Application Report
SLUA493–January 2009

bqEASY for Configuring Single Cell Gas Gauge bq27501

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ABSTRACT

Texas Instruments advanced fuel gauges, that employ the Impedance Track™ algorithm, offer an unmatched array of features and benefits. Sometimes the multiple configuration settings can make it challenging to begin the evaluation process. In addition, determining the correct chemistry model and producing the final *golden image* file can be time consuming. The bqEASY software is designed to simplify the process of configuring, calibrating, selecting chemistry, and performing charge-discharge learning cycles using the step-by-step procedural interface. bq27501 is a complex gas gauge that support two types of battery cells of different chemistry and capacity. This application report discusses the step by step use of bqEASY software for configuring bq27501.

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1 Introduction

Evaluating the complex configuration options of the Texas Instruments advanced fuel gauges can be simplified by using the bqEASY program. The bqEASY software procedure provides detailed configuration, calibrating, and chemistry selection instructions, and works within the Evaluation Software (EVSW). The discharge portion of the chemistry and learning cycles can be performed automatically with the use of a simple additional circuit connected between the target device or Evaluation Module (EVM) and the EV2300. When the automated process complete, a final *golden image* is generated that can be used in production application programming for all devices.

2 Software Installation

Software installation requires that the latest EV software be installed from the TI Website in the EVM tool folder for the part. bq27501 uses the same EVSW as for bq27500. In this document, the bq275xx EVM tool folder is referenced.

To install the software:

1. Ensure that the EV2300 is **NOT** connected to the computer prior to installation of software.
2. Go to the TI internet and get the latest EV software if not already done so. As described above, this can be found on the TI internet in the EVM tool folder Support Software section for the part being used. As an example, go to the *bq27500 EVM* folder *Support Software* section.
3. Install this EV software using the installer screen-displayed instructions. For additional assistance with EV Software installation, see the Quick Start Guide for bq2750x Family Gas Gauge (SLUA448). This document can also be found in the EVM tool folder for the product being used.
4. Once the EV software is installed, verify its functionality by setting up the EV2300 and a known bq27501 module. Ensure that the computer, EV2300, and bq27501 module all are operating normally and that communication to the module is functioning. For additional assistance help, refer to Quick Start Guide for bq2750x Family Gas Gauge (SLUA448).
5. Because chemistry file are added to the device internet EVM tool folder often, check the internet page for updates. A self-extracting installer is available for updating the chemistry file. Install these updates if they exist in the internet folder.
6. Start the Gas Gauge Evaluation Software using the menu commands **start** → **Programs** → **Texas Instruments** → **bq Evaluation Software.**
7. To access the bqEASY procedures, click the bqEASY button in the left column (below **Calibrate**) → (Figure 1)

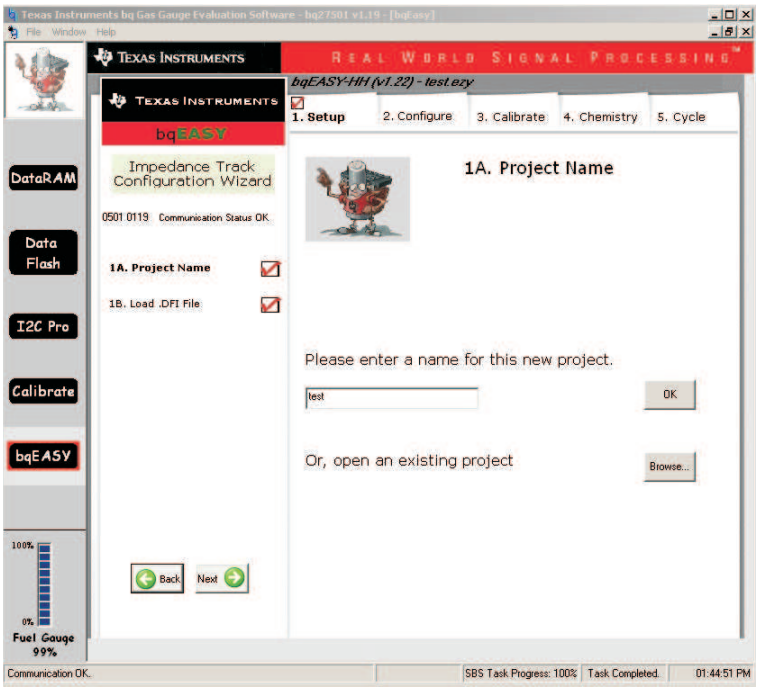

Figure 1. bqEASY in EV Software

3 Program Navigation and Flowchart

The operation sequence of bqEASY can be understood by reviewing the basic flowchart in Figure 2. Start a new project and follow the procedure steps. Use the **Next** button, or click the top dialog tabs and left subsection labels to move among the bqEASY dialogs. Some operations must be completed in sequence because of data dependencies, or to implement the required steps. TI recommends following the prescribed sequence, initially.

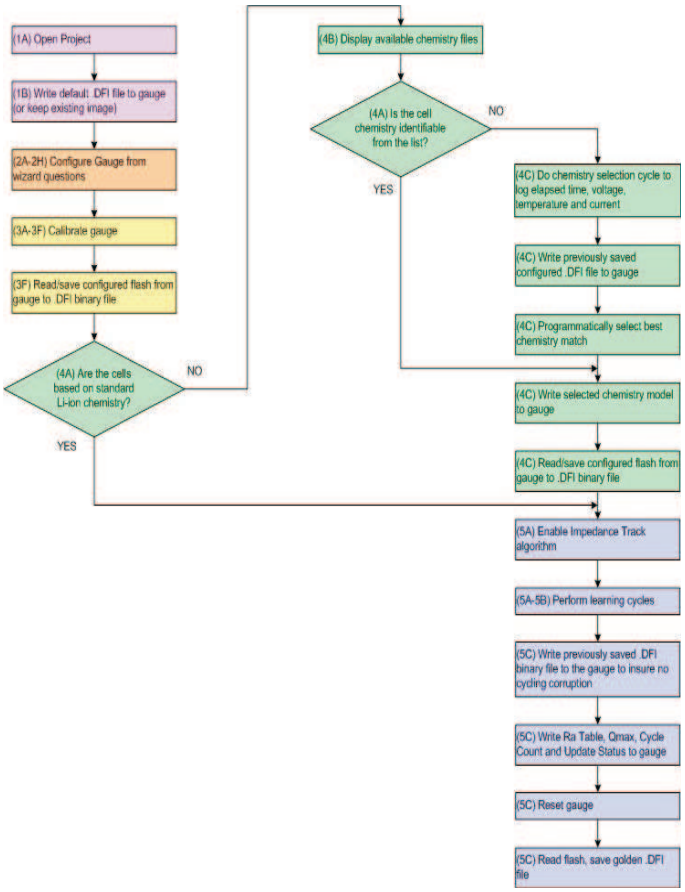

Figure 2. bqEASY Process Flowchart

4 Configuration Procedures

These configuration procedures can be used to set up the parameters without navigating through the entire user interface.

- Gas Gauge configuration using default or custom data
- Calibrate the EVM
- Chemistry data installation using available bqEASY chemistries

bq27501 supports two different type of battery cells. These two types of cells can be different in chemistry or different in capacity or both. This feature requires extra steps when setting up bq27501.

4.1 To configure the Gas Gauge using default or custom data:

1. Start the EVSW (**start** → **Programs** → **Texas Instruments** → **bq Evaluation Software**) and click the **bqEASY** button in the left column (below **Calibrate**) in the user interface

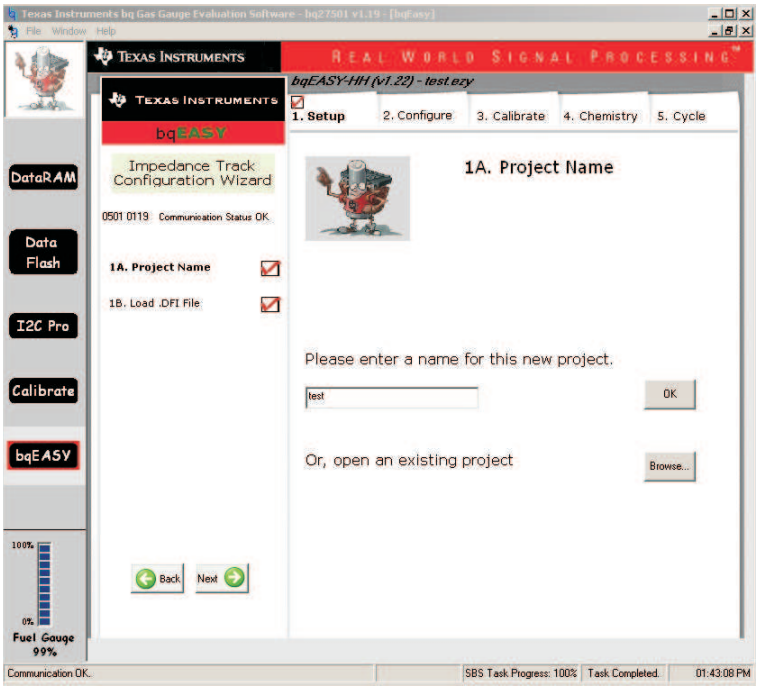

Figure 3. bqEASY Project Set Up

2. Click the **2. Configure** dialog tab at the top of bqEASY tabs. In step 2A, there are two columns of blanks need to be filled. Each represents one type of cell that will be identified as Pack A or pack B as shown in Figure 4.

Figure 4. bqEASY Cell Characteristics

3. Answer all questions or leave defaults for the **2. Configure** dialog tab. Be sure to click OK at the bottom of each **2. Configure** dialog to ensure that a completion checkmark displays for each page.

4. On page 2H, there are two different resistor values are assigned to Pack A and Pack B to represent two different Resistor IDs. It is recommended to use resistor with resistance 500Ω and 8000Ω, respectively, for different battery pack so that the bq27501 can clearly differentiate different type of cells (Figure 5). When click the **OK** button, the software asks if the user wants to write the information to the data flash memory. Click **Yes** to write the information to the data flash.

   The Gas Gauge module now has the data flash configured with the information entered in **2. Configure** bqEASY dialogs.

Figure 5. bqEASY Resistor ID

4.2 To Calibrate the EVM:

1. Start the EVSW (**start** → **Programs** → **Texas Instruments** → **bq Evaluation Software**) and click the **bqEASY** button in the left column (below **Calibrate**) in the user interface
2. Click the **2. Configure** dialog tab at the top of bqEASY tabs.
3. The actual calibration is under **Calibrate** dialog. Go to **Calibrate** dialog by click the **Calibrate** button on the left-hand column above **bqEASY**.
4. Complete the calibration by following the steps in Going to Production with the bq2750x (SLUA449)
5. Go back to **bqEASY** dialog and click **OK** all the way from step 3A to step 3F. Make sure all the steps are checked.

4.3 To install chemistry data using available bqEASY chemistries:

1. Start the EVSW (**start** → **Programs** → **Texas Instruments** → **bq Evaluation Software**) and click the **bqEASY** button in the left column (below **Calibrate**) in the user interface.
2. Click the **4. Chemistry** dialog tab at the top row of bqEASY tabs
3. Select **Use Default Chemistry**, or click **Enable Chemistry Selection** and select the correct chemistry from the list. To support bq27501, bqEASY has the option to assign chemistry profile to Pack A or Pack B (Figure 6). Correct chemistry profile has to be loaded for Pack A or Pack B separately by selecting profile A or profile B.
4. If the proper chemistry is not found, check the device EVM tool folder on the TI internet site for any new Chemistry file updates as described in the Software Installation section.

   The software configures all data flash locations on the Gas Gauge Module that deal with chemistry functions. No other data flash locations are modified.

Figure 6. bqEASY Chemistry Selection

5 Files

bqEASY uses four types of files to configure a fuel gauge.

1. ***.ENCR (Data Flash Files) –** default data-flash definition files found in the…*bq_Evaluation_Software* folder. A ENCR file is a copy of the entire data-flash from a fresh Gas Gauge prior to any data-flash updates by the user or the Gas Gauge. These files are unique for every version of each TI fuel gauge product. If working with a newer version fuel gauge and an older version of the EVSW with bqEASY, the correct file may not be present in the software. This requires a new version of the EVSW with bqEASY. Navigate to the TI internet in the EVM tool folder for the device being used, and download the latest version, or contact TI. For bqEASY, the ENCR files act as a dictionary to look up the address for a given data-flash location. For EVSW, the define window display parameters including address, display formulas and data type. An error message will appear if the correct .ENCR file cannot be found.

2. ***.CHEM (Chemistry Files) –** read-only files found in the...*bq_Evaluation_Software\Plugins\Chemistry* folder. When a new Li-Ion battery chemistry is developed, a new Impedance Track model is required to define the chemical model. During automated chemistry selection, each of these files is scanned in order to select the best match with the recorded data. If working with a newly developed chemistry, it is possible that an acceptable match will not be found. If this is the case, check for updated bqEASY software or Chemistry files on the TI internet in the EVM tool folder for the part being used.
3. **.DFI (Data-Flash Image Files) –** binary images of the fuel gauge data-flash with modified values based on the application. Because of the binary format, it is quick and easy to transfer them to and from a gauge. Each fuel gauge model and firmware version has a unique read-only .DFI which is found in the...*bq_Evaluation_Software\Plugins\Device_Defaults* folder of the application. During the bqEASY process, intermediate versions of .DFI files are recorded with current updated data in order to prevent data corruption. The final output of bqEASY is a .DFI file which is the called *golden image* and used to program production unit. This output file will be placed in the...*bq_Evaluation_Software\Plugins\Projects* folder.
4. ***.EZY (bqEASY Project Files) –** read/write text files which record header information regarding a project, answers to the wizard questions, and status regarding the stage of completion (the red check marks). They are kept in the...*bq_Evaluation_Software\Plugins\Projects* folder.

6 Completion Checkmarks

As the bqEASY questions and tasks are completed, completion checkmarks appear in two places – along the task list on the left and on the top dialog tabs. A checkmark on a top dialog tab displays only after all category tasks are completed. For example, in Figure 7, all of the **Setup** tasks and **Configure** tasks are completed.

Completion marks are saved in the *.EZY bqEASY project text file. When a completed or partially-completed project file is opened, the user is given the option to erase the checkmarks.

Figure 7. Completion Checks for Categories (tabs) and Tasks (above "Back/Next" buttons)

7 Device Detection

The bqEASY is designed to work with a fuel gauge present and already communicating with the Evaluation Software (EVSW) through the EV2300 USB interface. When the Evaluation software is started, it reads the device type and displays it on the upper title block. This information is used by bqEASY to select the correct default data-flash image (***.DFI**) and data-flash configuration file (***.ENCR**) for this particular device. To ensure that the device has not changed, bqEASY also checks the device type each time the users click the **bqEASY** button. If the correct files are not found, first check the TI internet in the EVM tool folder for the part being used, and download the latest version of EVSW with bqEASY support. If that does not help, then contact TI.

The major procedure areas in bqEASY are:

1. Setup

Step 1A allows the user to open an existing project file or start a new project. A new project is given a project file with the *.EZY extension.

Step 1B optionally loads the default data-flash image for the detected device. If starting from a known new device, this step can be skipped.

2. Configure

A sequence of dialogs used to collect information about the battery pack application that enable automatic configuration of the most critical data-flash parameters.

3. Calibrate

To proceed with automatic chemistry selection or *golden image* learning cycles, the Impedance Track fuel gauge must be accurately calibrated. The bqEASY dialogs ask the user to use the calibration window of the bqEVSW for this purpose.

With the Impedance Track™ devices, most calibration routines have been incorporated into firmware algorithms, which can be initiated with communication commands. The hardware necessary for calibration is simple. One current source, one voltage source, and one temperature sensor are required. The source stability is important, the accuracy is a secondary concern.

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 bq27501 calibration is to perform the calibration using 20 to 30 final application systems containing the bq27501 IC. All the calibration flash values are to be recorded and averaged among the 20 to 30 samples. The average values are used when creating the DFI file needed for production.

At time of calibration, access is required to the communication pins, both ends of the sense resistor, and battery power. The calibration process has to be completed in EVSW Calibrate dialog. The calibration consists of performing Coulomb Counter Offset Calibration, Voltage Calibration, Temperature Calibration, Pack Current Calibration and CC Board Offset Calibration one at a time. The EVSW is used to perform all calibration is shown in Figure 8. Each calibration has to be completed separately.

After the calibration is completed, click the close window control X in the upper right corner of the calibration window to close it.

CAUTION

The Calibration window must be closed after the calibration completed. Otherwise, it interferences with the bqEASY learning cycle.

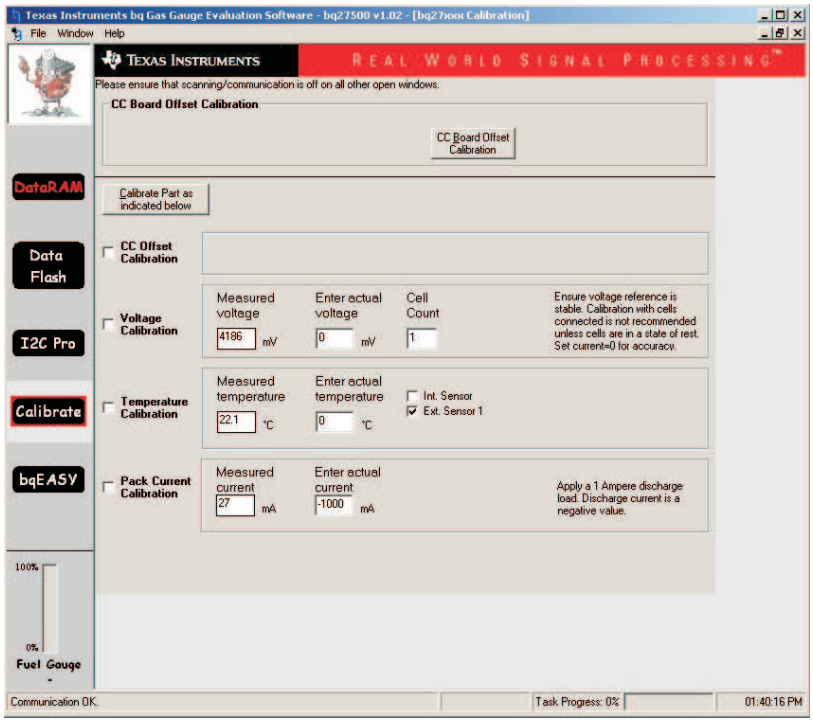

Figure 8. EVSW Calibration Screen

4. Chemistry

The choices presented in **4B Chemistry** are based on files in the *Chemistry* folder of the bqEASY application. The latest files are available for downloading from the Texas Instruments Internet site

Automation of the chemistry-selection cycle is made possible using a simple load and switch as depicted in Figure 9. The switch can be implemented with either a low VGS-threshold FET or a small relay such as the OMICRON G6RN-1 with a 5-VDC coil. Multiple 2N7000 FETs can be paralleled if nothing else is available. The load can be either a power resistor or an electronic load set to a discharge rate of C/5.

Hint: Follow the bqEASY dialog instructions exactly to prevent errors.

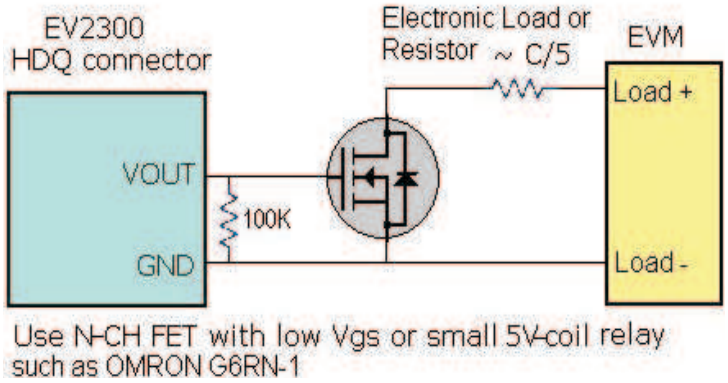

Figure 9. Example Load

5. Cycle

When preparing for mass production, cell learning is required, but only on one *golden* pack. The chemical information learned from one pack will be transferred to all production units, prior to calibration. Doing this correctly requires a series of charge and discharge cycles. The discharge part can be automated with bqEASY if the simple load circuit for the chemistry selection is available. Follow the bqEASY dialog instruction as shown in Figure 10. The bqEASY provides two ways to complete the learning cycle.

The first method is to use bqEASY semi-automatically to complete learning cycle. This includes:

- Auto-discharge the cell and auto-relax
- Manual initialize the Impedance Track
- Manual charge the cell to full and manual wait
- Auto-discharge to empty and auto-wait

  Another way to complete the cycle is to complete above step 1 to 4 manually. This method does not involve a constant voltage check by bqEASY and can be used with datalogging without any interference.

During the learning cycle, both Pack A and Pack B will be learned. When pack is inserted, the bq27501 detects the Resistor ID and select the proper chemistry profile for learning. The learned Qmax and Resistance will be updated in the proper data flash location based on Resistor ID detected. After both Pack A and pack B learning are completed, a golden image file can be generated in bqEASY step 5B

Figure 10. bqEASY Learning Cycle

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