



# LiTHIUM BALANCE A/S

Battery Management Systems  
for lithium-ion batteries  
in electric vehicles and machines

# A leading, European supplier of Li-ion battery management solutions



## LiTHIUM BALANCE supply:

- High end battery management solutions
- Engineering and integration services
- Consultancy

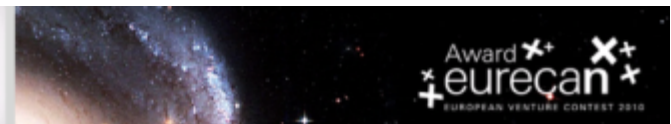
## LiTHIUM BALANCE have:

- Over 170 separate projects completed
- Several hundred vehicles driving
- Primary markets in industrial and automotive vehicles



Winner of the  
**Frost & Sullivan**  
European Automotive  
Powertrain Innovation  
Award

Runner up in the **Eurecan** venture  
contest 2010



# Li-ion batteries: unsafe unless well protected, perform poorly unless well managed

## Problematic with poor management

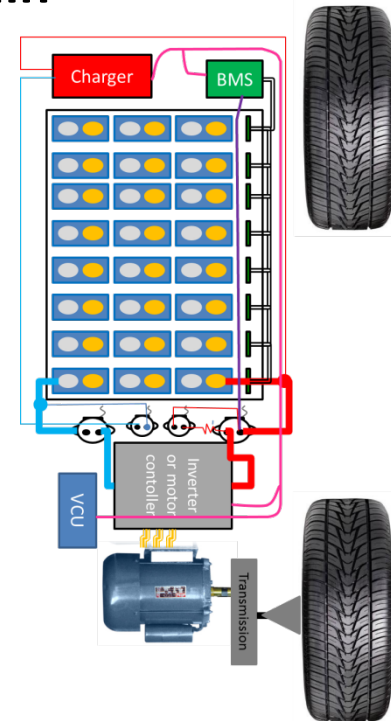


- Thermal run-away
- Shorter cell life
- Loss of capacity (and range)
- Longer charge time
- Warranty exposure

## All battery packs contain

- Battery cells
- BMS
- Charger
- Contactors
- Cables
- Shunt
- Packaging

**Lithium batteries can only be used when protected by a Battery Management System**



# The Battery Management System ensures safe, optimal and life-time performance



The BMS continuously monitors both the pack and all individual cells and manages charge and discharge accordingly

## PROTECTION

Lithium is sensitive to under and over voltage, which will damage the cell

The BMS keeps the battery within the voltage range and thus ensure safety and extends cell life

## PERFORMANCE

Lithium cells are never identical. A pack performs as the weakest cell

The BMS balances the cells to perform identically – thus increasing capacity

## INTERFACE

Both charger and load have to consider battery status

The BMS interfaces and controls battery, charger and vehicle and it logs data for diagnostics and warranty

# We have unique integration knowhow from 170+ different customer implementations



## TOYOTA

### First Lithium forklift

- No battery swap needed
- Works twice as fast
- Opportunity charging
- Maintenance free
- Lower total life cost



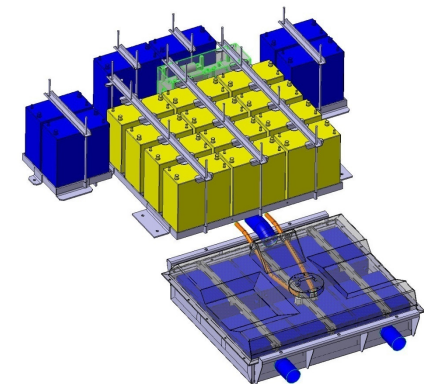
### First electric street sweeper

- Developed dual battery pack design
- Identified battery supplier
- Achieved 5 years battery warranty with our BMS



### First two electric prototype cars

- Modular battery pack
- Higher range per charge
- Tested UK, China, Malaysia
- Consistent performance over time





# Market coverage

Over **170** projects successfully completed all around the world



Also: USA,  
**China**, Israel,  
Saudi Arabia,  
Malaysia,  
Korea, Japan

# 3 BMS platforms

## Integrated (i-BMS)

- Basic BMS for simpler applications (Boat, Scooter, Robot)
- 12-72V versions
- Embedded switching
- RS232 communication
- TÜV automotive
- Production since 2008



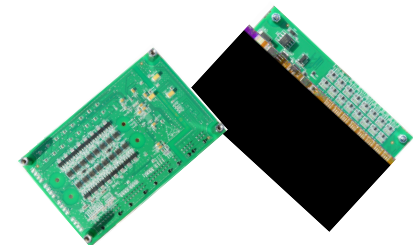
## Scalable (s-BMS)

- Advanced BMS for industrial and EV applications
- Modular 12-1000V
- Box or PCB versions
- RS232 and CAN-bus
- Industrial certification
- Production since 2009



## Network (n-BMS)

- Automotive grade BMS
- Modular 0-1000V
- 3mV precision
- Up to 1 temp sensor/cell
- Analogue redundancy
- CAN-bus board2board
- ISO26262 ASIL C
- 50% size reduction
- Production 2013



# One modular BMS for all applications

## BMCU

Manages the pack

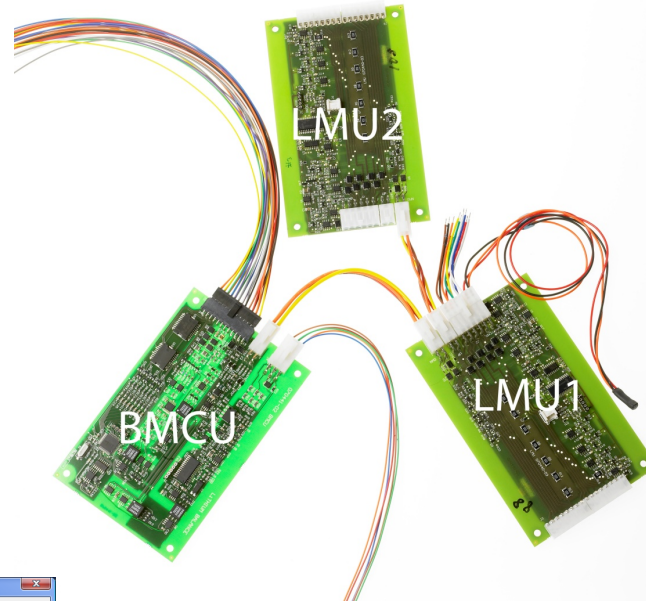
- Pack voltage
- Pack current
- SOC / SOH

Controls charger/motor

Interface to vehicle

Datalog for diagnostics

Fully SW configurable



## LMU

Distributed intelligence

Manages 8 cells

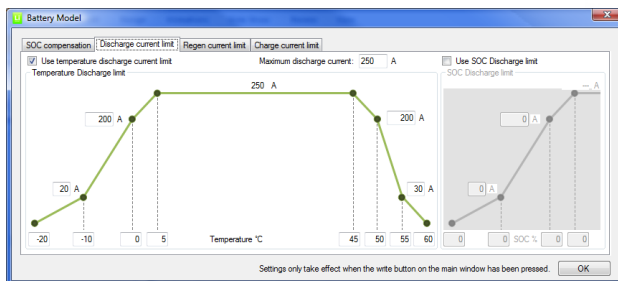
- Cell voltage
- Temperature
- Cell balancing

Up to 32 LMU/system

- From 12V to 1000V

Any Li-ion chemistry

Stack, box or integrate

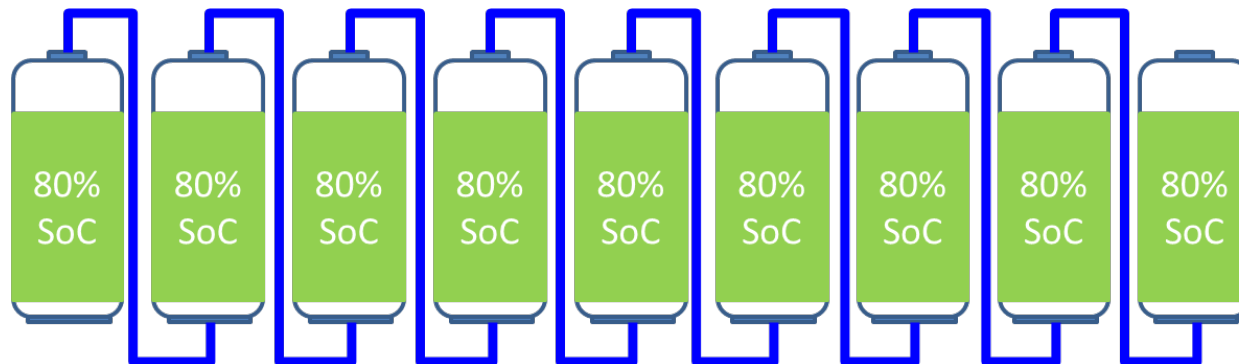






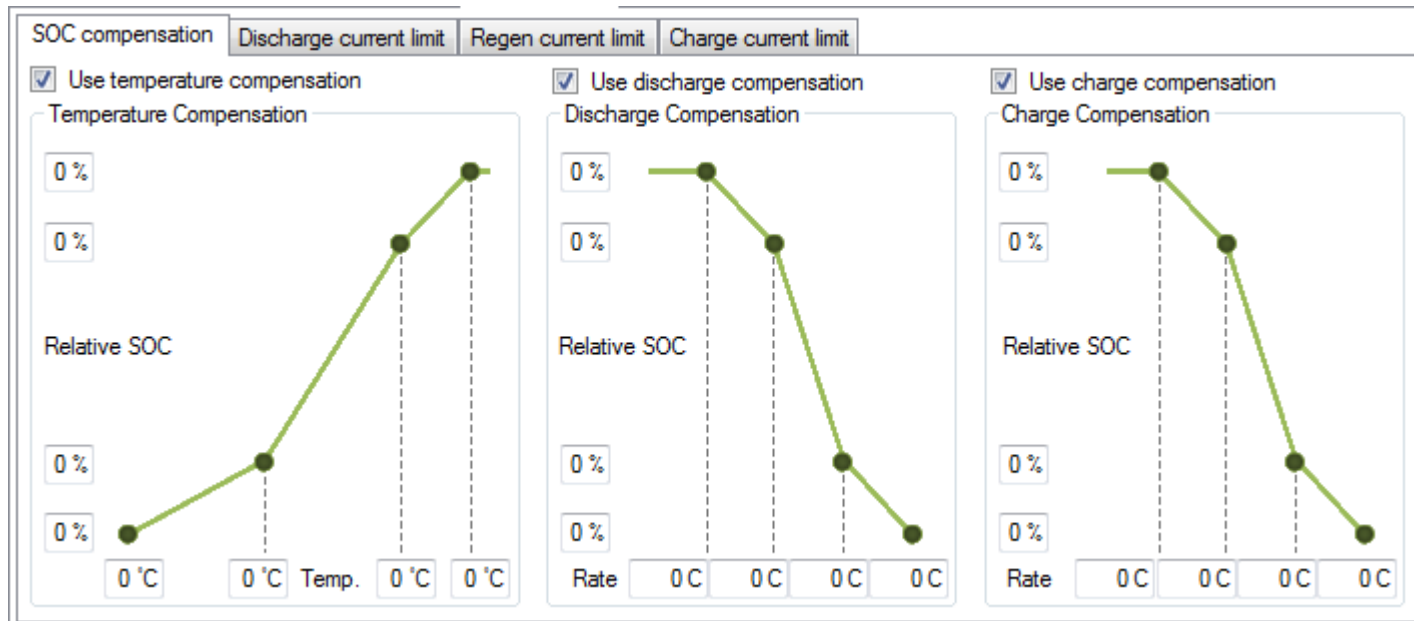
# Balancing

- Proprietary balancing algorithm reduces balancing time and minimizes wear-and-tear on cells
- Up to 1A balancing current per cell
- All cells in the pack can be balanced in parallel
- With finned heat sinks (available as accessory) and reasonable air flow the duty cycle is close to 100%
- Balancing to singular mV precision
- Proven in integration with an extensive list of chargers
- New charger integrations validated by Lithium Balance on a pre-project basis.



# Battery Model

- Add advanced battery chemistry data to your battery management system by means of configuration.
- Enhance State of Charge calculation
- Optimize battery utilization in various temperature conditions
- Optimize battery utilization in various state of charge ranges



*Battery model in Diagnostic Software*

**LiTHIUM BALANCE**

BATTERY MANAGEMENT SYSTEMS

# Electromagnetic Immunity



EMI – measured in a reverberation chamber (higher field strengths achievable than in a conventional chamber)

- ✓ 250 V/m @ 80-1000 MHz
- ✓ Peak noise 1100 V/m
- ✓ Up to 7 times above industry standards for EMC

Injected noise (transients)

- ✓ Tested on all critical inputs to 4kV twice the industry standard



# Current research projects

- SOMABAT (EU FP7)
  - Novel solid materials for high power Li Polymer battery – recyclable, lower cost, higher density
- Reliable (DK SFR)
  - Lithium-air battery development
- ALPBES (DK HTF)
  - Predictive tools to identify battery failure modes, and lifetime characteristics
- Automotive certification battery-system (DK EUDP)
  - Finalisation of automotive certified BMS
- INVI-MOBY (EU FP7)
  - Easy and safe inter-changeability between the battery modules used in house solar installations and on-board the vehicle