MIDTRONICS

Battery Management Innovation™

Conductance Questions and Answers

Conductance testing has recently been added to the IEEE draft standard for testing sealed valve regulated lead acid batteries. Extensive field test results were presented to Bellcore's T1Y1 Group, a Bellcore symposium on passive battery monitoring and testing, the International Lead Zinc Research Organization and the Battery Council International conferences in May of 1992, and the International Telecommunications Energy Conference in October of 1992. Many battery manufacturers are using Midtronics Conductance Testers, as well as every Regional Bell Operating Company, global telecommunications providers and manufacturers and users of Uninterruptible Power Supply (UPS) systems.

This acceptance of conductance methodology has resulted in a series of questions about conductance testing. The following are answers to some of the most frequently asked questions:

Q. What is conductance?

A. Conductance describes the ability of a battery to conduct current. It is the real part of the complex admittance. Various test data have shown that at low frequencies, the conductance of a battery is an indicator of battery state-of-health showing a linear correlation to a battery's timed-discharge capacity test result. This can be used as a reliable predictor of battery end-of-life.

Q. What is Ohmic testing technology?

A. In simplest technical terms, Ohmic technology is based on Ohm's law, which expresses the relationship between volts, amperes and ohms in an electrical circuit. Ohm's law can be expressed as follows: Volts (E) = Amperes (I) x Ohms (R). If any two of the three values of voltage (volts), current (amperes) or Resistance (Ohms) are known, the third value can be calculated using the above expression of the law.

Thus, Ohmic technology attempts to use voltage and current to determine the resistive characteristic of a battery. Higher resistance equates to a reduced ability to produce current. This characteristic is translated into a measurement of resistance or impedance (Ohms) in some Ohmic technologies; more recent technology uses a converse measurement, called conductance.

Q. Why test conductance?

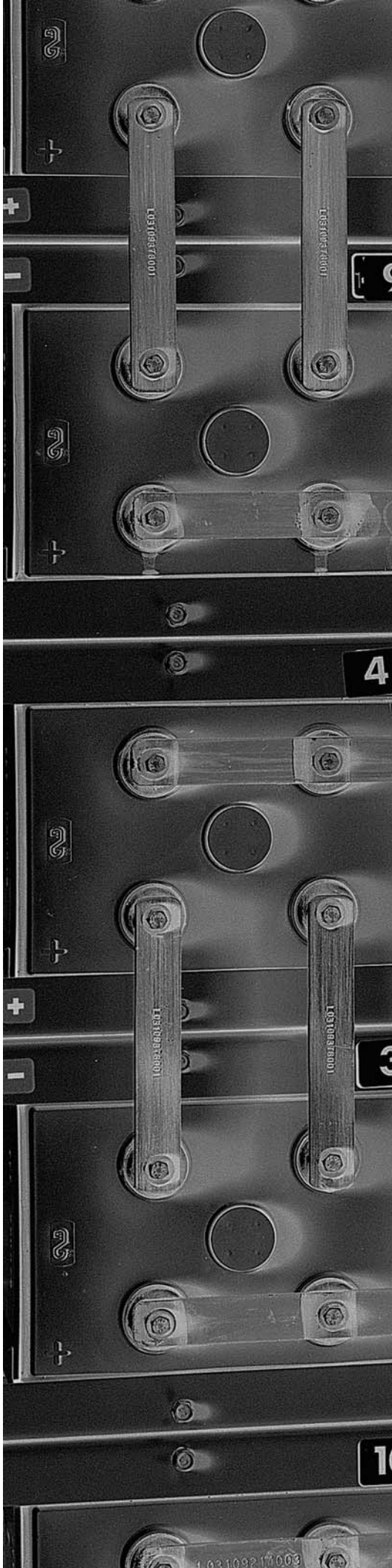
A. Through years of laboratory and field-based research, conductance has been found to correlate directly with battery capacity as measured in a timed discharge test. This correlation is nearly linear, meaning that if conductance can be measured, timed-discharge capacity can be predicted. Since voltage and specific gravity testing are not predictive, timed discharge testing is very time-consuming and expensive, and impedance testing does not correlate directly and linearly with timed discharge capacity, conductance testing is a very effective and economical alternative.

Q. How is the conductance test performed?

A. Simply by connecting the two test set leads to the positive and negative posts of the cell or battery under test, a measurement is taken in a matter of seconds. There is no need for additional leads to be connected to the ends of the string, or for clamp-on current measurements. A conductance measurement is displayed in Mhos or Siemens, sometimes abbreviated with a "G".

Q. What is the difference between Mhos and Siemens?

A. None. Mhos and Siemens are interchangeable terms for the same thing - the unit of measure of conductance.



Q. How can conductance readings be used?

A. A significant number of tests on a variety of valve regulated lead acid (VRLA) batteries demonstrate that conductance is predictive of battery state-of-health. Since conductance is directly related, and very nearly linear with timed-discharge capacity, a reading of the percentage of a known conductance reference value is a reliable predictor of a capacity test result. The conductance tester gives a quantitative measurement in Mhos (or Siemens), as well as a qualitative indication (percent of reference) of a battery as related to a standard.

Q. Are conductance readings difficult to interpret?

A. Unlike other testing techniques that require interpretation and mathematical calculation, conductance readings can be read instantly and can be related directly to the condition of the battery being tested.

Q. Since the qualitative conductance test requires a standard, how can that standard be established?

A. The most effective method for the establishment of a standard requires the performance of a timed discharge test to locate a cell or battery that performs to 100% of the rated discharge capacity. A conductance test can then be performed and a reference established. A sample of 30 or more new batteries can also be used to establish a standard. Without a set reference value, conductance testing can still be utilized to trend state of health, as batteries can be monitored through periodic conductance readings and the observation of deterioration over time.

Q. Will the battery manufacturer have reference numbers for my batteries?

A. Many battery manufacturers now publish conductance reference or base-line values. If not, a specific reference value can be established during installation for a new, healthy battery. An average can also be used from a sample of batteries of the same model, manufacture date, installation date and service history as detailed in the operating guidelines and instruction manuals.

Q. What if the batteries I am testing are really old? How do I determine what to use for a reference number?

A. For older batteries, combine conductance testing with a full physical inspection for any visible faults. Utilize the highest measurement as an initial benchmark and the string average as a starting point for comparison. If any batteries deviate by 30% below the highest jar, consider a discharge test to determine actual run-time.

Q. Can conductance testing be used to evaluate the quality of inter-cell connections?

A Yes. Since a conductance reading of a cell plus an inter-cell connection can easily be related to the conductance of the cell alone, conductance provides a very simple and reliable indication of the system's inter-cell connection quality.

Q. Can Midtronics conductance testers measure the condition of sealed valve-regulated batteries as well as flooded cells?

A. Yes. Correlation studies have been performed on a significant number of valve regulated cells. These studies have shown that conductance test results are very predictive of battery timed discharge capacity, while voltage measurements are shown to be of little value. This data has been presented to a number of international organizations. Additionally, recent data includes gelled batteries, and Midtronics' testing will soon include NiCad batteries.

Q. What kinds of batteries and cells can be tested utilizing conductance?

A. Typically any 2 Volt to 12 Volt, lead-acid, 5 to 2000 ampere-hour cells can be tested.

Q. Can Nickel Cadmium (NiCad) batteries and cells be tested utilizing conductance?

A. The Micro Celltron (CTM) from Midtronics will accurately measure the voltage and conductance of Nickel Cadmium batteries. Conductance will measure and identify gross failures of NiCad batteries. The Celltron will report hard shorts identified through low-voltage, and is a useful tool in testing the application of NiCad battery systems.

The feature of identifying the decline and forecasting the failure of battery cells, a superior feature of the Micro Celltron, is not as applicable when testing NiCads. Based upon their construction and chemistry, all NiCads will measure consistently (good) until there is a gross failure indicating the end of life. The Celltron will indicate this gross failure after the fact, a limitation that is true of all Ohmic measuring devices, including all existing impedance and resistance testers on the market.

As mentioned above, the Celltron contains a low voltage alarm, settable by the user to a minimum of 1.50 volts DC cell. The Celltron will report an audible alarm when testing single cell NiCads falling below the voltage benchmark. Additionally, the Micro Celltron will not test any battery or cell where the measured voltage is below 1.0 Volts DC, which would include any badly discharged or shorted NiCad cells.

(For more information on the testing, trending and analysis of NiCad batteries, please contact Midtronics.)

Q. Can a Midtronics conductance test be made while the battery is on float?

A. Yes. The current test technology enables successful testing of batteries while on float charge. In certain cases an excessive amount of electrical noise current can interfere with any test method.

Q. Does the Midtronics conductance tester need to be plugged in to AC power?

A. No. Midtronics Conductance testers require no external AC power. Midtronics testers derive test power by removing a small (less than 1 Amp) load from the battery under test. Additionally, the testers are powered by an on-board 9-volt alkaline battery for the test data review, test configuration, portable printing and transfer to PC.

Q. Can the signal from the Midtronics conductance tester interfere with or damage electronic equipment or cause danger to a defective cell?

A. No. Midtronics conductance testers do not apply a large current to the battery under test, as does other test equipment. Midtronics testers apply a signal frequency less than one Amp; therefore, it is highly unlikely that over-current damage to sensitive electronic equipment could result in the event of a defective cell. Testing on communication systems shows that conductance testing does not interfere with telephone signals. Users should be aware that other types of battery test equipment (non-conductance methods) do use AC power and many send a large current though the battery, which may affect sensitive electronic devices.

Q. How large are Midtronics conductance testers?

A. All Midtronics conductance testers are hand-held portable instruments. They are built to very rugged standards, yet weigh less than 2 pounds (1 kilogram) each. The testers are easily transportable and each includes some form of protective carrying case.

Q. How long has the Midtronics conductance test method been used for testing batteries?

A. The original technology was developed by Motorola in the 1970s for testing automotive batteries. Today's products are manufactured under license from Motorola, and include many new patents in North America, Europe and Japan. Midtronics has been developing and manufacturing conductance testers for more than ten years, and customers include the world's major battery manufacturers, major automotive manufacturers, telecommunications providers, electric power utilities, UPS manufacturers, and organizations in a variety of other industries. Midtronics has manufactured tens of thousands of battery conductance testers under the PowerSensor™, Midtron®, and Celltron® brands, as well as various private labels. Our products are manufactured and used extensively throughout the globe, making Midtronics the world leader in battery management technology.

Q. Has conductance testing been proven and accepted by the international community?

A. Yes. Extensive data has been gathered by the global telecommunications industry, battery manufacturers worldwide, international rail and transportation providers, and the electric power industry. This data has been presented to the IEEE Standards Committee, which now includes conductance testing in its draft standard for testing sealed valve-regulated batteries. Additionally, The data has also been presented to the International Lead Zinc Research Organization, the Battery Council International, and the International Telecommunications Energy Conference.

Q. Is correlation data available for review?

A. Yes. The global telecommunications, battery manufacturer, international rail and transportation, and the electric power industries have gathered extensive data. This data has been presented to the IEEE Standards Committee, which now includes conductance testing in its draft standard for testing sealed valve-regulated batteries. Additionally, The data has also been presented to the International Lead Zinc Research Organization, the Battery Council International, and the International Telecommunications Energy Conference.

Q. What is the optimal point of contact when making a conductance test?

A. Making direct contact with the lead post will usually provide the most consistent and accurate test result. In order to facilitate this contact (which can be difficult depending on the battery post design), Midtronics offers a variety of battery test interfaces, including clamps and contact probes of differing sizes. Contact with stainless steel post hardware will skew test results. It may be helpful for the user to experiment with different battery post designs to identify which test contact location provides the best conductance result.

Q. What if I cannot test my batteries directly at the post because of physical constraints?

A. If battery and cabinet construction makes testing at the post or lead strap impossible, BE CONSISTENT with every test. If you must test on the hardware, test in the same spot for every cell, every time. If you are inconsistent with your probe or clamp placement, your reading will be inconsistent as well.

Q. What is a Kelvin Connection and why is it needed for accurate conductance measurement?

A. The Kelvin Connection refers to any four-point connection electrical test interface. This technique provides for both a test signal injection and detection circuit. It provides an electronic method to reduce the affect of the variable resistance of the test interface. It is used to ensure the most accurate conductance measurements possible.

Q. Does battery temperature effect conductance measurement?

A. Yes. High temperatures make the conductance test result increase and cold temperatures have the opposite effect. The actual battery temperature should always be considered when making a conductance test. Most battery performance data is calculated at an optimal battery operating temperature of 77° Fahrenheit (25° Celsius). An Infrared Temperature Sensor is a standard component with the complete Micro Celltron test kit to accurately determine battery temperature and is also available from Midtronics as an accessory.

Q. Can the data collected by the Micro Celltron be manipulated by PC?

A. Yes. The new Celltron inFORM software and data logger from Midtronics facilitates the downloading and manipulation of data collected with the Micro Celltron. Data is presented in a graphical format and can be utilized for trend analysis as well as historical archiving. An infrared strip printer is also available for on-site printing and record keeping. inFORM upgrades can be downloaded over the Internet free of charge at www.midtronics.com.

Product Information Questions:

Q. Can I download my test from the Micro Celltron to my computer?

A. Yes. Midtronics' offers our optional inFORM software and IR Receiver (part number C061), which will allow you to download your data to a computer. inFORM is Windows NT compatible.

Q. Will the Micro Celltron test multiple battery strings and then print out all of those strings to the HP Printer or the Data Downloader for input to my computer?

A. The Micro Celltron will only test one string of batteries at a time, storing up to 252 individual tests in memory. To test and store data for multiple strings, Midtronics' offers our optional Multiple String Storage Module (part number C080). The Multiple String Storage Module is an infrared device that works in much the same way as the HP Printer included with the Micro Celltron kit. The Multiple String Storage Module will store up to eight individual strings of 252 tests in memory for download at a later time. Midtronics' inFORM® software is required.

Midtronics recommends that each battery string be treated individually so that record keeping can be maintained with consistency. This is especially critical if, for example, one string in a set of six strings is exchanged based on service issues. If different battery types and different manufacture dates are used in one installation, mixed battery data may cause confusion. Over time it can be virtually impossible to manage the changes that happen in the life cycle of different batteries.

Q. Can the Micro Celltron test a 24 Volt system? A 48 Volt system?

A. Yes. Midtronics standard testers will test any batteries as long as the system can be tested at the 12-volt level or less. The system voltage is not as relevant as is the lowest battery terminal voltage that can be safely accessed. The Micro Celltron is designed to test batteries/cells for lead/acid batteries with anywhere from 1 to 6 cells. That is a nominal 2 Volts up to a nominal 12 Volts. The Midtron will test either 6 Volt or 12 Volt batteries only. Some cabinet/battery designs limit or restrict access to the individual batteries. Midtronics recommends testing the smallest battery segment possible.

Q. How can I test batteries rated over 2000 amp/hour batteries that test above 10,000 Siemens with the Micro Celltron?

A. Batteries that are near or above the 2000 amp/hour C/8 rating can be tested with the Micro Celltron. If you consistently get a test reading below 9999 Siemens, there are no issues with the result. However, if the cell measures above 9999 Siemens, the battery is too large and it is out of the effective range of the tester. Make sure the test set is setup for the correct cell voltage and re-test. If the 9999 test result (>10,000 Siemens) appears again, the cell size is above the advertised and effective test limits of the Micro Celltron. Midtronics is currently developing a new platform to effectively test such large batteries. Contact Midtronics directly or consult your battery vendor for recommended alternative test methods for these large cells.

Q. My company does a yearly calibration of our instruments. Can I get a calibration procedure for my Micro Celltron?

A. Periodic calibration if the Micro Celltron or Digital Midtron is not required, as an on-board calibration function is executed prior to each battery test. It is still advisable to return the tester to Midtronics every 24 months to ensure proper operation. Due to the advanced technology of the Micro Celltron, coupled with the proprietary nature of Midtronics' patented conductance technology, calibration for your Micro Celltron can only be performed by an authorized Midtronics calibration specialist at Midtronics corporate headquarters. Should your Midtronics battery conductance tester require calibration, contact Midtronics for a Return Authorization number.

If you have a unique requirement for periodic calibration of test equipment, we will try our best to accommodate your specific needs. If a Certificate of Calibration is required, or if a representative of your company must be present to observe the calibration, please advise Midtronics when you obtain your Return Authorization Number (RA#). There is an additional charge for a Certificate of Calibration and/or any attended calibration visits or other custom services. Contact Midtronics Customer Service for current schedule and pricing details.

Q. I used to test batteries with an impedance tester. Can I convert those reference numbers to conductance reference numbers?

A. No, they cannot be directly calculated to each other. Midtronics testers measure the conductance as an AC function. Impedance meters use a pulsed load and calculate the resistance based on the step change in the current when the load is pulsed. Conductance is also an AC test. However, conductance testers look at the "real" part of the complex admittance, called Conductance or sometimes acceptance. These techniques are interrelated, but they are not identical. Additionally, different manufacturers take measurements using different frequencies.

Q. We have used an older Midtronics tester in the past. Will the battery reference numbers I used for that tester be the same reference numbers I use when testing with my Micro Celltron?

A. No, but a simple conversion with examples is provided in Section 6 of the Micro Celltron Operating Manual, enabling you to easily transition to using the Micro Celltron or Digital Midtron. Ideally, you will want to take consecutive readings with the older meter and the new one to ensure that the comparative offset or proportion shift between the test two sets is accurate.

Q. Can I get longer cables?

A. The Micro Celltron cables are fixed at the current length to ensure that the cable wiring does not skew the electronic measurements. The DB9 connector contains a calibration shunt that "zeroes" out any interference in the conductance measurements. Any change or alteration to the cable assembly or length would interfere with the accuracy of the measurement.

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