Flexible Battery Management System with Active Cell Balancing (FlexBMS)

- Preliminary -

Picture 1: Cell management controller (CMC) and module / battery management controller (MMC / BMC)

Description

The FlexBMS is a versatile battery management system (BMS) with active cell balancing. It is able to monitor and manage different combinations of battery cells. Each single battery cell has a miminum hardware module (cell management controller [CMC]) to measure cell voltage and temperature and communicate with the central management module (module management controller [MMC] or battery management controller [BMC]). Due to the isolated 2-wire communication, flexible serial or parallel combinations of battery modules are feasible. On-board temperature measurement at the battery terminals can replace external temperature sensor at the individual cells.

The active cell balancing in this BMS can transfer the energy between adjacent cells with currents up to 5 A. So all cells in the system can be completely charged and discharged. The efficiency of the balancing circuit ranges between 78-91 %.

The FlexBMS is comprised of 3 different electronic modules:

1. **CMC - Cell Management Controller:** This unit is mounted directly at the battery cell, measures cell voltage and cell temperature und communicates with others CMCs over a digital 2-wire bus. A third wire between the individual cells is needed for cell balancing. The design of CMC printed circuit board can be adapted to be mounted directly at the battery cell, so no extra wiring is required. Furthermore, the measurement of the cell temperature can be done directly on the printed circuit board at the battery terminals. Thus, costs for additional temperature sensors and installation effort for sensors can be saved. On this unit, an active cell balancing circuit is implemented, which uses balancing currents of around 5 A (mean, peak 10 A).

2. **MMC - Module Management Controller:** This unit collects the information from up to 16 CMCs and carries out a data preprocessing.

3. **BMC - Battery Management Controller:** This unit works as an upper layer, it collects data from the MMCs, communicates with the application (inverter, vehicle, etc.) and is required once per battery.

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Applications:
- Power Tools
- Electric Vehicles
- Uninterruptible Power Supply (UPS)

Features (preliminary):

CMC
- Up to 16 cells per module
- Power consumption:
    - idle / no load: ~70 µW
    - monitoring / load: ~1.7 mW
    - balancing enabled: ~40 mW
- Active cell balancing: 78 – 91 % efficiency (dependent upon load)
- Cellvoltage measurement resolution: 1 mV
- Temperature measurement resolution: 1 K ±2 K
- MCU: 32 Bit, 48 MHz

BMC
- Up to 250 modules in series or max. 2 kV system voltage
- MOSFET protection only up tp 150 V system voltage
- Protection: Overcurrent, over- / undervoltage & overtemperature
- Stackvoltage measurement resolution: 0.002 %
- Current measurement (example configuration):
    - discharge range: 0 – 170 A (continuous <120 A)
    - charge range: 0 – 60 A (continuous <60 A)
    - resolution: 8 mA ±200 mA
- Power consumption
    - idle / no load: 0 mW (switched off by CMCs)
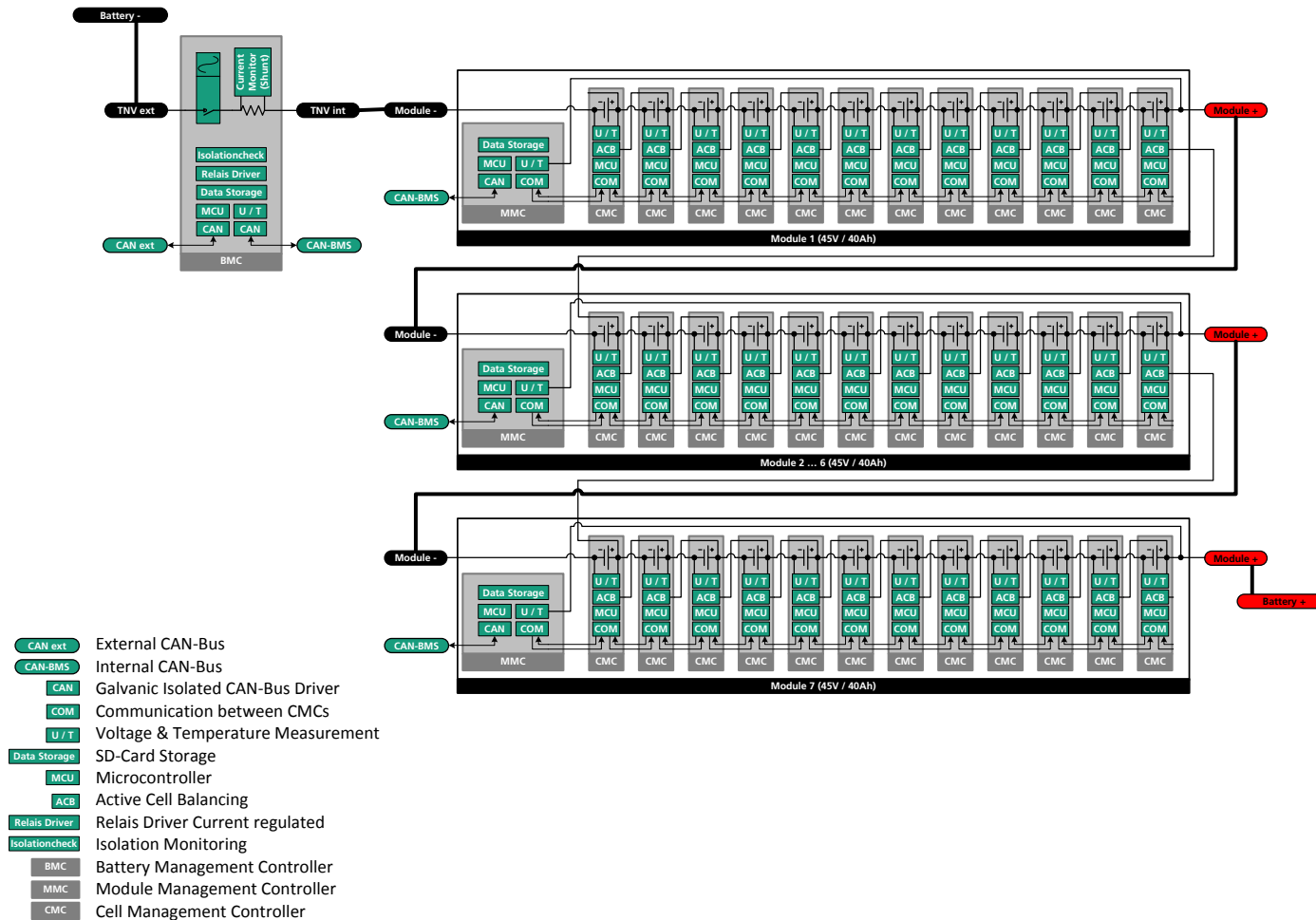   - monitoring / load: 300 mW
- MCU: 32 Bit, 168 MHz
- Interface: CAN

Block Diagram
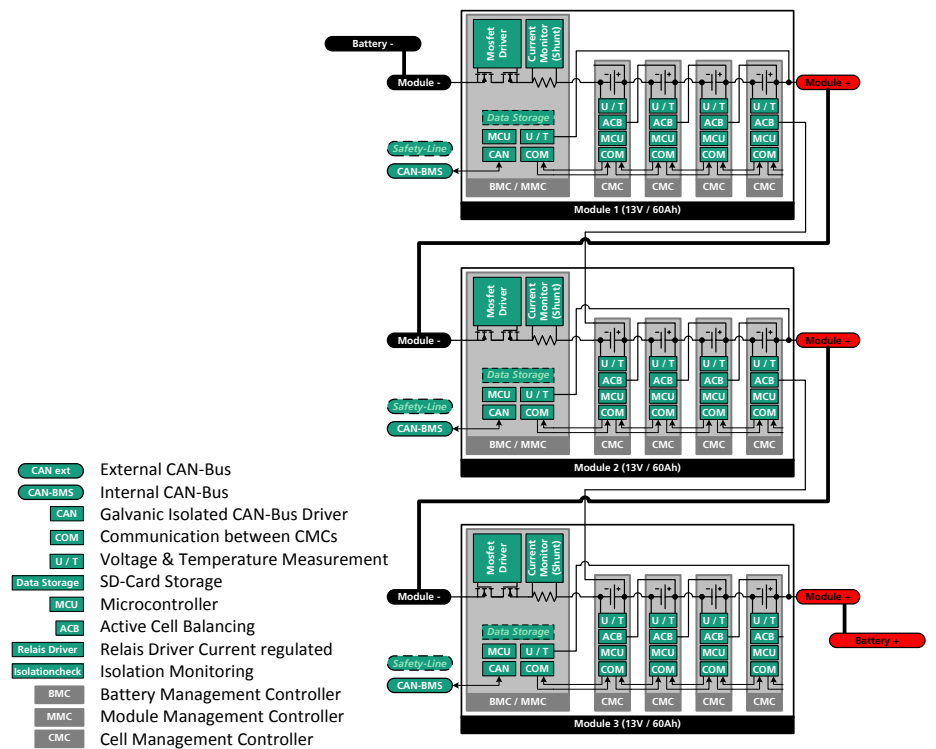
Picture 2: Serial connection of three 4-cell modules
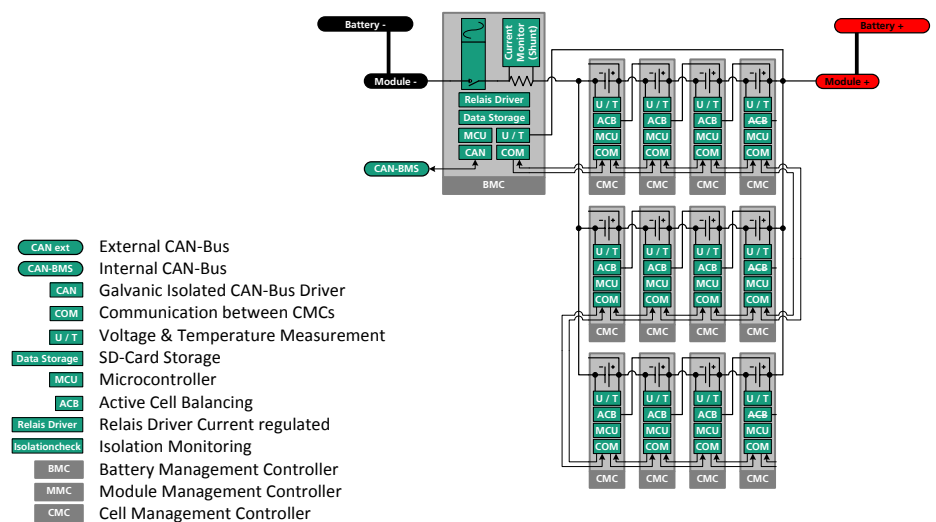
Picture 3: Parallel connection of three 4-cell modules

Picture 4: Series connection of three 12-cell modules

Legend:

CAN ext	External CAN-Bus
CAN-BMS	Internal CAN-Bus
CAN	Galvanic Isolated CAN-Bus Driver
COM	Communication between CMCs
U / T	Voltage & Temperature Measurement
Data Storage	SD-Card Storage
MCU	Microcontroller
ACB	Active Cell Balancing
Relais Driver	Relais Driver Current regulated
Isolationcheck	Isolation Monitoring
BMC	Battery Management Controller
MMC	Module Management Controller
CMC	Cell Management Controller