lead/Write Data Memory Content	3		
Calibration	Name	Value	Unit
	⊿ Voltage		
Settings	Cell Gain	12101	-
Destections	Pack Gain	49669	-
Protections	BAT Gain	48936	-
Permanent Fail	⊿ Current		
	CC Gain	1.036	mOhm
Advanced Charge Algorithm	Capacity Gain	1.036	mOhm
Cas Causian	⊿ Current Offset		
Gas Gauging	CC Offset	0	-
Power	Coulomb Counter Offset Samples	64	-
	Board Offset	0	
PF Status	CC Auto Config	07	hex
6 I D I	CC Auto Offset	17	-
System Data	⊿ Temperature		
I2C Configuration	Internal Temp Offset	0	degC
;	External1 Temp Offset	0	degC
Lifetimes	External2 Temp Offset	0	degC
	▲ Internal Temp Model		
Ka Table	Int Gain	-12143	-
	Int base offset	6232	-
	Int Minimum AD	0	-
	Int Maximum Temp	6232	0.1 degK
	▲ Cell Temperature Model		-
	Coeff a1	-11130	-
	Coeff a2	19142	-
	Coeff a3	-19262	-
	Coeff a4	28203	
	Coeff a5	892	
	Cooff b1	220	

Figure 4. Data Memory Screen

3.4 Calibration Screen

The voltages, temperatures, and currents should be calibrated to provide good gauging performance. Press the **Calibration** button while in the "Show Advanced view mode" to select the **Advanced Calibration** window, see Figure 5. 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.



Battery Management Studio

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🔉 Registers 🔐 Authentication View 🔲 Calibration 🛙		- 8
Advanced Calibration		
Perform Calibration		
Select the types of calibration to perform and enter the actual in	nput parameters in the corresponding boxes	
Current Calibration	Temperature calibration	
Applied Current	Sensor Applied temperature Calibrate	
mA Calibrate Current	Internal deg C	
	External 1 deg C	
Applied Cell 1 voltage		
mV Calibrate Voltage	Calibrate Gas Gauge	
Applied Battery Voltage		
mV 🔲 Calibrate Battery Voltage		
Applied Pack voltage		
mV 🔲 Calibrate Pack Voltage		

Figure 5. Calibration Screen

3.4.1 Voltage Calibration

- Measure the voltage from 1N to 1P and enter this value in the *Applied Cell 1 Voltage* field and *Applied Battery Voltage*, then select the **Calibrate Voltage** and calibrate battery voltage checkboxes.
- Measure the voltage from Charger+/Load+ to Charger-/Load- and enter this value in the *Applied Pack Voltage* field and select the **Calibrate Pack Voltage** box. If the voltage is not present, then turn the charge and discharge FETs on by entering a 0x22 command in the *Manufacturer Access* register on the **Register** screen.
- Press the Calibrate Gas Gauge button to calibrate the voltage measurement system.
- Deselect the Calibrate Voltage boxes after voltage calibration has completed.

3.4.2 Temperature Calibration

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- Enter the room temperature in each of the *Applied Temperature* fields and select the **Calibrate** box for each thermistor to be calibrated. The temperature values must be entered in degrees Celsius.
- Press the **Calibrate Gas Gauge** button to calibrate the temperature measurement system.
- Deselect the Calibrate boxes after temperature calibration has completed.



3.4.3 Current Calibration

The *Board Offset Calibration* option is not offered in *Battery Management Studio*, because it is not required when using the bq27750EVM. The *Board Offset Calibration* option is available in bqProduction.

- Connect and measure a 2-A current source from 1N (–) and Charger-/Load- 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.

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Battery Management Studio

3.5 Authentication Screen

The bq27750 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.

🔉 Registers 📴 Auth	entication View 🗵 🔲 Calibration 🚡 Chemistry 🛃	Firmware
Authentication		
Authenticate Device	2	
All data is displayed i	n hexadecimal with most significant digit first.	
SHA-1 Calculator		
Key: 012	23456789ABCDEFFEDCBA9876543210	Show Digest
Challenge: E34	A9AC282BA5F63EDF904EA561CCA38EBDF26AE3	
Digest:		
Gauge Authentica	tion by Host	
Key:	0123456789ABCDEFFEDCBA9876543210	🥜 Load Default Key
		🗱 Load Gauge Key
ci		
Challenge:		Generate Kandom Challenge
Expected Digest:	2FA27CEB5B616484620FE32217C29B0A8E3CF3F0	lange 🛞 Authenticate Gauge
Gauge Digest:		
Change Gauge Aut	thentication Key	
New Key:	0123456789ABCDEFFEDCBA9876543210	of Change Key
Challenge:	000000000000000000000000000000000000000	
Eveneted Digest	2FA27CFR5B616484620FF32217C29B048F3CF3F0	
Gauge Digest		
Gauge Digest:		

Figure 6. Authentication Screen

3.6 Chemistry Selection

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

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

- The table can be sorted by clicking the desired column. For example: Click the *Chemistry ID* column header.
- Select the *Chemistry ID* that matches your cell from the table (see Figure 7).
- Press Update Chemistry from Database to update the chemistry in the device.

nemistry Programming				
ogram Battery Chemistry				
lost Li-ion cells use LiCoO2 cathode and his tool allows the fuel gauge to be set up se this tool to load settings for any alterna ote : Right Click on the selected chemi	graphitized carbon anode, which is supported by the default firmw o for various alternate battery chemistries. ate chemistry if your cell manufacturer indicates that their cells us stry to apply it to individual cells. The menu appears only if the	vare in the Impedance e a different chemist e f/w supports indivi	e track fuel gauges. y than LiCoO2 cathode and graphite anode. dual 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	
3 A123	ANR26650M1-B Consult TI before use (2500	0453	LiFePO4/carbon	
💫 A123 Systems	26650A	0400	LiFePO4/carbon	
A123Systens	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	
S Acebel	ECFV1260 (60Ah)	0807	Lead Acid	
& AEenergy	AE1004765 (3500mAh)	0131	LiCoO2/carbon 4	
🚨 AEenergy	AE583696PM1HR (2150 mAh)	0222	PSS, LiNiO2 with Co, Mn doping	
AET .	TP2000-1SPL (2000mAh)	0190	LiCoO2/carbon 11	
AGM	INR34600K2 (7500mAh)	0210	NiCoMn/carbon	
AISIPU	3872C8 (5100mAh)	1335	LiCoO2/carbon 11	
S AISIPU	856360 (4750mAh)	3636	LiMn2O4 (Co,Ni)/carbon, 4.35V	
ALE	045062 (2300 mAh)	1254	LiNiCoMnO2/SGenNo1, 4.2V	
a 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	
ATL	604396	0100	LiCoO2/graphitized carbon (default)	
8 ATL	laminate 554490	0103	LiCoO2/carbon 2	
ATL	604396 (M1-V4 / Obsolete)	0105	LiCoO2/carbon 3	
ATL	laminate 606168 (M42-V2)	0105	LiCoO2/carbon 3	

Update Chemistry from Database Update Chemistry from External File...

Chemistry Version : 461

Figure 7. Chemistry Screen



Battery Management Studio

www.ti.com

3.7 Programming Screen

Press the **Programming** button to select the **Programming** window. This window allows the user to program the device firmware. Use the following procedures to program the device:

- Search for the .srec file using the Browse button.
- Press the Program button and wait for the download to complete.
- Click the Execute FW to return the device to NORMAL mode after programming has completed, see Figure 8.

🚳 Registers 📕 Programming 🛙 🧱 Golden Image 🗓 GPCPackager	= 8
Programming	
Perform Programming	
This plug-in will allow you to program image files to a device. Select Programmable File	
C:\Users\a0273591\Documents\BMS\HH\bq27750\EVM_PWR837A\RTMDocs\bq27750_v0_04_build_12.srec	▼ Browse
	Program
	Execute FW

Figure 8. Programming Screen

3.8 Advanced Comm Screen

Press the **Advanced Comm** button to select the **Advanced Comm** window. This tool provides access to parameters using I²C and Manufacturing Access commands, see Figure 9. The transaction log screen shows the history of sent commands.

NOTE: I'C commands are sent in Little-Endian form	rmat.
---	-------

Registers Advanced C	omm 🕅					
Advanced Comm I20	5					🥫 🔚 🗐 Clear Log Save Log Calculati
I2C Master Control Panel						
Byte Read/Write						
I2C Addr	ess (Hex)	aa				
Start Regi	ster (Hex)	3e				
Bitter to W						
Bytes to w	nite (Hex)	21 00			~ Write	
Number of Bytes to Read ((Decimal)	4			Read	
Transaction Log						
TimeStamp	Rd/Wr	Address	Register	Length	ata	
2015-09-17 09:15:47 459	Wr	aa	3e	2	6 00	
2015-09-17 09:15:47 835	Rd	aa	3e	4	5 00 10 12	
2015-09-17 09:15:54 341	Wr	aa	3e	2	100	

Figure 9. Advanced Comm Screen

Examples:

Reading an I²C Command.

- Read chemical ID (0x 0006).
 - Write to mac address 3e Command 06 00 (see Figure 9)
 - Read 4 bytes.
 - The result returned is 10 12, which is little endian for chem id 1210.

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

- With Impedance Track[™] disabled, send *Gauging()* (0x0021) to *ManufacturerAccess()*.
 - Write to mac address 3e command 21 00 (see Figure 9).



- -

Battery Management Studio

3.9 Golden Image

The golden image screen allows for the creation of a golden file to be used to program multiple devices. A flash stream file (.bqfs, .dffs or .gmfs) can be extracted by:

- Browsing to the desired location
- Creating a file name in the Base File Name field
- Checking the corresponding checkbox for the file that needs to be created
- Clicking the options button next to the fields, additional checkboxes pop up that allow additions such as the unseal codes, ROM command, and so forth, to the golden files, as needed
- Clicking the Create Image Files button, see Figure 10

🚳 Registers 🧱 Golden Image 🛛 <u>]</u> GPCPackager

olden Image Export		
his plug-in will allow It will read the data	you to export image files. memory contents of the connected gauge and save it to your hard drive in various formats.	
Output Location		
Output Directory	C:\ti\BatteryManagementStudio\OutputFiles	Browse
Base File Name	1750_0_04-bq27750	Open Directory
Output Formats		
SREC File (.srec)	1750_0_04-bq27750.srec	Options
👿 BQFS File (.fs)	1750_0_04-bq27750.bq.fs	Options
🔽 DFFS File (.fs)	1750_0_04-bq27750.df.fs	Options
THE CHARGE THE CON	1750 0 04-bc27750 am fr	Ontions

Figure 10. Golden Image Screen



3.10 GPC Packager

Battery Management Studio

This allows the creation of a file package to be uploaded to the *Gauge Parameter Calculator Packager* (gpc) tool on www.ti.com. Click on the gpc packager help for guidance on usage, see Figure 11

Registers 🗓 GPCPackager 🕸			-
Sauge Parameter Calculator Packager			
Prepare required data to send to GPC website.			
Select one of three packagers below by selecting the Find best chemistry match. (IT ChemID selection) Optimize room temperature performance. GG Maker. Chemis Optimize room temperature and low temperature performance	line with a left mouse click. Select a try tables must be programmed before gg fil ce. GG Maker. Chemistry tables must be prog), b), or c) : is written. ammed before gg file is written. Includes (b).	
Active Gauge Parameter Calculator Package Process Selected GPC Packager: Find best chemistry match. (IT ChemID Gauge Parameter Calculator Overview GPC Packager Help ChemID Technical Reference GPC Packager Log File Rules	selection)		
File Information			
Log File of relax, discharge, relax IV data for chemistry matching.	C:\Temp\GPC\roomtemp_rel_dis_rel.log	Browse	
Output File Location	C:\Temp\GPC\Package	Browse	
	Load Files		
Configuration			
Column Mapping	lumn Manning		
Cell voltage column	Current Column	•	
Temperature Column	Elapsed Time Column		
	Generate Package		

Figure 11. GPC Packager Screen

3.11 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.

🖟 Watch 🛛 🗋 Errors 🗖 🗖
📫 Add Register 🔻 🌵 Add Data Memory Item 💌 📼 Remove 💌 🕨 🛵 💋 2000 💌

Figure 12. Watch Screen

15



3.12 Data Graph Screen

This enables specified registers and data memory items to be plotted in a graph in real time based on a specific time interval chosen as shown in Figure 13.

🔕 Regist	ters 🗃 Authentication View 🔯 Calibration 🛓 Chemi	stry 🔣 Firmware 💽 Data Graph 🟾				- 8)
				💠 Add Register 🔹	🕶 🖶 Add DF Item	▼ 📼 Remove 🔹 🕨 2000 ▼
* *	☆ 🛛 🙀 🕂 ≑ 🔍 🔍 🏹 🐼 🏈	6				
			Data Graph			
100						
90						
80						
70						
60						
en s						
N N						
40						
30						
20 1						
10						
0						
Ó	2 4 6 8 10 12 14 16 18 20 22 24	26 28 30 32 34 36 38 40 42 44	46 48 50 52 54 56 58 60 62 64 60	5 68 70 72 74 76	78 80 82 84	86 88 90 92 94 96 98 100
			inite (see)			

Figure 13. Data Graph Screen

3.13 Error Screen

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

V 💐	Vatch 📴 Errors 🛛	🖉 🛃 📄 🔤 🕅 [Filter/All 👻 🗖			
Sear	ch:				
	Message	View	Operation	TimeStamp	
-					





4 Circuit Module Physical Layouts and Bill of Materials

This section contains the printed-circuit board (PCB) layout, assembly drawings, bill of materials (BOM), and schematic for the bq27750 circuit module.

4.1 Board Layout

Figure 15 through Figure 20 illustrate the PCB layers and assembly drawings for the bq27750 module.



Figure 15. Top Silk Screen



Figure 16. Bottom Silk Screen



Circuit Module Physical Layouts and Bill of Materials







Figure 18. Bottom Assembly





Figure 19. Top Layer



Figure 20. Bottom Layer



4.2 Bill of Materials and Schematic

Table 3 lists the EVM BOM.

Table 3. Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		PWR837	Any
C1, C2, C3, C4, C5, C8	6	0.1uF	CAP, CERM, 0.1 µF, 6.3 V, +/- 10%, X5R, 0402	0402	GRM155R60J104KA01D	Murata
C6	1	2.2uF	CAP, CERM, 2.2 µF, 6.3 V, +/- 10%, X5R, 0402	0402	GRM155R60J225KE95D	Murata
J1	1		Terminal Block, 3.5 mm, 2x1, Tin, TH	Terminal Block, 3.5 mm, 2x1, TH	39357-0002	Molex
J2	1		Terminal Block, 3.5 mm, 3x1, Tin, TH	Terminal Block, 3.5 mm, 3x1, TH	39357-0003	Molex
J3	1		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex
JP1, JP3, JP4, JP5	4		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady
Q1	1	30V	MOSFET, 2-CH, N-CH, 30 V, A, YJG0010A (PICOSTAR-10)	YJG0010A	CSD87501L	Texas Instruments
Q2	1	60V	MOSFET, N-CH, 60 V, 0.31 A, SOT-323	SOT-323	2N7002KW	Fairchild Semiconductor
R1	1	1.0k	RES, 1.0 k, 5%, 0.063 W, 0402	0402	CRCW04021K00JNED	Vishay-Dale
R2	1	10k	RES, 10 k, 5%, 0.063 W, 0402	0402	CRCW040210K0JNED	Vishay-Dale
R3, R4	2	10Meg	RES, 10 M, 5%, 0.063 W, 0402	0402	CRCW040210M0JNED	Vishay-Dale
R5	1	10.0	RES, 10.0, 0.1%, 0.063 W, 0402	0402	CPF0402B10RE1	TE Connectivity
R6, R7, R10, R11	4	5.1k	RES, 5.1 k, 5%, 0.063 W, 0402	0402	CRCW04025K10JNED	Vishay-Dale
R8	1	0	RES, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R12, R13, R14, R15	4	100	RES, 100, 1%, 0.063 W, 0402	0402	CRCW0402100RFKED	Vishay-Dale
R16	1	0.001	RES, 0.001, 1%, 1 W, AEC-Q200 Grade 0, 1206	1206	CSNL1206FT1L00	Stackpole Electronics Inc
RT1	1	10.0k ohm	Thermistor NTC, 10.0k ohm, 1%, Disc, 5x8.4 mm	Disc, 5x8.4 mm	103AT-2	SEMITEC Corporation
S1	1		Switch, SPST-NO, Off-Mom, 0.05A, 12VDC, SMD	3.9x2.9mm	PTS820 J20M SMTR LFS	C&K Components
SH-JP1, SH-JP3, SH- JP4	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M
TP1, TP2	2		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP3, TP4, TP5, TP6, TP8, TP9	6		Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
U1	1		1-Cell to 2-Series Cell Programmable Battery Manager, DRZ0012A (VSON-12)	DRZ0012A	BQ27750DRZR	Texas Instruments
U2, U3	2		ESD in 0402 Package with 10 pF Capacitance and 6 V Breakdown, 1 Channel, -40 to +125 degC, 2-pin X2SON (DPY), Green (RoHS & no Sb/Br)	DPY0002A	TPD1E10B06DPYR	Texas Instruments
W1	1		Cable assembly, 4 pin Edge # 6575051	N/A	SMBUS CBL002	Any
C7	0	1uF	CAP, CERM, 1 µF, 35 V, +/- 10%, X5R, 0402	0402	GRM155R6YA105KE11D	Murata
C9, C10	0	0.1uF	CAP, CERM, 0.1 µF, 6.3 V, +/- 10%, X5R, 0402	0402	GRM155R60J104KA01D	Murata



Table 3. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A
JP2	0		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
R9	0	330k	RES, 330 k, 5%, 0.063 W, 0402	0402	CRCW0402330KJNED	Vishay-Dale
R17	0	0	RES, 0, 5%, 0.125 W, 0805	0805	CRCW08050000Z0EA	Vishay-Dale
SH-JP2, SH-JP5	0	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M
TP7	0		Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone



Circuit Module Physical Layouts and Bill of Materials

Figure 21 illustrates the EVM schematic.



Figure 21. Schematic



SLUUBP4–June 2017 Submit Documentation Feedback

STANDARD TERMS FOR EVALUATION MODULES

- 1. Delivery: TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
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 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
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 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.
- 3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 Japan

- 3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に 輸入される評価用キット、ボードについては、次のところをご覧ください。 http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page
- 3.3.2 Notice for Users of EVMs Considered "Radio Frequency Products" in Japan: EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

- 1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
- 2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
- 3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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- 3.3.3 Notice for EVMs for Power Line Communication: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page 電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page
- 3.4 European Union
 - 3.4.1 For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

- 4 EVM Use Restrictions and Warnings:
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
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