User's Guide BQ27427 EVM: Single-Cell Impedance Track Technology

i Texas Instruments

ABSTRACT

This evaluation module (EVM) is a complete evaluation system for the BQ27427. The EVM includes one BQ27427 circuit module with an integrated current-sense resistor. A separated orderable EV2400 PC interface board for gas gauge interface along with a PC USB cable, and Microsoft[®] Windows[®] based PC software is needed when using this EVM. The circuit module includes one BQ27427 integrated circuit and all other onboard components necessary to monitor and predict capacity for a system-side fuel gauge solution. The circuit module connected with the EV2400 interface board and software, the user can:

- · Read the BQ27427 data registers
- · Update the RAM for different configurations
- Log cycling data for further evaluation
- Evaluate the overall functionality of the BQ27427 solution under different charge and discharge conditions

The latest Windows-based PC software can be downloaded from the product folder on the Texas Instruments Web site.

Table of Contents

1 Features	3
1.1 Kit Contents	3
1.2 Ordering Information	3
2 BQ27427-Based Circuit Module	4
2.1 Circuit Module Connections	4
2.2 Pin Descriptions	4
3 Evaluation Module Physical Layout, Bill of Materials and Schematic	5
3.1 Board Layout	5
3.2 Bill of Materials	<mark>6</mark>
3.3 Schematic	7
3.4 BQ27427 Circuits Module Performance Specification Summary	7
4 EVM Hardware and Software Setup	<mark>8</mark>
4.1 Software Installation	<mark>8</mark>
5 Troubleshooting Unexpected Dialog Boxes	<mark>8</mark>
6 Hardware Connection	<mark>8</mark>
6.1 Connecting the BQ27427 Circuit Module to a Battery Pack	8
6.2 PC Interface Connection	8
7 Operation	10
7.1 Starting the Program	. 10
7.2 Setting Programmable BQ27427 Options	11
8 Calibration	. 13
8.1 Calibrating the BQ27427	13
8.2 Voltage Calibration	. 13
8.3 Board Offset Calibration	13
9 Advanced Communication I ² C	. 14
9.1 I ² C Communication	. 14
10 Related Documentation	16
11 Revision History	16

List of Figures

Figure 3-1. BQ27427EVM Lavout – Top Silk	5
Figure 3-2. BQ27427EVM Lavout - Mid Laver 2	5
Figure 3-3. BQ27427EVM Lavout – Mid Laver 3.	6



Figure 3-4. BQ27427EVM Layout – Bottom Layer	6
Figure 3-5. BQ27427EVM Schematic	7
Figure 6-1. BQ27427 Circuit Module Connection to Pack and System Load/Charger	8
Figure 7-1. Registers Screen	10
Figure 7-2. bqStudio Default Page	11
Figure 7-3. Data Memory Screen	12
Figure 8-1. Calibration Screen	13
Figure 9-1. Advanced Communication I ² C	14
Figure 9-2. Parameter Q&A Screen	14
Figure 9-3. Golden Image Output Screen	15
Figure 9-4. Gauge Programming Screen	15

List of Tables

Table 1-1. Ordering Information	3
Table 2-1. Pin Descriptions	4
Table 3-1. Bill of Materials	6
Table 3-2. Performance Specification Summary	8
Table 6-1. Circuit Module to EV2400 Connections	9
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1 Features

- Complete evaluation system for the BQ27427 gas gauge with Impedance Track[™] technology
- Populated circuit module for quick setup
- Personal computer (PC) software and interface board for easy evaluation
- Software that allows data logging for system analysis

1.1 Kit Contents

• BQ27427 evaluation module (BMS037)

This EVM is used for the evaluation of the BQ27427 battery gauge. Visit the product Web folder at www.ti.com and download the TRM for information how to configure the BQ27427.

1.2 Ordering Information

Table 1-1. Ordering Information

Part Number	EVM Part Number
BQ27427	BQ27427EVM



2 BQ27427-Based Circuit Module

The BQ27427-based circuit module is a complete and compact example solution of a BQ27427 circuit for battery management. The circuit module incorporates a BQ27427 battery gas gauge integrated circuit (IC) with integrated sense resistor and all other components necessary to accurately predict the capacity of a 1-series Li-ion cell.

2.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct connection to the battery pack (J5): PACK+, PACK-
- To the serial communications port (J10): SDA, SCL, and VSS
- The system load and charger connect across charger and load (J6 and J7): CHARGER+/LOAD+ and CHARGER-/LOAD-.
- · Access to signal outputs (J1 and J5): BIN and GPOUT
- External connect to power the IC (J4): EXT VDD and VSS

2.2 Pin Descriptions

Pin Name	Description
PACK+	Pack positive terminal
PACK-	Pack negative terminal
SDA	I2C communication data lin
EXT VDD	External supply connection
SCL	I2C communication clock line
VSS	Signal return for communication line, shared with charger and ground
CHARGER+/LOAD+	High potential of load or charger connection
CHARGER-/LOAD-	Low potential of load or charger connection (system VSS)
BIN	Battery insertion detection input
GPOUT	General purpose output

Table 2-1. Pin Descriptions



3 Evaluation Module Physical Layout, Bill of Materials and Schematic

This section contains the board layout, bill of materials, and schematic for the BQ27427 evaluation module.

3.1 Board Layout

This section shows the printed-circuit board (PCB) layers (Figure 3-1 through Figure 3-4), and assembly drawing for the BQ27427 module.



Figure 3-1. BQ27427EVM Layout – Top Silk



Figure 3-2. BQ27427EVM Layout - Mid Layer 2





Figure 3-3. BQ27427EVM Layout – Mid Layer 3



Figure 3-4. BQ27427EVM Layout – Bottom Layer

3.2 Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	Mfr
1	C1	0.47	Capacitor, Ceramic, 6.3V, X5R, 20%	0402		
1	C2	1	Capacitor, Ceramic, 6.3V, X5R, 10%	0402		

Table 3-1. Bill of Materials

Table 3-1. Bill of Materials (Continued)												
Count	RefDes	Value	Description	Size	Part Number	Mfr						
4	J1,J4,J6,J7	ED555/2DS	Terminal Block, 2- pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED555/2DS	OST						
4	J2,J3,J8,J9	PEC36SAAN	Header, Male 3-pin, 100mil spacing	0.100 inch x 3	PEC36SAAN	Sullins						
1	J5	ED555/3DS	Terminal Block, 3- pin, 6-A, 3.5mm	0.41 x 0.25 inch	ED555/3DS	OST						
1	J10	22-05-3041	Header, Friction Lock Ass'y, 4-pin Right Angle	0.400 x 0.500	22-05-3041	Molex						
1	R1	14.7k	Resistor, Chip, 1/16-W, 5%	0402	Std	Std						
1	R2	10k	Resistor, Chip, 1/16-W, 5%	0402	Std	Std						
2	R3,R4	5.1k	Resistor, Chip, 1/16-W, 5%	0402	Std	Std						
4	TP1,TP7,TP9	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone						
7	TP2,TP3,TP11,TP 12	5002	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone						
3	TP4,TP5,T6,TP10	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone						
1	U1	BQ27427YZF	IC, Battery Gauge	DSBGA	BQ27427	TI						

able 3-1 Bill of Materials (continued)

3.3 Schematic



Figure 3-5. BQ27427EVM Schematic

3.4 BQ27427 Circuits Module Performance Specification Summary

This section summarizes the performance specifications of the BQ27427 circuit module.



Table 3-2. Performance Specification Summary

Specification	Min	Тур	Max	Units
Input voltage Pack+ to Pack-	2.7	3.6	4.3	V
Charge and discharge current	0	1	2.5	А

4 EVM Hardware and Software Setup

This section describes how to install the BQ27427EVM PC software and how to connect the different components of the EVM.

4.1 Software Installation

Find the latest software version at https://www.ti.com/tool/bqStudio. Use the following steps to install Battery Management Studio:

- 1. Ensure that the EV2400 is not connected to the PC through a USB cable before starting this procedure.
- 2. Select the Tool and Software tab in the product folder
- 3. Under the Software section, click on Battery Management Studio (bqStudio) Software Suite.
- 4. Click the Download button to download the software.
- 5. Download software to hard drive.
- 6. Double-click the software executable and follow all instructions and prompts.

5 Troubleshooting Unexpected Dialog Boxes

The user that is downloading the files must be logged in as the administrator. The driver is not signed, so the administrator must allow installation of unsigned drivers in the operating system.

6 Hardware Connection

The BQ27427 evaluation system comprises three hardware components: the BQ27427 evaluation module, the EV2300 or EV2400 PC interface board, and the PC.

6.1 Connecting the BQ27427 Circuit Module to a Battery Pack

Figure 6-1 shows how to connect the BQ27427 circuit module to the cells and system load/charger.



Figure 6-1. BQ27427 Circuit Module Connection to Pack and System Load/Charger

6.2 PC Interface Connection

The following steps configure the hardware for interface to the PC.

- 1. Connect the BQ27427-based EVM to the EV2400 using wire leads as shown in Table 6-1.
- 2. Connect the PC USB cable to the EV2400 and the PC USB port.



Table 6-1. Circuit Module to EV2400 Connections

BQ27427EVM	EV2400
SDA	SDA
SCL	SCL
VSS	GND/VSS

The BQ27427EVM is now set up for operation.

7 Operation

This section details the operation of the bqStudio software.

7.1 Starting the Program

Run bqStudio from the Start | All Programs | Texas Instruments | Battery Management Studio. The main screen (Figure 7-1) appears. If instead of Figure 7-1 appearing, Figure 7-2 appears, it may mean that the EVM is not connected to the computer correctly. Make sure that the USB interface (EV2400) and the BQ27427 are connected and restart bqStudio. If this still does not resolve the issue, check if the I2C pullup resistors are connected. Data begins to appear once the <Refresh> (single-time scan) button is clicked, or when the Scan button is clicked. To disable the scan feature, simply click the Scan button again.

The continuous scanning period can be set by opening Window | Preferences \rightarrow Registers section. The range for this interval is 0 ms to 65,535 ms. Only items that are selected for scanning are scanned within this period.

Battery Management Studio provides a logging function which logs the values that were last scanned. To enable this function, select the Start Log button; this causes the Scan button to be pressed. When logging is Stopped, the Scan button will still be selected and has to be manually clicked again.

File <u>V</u> iew <u>W</u> ind	low <u>H</u> elp Registers > D at	ta Memory 💈 Com	mands	🞑 Ca	libration	*	Advano	ed Comm	n 🛓 Cl	hemist	ry 🔜 P	rogrami	ming	Go Go	olden I	mage								D.	^
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	11. 1.5.52	Registers																		-			CONTROL_S	TATUS	^
	EV2400 Version:0.25	Name		Value	Units	Log	Scan	Name			Value	Units	Log	g Scar	Nar	ne			Value	Units	Log	Scan	DEVICE_T Set VERS	YPE	
		Control		0x0202	Hex	•		Averag	ge Power		0	m	P	P	ER	emainin	g Capa	city	905	mAh	P	P	A LINK MEDG		
		✓ Temperature		21.55	°C			Preser	nt DOD		5040	dec %	2	2		ull Charg	je Capa	city	1252	mAh mAh	N N	×	% HW_VERS	ION	
41	I2C	Nominal Avail, Ca	apacity	915	mAh			Int Tem	n Charge 10		21.55	°C	R	R	ET	rue State	e of Cha	rae	73	%	R	R	DM_CO	DE	
.		Full Available Ca	pacity	1262	mAh	•	V	State o	of Health		94	%	P	V		OD0			5040	dec	P	M	PREV MAC	WRITE	
	bq27427	Remaining Capa	city	905	mAh				Current		2	mA	P			OD at E	OC Con		800	dec	P	9	A CUEMA	0	
	0427_2_02	Average Current	acity	1252	mAn	2	V	Simult	Current		4002	mA	2			lassed (Cap Charge		905	mAn	P I	R	* CHEM_I	D	
Yr.	21 35 °C	Qmax		1340	mAh	•		Remai	ning Cap	acity	905	mAh	P	P	EC	start			347	mAh	P	R	BAT_INSI	ERT	
U Z	21.55 C														E C	OD_Fin	al		16105	Num	P	R	BAT_REM	OVE	
																							SET_HIBER	NATE	
4002		Bit Registers																	Bit	High	Bit Low	RSVD	CLEAR_HIBE	RNATE	
		Name	Value	Log	Log Fie.	So	an Bit	15 Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	SET_CFGUP	DATE	
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-100-1000		i≣ Flags	0x0	V			× 0		RS	RS	LF I	HF I	FC	CHG	0C	DO	IIP	CF	BAI	SO	SO	DSG	SMOOTH_S	SYNC	~
-2000 T																							Log Panel	Clear	Log
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																							Name Cmd	Result Rea	i
<	>																	_							

Figure 7-1. Registers Screen

Figure 7-1 shows the main bqStudio window. Additional Flag and Status data can be viewed at the bottom of the Registers window.



a Target Selection Wizard	
Battery Management Studio (bqStudio) Supported Targets	
Please select a device type	
All	
Gauge	
Charger	
Wireless Charging	
Protector	
Reference Design	
Auto Detected Device : None	
If the type of device is not in the list above, you may download the latest version of bqStudio at <u>http://www.ti.</u> (new versions add support for newer devices)	<u>com/tool/bqstudio</u> .
< Back Next > Finish	Cancel

Figure 7-2. bqStudio Default Page

7.2 Setting Programmable BQ27427 Options

The BQ27427 data memory comes configured per the default settings detailed in the BQ27427 technical reference manual (SLUUAC5). Ensure that the settings are correctly changed to match the pack and application for the BQ27427 solution being evaluated.

IMPORTANT: The correct setting of these options is essential to get the best performance. The settings can be configured using the Data Memory screen (Figure 7-3).

Battery Mana													
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		Read (Mirite Date	> Memory Contents									CONTROL STATUS	11
Л		Reau/ Write Date	a memory contents										
	EV2400	Configuration	Name	Private	Value	Unit	Subclass ID	Data Length	Block Num	Block Offset	Native Uni 🔺	W DEVICE_TYPE	
	Version:0.25	0	Trace Resistance		0	mOhm	0x50	2	2	11	mOhm	FW VERSION	
		Gas Gauging	Downstream Resistance		0	mOhm	0x50	2	2	13	mOhm		
		Ra Tables	Predict Ambient Time		2000	S	0x50	2	2	15	S	A HW_VERSION	
	120	Chomistry Info	East Scale Load Soloct		3	Num	0x50	1	2	19	Num		
- 🖤 📕	120	Chemistry into	Cha DOD Correction Start SOC		90	Num	0x50	1	2	19	Num	DW_CODE	
<u>~</u>		Calibration	Chg DOD Correction Taper Ratio		20	Num	0x50	1	2	20	Num	PREV_MACWRITE	
	bq27427 0427_2_02	Security	✓ Current Thresholds									A (117) (117)	
			Dsg Current Threshold		167	.1 Hr rate	0x51	2	0	0	.1 Hr rate	S CHEM_ID	
	Addr: 0xAA		Chg Current Threshold		100	.1 Hr rate	0x51	2	0	2	.1 Hr rate	# BAT INSERT	
~J~	21.45 °C		Quit Current		250	.1 Hr rate	0x51	2	0	4	.1 Hr rate		
-			Dsg Relax Time		60	s	0x51	2	0	6	s	BAT_REMOVE	
(Ouit Polay Timo		1	5	0x51	1	0	0	s		i
			Max IR Correct		400	mV	0x51	2	0	12	mV	* SEI_HIBERINATE	
4002			✓ State		100		UND T	-	, in the second s	12		CLEAR HIBERNATE	
mV			Qmax Cell 0		16384	Num	0x52	2	0	0	Num	-	
			Update Status		00	Hex	0x52	1	0	2	Hex	SET_CFGUPDATE	
			Reserve Cap-mAh		0	mAh	0x52	2	0	3	mAh	✓ SET EAST HIBERNATE	1
S () 3			Load Select/Mode		81	Hex	0x52	1	0	5	Hex	Der_mon_moenterie	
10001000	1		Design Capacity		1340	mAh	0x52	2	0	6	mAh	SMOOTH_SYNC	
2000	1		Terminate Voltage		3200	mV	0x52	2	0	8	mV		ñ
-2000			T Rise		20	Num	0x52	2	0	16	Num	Log Panel Cle	ar Lo
0			T Time Constant		1000	s	0x52	2	0	18	s	Cic	
			SOCI Delta		1	%	0x52	1	0	20	%	Transaction Log	
			Taper Rate		100	.1 Hr rate	0x52	2	0	21	.1 Hr rate	Name Cmd Result F	Rea
			Sleep Current		10	mA	0x52	2	0	23	mA		
			Avg I Last Run		-50	.1 Hr rate	0x52	2	0	25	.1 Hr rate		
			Avg P Last Run		-50	.1 Hr rate	0x52	2	0	27	.1 Hr rate		
			Detta Voltage		1	mv	UX52	2	U	29	mv v		

Figure 7-3. Data Memory Screen

Memory window. Make sure the device is not sealed and in full access to read or write to the data memory. To update a parameter, click on the desired parameter and a window pops-up that provides details on the selected parameter. Next, enter the value in the value textbox and press Enter. After pressing Enter, bqStudio updates the selected parameter. The Import button in the Data Memory window can be clicked in order to import an entire configuration from a specified *.gg.csv file.

Save the configuration to a file by clicking the Export button in the Data Memory window and entering a file name. The configuration is saved to a *.gg.csv file. The module calibration data is also held in the BQ27427 data memory. If the Gauge Dashboard is not displaying any information, then the BQ27427 may not be supported by the bqStudio version being used, a bqStudio upgrade may be required.

TEXAS



8 Calibration

The BQ27427EVM must be calibrated to ensure accurate value reporting. This is done using the Calibration window in bqStudio (Figure 8-1).

8.1 Calibrating the BQ27427

- 1. Select the types of calibration to be performed (see Figure 8-1).
- 2. Enter the measured values for the types selected.
- 3. Press the button to calibrate.

8.2 Voltage Calibration

Voltage calibration usually is not required. If needed, follow these steps:

- 1. Measure the voltage across Pack+ and Pack-.
- 2. Type the voltage value in mV into Enter measured value.
- 3. Press the Calibrate button.

8.3 Board Offset Calibration

This performs the offset calibration for the current offset of the board.

It is expected that no current is flowing through the sense resistor while performing this calibration step.

1. Remove load and short PACK- to LOAD-.

2. Press the Calibrate button



Figure 8-1. Calibration Screen

9 Advanced Communication I²C

9.1 I²C Communication

I²C read/write operations serve as general-purpose communication tools (Figure 9-1).

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~		s	tart Regist	er (Hex) 1C	7				A HW VERSION	
	12C	Ву	/tes to Wri	ite (Hex) 00		~	Write			
									PREV MACWRITE	
	bq27427 0427_2_02 Addr: 0xAA				7	~	0		CHEM ID	
LIP.		Number of Bytes	to Read (L	Decimal) 2			Read		BAT INSERT	
MLZ,	19.75 °C	Transaction Log	D-LAM-	Address	Decister	Legath	Data		RAT REMOVE	
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2002						-				6.1
V										
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🖉 DashBoard 🗸 🖓 🗖	Registers Golden Image 33	- 8	🕏 Commands 🛛 👘
Auto Refresh is ON - Click to Tu	Golden Image	Commands	
bqStudio Version: 1.3.92	Golden Image Export	CONTROL_STATUS	
EV2400	This plug-in will allow you to export image files.	DEVICE_TYPE	
Version:0.28	It will read the data memory contents of the connected gauge and save it to your hard drive in various formats. Output Location		FW_VERSION
~	Output Directo C:\ti\BatteryManagementStudio\OutputFiles	Browse	& HW_VERSION
12C	Base File Name 0427_2_02-bg27427	pen Director	DM_CODE
	Output Formats		PREV_MACWRITE
0427_2_02	OTFS File (.f) 0427_2_02-bq27427.ot.fs	Options	CHEM_ID
Addr: 0xAA	GMFS File (. 0427_2_02-bq27427.gm.fs	Options	BAT_INSERT
U Z 18.75 C	Create Image Files		BAT_REMOVE
	a score may the		SET_HIBERNATE
3889		CLEAR_HIBERNATE	
mV		SET_CFGUPDATE	
NUT AND			SET_FAST_HIBERNATE
-100-1000			SMOOTH_SYNC
-2000			SHUTDOWN_ENABLE
			Log Panel Clear Log
			Transaction Log
			Name Cmd Result Rea
< >>	🔒 Texas he	TRIMENTS	

Figure 9-3. Golden Image Output Screen

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📋 Project 傡	<u>R</u> egisters D ata	a Memory 🥏 Commands 🔟 Calibration 🎯 Advanced Comm 🛓 Chemistry 🗒 Programming 鼲 Golden Image 💢 Learning Cycle 🛞 Param	eter Q&A 📓 🛛	<u>V</u> atch 🔚 Data Graph 🔤 Errors
🖋 DashBoard	~	© Registers ■ Programming 🛙	- 0	Commands 🛛 🗌 🖓
Auto Refresh	is ON - Click to Tu	Programming		Commands
bqStudio versio	on: 1.3.92	Perform Programming		CONTROL_STATUS
n	EV2400	This plug-in will allow you to program image files to a device.		DEVICE_TYPE
carl.	Version:0.28	Select Programmable File	FW_VERSION	
~		0426_2_02-bq27426G1.gm.fs ~	Browse	& HW_VERSION
11	I2C		Program	DM_CODE
	ba27427		Execute FW	PREV_MACWRITE
A 3 3 3	0427_2_02			CHEM_ID
4	Addr: 0xAA			BAT_INSERT
U Z	15.75 C			BAT_REMOVE
\bigcirc				SET_HIBERNATE
3887				CLEAR_HIBERNATE
mV				SET_CFGUPDATE
New Contraction				SET_FAST_HIBERNATE
-100-1000				SMOOTH_SYNC
-2000	7			SHUTDOWN_ENABLE
0				Log Panel Clear Log Transaction Log Name Cmd Result Rea
<	>			
		投 Texas Instruments		

Figure 9-4. Gauge Programming Screen



10 Related Documentation

BQ27427 System-Side Impedance Track[™] Fuel Gauge with Integrated Sense Resistor data sheet

11 Revision History

DATE	REVISION	NOTES
May 2021	*	Initial Release

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