Going to Production With the bq274xx Family of Gas Gauges

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ABSTRACT

This application report presents a strategy for high-speed, economical calibration and production programming of the bq274xx single-cell gas gauge. 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 bq274xx devices on the production line.

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1 Introduction

The bq274xx 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 it is no longer necessary to identify the battery pack chemistry or perform a learning cycle. The golden data flash image (DFI) file is simply read after it is properly configured with approximately 20 parameters. This golden DFI can be used to program each bq274xx device in production. Also, the calibration method is quick and simple. In mass production, the average calibration values can be used instead of individually calibrating each board.

2 Determining Data Flash Constants

To configure a bq274xx integrated circuit (IC) for a given application, the data flash set must be programmed depending on the cell characteristics, and end-system and charger requirements. The application report entitled *How to Configure and Use the bq27410* (SLUA596) gives a detailed description of all the data flash constants that the user can modify. All bq274xx ICs for an application must contain the same data flash set.

The Golden Data Flash Image (DFI) is a file that contains all flash data that is used at the production line to program the bq274xx. The DFI is programmed using I^2C communication with the bq274xx using a test platform developed by the customer. Figure 1 summarizes the process of creating the DFI.

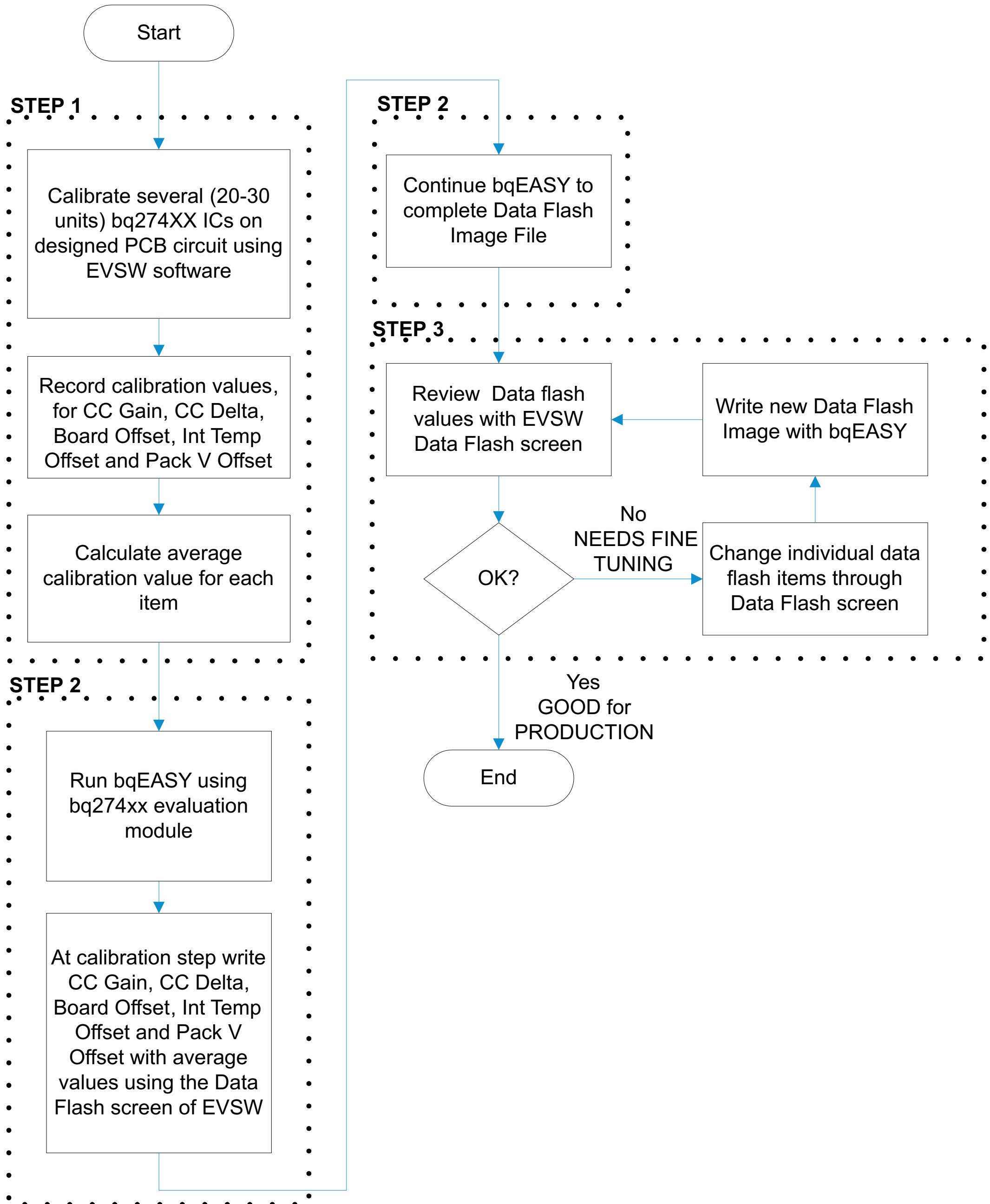

Figure 1. DFI Creation Flow at Preproduction

STEP 1: Characterize the Calibration Process

Devices of bq274xx single-cell gas gauges are quick and easy to calibrate. With the Impedance Track™ devices, most calibration routines have been incorporated into firmware algorithms, which can be initiated with I²C commands. The hardware for calibration is also simple. One current source, one voltage source, and one temperature sensor are all that is required. The accuracy of the sources is unimportant, only their stability. However, accurately calibrated reference measurement equipment must be used for determining the actual arguments to the function.

Two methods are available to follow for calibration. One is to characterize the calibration process and include the characterization results as part of the production DFI; the second is to calibrate individually every printed-circuit board (PCB) with a gauge that goes through the manufacturer's production line.

The recommended strategy for bq274xx calibration is to perform the calibration characterization using 20 to 30 final PCBs containing the bq274xx 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 to the I^2C pins, both ends of the sense resistor, and the battery power must be available. The calibration consists of performing coulomb counter offset, board offset, current gain, and temperature offset. The Evaluation Software (EVSW) is used to perform all calibration. Using the EVSW allows verification of the affected data flash values due to calibration (see Figure 2).

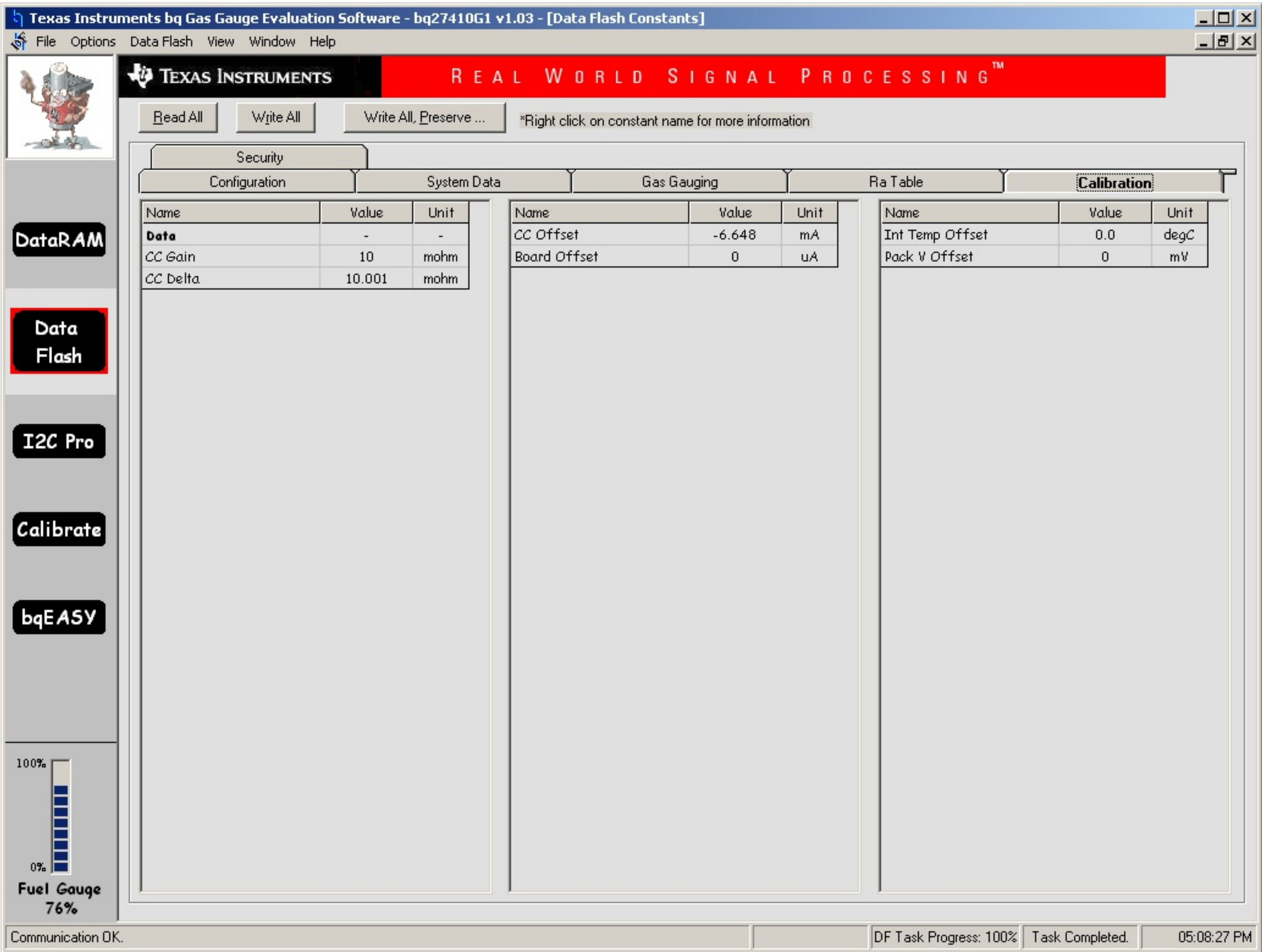

Figure 2. bq274xx EVSW Calibration Data Flash Screen

The voltage calibration is not required for this device, given that each IC is calibrated for voltage measurement at the device's final test process by Texas Instruments. The INT Temp calibration at room temperature only is not recommended as the INT Temp coefficients are optimized to compensate the temperature accuracy from –40°C to 85°C.

If calibration is needed, perform in order the following calibration tests on each of the system samples:
Coulomb Counter Offset Calibration – Click the Calibrate Coulomb Counter button, 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.

Voltage Calibration – Select the Voltage Cal checkbox; write the actual voltage measured by meter. Click the *Calibrate Voltage and Temperature as indicated below* button and wait for the EVSW to indicate that the calibration is completed. Read back and record the updated Pack V Offset data flash values 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 (if needed) – Select the Temperature checkbox. Write the actual temperature to which the INT temp sensor device is exposed, obtained by the reference equipment measurement; click on the *Calibrate Voltage and Temperature as indicated below* button and wait for the EVSW to indicate that the calibration is completed. Read back and record the Int Temp Offset value from the Data Flash screen.

Board Offset Calibration – Ensure that no current is flowing through the sense resistor (no charge or discharge occurring). Click on the Calibrate Board Offset button, and wait for the EVSW to indicate that the calibration is completed. Read back and record the updated Board 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.

Pack Current Calibration – Write the actual current measured by the meter (negative sign indicates current in discharge direction); click on the Calibrate Pack Current button, and wait for the EVSW to indicate that the calibration is completed. Read back and record the updated CC Gain and CC Delta data flash values 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.

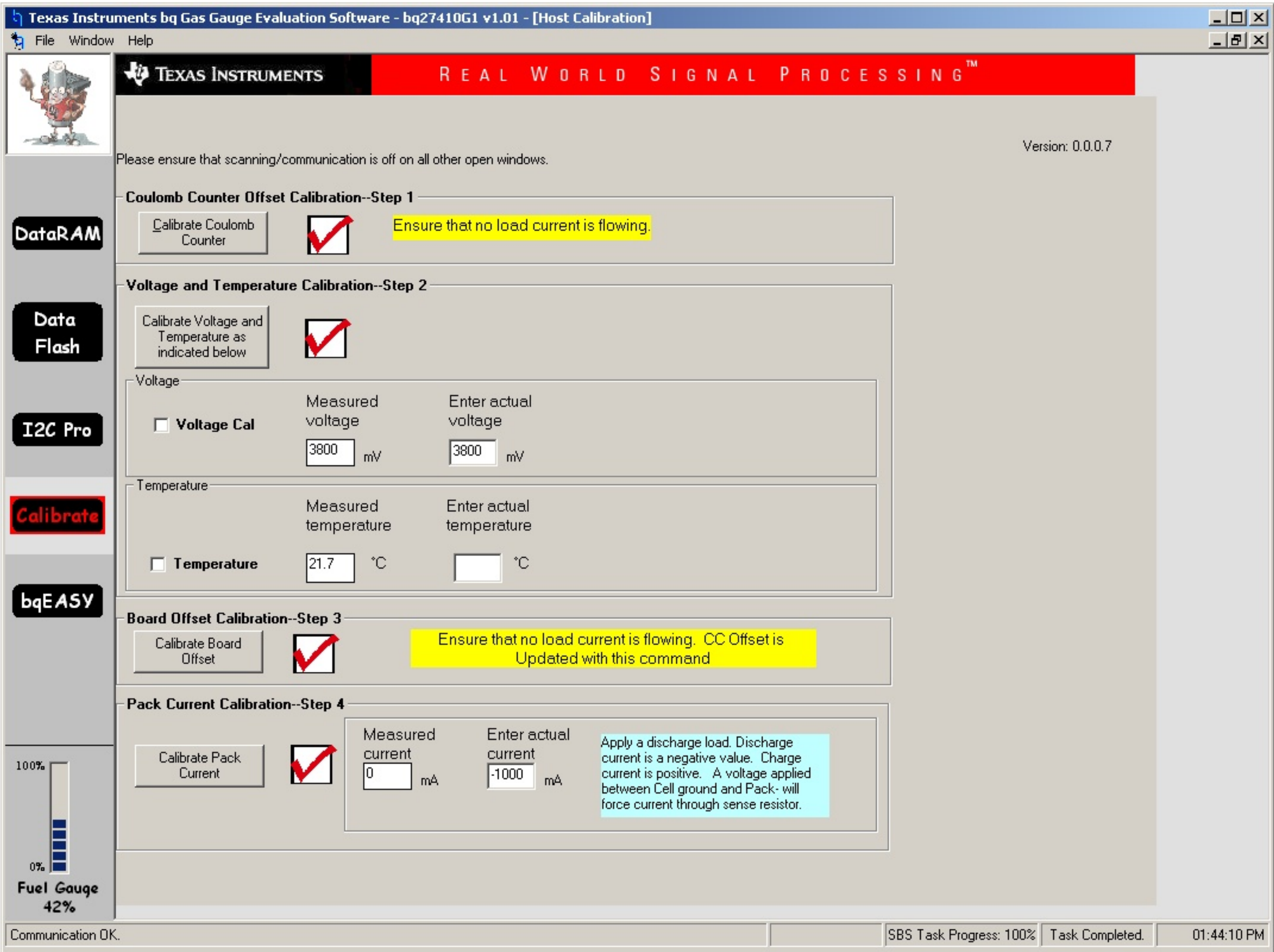

Figure 3. bq274xx EVSW Calibration Screen

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

STEP 2: Using bqEASY™ Software for Production Preparation

The bqEASY™ software (Figure 4) is a tool embedded within the EVSW that provides detailed instructions and automates processes that on completion creates the DFI and ROM (not implemented yet) files that are used at production to program all bq274xx devices for a given application.

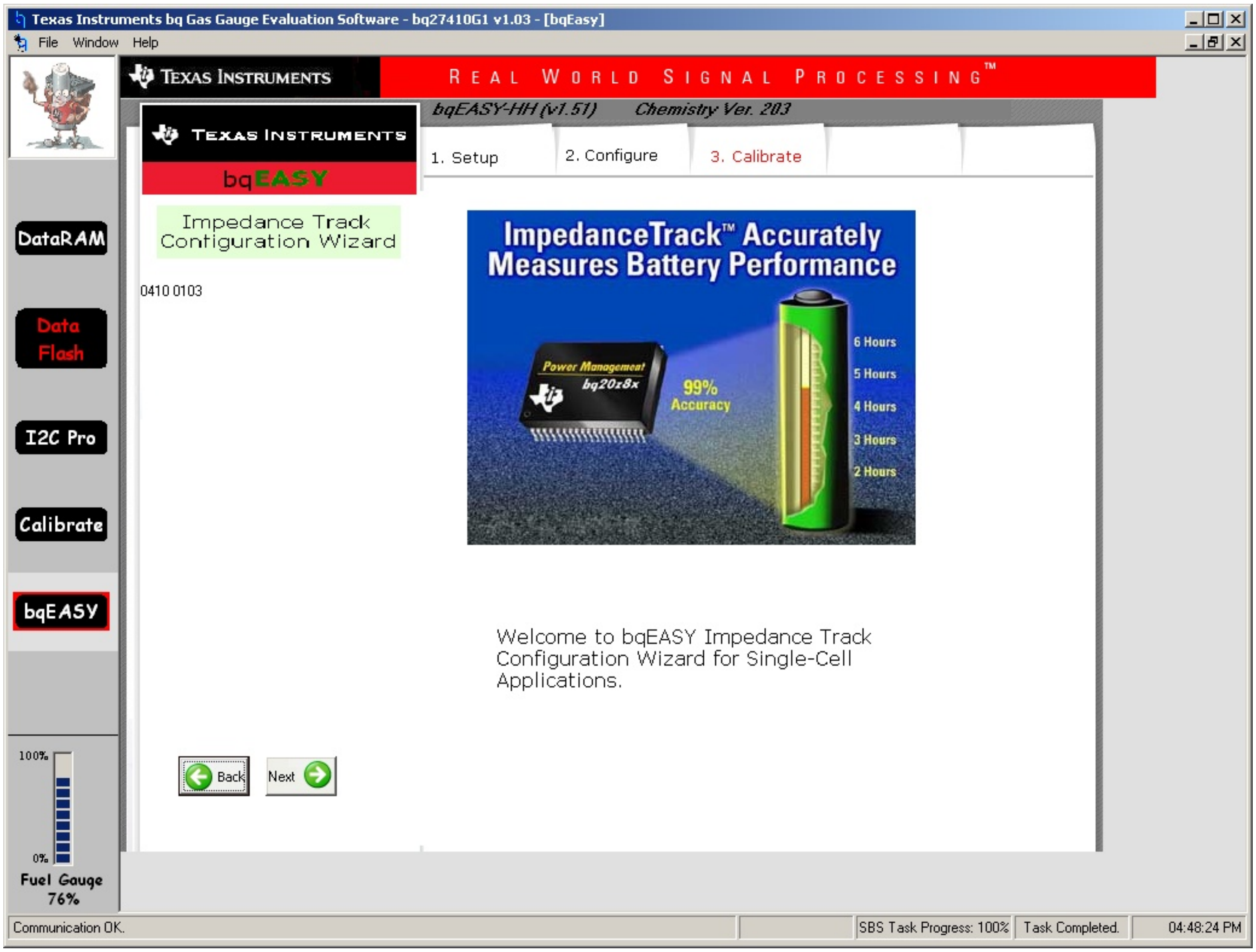

Figure 4. bqEASY™ Screen

The data flash of the bq274xx device is configured based on a question and answer session within the Configure section of the bqEASY™ software. The questions involve topics specific to the battery, the charger, and the system application.

At the Calibrate session of the bqEASY™ design tool, the user is expected to navigate to the Data Flash section of the EVSW and to enter the average calibrations obtained from the process described in the *Characterize the Calibration Process* section of this document.

It is unnecessary to select chemistry ID or run a learning cycle for bq274xx device, which uses a simplified Impedance Track™ algorithm.

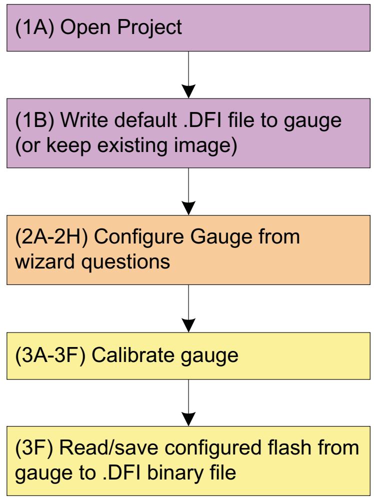

Figure 5. bqEASY™ Process Flowchart

STEP 3: Data Flash Review

When following the actual steps of the bqEASY™ software, the user is prompted by the tool to review the data flash constants for advanced configurations that may not have been addressed by the bqEASY™ design tool. The application report *How to Configure and Use bq27410* (SLUA596) defines all the bq274xx data flash constants. Use this document for reference 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.

STEP 4: Writing the DFI at Production

System designers must ensure that access is available to the I^2C lines of the bq274xx and battery power 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 6 shows the steps that must be followed to write the DFI created with the bqEASY™ software. System test developers can use the flowchart to call I^2C commands with their test setup and program all the flash of the bq274xx embedded in the application system.

The last step of the bq274xx configuration at production is to give the RESET (0x0041) and if needed, SEALED (0x0020) commands. These commands are given by writing the corresponding two-byte data value into the CONTROL register (command 0x00/0x01) using I^2C protocol.

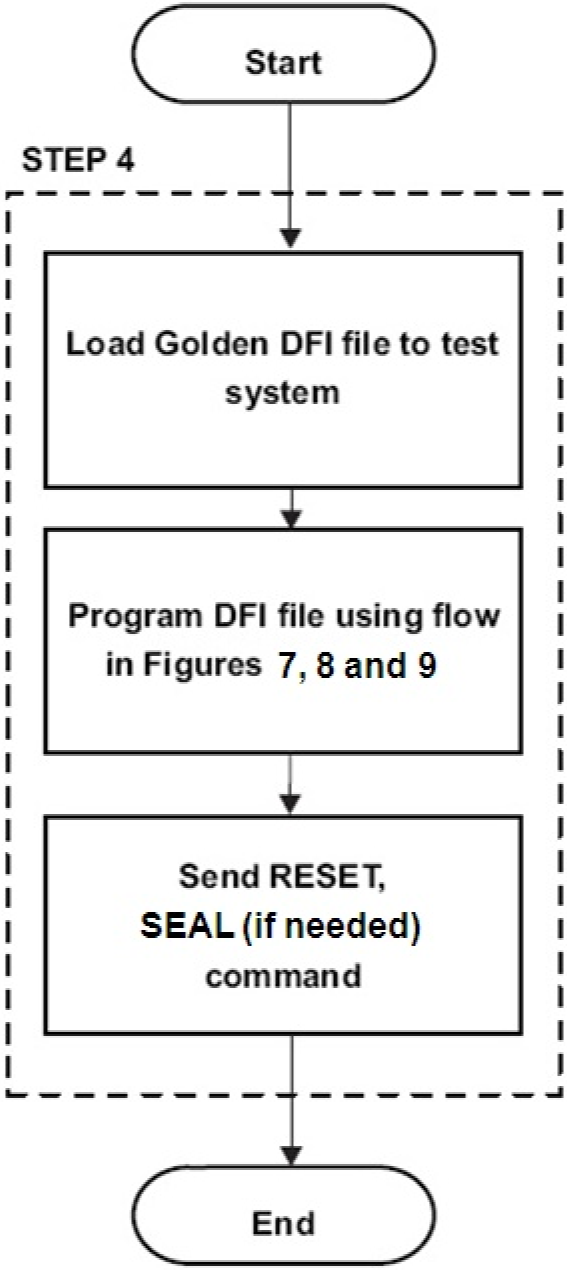

Figure 6. Production Flow

If users want to develop their own tools to program the DFI using the host processor, they can refer to the application report *Updating the bq275xx Firmware at Production* (SLUA541) for using bqfs and dffs script files.

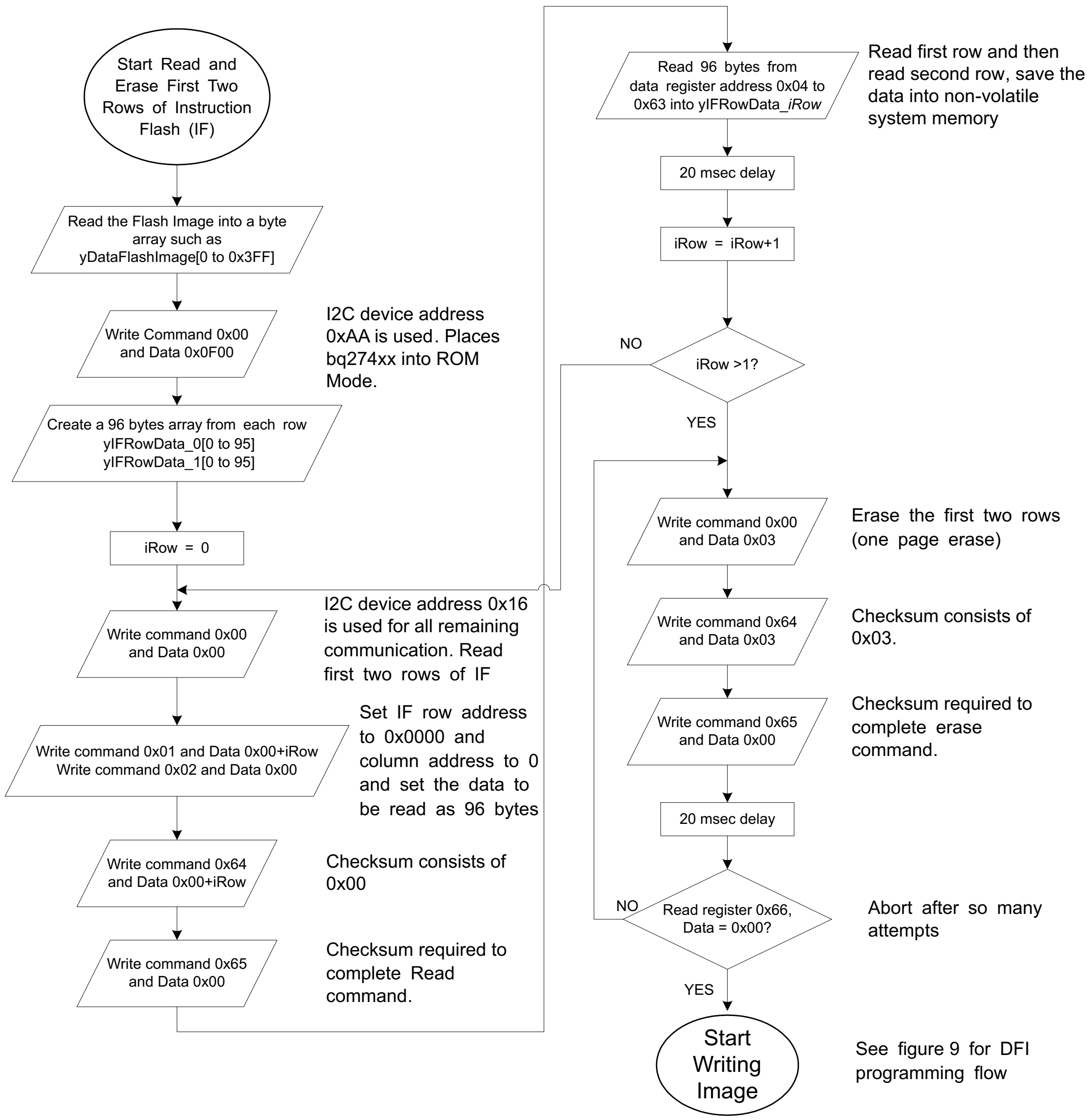

Figure 7. DFI Write Flow, Page 1 of 3

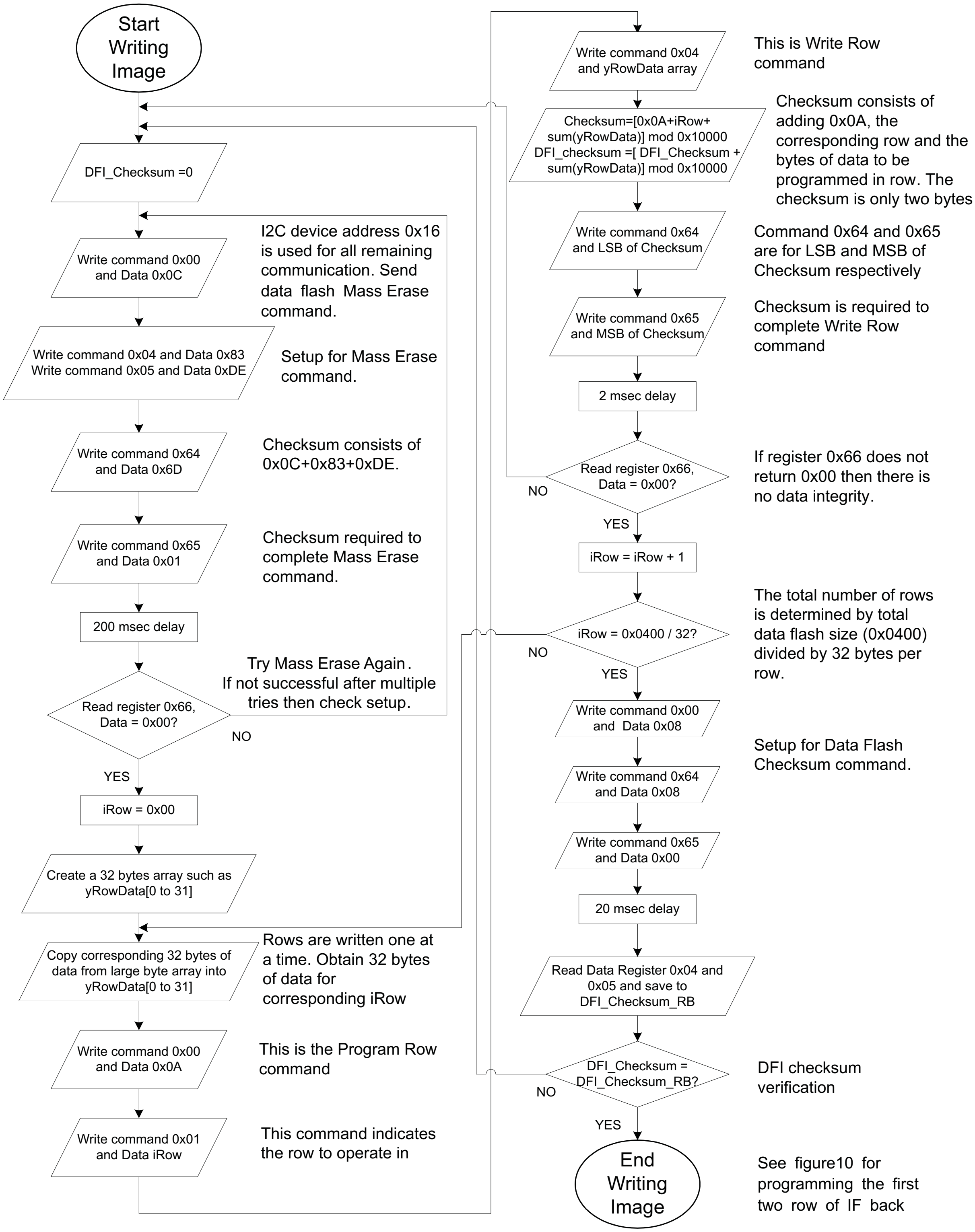

Figure 8. Continuation of DFI Write Flow, Page 2 of 3

Figure 9. Continuation of DFI Write Flow, Page 3 of 3