

Going to Production With the bq274xx Family of Gas Gauges

*Ming Yu**Battery Management*

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.

Contents

1	Introduction	2
2	Determining Data Flash Constants	2

List of Figures

1	DFI Creation Flow at Preproduction	3
2	bq274xx EVSW Calibration Data Flash Screen.....	4
3	bq274xx EVSW Calibration Screen	5
4	bqEASY™ Screen	6
5	bqEASY™ Process Flowchart.....	7
6	Production Flow	8
7	DFI Write Flow, Page 1 of 3	9
8	Continuation of DFI Write Flow, Page 2 of 3	10
9	Continuation of DFI Write Flow, Page 3 of 3	11

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 I²C communication with the bq274xx using a test platform developed by the customer. [Figure 1](#) summarizes the process of creating the DFI.

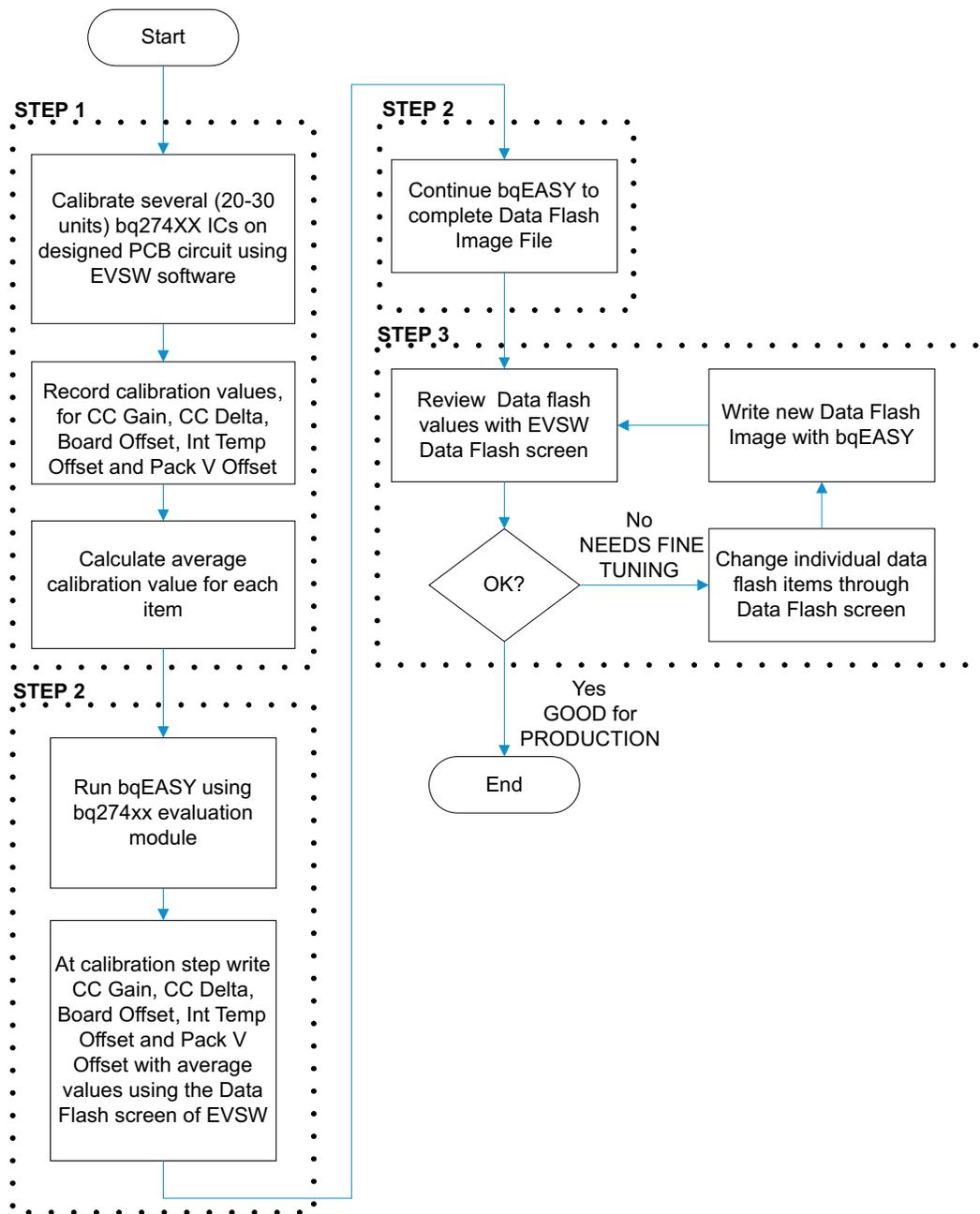


Figure 1. DFI Creation Flow at Preproduction

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 I²C 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 (EVSU) is used to perform all calibration. Using the EVSW allows verification of the affected data flash values due to calibration (see Figure 2).

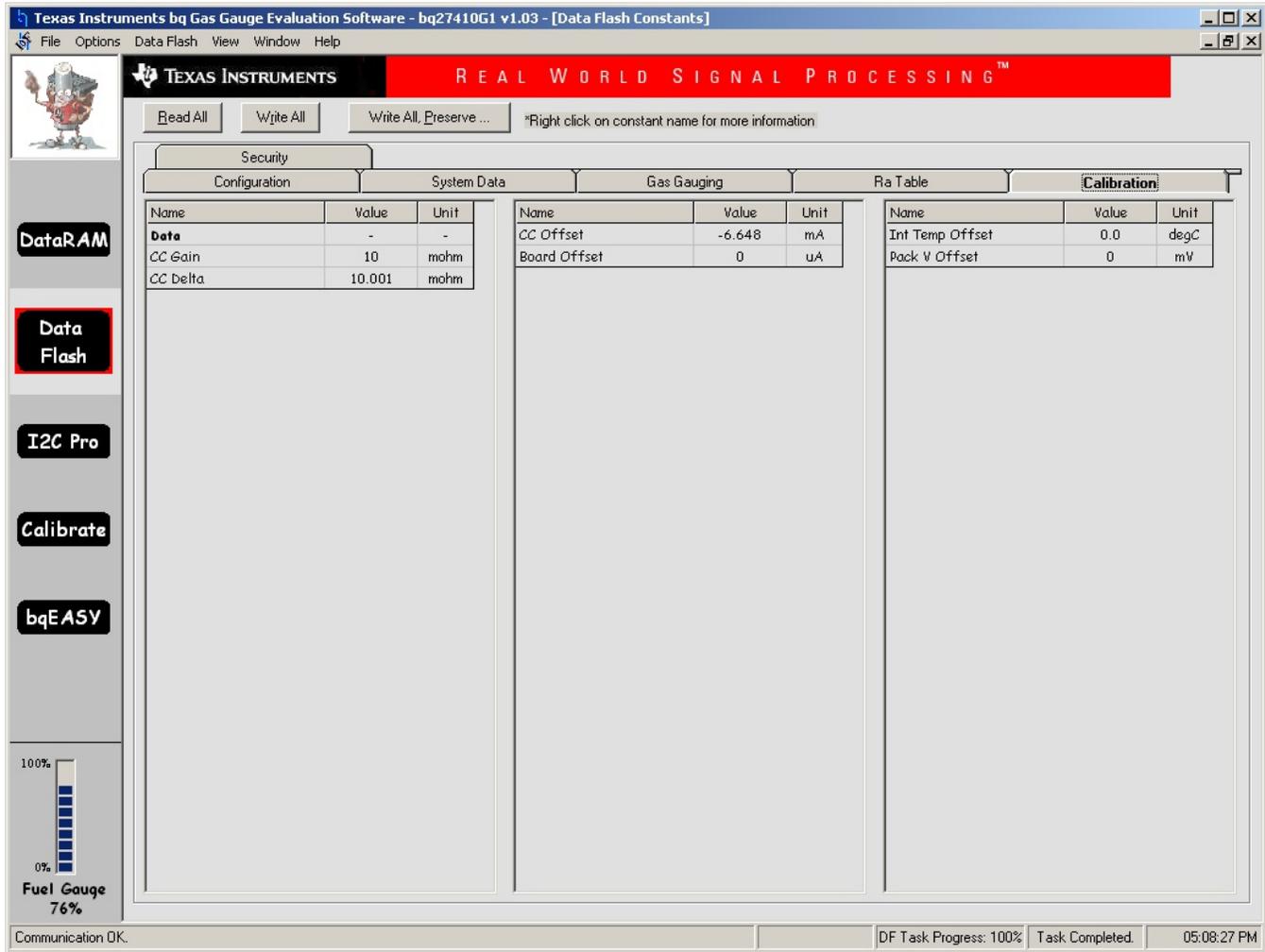


Figure 2. bq274xx EVSW Calibration Data Flash Screen

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.

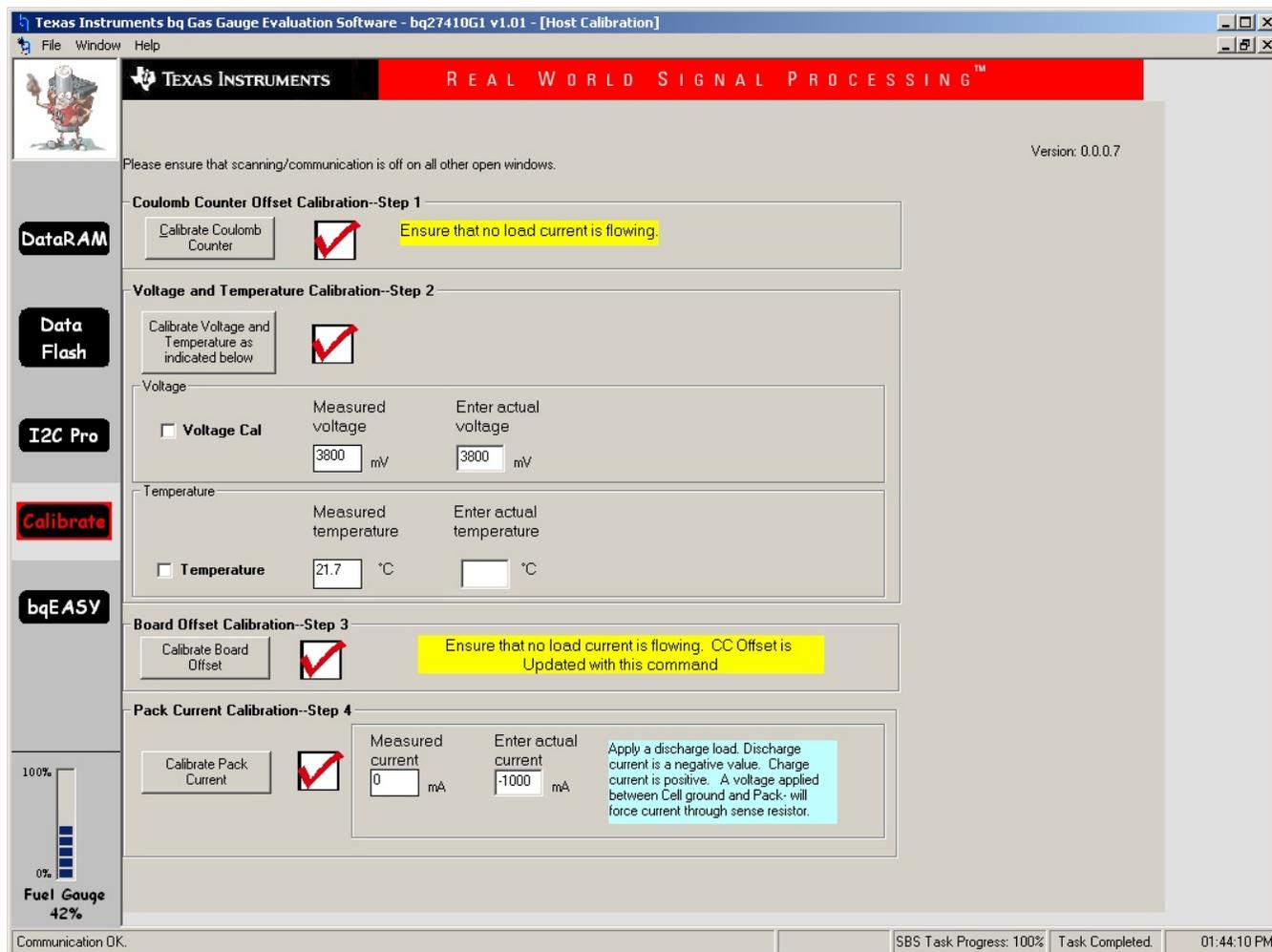


Figure 3. bq274xx EVSW Calibration Screen

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.

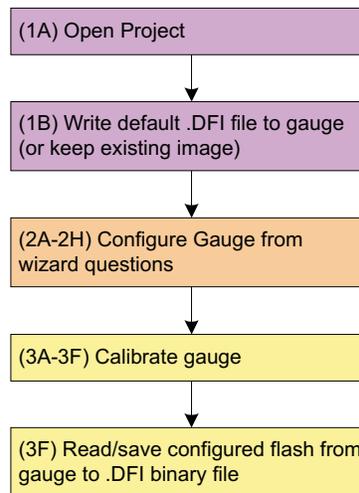


Figure 5. bqEASY™ Process Flowchart

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 I²C 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 I²C 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 I²C protocol.

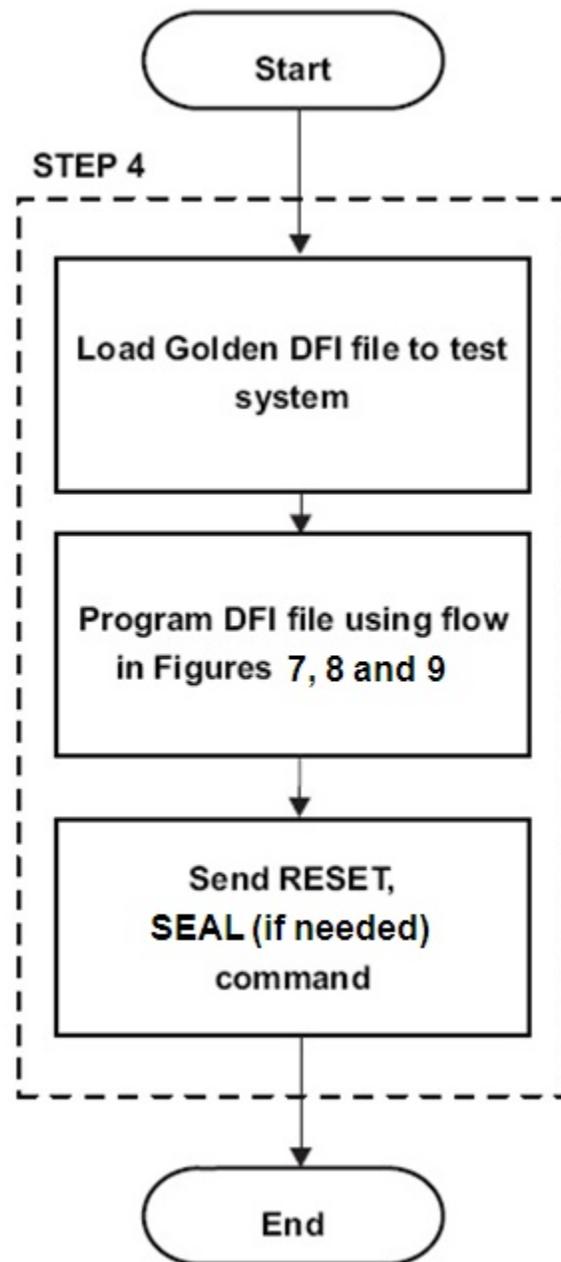


Figure 6. Production Flow

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.

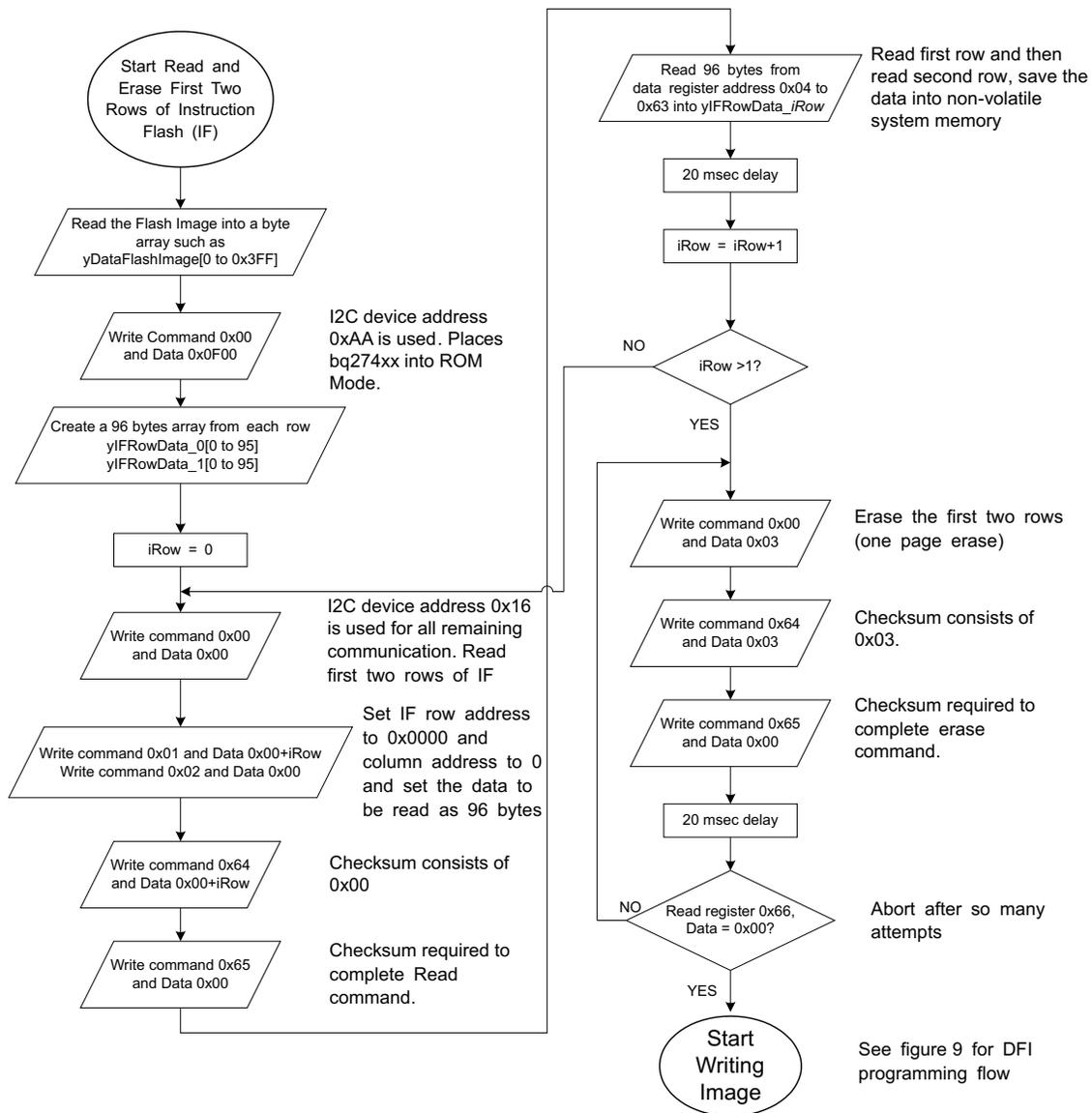


Figure 7. DFI Write Flow, Page 1 of 3

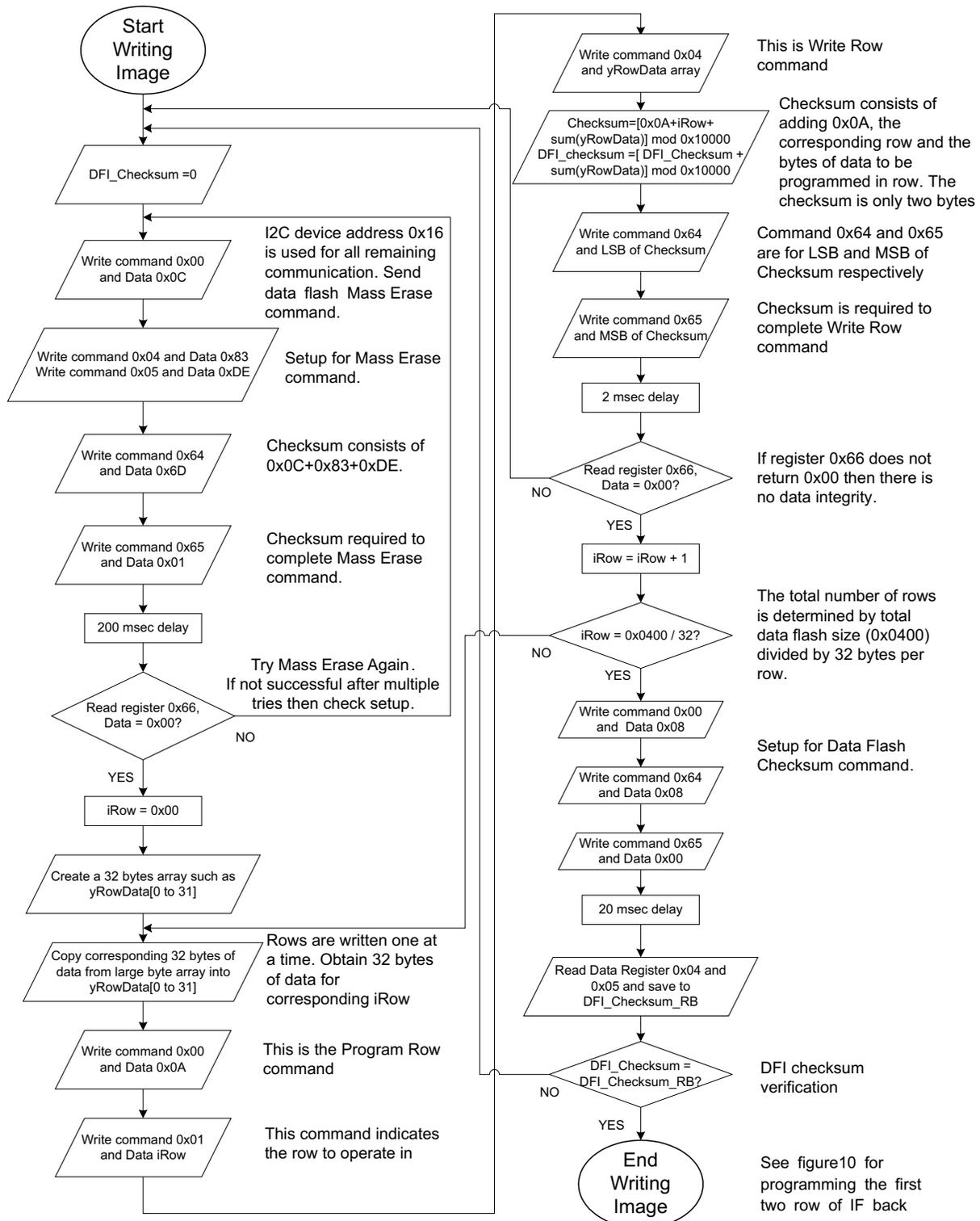


Figure 8. Continuation of DFI Write Flow, Page 2 of 3

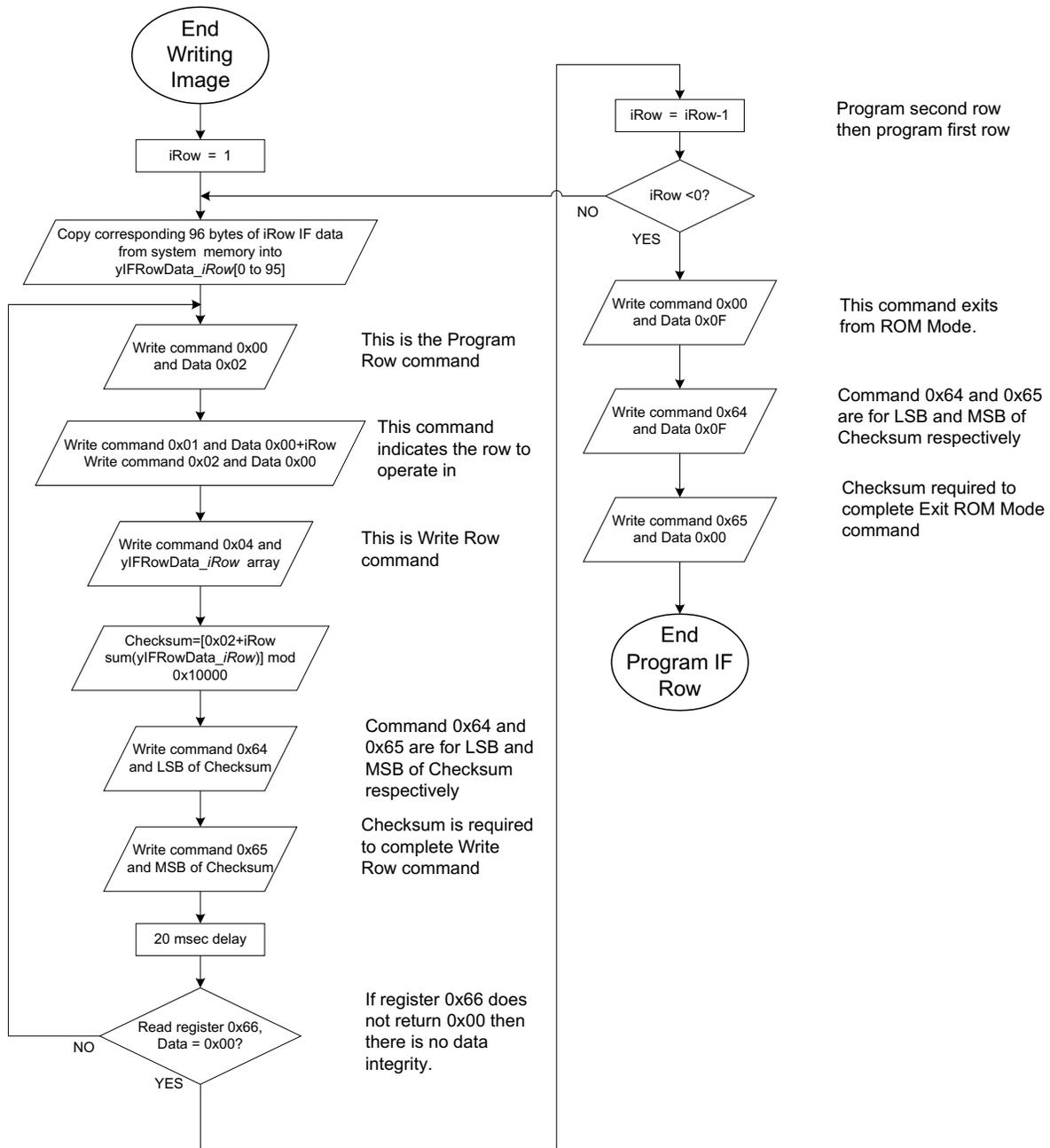


Figure 9. Continuation of DFI Write Flow, Page 3 of 3

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Transportation and Automotive	www.ti.com/automotive
Video and Imaging	www.ti.com/video
Wireless	www.ti.com/wireless-apps

TI E2E Community Home Page

e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated