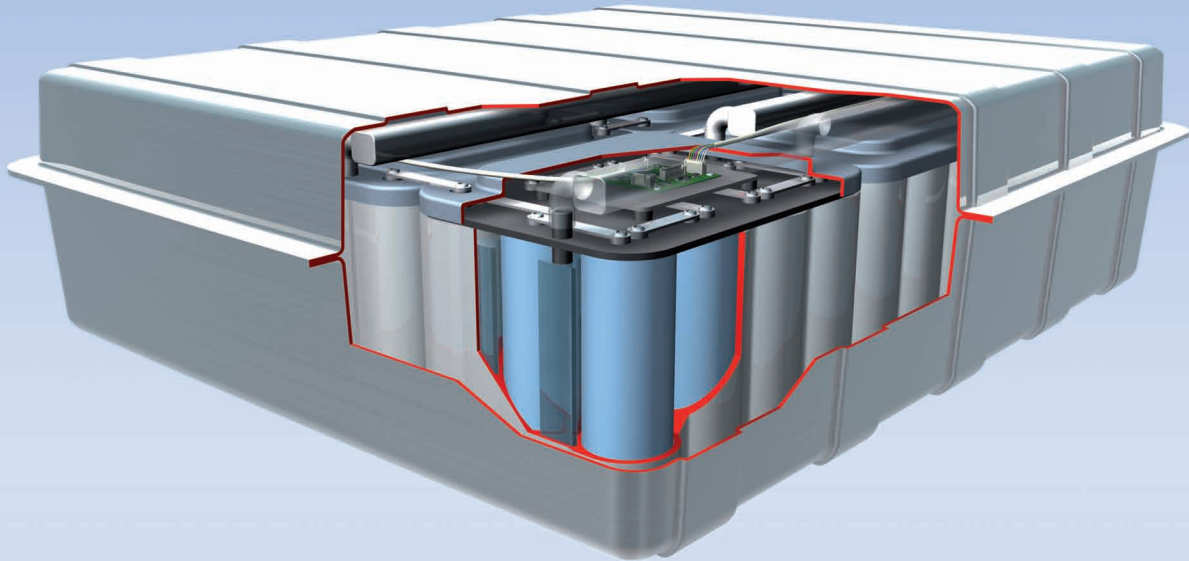


# Battery Management System For Lithium-Ion Cells



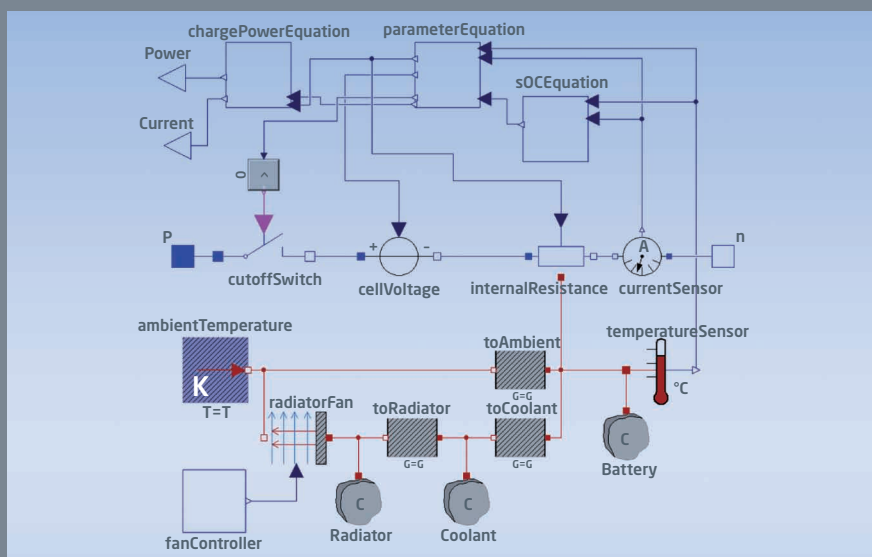
## Intelligent Battery Management for Lithium-Ion Cells

Tomorrow's hybrid and electric vehicles will be heavily equipped with lithium-ion batteries. These batteries promise high storage density. Yet to exploit their potential and ensure long-term operation at a high level of performance, they demand an intelligent and complex system of management. A further challenge lies in integrating the battery in the powertrain and overall vehicle.

IAV's battery management system supports all relevant system requirements, for use in battery systems for prototypes and small-scale production.

## Main Functions:

- ▶ Cell state detection (SOC, SOH, SOF)
- ▶ Cell monitoring
- ▶ Prediction of power output
- ▶ Operating strategy
- ▶ Thermal management
- ▶ Cell balancing
- ▶ HV charge management

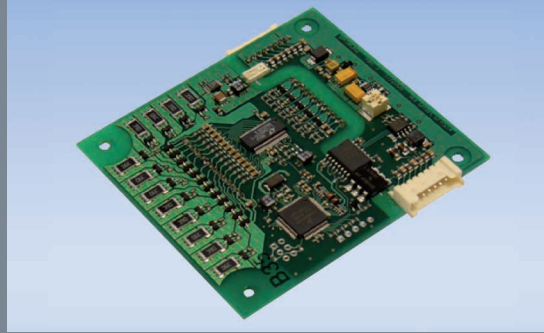


Battery system model

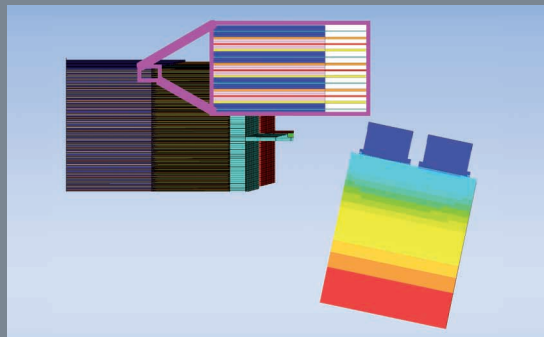




BMS control unit (master)



Cell measuring module (slave)



CFD and thermal simulation of battery cells



Cell tester - up to 640 A - and two climate chambers

### Functionalities of the BMS Control Unit (Master)

- ▶ Master-Slave-System
- ▶ Based on IAV's miniUCU® rapid-prototyping control unit (under development: dedicated battery control unit)
- ▶ Model-based software, permitting calibration for various cells
- ▶ Monitors cell voltages and cell temperatures
- ▶ Determines battery current
- ▶ Determines SOC and SOH
- ▶ Controls charge balance (cell balancing)
- ▶ Predicts present current and voltage limit (dynamic and long-term)
- ▶ Thermal management
- ▶ Determines SOC also for short stops (option in hybrid mode)
- ▶ Determines internal resistance (optional, AC component)
- ▶ Supervisory controller
- ▶ Pilot line, crash signal

### Functionalities of the Cell Measuring Module (Slave)

- ▶ Measurement of a maximum of 12 cell voltages, cumulative sampling rate over all channels: 70 Hz, accuracy:  $\pm 4$  mV (under development: 20 kHz,  $\pm 2$  mV)
- ▶ Sensing a maximum of 5 temperature measurement points
- ▶ Communication with BMS via isolated CAN
- ▶ Independent fault monitoring (overvoltage/undervoltage, overheating, communication with master)
- ▶ Disconnection of a cut-off line for emergency shutdown in the event of a fault (isolated PWM signal)
- ▶ Bypass for passive balancing (bypass current approx. 100 mA)
- ▶ Watchdog, ADC diagnosis