User's Guide BQ27Z746EVM Impedance Track™ Battery Gas Gauge and Protection Solution for 1-Series Cell Li-ion Battery Packs

TEXAS INSTRUMENTS

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ABSTRACT

The BQ27Z746EVM comes with the BQ27Z746 integrated gas gauge and protection IC with external high-side protection N-Channel FETs. This user's guide will walk you through the following tasks:

- · Connect the necessary components together to power up the EVM
- · Installation of the necessary Texas Instruments software tools
- Bring up the EVM for a basic chemistry and accuracy cycle check
- Evaluate the functionality of the BQ27Z746 solution under different charge and discharge conditions

The latest Windows[®]-based PC software can be downloaded from the product folder on the Texas Instruments website. Use the Texas Instruments web search for Battery Management Studio on www.ti.com.

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1 Trademarks

Impedance Track[™] is a trademark of Texas Instruments. I2C[™] is a trademark of NXP. Windows[®] and Microsoft Excel[®] are registered trademarks of Microsoft Corporation. All trademarks are the property of their respective owners.



2 Features

- Complete evaluation system for the BQ27Z746 gas gauge and protection with Impedance Track[™] technology
- Populated circuit module for quick setup
- Personal computer (PC) software and interface board for easy evaluation
- Software that allows configuring and data logging for system analysis

2.1 Kit Contents

BQ27Z746 circuit module (BMS047)

This EVM is used for the evaluation of the BQ27Z746. Visit the product web folder at www.ti.com to properly configure the BQ27Z746.



3 BQ27Z746-Based Circuit Module

The BQ27Z746 based circuit module is an example solution of a BQ27Z746 circuit for battery management. The circuit module incorporates a BQ27Z746 battery gas gauge and protection integrated circuit (IC) with external sense resistor to accurately predict the capacity of a 1-series Li-ion cell. In addition, it includes external N-channel FETs for high-side battery protection.

3.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct cell connection to the battery pack (J1): BAT+, BAT-
- Direct system connection for charging and discharging (J2): PACK+, PACK-
- I2C[™] communications via external EV2400 to Windows-based PC USB port (J11): SDA, SCL, VSS
- Cell voltage sensing outputs (J7): BAT_SP, BAT_SN,

3.2 Pin Descriptions

Table 3-1. Pin Descriptions

Pin Name	Description
PACK+	Pack positive terminal
PACK-	Pack negative terminal
BAT+	Battery positive terminal and BQ2980 bypass path
BAT–	Battery negative terminal
SDA	External I ² C communication data line
SCL	External I ² C communication clock line
VSS	Device ground
BAT_SP	Cell sensing positive output terminal
BAT_SN	Cell sensing negative output terminal



4 Circuit Module Physical Layout, Bill of Materials, and Schematic

This section contains the board layout, bill of materials, and schematic for the BQ27Z746 circuit module.

4.1 Board Layout

This section shows the printed-circuit board (PCB) layers (Figure 4-2 through Figure 4-4), and assembly drawing for the BQ27Z746 module.



Figure 4-1. EVM Image



Figure 4-2. Top Layer Composite

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Figure 4-3. Top Layer



Figure 4-4. Bottom Layer



4.2 Schematic

This section contains the schematic of the different (PCB) components.



Figure 4-5. BQ27Z746 Reference Schematic

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4.3 Bill of Materials

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
PCB1	1		Printed Circuit Board		BMS047	Any
C1, C2, C3, C4	4	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X5R, 0201	0201	GRM033R61E104KE14J	MuRata
C5	1	1uF	CAP, CERM, 1 uF, 10 V,+/- 20%, X5R, 0201	0201	GRM033R61A105ME15D	MuRata
C6, C8	2	0.1uF	CAP, CERM, 0.1 uF, 16 V,+/- 10%, X7R, 0201	0201	GRM033Z71C104KE14D	MuRata
C10	1	0.01uF	CAP, CERM, 0.01 uF, 10 V, +/- 10%, X5R, 0201	0201	GRM033R61A103KA01D	MuRata
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
J1, J7, J15	3		Terminal Block, 5mm, 2x1, R/A, TH	Terminal Block, 5mm, 2x1, R/A, TH	1792863	Phoenix Contact
J2	1		Terminal Block, 5mm, 4x1, R/A, TH	Terminal Block, 5mm, 4x1, R/A, TH	1792889	Phoenix Contact
J3, J8, J9, J13, J16	5		Header, 2.54 mm, 2x1, Gold, TH	Header, 2.54 mm, 2x1, TH	GBC02SAAN	Sullins Connector Solutions
J4, J5, J10	3		Header, 2.54 mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	61300311121	Wurth Elektronik
J11	1		Header, 2.54mm, 4x1, R/A, Tin, TH	Header, 2.54mm, 4x1, R/A, TH	640455-4	TE Connectivity
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
Q1	1		Power MOSFET for 1 Cell Lithium-ion Battery Protection 12V, 3.2mOhm, 27A, Dual N- Channel, SMD	1.77x3.54mm	EFC8811R-TF	ON Semiconductor
R1, R6	2	0.001	RES, 0.001, 1%, 1 W, AEC- Q200 Grade 0, 1206	1206	CSNL1206FT1L00	Stackpole Electronics Inc
R2, R3, R7, R8, R17, R18	6	49.9	RES, 49.9, 1%, 0.05 W, 0201	0201	CRCW020149R9FKED	Vishay-Dale
R5	1	10Meg	RES, 10 M, 5%, 0.05 W, 0201	0201	RC0201JR-0710ML	Yageo America
R9	1	10	RES, 10, 5%, 0.05 W, 0201	0201	RC0201JR-0710RL	Yageo America
R12, R13	2	0	RES, 0, 5%, 0.05 W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale
R14	1	5.1k	RES, 5.1 k, 5%, 0.05 W, 0201	0201	RC0201JR-075K1L	Yageo America
R19, R27, R30	3	1.0k	RES, 1.0 k, 5%, 0.05 W, 0201	0201	RC0201JR-7D1KL	Yageo America
R21, R22	2	100	RES, 100, 1%, 0.05 W, 0201	0201	CRCW0201100RFKED	Vishay-Semiconductor
R23, R25	2	10k	RES, 10 k, 5%, 0.05 W, 0201	0201	RC0201JR-7D10KL	Yageo America
R26	1	51k	RES, 51 k, 5%, 0.05 W, 0201	0201	RC0201JR-7D51KL	Yageo America
RT1	1	10k	Thermistor NTC, 10.0k ohm, 1%,		103AT-4-70261	SEMITEC Corporation



Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
S1, S2	2		Switch, SPST-NO, Off-Mom, 0.02 A, 15 VDC, SMD	4.9x4.9mm	EVQ-PLHA15	Panasonic
SH-J1, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8	7	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1	1		Test Point, Miniature, Green, TH	Green Miniature Testpoint	5116	Keystone
TP2	1		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP3, TP4, TP5, TP6, TP7, TP21, TP23, TP24	8		Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP22	14		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone
U1	1		Impedance Track!" Battery Gas Gauge and Protection Solution for 1-Series Cell Li- Ion Battery Packs, YAH0015 (DSBGA-15)	YAH0015	BQ27Z746YAH	Texas Instruments
U3, U4, U5, U6	4		Single-Channel ESD in 0402 Package With 10pF Capacitance and 6V Breakdown, DPY0002A (X1SON-2)	DPY0002A	TPD1E10B06DPYR	Texas Instruments
C7, C9	0	0.1uF	CAP, CERM, 0.1 uF, 16 V,+/- 10%, X7R, 0201	0201	GRM033Z71C104KE14D	MuRata
J6, J12, J14	0		Header, 2.54 mm, 2x1, Gold, TH	Header, 2.54 mm, 2x1, TH	GBC02SAAN	Sullins Connector Solutions
Q2	0	60V	MOSFET, N-CH, 60 V, 0.17 A, SOT-23	SOT-23	2N7002-7-F	Diodes Inc.
Q3	0		23V 30A Common-Drain Dual N-Channel MOSFET	AlphaDFN3.2x2.1_10	AOCA36136E	Alpha and Omega Semiconductor
R4	0	2.0k	RES, 2.0 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K00JNED	Vishay-Dale
R10, R11, R15, R16, R28, R29	0	0	RES, 0, 5%, 0.05 W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale
R20, R24	0	1.0k	RES, 1.0 k, 5%, 0.05 W, 0201	0201	RC0201JR-7D1KL	Yageo America
U2	0		Single-Channel ESD in 0402 Package With 10pF Capacitance and 6V Breakdown, DPY0002A (X1SON-2)	DPY0002A	TPD1E10B06DPYR	Texas Instruments



4.4 BQ27Z746 Circuits Module Performance Specification Summary

This section summarizes the performance specifications of the BQ27Z746 circuit module.

Table 4-2. Performance Specification Summary

BQ27Z746 Specification	Min	Тур	Max	Units
Input voltage Pack+ to Pack-	-12	3.6	24	V
Input voltage Bat+ to Bat-	-0.3	3.6	6	V
Hardware Protection Specification				
Overvoltage protection	4.300	4.460	5.000	V
Undervoltage protection	2.000	2.500	3.000	V
Overcurrent in charge	-22	-9	-1	mV ⁽¹⁾
Overcurrent in discharge	1	9	22	mV ⁽¹⁾

(1) Based on $1-m\Omega$ sense resistor.



5 EVM Hardware and Software Setup

This section describes the installation of the BQ27Z746EVM PC software, and how to connect the different components of the EVM.

5.1 System Requirements

The bqStudio software requires Windows 7 or later. Using earlier versions of Windows operating system may not work with the USB driver support.

5.2 Software Installation

Find the latest software version of bqStudio on http://www.ti.com/tool/bqStudio. Search for the BQ27Z746 part number to get to the tool folder for the device. Following these steps to install the BQ27Z746 bqStudio software.

- 1. Before starting this procedure, make sure the external EV2400 is not connected to the personal computer (PC) through the USB cable.
- 2. Open the archive containing the installation package and copy its contents into a temporary directory.
- 3. Rename any previous BatteryManagementStudio folder by adding a version to the end.
- 4. Open the bqStudio installer file that was downloaded from the TI website.
- 5. Follow the instructions on-screen until completing the software installation.
- 6. Before launching the evaluation software, connect the EV2400 USB cable to the computer and I²C port to the EVM board (J11).
- 7. For the EV2400, the driver should be installed along with the bqStudio software installation.



6 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. If using Windows 7, install the software with administrator privileges.



7 Hardware Connection

The BQ27Z746 with integrated protection evaluation module requires three hardware connections: the cell(s), the I^2C communication (EV2400), and the system load/charger.

7.1 Connecting the BQ27Z746 Circuit Module to a Battery Pack

Figure 7-1 shows how to connect the BQ27Z746 circuit module to the battery, personal computer (PC), and a system load/charger.



Figure 7-1. Connect the BQ27Z746 Circuit Module to a 1SxP



7.2 EVM Jumpers Description

The following section describes the critical jumpers and their purpose on this board:

- 1. **J3 LDO Regulator Input (VDD):** This jumper ties the BQ27Z746 VDD pin to the cell+. This jumper is intended to be able to install a shunt resistor/ammeter to monitor device current consumption under various operating conditions. The shunt needs to be installed for normal operation.
- J9 I²C Clock Pullup (SCL): This jumper applies a 10-kΩ pullup resistor on the I²C communication line. When using a communication device without external pullup, install this shunt. If attaching an EV2400 and/or debug sniffer which contains unremovable pullups, these jumpers can be removed.
- J8 I²C Data Pullup (SDA): This jumper applies a 10-kΩ pullup resistor on the I²C communication line. When using a communication device without external pullup, install this shunt. If attaching an EV2400 and/or debug sniffer which contains unremovable pullups, these jumpers can be removed.
- 4. J5 Current Sense Resistor Negative Input (SRN): This jumper selects high-side or low-side current sensing for the SRN pin of the BQ27Z746. Install this shunt in the "LO" position for low-side current sensing or "HI" position for high-side current sensing. This shunt must be in the same position on both J4 and J5 jumpers.
- J4 Current Sense Resistor Positive Input (SRP): This jumper selects high-side or low-side current sensing for the SRP pin of the BQ27Z746. Install this shunt in the "LO" position for low-side current sensing or "HI" position for high-side current sensing. This shunt must be in the same position on both J4 and J5 jumpers.
- 6. **J10 External Temperature Sensor (TS/GPO):** This jumper ties the TS pin or GPO pin to an external temperature sensor (NTC) through terminal J15. Install this shunt in the "TS" position to connect the TS pin to an external temperature sensor and remove the shunt for jumper J13 or install this shunt in the "GPO" position to connect the GPO pin to an external temperature sensor.
- 7. **J13 Onboard Temperature Sensor (TS):** This jumper ties the TS pin to an onboard temperature sensor (NTC). Install this shunt for normal operation when using the default TS pin for temperature sensing.
- J16 External Enable (ENAB): This jumper ties the ENAB pin to the SDA pin to provide a system side wakeup or exit from SHUTDOWN option for pin limited battery pack connectors without requiring a charger be connected to exit SHUTDOWN.



8 Operation

This section details the operation of the BQ27Z746 bqStudio software.

8.1 Starting the Program

Run bqStudio from the desktop. The window consists of a tools panel at the top, and other child windows that can be hidden, docked in various positions or allowed to float as separate windows. When bqStudio first starts up the *Gauge Dashboard* window, the Registers window, and *Data Memory* window should be seen in the main window. *Registers, Data Memory, Commands*, and other windows can be added to the main window by clicking on the corresponding icon in the tools panel at the top of the main window. Data should appear initially in the *Gauge Dashboard, Registers* and *Data Memory* sections. The **Refresh** (single time scan) or the **Scan** (continuous scan) buttons can be clicked in order to update the data in the *Registers* and *Data Memory* windows. Continuous scan is enabled when the *Scan* checkbox is highlighted green and disabled when the *Scan* checkbox is not highlighted. The continuous scanning interval can be set with the *stopwatch* icon next to the **Scan** button. When the *stopwatch* icon is clicked, a drop-down menu appears and the desired scanning interval can be selected. The scan interval value shows up next to the *stopwatch* icon.

bqStudio provides a logging function which logs selected Data Registers last received from the BQ27Z746. To enable this function, click **Start Log**. The default elapsed interval is 4000 milliseconds. To change this interval, go to Window, select Preferences, choose Registers, and change Scan/Log Interval from 4000 to 1000 milliseconds. There is no need to log faster than 1 second as the gas gauge does not update the registers faster than 1 second.

oard	~ - E	Contraction Registers											- 0	Commands 🛙	
sh is ON - O	Click to Turn OFF	Registers										Start Log	Refresh	Commands	
ersion: 1.3.1	107	Registers												DEVICE_NUMBER	
Λ		linguiers												HW_VERSION	
	EV2400	Name	Value	Units	Name	Value	Units	Name	Value	Units	Name	Value	Units ^	FW_VERSION	
y	version: 0.18	Manufacturer Access	0x0054	hex	Volt Lo Clear	2600	mV	Cell Power	0	cW	T_sim	27.2	degC	🗸 EW BUILD	
		At Rate	0	mA	/ Temp Hi Set	60	degC	Int Temperature	25.2	degC	T_ambient	27.1	degC	2 TH_00120	
		At Rate Time To Empty	65535	min	Temp Hi Clear	55	degC	TS1 Temperature	27.1	degC	Cell 1 RaScale	1000		CHEM_ID	
		Temperature	27.1	degC	Temp Lo Set	0	degC	TS2 Temperature	-273.2	degC	E Cell 1 CompRes	0	mOhr		
<u>.</u>	I2C	Voltage	3994	W	Temp Lo Clear	5	degC	Cell Temperature	27.1	degC	PackGrid	0		SHIPMODE_ENABLE	-
		Current	0	mA	SOC Delta Set	1	%	E FET Temperature	-273.2	degC	E Cell 1 Grid	0	-	SHIPMODE DISABLE	
		Average Current	0	mA	BTP Dsg Set	150	mAh/	Cell 1 Raw Voltage	3994	mV	StateTime	40237	8	-	
2		Average Power	0	cW	BTP Chg Set	175	mAh/	Cell Raw Current	-4	mA	Cell 1 DOD0	4511	-	SHELF_ENABLE	
a ` ⊷	bq27z746	Relative State of Charge	73	%	Charging Current	4004	mA	Fit Rem Q	3828	mAH	DOD0 Passed Q	0	mAh	SLIELE DISABLE	
	1746_0_01	Remaining Capacity	3828	mAh	Charging Voltage	4400	mV	Fit Rem E	1431	CWH	DOD0 Passed E	0	cWh	· JITEL DIJKOLL	
~ 10	Addr: 0xAA	Full charge Capacity	5303	mAh	Creat Cycle Count	0	1.1	Fit Full Chg Q	5303	mAH	DOD0 Time	1	h/16	SHUTDOWN	
∼z' –	27.2 degc	Average Time to Empty	65535	min	Z Terminate Voltage	3000	mV	E Fit Full Chg E	2035	CWH	Cell 1 DODEOC	0	-		
4		Average Time to Full	65535	min	Cycle Count	0	1.1	True Rem Q	3828	mAh	Cell 1 QMax	5359	mAh	T QMAX DAY	
_		Max Load Current	-500	mA	State of Heath	99	%	True Rem E	1431	cWh	Cell 1 QMax DOD0	0	-	CHG FET TOGGLE	
		Max Load Time to Empty	459	min	Elapsed Time	0	sec	🗐 Initial Q	1475	mAh	QMax Passed Q	0	mAH		
		Volt Hi Set	4500	mV	Pack Pin Voltage	4005	mV	🗐 Initial E	604	cWh	GMax Time	178	h/16	DSG_FET_TOGGLE	
mV %		Volt Hi Clear	4400	mV	Cell Voltage	3994	mV	True Full Chg Q	5303	mAh	Temp k	2.0		# DET EN	
mV		Volt Lo Set	2500	mV	Cell Current	0	mA	True Full Chg E	2035	cWh	E Temp a	1000		* reijen	
•											Cell 1 Raw DOD	4512	- ×	GAUGE_EN	
														LIFETIME_EN	
		Bit Registers										Bit High Bit Li	ow RSVD	LT_RESET	
500	1	Name	Value	Bit7	Bit6	Bits		Bit4	Bit3	BK	2 Bit1	BRO	^	LT_FLUSH	
1000	A	Interrupt Status	0x00	RSVD	RSVD	RSV)	SOC_DELTA	TEMP_LO	TEMP	_HI VOLT_LO	VOLT_I	HI		
1500	9	Battery Status (high)	0x00C0	OCA	TCA	RSV)	OTA	TDA	RSV	D RCA	RSVD		LT_TEST	
2000 🧳	9	Battery Status (low)		INIT	DSG	FC		FD	RSVD	RSV	D RSVD	RSVD		CAL TOGGLE	
L.		Dperation Status A (hig	0x8186	SLEEP	XCHG	XDS	3	RSVD	SS	SD\	V SEC1	SECO			
		Operation Status A (low)		BTP_N	r SHELF	RSV)	SHIP	ZVCHG	CHO	3 DSG	SHPV	·	PARTIAL RESET	
		Dperation Status B (hi	0x0040	SHELF	/ SHIPM	RSV)	RSVD	RSVD	SLP	AD RSVD	INIT		# DECET	
		Operation Status B (low)		SHELF	XL	RSV)	CAL	RSVD	AUT	H RSVD	SDM	_	* KESET	
		Temp Range (high)	0x10	RSVD	RSVD	RSV		RSVD	RSVD	RSV	D RSVD	RSVD		Log Panel	
		Temp Range (low)		RSVD	OT	HT		STH	RT	STL	. u	UT			
		Charging Status (high)	0x0004	RSVD	RSVD	RSV		RSVD	NCT	RSV	D CV_DGRD1	CV_DGR	ID0	Transaction Log	
		Charging Status (low)		VCT	RSVD	SU		N	HV	MV	LV	PV		Name Cmd R	esult F
		Gauging Status	0x40	RSVD	DSG	EDV		RSVD	TC	πο	FC	FD			
		T Status (high)	0x2801	RSVD	RSVD	QMAXDO	IDOK	OCVFR	LDMD	RX	CIMAX	VDQ			
		T Status (low)		NSFM	OCVPR	ED SLPQ/V	AX	QEN	VOK	RDI	S RSVD	REST			
		Manufacturing Status (0x0010	CAL_E	LT_TES	RSV)	RSVD	RSVD	RSV	D RSVD	FET_OV	RD		
		Manufacturing Status (RSVD	RSVD	LF_E	N	FET_EN	GAUGE_EN	DSG_T	EST CHG_TEST	RSVD			
		Batt Sense Output	0x60	MANUA	RLO_P_	EN RLO_N	EN	RLO_SEL	BUF_P_EN	BUF_N	LEN BUF_REF_1	BUF_REF	_0		
		Batt Sense Status	0x00	RSVD	RSVD	RSV)	RSVD	BCP	BDP	P BCN	BDN			
		Safety Alert 1 (high)	0x0000	RSVD	RSVD	0000		OTC	RSVD	RSV	D RSVD	RSVD			
		Safety Alert 1 (low)		RSVD	RSVD	RSV)	OCD	RSVD	000	c cov	CUV			

Figure 8-1. Registers Screen

Figure 8-1 shows the main bqStudio window. Additional Flag and Control Status data can be viewed at the bottom of the registers window.

8.2 Setting Programmable BQ27Z746 Options

The BQ27Z746 comes configured per the default settings detailed in the BQ27Z746 data sheet. Ensure that the settings are correctly changed to match the pack and application for the BQ27Z746 solution being evaluated.



Note

The correct setting of these options is essential for best performance. Configure these settings using the *Data Memory* window seen in the main bqStudio window (Figure 8-2).

3 000	Data Memory X					- 0	Commar 🗸	nds 🖾	
is ON - Click to Turn OFF	Data Memory			Filter/Search	Auto Export In	nport Write_All Read All View	Comma	nds	
	Read/Write Data Memory Con	tents					🤹 DEV	VICE_NUMBER	
	Calbration	Name	Private		Value	Unit	2 H	W_VERSION	
EV2400		✓ Voitage					🤹 F	W_VERSION	
Version: 0.16	Protections	Cell Gain			12101	-		EW PLUED	
	Settings	Pack Gain			24835	-	-	141_00100	
		Current			1.000	mOhm.	2	CHEM_ID	
N	Advanced Charge Algorithm	Coldan Canachy Gain			1.000	mOhm	🖉 SHID	MODE ENABLE	
12C	Gas Gauging	Y Temperature							
·		Internal Temp Offset			0.0	*C	SHIP	MODE_DISABLE	
	Power	External1 Temp Offset			0.0	°C	🛷 Sł	HELF ENABLE	
Do272746	System Data	External2 Temp Offset			0.0	°C			
1746_0_01	200.0	 Internal Temp Model 			42000		SH	HELF_DISABLE	
Addr: 0xAA	12C Configuration	Int dam			-13300		· · · ·	SHUTDOWN	
27.1 degC	Lifetimes	Int Minimum AD			0				
2	Do Table	Int Maximum Temp			6959	0.1degK	2	QMAX DAY	
	Kallable	✓ Cell Temperature Model					🖉 CH	G FET TOGGLE	
		Coeff a1			-17447	-			
-		Coeff a2			29322	-	✓ DSC	G_FET_TOGGLE	
W III		Coeff a3			-25430	-	4	FET_EN	
10		Coeff as			29030				
		Coeff b1			-293			GAUGE_EN	
		Coeff b2			552	-	1	LIFETIME_EN	
		Coeff b3			-2887			-	
TTTT-		Coeff b4			4591	-	1	LT_RESET	
500		Rc0			11703	-	1	LT_FLUSH	
1000		Adc0			11703	-		-	
1500 -		Rpad			1	-	1	 LT_TEST 	
2000 3		Y 2nd Temperature Model			10000			CAL TOGGLE	
		Coeff a1			-17447	-		-	
-		Coeff a2			29322	-	· P/	ARTIAL RESET	
		Coeff a3			-25430	-	1	RESET	
		Coeff a4			29836	-			
		Coeff a5			1200	-	Log Panel		Cle
		Coeff b1			-293	-	Transactio	on Lon	
		Coeff b3			_2887		Name	Cond Paul	Pered
		Coeff b4			4591		Inditie	Cinia Result	. Neau
		Rc0			11703	-			
		Adc0			11703	-			
		Rpad			1	-			
		Rint			18000	•			
		 Current Deadband 							
		Deadband Carlorb Country Deadband			3	mA			
		Counter Deadoand			9	Viori			

Figure 8-2. Data Memory Screen

To read all of the data from the BQ27Z746, click the **Read All** button in the *Data Memory* window. 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 8-2 to export and import .gg.csv files. The auto export button enables gg files to be exported periodically at intervals. This feature is useful when debugging issues with the gauge. A write command is necessary if a .gg.csv file is imported to ensure that all changes made on the .gg.csv file are affected on the gauge. Use the read command to read back all of the data written to the gauge to verify the changes were made. 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 the file, which bqStudio rejects. Make sure to use a text editor like notepad or similar to edit a .gg.csv file.

8.2.1 Important Data Memory Parameters to Change

This section outlines the minimal critical settings that should be changed for even a basic evaluation. A short description is included which can be used as a recommendation on how to set the parameter value. Additional updates are needed for a production setting.

- 1. **[Gas Gauging][State][Qmax Cell 1]:** Update this value to the default design capacity of the battery being used. It represents the full unloaded chemical capacity of the cell. This value is updated by the gauge when proper learning is performed and in the field over the life of the battery.
- 2. **[Gas Gauging][IT Cfg][Term Voltage]:** Set this value to the minimum value of the end system when the absolute 0% state of charge should be reported. For normal Li-ion cells this value should range between 3.2 V to 2.75 V. It is recommended this value is not set above 3.4 V.
- 3. **[Gas Gauging][Advanced Charge Algorithm][Charge Term Taper Current]:** Set this value to slightly above the capabilities of your charger to taper to. A recommended value is C/20 where C is the default capacity of the cell. For example, a battery with 1000-mAh capacity should have a taper current of around 50 mA.
- 4. [Gas Gauging][Advanced Charge Algorithm][Low/Standard/High/Rec Temp Charging][Voltage]: Update this parameter to the maximum charging voltage of the battery to be used. For a typical Li-Ion battery this value is between 4.45 V to 4.2 V.
- 5. **ChemID:** It is important that the correct ChemID is updated for the best accuracy. Refer to Section 8.3 on how to update the chemistry in the device. If your cell is not included in the chemistry list, it is possible to run a match on the battery by following the steps at the following link: http://www.ti.com/tool/gpcchem. For basic testing, if the correct chemistry is unknown it is important to chose a chemistry ID with the same maximum charging voltage as the intended cell. The recommended IDs for common charging voltages are as follows:
 - 4.2 V (ID 1202)
 - 4.35 V (ID 3230)
 - 4.4 V (ID 3142)

8.3 Setting the Chemistry

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.
- Press Program Selected Chemistry to update the chemistry in the device.

Operation

	····				· · · · · · · · · · · · · · · · · · ·		Comm	unde SZ		
snBoard		Chemistry Pregramming					Comm			
efresh is ON - O io Version: 1.3.1	Click to Turn OFF	Chemistry Programming					Comm	ands		
		Program Battery Chemistry					🤹 D	EVICE_NUMBER		
$\boldsymbol{\Lambda}$		Most Li-ion cells use LiCoO2 cathode and graphit load settings for any alternate chemistry if your c	tized carbon anode, which is supported by the default firmware in the Imp ell manufacturer indicates that their cells use a different chemistry than LiC	edance track fuel gauges. This tool allow toO2 cathode and graphite anode.	is the fuel gauge to be set up for various alternate battery chemistries. Use this too	ol to	2	HW_VERSION		
	EV2400	Manufacturer	Model	Chemistry ID	Description	^	2	FW_VERSION		
~	Version: 0.18	360FLY	PR-693231 (815mAh)	1318	LiCoO2/carbon 11			DW PUILD		
		5 60C)		1984	LiMn2O4 (Co.Ni)/carbon. 4.4V		1	PW_BUILD		
		A&TB	LGR18650OU	0100	LiCoO2/graphitized carbon (default)		1	CHEM_ID		
		5 A01	ALPBA002 (3430mAh)	0207	NiCoMn/carbon 2					
	I2C	A123	APR18650M1 (1100 mAh)	0404	LiFePO4/carbon		* SH	IPINIODE_EINABLE	•	
•		A123	26650M1B (2500mAh)	0434	LiFePO4/carbon		🛷 SH	PMODE_DISABLE	E	
^		A123	ANR26650M1-B (2500mAh)	0440	LiFePO4/carbon					
		A123	ANR26650M1-B Consult TI before use (2500mAh)	0453	LiFePO4/carbon			DHELF_EINABLE		
200 m	1745 0 01	A123 Systems	26650A	0400	LiFePO4/carbon		1	HELF_DISABLE		
	Addr: 0xAA	A123Systems	ANR26650M1-B (2500mAh)	0465	LiFePO4/carbon			CUUTDOWN		
	26.3 degC	A123Systens	A123_Pack (20000mAh)	6105	NiMH			SHOTDOWN		
'U'Z		A123Systens	A123 (20000mAh)	6111	NiMH		1	QMAX DAY		
		AA Portable Power	LFP-18650-1500 (1500 mAh)	0439	LiFePO4/carbon					
67		AAPortable	26650 (3300mAh)	0451	LiFePO4/carbon		* 0	HO_FEI_IOGGLE		
		AAPortable	8790160 (10000mAh)	0456	LiFePO4/carbon		/ D	SG_FET_TOGGLE		
		ABS	62D12000_InVista (12000mAh)	6116	NiMH			# FET EN		
3994 mV		ABS	BPI-50C5500_InVista (5500mAh)	6117	NiMH			 Fergeix 		
73%		Acebel	ECFV1260 (60Ah)	0807	Lead Acid		1	GAUGE_EN		
		Advanced Electronics Energy	AE18650C-26 (2600mAh)	2151	NiCoMn/carbon			LICETIME EN		
		AEenergy AEenergy	AE1004765 (3500mAh)	0131	LiCoO2/carbon 4		-	CIFC HIVIE_EIN		
CALCULATION OF THE OWNER		AEenergy	AE583696PM1HR (2150 mAh)	0222	PSS, LiNiO2 with Co, Mn doping			LT_RESET		
500 500		AESC	29589-3NK0B (16500mAh)	1554	LiCoO2/carbon 11					
1000 📘 1000 🗍		AESC	29589-4NN0A (10425mAh)	1561	LiCo02/carbon 11			cigreositi		
0 🔍 1500 🗄	3	AESC	ModuleHC3 (120Ah)	1785	LiMn2O4 (Co,Ni)/carbon, 4.4V			LT_TEST		
00 2000 🕃	7	AET	TP2000-1SPL (2000mAh)	0190	LiCoO2/carbon 11			CAL TOGGLE		
0 2		AGM	INR34600K2 (7500mAh)	0210	NiCoMn/carbon		-	CAL_IOOGLE		
		AISIPU	3872C8 (5100mAh)	1335	LiCoO2/carbon 11		1	PARTIAL RESET		
		AISIPU	723292 (3080mA)	1363	LiCoO2/carbon 11			· PESET		
		AISIPU	856360 (4750mAh)	3636	LiMn2O4 (Co,Ni)/carbon, 4.35V			* KESET		
		MALE	045062 (2300 mAh)	1254	LiNiCoMn02/SGenNo1, 4.2V		Log Pane			Clear Lor
		ALE .	ALE0/34/0 (1/00mAn)	2047	NICOMIN/carbon					
		Alees	20/00FE (3300mAn)	0411	LIFePO4/carbon		Iransac	ion Log		
		Allees	A2/70102 (15000HAH)	1050	LinerOw/carbon		Name	Cmd R	esult	Read A
		Allum	ABISUBUSU (SSUUMAN)	1039	LININ204 (C0,NI)/ carbon, 4.35V					
		Amita	LPC 7/6285M	0204	NiCowin/carbon	~				
			Program Selected Chemistry	Program from GPCRB file						

Figure 8-3. Chemistry Screen



9 Related Documentation from Texas Instruments

Updated documents also can be obtained through the TI website at www.ti.com.

- 1. Texas Instruments Data sheet: BQ27Z746 System-Side Impedance Track™ Fuel Gauge with Integrated Sense Resistor, SLUSDW2
- 2. Texas Instruments Technical Reference Manual: BQ27Z746 Technical Reference Manual, SLUUCA6

10 Revision History

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

DATE	REVISION	NOTES
October 2021	*	Initial Release

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