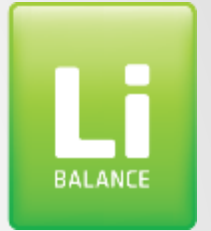




Sensata
Technologies

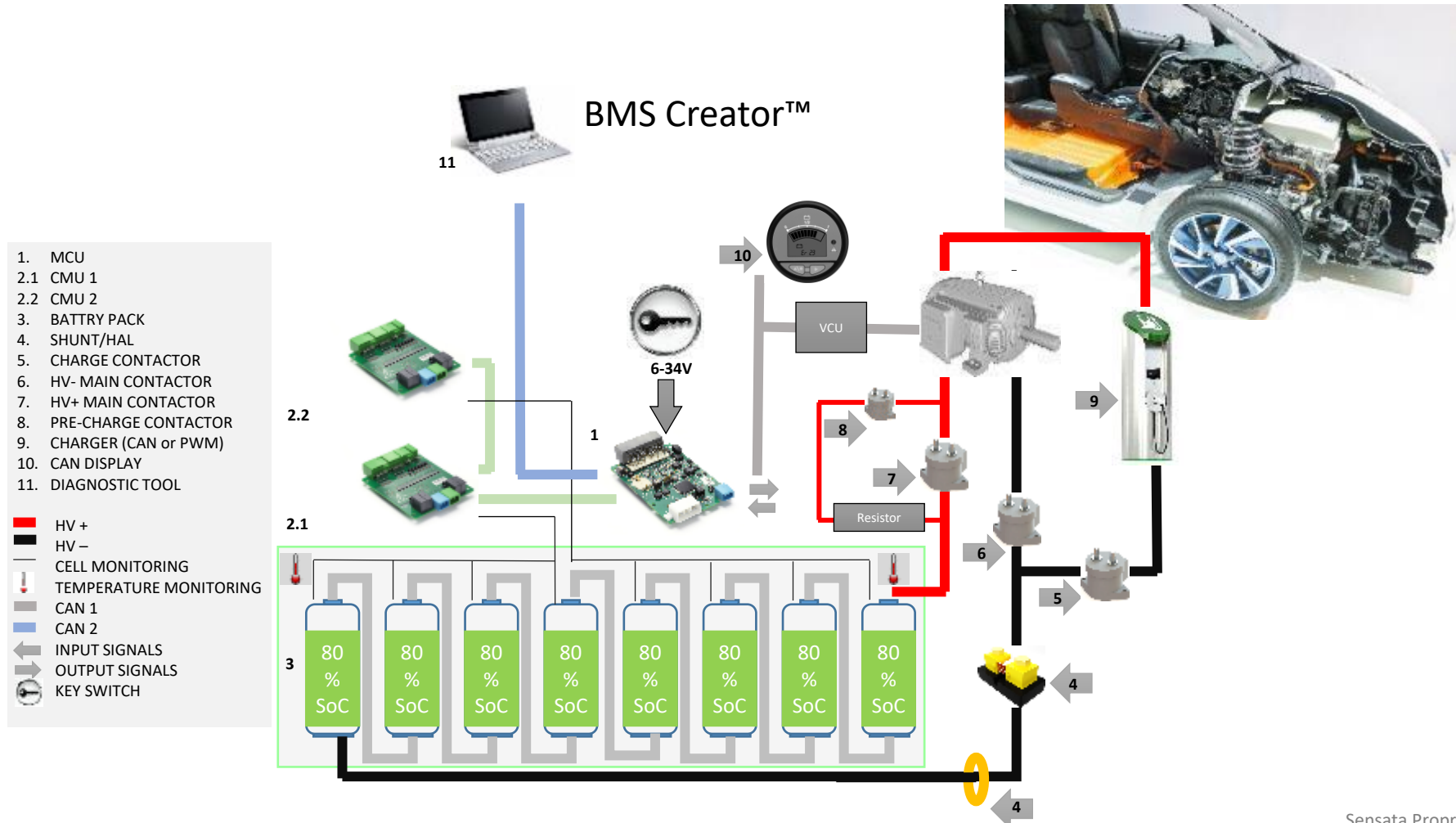
LiTHIUM BALANCE
BATTERY MANAGEMENT SYSTEMS



LiBAL n-BMS

High Voltage Battery Management System

System overview



System overview

Battery Management for up to 1000V

- 384 cells in series
 - Up to 32 Cell Monitoring Units (CMU)
 - 12 cells per CMU
- Multiple CMU options
 - CMU 100801 - 12 temp. sensors per CMU, 104 x 92 mm
 - CMU 100809 – 4 temp. sensors per CMU, 75 x 65 mm
 - CMU 100819 – 4 temp. sensors per CMU, 75 x 65 mm *)
- All cell voltages measured in 150 [ms]
- Current measured in 150 [ms]
- Pack temperature measured in 150 [ms]
- 1,5 [mV] maximum cell voltage error
- CMU error diagnostics on all inputs
- MCU dual core master controller
- MCU safe real time operating system
- MCU safe power supply
- MCU real time clock
- 16 General Purpose I/O on MCU
- 11 Temperature sensors on MCU

MCU – Master Control Unit



CMU
100801



CMU
100809



CMU 100819
*) isoSPI connector at side
Balancing current 75mA (@4.2V)

Safety

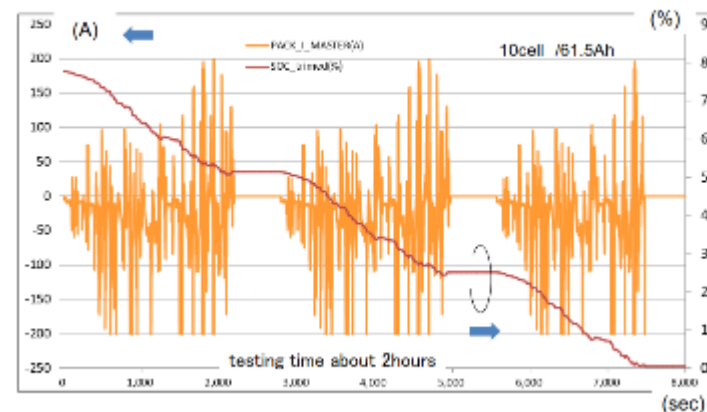
- Robust key components
- Real time operating system (RTOS) at ASIL D level
- All 4 safety critical functions has built in self-diagnostics meeting ASIL C level
- Open wire detection
- Built-in leak detection



Performance

- High speed main processor enables system to do advanced algorithms for high precision SOC.
- BMS tested by leading Japanese automotive Tier 1, where SOC accuracy in a vehicle drive cycle show an impressive $\pm 0,37\%$ deviation (see below)
- isoSPI internal communication protocol reduces CMU cost and provides efficient service when software needs to be updated in the field.

Evaluation of measured and calculated SOC w/Hall sensor



difference between measured SOC and calculated SOC(trimed) is 0.37%

Lifetime optimization

- Intelligent balancing and SOC algorithms enabled by high speed (150 ms) and accurate measurements ($\pm 1,5\text{mV}$).
- Synchronized measurement of current, temperature and voltage ensure a precise status of each individual cell.



MCU – Master Control Unit



n-BMS CREATOR™

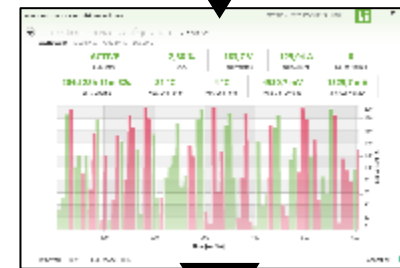
- PC configuration tool with comprehensive possibilities for customization
- Enables the battery designer to create a UNIQUE BMS based on "off the shelf" HW and SW platform
- Key Parameter configuration:
 - Error settings
 - Battery model
 - SOC model based on OCV
 - Current regulation
 - I/O controls
 - CAN communication incl. full CAN open support
 - CAN Custom processing machine
- Live view monitoring and Control
- Service



CONNECT



CONFIGURE



CONTROL



SERVICE

Specifications

Module specifications

Cells per CMU: 5 – 12 (min. 11 V)

Cell voltage: 0,5 V – 4,5 V (0V – 5V with reduced accuracy)

Cell voltage measurement accuracy: $\pm 1,5\text{mV}$ (full temp. range)

Cell voltage, Current and Temperature sampling frequency: 150 ms

Temperature sensors: up to 12 or 4 per CMU

Temperature measurement accuracy: $\pm 1^{\circ}\text{C}$

Communication: isoSPI

PCB Dimensions: MCU: 92mm x 166mm / CMU 92x118mm
(new CMU 75x80mm)

Balancing current: 200mA (at 4,2 V)

Specifications

System specifications

Supply Voltage: 6-34 (VDC)

Pack voltage: Up to 1000 (VDC)

Pack current: Up to 2000 (ADC)

Communication: 1 isolated CAN bus (CAN 2.0A, CAN 2.0B up to 1Mb/s) and 1 non-isolated CAN bus

Pack current measurement accuracy: $\pm 0.2\%$ maximum, with SHUNT sensor error: $\pm 0.5\%$ maximum (HOBUT CLASS 0.5) or HALL effect sensor error: $\pm 1\%$ maximum (LEM DHAB S/18) and @25°C

Pack temperature and current sampling rate: 150 ms

SOC, SOH calculations: Coulomb counting and OCV models

Temperature range: Operational -40°C to 85°C, Storage -40°C to 105°C

Test and validation

System tests

CISPR 25: EMC susceptibility 150 kHz – 2 GHz

ISO 11452: EMC susceptibility

ISO 10605: ESD for road vehicles

ISO 16750-2: Electrical Loads (Code A, Reversed, over voltage ect.)

ISO 16750-3: Mechanical Loads (Sinusoidal and random vibration)

ISO 16750-4: Climatic Loads (Code G: -40 to 85°C)

ISO 7637: Electrical disturbances from conduction and coupling