

Application Report SLUA771-May 2016

bq27220 Calibration Guide

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PMP/BMS/Handheld

ABSTRACT

The bq27220 includes one-time programmable (OTP) profiles that allow users to program the settings that would otherwise be required to be initialized in RAM after powering up. Calibration data is one of the included subsets of data that can be programmed in to OTP. This guide goes over the process on how to calibrate the bq27220 using the provided TI tools and how to transfer that to OTP.

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1 Tools Required for Calibration

The following tools are required for calibration:

- bq27220EVM with EV2400
- 2x power supplies, one for powering the gauge; another, for the OTP programming voltage.
- DC load capable of at least 1 A.
- bqStudio (minimum v1.3.51)
- SmartFlash

2 Operation

This section details the operation of the bq27220 bqStudio software.

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Operation

2.1 Starting the Program

With the EV2300 or EV2400 and the bq27220EVM connected to the computer, run bqStudio from the desktop or installation directory. 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 *DashBoard*, the *Registers*, and the *Commands* windows should be open. Additional windows can be added by clicking the corresponding icons in the tools panel at the top of the main window.

The **Scan** (continuous scan) or **Refresh** (single time scan) buttons can be clicked in order to update the data in the *Registers* and *Data Memory* windows.

bqStudio provides a logging function which logs selected *Data Registers* last received from the bq27220. To enable this function, click the **Start Log** button. The default elapsed interval is 4000 milliseconds, to change this interval, go to *Windows*, 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 gauge will not update the registers faster than 1 second.

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Figure 1. Registers Screen

2.2 Setting Programmable bq27220 Options

The bq27220 comes configured per the default settings detailed in the *bq27220 Technical Reference Manual* (TRM – SLUUBD4). Ensure that the settings are correctly changed to match pack and application for the bq27220 solution being evaluated.

NOTE: The correct setting of these options is essential to get the best performance. The settings can be configured using the *Data Memory* window (Figure 2).



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Figure 2. Data Memory Screen

To read all the data from the bq27220 RAM, OTP, and non-volatile memory, click on the **Read All** button on the *Data Memory* window. Make sure the device is not sealed and in full access to read/write to the data memory. To update a parameter in RAM, click on the desired parameter and a window will pop-up that provides details on the selected parameter. Next, enter the value in the value textbox and press **Enter**. After **Enter** has been pressed, bqStudio will update the selected parameter.

See the TRM (SLUUBD4) for details on how to program the OTP values on the bq27220.

The **Import** button in the *Data Memory* window can be clicked in order to import an entire configuration from a specified *.gg.csv file.

The configuration can be saved to a file by clicking the **Export** button in the *Data Memory* window and entering a file name. The configuration will be saved to a *.gg.csv file. The module calibration data is also held in the bq27220 data memory. If the *Gauge Dashboard* is not displaying any information, then the bq27220 may not be supported by the bqStudio version that is being used, a bqStudio upgrade may be required.

3 Calibration Process

The process to calibrate and program the OTP on the bq27220 is as follows:

- 1. Connect the bq27220 to bqStudio using the EV2400.
- 2. Perform the calibration storing the calibration data in RAM.
- 3. Use bqStudio to generate the ot.fs file required for OTP programming.
- 4. Use SmartFlash to program the OTP profile on the gauge.

See the following sections detailing the steps.

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3.1 Calibration

The bq27220 must be calibrated to ensure accurate value reporting. This can be done by going to the *Calibration* window in bqStudio.

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Figure 3. Calibration Screen

NOTE: Please ensure the gauge is unsealed and in full access before proceeding with the calibration procedure. See the TRM for details on how to unseal and place the gauge in full access.

Calibration consists of the following:

- CC Offset/Board Offset: Simply check Calibrate CC Offset and Calibrate Board Offset and click Calibrate Gas Gauge to calibrate the Coulomb counter and board offsets. Ensure no current is flowing through the sense resistor during these steps. After a successful calibration, a green check mark shows next to the Calibrate Gas Gauge button.
- Current: Connect a 2-A load to LOAD+/LOAD- or a current source to LOAD-/PACK-. Ensure the
 measured current reported is negative, or else reverse the connections. Check Calibrate Current and
 enter the current into the textbox followed by Calibrate Gas Gauge.
- Voltage: Apply a known DC voltage to PACK+/PACK- with no current flowing through the sense resistor. Check Calibrate Voltage and enter the voltage into the textbox followed by Calibrate Gas Gauge.

Once these steps are completed, program the design parameters for the application in RAM. Once both the design and calibration parameters are verified, the ot.fs file can be generated. This file is used to program the OTP profile by using SmartFlash.

The OTP profile must be programmed in its entirety using the ot.fs. In order to avoid programming incorrect values, validate the configuration files before programming the OTP, for example, test out the values in RAM and ensure performance is acceptable before proceeding with writing to OTP.



4 OTP Mode FlashStream (ot.fs) Files

The Battery Management Studio (bqStudio) software allows generation of specific instruction files (ot.fs files), containing the necessary I²C commands a host can send to the bq27220 device to program the RAM-based data memory parameters. The commands in these files are largely ROM commands only used when the gauge is in CONFIG_UPDATE mode.

The ot.fs file is an ASCII text file containing commands and data. Each line of the file represents one command and potentially 96 bytes of data, as described in the following text. No row contains more than 96 data bytes. The first two characters of each row represent the command, followed by a ":

- "W:" Indicates that the row is a command to write one or more bytes of data.
- "C:" Indicates that the row is a command to read and compare one or more bytes of data.
- "X:" Indicates that the row is a command to wait a given number of milliseconds before proceeding.

White space is used to separate fields within the ot.fs files. Each row contains only one of the four commands. The commands discussed in this section can be implemented by a system that can perform multi-byte or single-byte operations for I²C.

Figure 4 shows a typical ot.fs file snippet generated from the bqStudio software.



Figure 4. Typical ot.fs File Snippet

4.1 Write Command

The write command "W:" instructs the I²C master to write one or more bytes to a given I²C address and given register address. The I²C address format used throughout this document is based on an 8-bit representation of the address. The format of this sequence is:

"W: I2CAddr RegAddr Byte0 Byte1 Byte2 ""

For example, the following:





W: AA 55 AB CD EF 00

indicates that the I²C master writes the byte sequence 0xAB 0xCD 0xEF 0x00 to register 0x55 of the device addressed at 0xAA.

More precisely, it indicates to write the following data to the device address 0xAA:

0xAB to register 0x55

0xCD to register 0x56

0xEF to register 0x57

0x00 to register 0x58

4.2 Read and Compare Command

The read and compare command is formatted identically to the write command. The data presented with this command matches the data read exactly, or the operation should cease with an error indication. The ot.fs file contains no information about program flow or decision making. If a read and compare command results in data which does not match the expected values, the interpreting program needs to handle the next step itself. It should not continue with further commands but would typically go back to the beginning of the ot.fs file and try again several times before giving up.

The format of this sequence is:

"C: i2cAddr RegAddr Byte0 Byte1 Byte2"

An example of this command is as follows:

C: AA 55 AB CD EF 00

This example expects the master to read back 4 bytes from the register address 0x55 of the device addressed at 0xAA and then compare the data to the values given on the line command in this same order as 0xAB, 0xCD, 0xEF, and 0x00.

4.3 Wait Command

The wait command indicates the host waits a minimum of the given number of milliseconds before continuing to the next row of the FlashStream file. A wait command is typically used to allow the fuel gauge processor to complete a process before proceeding to the next command in the file.

For example, the following:

X: 200

indicates that the I²C master must wait at least 200 ms before continuing.

4.4 CONFIG UPDATE Mode

If the application requires different configuration data for the fuel gauge, the system processor can update RAM-based data memory parameters using the *Control()SET_CFGUPDATE* subcommand to enter the CONFIG UPDATE mode.

NOTE: To ensure that the fuel gauge has entered CONFIG UPDATE mode correctly, there must be at least an 1100-ms delay after sending the *SET_CFGUPDATE*. Operation in this mode is indicated by the *Flags()*[*CFGUPMODE*] status bit.

In this mode, fuel gauging is suspended while the host uses the extended data commands to modify the configuration data blocks. To resume fuel gauging, the host must send a *Control()SOFT_RESET* subcommand to exit the CONFIG UPDATE mode, which clears both *Flags()[ITPOR]* and *[CFGUPMODE]* bits. After a timeout of approximately 240 seconds (4 minutes), the gauge automatically exits the CONFIG UPDATE mode if it has not received a *SOFT_RESET* subcommand from the host.



The memory of the bq27220 device is separated into memory subclasses defined in this document. The memory cannot be directly addressed, but is updated through a sequence of extended commands that can access each block of memory indirectly. The ot.fs file updates these blocks to write the proper configuration so the bq27220 device can have proper gauging performance and match the system characteristics. These updates are stored in RAM and need to be reprogrammed any time the device loses power. (The *[ITPOR]* bit in the *Flags()* register indicates that the RAM configuration has been reset to the defaults and is in need of updating using the ot.fs file.)

4.5 Programming Instructions

4.5.1 Using ot.fs Files

The following list shows how to use ot.fs files to configure the bq27220 device on power up:

- 1. Use the GPCCEDV tool (on ti.com) to generate the 7-point CEDV parameter and the 11-point loaded voltage points, see the *bq27220EVM-744 User's Guide* (SLUUBF5).
- 2. Use the Battery Management Studio (bqStudio) software to finalize all the values for Calibration, Configuration, or Gas Gauging in RAM based on the application.
- 3. Complete the following OTP profiles:
 - (a) Programming the OTP Profile 1
 - (i) Fill out the CEDV Profile 1 section in RAM with required values.
 - (ii) Write CEDV Profile Select \rightarrow Battery ID to 4.
 - (b) Programming the OTP Profile 2
 - (i) Fill out the CEDV Profile 1 section in RAM with required values.
 - (ii) Write CEDV Profile Select \rightarrow Battery ID to 8.
 - (c) Programming the OTP Profile 3
 - (i) Fill out the CEDV Profile 1 section in RAM with required values.
 - (ii) Write CEDV Profile Select \rightarrow Battery ID to 16.
- 4. Use bqStudio to generate the ot.fs file, which contains I²C instructions (with data) on how to program the OTP with the values that were just set up in RAM.
- 5. Use the ot.fs file with the SmartFlash programming tool; the OTP on the bq27220 device can be programmed.

4.6 General Setup and Software Installation to Program OTP

- 1. Equipment needed:
 - (a) Lab power supply configured for 7.4-V output (expect approximately 5-mA maximum current)
 - (b) Battery or second power supply with \geq 3.0-V output (expect approximately 1-mA maximum current)
 - (c) EV2300 (v3.1r or later) or EV2400 USB with I²C interface adapter
 - (d) Unprogrammed bq27220 device assembled in the battery pack or on the EVM
 - (e) Example .gg file provided by factory
 - (f) Battery Management Studio (bqStudio) software installer
 - (g) SmartFlash software executable
- 2. Install bqStudio software.
- 3. Connect the EV2300 or EV2400 to the unprogrammed device or EVM.
- 4. Connect the battery to BAT(+) and VSS(-) pins.
- 5. With output disabled, connect the lab power supply to GPOUT and VSS(-) pins.

NOTE: Do not apply 7.4 V to the device until prompted by software.

4.7 Launch bqStudio Software

- 1. Launch bqStudio software.
- 2. Confirm Gauge Dashboard panel detects the EV2x00 adapter and the bq27220 device.
- 3. If the device has been previously SEALED, UNSEAL it by sending the appropriate keys to *Control()* (0x00 and 0x01). The bq27220 boots up in UNSEAL mode, but not in FULL ACCESS mode. Enter FULL ACCESS mode to gain access to the *Data Memory*.
- 4. Click **Data Memory** to show the OTP factory defaults that are in data memory (RAM).
- 5. Click **Import** to load **Data Memory** contents from the provided sample .gg file.

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0220.0.03 22.4 degC Bit Registers Log P B684 mV 5000 Bit Registers Log P Bit Registers Control (hgh) Bit Registers Log P Control (hgh) 0x0000 RSX0	Bit Registers Still PROFILE 6 * Still PROFILE 6 * Still PROFILE 6 Bit Registers Name Bit 7 Bit 6 Bit 8 Bit 4 Bit 3 Bit 2 Bit 1 Bit 0 Control (ling) Control (ling) Control (ling) Control (ling) Control (ling) Bit 1 B	bq27220													SET_PR	OFILE_5	
Bit Registers Log P Bit Registers Bit Registers Control (high) Control (high) Control (high) Control (high) Control (high) Bit X0000 RSV0 RSV0 RSV0 RSV0 RSV0 RSV0 Bit Registers Tan Control (high) Control (high) Control (high) RSV0 RSV0 RSV0 Bit Registers Tan Did control (high) Control (high) Control (high) Control (high) Control (high) RSV0 Bit Registers Tan Battery Status (high) Control (high) Control (high) Control (high) Control (high) Control (high) Control (high) RSV0 Battery Status (high) RSV0 Battery Status (high) RSV0 Did Control (high) RSV0 Did Control (high) RSV0 Did Control (high) RSV0 RSV0 RSV0	Bit Registers CC_OFFSET CC_OFFSET Name Value Bit 7 Bit 6 Bit 5 Bit 4 Bit 3 Bit 2 Bit 1 Bit 0 CC_OFFSET_SAVE Control (high) 0:0000 RSVD RSVD <td< td=""><td>0220_0_03</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>SET_PR</td><td>OFILE_6</td></td<>	0220_0_03													SET_PR	OFILE_6	
B94 mV Bit Registers Log P 65% Bit Registers Image: Control (might) 0x0000 RSV0 RSV0 </td <td>BIR Registers Name Value Bit 7 Bit 6 Bit 5 Bit 4 Bit 3 Bit 2 Bit 1 Bit 0 CC_OFFSET_SAVE Control (high) 0x0000 RSVD <</td> <td>22.4 degC</td> <td></td> <td>BOARD</td> <td>OFFSET</td>	BIR Registers Name Value Bit 7 Bit 6 Bit 5 Bit 4 Bit 3 Bit 2 Bit 1 Bit 0 CC_OFFSET_SAVE Control (high) 0x0000 RSVD <	22.4 degC													BOARD	OFFSET	
Bit Registers Log P 000 Bit Registers Image: Control (high) 0x0000 RSV0 RSV0 <td>Bit Registers CC_OFFSET_SAVE Name Value Bit 7 Bits Bit 8 Bit 3 Bit 2 Bit 1 Bit Cop Panel Cop Panel<</td> <td>v</td> <td></td> <td>CC_0I</td> <td>FFSET</td>	Bit Registers CC_OFFSET_SAVE Name Value Bit 7 Bits Bit 8 Bit 3 Bit 2 Bit 1 Bit Cop Panel Cop Panel<	v													CC_0I	FFSET	
Bit Registers Since Bit Registers Corp P 2 Or corr (ling) 0x0000 BXVD	Bit Registers Name Value Bt7 Bt6 Bt5 Bt4 Bt3 Bt2 Bt1 Bt0 2 Centol (lipid) 0x0000 RSVD RSVD RSVD RSVD RSVD RSVD Bt7 Bt6 Bt5 Bt4 Bt3 Bt2 Bt1 Bt0 2 Betry Status (init) 0x0429 FD 0CVCOMP OVCOMP COA BCA SNO02 BAT1_D2 BAT1_D0 BCA SNO0 RSVD R	\mathbf{P}													CC_OFFS	ET_SAVE	
56% Bit Registers Log P Name Value Bit 7 Bit 8 Bit 4 Bit 3 Bit 2 Bit 1 Bit 0 2000 0x0000 BSV0 RSV0 RSV0 <td>Bit Registers Name Value Bit 7 Bit 6 Bit 5 Bit 4 Bit 3 Bit 2 Bit 1 Bit 0 2 Portol (high) 0x0000 RSV0 <t< td=""><td>3694 mV</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>CMD</td></t<></td>	Bit Registers Name Value Bit 7 Bit 6 Bit 5 Bit 4 Bit 3 Bit 2 Bit 1 Bit 0 2 Portol (high) 0x0000 RSV0 RSV0 <t< td=""><td>3694 mV</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>CMD</td></t<>	3694 mV														CMD	
Name Value Bu7 Bit Ba5 Ba4 Bu3 Bit2 Bit1 Ba0 \$00 Centrol (hgh) 0x0000 RSX0	Name Value Bit Bit<	56%	Bit Registers													Clear	
Image: Control (high) 0.0000 RSV0 RS	2 Control (high) 0.0000 RSV0 RSV0 </td <td></td> <td>Name</td> <td>Value</td> <td>Bit7</td> <td>Bit6</td> <td>Bit5</td> <td>Bit5</td> <td>Bit5</td> <td>Bit4 Bit</td> <td colspan="2">Bit3 Bit</td> <td>2 Bit1</td> <td colspan="2">Bit0</td> <td>Transaction Log</td> <td></td>		Name	Value	Bit7	Bit6	Bit5	Bit5	Bit5	Bit4 Bit	Bit3 Bit		2 Bit1	Bit0		Transaction Log	
Control (low) RSV0 RSV0 CCA BCA SNOOZE BATL 02 BATL 101 BATL 100 (2) Battery Struis (hi 0x4029 FD 0CVCX0MF 0CVFAL SLEEP 0170 0170 FC CHRIN Battery Struis (hii 0x4029 FD 0CVCX0MF 0CVFAL SLEEP 0170 0170 FC CHRIN D00000 RSV0 TCA 0CVCX0MF 0CV	Control (row) RSVD RSVD CCA BCA SNO2E BAT_ID2 BAT_ID1 BAT_ID1 Ø Batery Status (n., 0x4029 FD OCVCXMP OCVFAK SEEPP OTC OTD FC CHCRHH Batery Status (n., 0x4029 RSVD TCA OCVFAK SEEPP OTC OTD FC CHCRHH Ø Operation Status (-, 0x004 RSVD	Contrast of the second s	Control (high)	0x0000	RSVE	RSVD	RSVD		RSVD RSV	/D	RSV	/D RSVD	RSV	D	Name Cmd	Result	
Open // Battery Status (n 0x4023 FD OCVCOMP OCVCAL SLEEP OTC OTD FC CHIGH Battery Status (nu) BSVD TCA OCVCOMP AUTH GO BATTRES TDA SYSUWN DSG 000000000000000000000000000000000000	☑ Battery Status (m.) 0x020 FD 0x0200P 0x07xAL SEEEP 010 FC 0F0RH Battery Status (m.) RSVD TCA 0X020A AUTH_GD BATTRES TDA SYSDW1 DSG Ø operation Status (0x08L RSVD RSVD RSVD RSVD RSVD RSVD RSVD OF0LIPATE RSVD RSVD Ø operation Status (0x08L ETPNT SMTH INTCOMP VDQ EDV2 SEC1 SE09 CAMD ☑ Gauging Status (VDQ EDV2 EDV1 RSVD RSVD RSVD RSVD Gauging Status (CF DSG EDV RSVD TC TD FC FD	500	Control (low)		RSVE	RSVD	CCA		BCA SNO	DZE	BATT	ID2 BATT_ID1	BATI	IDO			
Balling Status (low) KSVU ILA OUVGO AUIH GU BALINGES IDA SYSUWA DSG	Bittery Status (i MSVD ICA UCKeg0 AUH (g) BATHESS I/DA STSTWH USS Ø operation Status (60/084 RSVD RSVD </td <td>004 [2]</td> <td>Battery Status (hi</td> <td>0x4029</td> <td>FD.</td> <td>OCVCOMP</td> <td>OCVFA</td> <td>L</td> <td>SLEEP OT</td> <td>C</td> <td>011</td> <td>D FC</td> <td>CHGI</td> <td>Ab4</td> <td></td> <td></td>	00 4 [2]	Battery Status (hi	0x4029	FD.	OCVCOMP	OCVFA	L	SLEEP OT	C	011	D FC	CHGI	Ab4			
	⊘ Operation Status (0 MOV NOV NOV NOV NOV NOV NOV Operation Status (CF Strift i NITOOM VDQ EDV2 EDV1 RSVD FCCX RSVD RSVD Gauging Status (CF DSG EDV RSVD TC TD FC FD	2000 2000 3	Battery Status (low)	0.00004	RSVL		DEVGL		AUTH_GD DATTH	RES ID	10/	DATE DEVID	DSU	2 D			
	Operation Status (DPMIN SHIIN PRODUCT VOL EUV2 SECU SECU OCUM □ Gauging Status (0x000 VDQ EUV2 EUV1 RSVD RSVD FCCX RSVD RSVD Gauging Status (CF DSS EDV RSVD TC TD FC FD	CE X	Operation Status (000004	ETDIM	T CALL	INITCOM	0	NOO ED	10	Croor	Mare Rovo	CAL	40			
	Cenging statis (I success for the second state sta	-00	Generation Status (0~9000	MDO	EDV2	EDVM			/D	ECC	V PSVD	DRIV	nD.			
Gauging States (III. School CF DVS EDV SKVD III. TO TO FC FD			Gauging Status (I	0,0000	CE	DSG	EDV		RSVD		TIT	FC	FD	0			
															• m		

Figure 5. Launch bqStudio Software

4.8 Load .GG File

This procedure imports the fuel gauge data or the data memory image to the device.

1. Browse to a desired template or sample *.GG parameter file. (example: bq27220.gg.csv in Figure 6.)

2. Click the **Open** button.



Name +	Date modified	Туре	Size
📙 Configuration Files	3/10/2016 12:02 PM	File folder	
Jocumentation	3/11/2016 12:02 PM	File folder	
🌽 Firmware	3/10/2016 4:41 PM	File folder	
鷆 Report	3/14/2016 11:37 AM	File folder	
퉲 Sourcecode	3/11/2016 11:06 AM	File folder	
🎉 Test Log Files	3/10/2016 11:37 AM	File folder	
🛂 bq27220.gg.csv	3/15/2016 9:35 AM	Microsoft Excel Com	46 K
(
er li enne			
File name: [bq2/220,gg.csv		°.gg.csv	
		2.2 - 1.4 C -	
		Open 👻	Cancel

Figure 6. Load .GG File

4.9 Confirm or Update Data Memory Parameters

Use the following list to confirm or update data memory parameters:

- 1. Imported Data Memory (RAM) parameters that differ from the factory defaults appear in orange font.
- 2. Confirm or update Data Memory (RAM) parameters as required.
- 3. Save .gg file for future reference by clicking Export.



OTP Mode FlashStream (ot.fs) Files

ters Data Memory	ands Calibration	Golden Image	Watch Da	ta Graph Erro	S Irs						🗳 🍳 Battery Mana
gisters 🗢 Data Memory 🕮 a Memory	Calibration 🦃 Advanced Comm			Filter/Search	5		n	•	2 /	• • • •	Commands
/Write Data Memory Cont	ents				Auto Export	Hex Dump Exp	port Impor	t write_Au	Read All Vie	BW	
,	T Page 100	1		1	1.00				1 C 1 S	1001	ENTER_CPG_UPDAT
Calibration	Name	Private	Value	Unit	Physical S	Data Length	Row Num	Row Offset	Native Units	1-1	EXIT_CFG_UPDATE_RE
C	Full Charge Capacity		3000	mAn	0x929d	2	660	29	mAn		EVIT CEC LIDOAT
Configuration	Design Capacity		3000	mAn	0x9291	2	000	31	mAn		# EXIT_CFG_OPDAT
Gas Gauging	Charge Termination Voltage		07.08	mv mV	0x9283	2	001	5	mv		SET PROFILE 1
	Charge Termination Voltage		2240	mv	0x92a5	2	001	2	mv		
Calibration (Present OTP)	CO		4.40		0x92a7	2	661	0	-		SET_PROFILE_2
infiguration (Present OTP)	PA		867		0x92a5	2	661	11	-		
migdradon (rresent on)	TO		4030		0x92ad	2	661	13	2		SET_PROFILE_3
as Gauging (Present OTP)	P1		216		0x92af	2	661	15	<u> </u>		SET PROFILE 4
M	TC		9		0x92b1	1	661	17	-		
Calibration (ROM Default)	C1		0		0x92b2	1	661	18	_		SET_PROFILE_5
onfiguration (ROM Default)	Age Factor		0	-	0x92b3	1	661	19	_		
	Fixed EDV 0		3631	mV	0x92b4	2	661	20	mV		SET_PROFILE_0
as Gauging (ROM Default)	EDV 0 Hold Time			s	0x92b6	1	661	22	s	÷	
	Fixed EDV 1		3385	mV	0x92b7	2	661	23	Vm	1	Log Panel Clear
	EDV 1 Hold Time		1	s	0x92b9	1	661	25	s		Transaction Lon
	Fixed EDV 2		3501	mV	0x92ba	2	661	26	mV		Name Cmd
	EDV 2 Hold Time			s	0x92bc	1	661	28	s		ENTER 0x90
	Voltage 0% DOD		4173	mV	0x92bd	2	661	29	M		EXIT C 0x91
	Voltage 10% DOD		40.43	mV	0x92bf	2	661	31	mV		ENTER 0x90
	Voltage 20% DOD		3925	mV	0x92c1	2	662	1	mV		EXIT C 0x91
	Voltage 30% DOD		3821	mV	0x92c3	2	662	3	mV		ENTER 0x90
	Voltage 40% DOD		3725	Wm	0x92c5	2	662	5	Vm		EXIT C 0x91
	Voltage 50% DOD		3656	mV	0x92c7	2	662	7	mV		ENTER 0x90
	Vottage 60% DOD		3619	mV	0x92c9	2	662	9	M		EXIT C 0x91
	Voltage 70% DOD		3882	mV	0x92cb	2	662	11	mV		ENTER 0x90 1
	Voltage 80% DOD		3515	mV	0x92cd	2	662	13	mV		EXIT C 0x91
	Voltage 90% DOD		3439	mV	0x92cf	2	662	15	mV		ENTER 0x90
			and the second second	10.00 M	0.0014		000	1. CA-		1000	

Figure 7. Confirm or Update Data Memory Parameters

ogisters Data Memory Comman	Ids Calibration Ad	wanced Comr	n Golden In	age Watch Data	a Graph Errors								E 4 8	attery M
Registers 🗢 Data Memory 🖾 🛄	Golden Image									- 8	Comm	ands 🖾		-
ata Memory							Filter/Search	Auto Export Export	Import Write_	all Read All View ▼	Comm	ands		
ead/Write Data Memory Contents											EN	NTER_CFG	UPDATE	
	Name					0	rivate	Value		loit 🔺	✓ EXIT.	_CFG_UPE	ATE_REI	NIT
Calibration	A RTD						indic	Value						=
Configuration	IO Config							00		1ex		.xii_cio_	OFDATE	_
	Init Discharge Se							150		nAh	1	SET_PRC	FILE_1	
Gas Gauging	Int Charge Set 175 mAh										SET_PROFILE_2			
Calibration (Present OTP)	# Power											CET DDG	-	-
	Sleep Current 10 mA											SET_PRC	FILE_3	
Configuration (Present OTP)	Bus Low Time							5		s		SET_PRC	FILE_4	
Gas Gauging (Present OTP)	Offset Cal Inhibit	Temp Low						5.0		°C		SET DRC	EILE 5	-
6 17 17 19 19 19 19 19 19 19 19 19 19 19 19 19	Offset Cal Inhibit	Temp High						45.0		°C		SEIGING	AILL_S	
Calibration (ROM Delauti)	Sleep Voltage Tir	ne						20		s	1	SET_PRC	FILE_6	
Configuration (ROM Default)	Sleep Current Tin	Time 20 s		s	BOARD_OFFSET		OFFSET							
Cas Causing (BOM Default)	 Current Thresholds 												FOFT	-
Gas Gauging (ROM Default)	Discharge Detect	ion Threshold						60	r	mA		<pre>CC_OF</pre>	FSEI	
	Charge Detection Threshold 75 mA									CC_OFFSET_SAVE				
	Quit Current							40	r	mA				<u>_</u>
	Discharge Relax	lime						60		s	Log Pan	el		Clear Lo
	Charge Relax Tin	ne						60		s	Transac	tion Log		
	Quit Relax Time							1		S	Name	Cmd	Result	Read
	⊿ Data													
	Initial Standby							-10	ſ	mA				
	 Discharge 													
	SysDown Set Vol	t Threshold						3150		mV =				
	Sys X					Battery ID								
	Sys		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0				
	# SOC	MSB	RSVD	RSVD	RSVD	BATT ID5	BATT ID4	BATT ID3	BATT ID2	BATT ID1				
	Flag	MOO							-					
	Flag				is a second s	· Write to Data Merr	ory							
	A CEDV													
	Battery ID							04	,	nex				
	# 01P													

Figure 8. Update Battery ID

4. Set BATT_ID2 to 1.

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4.10 Save .OTFS File

The following steps show how to save an .OTFS file

- 1. Click the GoldenImage icon.
- 2. From the GoldenImage panel, enter desired .OTFS base file name (example, bq27220.ot.fs).

NOTE: No Options changes are required.

- 3. Click Create Image File.
- 4. Exit bqStudio software.

Battery Manager	nent Studio (bgStudio) 1.3.50					_ 0 X		
Registers Data M	remory Commands Calib	Advanced Co	mm Golden Image Wath Data Graph Errors		1	Battery M		
JashBoard	×=8	🚳 Registers 🗢 Data	Memory 🛄 Golden Image 🖾	° 0	Commands	x • E		
Auto Refresh is 0	OFF - Click to Turn On	Golden Image			Command	s		
bqStudio Version:	1.3.50	Golden Image Expo	rt		ENTER (CFG UPDATE		
	510300	This plug-in will allo	w you to export image files.		✓ EXIT_CFG_	UPDATE_REINIT		
2	Version:3.1m	Output Location	memory contents of the connected gauge and save it to your hard drive in various formats.		EXIT_C	FG_UPDATE		
~		Output Directory	C:\TI\BatteryManagementStudio\OutputFiles	Browse	✓ SET_I	PROFILE_1		
	100	Base File Name	0220_0_03-bq27220	Open Directory	SET_	PROFILE_2		
	Output Formats							
-		GMFS File (.fs)	0220_0_03-bq27220.gm.fs	Options	SET_I	PROFILE_4		
	bq27220	OTFS File (.fs)	0220_0_03-bq27220.ot.fs	Options	SET_J	PROFILE_5		
V.	Addr: 0xAA		Create Image Files		SET_I	PROFILE_6		
y and the second	22.2 degC				Ø BOAR	D_OFFSET		
60					CC,	OFFSET		
3694 mV					<pre> CC_OF</pre>	FSET_SAVE		
56%					l on Daniel	V CMD		
					Log Panel	Clear Log		
500	1				Name Cm	og d Result Re		
-1000-								
-2000 2000 -62	ŧ.							
					×			

Figure 9. Save .OTFS File

4.11 Launch SmartFlash Software

Use the following steps when launching the SmartFlash software:

- 1. Launch SmartFlash software.
- 2. Confirm auto-detection of the EV2x00 adapter, gauge = 220 and version \geq 1.09.
- 3. Click File \rightarrow Open.

NOTE: It is important to exit the bqStudio software because the EV2x00 adapter must be freed for SmartFlash.



OTP Mode FlashStream (ot.fs) Files

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🖳 SmartFlash v0.9.2		_ 🗆 🗙
File Log Help		
 Adapter: EV2300a Gauge: 220 (I2C) Version: 0.03 Refresh Program 	3/15/2016 1.04:27 PM >> SmartFlash v0.9.2	A
No valid SmartFlash file has been opened.		

Figure 10. Launch SmartFlash Software

4.12 Open ot.fs File

- 1. From the pop-up dialog box, click the needed ot.fs file and click **Open**.
- 2. Confirm successful file load from log window.







4.13 Program OTP

- 1. Click the **Program** button.
- 2. When the *Apply Programming Voltage* pop-up dialog box appears, enable 7.4-V power supply and click **OK**.
- 3. After a brief delay (approximately 1-second) for OTP programming and when the *Remove Programming Voltage* pop-up dialog box appears, disable the power supply and click **OK**.

🖳 SmartFlash v0.9.2				
File Log Help				
Adapter: EV2300a Gauge: 220 (I2C) Version: 0.03 Refresh Program	3/15/2016 5:23:28 PM > 3/15/2016 5:23:46 PM > 3/15/2016 5:23:46 PM > 3/15/2016 5:23:58 PM > 3/15/2016 5:23:58 PM >	> SmartFlash v0.9.2 > Open FS File: C:\Ti\BatteryMana > FileTarget 0 v0.00 > Target Gauge: 220 v0.03 > Programming Gauge gramming Voltage pply Programming Voltage (7	agementStudio\OutputFiles\0220_0_03-bc	(27220.otfs
Programming Gauge			OK	

Figure 12. Apply 7.4 V



Figure 13. Program OTP

4.14 Confirm Success

- 1. Confirm the message *Programming completed successfully!* from the log window.
- 2. The device is now fully programmed.



OTP Mode FlashStream (ot.fs) Files

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Figure 14. Confirm Success

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RFID	www.ti-rfid.com			
OMAP Applications Processors	www.ti.com/omap	TI E2E Community	e2e.ti.com	
Wireless Connectivity	www.ti.com/wirelessconnectivity			

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