A Distributed Smart Battery Management System – sBMS, for Stationary Energy Storage Applications

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Abstract — Currently, electric energy storage systems for stationary applications have known an increasing interest, namely with the integration of local renewable energy power sources into energy communities. Li-ion batteries are considered the leading electric storage devices to achieve this integration, and Battery Management Systems (BMS) are decisive for their control and optimum performance. In this work, the advancement of a smart BMS (sBMS) prototype with a modular distributed topology is described. The system, still under development, has a distributed architecture, with modular characteristics, to operate with different battery pack topologies and charge capacities, integrating adaptive algorithms for functional state real time monitoring and management of multicellular Li-ion batteries, and is intended for application in the context of a local energy community fed by renewable energy sources. This sBMS system includes different developed hardware units:

- Cell monitoring units (CMU's), for interfacing with each individual cell or module monitoring within the battery pack;
- Battery monitoring and switching unit (BMU), for global battery pack monitoring, thermal control and functional operating state switching;
- Main management and local control unit (MCU), for local sBMS's management and control, serving also as communications gateway to external systems and devices.

This architecture is fully expandable to battery packs with large number of cells, or modules, interconnected in series, as the several units have local data acquisition and processing capabilities, communicating over a standard CAN bus, and will be able to operate almost autonomously. The CMU units are intended to be used with Li-ion cells, but can be used with other cell chemistries, with output voltages within the 2.5 to 5 V range. The different unit's characteristics and specifications are described, including the different implemented hardware solutions. The developed hardware supports both passive and active methods for charge equalization, considered fundamental functionalities for optimizing the performance and the useful lifetime of a Li-ion battery package. The functional characteristics of the different units of this sBMS system, including different process variables data acquisition using a flexible set of sensors, can support the development of custom algorithms for estimating the parameters defining the functional states of the battery pack (State-of-Charge, State-of-Health, etc.) as well as different charge equalizing strategies and algorithms. This sBMS system is intended to interface with other systems and devices using standard communication protocols, like those used by the Internet of Things. In the future, this sBMS architecture can evolve to a fully decentralized topology, with all the units using Wi-Fi protocols and integrating a mesh network, making unnecessary the MCU unit. The status of the work in progress is reported, leading to conclusions on the system already executed, considering the implemented hardware solution, not only as fully functional advanced and configurable battery management system but also as a platform for developing custom algorithms and optimizing strategies to achieve better performance of electric energy stationary storage devices.

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