Conductance Testing as an Integral Element in Battery Management

Today's CATV communication networks are being overrun by an increasing demand for bandwidth and reliability. Lapses in commercial utility power can be a serious, if not a costly predicament. Battery systems are provisioned specifically as insurance against such crises. Maintaining these critical battery investments with conductance monitoring helps guarantee standby capacity when it is needed.

Batteries are being installed in increasing numbers by cable and communications companies around the globe as an insurance policy against the risks associated with disruptions or temporary loss of the commercial power grid. Proper preventative maintenance and monitoring of batteries is essential to optimize the considerable investment and assure the highest level of network quality of service.

Implementing a battery monitoring and maintenance program based on performing an open circuit voltage combined with a long duration load testing is the highest quality state-of-health measurement technique available. Due to the distributed nature of CATV standby battery systems the test duration, logistics and cost of using such a program is impractical. The technician must physically disconnect the battery string from service, discharge the batteries at a fixed rate and measure the time to reach the end voltage to determine the available capacity. After the test, the battery string must be reconnected and recharged before it is available for service. As a consequence, many operators do not implement a battery monitoring and maintenance program.

A fast, reliable and affordable testing process is now available with the development of conductance based battery measurement technology. By coupling conductance testing with a simple utility load test, the system operator can easily be armed with the level of data necessary to confidently know the status of their installed standby batteries and budget their replacement with confidence.

A simple utility load test removes the surface charge from the plates, which often masks the batteries service condition and can be performed by switching the power supply into the standby mode for five minutes.

Conductance Testing

Conductance measurements, sometimes called acceptance measurements, are performed by applying an AC voltage of a known frequency and amplitude across the battery and observing the current that flows as the result. Conductance is the ratio of the AC current that is in-phase with the AC voltage compared to the amplitude of the AC voltage producing the current. Test results are expressed in Siemens or Mhos (the inverse of Ohms). The higher the relative

conductance value to the original new value (lower internal resistance), the better the state-of-health and expected performance potential from the battery.

The conductance value of a battery reflects the integrity of inter-cell connections, ionic conductivity of the electrolyte, specific gravity of the cell(s) and the actual battery state of charge. The test results are the product of the internal electrical resistance of the battery and reflects the combined influences of the mechanical state of health in the battery and the electro-chemical condition or efficiency of the grid/plate structures.

As a battery ages, the positive plate will deteriorate and change chemically adversely affecting the batteries ability to perform. This normal aging process begins when the battery is activated during the formation process at the end of the battery production line and will continue for the life of the battery.

For power provision, this means that conductance can be used to track changes and detect battery defects, shorts, open circuits and prolonged undercharging, which will reduce the ability of the battery to perform. Conductance test measurements become a valuable tool to identify the point at which the battery is approaching its end of service life.

Correlation of Conductance to Capacity

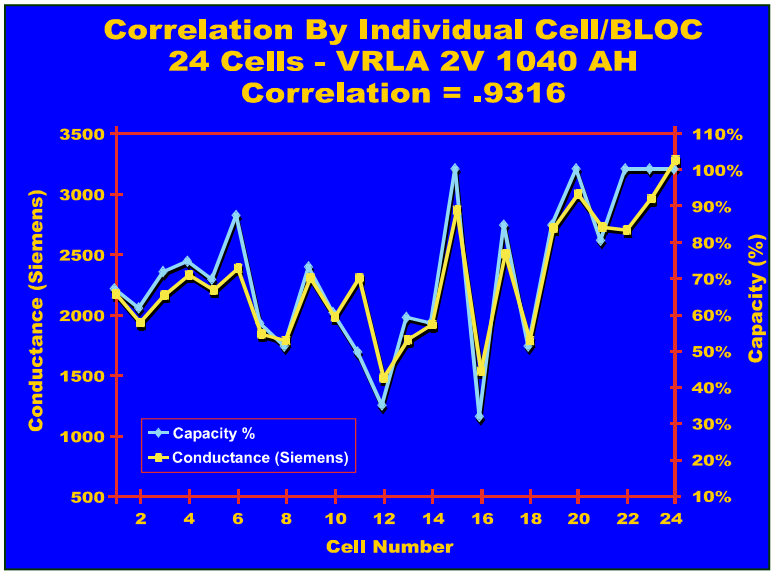
There is no direct correlation between conductance and the available capacity from a battery; hence a coefficient does not exist. As remaining battery life decreases, so does the conductance. Conductance test measurements can reliably track and predict the rate of battery degradation.

Battery capacity (rated ampere hours) is the ability of the battery to deliver a given current for a given period of time (Ah = I x t). At present, the only way to determine a battery's actual capacity is by performing a true long duration load test.

Years of evaluating conductance test technologies and many attempts to establish a correlation between capacity and conductance has shown that the least correlation exists when the battery is at 80% capacity and above. As the battery deteriorates and approaches 80% capacity the correlation between capacity and conductance increases providing visibility to the approach of the end of the service life of the battery.

When a battery is at end of life or 80% of rating (20% reduction) the conductance will be approximately 50% of initial value (50% reduction). The following chart shows the general correlation of capacity to conductance (Figure 1).

Figure 1.



Reduce Potential Failures

Conductance monitoring can prevent system failures in a standby power system by exposing gross deviations among batteries.

If a battery has a conductance measurement of 400 Siemens, while the rest of the batteries in a string read an average of 800, the operator can be certain that a significant loss of capacity has occurred in that particular battery and cannot be expected to perform to its designed level. This type of battery fault can be identified prior to a failure, without a service discharge, and without removing the equipment from service. Corrective actions can be scheduled under non-emergency conditions, significantly reducing costs.

Battery Replacement Strategy

Conductance monitoring promotes increased service life, confidence and ensures optimum use of the battery investment. By monitoring and testing a battery installation, warning signs of unacceptable operating conditions can be detected and rectified prior to a performance shortfall. Early corrections to the power system can extend the batteries service life and minimize costs.

Another benefit of conductance testing and monitoring is the ability accurately predict the end of a battery's service life and schedule their replacement prior to their failure to meet system requirements when combined with a battery maintenance program.

Initial conductance value for the most batteries can be provided by the battery manufacturer. If the batteries conductance value is not available it can be reasonably established by using the average of 20 to 30 measured conductance values provided they are the same type of battery, date code and state of charge. Measure and record the initial conductance value after battery installation and with one to six months of float service.

When measured conductance degrades 40% from that reference value, the battery is ranked as having marginal capacity. When conductance approaches 50% or the initial value, it is typical that the cell will not deliver 80% of its rated capacity. An example may is as follows:

New battery @ 1000 Siemens
Safe operating range = 700 to 1000 Siemens
Marginal battery = <600 Siemens (Activating a replacement plan is recommended)
Likely capacity failure = <500 Siemens

Simple Battery Management

The benefits of implementing a conductance based battery management and replacement strategy over other test methods are summarized below:

Fast. Conductance testing is fast. A string of batteries can be accurately measured and recorded in less time than it takes to perform a load test on a single battery.

Simple. In addition to being quick, conductance testing can also be very simple. Removing the guesswork of battery interpretation is only the start. The newest conductance testers are menu-driven, require only pinpoint connection to two battery posts or straps, and provide absolute measurements with no further mathematical calculations needed.

Passive. Conductance battery monitoring tests are passive and do not alter or cycle the battery to cause premature aging. Discharge testing involves system downtime. The network being supported by the batteries is at risk during the test.

Safe. The passive nature of conductance technology makes it inherently safe. A discharge test produces heat, which can be dangerous to both operator and the overall site. In comparison, testers and monitors utilizing conductance technology eliminate the hazardous potentials posed by heat and arcing when load testing cells.

Repeatable. Conductance testing is repeatable when batteries are fully charged.

Cost. The brightest news associated with conductance technology advances is that the equipment is relatively inexpensive when compared to other technologies. The savings in resources and improved safety aspects alone make this technology an affordable and desirable service option positioned to become a standard tool of technicians in the rapidly growing cable television/broadband industry worldwide, expanding the benefits of conductance testing even further.

Battery Test Method Contrast

Full Capacity Load Test

Time Consuming - Requires removing the batteries from service during test.
Costly.
Most Accurate Capacity Indicator.

High Load Short Duration Test

Time Consuming - This test is faster than the true load test but also requires removing batteries from service.
Dangerous – Batteries are a hydrogen source and may present a risk to the less skilled technician.
Low to Average Accuracy.

Voltage Test

Quick.
Not Complete – This method does not account for other variables.

Utility Discharge Test

Quick – Performed by switching power to the batteries for 5 minutes or more.
Low Cost – Requires a voltmeter to perform.
Removes the plate surface charge to reveal the batteries ability to support the load.
Not Complete – This method does not account for other variables.

Conductance/Resistance

Quick – This test can be performed in approximately seven seconds.
Conductance is the inverse of resistance.
Reliable - Alpha recognizes conductance testing as a key component in an efficient battery monitoring and maintenance program.
High Correlation to a batteries ability to perform.
Batteries Remain in Standby Mode.
Voltage Check – Conductance testers display voltage readings.
Non-Invasive.
Capacity – The correlation between conductance and capacity decreases from 80% to 100%. (There is a higher correlation at 80% capacity than at 100%.)

Conductance based battery testing combined with a simple utility load test provides the technician the necessary information needed to optimize the financial investment of the communications system and assure the highest quality of service.

Contact Alpha Technologies for additional information on battery maintenance and conductance technology.

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