

## **Updating the bq275xx Firmware at Production**

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### **ABSTRACT**

The bq275xx devices are gas gauges that are flash based and can be updated, if necessary. Sometimes, however, the gas gauge firmware has been updated, but the system-side gas gauges, such as bq27500 or bq27510, may already be embedded in an enclosed system. This prevents external communication access to the gas gauge device to allow updating with external tools. In this case, it may be useful that the application system main processor perform the actual firmware updating, rather than having an external tool do so. Another situation is a pack-side device implementation, in which the data flash image needs updating, but I2C is no longer accessible and HDQ communication must make the update. This application report provides all the information necessary to implement a system firmware that sends the necessary I2C or HDQ commands to update the firmware or data flash in the bq275xx devices. This application report must be used along with a file of .bqfs type for firmware plus data flash updates or a file of .dffb type for data-flash-only updates. Also available is a tool that allows creating a bqfs and a dffb file with an encrypted record (senc) and optional file containing the specific Data Flash Image (DFI).

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## **1 Flash Stream File Format**

This section describes the file format for the TI BMS FlashStream (.bqfs) and Data Flash FlashStream (.dffb) files. These files contain instructions for I2C or HDQ operations required for updating a device's instruction flash (IF) and/or data flash (DF).

### **1.1 File Structure**

The .bqfs file is an ASCII text file which contains both 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.

"R:" – indicates that the row is a command to read 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 .bqfs and .dffb files. Each row contains one and only one of the four commands.

The commands discussed in this section can be implemented by a system that can perform multibyte operations for I2C or single-byte operations for I2C and HDQ.

## 1.2 Write Command

### I2C

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

### HDQ

The write command "W:" instructs the HDQ master to write one byte to a given register address. The format of this sequence is:

"W: RegAddr Byte".

For example, the following:

W: 55 AB

indicates that the HDQ master writes the data 0xAB into register 0x55.

## 1.3 Read Command

### I2C

The read command "R:" instructs the I2C master to read a given number of bytes from a given I2C address and given register address.

The format of this sequence is:

"R: I2CAddr RegAddr NumBytes"

For example, the following:

R: AA 55 100

indicates that the I2C master reads 100 (decimal) bytes of data from register address 0x55 of device address 0xAA.

### HDQ

"R: RegAddr NumBytes".

For example, the following:

R: 55 1

indicates that the HDQ master reads 1 byte from register address 0x55.

## 1.4 Read and Compare Command

### I2C

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 ceases with an error indication to the user.

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.c.

### HDQ

The read and compare consists of making an HDQ read to a given register address and verify that the data received is the same as expected by the FlashStream command.

The format of this sequence is:

"C: RegAddr Byte".

An example of this command is as follows:

C: 55 AB

This example expects the master to read back the data from register address 0x55 and compare to data 0xAB. An error indication is provided to the user if data is not 0xAB.

## 1.5 Wait command

The wait command indicates that the host waits a minimum of the given number of milliseconds before continuing to the next row of the flash stream.

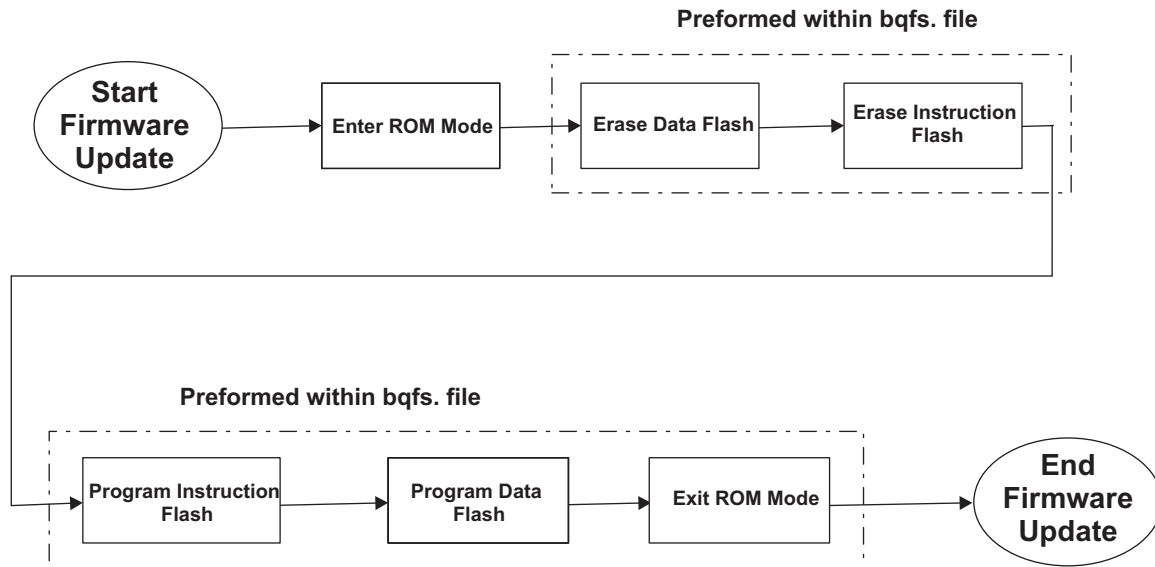
For example, the following:

X: 200

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

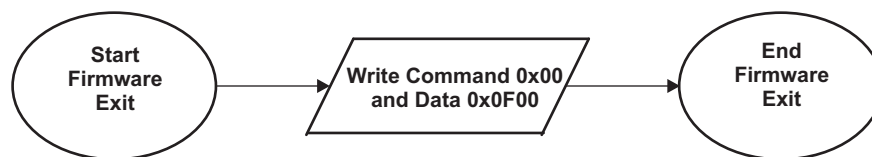
## 2 Firmware Updating Flow

The basic programming flow expected for users to update the firmware and/or data flash of a bq275xx device is summarized in [Figure 1](#). To call on the commands given in the bqfs or dffs file, the user must ensure that the target device is in ROM mode. While in ROM mode, the target device responds to the I2C address of 0x16 (8 bit) or 0x0B (7 bit) if using I2C. From here, the 8-bit I2C address reference is used. To enter ROM mode, 0x0F00 must be written to register address 0x00 of the target device if in the I2C mode, or 0x00 into register 0x00 and 0x0F into register 0x01 if in the HDQ mode. Remember that the I2C address of the device is 0xAA while it is in normal gas gauge mode (default). This step of the process is not part of the bqfs or dffs command sequence. It is up to the user to provide the Enter ROM mode command before using the bqfs or dffs file ([Figure 2](#) and [Figure 3](#)).

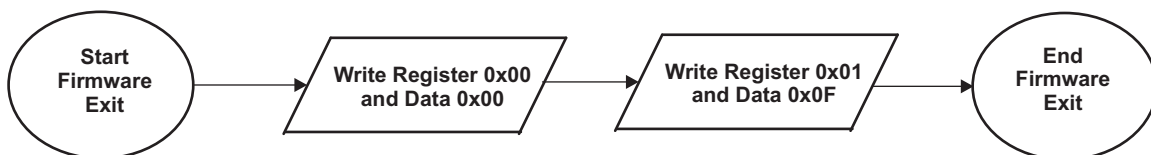


**Figure 1. Basic Firmware Programming Flow**

Before entering the ROM mode, it must be confirmed that the device is not sealed from a firmware perspective. To verify that the device is not sealed, read Control Status by first writing 0x00 into register 0x00 and 0x01, and then read back register 0x01. If bit 5 is set, then sending the Unseal keys is required. If bit 6 is set, then it requires sending the Full Access Unseal key. These keys are sent by writing the respective keys into the Control register. The keys are 32-bit each. If both keys are required, then they must be entered in the order of Unseal key first and then Full Access Unseal key. For any 32-bit key, no intermittent communication is allowed other than the actual communication to write the keys.



**Figure 2. Command to Enter ROM Mode in I2C**

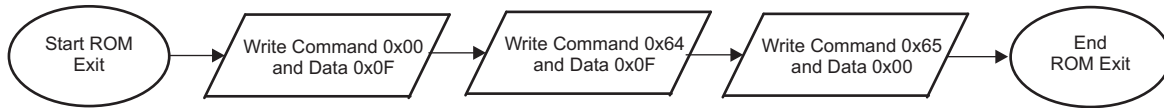


**Figure 3. Commands to Enter ROM Mode in HDQ**

In I2C, it is evident when operating in firmware or ROM mode based on the I2C slave address. If the device sends an Acknowledge signal to the address 0xAA, the device is indicating that it is in firmware mode; if it acknowledges the address 0x16, then it is in ROM mode. Unfortunately, HDQ does not support slave addressing. The following process can indicate in what mode the gas gauge IC is operating:

1. Try to modify register address 0x04. It must be "read only" in firmware mode.
  - (a) `x = ReadByte( 0x04 )`
  - (b) `WriteByte( 0x04, ~x )` // Write back different data
  - (c) `y = ReadByte( 0x04 )`
  - (d) if ( `x == y` ) then ~'not in ROM mode'
2. If step 1 indicates that the ROM mode is required, then proceed with the bqfs or dffs sequence.

Once in ROM mode, the user test setup must be able to open the bqfs or dffs file and perform each one of the I2C or HDQ transactions in strictly the same order as given with the FlashStream file. On completing all the commands within the FlashStream file, the user test system sends the Exit ROM mode procedure (Figure 4). At least a 250-ms delay must occur before attempting to proceed with I2C or HDQ communication to the target device using the I2C address 0xAA after exiting ROM Mode.



**Figure 4. ROM Mode Exit Sequence in I2C or HDQ**

### 3 Debugging bqfs Reader and Programmer

Some development effort is necessary for a user to implement a program that can open a bqfs and give out I2C or HDQ commands based on bqfs format. During the development phase, TI recommends that a user have a dedicated prototype board that allows easy replacement of target devices. This is because during the debugging of the program, it is most likely that devices become useless.

The bqfs sequence is created so as to minimize the chances of hindering any devices in the program debug process and also during the actual production run. During debug, once a target device is placed in the ROM mode, the program developer must not exit the ROM mode unless the full process is completed successfully. Exiting the ROM mode while the firmware or data flash is not fully programmed can place the device in an unrecoverable mode.

The bqfs file contains some sequences defined as Read and Compare. When implementing these commands within the user's program, these commands must be used as checkpoints with which the program developer decides to continue with the process or actually start from the beginning of bqfs sequence. The user must decide how many attempts to make before considering a device unprogrammable.

### 4 Creating a bqfs and dffs Containing User-Specific DFI

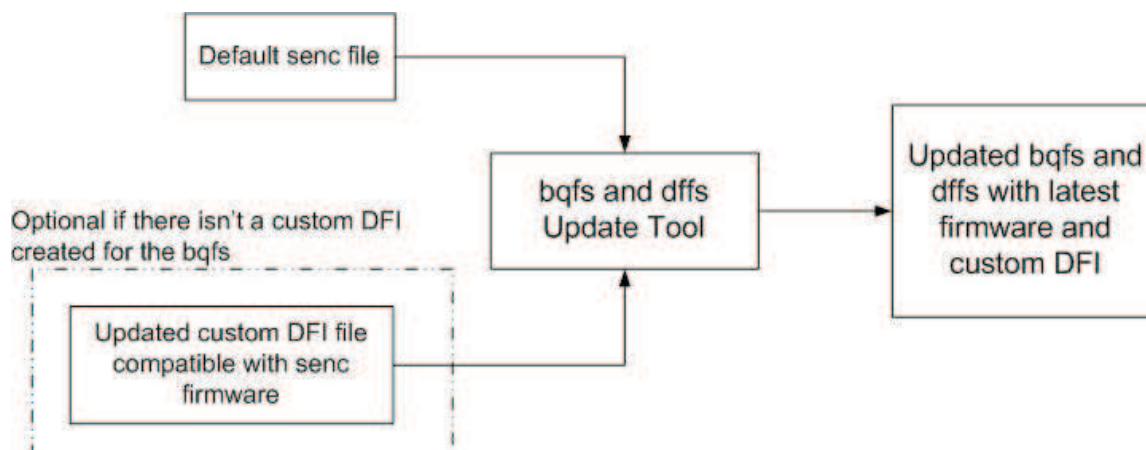
The bqfs file provided with this document is based on the latest firmware revision for a given bq275xx device and its default data flash configuration. A user can have one of two situations in a production environment:

- The situation requires programming a specific DFI and retaining the current version of firmware, or
- The situation requires programming firmware and also a specific DFI. It is not time-effective for developers to use a bqfs that programs the default firmware and data flash, and then to reprogram the data flash to a custom DFI.

Also, a tool is available that allows converting a senc file into a version that programs custom DFI from the beginning. It is necessary to have a DFI file to use this tool and an original senc file. A senc file is a file that actually is used to reprogram the firmware of a bq275xx device by using the evaluation software. These files are input to the bqfs Update Tool and after executing creates a bqfs and dffs file that contains the desired firmware with the data flash configuration specific to a user's application (Figure 5).

The user has the option to create a bqfs and dffs based on I2C (default) or HDQ. The Update Tool is called from a command screen (DOS) by running the FlashStream.exe file. The command structured for the tool is displayed when calling the FlashStream.exe. The associated files used with the Update Tool must be within the same directory as the tool.

The application report *Going to Production With the bq2750x* (SLUA449) describes how to create a DFI for the first time. The application report *Updating Firmware With the bq2750x and EVM* (SLUA453) describes how to update a DFI that was created with an older version of firmware and now must have a DFI that is compatible with the later version firmware without requiring going through the whole process described in SLUA449.



**Figure 5. bqfs and dffs Update Tool Process**

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