Li-Ion Cell-to-cell Active Balancing Battery Management System for 2nd Life Applications

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Overview

The institute of energy systems has developed an active balancing battery management system (BMS) prototype for up to 8 cells in series. It is capable of equalizing charge imbalances in 7SxP (Li-NMC, Li-NCA) or 8SxP ($LiFePO_4$) battery systems.
A versatile cell-to-cell topology has been implemented, based on a multi-winding transformer which is operated either in buck/boost-mode or flyback-mode (see [1]).

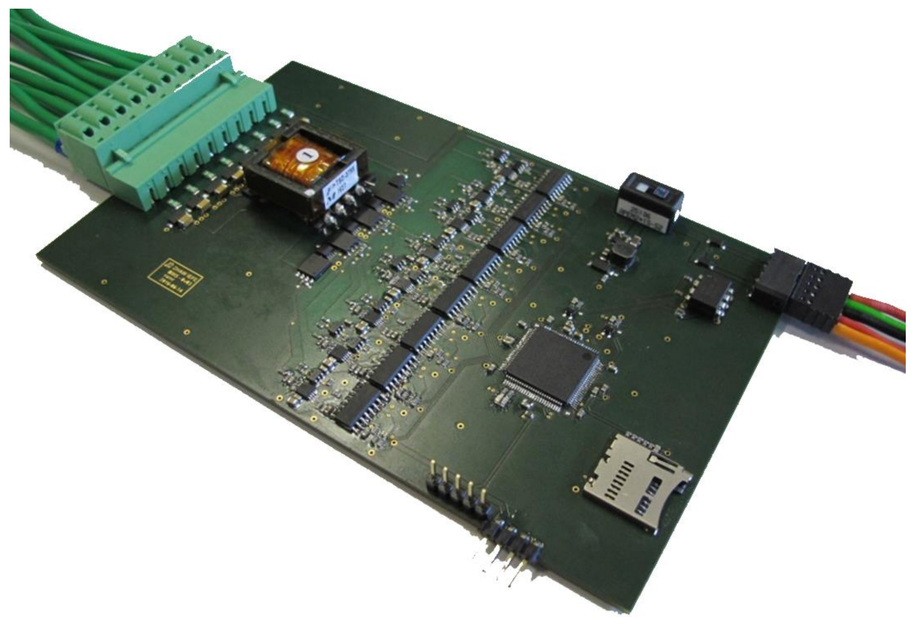

Figure 1: BMS Hardware prototype (PCB 150x90 mm)

Benefits of active balancing

- Increased battery capacity (5-20% depending on cells)
- Longer usable battery life
- Faster charging time
- Fewer balancing losses (~ 80% less)

Specifications

- 32 Bit ARM Cortex-M3 processor
- 16 Bit ADCs with I^2C
- Up to 4 A balancing current
- Live-Monitoring / Communication over RS232
- SD-Card data logging
- Solid-State-Relay (SSR) interface
- Protected inputs (Short circuit and overvoltage)

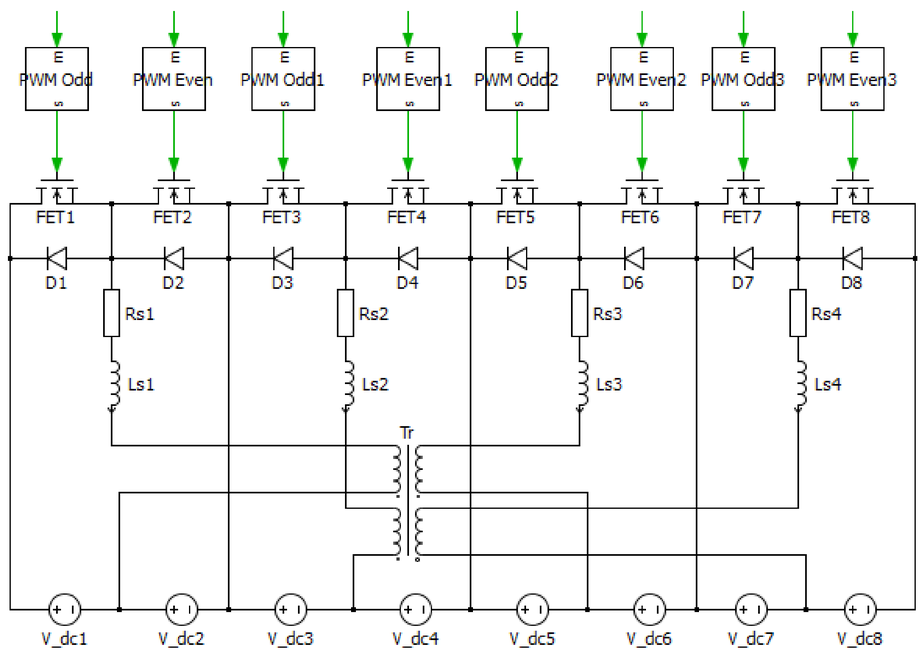

Figure 2: PLECS® simulation model and main circuit overview (8 MOSFETs with antiparallel diodes, V_dc: Battery cells, Tr: Multi-winding transformer, Rs and Ls: Parasitic transformer impedances)

Results

- 12% increase of battery capacity in test system (see Figure 3)
- Charge transfer efficiency of 86-89% (Buck/Boost) and 86-89% (Fly-back) (see Figure 4)
- Charge transfer efficacy of >95% (Buck/Boost) and >87% (Fly-back)

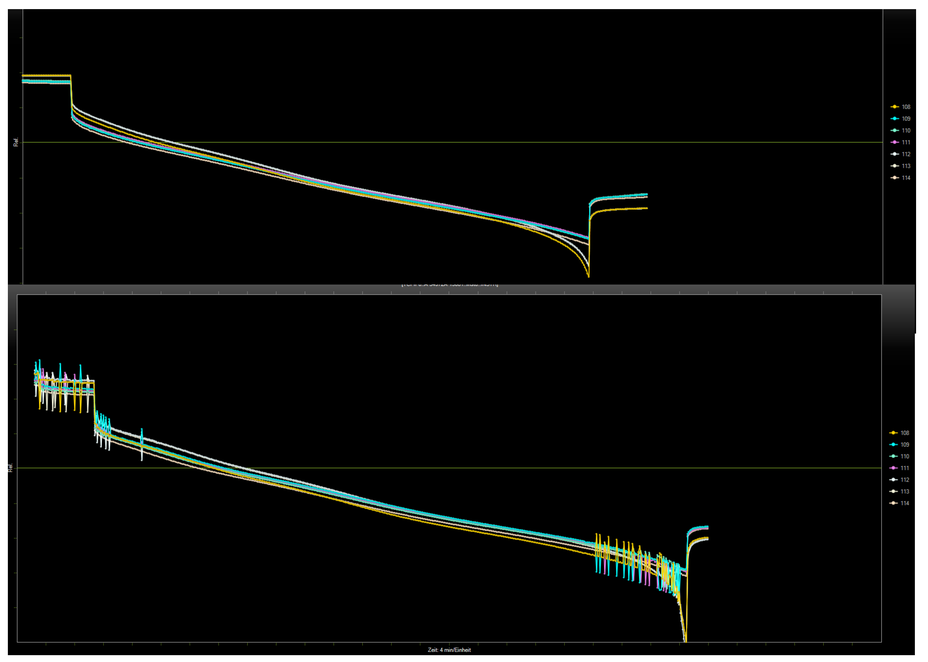

Figure 3: Discharge cycle without/with active balancing (2 weak cells are balanced towards the end of the cycle as soon as the cell voltages drift apart → Discharge capacity increases by 12%)

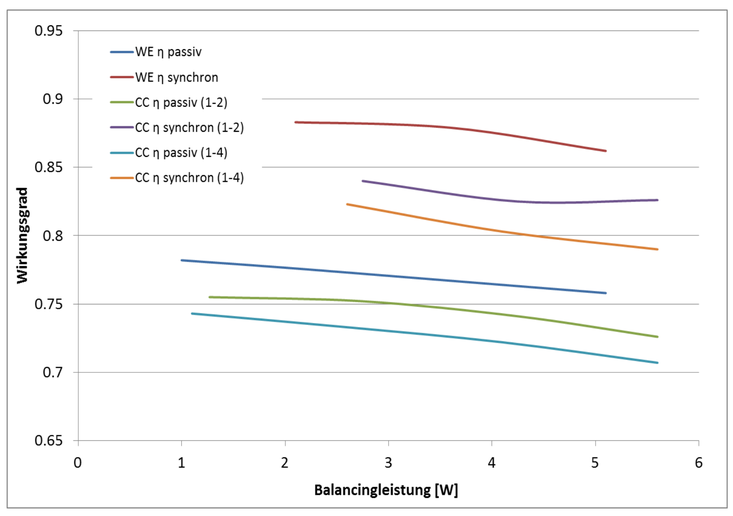

Figure 4: Charge transfer efficiency as a function of balancing paths and balancing current

Acknowledgement

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References

[1] Xu, Li, Mi, "SOC Based Battery Cell Balancing with a Novel Topology and Reduced Component Count", Energies 2013

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