

# Who is Alber?

Established 1972

Based in Boca Raton  
Florida

We manufacture battery test equipment based on extensive experience in and knowledge about Battery design and Battery aging characteristics.

**We are the Battery Test Experts!**



***Alber***



# Why Monitor?

## Is it worth it?

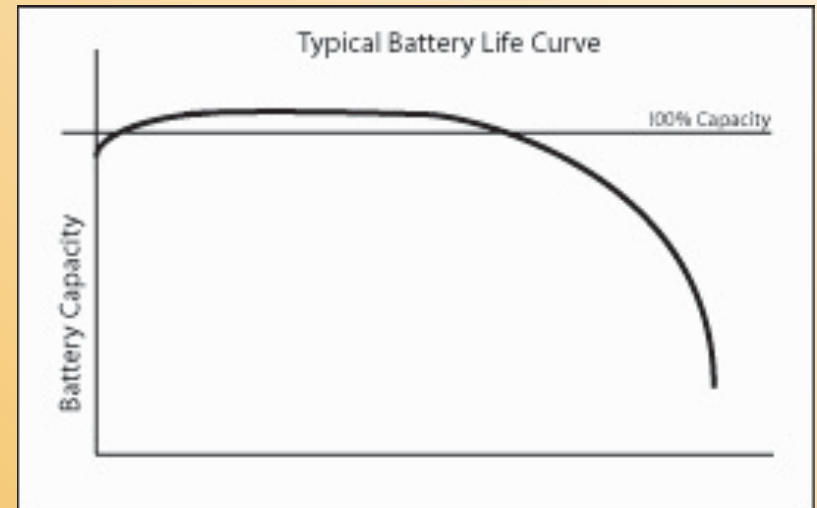
- US Department of Energy estimates that the total annual losses from Power outages for large industries may be as high as 150 billion dollars.
- Someone rightfully said:  
“-Power System Reliability is spelled with B... as in Batteries”

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# Batteries fail

Batteries are like humans. Sooner or later the battery will reach end of life. It can happen through...

- “Normal” ageing
  - Corrosion
- Pre-mature failure
  - Manufacturing defects
- Battery abuse
  - High temperature
  - Excessive charge current
  - Defective chargers
  - Damaged battery jars



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# The question is...

## Can you afford not to monitor?

<u>Industry</u>	<u>Avg. Cost Per Hour*</u>
Cellular communication	\$41,000
Telephone Ticket Sales	\$72,000
Airline Reservation	\$90,000
Credit Card Operation	\$2,580,000
Brokerage Operation	\$6,480,000

\* Does not include intangible losses such as damaged reputation and lost customers.

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# Why monitor?

- Increase battery system reliability
  - Avoiding costly unplanned down time
- Cost savings
  - Reduced maintenance man-hours or redirection to proactive maintenance activities
  - Optimization of battery life



# Increase Reliability



How?  
Detect problems  
**before**  
they cause a  
catastrophic  
**system failure!**



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# Increase Reliability

- Most monitors will be able to detect a failed battery by...
  - monitoring cell voltages during discharge
    - if the discharge is long enough to show a drop in voltage.
  - use of antiquated measuring techniques.
    - Impedance or conductance
    - mid-point monitoring



# Increase Reliability



Internal resistance is directly related to a battery cells capability to generate power

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# Increase Reliability

What is needed to detect a failing cell **before** it causes a problem?

- We have to detect conduction path problems
  - Internal to the cells
  - Inter-cell connections.

Internal resistance is directly related to a battery cells capability to generate power

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# Problem Detection

The proven way to detect these problems is to:

Perform proactive testing such as:

- Battery Capacity Testing
- Internal Resistance Testing

**IEEE** recommends both of these tests be performed at regularly scheduled intervals.



# Problem Detection

## Capacity vs. Internal Resistance Test.

What's the difference?

- Battery Capacity Testing (Capacity Assessment)
  - + Off-line discharge test at constant load
  - Time consuming (15 min. to 10 hours plus recharge and not including setup)
  - Requires external load bank and spare battery
  - + **Reliable**. Only way to assess the battery's absolute capacity



# Problem Detection

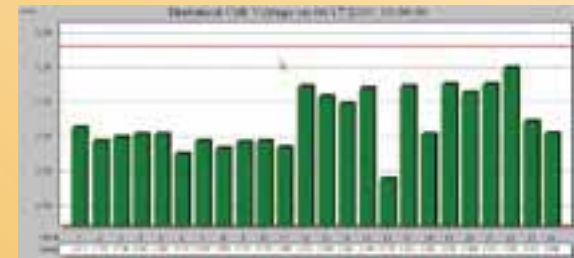
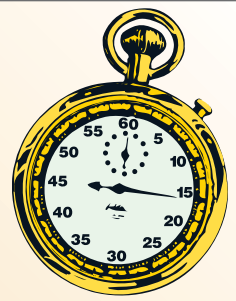
## Capacity vs. Internal Resistance Test.

What's the difference?

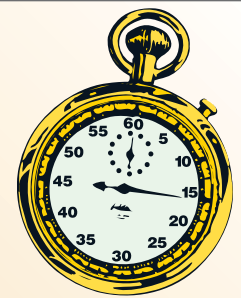
- Internal Resistance Testing (Condition assessment)
  - + On-line, non-invasive test that can be performed manually (Cellcorder) or automatically (Monitor System)
  - + Provides absolute state-of-health assessment parameters on individual cell level
  - + Detects failing cells before they cause problems
  - Does not provide an absolute capacity value and chemical problems are harder to detect.



# Early Detection Methods

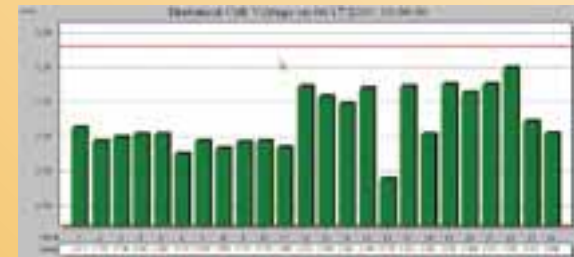


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# Early Detection Methods

- **Early detection of failing cells using a Monitor System is achieved by:**
  - Proactive internal resistance testing
  - Auto capture of discharge events
  - Real time data display



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# Ohmic measurements

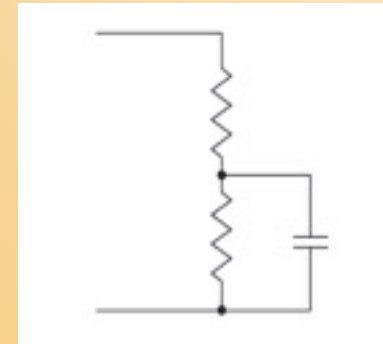
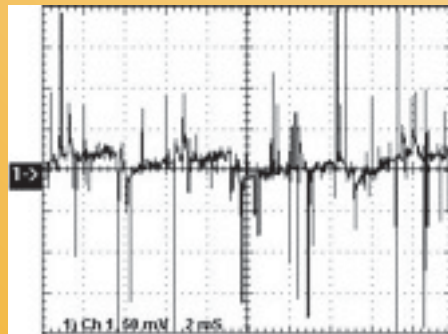
- The following terms are used, in the battery industry, to describe internal ohmic measurements :
- AC Impedance
- AC Conductance
- DC Resistance



# Resistance measurements

Alber's Internal Resistance measurement method is superior because of the following reasons.

- Eliminates the "capacitor phenomenon"
- Not affected by ripple or noise
- Adequate resolution



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# Simplified equivalent circuit

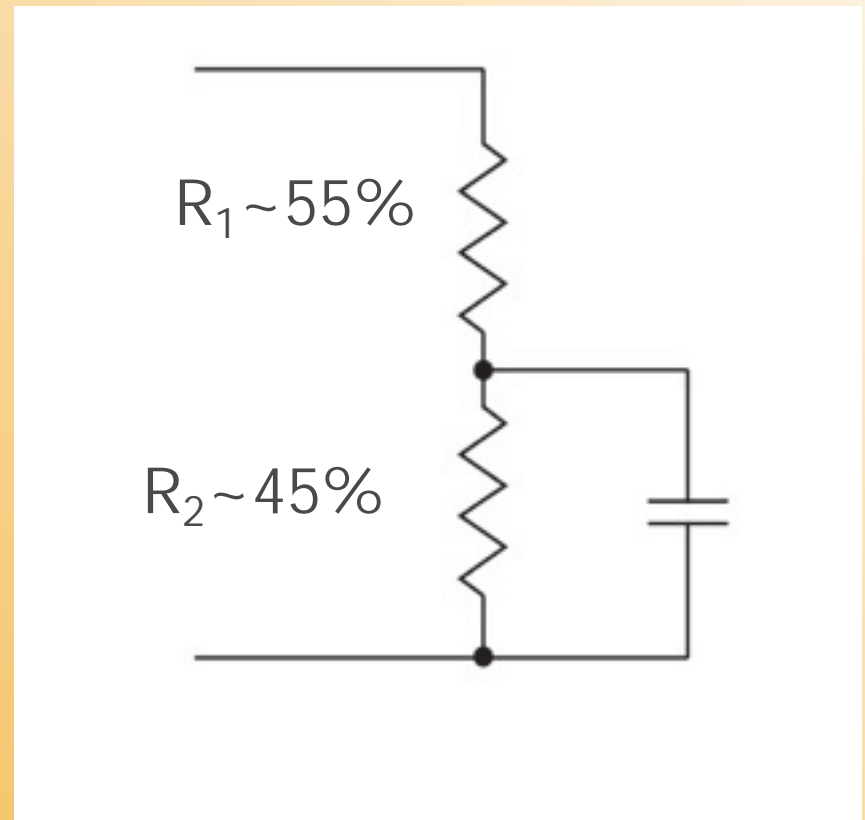
The conduction path through  
a battery includes the:



# Simplified equivalent circuit

The conduction path through a battery includes the:

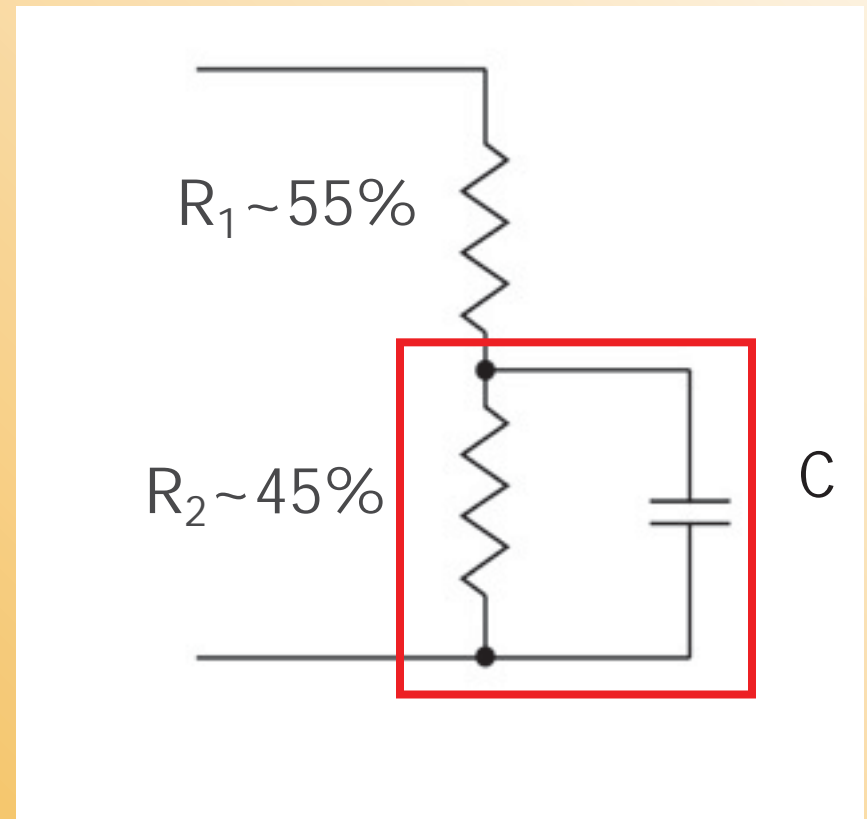
- Resistance of the Post, Strap, Grid, Paste-to-Grid, Paste, Electrolyte, and so on...



# Simplified equivalent circuit

The conduction path through a battery includes the:

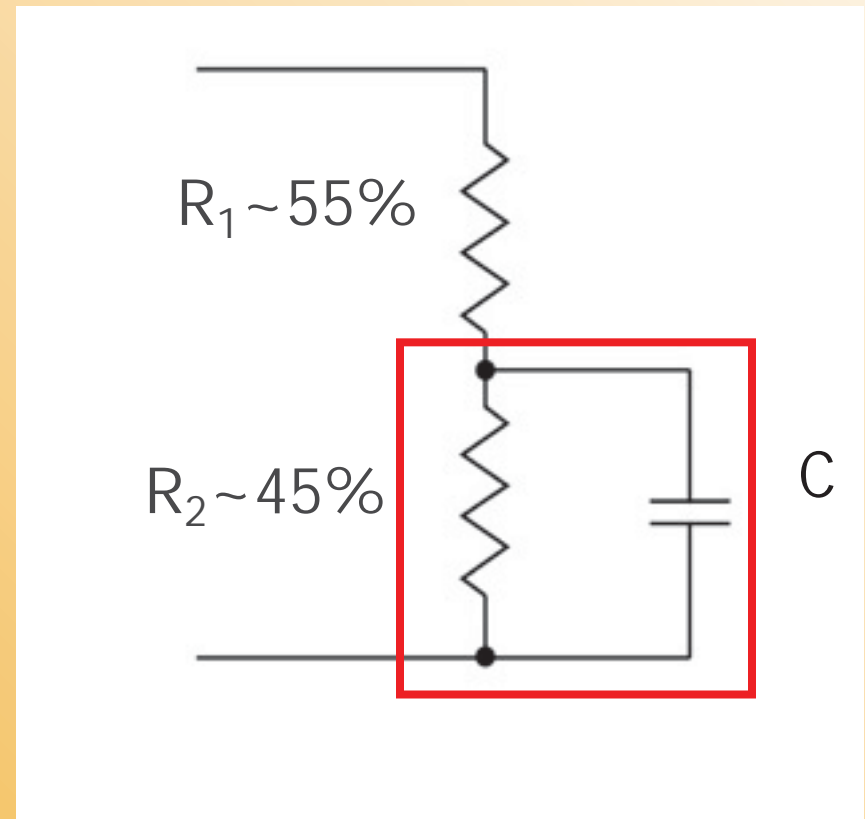
- Resistance of the Post, Strap, Grid, Paste-to-Grid, Paste, Electrolyte, and so on...
- The cell also has a huge capacitor
- This capacitor is connected in parallel over about 45% ( $R_2$ ) of the total resistance



# Simplified equivalent circuit

The conduction path through a battery includes the:

- Resistance of the Post, Strap, Grid, Paste-to-Grid, Paste, Electrolyte, and so on...
- The cell also has a huge capacitor
- This capacitor is connected in parallel over about 45% ( $R_2$ ) of the total resistance
- It is this capacitor in parallel over a part of the resistive path that constitutes the difference between AC and DC measurements!



# AC Measurements

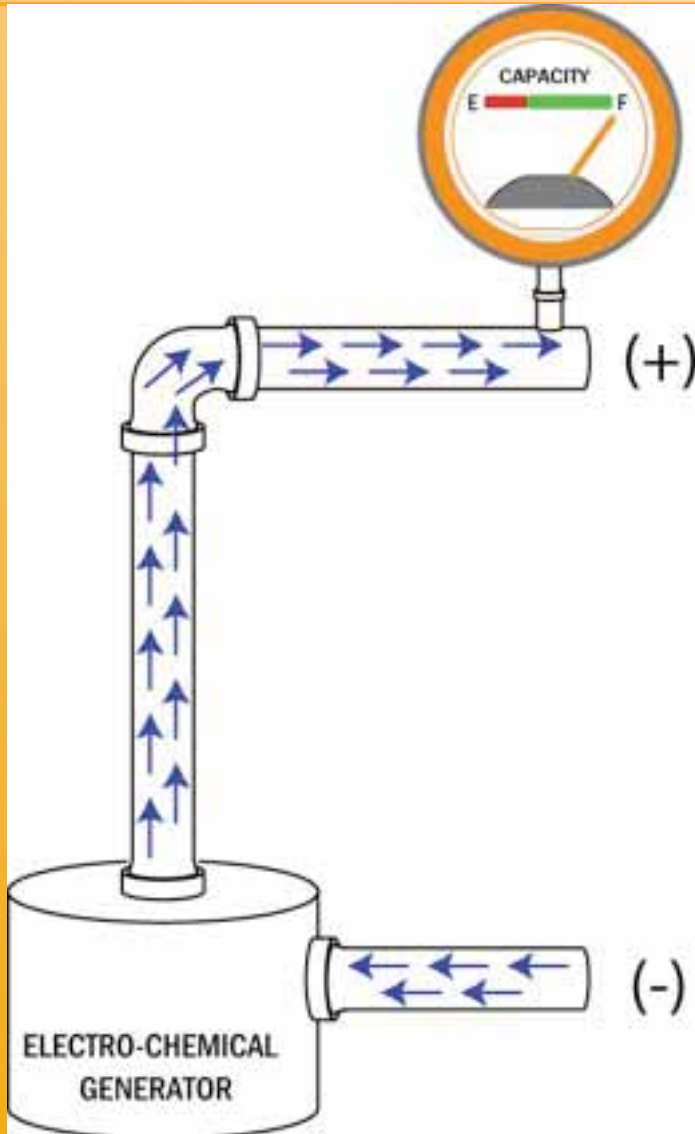
The Ohmic value of a capacitor depends on the size of the capacitor and the frequency of the test current.

$$X_c = 1 / 2\pi fc$$

The higher the test current frequency and the bigger the capacitor, the smaller the ohmic value of the capacitor.



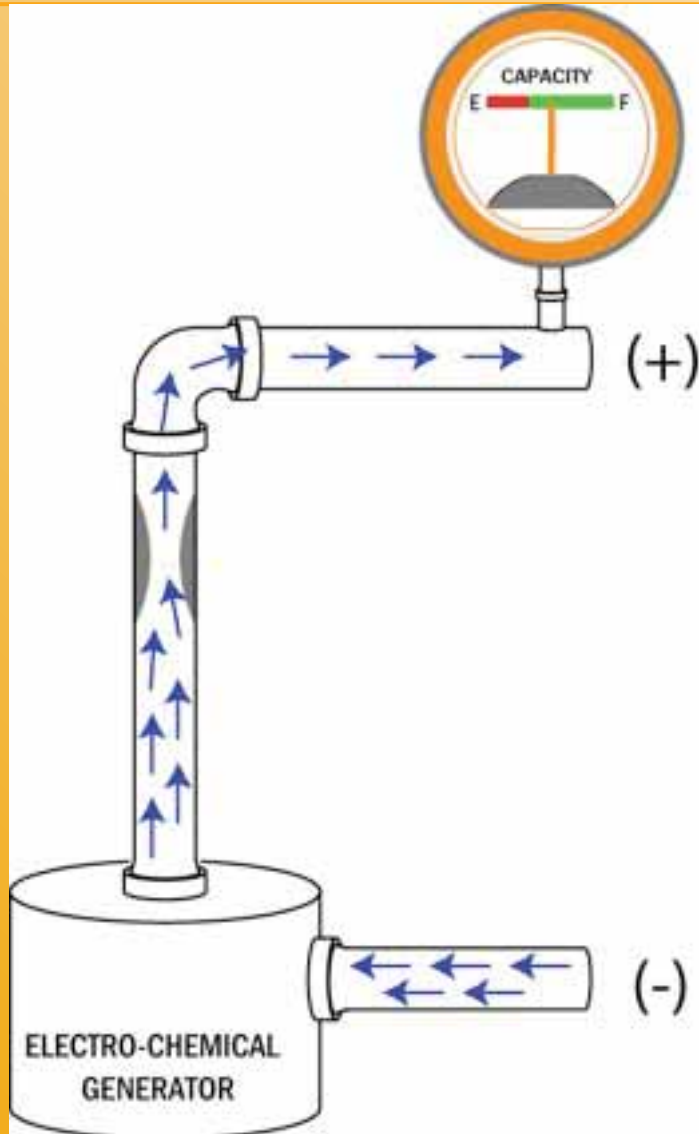
# Pipe analogy



- A healthy battery will produce power and allow easy flow of DC current.
- The more power that is required, the more power will be produced
- When the fuel is gone, it has to be charged

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# Aging

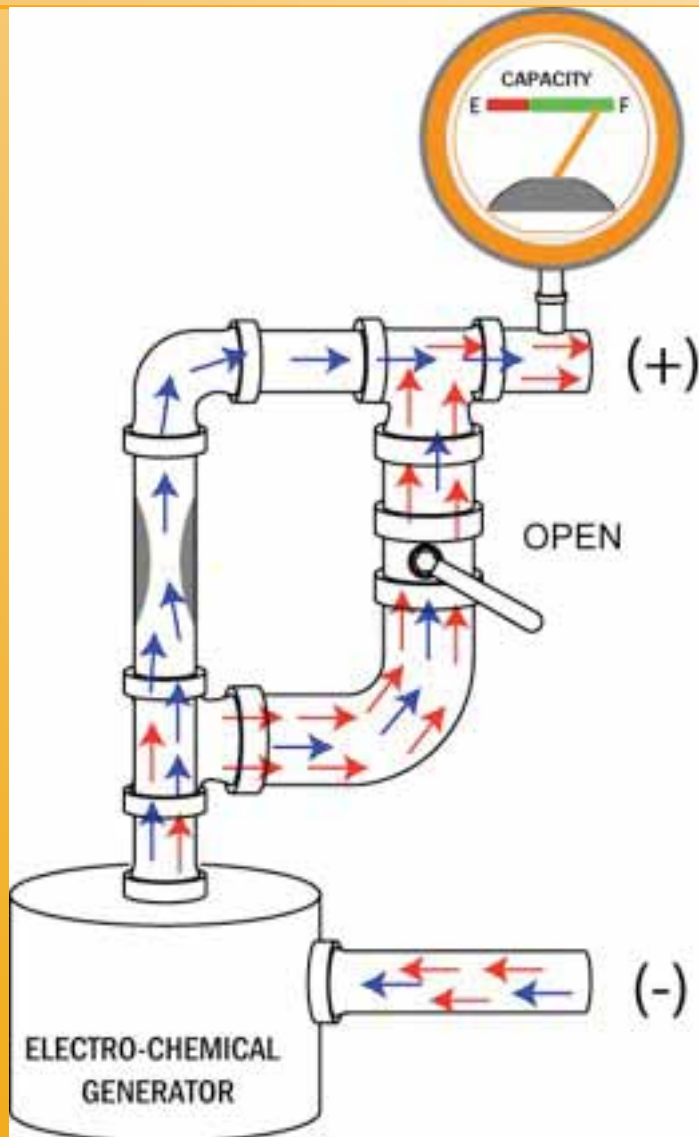


- As the battery ages, the capacity diminishes.
- It is as if the pipe has clogged up.
- It cannot produce the desired capacity

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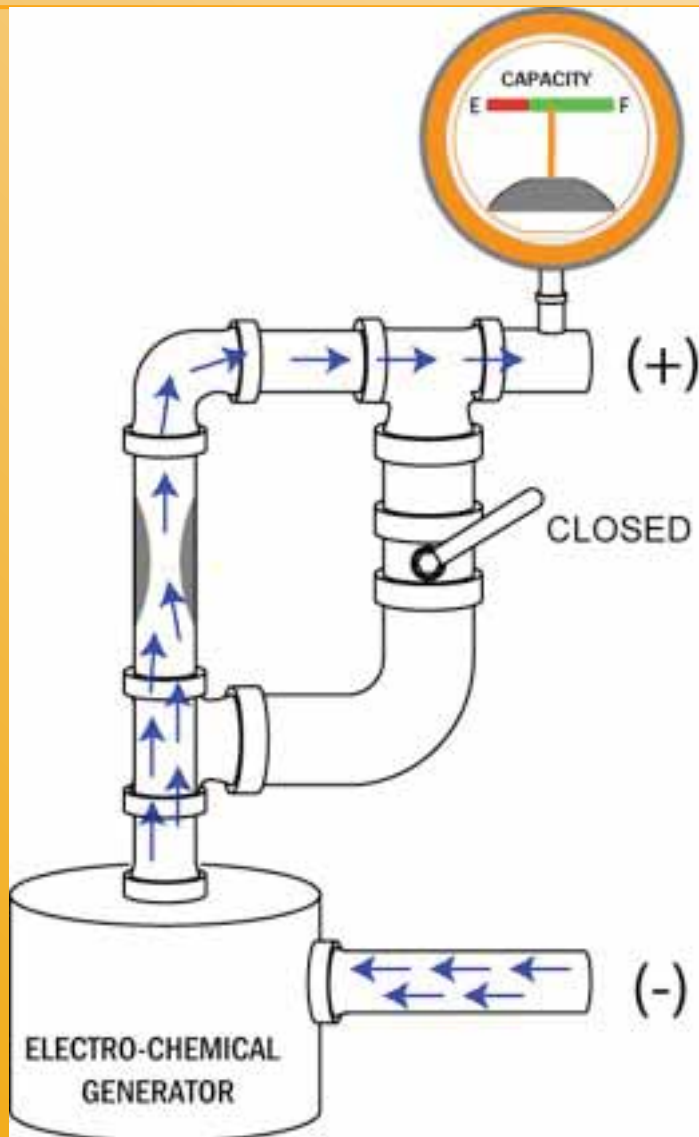
# AC based testing



- A battery has a huge built-in capacitor (Parallel plates)
- Capacitor will allow AC current to flow but will block DC current
- When testing with AC the battery may look healthy as the AC test current will pass through capacitor

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# DC based Testing



- Alber's DC test does not look at the AC path
- It measure the battery's resistance under normal working condition
- This makes it possible to assess the health and detect early signs of degradation

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# Circuit Analysis

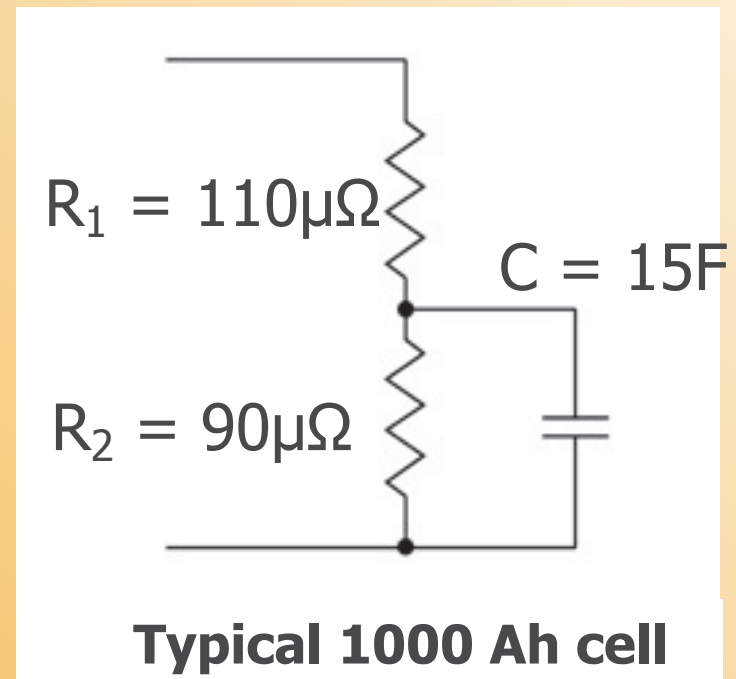
We will use the below formula to calculate the Impedance if the resistance values in  $R_1$  and  $R_2$  changes

$$R_{\text{tot}} = R_1 + R_2 = 200\mu\Omega$$

$$X_C = 1 / (2)(3.14)(15)f$$

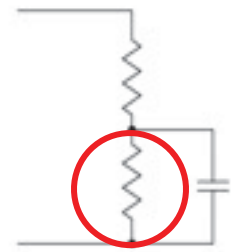
$$Z_{\text{tot}} = R_1 + \frac{(R_2)(jX_C)}{R_2 + jX_C}$$

$$Z_{\text{tot}} = R_1 + R_2 X^2 + j R_2^2 X$$



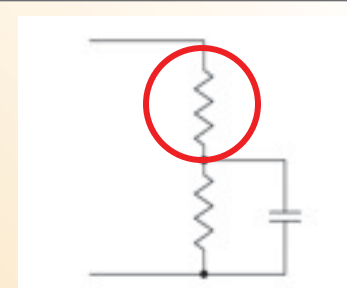
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# $R_2$ vs. $R_{total}$ and $Z_{total}$



Test Freq	Cell failure	$R_{tot}$ $R_1 + R_2$	% Change $R_{tot}$ from baseline	$Z_{tot}$	% Change $Z_{tot}$ from baseline
60	None	200 $\mu\Omega$	0	185	0
60	$R_2 > 140$	250 $\mu\Omega$	25	208	12
60	$R_2 > 190$	300 $\mu\Omega$	50	220	19
200	None	200	0	139	0
200	$R_2 > 140$	250	25	135	-2.2
200	$R_2 > 190$	300	50	133	-4.0

# $R_1$ vs. $R_{total}$ and $Z_{total}$



Test Freq	Cell failure	$R_{tot}$ $R_1 + R_2$	% Change $R_{tot}$ from baseline	$Z_{tot}$	% Change $Z_{tot}$ from baseline
60	None	200 $\mu\Omega$	0	185 $\mu\Omega$	0
60	$R_1 > 160$	250 $\mu\Omega$	25	234 $\mu\Omega$	26.5
60	$R_1 > 210$	300 $\mu\Omega$	50	284 $\mu\Omega$	53.5
200	None	200 $\mu\Omega$	0	139 $\mu\Omega$	0
200	$R_1 > 160$	250 $\mu\Omega$	25	187 $\mu\Omega$	35
200	$R_1 > 210$	300 $\mu\Omega$	50	236 $\mu\Omega$	70

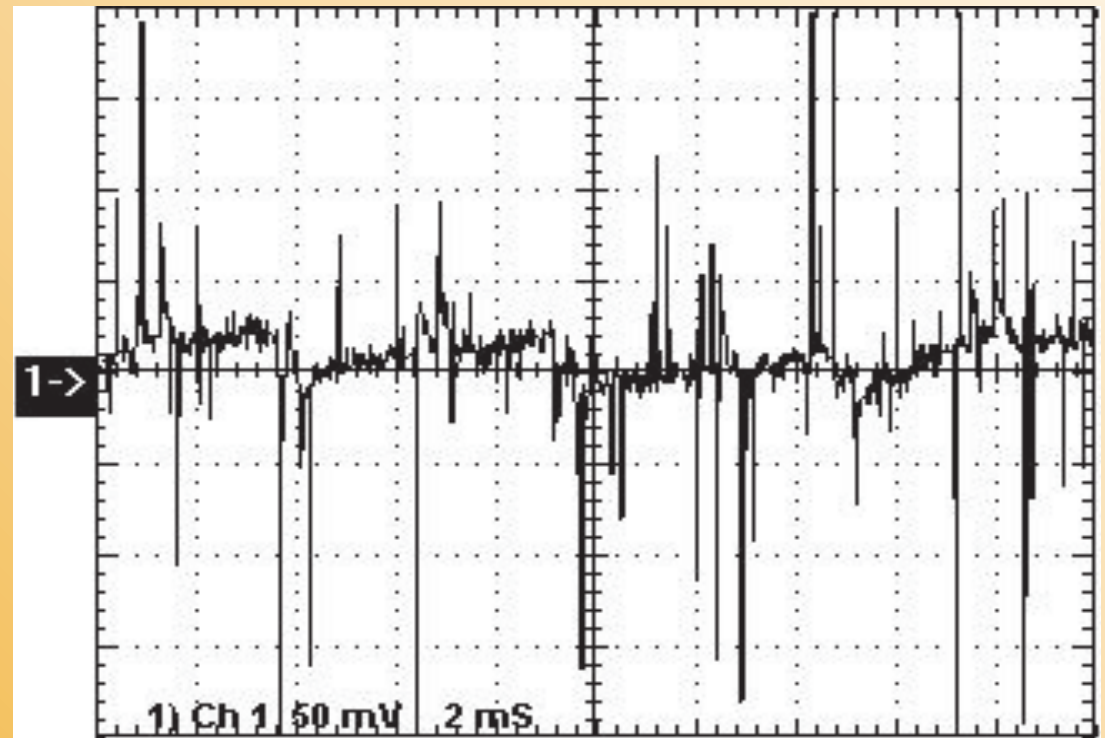
# Noise

Typical AC Ripple riding on  
a 2 volt UPS Cell

Ripple voltage is  $\sim 40\text{mV}$  or  
 $40,000\mu\text{V}$ .

Most AC instruments inject  
a 1 A AC test signal which  
will generate a  $300\mu\text{V}$   
signal through a  $300\mu\Omega$  cell

This means that the test  
instrument will have to  
accurately resolve a  $300\mu\text{V}$   
signal in  $40,000\mu\text{V}$  ripple  
noise!



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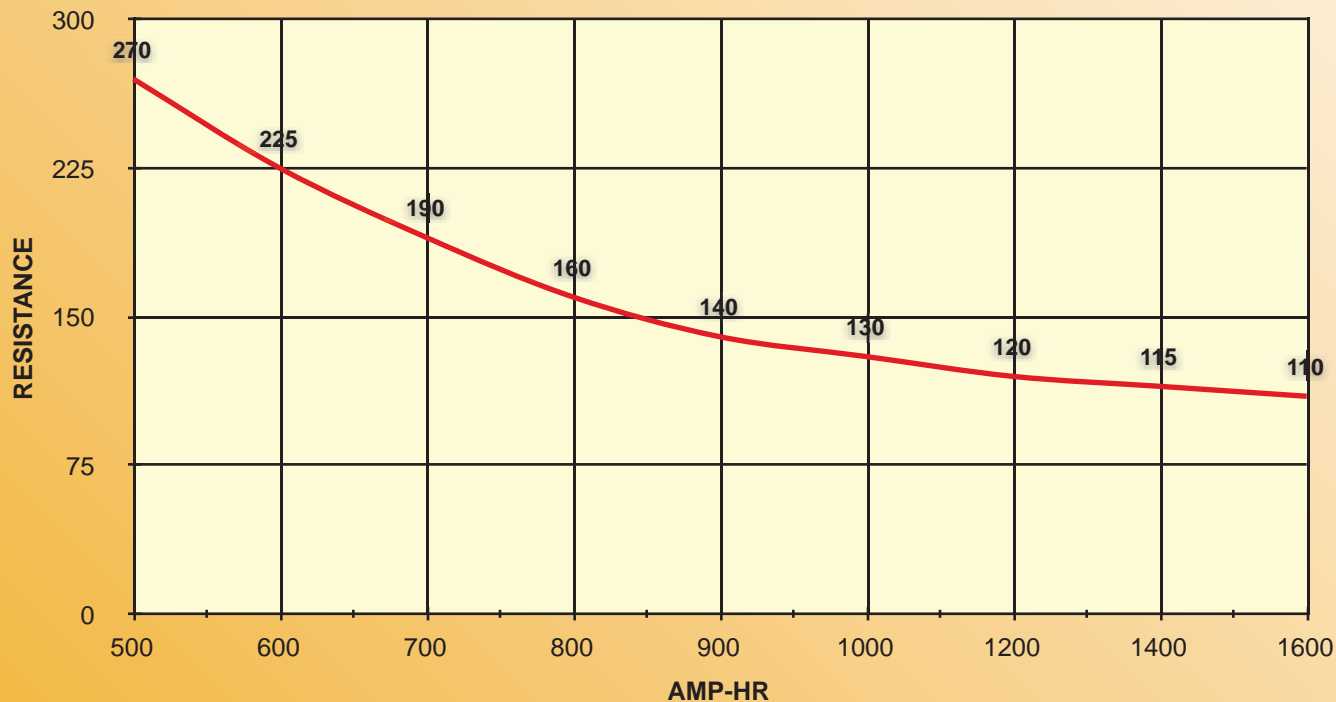
# Resolution

The Resistance difference between good and bad 1000 Ah cell is  $< 50 \mu\Omega$ .  
A 1 amp test instrument would have to resolve  $50 \mu\text{V}$  to detect a cell turning bad!



# Typical Resistance Values

RESISTANCE VS AMP-HR FOR FLOODED UPS (SG=1.250) & VRLA CELLS 500 to 1600 Amp-Hr

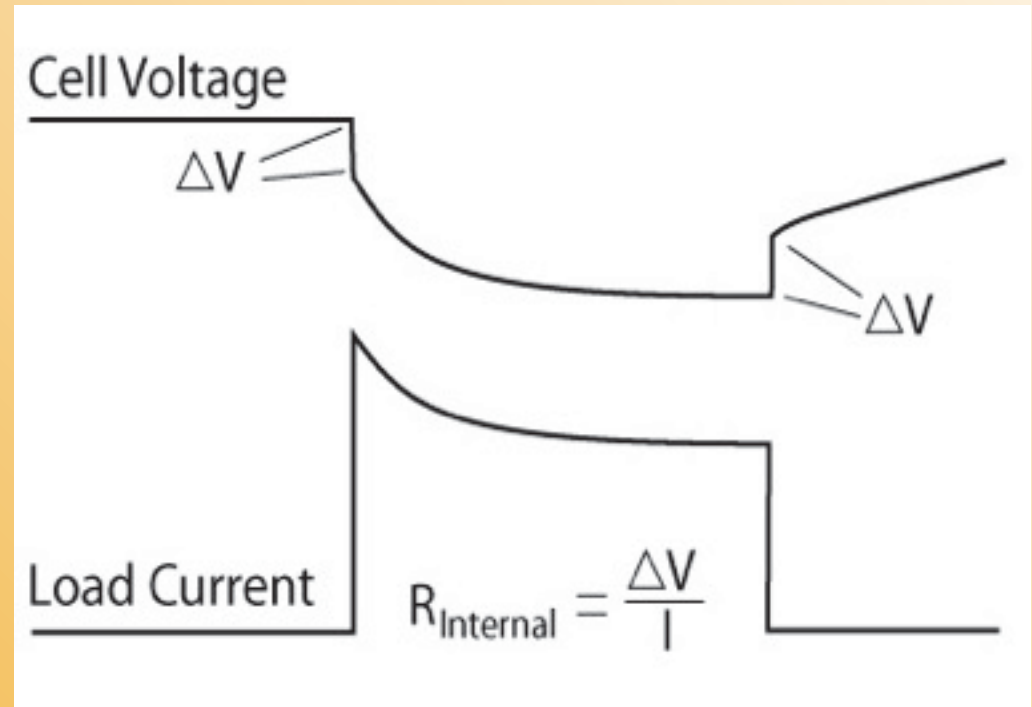




# How are Resistance Measurements made?

The instantaneous voltage drop at time zero and when the load is removed shows the voltage drop across the internal resistor

$$\text{Resistance} = \Delta V / \Delta I$$



# Why Internal Resistance?

## Alber's Statement

The Internal Resistance of a cell is directly related to its capacity.

A correct assessment of a Battery's Internal Resistance is therefore an indicator of a Battery's "State-of-Health"

The logo for Alber, featuring the word "Alber" in a bold, italicized, sans-serif font. The letter "A" is significantly larger than the other letters and has a yellow-to-orange gradient fill. The remaining letters "lber" are in a dark blue color.

# Auto Discharge Capture

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# Auto Discharge Capture

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Most power outages that occur are less than 30 seconds.

Many monitors cannot record cell voltages in these short events.

**Remember:**

A battery is only as good as its weakest cell.



# Real Time Data Display



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# Real Time Data Display

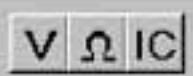
Cell **explosions** and **fires** occur due to failing cells or intercell connections during a high current discharge.

It is imperative for equipment and personal **safety** that a real time graphical display is available during power outage or capacity testing.

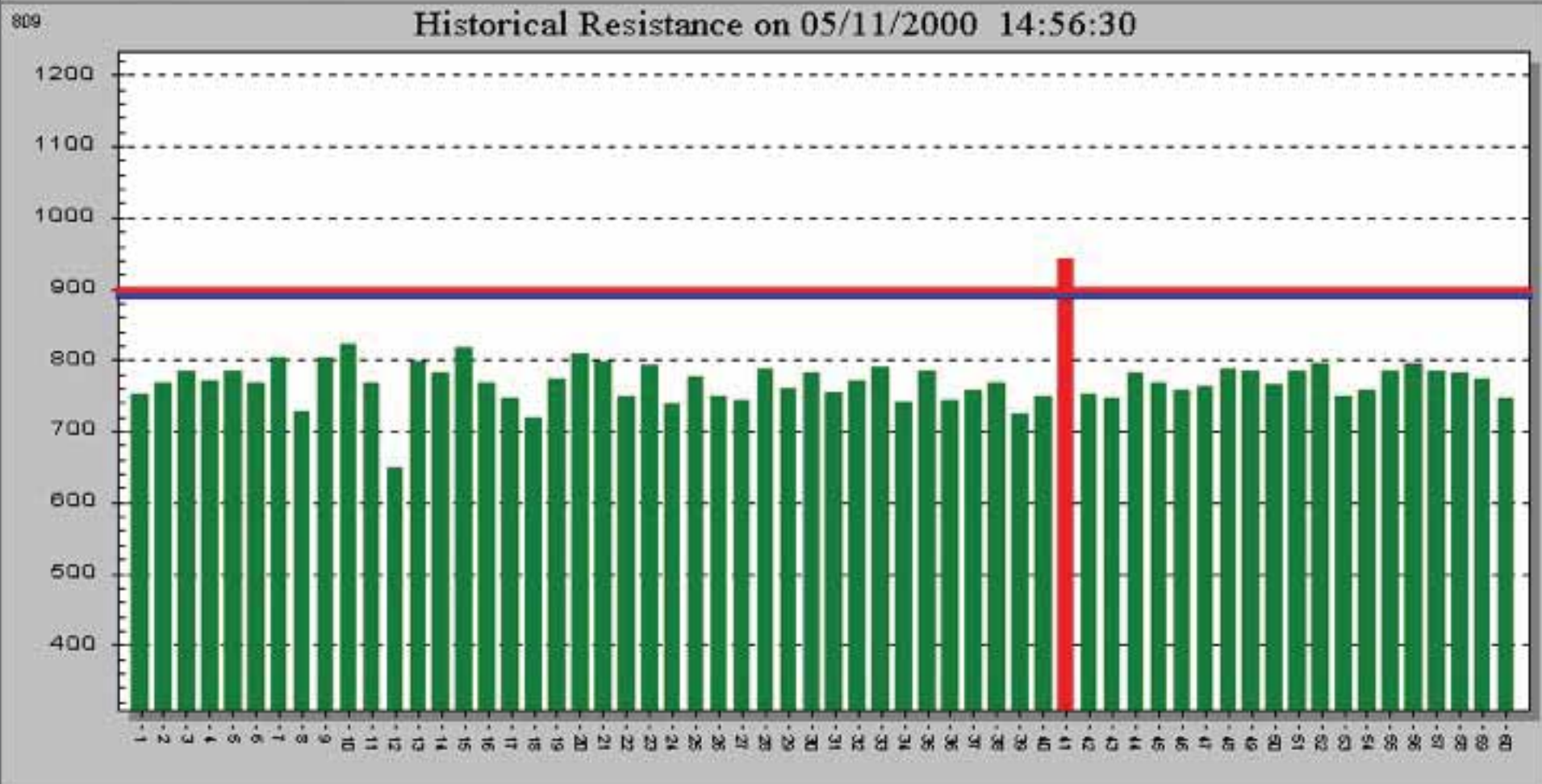


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Select String



Cell Resistance (microhms)	
Maximum (41):	941
Minimum (12):	647
Average:	771

Intertier Resistance (microhms)			
Intertier R 1 (Cell 15):	121	Intertier R 6:	0
Intertier R 2 (Cell 30):	344	Intertier R 7:	0
Intertier R 3 (Cell 45):	72	Intertier R 8:	0
Intertier R 4:	0	Intertier R 9:	0
Intertier R 5:	0	Intertier R 10:	0
		Intertier R 11:	0
		Intertier R 12:	0
		Intertier R 13:	0
		Intertier R 14:	0
		Intertier R 15:	0

String Status: Unknown

Communication Status: Idle

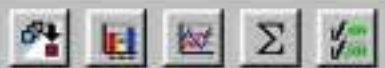
Password: Unchecked



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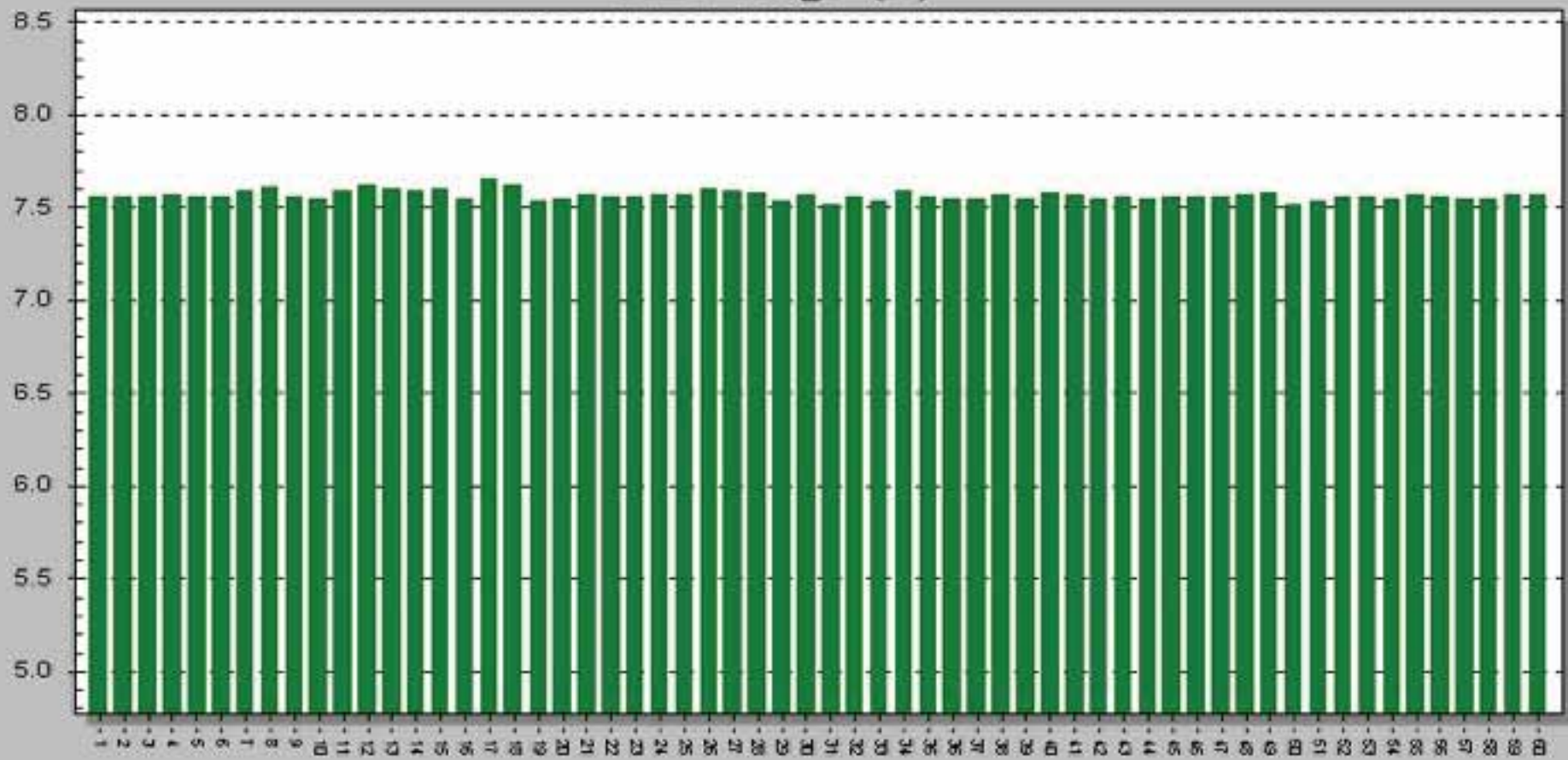
Monday, November 13, 17



Replay forward

Starting Time: 10:38:04    Ending Time: 10:56:08    Time Interval: 01:00    Elapsed Time: 00:01:00  
Overall Voltage (V): 453.5    Discharge Current (A): 903

### Cell Voltage (V)



Communication Status: Unknown

New Data: No New Data

Sort: End Date/Time (D)

# Reliable Battery Systems

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# Reliable Battery Systems

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**Early detection is the key to preventing system failures.**

**We believe that our Monitor is the only product capable of providing the early warning that is crucial in maintaining a reliable battery system.**



# Full Function Battery Monitors



# Full Function Battery Monitors

UL Listed

CE Approved

Made in USA

**Alber**

# Battery Monitors



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# Battery Monitors

## BDS-256

### Battery Diagnostic System

Monitor any battery system  
up to 600 volts DC

- UPS systems
- Generating stations
- Industrial



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# Battery Monitors



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# Battery Monitors

## MPM-100

### Multi Purpose Monitor

12 to 120 volt applications

- Telecommunication
- Substations
- Generator start



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# Parameters Monitored

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# Parameters Monitored

- Overall voltage
- Discharge current
- Charger float current
- 2v cells, NiCad cells, 4v, 6v, 8v and 12v modules
- Temperature
- Resistance of all cell/jars, intercells, and intertiers



# System Level I/O

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# System Level I/O

- **System inputs**
  - Remote alarm reset
  - 16 digital inputs
- **System outputs (form C contacts)**
  - Maintenance alarm
  - Critical alarm
  - 8 programmable control outputs(BDS-256)



# Communication

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# Communication

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- Two RS-232 for local computer
- RJ-11 for telco dial up
- RJ-45 for Ethernet connection
- Standard Modbus protocol





# Data Collection Module (DCM)



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# Data Collection Module (DCM)

The Data Collection Module acquires all readings from the battery

- 48 cells or modules
  - Voltages & Resistance
- 2 temperatures
- Discharge current
- Charger float current



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# BDS Controller



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# BDS Controller

The “Brain” that controls the system.

- Collects and stores data from the DCMs
- Microprocessor driven
- Stand alone – No on site PC required.
- 8 strings of 256 cells per Controller



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# External Load Module

Supports proactive DC internal resistance testing



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# External Load Module

## Supports proactive DC internal resistance testing

- One ELM for each string
- Tests battery in 10% increments
- Test current approximately 30 amps



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# Ease of Installation

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# Ease of Installation

- Modular design allows the DCMs to be located near the battery, reducing wire lengths
- One 120 vac power connection required for up to 8 strings of 256 cells.



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# BDS-256 Installation

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Rear View of two – DCM's



# BDS-256 Installation



Rear View of two – DCM's

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# BDS-256 Installation

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Multiple BDS Systems



# BDS-256 Installation



Multiple BDS Systems

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# BDS-256 Installation

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Mounted on top of MGE 6000 Cabinet



# BDS-256 Installation



Mounted on top of MGE 6000 Cabinet

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# MPM-100



## Applications

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# MPM-100



The MPM-100 (Multi Purpose Monitor) is a low cost, single module solution for all applications of 150 volts or less

## Applications

**Telecommunications  
Switchgear**

**Microwave  
Solar**

Supports over 100 standard battery configurations

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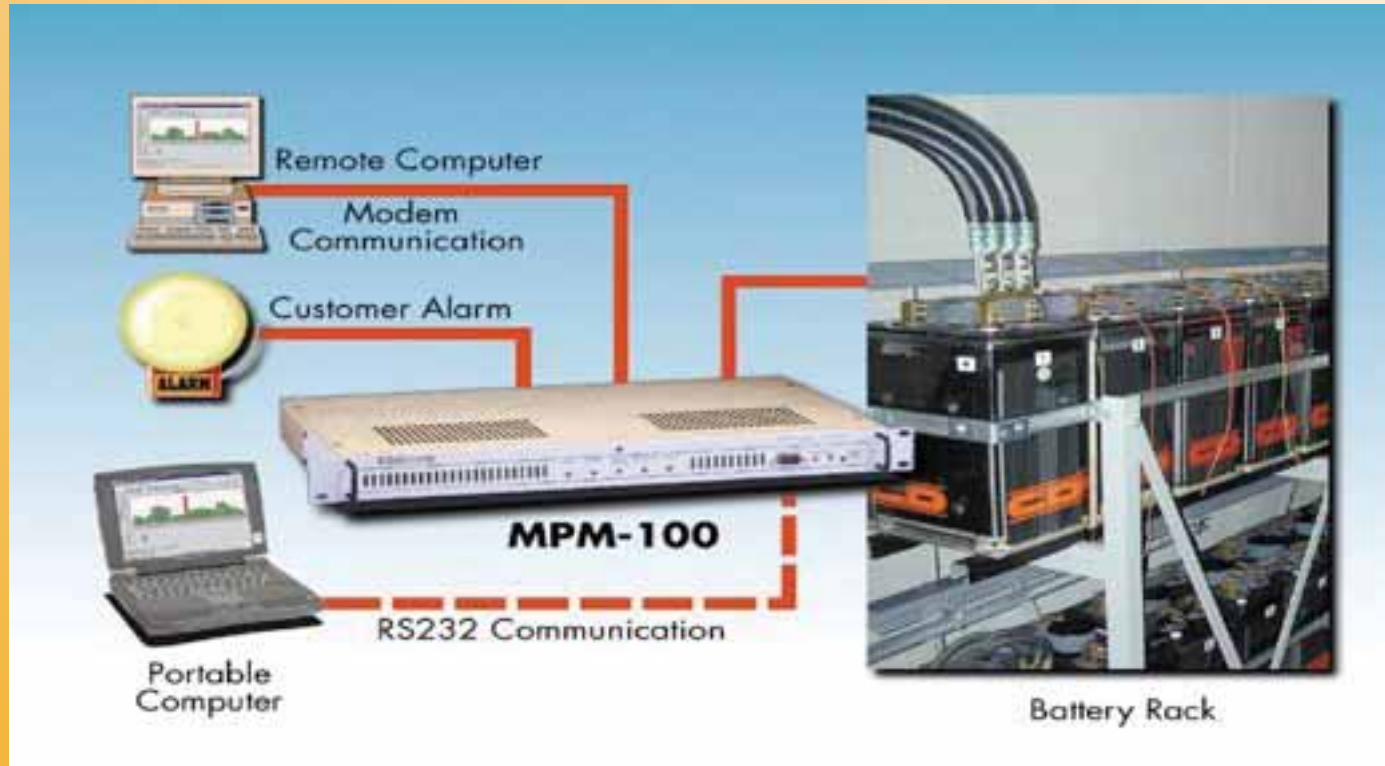


# MPM-100

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# MPM-100



A typical system has one MPM for one to four strings

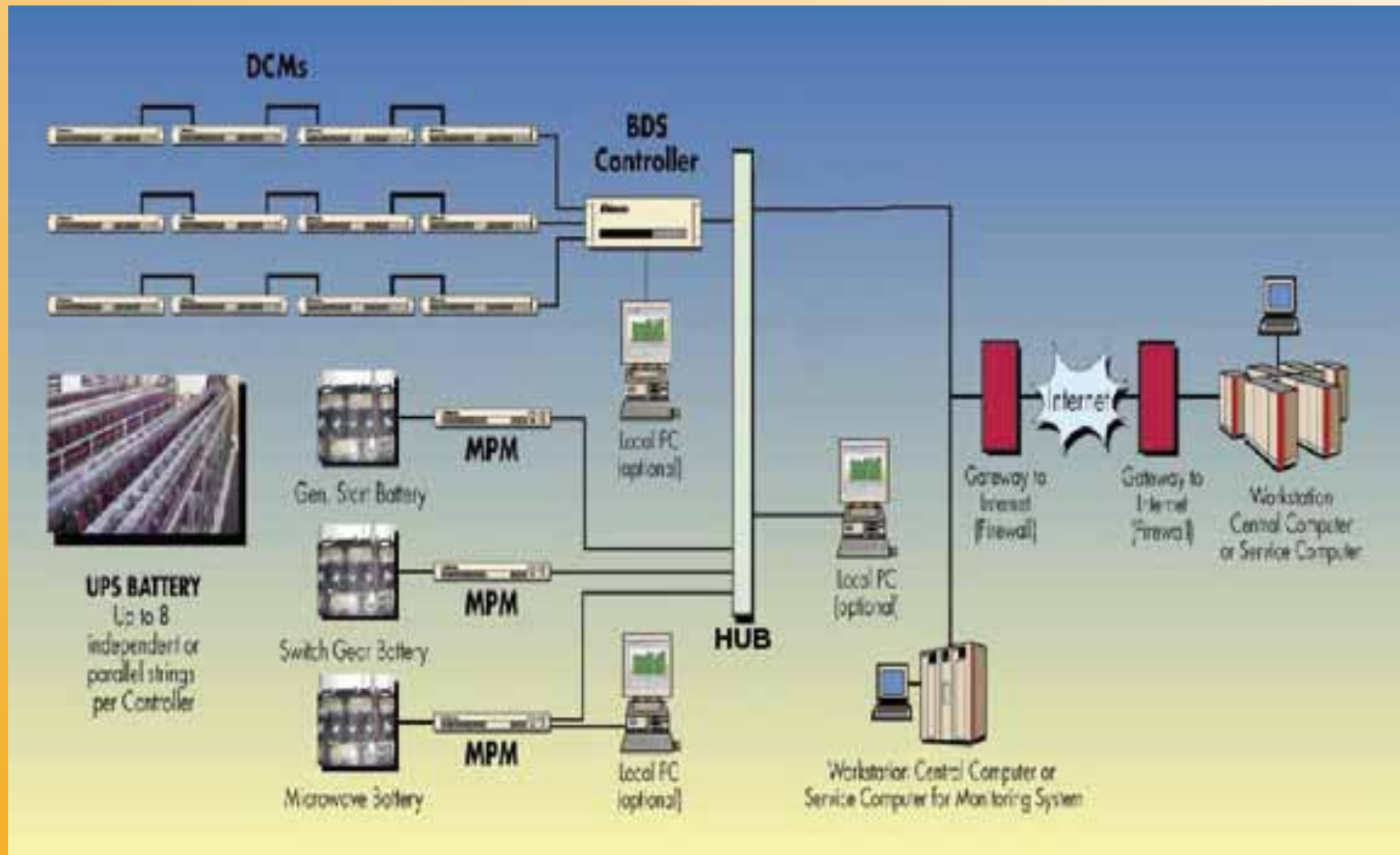
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# Network Configuration

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# Network Configuration



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# System Software

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# System Software

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## **Battery Monitor Data Manager and Report Generator**

**Common software for both  
MPM-100 and BDS-256  
systems**



# System Software

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# System Software

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**Installs on standard Windows PC**

**For more information on the monitor system software please view the BMDM Software Demonstration Presentation.**



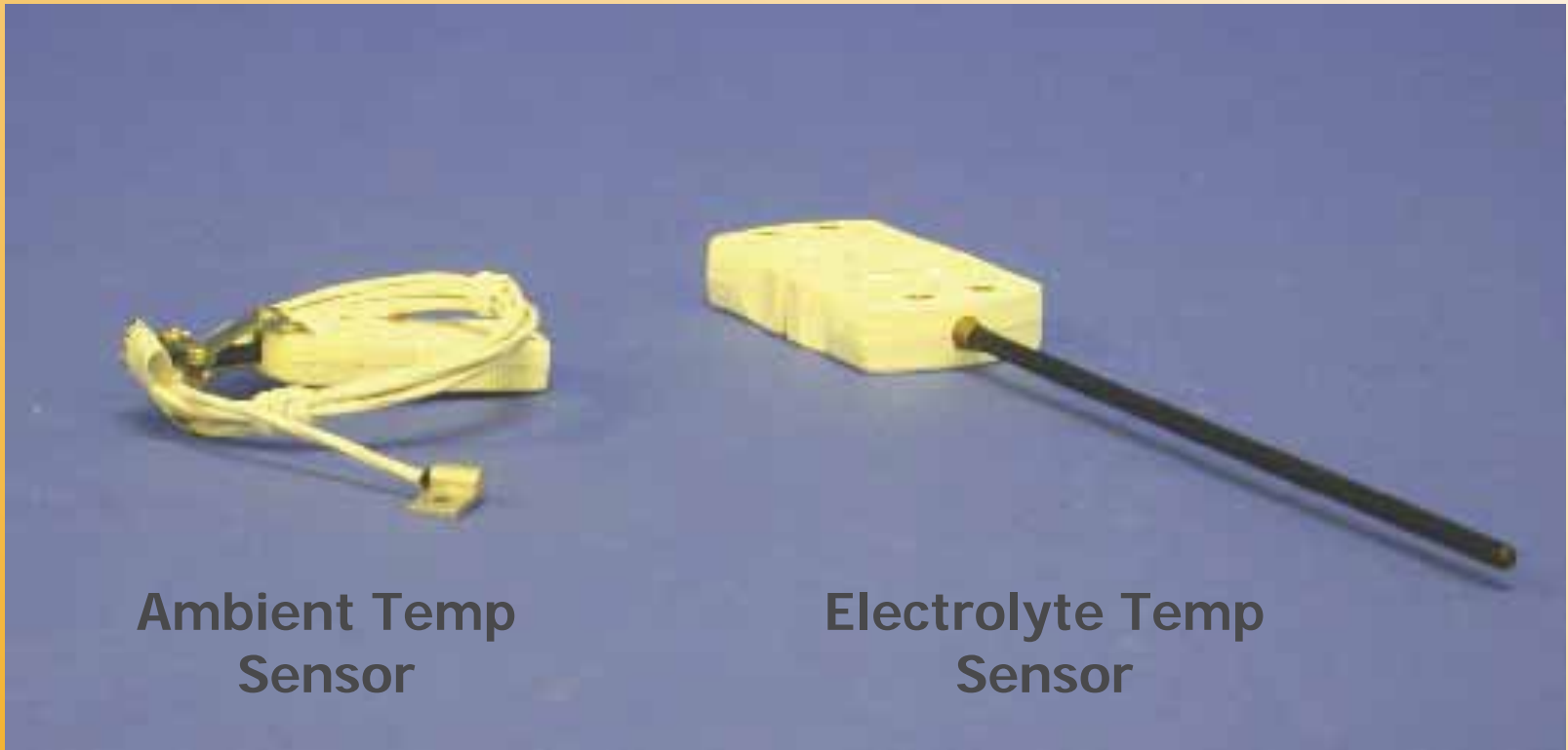


# Options

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# Options



Ambient Temp  
Sensor

Electrolyte Temp  
Sensor

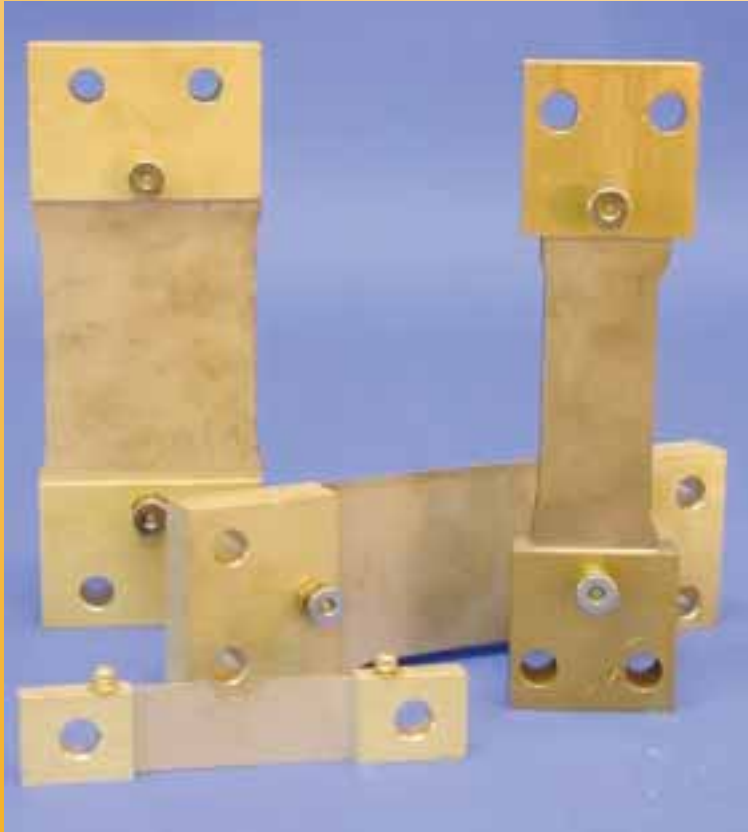
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# Discharge Current Measurement

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# Discharge Current Measurement



**Discharge Current measurement can be taken from an existing shunt if available.**

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# Discharge Current Measurement

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# Discharge Current Measurement



For a battery system without a shunt, a non-intrusive hall effect sensor can be used

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# Serial Port Multiplexer

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# Serial Port Multiplexer



The Multiplexer allows for one telephone line or one RS232 serial cable to connect to up to 128 strings being monitored

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# Continuous Load Units

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# Continuous Load Units



**Continuous Load Unit (CLU) product line easily interfaces with the BDS for performing IEEE capacity testing**

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# Computer Options

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# Computer Options



**Lockable computer cabinet with desktop computer and optional printer**

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# System Feature Summary

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# System Feature Summary

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**BDS-256**

**Battery Diagnostic System**

for monitoring

**UPS Systems**

**Generating Stations**

**Industrial Systems**

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# System Feature Summary

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# System Feature Summary

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**MPM-100**

**Multi Purpose Monitor**

for monitoring

**Telecommunication**

**Substations**

**Generator Start**

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# System Feature Summary

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# System Feature Summary

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**Auto detects discharges.  
Data displayed in real time  
and saved for playback**



# System Feature Summary

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# System Feature Summary

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**Performs proactive resistance test for identifying abrupt system failure potentials**



# System Feature Summary

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# System Feature Summary

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**Extensive  
communications  
capabilities**



# System Feature Summary

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# System Feature Summary

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Feature rich software with  
immediate access to  
trending reports





# System Feature Summary

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# System Feature Summary

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**Interfaces directly to  
Continuous Load Unit for  
capacity testing**



# System Feature Summary

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# System Feature Summary

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**Easily interfaces to  
third party building  
management systems**



# The End

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# The End

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**For more information please  
call us at (561) 997-2299 or  
visit us on the web at  
[www.alber.com](http://www.alber.com)**

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