Going to Production with the bq275xx

ABSTRACT

This application report presents a strategy for high-speed and economical calibration and production programming of the bq27500/1 single-cell gas gauge chipset. Flowchart examples are provided, along with step-by-step instructions for preparing a calibration data set that is required when creating the Golden Data Flash Image (DFI) that is programmed into all bq27500/1 devices at the original equipment manufacturer (OEM) production line.

This is applicable to all system-side, single-cell gas gauge devices that use EVSW and the bqEASY plug-in for golden file generation. Newer products may use different software tools to generate a golden file (such as Battery Management Studio/bqStudio), but the concepts and flow are similar. Furthermore, the production programming flow detailed in Section 6 can be replaced for any single-cell gauge with the Flashstream procedure outlined in the application report entitled *Updating the bq275xx Firmware at Production* (SLUA541).

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1 Introduction

The bq27500/1 gas gauge is built with new technology and a new architecture for both data flash access and calibration. With this new architecture, unit production cost and capital equipment investment can be minimized, as there is no longer a need to perform a learning cycle on each pack. A single Golden DFI can be used to program each bq27500/1 in production. Also, the calibration method is quick and simple because most of the calibration routines are built into the firmware of the target device or can be based on average values.

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2 Determining Data Flash Constants

To configure the bq27500/1 for a given application, the data flash set must be programmed depending on the cell, application system, and charger. The application report *Configuring the bq27500 Data Flash* (SLUA432) gives a detailed description of all the data flash constants that the user can modify. All bq27500/1 integrated circuits (IC) for an application must contain the same data flash values.

The DFI contains all flash values and is used at the system application production line to program the bq27500/1. The DFI is programmed using I²C communication with the bq27500/1. Creating the DFI can be summarized with the process depicted in Figure 1.

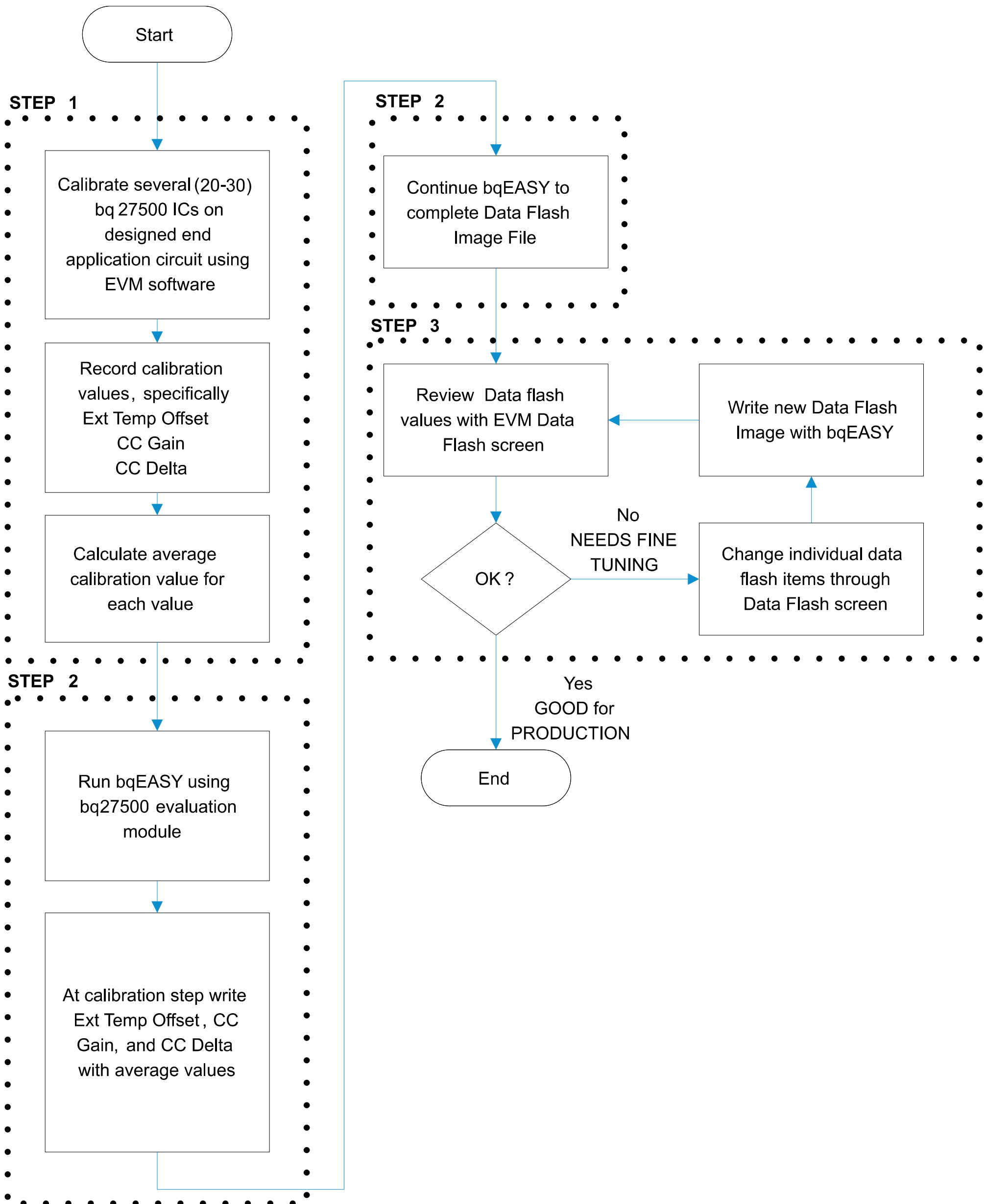

Figure 1. DFI Creation Flow

3 STEP 1: Characterize the Calibration Process

Devices of bq27500/1 single-cell gas gauges can be quickly and easily calibrated. With the Impedance Track™ devices, most calibration routines have been incorporated into firmware algorithms, which can be initiated with I^2C commands. The hardware necessary for calibration is also simple. One current source, one voltage source, and one temperature sensor are all that is required. The stability of the sources is important, not so much the accuracy. However, accurately calibrated reference measurement equipment should be used for determining the actual arguments to the function. For periodic voltage measurement, a digital voltmeter with better than a 1-mV accuracy is required.

The recommended strategy for bq27500/1 calibration is to perform the calibration using 20 to 30 final application systems containing the bq27500/1 IC. All the calibration flash values are to be recorded and averaged among the 20 to 30 samples taken. The average values are the ones to be used when creating the DFI file needed for production. At time of calibration, access is required to the I^2C pins, both ends of the sense resistor, and battery power. The calibration consists of performing coulomb counter offset, current gain, and temperature offset. The Evaluation Software (EVSW) is used to perform all calibration. By using the EVSW, it allows verification of the affected data flash values due to calibration (see Figure 2).

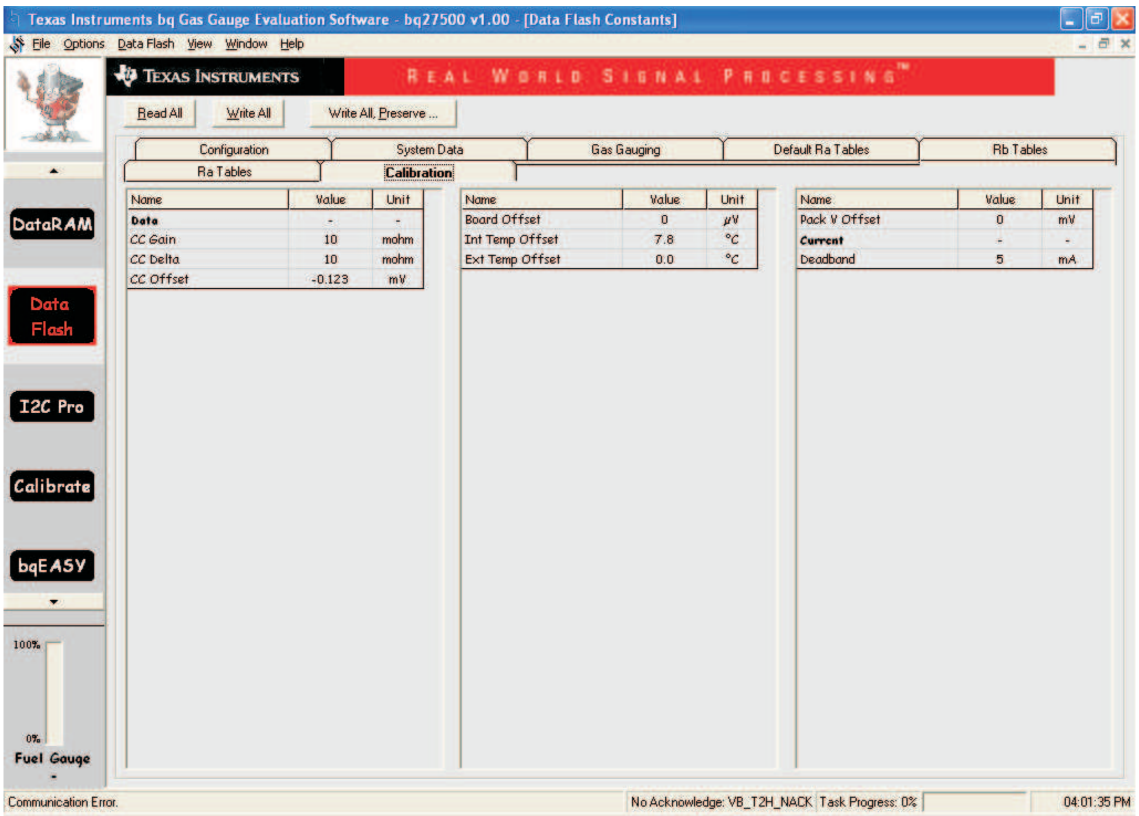

Figure 2. bq27500 EVSW Calibration Data Flash Screen

Perform the following calibration tests on each of the system samples:

CC Offset Calibration—Select the *CC Offset Calibration* checkbox. Then, click on the *Calibrate Part as indicated below* button (Figure 3), and wait for the EVSW to indicate that the calibration is completed. Read back the updated CC Offset data flash value by going to the Data Flash screen in EVSW and selecting the Calibration tab. Press the *Read All* button so that all the data is refreshed on the screen.

Temperature Calibration—Select the *Temperature Calibration* checkbox. Write the actual temperature to which the thermistor is exposed, obtained by the reference equipment measurement. Click on the *Calibrate Part as indicated below* button, and wait for the EVSW to indicate that the calibration is completed. Read back, and record the Ext Temp Offset value from the Data Flash screen.

Pack Current Calibration—Select the *Pack Current Calibration* checkbox; apply a current to flow through sense resistor; and write the actual current measured by meter. Click on the *Calibrate Part as indicated below* button, and wait for the EVSW to indicate that the calibration is completed. Note that a negative sign indicates current in the discharge direction. Read back, and record the updated CC Gain and CC Delta data flash values by going to Data Flash screen in EVSW and selecting the Calibration tab. Press *Read All* button so that all the data is refreshed on the screen.

The voltage and board offset calibration are not required unless there was poor layout that would add any offsets to voltage or current measurements. The EVSW does provide the means of calibrating these parameters. To perform board offset, it is expected that no loads are applied during calibration.

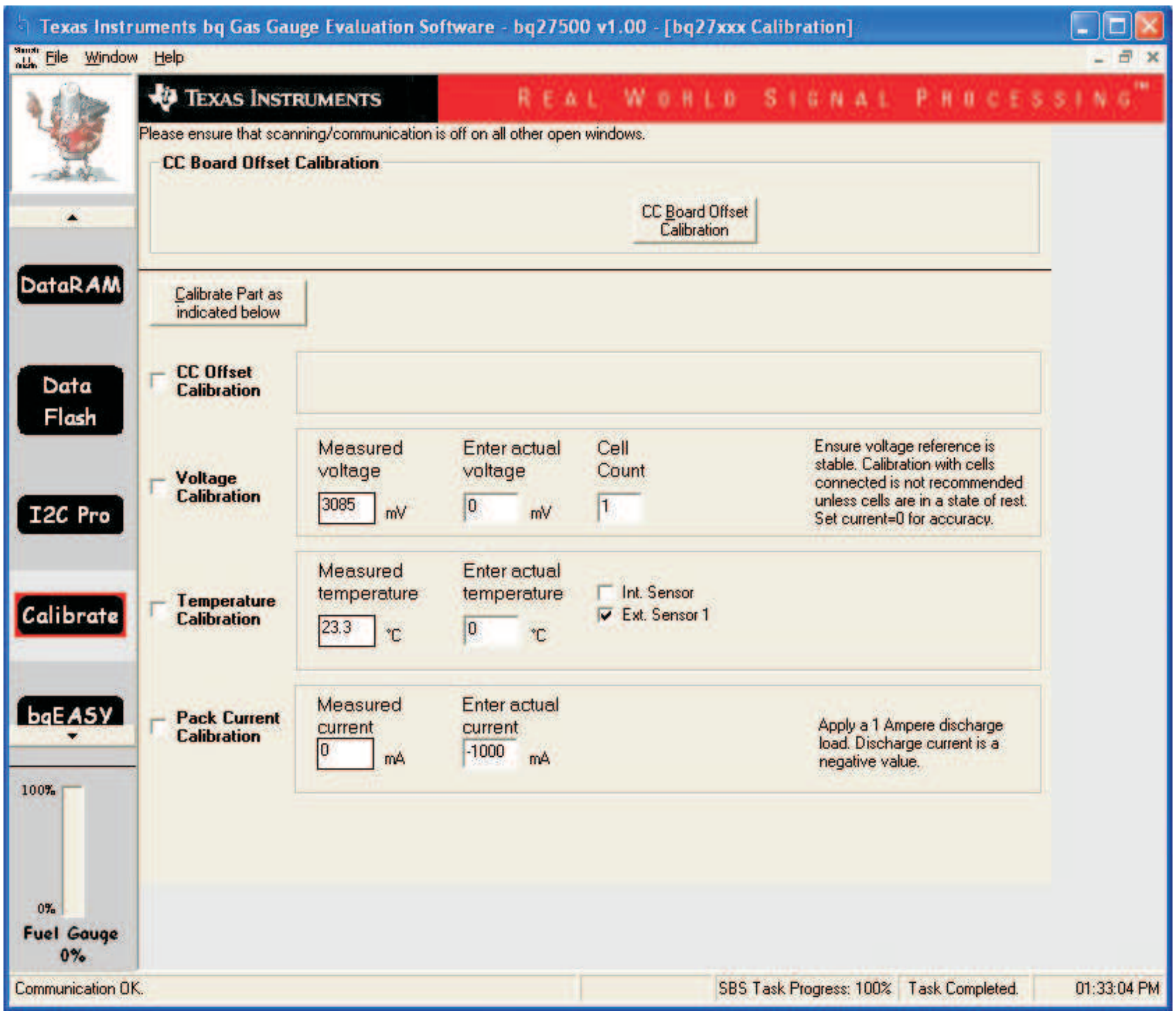

Figure 3. bq27500 EVSW Calibration Screen

The average Ext Temp Offset, CC Gain, and CC Delta values are entered into the DFI file in Step 2.

4 STEP 2: Using bqEASY for Production Preparation

The bqEASY (see Figure 4) is a tool embedded within the EVSW that provides detailed instructions and automates processes that on completion creates the DFI that is used at production to program all bq27500/1 for a given application.

Figure 4. bqEASY

The data flash of the bq27500/1 is configured based on a questions and answers session within the Configure section of bqEASY. The questions involve topics specific to the battery pack, the charger, and the system application.

At the Calibrate session of bqEASY, it is expected that the user navigates to the Data Flash section of the EVSW and enters the average calibrations obtained from the process described in the *Characterize the Calibration Process* section of this document.

The Chemistry session in bqEASY is a valuable tool that allows the user to select the chemistry of their battery pack from a database. If the user does not know the chemistry of its battery pack, then the bqEASY gives instructions on testing the battery for determining the chemistry. The discharge during the test is automated. For automated discharge, a setup as described in Figure 5 is required. The load must be selected so that it has a C/5 rate when turned on. During automated discharge, the EV2300 board controls when to enable and disable the discharge, allowing the necessary relaxation periods for OCV measurements. Once the chemistry is determined, the data flash of bq27500/1 is updated so that it contains the proper OCV data that is characteristic of the selected chemistry. Having proper chemistry data is integral for the Impedance Track algorithm performing accurately.

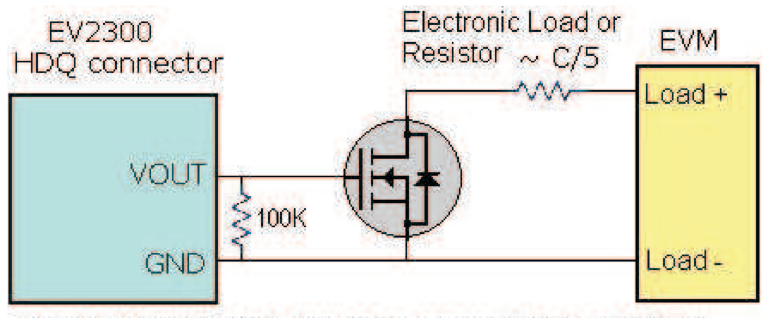

Figure 5. Load Connection for Automated Discharge

The final session of the bqEASY is for running a learning cycle so that Qmax and the impedance tables are updated. The bqEASY provides step-by-step instructions on how to perform the learning cycle. By having learned Qmax and the impedance values, the DFI can be created so that when used to program bq27500 ICs in production, a learning cycle is unnecessary before a device can perform accurate battery fuel gauging as of the first cycle in the system.

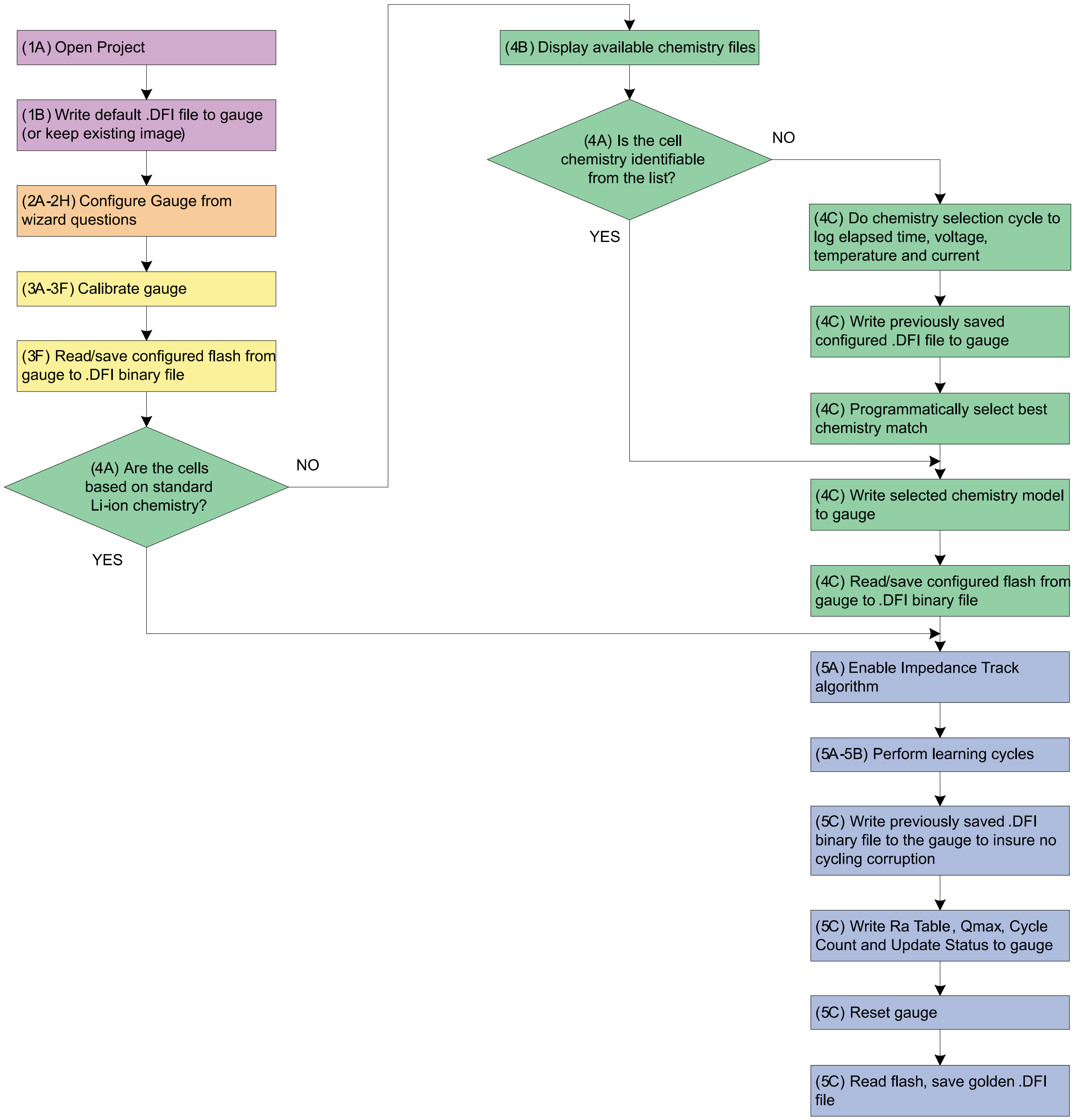

Figure 6. bqEASY Process Flowchart

5 STEP 3: Data Flash Review

While following the actual steps of bqEASY, the tool prompts the user to review the data flash constants for advanced configurations that might not have been addressed by bqEASY. The application report *Configuring the bq27500 Data Flash* (SLUA432) defines all the bq27500/1 data flash constants. Refer to this document when reviewing the data flash configuration against the application needs.

To modify the data flash constants, proceed to the Data Flash screen of the evaluation software and search for the desired data flash value to be modified, and change accordingly.

6 STEP 4: Writing the DFI at Production

System designers must ensure that there is access to the I²C lines of the bq275xx and battery power access at the time of writing the DFI in production. It is expected that the OEMs add the Write DFI step within their final complete system test that verifies the product to be functional for release to market. The flowchart in Figure 8 shows the steps that must be followed to write the DFI created with bqEASY. System test developers can use the flowchart to call I²C commands with their test setup and program all the flash of the bq275xx embedded in the application system.

The last step of the bq275xx configuration at production is to give the RESET (0x0041), IT ENABLE (0x0021), and SEALED (0x0020) commands. These commands are given by writing the corresponding two-byte data value into the CONTROL register (command 0x00 and 0x01) using I²C.

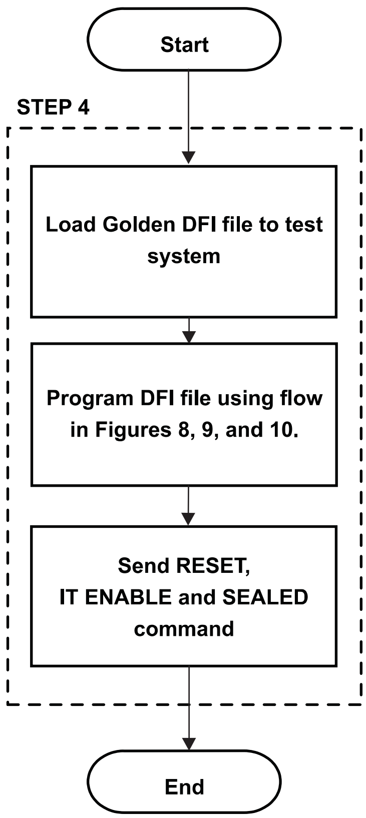

Figure 7. bq275xx Production Flow

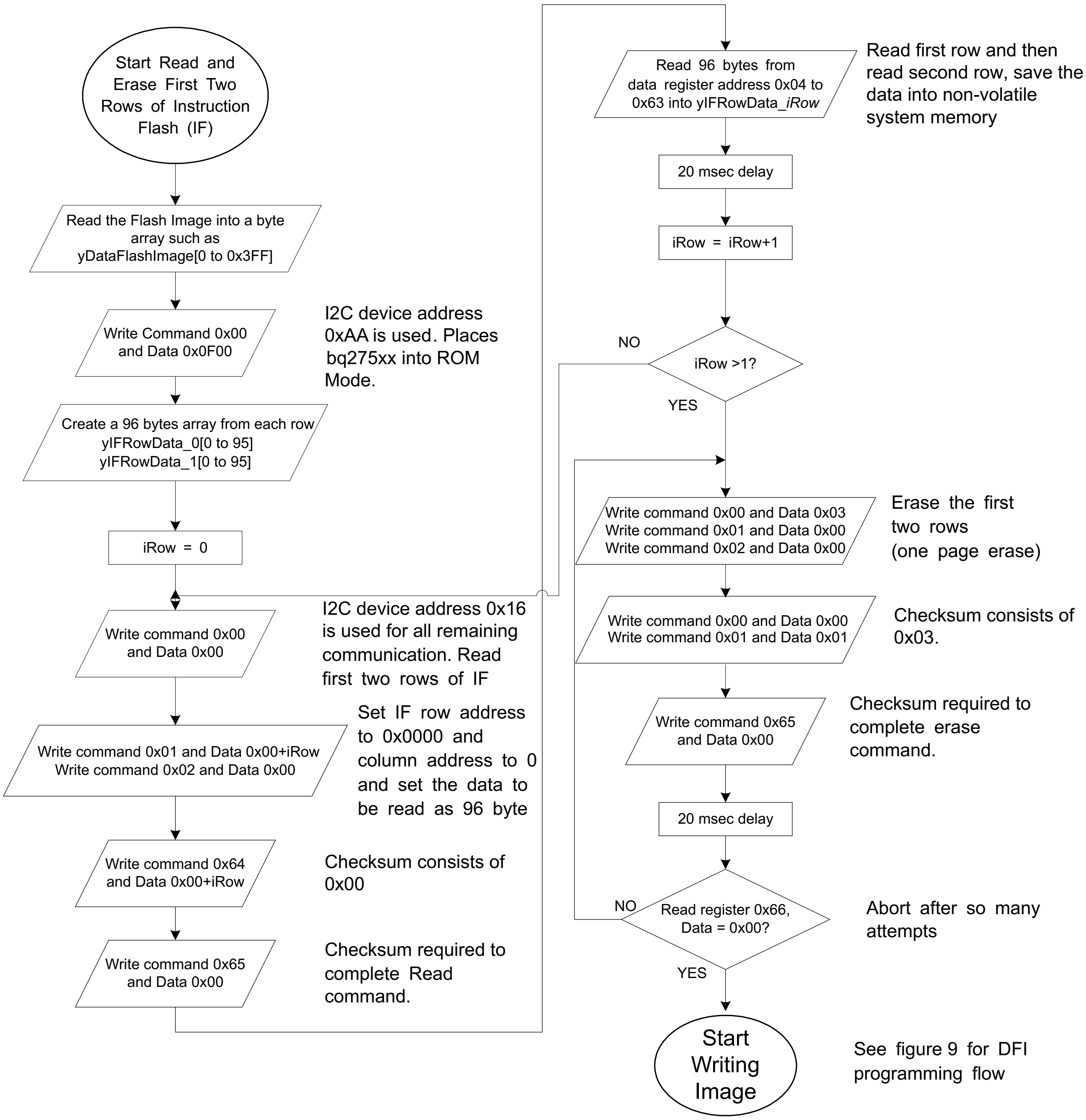

Figure 8. Instruction Flash First Two Row Record and Erase Flow

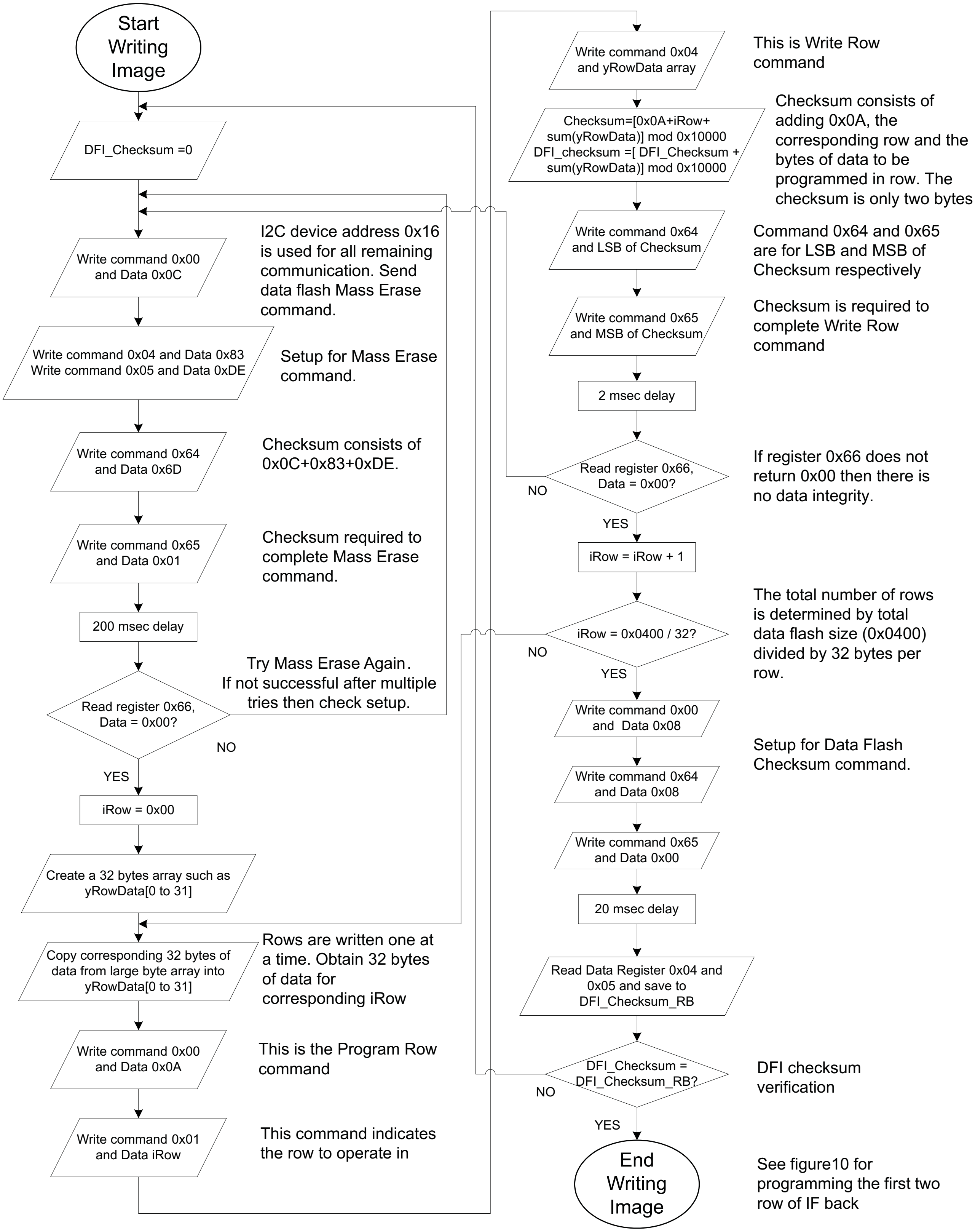

Figure 9. DFI Write Flow

Figure 10. Instruction Flash First Two Row Reprogram Flow

Revision History

Changes from E Revision (January 2012) to F Revision	Page
• Updated the Abstract	1
• Changed bq27500 to bq275xx in Section 6	8
• Changed Figure 8	9

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

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