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INVITATION TO TENDER

BACS / English

BATTERY MANAGEMENT SYSTEM (BMS) SPECIFICATIONS

Contents:

Tender text template for a
BATTERY MANAGEMENT SYSTEM (BMS)

PART 1 – OVERVIEW

1.01 SUMMARY

The abbreviation "BMS system" is understood either as a (B)attery (M)onitoring (S)ystem or as a battery (M)anagement system.

The significant differences between the two types of systems can be seen in many ways, both in terms of maintenance and general performance, as a monitoring system only displays values such as battery parameters such as voltage, current, temperature, etc., but does NOT actively intervene in the operation of the system battery system. If there are problems with the battery system, intervention and corrections by qualified personnel are absolutely necessary, making operation significantly more complex and critical for the safe operation of a “monitoring” system.
A battery “management” system, on the other hand, not only monitors the battery parameters, but also REGULATES them automatically, usually by balancing or equalizing the voltage of the cells or blocks within a battery string. In addition, a management system usually offers programmable event management and thus reaction options that are triggered in direct dependence on the respective malfunction or the threshold values during measurements. In addition, battery management systems are equipped with safety mechanisms (e.g. separation of battery cells) to protect the system itself or even to disconnect battery strings to prevent catastrophic thermal overloads. This massively improves the reliability and service life of the battery system and reduces operating costs as a result, making a battery management system significantly superior to a battery monitoring system.

This type of adaptive control of batteries is known for lithium battery packs, as such control concepts must be present as an important safety feature in this type of battery chemistry. This is not just about improving capacity but, above all, ensuring operational stability. Even with lead-acid, NiCd, NiMH or other battery chemistries with lower energy density orCapacity, the effect of an adaptive control has a massive impact on the SOC (State of Charge) and thus on the SOH (State of Health) of the batteries. The more cells/blocks are regulated in a string, the more striking the improvement in capacity and extension of the lifespan of each individual battery becomes. This regulation is known as “balancing” from lithium technology, and a distinction is made between:"passive" and "active" balancing:

In a "passive" balancing system, the overcharged cells are discharged and the excess energy is released from the system into the environment in the form of heat. This process is irrelevant for a stationary battery system because the batteries are typically under trickle charge and balancing only takes place when the charger is active. This is the most cost-effective and efficient balancing system and is ideal for all types of battery chemistry with smaller capacities and stationary applications. For battery chemistry types with low capacity (lead-acid, NiCd, NiMH), passive adjustment is sufficient and quickly ensures a perfect balance. This also works well with larger cells (over 200Ah), but only takes longer and is therefore more focused on stationary battery systems where there is more time for compensation. Furthermore, the problem of unbalanced cells is smaller the larger they are, e.g. "wet cells" and do not have such dramatic voltage deviations as AGM or other multi-cell battery blocks.

"Active" balancing avoids the conversion of overcharged cell energy into heat, it transfers the energy to neighboring cells and thereby improves the efficiency and rate of balancing energy. With higher capacities and compact lithium cells, it becomes interesting to avoid energy losses and in this way increase efficiency and accelerate balancing (e.g. for EV, traction and solar inverter applications).

Due to the significantly higher installation effort (cables to each cell), such "Active Balancing" BMS systems are typical of EV automotive battery packs based on high-density lithium cells and are therefore quite expensive to manufacture and maintenance is hardly possible. Both balancing methods have their specific advantages and disadvantages, which should be weighed up individually when planning, depending on the intended use.Whether active or passive, such a "battery management system" always has the advantage that it automatically ensures the availability of a battery system at all times and guarantees the 100% SOC level of all cells/blocks in the system and is therefore absolutely simple Monitoring system is preferable.

*Differences from battery **monitoring** – 3 key points*

1. Ensuring the charge level at 100% SOC

In fact, this value can only be achieved and used for calculations if active balancing is carried out, since only through balancing is it possible to fully charge each cell. By using balancing - as opposed to a more cost-effective monitoring system - the user can assume 100% verified SOC. With a pure battery monitoring system, the charging status can only be guessed based on charging times.

2. Balancing verifies the reliability of a battery

Provided that the charger is set correctly, balancing can achieve an almost 100% identical cell/block voltage in the string. Together with the impedance measurement value, which can ONLY be collected at 100% identical voltage and capacity, a uniquely accurate picture of each individual operating state of batteries in the string is created, which is the basis for reliable fault prediction. Only if balancing is active can the impedance value be used for error prediction. This means that the impedance value that may be determined in a monitoring system can be viewed as unreliable because in a pure battery monitoring system the voltages of each cell/block are different and therefore an impedance measurement would be required are not comparable. This means that an impedance measurement in battery monitoring systems is worthless and the user has to discharge their batteries at regular intervals in order to identify the really weak cells.

3. With balancing and battery capacity measurement, we raise the level of requirements for BMS systems

Measuring the battery capacity is only possible with a lot of technical effort. By means of balancing, the SOC can be guaranteed and the battery capacity can therefore be calculated sensibly. Any battery system that can determine a battery capacity must use balancing to meaningfully determine a battery capacity. Full control over the battery condition from the start of battery use to disposal also meets EU requirements for battery systems placed on the market after 2024.

1.02 DESCRIPTION

A. The provider must provide a turnkey installation for a complete and functional battery management system (not a battery monitoring system) for monitoring and controlling the batteries. The installation process includes all installation work, documentation, testing and training as specified in the requirements set out in the contract documents.

B. The provider must provide a complete battery management system for the monitoring and control of sealed or closed cells of all electrochemical technologies (e.g. lead-acid, nickel-damium, lithium, zinc, nickel, etc.). In particular, the system must provide functions for monitoring battery voltages, ohmic value (defined as resistance, impedance or conductivity), the temperature of the individual cells and the current of the battery strings. It must ensure voltage balance by keeping the target voltage of each battery within 0.01 VDC of the charger's target voltage in order to measure comparable and meaningful impedance values and battery capacities.

The system must be complete and include all hardware, software, cabling and other components to enable safe and reliable collection and display of battery data and error conditions.

Delivery follows the following guidelines:

1) The delivery of the complete operating and maintenance instructions for the new battery management system (BMS).
2) The provider must ensure that installation work, commissioning and training for the system delivered is carried out by qualified employees.
3) The battery management system (BMS) provider must be able to guarantee the supply of spare parts for the system for up to ten years after the installation date.
4) The equipment supplied is guaranteed against defects for 24 months from delivery

1.02 STANDARDS

A. The hardware of the battery management system (BMS) must comply with the current regulations and latest recommendations of the following international standards:

Underwriters' Laboratories (UL) for North America
European Conformity (CE) for EU
Canadian Standard Association (CSA) for Canada
National Electrical Code (NEC) for North America
Institute of Electrical and Electronics Engineers (IEEE) for North America
National Electrical Manufacturers Association (NEMA) for North America

B. Standards for electrical interference and interference from neighboring systems:

International test results
EN55022:2006 + A1:2007

North American Test results
FCC 47 CFR Part 15, Subpart B for Digital Devices
ICES-003 Issue 4 February 2004

C. Electrical system safety standards:

CAN/CSA C22.2 No 60950
UL60950-1
IEC60950-1 2nd ED (205-12)

D. Cybersecurity standards:

UL2900-1 or equivalent EU standard

1.03 OPERATING AND MAINTENANCE INSTRUCTIONS FOR EQUIPMENT

A description of the proper operation and maintenance of all devices and systems equipped with the battery management system (BMS) should be provided. In addition, detailed, meaningful and up-to-date user manuals for the system must be available and must be included with the system documentation.

1.04 QUALITY ASSURANCE

A. The provider's executive technicians must be factory certified and trained in the assembly, installation and maintenance of these devices.

B. A general warranty of 24 months from delivery applies to all components of the battery management system (BMS).

1.05 SPARE PARTS

A. Include with the documentation a price list for spare parts as well as a concept for delivery and replacement of defective parts of the documentation.

B. Also provide a list of recommended components for an active parts inventory.

1.06 TRAINING

A. The provider must be factory trained and certified or be able to appoint trained personnel who can demonstrate the necessary general technical expertise required for user training for the purchased battery management system (BMS). The training must be carried out immediately after successful installation of the system and is the responsibility of the provider. The training must cover the following topics:

1. Regular operation
2. Fault diagnosis
3. General trend determination for batteries
4. Interpretation of an alarm status
5. Retrieval of data and log files
6. Interpretation of battery data and log files
7. Using data to troubleshoot hidden battery problems

B. The provider must provide appropriate training materials for the operation and maintenance of the system. The training must be conducted in appropriate facilities at the owner's facility or at a location designated by the owner and suitable for the training.

Part 2 – PRODUCT FEATURES

2.01 BATTERY MANAGEMENT SYSTEM MEASUREMENT CAPABILITIES

A. As a core function, the system must be able to measure or otherwise record and provide the following data points through direct measurement for all battery types. For example, if direct measurement is not possible, the system must alternatively determine the necessary data independently through calculation can:

1) Individual voltage values for all battery types in each phase (trickle charge, discharge within the manufacturer's measurement specifications)

2) Total voltages for all battery types within battery strings.

3) Determination of the ohmic resistance of all battery types, regardless of battery chemistry, for optimal evaluation of the respective battery condition between potential failure detection and direct failure with an acute need for action.

4) Recording and regulating the individual current values within battery strings during chargingand (optional with active balancing)unloading processes.

5) Individual temperature for all battery types (either in °C or °F)

6) Individual battery capacity per cell/block and display of the current values for balancing and string capacity.

7) Threshold values for alarm behavior should be able to be set individually for each measurement or each calculated value.

8) Differential currents, differential voltages, temperature errors, impedance changes or other exceeding/undershooting of limit values of all types should be detected when they occur and trigger an alarm for the user

9) Current sensors should display both the DC current and any AC currents in order to calculate the capacity and, in the case of AC currents, to detect any aging of rectifiers which can have an impact on the SOH.

B. Advanced connectivity options and uplink to assistance systems

In addition, numerous peripheral and assistance systems are often in use to ensure smooth operation and to intervene actively if necessary in order to counteract any emerging danger from the outset and automatically take over acute emergency measures.

The battery management system must not only be able to collect data, but also automatically inform assistance or building management systems and, if necessary, autonomously record and evaluate the status of peripheral systems (e.g. UPS systems, chargers, environmental measurements, etc.) and carry out appropriate actions .

In parallel to the core function described under A, the monitoring and regulation of the charging currents of the batteries and the control of the respective charging states, the following expansion options are expected from this management system:

1) The management system should include UPS systems, charging systems (chargers),energy storage systems,Can monitor and regulate diesel and solar generators

2) An integral component must be a system for detection and automated counter-reaction in the event of a “thermal runaway” (risk of overheating/fire of cells).to ensure operatorless operation even in emergency situations (according to US Firecode/ International Fire Code 2018 1206.2.10.7).

3) Environmental control sensors for temperature and humidity, hydrogen sensors or level sensors should be supported, and climate control, building management systems, alarm systems and similar devices should be able to be actively supported and managed based on measurement results.

4) All connected systems should be individually programmableFor example, it can be linked via a matrix with AND/OR logic in order to be able to define alarms from several sub-alarms and thus to be able to individually set each alarm that the system offers and also to be able to define your own new alarms.

5) Digital input/output relays (switching contacts for building management systems) should be available and can be monitored.

6) The BMS should optionally be able to detect a ground fault or residual current in order to be able to constantly monitor operational safety on site. In the event of a fault, the operator must be warned that leakage currents may occur and the service personnel must find and correct the cause.

The goal is to establish a system that can actively control all installed assistance systems autonomously, as far as possible, without service personnel, and only interacts with a user when necessary.

2.02 BATTERY MANAGEMENT SYSTEM REQUIREMENTS

The direct requirements that the battery management system must be able to meet or exceed during operation are listed and explained below. Further features that are not listed can be understood as an additional argument.

A. The battery management system (BMS) must be able to maintain individual battery voltages within +/- 0.01 VDC of the target voltage set by the ECU.

B. The battery management system (BMS) must automatically adjust the individual voltage values during boost or equalizing/balancing charging modes to ensure that any deviations in the batteries in a string remain within the tolerance limit of 0.01 VDC.

C. The battery management system (BMS) must be capable of managing a total of at least 512 batteries configured in up to 16 parallel strings. The range of functions for administration includes, among other things, voltage compensation, voltage measurement, impedance and temperature measurement values for each individual battery as well as qualified current measurement per string.

D. The battery management system (BMS) must be able to meet the following system requirements and optional additional functions:

   1) Individual measuring points for voltage, ohmic values and temperatures.

2) Current sensors for the individual battery strings with display of the battery capacity
3) Display of the target voltage for trickle charging and % display of the balancing power per cell/block
4) If necessary, the BMS must be able to be upgraded using optionally available accessories such as current sensors so that data for individual battery capacity measurement and display of the measurement results is possible for each cell/block.

E. After commissioning, the battery management system (BMS) must autonomously provide all collected measurement data in a prepared form. The battery management system (BMS) must be able to carry out measurements on non-local auxiliary and replacement batteries for electrical switchgear or generator starting batteries and replacement batteries for substations and to display the results clearly.

1) Via a web interface (encrypted, IP V4 and IP V6)

All measurement data and alarm states must be displayed intuitively and clearly and communicated to a user in order to be able to make the best possible decision on how to proceed in an emergency on site. Each battery or battery string within the managed system must be clearly identifiable for the end user and clearly displayed on a graphical interface. The end user must be able to add their own descriptions for each battery cell or block, which are retained even after a firmware update.

2) Via another network protocol (TCP/IP)

The system must provide the measured values collected via standard communication systems upon request through further management systems. The minimum requirements include RSyslog, SNMP, MODBUS and BACnet to ensure transparent and flexible integration into modern building and monitoring systems.

F. The present battery management system (BMS) must at least be able to fulfill or exceed the following range of functions:

1) Measuring tolerance below 0.5% at full capacity

With any number of batteries (maximum 512), the measurement tolerance between min. 1.2 VDC and max. 16 VDC must generally be less than 0.5%.

2) Early detection of thermal runaway and alarm behavior in accordance with International Fire Code 2018 1206.2.10.7

As a core feature that allows early detection of the conditions that may favor a battery's thermal runaway, individual temperature measurement for wet cells and VRLA batteries must be in the range of -35 ° C to 85 ° C (-31 ° F to 185°F) may be possible. In order to increase the accuracy in the early detection of thermal problems, it must also be possible, if necessary, to measure and compare the current consumption of individual battery strings using additional current sensors.

According to the International Fire Code, the possibility should be given to initiate automated countermeasures. The battery management system should therefore have autonomous contact options that can trigger installed emergency circuits if necessary.

3) Error detection of common problems with wet cells and VLRA batteries via resistance measurement

Ohmic resistance values must be used to diagnose common problems with wet cells or VRLA batteries, such as: B. faulty cells and housing parts, corrosion or poor connections can be determined. The measurement tolerance must be less than 10% if it is ensured that all voltages are 100% identical.

4) Additional sensors for current measurement -2000Amps / +2000 Amps

   Sensors for measuring current within a string from - 2000Amps to +2000Amps. For both direct current (DC) and alternating current (AC)

5) Operational safety requirement: Electrical insulation

   Any electrical measuring device that collects data about batteries is electrically isolated from other electrical measuring devices and the central control system

6) The alarm behavior must support the following components, both locally and network-based:

   i. Potential-free contact connections for alarm wires and switch contacts
   ii. Automatable and regular data transmission of measured values and operating states using standardized email services (email and email traps)
   iii. HTTP/HTTPS
   iv. SMS
   v. SNMP trap messages

7) Third party integration:

   i. Compatible with the most important manufacturers on the market
   The system must be able to transfer the measured values collected from the monitored batteries and battery-related UPS solutions from different manufacturers to any manufacturer of monitoring systems based on a TCP/IP standardized SNMP/Modbus/BACnet data structure: The special requirements also include the flexible adaptability to generators, Solar and AC chargers as well as power distribution units and other power supply devices accessible in the network. The integration must be flexible, intuitive and based on internationally recognized standards.

   ii. In addition to Modbus TCP, a Modbus RS232 or RS485 platform must also be available as a series standard.

   iii. A simple connection to the “Remote Console Command (RCCMD)” software tool is desirable in order to automatically stop a variable number of UPS and battery-related assistance systems in a heterogeneous IT landscape if necessary.

   iv. For automated analysis functions via Syslog Reveiver, the system must have a standardized remote syslog interface on remote syslog (Remote Syslog).

   v. Optional: LonWorks, Profibus or other bus systems should above optionalAdapters are available.

G. The battery management system (BMS) and all components must be designed for operating environments from 0°C to +60°C.

H. The battery management system (BMS) must not be custom-made, but must consist of commercially available standard componentswhich are available worldwide.The manufacturer must be able to provide reliable evidence that

- his system is used and installed regularly.
- it has been used successfully several times in the last 24 months,
- technical support is available
- the supply of spare partshe at least 10 yearsis guaranteed
- allComponents developed in-house (in particular the central controller of the system connected to the network), testedand manufactures
- his system is not an individually compiled module solution from different manufacturers that is sold under one label.

2.03 ELECTRICAL REQUIREMENTS

A. Installation, connection, materials and coding must be standardized and conform to the requirements of the International Electrotechnical Commission, the National Electrical Code, OSHA and applicable local codes and standards.

B. Any component connected to the system that requires power greater than 12V must include appropriate UL or CE approval, depending on the location of the offering.

C. The battery management system (BMS) must be designed and manufactured to ensure operational reliability during over- and under-voltage transients of any duration, as well as over-current conditions that may be caused by a primary 110V/240V AC power source.

D. The low voltage components of the battery management system (BMS) connected to the battery may only draw current from the battery being measured during the ohmic resistance test.

E. The battery management system (BMS) must be able to run without further customer-specific cable installation. All cabling required to operate the system must be carried out during installation.

F. The system must not emit radio, Bluetooth or WLAN emissions to avoid interference with other devices.

G. The system must be easy to install and maintain. The connectors and cables should be serviceable by trained battery service technicians. The batteries must be accessible in such a way that maintenance work such as refilling fluids and replacing individual batteries can be carried out quickly and easily.

H. The uplink to data networks must be carried out using commercially available network cables and standard technologies that are easy to obtain or repair and/or replace.

2.04 SAFETY

A. All components of the battery management system (BMS) are interconnected to ensure that no device connected to a battery is energized in any operating mode at any time.

B. To reduce the risk of confusion with live cables, all cables leading to or from the battery must be clearly marked, either marked with cable markers or with color-coded cables.

C. To avoid the risk of damage caused by improper installation or defective batteries, all measuring circuits connected to the battery must be protected by high-resistance circuits or appropriate fuse concepts. At least one fuse per measuring cablel / or measuring moduleis absolutely necessary with 4 poles. Impedance measurement of at least 2 fuses.

D. For the operational safety of the battery management system (BMS), only measuring cables supplied by the original manufacturer may be used during installationl / measuring modules be used with calibrated fuses.

E. The system components used, such as cables, housings and displays that are directly connected to the battery or are part of the human interface, must neither be flammable nor reach a temperature that, if touched, poses a danger to direct users, maintenance technicians or service personnel.

F. All materials used must be both flame retardant and halogen-free.