

# ***bq2650X Single-Cell Battery Fuel Gauge Tester and Programmer***

*PMP Portable Power*

## **ABSTRACT**

The Texas Instruments bq2650X Tester Kit tests and programs bq26500 and bq26501 single-cell Li-ion and Li-polymer battery gas gauge devices. The kit includes a bq2650X Test and Program PC interface board for gas gauge testing, one RS-232 cable, a CD ROM including Windows™-based PC software, and support documentation.

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## 1 Introduction

The Texas Instruments bq2650X Tester Kit tests and programs bq26500 and bq26501 single-cell Li-ion and Li-polymer battery gas gauge devices. The kit includes a bq2650X Test and Program PC interface board for gas gauge testing, one RS-232 cable, a CD ROM including Windows™-based PC software, and support documentation. This kit tests the electronic modules prior to pack installation.

### 1.1 Features

- Complete test and program system for the bq26500 and bq26501 battery gas gauge
- PC software and interface board for production test
- Software allows EEPROM programming and production data logging.

### 1.2 Kit Contents

1. HPA048 PC interface test board (bq2650X Test and Program) for RS-232
2. CD ROM including Windows-based PC software and support documentation
3. RS-232 cable

## 1.3 Ordering Information

| KIT PART NUMBER   | PC INTERFACE BOARD | CHEMISTRY | PACK VOLTAGE   |
|-------------------|--------------------|-----------|----------------|
| bq2650XTester-Kit | RS-232             | Li-ion    | 2.6 V to 4.5 V |

## 2 Installation and Setup

### 2.1 Minimum System Requirements

- Operating system: Windows 98, 2000, or XP
- Video: Super VGA – 1024 x 768 minimum resolution
- RAM: 16M bytes
- Hard drive space: 5M bytes
- RS-232 port: 1 available

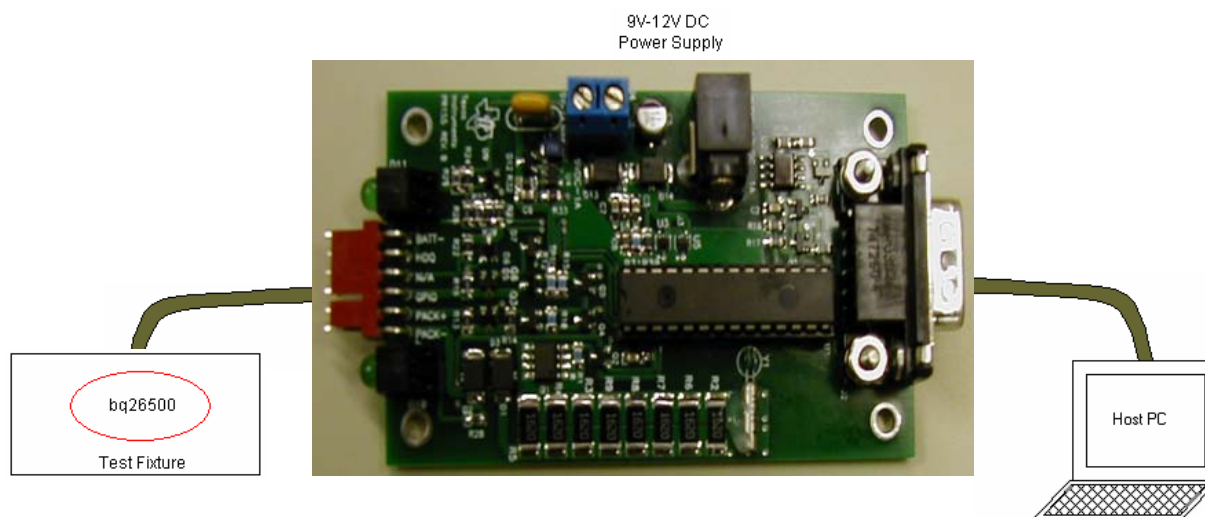
### 2.2 Final Test Board Specifications

- +9 V to +12 V DC minimum 1 A
- Analog inputs:  $\pm 6$  V
- Digital inputs: 0 to + 5 V

**Note:** Values greater than these limits entered into the final test system connections to the hardware may cause permanent damage to the final test board.

### 2.3 Interface Connections

The bq2650X Test and Program system requires the host PC to be connected to the final test board using RS-232. The power supply is connected to the connector on the side of the final test board, as shown in Figure 1. The test head (test fixture) can be constructed following the interface connection table in section 2.3.1 using a schematic and assembly drawing for the module to be tested. It is recommended that test head cables not exceed 12 inches in length. Spring-loaded test pins are recommended for module testing. Connection of test head to module requires precision contacts to ensure good electrical contact.



**Figure 1. bq2650X Test and Program Board**

### 2.3.1 Test Head Fixture Interface

The test head interface for the bq2650X Test and Program board requires a Molex female 6-pin connector #22-01-3067 with crimp terminals (tin) #08-50-0114. Table 1 contains data pertaining to the test points.

**Table 1. Test Points**

| Molex Connector Pin | Description | Color Code | Wire Gauge Insulated (12 inches) |
|---------------------|-------------|------------|----------------------------------|
| 1                   | Batt -      | Black      | 22 AWG                           |
| 2                   | HDQ         | Brown      | 22 AWG                           |
| 3                   | N/C         | N/A        | N/A                              |
| 4                   | GPIO        | White      | 22 AWG                           |
| 5                   | Pack+       | Red        | 22 AWG                           |
| 6                   | Pack -      | Black      | 22 AWG                           |

### 2.3.2 Computer to Test System Interface

Connect the bq2650X Test and Program board to the computer communication port using the RS-232 cable.

## 2.4 System Power Up

After all connections are made, the final test board is powered with a power supply that provides +9 V to +12 V DC (minimum 1 A) into the jack located on the side of the test board. Visually verify the green LED labeled D11 is ON. Power can also be applied using an external power supply between +9 V to +12 V DC (minimum 1 A).

## 3 Software Contents and Installation

### 3.1 Software Contents

The bq2650X Tester Kit contains all software on a CD ROM as follows:

1. Documentation
  - a. bq2650X User's Guide (SLUU185A)
  - b. bq26501 Data Sheet
  - c. HPA048 Schematic
  - d. HPA048 Top Assembly
  - e. HPA048 Bill of Materials
  - f. PIC Program V402 hex
2. Install Executable Program
  - a. CAB Files
  - b. *setup.exe*
  - c. *bq2650X.gg* Default EEPROM File
3. Visual Basic Source Code
4. *ReadMeFirst.txt* File

### 3.2 Software Installation

Use the following steps to install the bq2650X Test and Program software:

1. Insert the CD ROM into a CD ROM drive.
2. Select the CD ROM drive using My Computer or File Manager.
3. Select the *ReadMeFirst.txt* File.
4. The setup program installs a Windows application group.

## 4 Operation

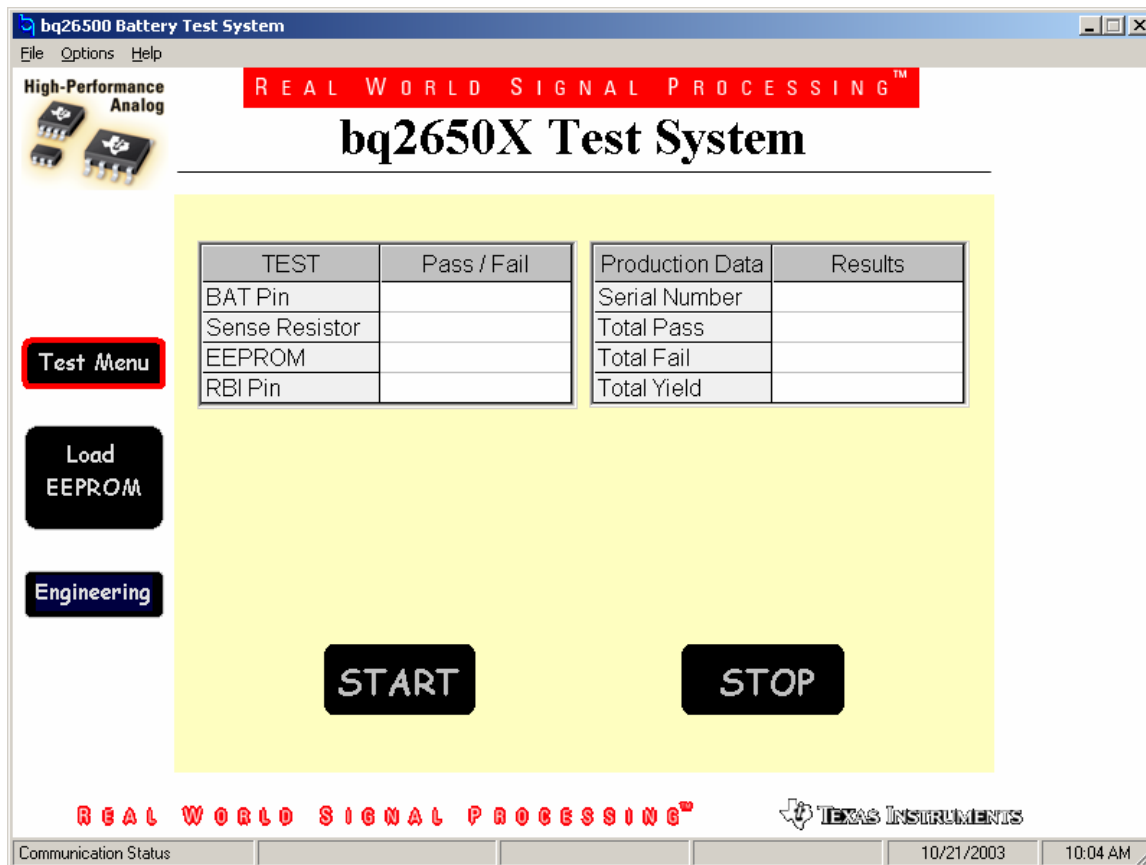
The bq2650X Test and Program board verifies assembly functions for the RBI pin, Sense Resistor, and Battery pin, while also programming EEPROM data.

The bq2650X reference module (EVM HPA033) can be used to test the integrity of the Device Test Port prior to connecting the test head fixture. Perform the reference test anytime the device under test (DUT) port is in question.

Perform module tests before pack tests so that complete calibration and functional testing is accomplished prior to pack assembly. The bq2650X test board is for module test only. Do not attempt to use for pack test.

## 4.1 Starting the Program

Run the program from the **Start|Programs|Texas Instruments|bq2650X** menu sequence. If the bq2650X Test and Program board is connected to the RS-232 port, the program loads and displays the initial Test Menu Screen shown in Figure 2. The communication port can be changed by selecting the port under the Options menu.



**Figure 2. Test Menu Screen**

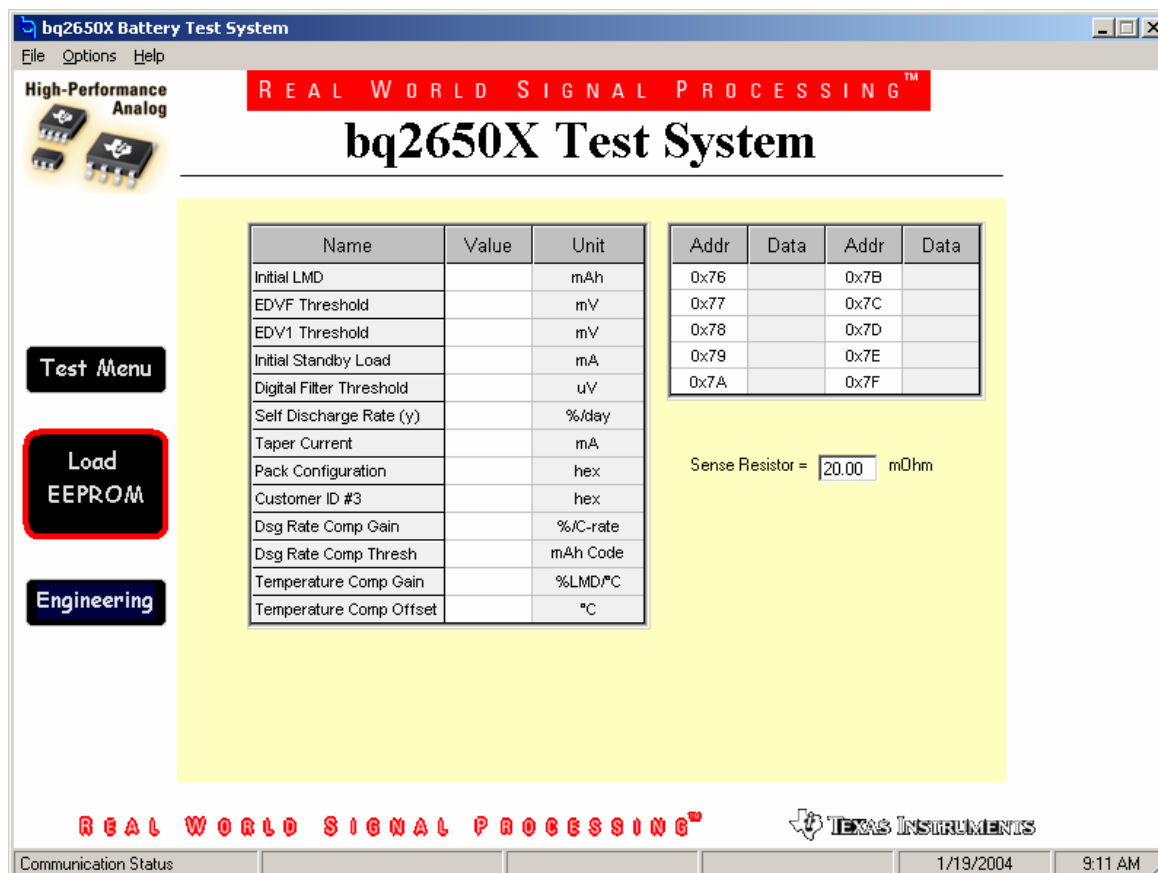
## 4.2 Initialization

This section describes the settings that must be made before testing the bq2650X.

### 4.2.1 Load EEPROM

Click on the Load EEPROM selection. The Load EEPROM screen appears as shown in Figure 3. From the menu bar, select File → Open Gas Gauge EEPROM Constants. Find the directory where the *bq2650X.gg* file is located, and select the file. Once you have selected the configuration file, click on Test Menu, and skip to section 4.4 to begin testing.

**Note:** Do not attempt to change the configuration data while in the Load EEPROM menu selection. See section 4.3.2 to modify and save configuration files.



**Figure 3. Load EEPROM Screen**

## 4.3 Engineering

The Engineering section is a password-protected menu providing the opportunity to change the configuration file or enable/disable specific tests. This menu is for engineering debugging in a production test environment.

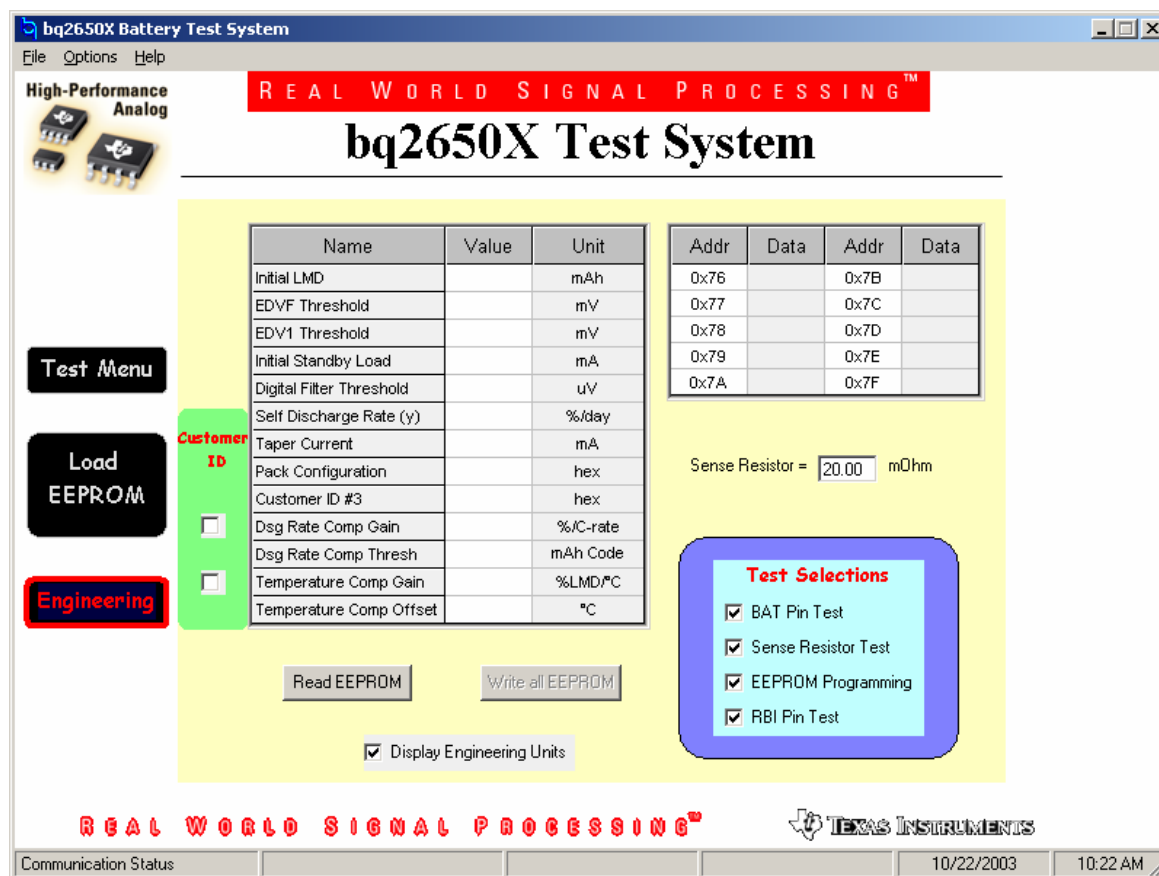
### 4.3.1 Password

Selecting the Engineering option brings up a password entry selection. Enter *bmrq* in the password field; the User ID field is left blank. It is recommended that the password be changed once the system is ready for production test. Use the menu bar, and select Options to change the password.

If the password is modified and the new password is not known, the bq2650X.exe must be reloaded where the password is now the default.

### 4.3.2 Test Selection Options

The Engineering screen is now present as shown in Figure 4. In this section, use the menu bar to select File → Open Gas Gauge EEPROM Constants. Find the directory where the *bq2650X.gg* file is located, and select the file. Configuration data can be modified and saved to a file but only in the Engineering menu selection. Using the mouse, click on the data to modify, and after updating the field, press the Enter key. Select Save As from the File menu, and enter a file name to save the new configuration file. Once the configuration file has been selected or saved, click on Test Menu, and go to section 4.4 to begin testing modules.



**Figure 4. Engineering Screen**

## 4.4 Production Test

At this time, power to the bq2650X Test and Program board is on, and testing can begin. Figure 5 displays an example of the status and results when testing a passing module.

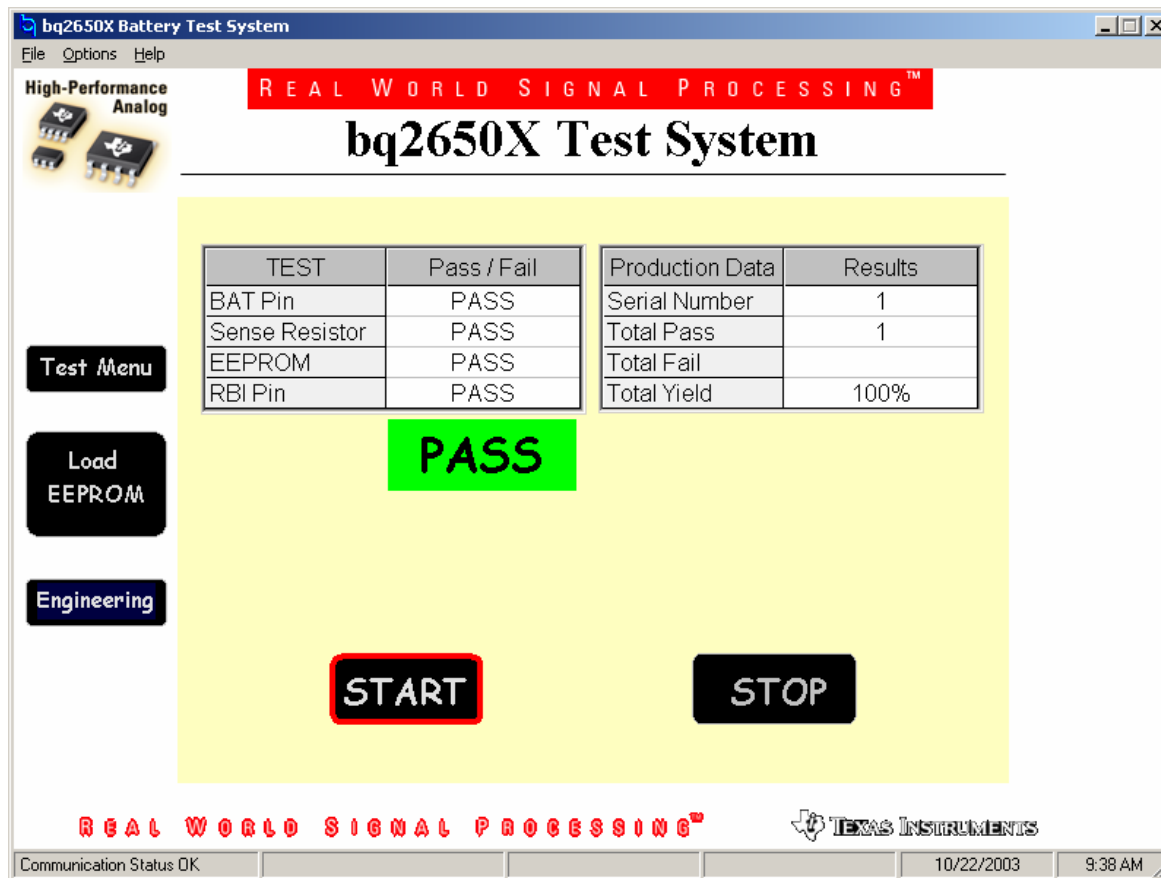


Figure 5. Test Menu Results Screen

#### 4.4.1 Start and Stop Functions

The Start icon on the Test Menu screen is used to begin testing the module. The test results appear on the screen after each test selected with either a PASS or FAIL indication. The Stop icon immediately stops the test, and the Results section will not be updated.

#### 4.4.2 Display Definitions

Completed status of the module under test is indicated with a green PASS or red FAIL condition.

Results: Displays and keeps running totals of modules tested.

1. Serial Number: Displays the last serial number tested.
2. Total Pass: Displays the total number of good modules.
3. Total Fail: Displays the total number of rejected modules.
4. Total Yield: Displays the total good divided by the total tested on a percentage basis.

## 4.5 Pass/Fail Status

### 4.5.1 Data Logging

Data is logged on the computer monitor and can also be placed in a lot summary data file. After all testing has been completed, the results can be stored in a .SUMMARY file. From the Menu bar, select File → Log Test Summary. A prompt asks for a file name; at this time, select a directory where the test summary data log file will be placed. The lot summary data log file is recommended during production test to keep information stored on a by-lot basis.

**Note:** The program does not log the data into a .SUMMARY file until all testing is complete.

### 4.5.2 Example Data Log .SUMMARY File

```
Texas Instruments bq2650X Gas Gauge Production Test Summary
bq2650X Version 1.0.0
9/24/2003 4:14:02 PM
```

```
[Production Test Summary]
```

```
Serial Number from 1 to 4
```

```
Total Pass=3
Total Fail=1
Total Tested=4
Yield=75%
```

```
[Module Pass/Fail Summary]
```

```
Pass = 3
Fail BAT Pin=0
Fail Sense Resistor=1
Fail EE Verification=0
Fail RBI Pin=0
```

## 5 Test Descriptions for bq2650X

### 5.1 Theory of Operation for bq2650X

This section contains a brief description of the bq2650X Module Test procedures. Power supply voltage to Pack + ( $V_{cc}$ ) equals 3.8 V +/- 20 mV.

#### 5.1.1 BAT Pin Test

Verify the VOLTH and VOLT\_L registers contain the reported battery voltage measured on the BAT pin. It is important to wait for the device to complete a full conversion, approximately 1.8 seconds, before taking a measurement. The program is set up to read back 3.8 V +/- 100 mV from the specified registers.

### 5.1.2 Sense Resistor Test

Verify that the sense resistor is functioning properly with the following procedure:

1. Read Discharge Counts Register (DCR) from address registers 0x6A and 0x6B, record the values, and store in DCR counts "Original."
2. Source current on Pack - to generate DCR counts.
3. Read DCR from address registers 0x6A and 0x6B, record the values, and store in DCR counts "Final."
4. Compare absolute DCR counts "Final" minus DCR counts "Original," and check for a specified range of valid DCR counts for the sense resistor value used.

### 5.1.3 EEPROM Programming

1. Enable the programming mode by writing data 0xDD to the EE\_EN register (addr 0x6E).
2. Latch data by performing a Write, then Read operation from the .gg configuration file.
3. Apply 21 V to GPIO pin to program latched EEPROM data into the gas gauge.
4. Read verify from EEPROM registers for values equal to the .gg configuration file.
5. Disable the programming mode by writing data 0x00 to the EE\_EN register (addr 0x6E).

### 5.1.4 RBI Pin Test

Verify that the RBI pin provides backup power to the internal registers when  $V_{CC}$  drops below the power-on-reset (POR) voltage. The test procedure is as follows:

1. Write data 0xA5 to At Rate register 0x02.
2. Write data 0x5A to At Rate register 0x03.
3. Enable WRTNAC bit in Mode register 0x01.
4. Write 0xA9 to Device Control register 0x00, which clears the POR bit.
5. Read Control Register 0x00 until the register has cleared.
6. Generate POR condition by turning Pack+ OFF for 200 ms.
7. Turn Pack+ ON, and read Mode register 0x01 to verify the POR bit has been set.
8. Read and store the values from NAC registers 0x0C and 0x0D.
9. Verify NAC register values retained the data written in the foregoing steps 1 and 2.

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