Lithium Batteries & BMS technology

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About me

- Master of Science in Computer Science and Engineering
- Started Hybricon AB (now Hybricon Bus Systems) with Boh Westerlund 2009
- Developed PHEV conversion kits for Toyota Prius
- Keywords: battery, BMS, charger & EV connectors, CAN-bus, vehicle ECUs, CoDeSys

PHEV conversion, Umeå 2010

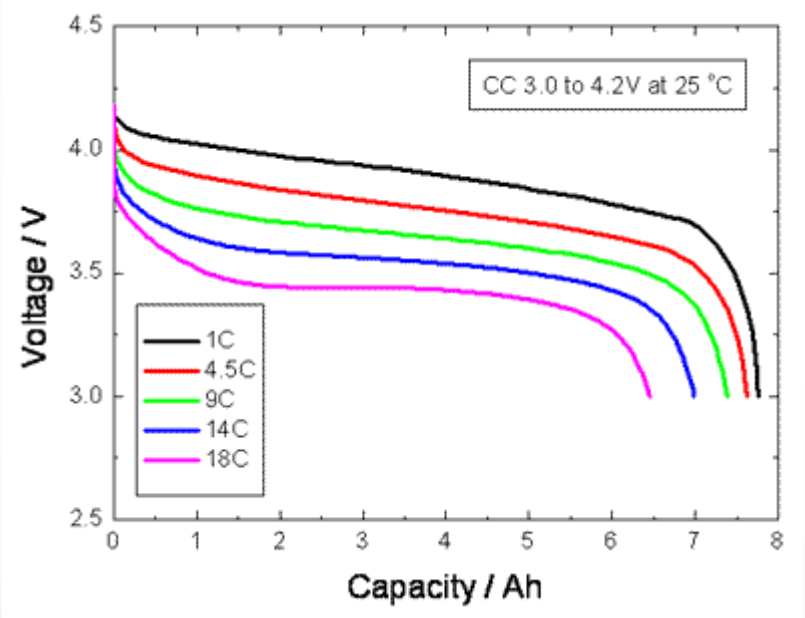
Bus and 100 kW charging station, Umedalen, 2011

Lithium Batteries & BMS technology

Modern Large Format Batteries

Battery Properties

V, Ah, kg, kWh/kg, l, kWh/l, mΩ, cycles, $/kWh, C-rate, self discharge... But a charge/discharge curve gives a lot of info:



Shapes

- Small cylindrical (solid body without terminals, such as those used in laptop batteries)
- Large cylindrical (solid body with large threaded terminals)
- Pouch (soft, flat body, such as those used in cell phones)
- Prismatic (semi-hard plastic case with large threaded terminals, such as vehicles' traction packs)

Source: Wikipedia

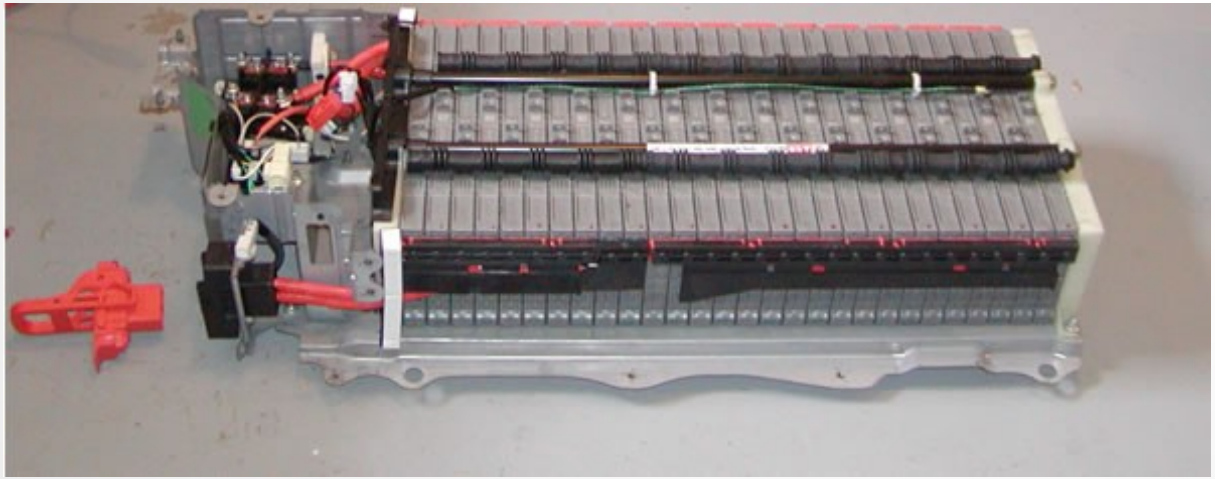
Shapes


Energizer
Energizer


Panasonic
Lithium ion
Rechargeable battery
Li-ion

Nickel–metal hydride, NiMH

- 2-3 times the capacity of NiCd
- Energy density can approach that of a lithium-ion battery
- Available as Cylindrical and Prismatic Cells
- Common in hybrid vehicles and rechargable consumer batteries

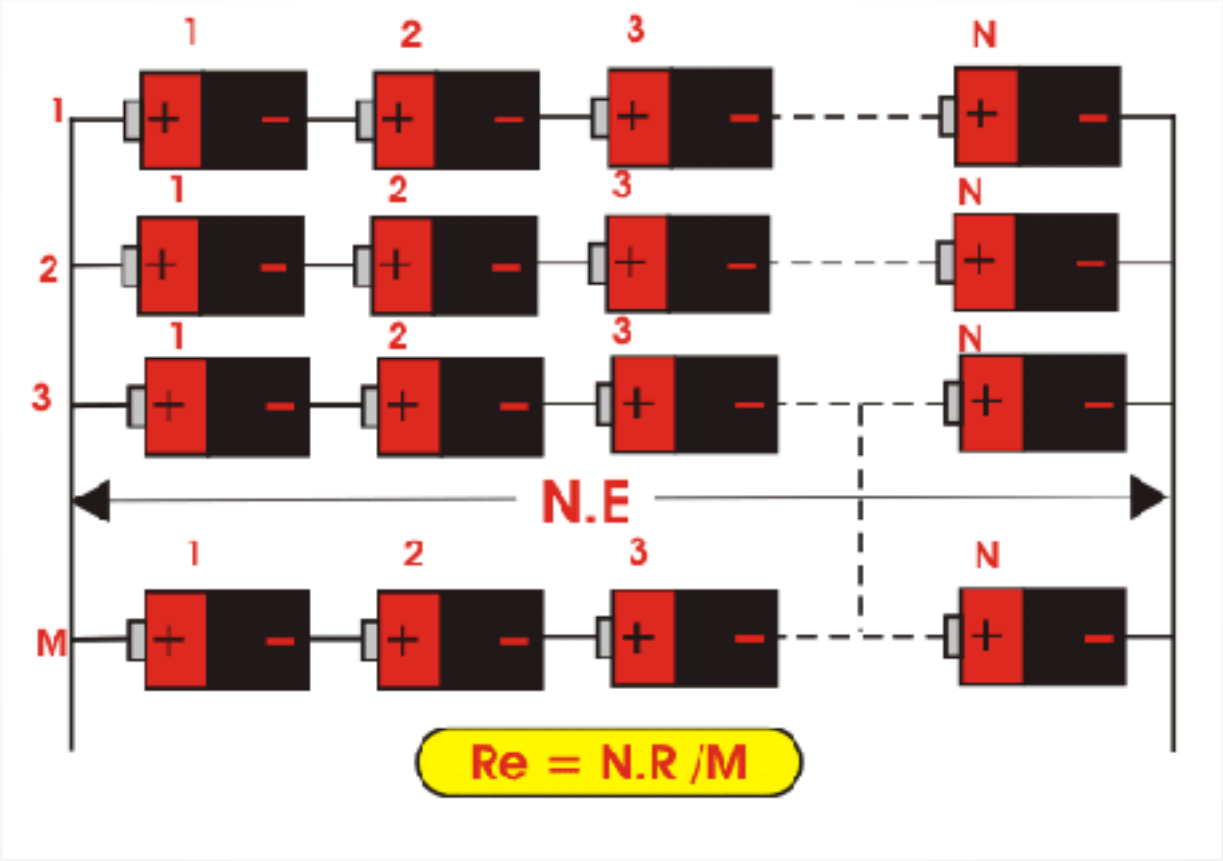


Lithium-ion batteries

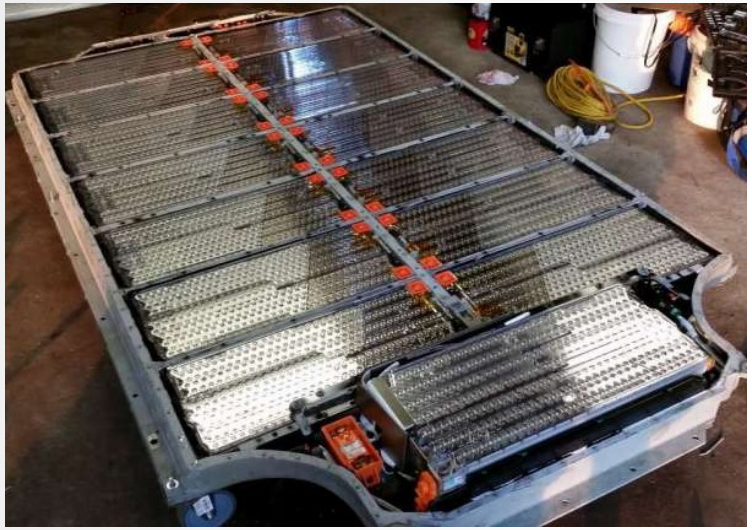
- Common Lithium-ion based batteries:
  - Lithium Nickel Manganese Cobalt Oxide (NMC), 3.6-3.7 V
  - Lithium Iron Phosphate (LFP, LiFePO4), 3.2 V
  - Lithium Titanate (LTO), 2.3 V

Battery Modules

Connecting cells



Battery Pack



BMS Technology

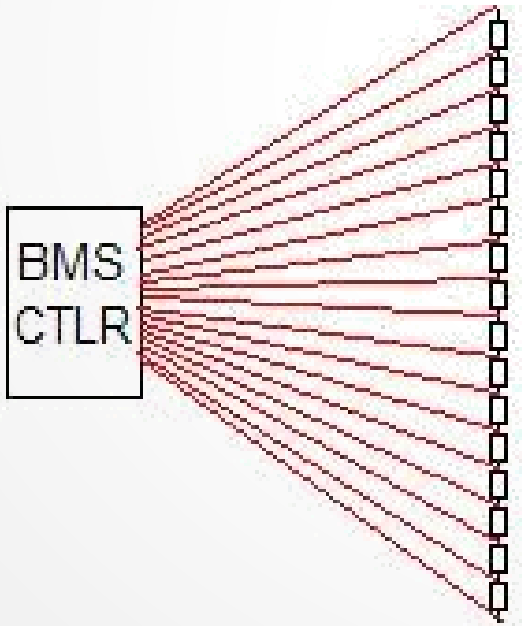
Battery Management Systems

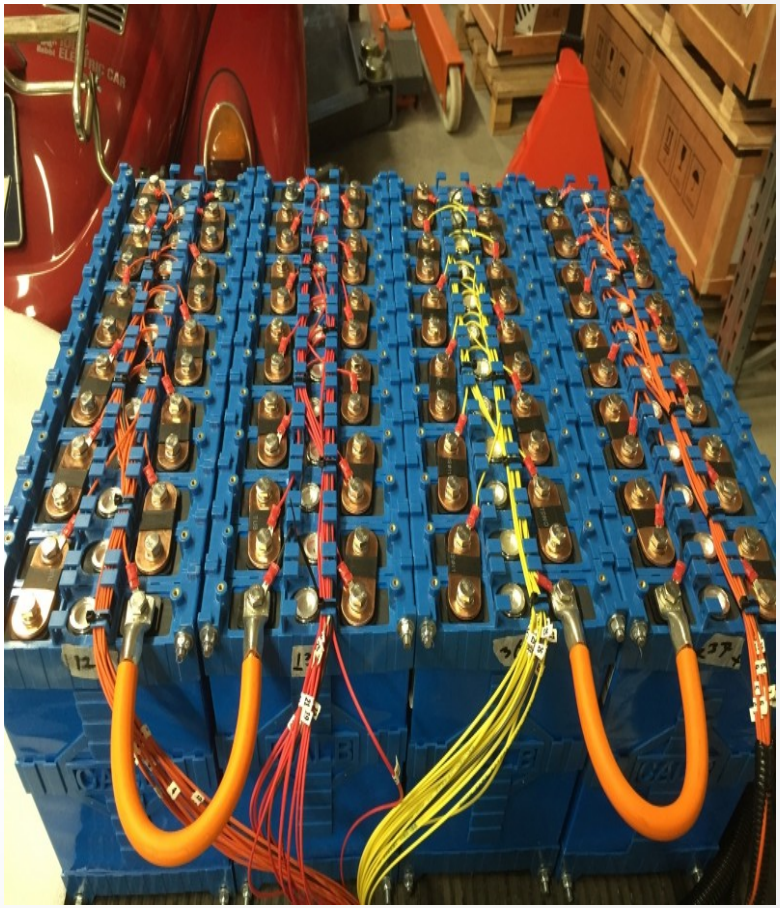
BMS Technology

- „Battery Management System“ functions:
  - Protect the battery!
  - Maximize the battery capacity (balancing)
  - Monitor state - report voltage, current, temperature etc
  - Calculate values such as SOH, SOC, CCL, DCL, Ir etc

BMS Topologies

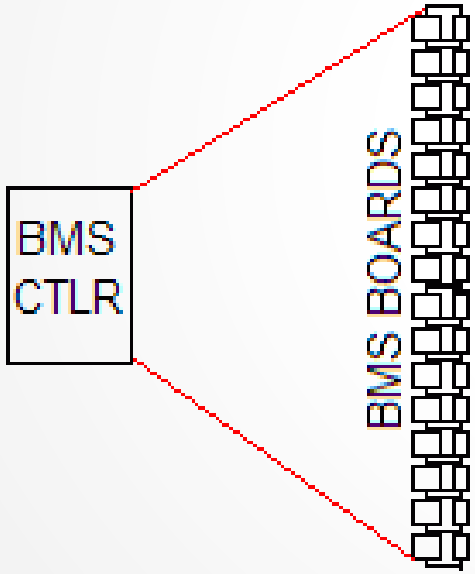
- Centralized: a single controller is connected to the battery cells through a multitude of wires

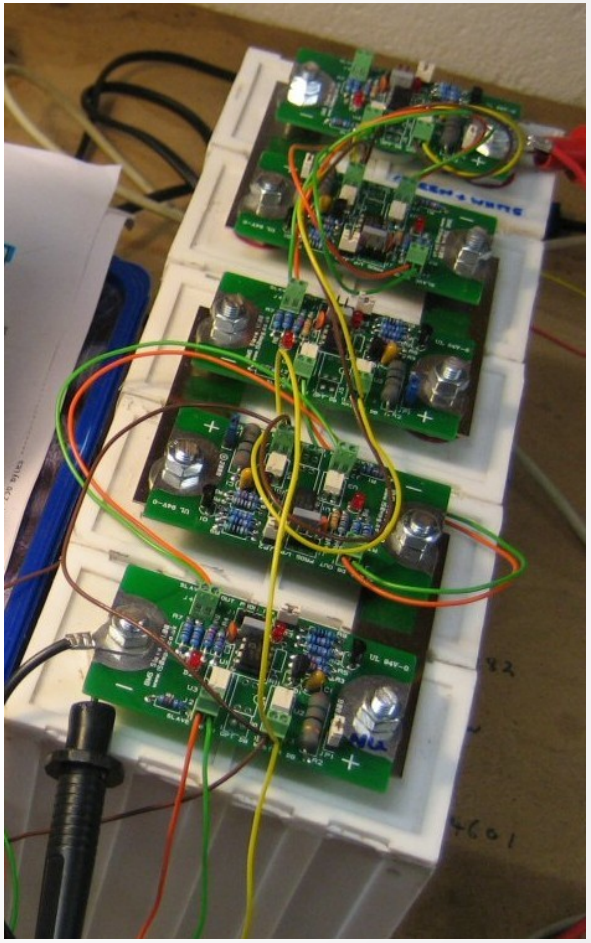




BMS Topologies

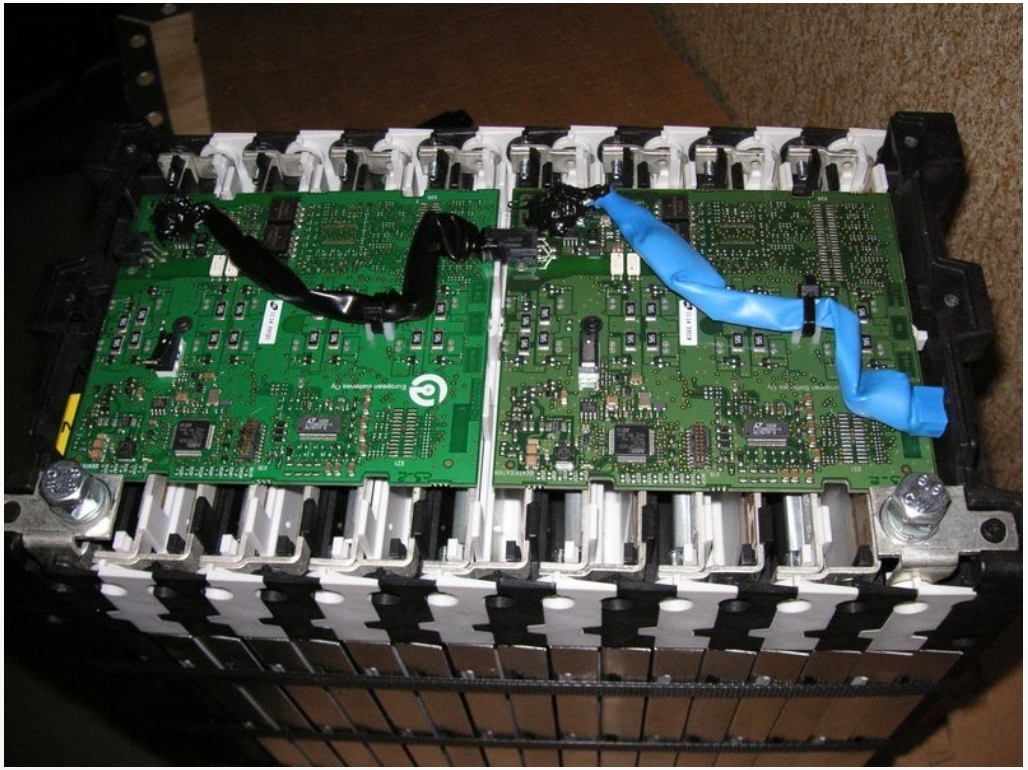
- Distributed: a Cell Board is installed at each cell





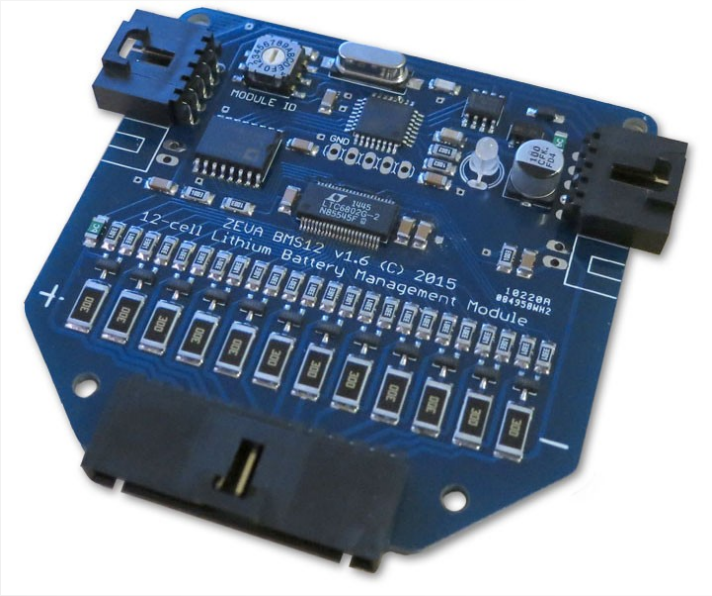
BMS Topologies

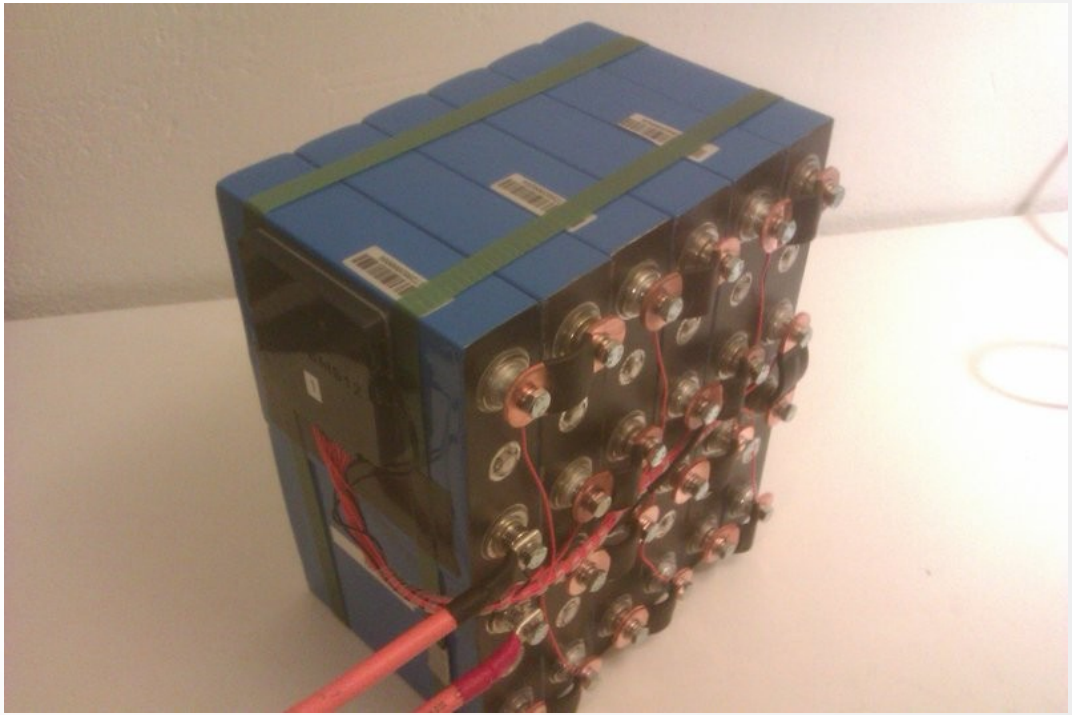
- Modular: few boards, each handing a certain number of cells (1/3)



BMS Topologies

- Modular: few boards, each handing a certain number of cells (2/3)





BMS Topologies

- Modular: few boards, each handing a certain number of cells (3/3)

BMS Topologies

- With modular and distributed topologies, a central controller is required
- Communication with central controller can be a discrete signal, but often a serial communication such as a CAN bus is used
- My preference: modular boards