Battery Monitoring System with Equalization BMSV for VRLA – AGM, GEL Batteries

Operation of the monitoring system BMSV is suitable for applications, which require monitoring of no-failure operation of batteries. Utilization of the battery monitoring system will offer the user information about an upcoming battery failure, extension of battery lifespan, and will prevent back-up system failures caused by poor battery condition and prevent destruction of an entire battery set due to failure of one cell.

Active monitoring and equalization of batteries results in the following benefits:

- Detects an imminent risk of battery failure
- Prevents battery overcharging
- Prevents battery undercharging
- Prevents sulfation
- Detects battery issues through monitoring temperature and internal resistance
- Individually regulates battery voltage
- Prevents uncontrollable thermal reactions
- Extends lifespan by up to 25% [1]
- Duly identificates necessary battery replacement

The BMSV monitoring system monitors and signals states of accumulator batteries in real time as voltage / resistance of individual cells / batteries of battery sets, voltage balance of cells / batteries, excessive discharging (or respectively charging) currents of a battery set, battery temperature variations from the stated value and other parameters. Overrun of every mentioned parameter can destroy the entire battery set, therefore having immediate information on battery status is essential.

Measurement modules (MM) are connected directly to individual batteries. They monitor voltage, internal resistance and temperature of each battery. Measurement modules actively balance voltage of the batteries as to assure correct voltage on each battery throughout the entire charging process, as well as after its conclusion. This process is called Balancing, or Equalizing.

There are three largest battery issues which we can detect and eliminate through monitoring:

Issue n.1: SULFATION

Sulfation occurs during deep discharging, discharging or charging with large currents. This process lowers the battery capacity and increases its internal resistance.

Sulfation symptoms:

- **capacity reduction, electrolyte has higher temperature while charging, individual cells begin to gassing soon following the commencement of charging, battery terminal voltage can be higher while charging**

An effective risk prevention of sulfation is regular and correct charging. Another example of a problem is the fact that sulfate has a larger volume than active substance, which causes mechanical strain to cells, gradual separation and loss of active substance (as an irreversible process).

Issue n.2: INTERNAL RESISTANCE

Internal resistance / conductivity is related to condition / state of a battery. Size of internal resistance depends on:

- **age of battery, history of battery (storage period, time in floating, operating temperature), battery charge status, battery temperature, condition of battery at the time of measuring: values can vary, unless the measured values won't be accepted at the same time, for example when the batteries are on float voltage, or in unconnected state.**

Issue n.3: THERMAL DEGRADATION

VRLA batteries have an inherent risk of thermal degradation. This condition is the outcome of heat generated inside the cell, which results in accelerated dry-out of the electrolyte and also, in extreme cases, melting or damaging of plastic case.

The following conditions can contribute to thermal degradation:

- **high ambient temperature, insufficient space between batteries, insufficient compensation of voltage from temperature, configuration of incorrect float voltage, failure / defect of an individual cell within a battery, charger failure.**

[1] Extended lifespan is indicated as opposed to batteries, which do not utilize BMSV. This percentage can be higher or lower depending on type / manufacturer of battery and its operating conditions.

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Functions, advantages and properties of battery monitoring system with equalizing:

Detection of imminent battery failures

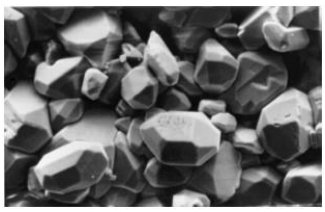
Typical battery problems like sulfation, corrosion, gassing, dry-out, thermal runaway are detectable given proper monitoring. Changes in impedance and temperature trend indicate onset of such issues.

Avoiding undercharging / overcharging – recovering battery capacity

BMSV guarantees a full charge and optimal functioning of the battery system by means of a process called Equalization (or Balancing). The Equalization process also prevents unintended undercharging / overcharging of certain cells / batteries, which results in optimal battery voltage. This in turn substantially prevents sulfation and loss of capacity – recovery of capacity is achieved through correct charging.

Avoiding sulfation

Sulfation is often a problem for UPS batteries given that they are consistently held at a float charge level or subject to a charging principle that leaves them uncharged for long periods. Without proper regulation, there is no guaranteeing that all batteries have been fully charged. Often enough, when this takes place, some batteries are overcharged, while others remain incompletely charged. Through Equalization BMSV avoids sulfation by maintaining ALL batteries at a balanced voltage level and keep them at the ideal SOC.



Extension of service life by *25%*

The service life of a set of batteries depends on the weakest cell of the weakest battery in the string. Typically, in a UPS, the service life of such a string is 50-60% of the value indicated by manufacturing designs. By Equalizing (Balancing) process, each of the batteries within the string is maintained at optimal voltage levels, eliminating the ill-effects of improper charging. The constant care provided for by the Equalizing (Balancing) process has been shown to increase service life of batteries by more than 25%. BMSV proves it is possible to meet—and even exceed—service lives called for by manufacturers (provided that the batteries do not contain hidden technological defects / deviations from manufacture).

Our statistic on battery failure rate – capacity decrease, which analyzes data from the last 10 years, shows that with 12 year old batteries, 8% had to be replaced within 5 years of their placement on customer's site, while within 8 years of their placement this percentage rose to almost 30%, with batteries showing low capacity or high internal resistance!

(The batteries in question were 12V batteries of VRLA type with capacities between 100–200 Ah, in total number of more than 2000 pcs. – for which complete data was available)

Protection of new batteries

Equalizing voltage of batteries of a given battery system results in prevention of damage caused by neighbouring batteries within the system. Therefore even a new battery can be swapped into a string of older ones without risking damage to others through overcharging. A complete replacement therefore isn't needed in such a case.

Individual regulation of voltage

BMSV regulates voltage of each individual cell / battery through the equalization process. This process results in optimal performance and a extended battery life.

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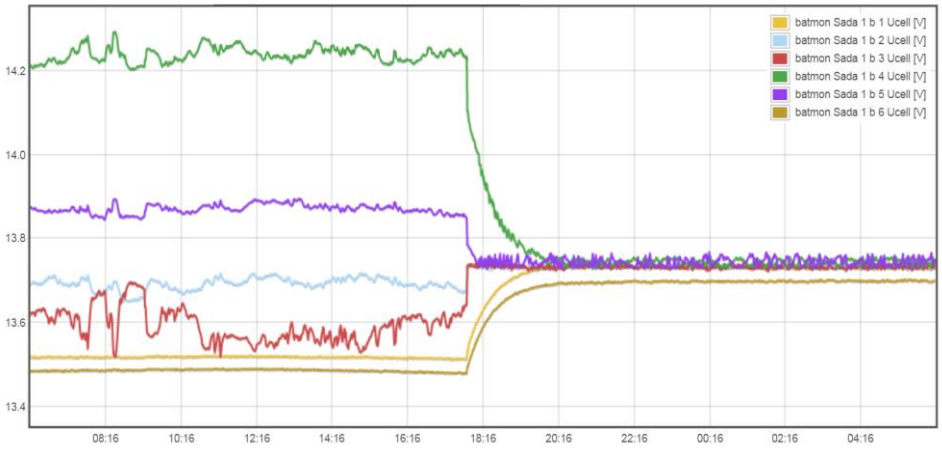
The following graph showcases voltage on a battery string with an age of approx. 6 years. As evident on the graph, some batteries are overcharged – starts excessive gassing of the cells, which is resulting in dry-out of the electrolyte. On the other hand, some are undercharged and result in excessive sulfation – loss of capacity.

The graph below displays the same battery string after applying Equalization of voltage in cells. As evident from the graph, BMSV can equalize these cells over a few hours and therefore extend their lifespan.

The BMSV system should ideally be applied to new batteries and remain installed throughout their lifespan.



Prevention of thermal runaways

By means of an embedded dry contact output, the BMSV system is capable of tripping the battery breaker in the event of a thermal runaway, or of stopping charging provided that the power feed system allows for it.

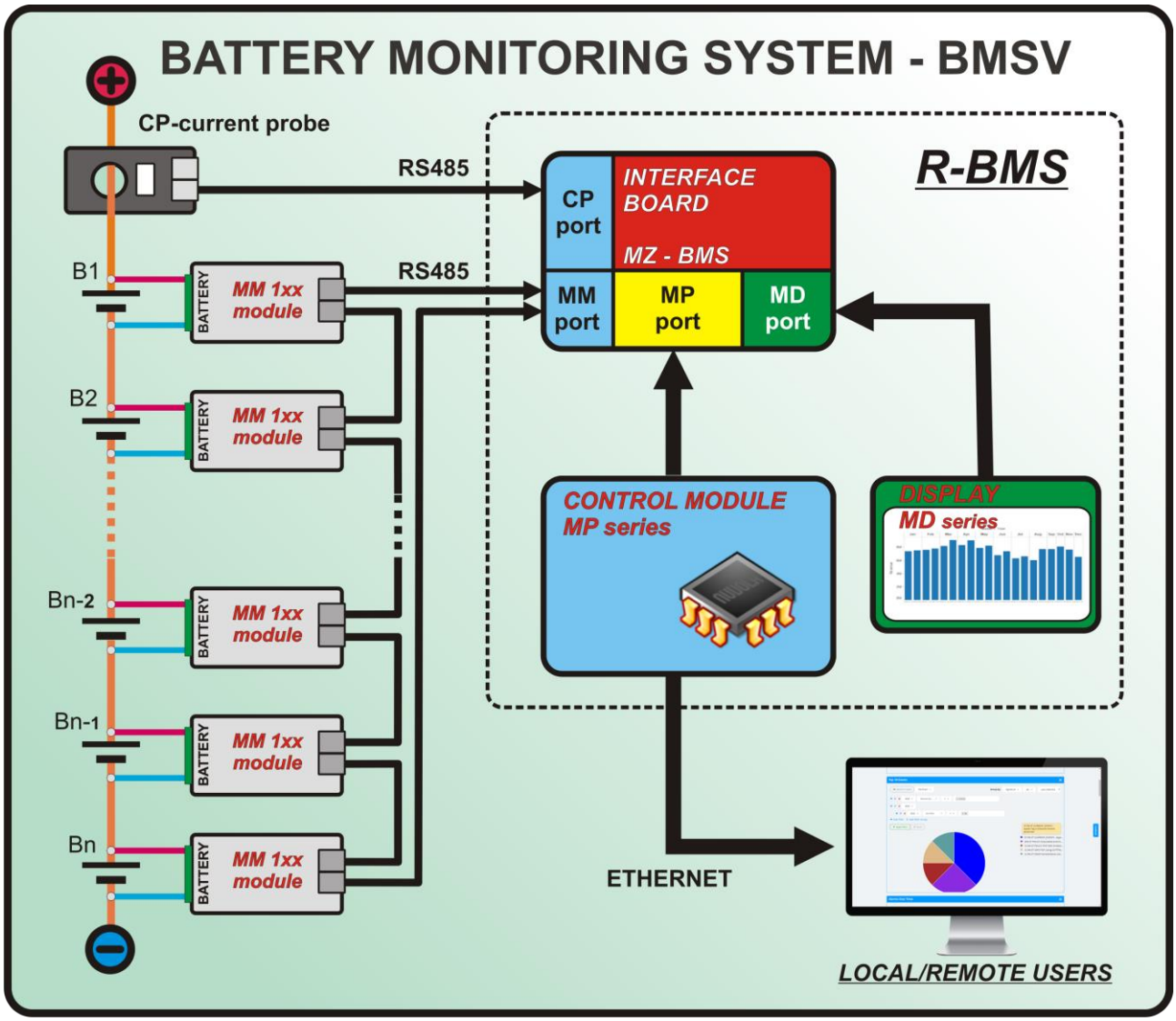
Identification of a required battery replacement

By monitoring impedance trends, BMSV allows the user to detect weak or damaged batteries in early stages of deterioration. Timely replacement of bad batteries is vital to improving the lifespan of the battery system as a whole.

Simpler maintenance

BMSV improves the service quality by providing remote monitoring through Internet – LAN, GSM, VPN, or any other network. It also allows testing batteries without going through the trouble of disconnecting them from the system. Maintenance and testing take place under real operating conditions and require no downtime!

BMSV system block scheme



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Components of BMSV system

The entire system is comprised of a control unit (MP) and an appropriate number of measure modules (MM) of identical construction design, current probes (CP), temperature sensors (MT) and an appropriate number of connecting wires and voltage sensors' wires.

Display Module MD	
Dimension w x h x d	170 x 110 x 30 mm
Power supply	from control module
Power consumption	max. 3 W
Communication	RS485, RJ45
Display	graphic, colour, 240x320
Cover	front IP 65, back IP20
Mounting	on a panel

Control Module MP	
Dimension w x h x d	120 x 115 x 22,5 mm
Power supply	from measured battery
Power consumption	max. 5 W
Communication	RS485, MODBUS RTU RS232 ETHERNET, SNMP, MODBUS TCP
Dig input / output	4 x relay 4 x dig. input
Number of battery string	max. 4
Number of cells per string	max. 250
Number of temp. sensors	max. 4 / string
Number of current probes	1 / string
Cover	IP20
Mounting	DIN rail

Measure Module MM104 / 106 / 112	
Dimension w x h x d	100 x 51 x 27 mm
Power supply	from measured battery
Power consumption	< 0.2 W
Communication	RS485, galvanically isolated
Nominal voltage	4 / 6 / 12 V
Voltage Range / resolution	0-6 / 0-10 /0-20V / 1mV
Resistance Range / resolution	0,5 – 30 mOhm / 0,050 mOhm
Temp. measure range / resolution	-25 to 75 °C / ± 2 °C
Balance current	400 / 250 / 100 mA

Current Probe CP200/400/800 (IP-option)	
Dimension w x h x d	100 x 51 x 27 mm
Power supply	from control module
Power consumption	< 0.5 W
Communication	RS485
Nominal current range / resolution	± 200 A / 400 A / 800 A / 0,1 A

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Temperature Sensor MT01-5/10 - option		
Dimension w x h x d	35 x 35 x 20 mm	
Power supply	from measure module	
Power consumption	< 0.1 W	
Temp. measure range	-25 to 75 °C (depends on sensor type)	

Main features of the battery monitoring system

Monitoring

- Total voltage of battery sets
- Cell voltage / resistance of a particular cell of battery set
- Voltage / resistance balance on a particular cell of battery set
- Control of min. / max. voltage / resistance of cells
- Control of max. charging current
- Control of max. discharge current during backup
- Current balance of battery sets
- Temperature of a particular cell
- Ambient temperature
- Number of satisfactory / unsatisfactory cells
- Option: configuring control of mutual parameters among battery sets
- Option: monitoring of battery sets with a varying number of cells

User communication:

- Alarm report
  - visually (LED)
  - alarm relay dry contacts
- Communication via serial interface RS232 or RS485 –MODBUS RTU protocol
- Communication via standard net protocols – MODBUS TCP, SNMP, WEB interface

Control:

- Remotely via an external display
- Remotely via Ethernet interface, WEB or Modbus TCP

Software:

- Support of OS MS Windows XP, Windows 7 / 8 / 8,1 / 10

Operating temperature range:

- -25 °C to 55 °C

Protection:

- IP20
- If the location of the monitoring system is in a room with open batteries, it is necessary to place the control unit and measurement modules into cabinets with IP54 and to use a CPxxxIP current probe.