Application Note

Comparison between internal resistance and capacity test

Predicting whether a battery system will perform its intended operating role is a major problem for battery users. There are a number of different tests, which are recommended by IEEE, NERC and other standards for diagnostics of battery banks conditions. The two most commonly used methods to determine how a battery is going to perform when required, are the **internal resistance** test and the **capacity** test.

Capacity (Discharge) test

Batteries are designed and sized to produce a certain amount of current for a given amount of time. The only method to determine whether the battery will support the load for the needed duration is a capacity test. That is why among all the tests, the discharge test, (also known as a load test or a capacity test) is the only test that can accurately measure the true remaining capacity of a battery system and consequently get an insight in an operational condition of a battery. A discharge test needs to be performed with automated test equipment that can log data of all individual cells during the discharge process and at the end locate the weak cells and faulty inter-cell connectors. The figure below illustrates the weak cell detected during the discharge test performed with the BLU and BVR series of instruments using DV-B Win software.

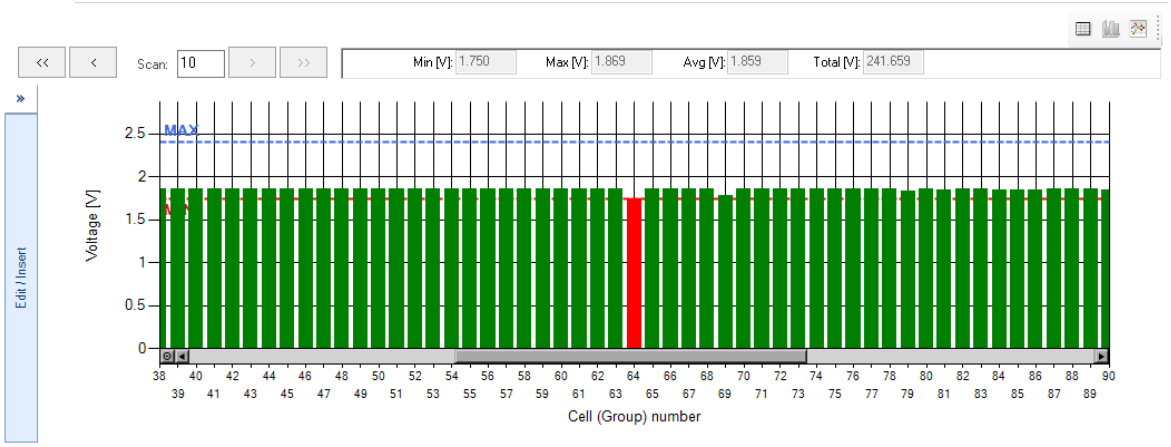

Figure 1 Cell Voltage graph during the capacity test

Internal resistance test

Since the capacity testing is time consuming, and expensive, there needs to be an additional method to estimate the battery operational condition in a faster and a cheaper way. Internal ohmic measurements are used to learn about a battery condition by monitoring the internal resistance of its individual cells. A number of factors can affect the internal resistance and capacity of a cell simultaneously. However not all factors affect a cell capacity to the same degree as they affect the internal resistance, or vice-versa. There is a general correlation among the most frequent factors that

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increase the internal resistance and, at the same time, tend to decrease the capacity. The Table below presents the effect of various factors on a cell internal resistance.

Factor	Internal cell resistance	Effect on capacity	Comments
Grid corrosion	Increase	Decrease	Natural aging process
Grid swelling and expansion	Increase	Decrease	Loss of contact between active material and grid
Loss of active material	Increase	Decrease	Active material sheds from plates, forming sediment
Discharge	Increase	Decrease	Either self-discharge or load discharge
Sulfation	Increase	Decrease	Attributable to undercharging
Internal short circuits	Possible decrease followed by an increase	Decrease	Internal short circuits can cause resistance to decrease, but the subsequent low voltage, self-discharge will manifest as a higher resistance.
Temperature decrease	Increase	Decrease	Low temperature degrades the cell chemical reaction, slows the aging process, and limits available capacity
Temperature increase	Decrease	Increase	High temperatures accelerate the cell chemical reaction, shorten the cell life, and increase the available capacity.
Rated cell capacity	Decrease	Increase	Resistance tends to decrease as a cell size increases.

Even though the above table indicates that the internal resistance test may be used instead of the capacity test, the internal resistance tests cannot tell us everything regarding the battery capability or condition. Low capacity cells can be identified, but absolute predictions regarding the cell capacity are more difficult to make. Some points to consider are:

- Ohmic measurements are not substitute for the capacity testing and cannot be used to predict real capacity values.
- Ohmic measurements may be used as a trending tool to identify cells requiring a further evaluation. When significant deviations from the baseline occur, the capacity testing should be used to verify whether identified cells are defective and need replacement.

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- For the team members that are involved in a battery testing, the capacity testing procedure is very highly recommended. It is the only test that can accurately measure the true capacity capabilities, and provide an accurate insight in the battery operational status.

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