APPLICATION NOTE

# Battery Testing with new Model Instrument

Megger

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# Application Note

**When changing the make or model of a battery impedance tester, the measured value can change. What impact does this have on any new testing and how does it affect any legacy data?**

Maintenance could have a great deal of legacy data. What happens to that data?

The question to ask is "what is the goal of the battery maintenance?". First and foremost is to locate bad and / or poor batteries. Secondly is to forecast when they may fail.

How is this addressed? When impedance measurements change by a given amount this is an indicator of a change in the batteries state of health.

What makes an ohmic reading change from instrument to instrument?

In general, it is the frequency and the amplitude of the test current, used by the instrument.

As the frequency changes the measured impedance changes.

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Since a battery has resistive, inductive and capacitive properties, testing at different frequencies can measure different properties. Measuring at low frequencies will measure primarily the resistive properties of the battery, ignoring the capacitive double layer effect. Measuring at high frequencies will measure primarily the inductive characteristics of the battery. Therefore, one cannot just apply an offset when testing at a different frequency.

The amplitude of the test signal will also have an effect on both resolution and repeatability. Testing with a higher amplitude signal provides a higher resolution. This means in larger, low resistance cells, changes in the state of health will be seen sooner, due to the higher resolution.

The higher current can also be beneficial where string noise is present. A higher test current provides a better signal to noise ratio. This will result in better noise rejection and better repeatability.

How much does the measurement change? This will depend on the battery and the tester.

| Lead Calcium (Lead Acid Battery) | | | | Lead Antimony (Lead Acid Battery) | | | |
|---|---|---|---|---|---|---|---|
| **Cell** | **BITE2** | **BITE3** | **BITE5** | **Cell** | **BITE2** | **BITE3** | **BITE5** |
| 1 | 2.49mΩ | 2.23mΩ | 1.98mΩ | 1 | 4.91mΩ | 4.86mΩ | 4.00mΩ |
| 2 | 2.59mΩ | 2.32mΩ | 2.01mΩ | 2 | 4.72mΩ | 4.72mΩ | 3.77mΩ |
| 3 | 2.52mΩ | 2.26mΩ | 1.97mΩ | 3 | 4.51mΩ | 4.50mΩ | 3.53mΩ |
| 4 | 2.49mΩ | 2.19mΩ | 1.95mΩ | 4 | 3.70mΩ | 3.70mΩ | 3.10mΩ |
| 5 | 2.46mΩ | 2.18mΩ | 1.97mΩ | 5 | 5.57mΩ | 5.52mΩ | 4.55mΩ |

In the above testing performed on lead acid batteries, we can see the BITE5 measurement is on average about 20% lower than that of the BITE2 or BITE3. This is primarily due to the higher test frequency.

IEEE1188 Indicates that in general an ohmic increase of 30%-40% from baseline would indicate a sealed lead acid battery is at approximately 80% of its capacity.

**3. Interpretation of Ohmic Measurements**

3.1. As a battery ages and loses capacity, the internal ohmic values change. Although the change may not be perfectly consistent over all battery models and sizes, experience and test data shows that an increase of 40% or greater from the baseline impedance or resistance, or decrease in conductance value means that it is likely that the actual battery capacity has dropped to 80% or lower (for lead-acid batteries, capacity drops off rapidly once the 80% capacity point is reached in the lifetime curve, so this is known as the “knee” of the capacity vs. lifetime curve). This is the level at which battery manufacturers recommend replacement of a battery.

3.2. An increase in internal impedance or resistance, or a decrease in conductance of 30% - 40% from the baseline value would indicate that the battery may be less than 100% efficient. For measurements in this range::

i. Consult your company documentation to see if there is a recommended battery replacement criteria
ii. Contact the battery manufacturer for recommendations
iii. Contact the ohmic test equipment manufacturer for recommendations
iv. In the absence of such recommendations be prepared to replace the battery at the next six month testing interval

IEEE450 does not provide a percentage change for flooded cells. It provides a general table on the effects of cell changes on ohmic values.

| Factor | Internal cell resistance | Effect on capacity | Comments |
|---|---|---|---|
| Grid corrosion | Increase | Decrease | Natural aging process. |
| Grid swelling and expansion | Increase | Decrease | Includes loss of contact between active material and grid. |
| Loss of active material | Increase | Decrease | Active material sheds from plates, forming sediment. Too much sediment can lead to internal shorts. |
| Discharge | Increase | Decrease | Either self-discharge or discharge into a load. |
| 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, and sulfation will lead to a higher resistance. |
| Temperature decrease | Increase | Decrease | Low temperature retards 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 cell size increases. |

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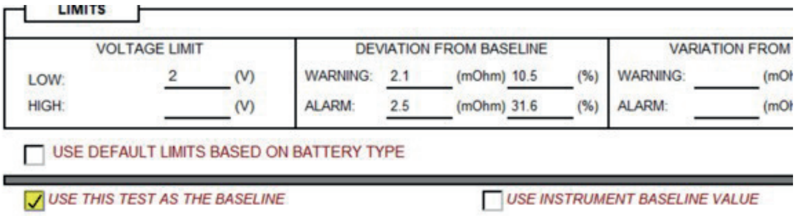
In Megger's experience it is found that in general an ohmic increase of 50%-100% from baseline would indicate a flooded lead acid battery is at approximately 80% of its capacity.

If changing from a BITE2 or a BITE3 to a BITE5, even though the values are relatively close, it is recommended to establish a new baseline value. This can be done in a couple ways.

**1. Automatically with Power DB.**

After performing the first test with the BITE5, transfer the data to Power DB. Then select "USE THIS TEST AS THE BASELINE". Power DB will automatically calculate the new baseline value, discarding any values that may skew the value.

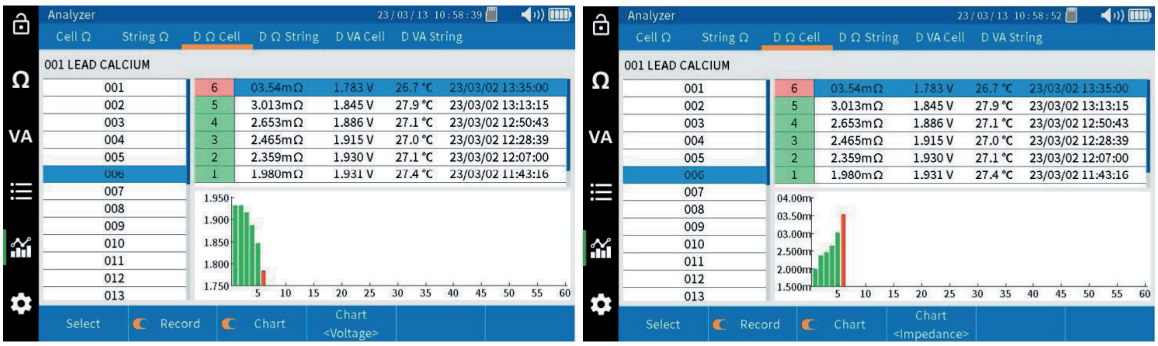



**2. On the BITE5 itself.**

Using the METER mode measure several of the known good batteries. Note their value and program that into the BITE5 string configuration. Then when downloading the data into Poiwer DB select "USE INSTRUMENT BASELINE VALUE".

Additionally

Perform an Impedance – Discharge test to establish a limit. This is a unique feature of the BITE5. Perform a discharge test on the string using the BITE5 to measure the discharge on the batteries. Record both the voltage and impedance. It is then simple to identify an impedance limit that correlates with the low capacity of the battery.




Note the impedance value during the low voltage value. This can help set a more precise ohmic limit for future battery impedance testing.

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