Sandia National Laboratories

Battery Management System Standards

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Updated Working Scope / Purpose

Scope:

This recommended practice includes information on the design, configuration, and interoperability of battery management systems in stationary applications. This document considers the battery management system to be a functionally distinct component of a battery energy storage system that that includes active functions necessary to protect the battery from modes of operation that could impact its safety or longevity.

This document covers battery management technologies, configuration by application and battery type, and interoperability with other systems. Technologies include battery management peripheral devices and subsystems, balancing methods, sensor types and placement, physical and software architectures, and battery management functions. Configuration includes both grid-supporting and non-grid-supporting applications and specific recommendations for the following battery types: lithium-ion, flow, sodium-beta, and alkaline. General recommendations applicable to other battery types are provided. Interoperability recommendations include guidance such as minimum measurement accuracy and state-of-charge reporting standards, communications including information models, and cybersecurity including access control and software update management best practices.

Transportable energy storage systems that are stationary during operation are included in this standard. This document does not cover battery management systems for mobile applications such as electric vehicles; nor does it include operation in vehicle-to-grid applications. Energy storage management systems (ESMS), which control the dispatch of power and energy to and from the grid, are not covered. Refer to IEEE 1491 for battery monitoring systems, which do not enforce interrupt constraints on battery operation

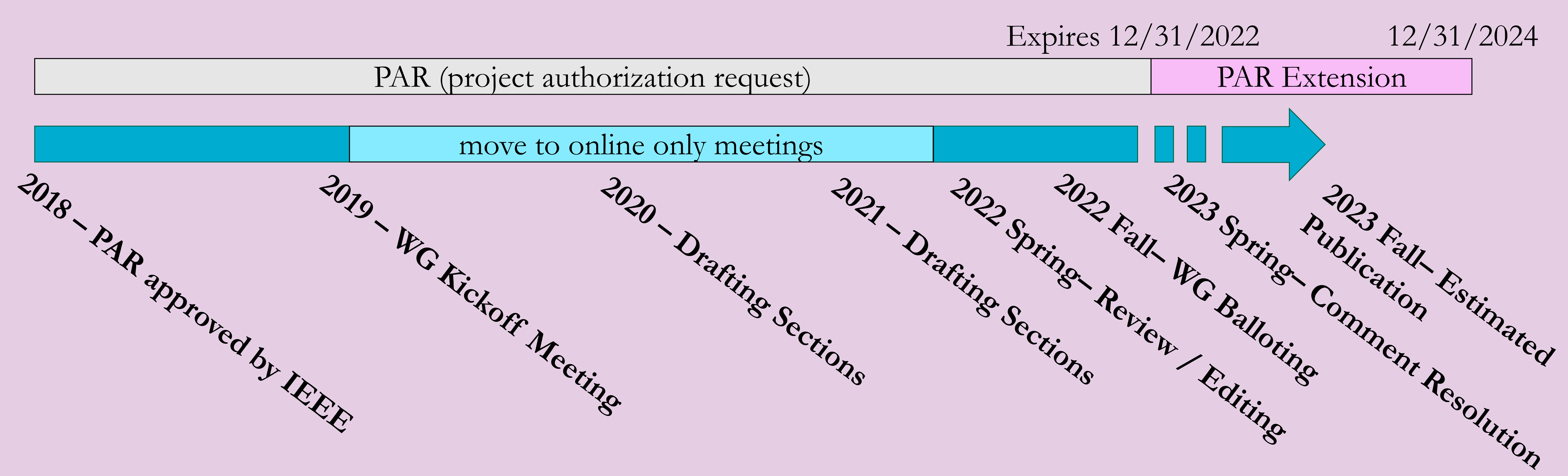
Purpose

Well-designed battery management is critical for the safety and longevity of batteries in stationary applications. This document aims to establish best practices in the design, configuration, and integration of battery management systems used in energy storage applications.

IEEE P2686 Recommended Practice for Battery Management Systems in Stationary Energy Storage Applications

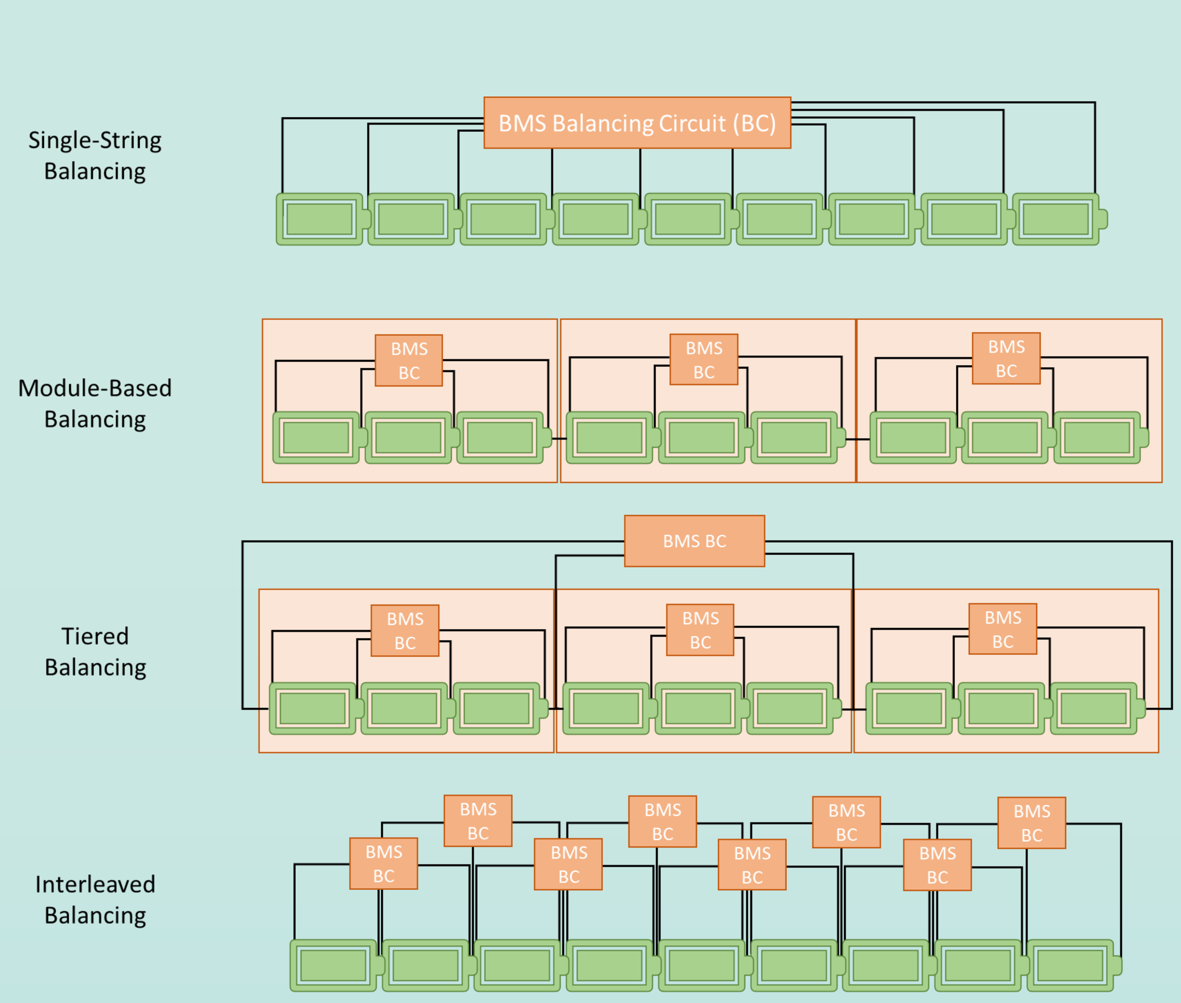
The IEEE P2686 working group has spent FY22 reviewing and editing every section. The draft went through its first circulation in July and it received 100+ editorial and technical comments. This is a multi-year consensus-based effort to develop a new standard for battery management systems and will substantially impact how battery systems are designed and built in the coming decades.

P2686 Development Timeline



New Content Highlight (Balancing circuits)

The balancing circuit's architecture should match the physical architecture of the battery. A balancing circuit design should minimize both the number and length of current carrying wires.



Example Balancing Circuit (BC) Architectures

New Content Highlight (Recommended Configuration by battery type)

Lithium ion battery systems should implement the following battery management functions:

Voltage management

- Functions: over voltage, under voltage, voltage imbalance
- Operational constraints: maximum cell voltage, minimum cell voltage
- Warning thresholds: high cell voltage warning, low cell voltage warning, cell voltage imbalance warning
- Interrupt constraints: trip max cell voltage, trip min cell voltage
- Notes: This is safety function. It should be implemented on each cell in the system.

Current management

- Functions: excessive discharge current and excessive charge current
- Operational constraints: max discharge current, max charge current
- Warning thresholds: high discharge current warning, high charge current warning
- Interrupt constraints: trip max discharge current, trip max charge current
- Notes: This is safety function. It should be implemented on each string system. Parameters can be adjusted based on temperature and SOC. This function is in addition to short-circuit overcurrent protection that should be implemented in each module with an appropriately sized circuit breaker or fuse.

Charge management

- Functions: Overcharge, Overdischarge, and unbalanced charge
- Operational constraints: max SOC, min SOC
- Warning thresholds: high SOC warning, low SOC warning
- Interrupt constraints: trip max soc, trip min soc
- Notes: This is a safety and longevity function. The BMS supervises the ESMS to provide redundant overcharge protection. Cell charge balancing is an important BMS function for most lithium-based chemistries.

Temperature management

- Functions: Overtemperature and undertemperature
- Operational constraints: max temperature, min temperature
- Warning thresholds: high temperature warning, low temperature warning
- Interrupt constraints: trip max temperature, trip min temperature
- Notes: This is a longevity function. The battery system should be designed to be robust to failures of the thermal control system, such that the thermal control system is not essential to the safety of the overall system.

New Content Highlight (BMS Cybersecurity)

The goals of cybersecurity are to protect the confidentiality, integrity, availability, and non-repudiation of information. Confidentiality refers to information only being known by those people and systems who are authorized. Integrity refers to the authenticity of information and its source. Availability is the ability of the intended recipients to make use of the information. Lastly, non-repudiation is the ability to accept information when the communication is authorized or legitimate. IEEE 1547.3-202X provides detailed recommendations for cybersecurity of DER. IEEE 1547.3-202X emphasizes the importance of implementing cybersecurity within and across organizations and networks. Network cybersecurity is normally implemented via a gateway that also converts from the Modbus communication within the BESS to the SCADA protocol implemented by the local utility (often DNP 3). Such gateways are beyond the scope of this document. The role of the BMS in cybersecurity is to have specific features that enable cybersecurity at the network and organizational levels. This subclause provides recommendations for BMS features that support this purpose.

If you have knowledge of BMS design and would like to participate in the development of a new IEEE recommended practice, then please contact the working group chair, David Rosewater dmrose@sandia.gov, and join us for the next digital working group meeting.

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