Lead Acid Battery Monitoring Implementation for Inverters Using bq34z110

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ABSTRACT

This application report provides instructions for battery monitoring using the bq34z110.

A power back-up DC-AC Inverter is an example of a widespread application that at present doesn't have an easy, accurate and automated method of monitoring and reporting battery condition. How long will the battery retain its life? When will we need to replace the battery? Such questions remain unanswered.

A battery monitor with an ability to report battery status accurately will definitely enhance the end-user experience. An understanding of the following battery monitoring terms is necessary:

- *State of Charge (SoC)* in % = Remaining Battery Capacity / Full Charge Capacity
- *State of Health (SoH)* in % = Full Charge Capacity / Battery Design Capacity

Remaining Battery Capacity changes when the battery is charged or discharged. By comparing remaining capacity to Full Charge Capacity (FCC), *SoC* monitors the current state of the battery. As the battery ages, chemical degradation causes reduction in the battery's maximum chemical capacity. By comparing FCC at 25° C to the battery design capacity, *SoH* monitors the effect of battery aging.

The *bq34z110* uses the impedance track technique to accurately predict a battery's SoC and SoH. Using this device helps extend battery lifetime by giving us relevant information that compensates for the battery temperature, aging, self-discharge, discharge rate, and their effect on the battery impedance. For more details, visit http://www.ti.com/product/bq34z110.

Usage of bq34z110 in an Inverter System

Any inverter system can be described as done in the following five conditions. Note that the *current* values may vary with the system. These are listed with respect to a standard configuration (850-VA system with a 150-Ah battery):

(A) Inverter ON, discharging with 2-A internal load

(B) Inverter ON, discharging with 20-A external load

(C) Inverter ON, in cut off stage (when battery voltage falls below a certain threshold). Load current is minimal at approximately 100 mA.

(D) Inverter OFF, manually turned OFF completely. Almost no load current flows.

(E) Inverter ON, charging with 10-A charging current

Step-By-Step Optimization Process Instructions

1. Battery characterization phase: Go to *bqChem* inside bq Gas Gauge Evaluation Software and select the closest ChemID. This ChemID is used as a starting point and the gauge automatically corrects itself to actual values as it learns from the battery. If you don't see a close match, contact your nearest TI Technical Support team. The team will help take down the readings of OCV1 and OCV2.
2. OCV1 means Depth of Discharge (DOD) of 0%, OCV2 means DOD of 100%. The gas gauge doesn't know how the battery behaves below OCV2 and above OCV1, therefore, it is important to take these two readings accurately. Figure 1 demonstrates what these terms mean.

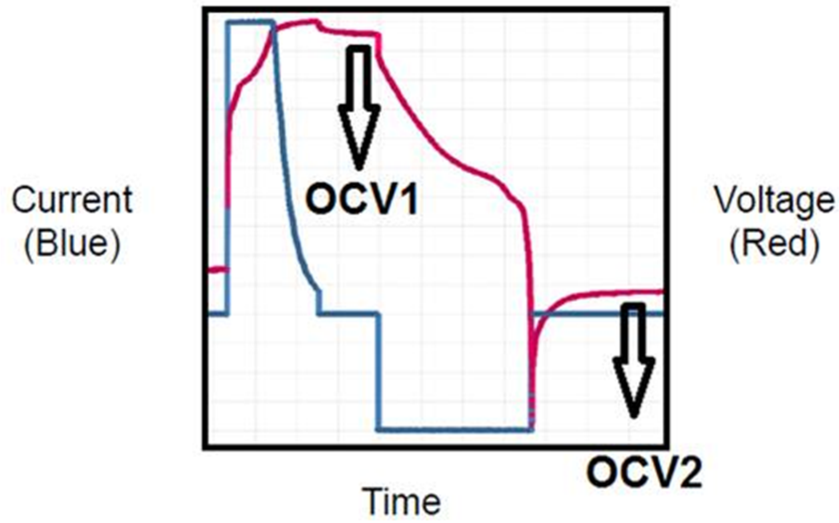

Figure 1. Illustration of OCV1 and OCV2

3. Subsequent to the characterization process, we get an OCV table versus DOD and construct a Ra table.

Next, go to the *bqEvaluation* software connected with the bq34z110 device through EV2300.

1. Under *I2C Pro → Write I2C Data Block*, input the I^{2}C command as *00* and Data Block as *000f*, and click on *Write Data*.
2. Select the *Senc* file under programming, and click on *Program*.
   - Charge current is nearly 12 A. We can enter 300 mA. (Design scale of 10, “3 A” can be safely assumed to be the point when devices enter the charging phase).
   - Discharge current of –500 mA is entered, discharge occurs at > 20 A.
   - Quit Current = 100 mA. Normally the inverter is in the *A* state but the inverter is in the *C* state when the battery voltage falls below 10.8 V.

The previous parameters can be entered directly into the GUI, or the Senc file can be requested from the BU with any modifications.

The above threshold values ensure the device knows when it has entering the charging, discharging, or relaxation phase.

Calibration Process

1. Calibrate the battery pack *before* proceeding further. (Voltage, Current, Coulomb Counter)
   - Go to Calibrate → Calibrate Coulomb Counter (Inverter in D/A state).
   - Calibrate voltage and temperature. Use a multimeter to check and note readings.
   - Calibrate board offset – Not required.
   - Calibrate pack current – Inverter in B stage. Enter “–2000mA” as measured current.
2. Fully charge and relax the battery. Check the voltage after resting, it should be ≥ OCV1.
3. Go to Data RAM, read DOD0, then divide by 163.84. The calculated value should be as low as possible, ideally 0, since the battery hasn’t discharged yet.
4. Enter 21 in the Control. IT is enabled. VOK and QEN flag becomes red.
5. Inverter reaches C point. Determine if DOD has changed by > 50% (ideally it should be near 100%). If not, turn the inverter OFF and turn it back ON. The inverter goes to the *A* stage and let it go back to *C* state. After multiple such attempts, the voltage will quit recovering to a higher voltage. Allow the pack to rest until the OCVTAKEN flag is set.
6. Update Status should change to 5

7. Charge the battery until full (again pack voltage should be ≥ OCV1). The VOK and QEN flags are set during the charging operation.
8. Allow the battery to relax. The VOK flag remains set.
9. Discharge the battery at C/10 until the battery is empty. Inverter goes from *B* to *C* state.
10. Allow the battery to relax. Wait for The OCV reading to be taken and the VOK flag to clear. The update status should now be set to 6.

Note 1: If the pack voltage rests above OCV2 reading (taken during characterization), discharge pulses must be applied to reduce the rested voltage.

Note 2: The Update Status value only changes after the pack has updated Qmax and then updated the Ra-table. It will not change if the conditions are not met to update these parameters.

Useful Links

- *Going to Production with the bq34z1xx* (SLUA665)
- *Configuring the bq34z100 Data Flash* (SLUA664)
- bq34z110 datasheet *Wide Range Fuel Gauge with Impedance Track™ for Lead-Acid Batteries*:SLUSB55B
- *bq34z110EVM Impedance Track™ Enabled Fuel Gauge for Lead Acid Batteries* (SLUUA15)

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