BEUTH HOCHSCHULE FÜR TECHNIK BERLIN
University of Applied Sciences

Research Group Battery Management

Prof Dr. Detlef Heinemann
Hans Harte
Frank Stenzel

BEUTH HOCHSCHULE
FÜR TECHNIK
BERLIN
University of Applied Sciences

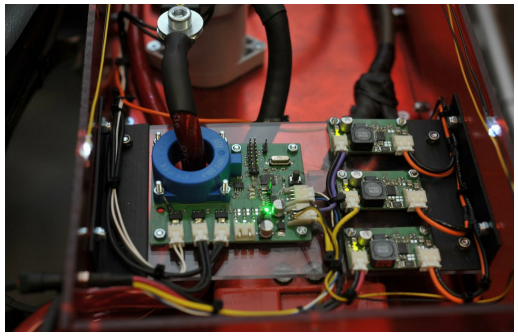
Modular Battery Management System for Electric Vehicles

MoMo

- EFRE financed Project

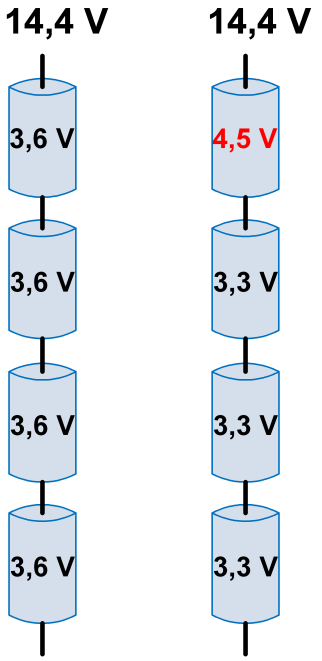
Mobile Computing and Eco-Mobility

- Subproject Battery Management
  - Setup infrastructure for a Battery Test Lab
  - Development of a modular BMS
  - Battery tests for the development of a state of charge algorithm
  - Demonstrators



Why do we need Battery Management?

- Lithium based cells have a comparable high energy and power density
- Wrong usage may result in thermal runaway (fire, explosion)
    - Overcharge
    - Deepdischarge
    - Overcurrent



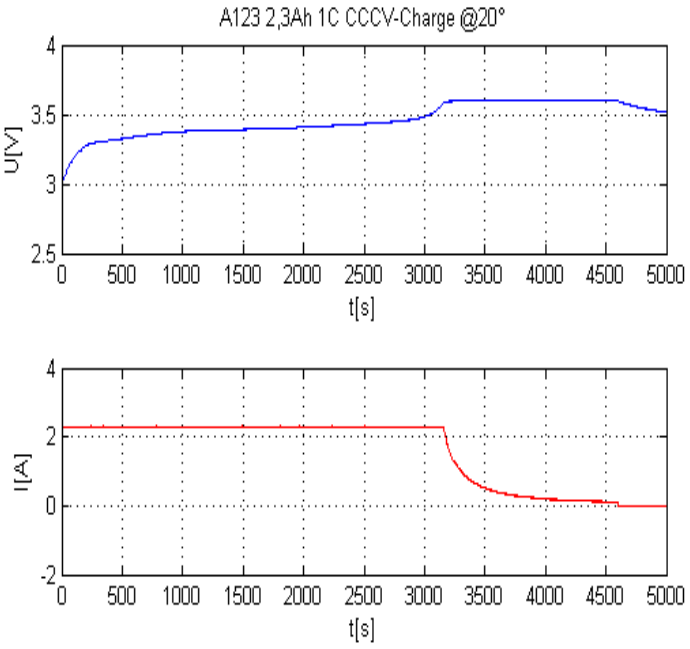
- BMS Tasks:
    - BMS has to ensure that all cells of a battery are only used within the specified range

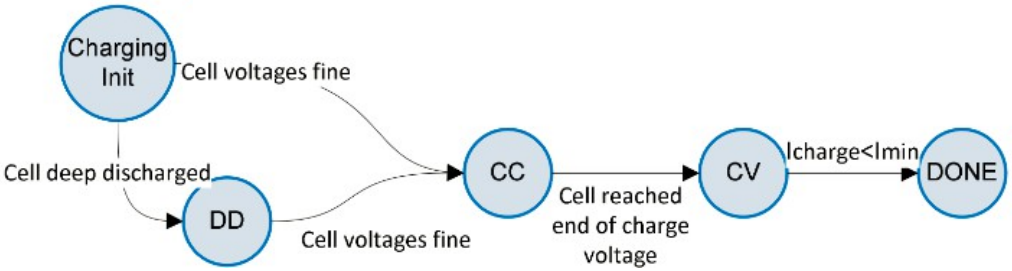
→ Supervise temperatures, voltages and currents of EVERY cell

- Maximize usable capacity
- State of charge estimation
- Charge algorithm

Charging

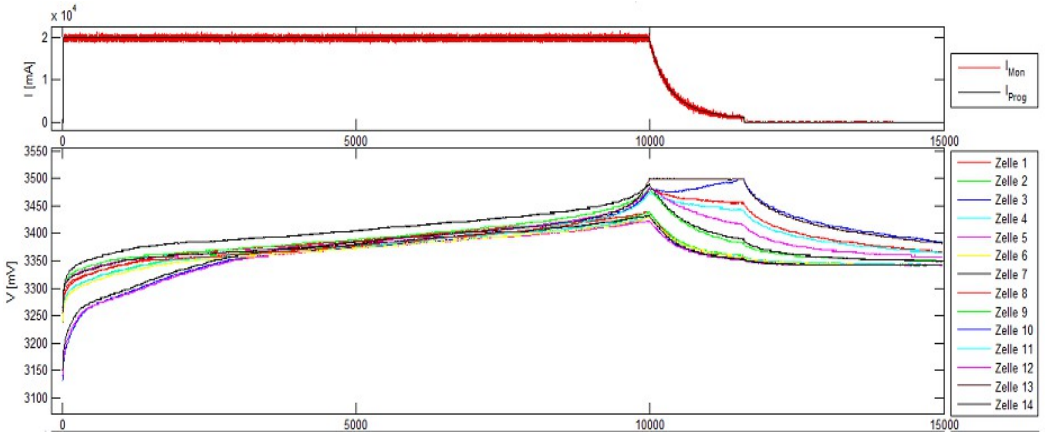
- Constant Current, Constant Voltage (CCCV-Charging)
  - CC until end of charge voltage is reached
  - CV until currents drops below predefined value
- BMS communicates desired values to charger and supervises actual values



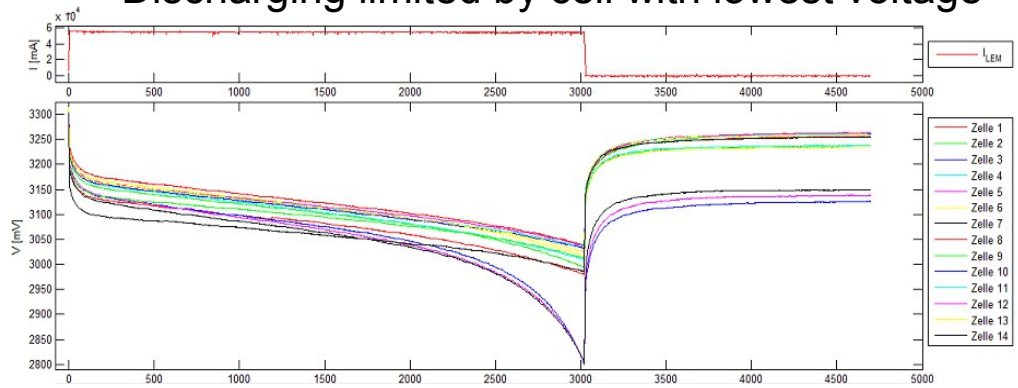


Maximize usable capacity with balancing

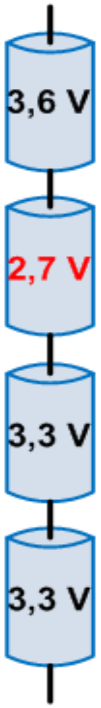
- Charging limited by cell with highest voltage

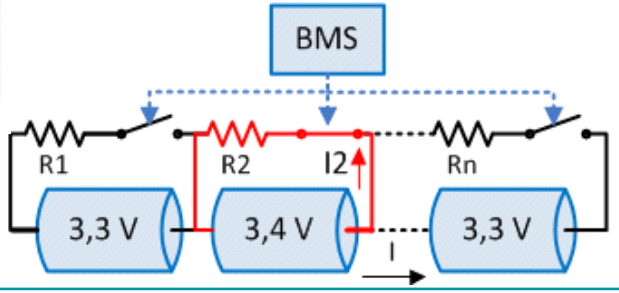


- Discharging limited by cell with lowest voltage



- Solution: Passive Balancing
  - Selectivly discharge cells





Problems State of Charge estimation

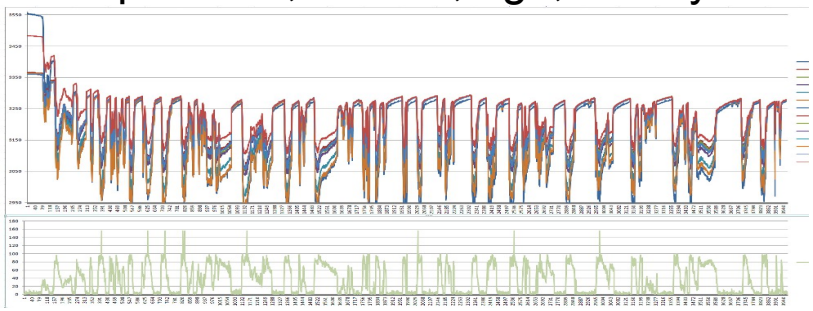
- Difficult based on cell voltage
  - Flat curve ,influenced by temperature, current, age, history
- Coulomb counting

→ cummulative error

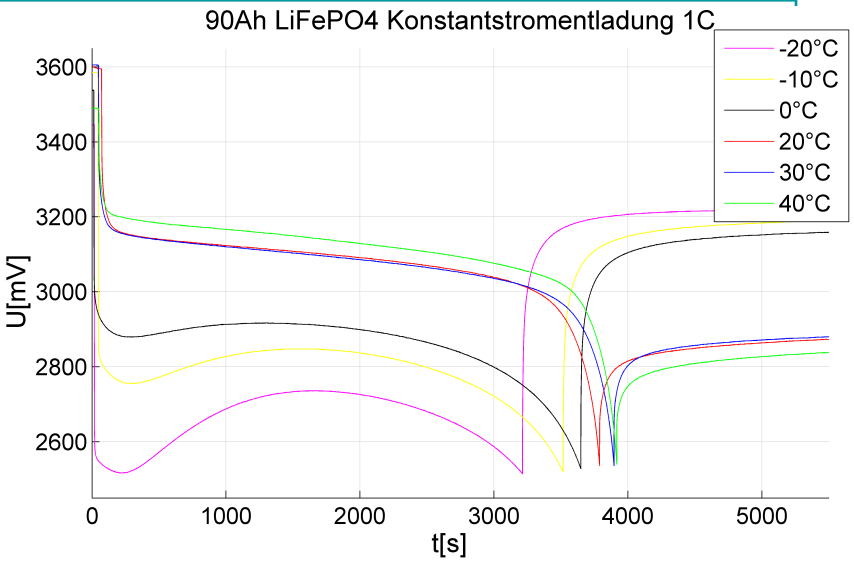
- Fully discharged seldom reached

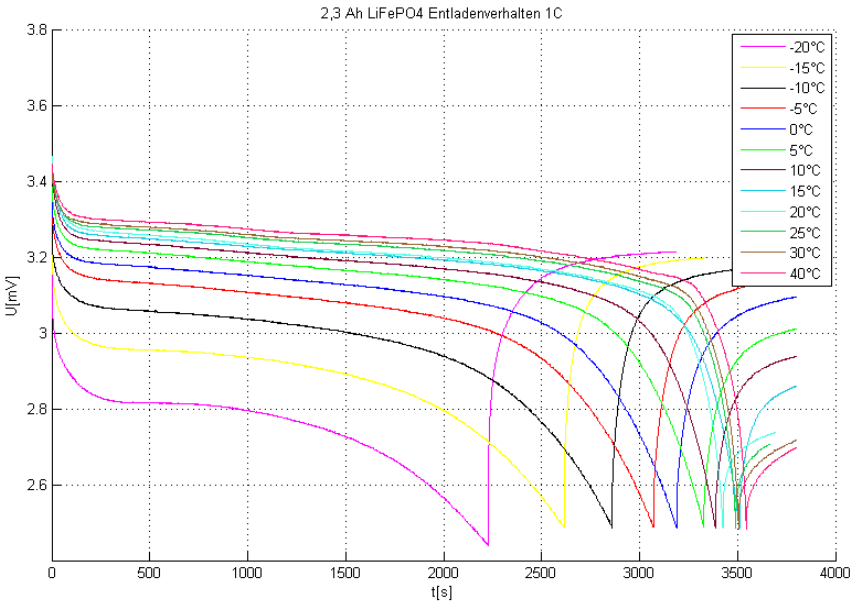
→ actual capacity unknown

- Usable capacity influenced by temperature, current, age, history



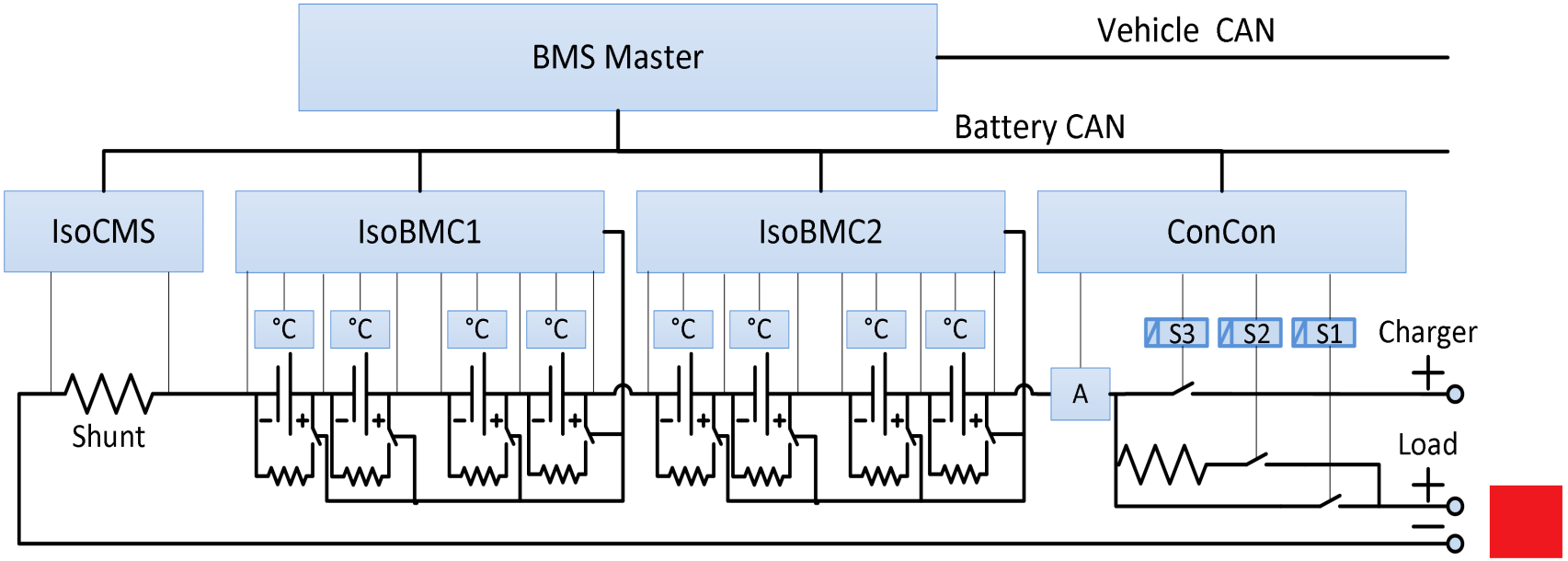
- Goal: adaptive prediction of usable capacity and culomb counting for state of charge estimation





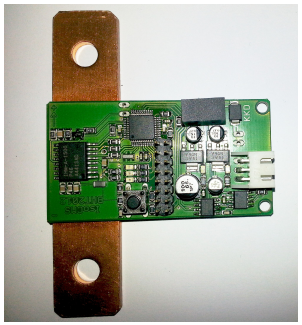
Realized Topology

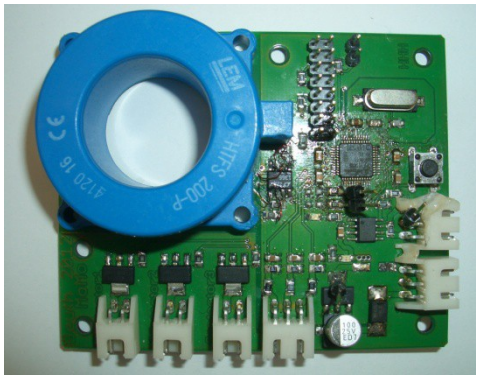
- Modular Battery Management System
  - Isolated Battery Module Controller — IsoBMC
  - Isolated Current Measurement System — IsoCMS
  - Contactor Controller — ConCon
  - BMS Master (under development)



Controller Tasks

- IsoCMS (Infineon XC886)
  - High precision current measurement
  - Mean-value transmitted every 500 ms
  - Present value transmitted directly if outside of allowed limits
- IsoBMC (Infineon XC886 and LTC6802)
  - Measures all cell voltages and temperatures
  - Mean-Value transmitted every 500 ms
  - Cell balancing during charging
- ConCon (Infineon XC886)
  - Contactor control
  - Supervision of all measured parameters
  - Error detection
  - Redundant current measurement
  - Voltage measurement at testpoints
  - Master functionality until BMS Master is developed





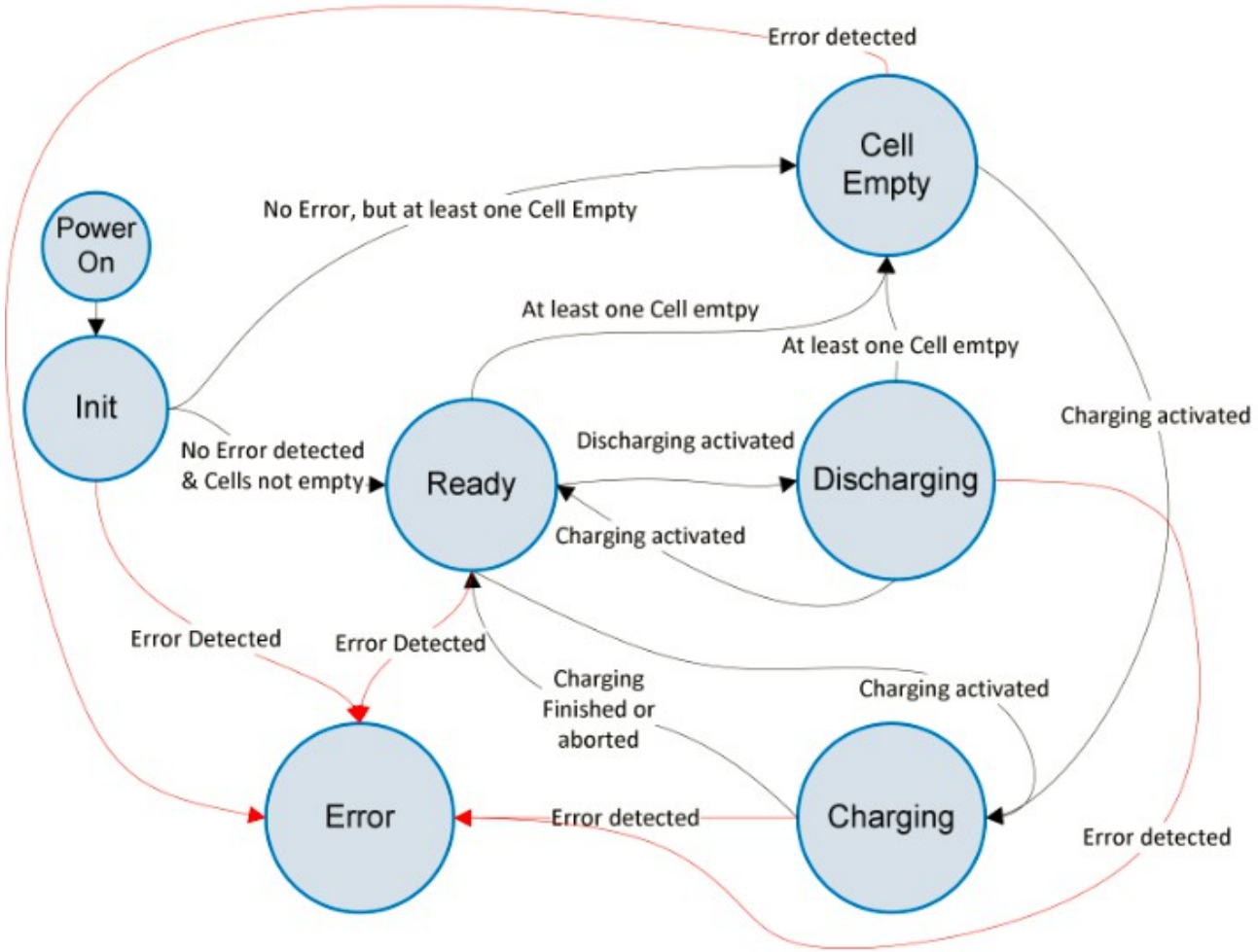
BMS Master Tasks (under development)

- Using Infineon XMC4500
- Replace ConCon

- Control of 5 contactors
- Redundant current measurement
- 12 analog channels for redundant data acquisition
- Serial logging and configuration interface
- Data logging on SD-Card
- Charge algorithm
- Supervise all measured parameters
- Communication with vehicle control unit
- State of charge algorithm

BMS States

- State Machine running currently on ConCon

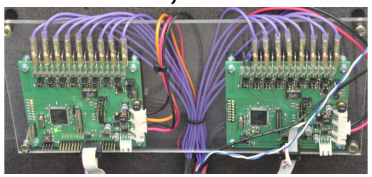


Demonstrators

- eBike
  - 12S2P A123 2,3Ah
  - ca. 182 Wh

Ekart, cityEL

- 14S1P TS 90Ah
- Ca 4,2 kWh



Thank you for your attention!

Contact:
Prof. Dr. Detlef Heinemann detlef.heinemann@beuth-hochschule.de
Hans Harte h.harte@beuth-hochschule.de