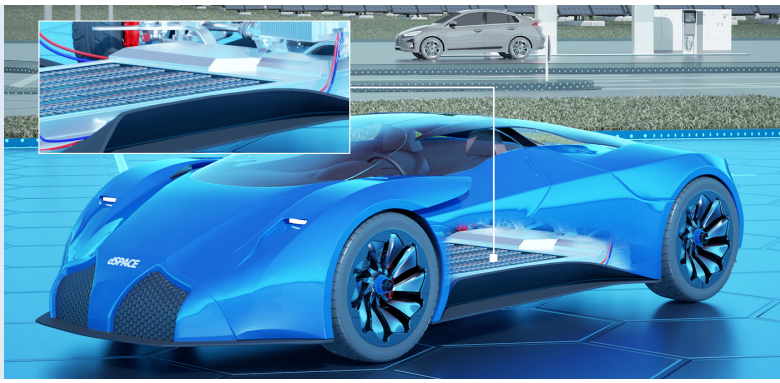
Battery Management Systems

Hardware-in-the-loop testing with dSPACE solutions

Highlights

- High degree of customization
- Seamless workflow with Simulink®
- Real-time-capable multicell battery model
- Safety concept to protect users and equipment against high voltages



Application Areas

Each battery-electric vehicle needs a battery management system (BMS) to ensure safe operation of the battery. This BMS must handle various tasks, including voltage and temperature measurement, overall current measurement, thermal management as well as the balancing of the level of charging for the individual cells. dSPACE provides preconfigured BMS test systems so you can validate the functionality of state-of-the-art battery management systems. With a system voltage of up to 1,000 V, our key solutions can be tailored to any number of battery cells, temperature sensors, and high-voltage probes.

Key Benefits

- Compact test system design
- Large safety compartment for the device under test (DUT)
- High voltage accuracy thanks to the high-precision EV1077 Battery Cell Voltage Emulation Board
- Support of multiple high-voltage probes
- Option for current sensor stimulation with real currents of several hundred amperes
- Flexible temperature sensor simulation via isolated voltages
- Isolation monitoring for each high-voltage circuit
- Safety logic controller for supervision of the entire system
- Full automation via dSPACE AutomationDesk or a third-party tool

dSPACE Solutions for BMS Testing

For BMS testing on a high-voltage level, we provide preconfigured test systems that can be used to test the complete BMS with all its measurement and balancing devices, precharge circuits, and isolation failure monitors. The dSPACE test systems emulate all inputs of the BMS. This includes all battery cells and their voltages, the battery current as well as all signals coming from the various high-voltage sensors in the vehicle, e.g., the sensors at the inverter, the battery, or the charging point. Each BMS test system is equipped with several high-precision battery cell voltage emulation boards, which make it possible to simulate high-voltage batteries at the cell level. To ensure safe operation, the test systems have an integrated safety compartment to protect the test engineers and the equipment against high voltages. Thanks to their modular design, our test systems are highly scalable and can be easily adapted to individual project requirements.
On the software side, the dSPACE model library ASM Electric Components offers open, ready-to-use multicell battery models as well as an interface for connecting batteries in parallel.

Typical BMS test system from dSPACE.

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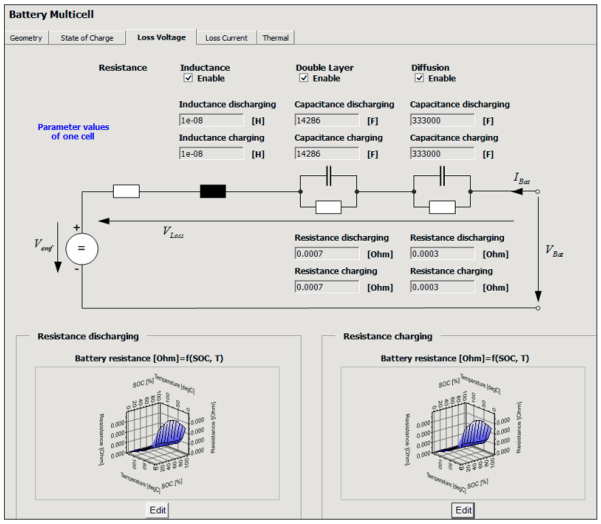
Modeling the Battery

In the Automotive Simulation Models (ASM) tool suite, dSPACE provides a multicell battery model with easy parameterization and highly efficient calculation behavior. All Simulink® blocks are visible in the model, making it easy to add components or replace them with custom models to precisely adjust the properties of the modeled components to individual requirements. Our parameterization tool ModelDesk allows for easy access to all parameters.

To simulate high-voltage batteries consisting of multiple battery cells, ASM interconnects single cells of identical design to provide a calculation-efficient determination method for each cell state. Therefore, this approach is perfectly suited for developing and testing battery management systems (BMS).



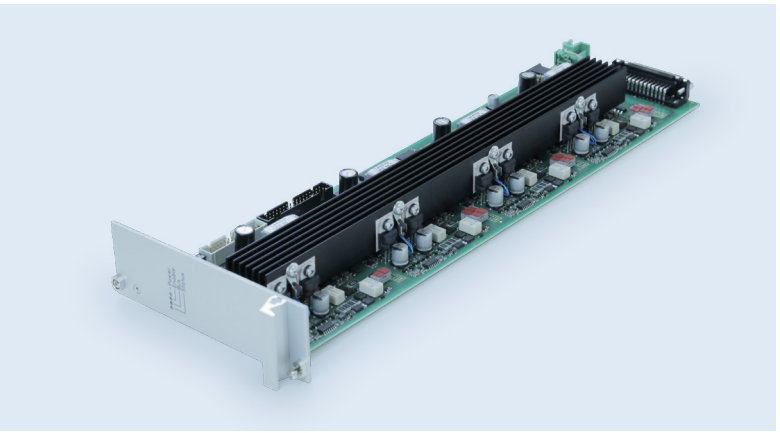
Graphical parameterization of the battery model in dSPACE ModelDesk.

Key Features of the ASM Multicell Battery Model

- Real-time-capable simulation of multiple battery cells
- Supports lead-acid (Pb), nickel-cadmium (NiCd), nickel-metal hydride (NiMH), and lithium-ion (Li-ion) batteries
- Terminal voltage, state of charge, and temperature calculation
- Multiple batteries can be connected in parallel
- Complexity of the model is independent of the number of cells
- Individual physical effects, such as internal resistance, diffusion, and double-layer capacity
- Supports charge, discharge, and leakage currents
- Online and offline simulation

EV1077 Battery Cell Voltage Emulation Board

The EV1077 Battery Cell Voltage Emulation Board is the core component of the dSPACE BMS test system. The board emulates a controllable, highly precise terminal voltage for single battery cells. Depending on the battery type and the test focus, several boards can be used in one HIL system.



Technical Details

Parameter	Specification
EV1077 External Power Supply	
Typical supply voltage	■ 24 V
Tolerance of nominal supply voltage	■ ±10%
Cell Output	
Output voltage	■ 0 … 6 V
Accuracy	■ ±1.0 mV
Accuracy[1)]	■ ±0.5 mV
Resolution	■ 115 µV
Maximum output current	■ 1 A[2)]
Output current feedback accuracy	■ 10 mA
Fault Simulation	
Broken wire between ECU and battery	✓
Short circuits between cells	✓
Isolation	
Maximum voltage between the cells of a module	■ 60 V
Maximum voltage between the cells and the environment	■ 1,000 V

1) *Under laboratory conditions for the EV1077-08.*
2) *Increase to 2 A possible via dSPACE Engineering Services.*

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