

Battery Management Systems

BMS & Modules: Testing – Balancing – Simulation

Overview

The rapid growth of the Hybrid-Electric Vehicle (HEV) and Electric Vehicle (EV) industry presents many new opportunities and unknowns for product testing. One of the major components of the vehicle's power train is the Battery Management System (BMS) and its accompanying modules. The system as a whole controls the performance of the energy storage system (ESS) and has general functionality such as voltage and current monitoring, cell balancing, determining state of charge, and ensuring overall pack safety.

The architecture of standard HEV and EV energy storage systems consists of a BMS board and a series of modules (Figure 1). A module contains a module board and a cell stack, which typically consists of series and/or parallel connected lithium-ion (Li-ion) cells. The module board performs all of the cell and temperature monitoring for its specific cell stack while communicating status back to the BMS via a CAN interface. Combining the modules creates a battery pack that can deliver over 600V at 500A. The BMS is responsible for system level monitoring such as pack current and voltage levels, system safety, and managing all of the modules to achieve optimal ESS output and performance.

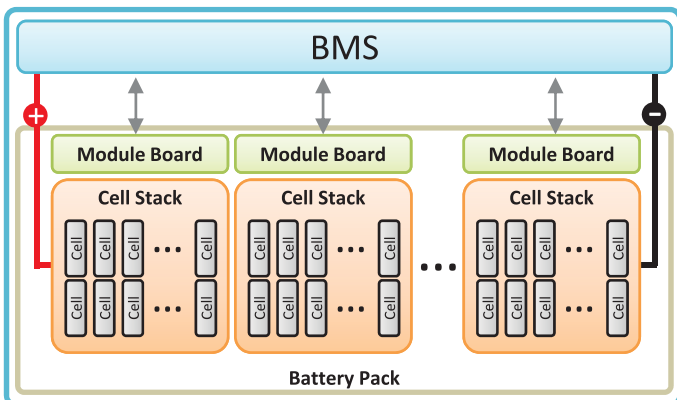


Figure 1: Energy Storage System Architecture



System Requirements

Bloomy Controls has developed a modular, mixed-signal, high-performance test system specifically for testing battery management systems and modules for HEV and EV companies. An automotive battery management system has strict test requirements; it must work in real-time, under rapid charge and discharge conditions, and communicate status to other systems within the vehicle. Some of the major BMS and module functions that need to be tested are:

- Overall battery pack monitoring
- Individual cell monitoring
- Over voltage and under voltage protection
- Cell balancing
- Inrush current switching
- Non-volatile memory storage
- Temperature monitoring
- System communications (CAN, Serial, etc.)
- Safety interlocks / fault condition recognition



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System Hardware

The BMS & Module test system builds on the Bloomy Controls Universal Test System platform; it incorporates National Instruments' PXI data acquisition and modular instrumentation, programmable power supplies for providing high power battery pack simulation, and a mass interconnect. The mass interconnect provides an interface to the instrumentation so multiple types of BMS and module boards can be tested without duplicating the core instrumentation, in turn reducing overall test system development time and costs. Standard instrumentation hardware includes:

- PXI chassis and embedded controller
- Triple-output power supplies connected in series (up to 10 in series for cell simulation)
- 7½-digit DMM: +/-10nV to 1000V, and current readings with a 1pA sensitivity
- 64-channel multiplexer
- High speed Analog and Digital I/O
- Dual port high speed CAN interface
- High Voltage Programmable power supplies

When testing battery management system boards, there are several critical functions that need to be verified. These functions include total pack voltage and current monitoring circuits, temperature monitoring and control, interlock and safety control. The BMS Test System also includes a dual isolated 40V programmable power supply for providing system voltages and an isolated high voltage programmable supply capable of up to 600VDC used to simulate total pack voltage. In addition, analog voltage outputs are used to simulate current shunts and other transducers. The system can simulate fault conditions to trip safety mechanisms and cause the UUT to switch interlock relays. High speed measurements can be taken to monitor PWM signals, timing signals, and verify the response times of safety circuitry.



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Li-Ion Cell Simulation

The BMS Test System utilizes series-connected strings of the National Instruments' PXI-4110 programmable DC power supply to simulate packs of cells for module board testing. The low ripple, fast response, and high resolution make the supply ideal for this application. The isolated +/- 20V legs of the supply are strung together to form a pack. Up to ten supplies may be connected together to form packs of up to 20 cells which can output up to 4.2V at 1A per cell. During balancing tests, the 16-bit read back resolution of the supplies allows the currents at each cell to be measured using the supply without the need for external sensors.

System Software

The BMS Test System is accompanied by a fully developed application built on the National Instruments TestStand and LabVIEW platforms. There are two main modes of operation, manufacturing and engineering. Standard operation requires minimal operator interaction; the test starts by opening the safety lid of the fixture, scanning the UUT barcode serial number, and then closing the fixture. When testing is completed, the test result is shown, test data is logged to file, and any failed tests are highlighted for the technician. The engineering mode provides access to all system functionality allowing engineers to use the system in an R&D environment. This feature allows the engineers to manually read all system voltages and currents, control all power supplies, actuate relays, and communicate with the UUT.

If the specifications outlined do not fit your needs, a custom configuration can be developed.

Please contact Bloomy Controls to discuss your BMS and Module test needs.

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