Sarel Electronics Ltd.

Power Electronic, Controls and More

Portable Battery "Cell Recovery/Analyzer" Tester

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1.0 Cell Recovery Analyzer - General Description

The CRA is a portable, dual purpose instrument that is indispensable for the ongoing preventative maintenance of multi-cell battery systems used in UPS and telecommunications plant.

The instrument is plugged into a standard 120V, 1 phase outlet and performs as an AC or DC constant current source depending upon the setting of a selector switch, and is then carried by the serviceman from point to point on the battery system.

2.0 Charger Operation

In the DC mode, it is used as a charger to supply current (available in 2 selectable ranges, 0 - 7.5A and 0 - 15.0A) only as required to boost weak cells in the string. The constant current can be maintained up to a maximum output voltage of about 24V DC permitting approximately 10 cells in series in the current loop to be charged simultaneously. The charge current selected and its duration are based on room temperature and battery manufacturer's specifications. In this manner only weak cells in the string are treated while the battery system and its associated constant voltage charger are on line. It should be noted that our instrument is not a substitute for the permanent constant voltage charger connected to the battery system. Cell charging duration and selection of the charging current will be a function of the A/H rating of the cell divided by the charging current. About 20% of the rated capacity is recommended to restore back to a cell that shows sign of being week compared to the rest of the cells in any given battery bank.

The main charger is necessary for "floating" (or trickle charging) the cells as well as recharging them after a discharge, and is essential for preserving healthy cells throughout their specified float life. Absence of the float voltage for any length of time could seriously affect both the life and capacity of the cells to deliver power during utility outages. However, when some cells in the string deteriorate during float service, as manifested by low cell voltage and/or excessively variable cell resistance, the constant current method of restoring them has proved (in our experience) to be more effective than the conventional methods of temporarily raising the output voltage of the system charger in an attempt to "equalize" the cells or maintain voltage on good units and raise it on low ones. Experience shows that this procedure has to be carried out several times in succession in order to have any effect and requires as many site visits.

This is due to the fact that an increase in the overall charger voltage cannot be guaranteed to be properly distributed over all the cells due to variations in individual cell condition, such as electrode corrosion, internal resistance and re-charge rate. Essentially a deteriorating cell needs to have its store of charge (measured in amp-hours) replenished and this is best accomplished by supplying only to that cell a constant current for a limited time. Equalizing the entire battery bank by increasing the float voltage from 2.25 to 2.35 or 2.4 volt per cell will also increase the gassing current of the cell and the water consumption.

3.0 Resistance Measurement

In the AC mode the instrument is used to measure low resistance of the order of 20 micro-ohms, i.e., internal cell and connector contact resistance. The constant current source supplies current through one set of probes in 2 selectable ranges, 1 - 10 A and 0 - 20 A to a group of connected cells and interconnections in the string and senses through another set of probes the corresponding voltage drop. The total resistance of that section is either calculated or directly read. AC is employed so that the test current can be passed through the cells without affecting their state of charge.

The condition of a cell can be monitored by measuring it's internal resistance which changes with the variation of certain characteristics such as electrode corrosion, plate and electrolyte condition. A typical internal resistance value for a healthy cell would be about 200 micro-ohms.

Similarly, increased inter-cell contact resistance would reflect the level of corrosion and the amount of torque required on connection bolts during maintenance.

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4.0 Impedance Testing

In recent years sealed lead-acid batteries have been commonly used as a stationary battery for UPS applications, replacing many wet-cell systems.

In the case of sealed batteries, the conventional methods of determining the life and degree to which the battery is worn out [like measurement of specific gravity and visual checks] cannot be performed. The only means to obtain information regarding battery condition and eventual deterioration is through:

- *Cell voltage monitoring*
- *Capacity testing*
- *Internal cell impedance testing*

Capacity testing is the most reliable but troublesome method of testing the condition of the battery. Usually the test requires substantial downtime of the system and discharging the battery which decreases it's life. As a result the capacity test is not performed more often than once a year.

Cell voltage monitoring is the most common method of evaluating the condition of the battery system.

Any irregularity in the battery string indicates a problem. Usually the information is not sufficient to determine which battery is bad. In such cases, the equalizing charge is required, as well as watching the battery after the equalizing voltage is removed.

The newest method, and probably the only one available today, of evaluating the condition of the battery is internal impedance testing. Battery research indicated that internal cell impedance increases with age, discharge history of a cell, and also depends on the state of the charge.

As indicated by one of the leading battery Manufacturers, "*cell impedance testing is as accurate as a battery discharge test*".

Cell equalizer and impedance tester is a compact instrument designed for testing and maintaining the stand-by batteries without downtime and taking battery off-line. Using the device you can perform the impedance test for each cell.

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The results help to determine replacement criteria based on impedance trends, since cell impedance increases as the battery ages. This procedure also identifies weak or open cells in the string by comparing each individual cell impedance against the average value and/or against previous records.

5.0 EQUALIZING PROCEDURE (DC MODE) (charging)

1. Set the "Mode Selector Switch" S3 on the face of the tester to "DC" position.

2. Connect the leads to battery(s) to be equalized. FOR DC MODE - POLARITY IS IMPORTANT. The red lead must be connected to the positive battery pole and the black lead to the negative battery pole.

1. Depending on the number of cells to be equalized, set the "Current Selector Switch" S2 on the face of the tester to "High" or "Low" position. In the "High" position the DC current on the output is 15A DC at 12V DC [6 cells]. In the "low" position the DC current on the output is 7.5A DC at 24VDC [12 cells].

2. Ensure the "DC Circuit breaker" on the face of the unit is in the ON position.

3. Turn on the "AC Input Power Switch" S1 located on the front panel.

4. Keep the battery on equalizing mode for at least 24 hours

5. Disconnect leads.

6. Record cell voltages across battery string looking for irregularities.

6.0 IMPEDANCE TEST PROCEDURE (AC MODE)

1. Set the "Mode Selector Switch" S3 on the face of the tester to "AC" position.

2. Set the "Current Selector Switch" S2 on the face of the tester to "High" or "Low" position. In the "High" position the AC current on the output is 20A AC. In the "low" position the AC current on the output is 10A AC.

Recommended Setting: "High" (APR. 20A AC) for higher accuracy.

3. Connect the leads to battery under test. **FOR AC MODE** - polarity is not important. The red lead can be connected to either positive or negative battery pole, however, the same polarity should be observed when moving the probes from one location to another.

4. Turn on the "AC Input Power Switch" S1 located on the front panel.

5. Check the current meter on the front panel. It should indicate 10 or 20A depending on position of the Current Selector Switch S2.

6. Using a fluke digital AC voltmeter measure AC voltage (normally millivolts) across the battery(s) under test. Record the value for comparison and/or trending. As most tests are to establish the condition of the battery under test RELATIVE to the remaining in the string it is not normally required to calculate the impedance in micro-ohms. The voltmeter leads should be connected as close as possible to the cell posts to avoid adding up the voltage drop across the tester leads. For maximum accuracy of measurement it is highly

7. recommended to connect the voltmeter leads always at the same place on the post to eliminate voltage reading variation.

8. To calculate the cell impedance value in micro-ohms, divide reading [Vac] by 10 or 20A depending on current through the cell.

$$Z = \frac{Vac}{10} \times 1000 \quad \text{OR} \quad Z = \frac{Vac}{20} \times 1000$$

Where Z = cell impedance in micro-ohms.

9. Turn off the "AC Input Power Switch" S1 on the front panel, move leads to the next battery. Turn on switch S1. Repeat the measurements per items 6 and 7 above.

CAUTION

Do Not Disconnect Or Reconnect The Test Leads With Input Power Switched ON Or An Arc Will Develop.

10. Repeat for all batteries in the system.

NOTE

The test can be performed on more than one battery at a time, but the total connected DC voltage should not exceed 65V DC, (28 cells at 2.25 vpc). The resultant measured values would represent the total impedance of all the cells and their intercell connectors under test.

Most wet type stationary batteries have extremely low internal impedance's therefore testing with 10 or more cells at a time will provide more accurate results. If a high value is noted the technician will need to repeat the test with fewer cells until the trouble cell or intercell / intertier connector is located.

Most sealed type batteries are comprised of six cells therefore it is preferred to test each battery separately but with at least one battery jumper in the test circuit to ensure both the battery and the connections are tested.

7.0 Technical Data

- Power requirements - 120V AC, 60Hz 5A Max.
- Output voltage for DC Operation - 24V DC or 12V DC
- Current limit - 7.5A at 24V DC / 15A at 12V DC
- Output current - in AC mode 10A AC at 12V AC / 20A AC at 6VAC
- Maximum DC voltage to be connected to the output leads 65V DC.
- Portable Design
- Totally isolated from input line
- Selection switch for mode of operation "DC" Cell Equalizer / "AC" Cell Impedance Tester
- Selection switch for current range
- Ammeter for "AC" and "DC" current measurement
- Flashing LED indicating voltage present
- Output breaker for "DC" current source protection against reverse polarity
- Color coded leads [Red positive/Black negative] suitable for any size battery
- Can be used to measure on-line battery

Cell Equalizer Mode

- Dc current source design
- Selection switch for max current value: 15A DC for 12V DC / 7.5A DC for 24V DC
- Charges single or multiple cells
- Protected against reversed polarity

Impedance Tester Mode

- Ac current source design
- Selection switch for current value: 10A AC for 12V AC / 20A AC for 6V AC
- Maximum dc voltage of cells under test 65V DC
- Can be used on single or multiple cells

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