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The 27th INTERNATIONAL ELECTRIC VEHICLE SYMPOSIUM & EXHIBITION
BARCELONA
17th-20th November 2013

+ESTRELIA

Safe Batteries with power

Manfred Brandl

Organized by Fira Barcelona avele
Hosted by AVERE mea Ajuntament de Barcelona
In collaboration with EVAAP EDTA
Supported by European Commission

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Energy STorage with lowered cost and improved Safety and RELIAbility for electrical vehicles

May 2011 – April 2014

Coordinator/ Partners:

Austria:

ams
www.ams.com

ABR Austrian Battery Research Laboratory GesmbH.

France:

Valeo

CORNING

cea

E4V Energy for EV

Germany:

Fraunhofer IISB

AppliedSensor

Italy:

Active Technologies AT
Electronic Instrumentation and Test Equipment

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Concerns for electrical cars

Safety

⇨ New Safety sensors

Battery Life

⇨ New BMS concepts

⇨ Ultra caps

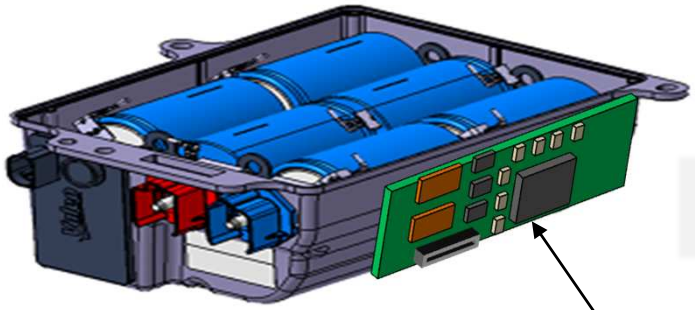
High Costs

⇨ Cost-efficient BMS ICs and safety components

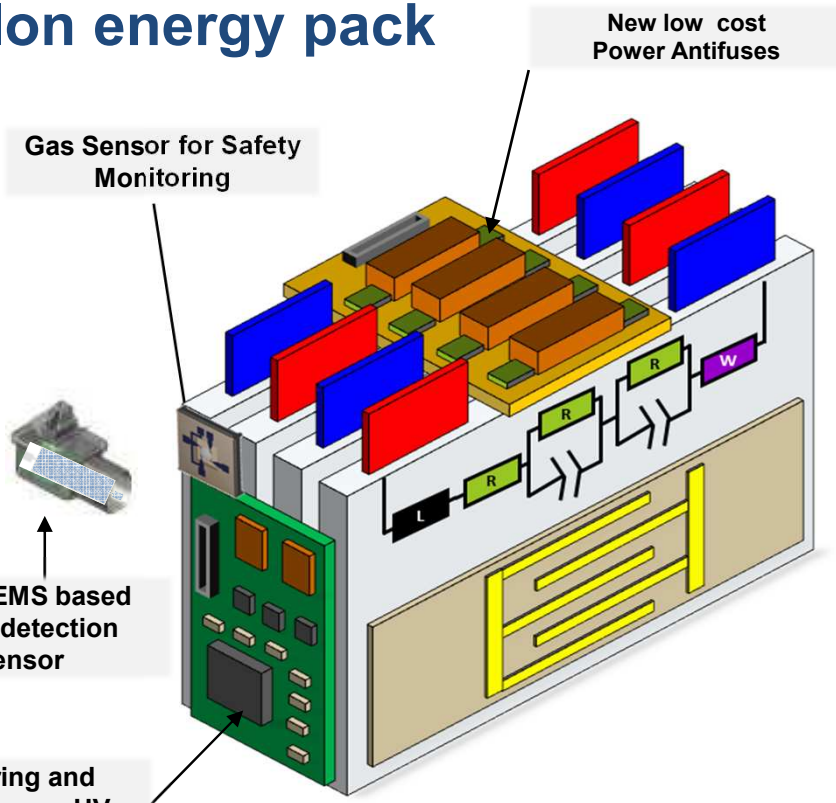
New developments

Ultra Capacitor power pack
as extension for Li-Ion batteries

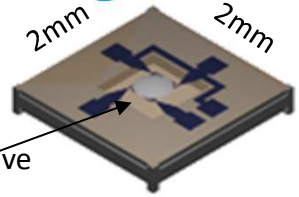
New high density ultra capacitors



Li-Ion energy pack



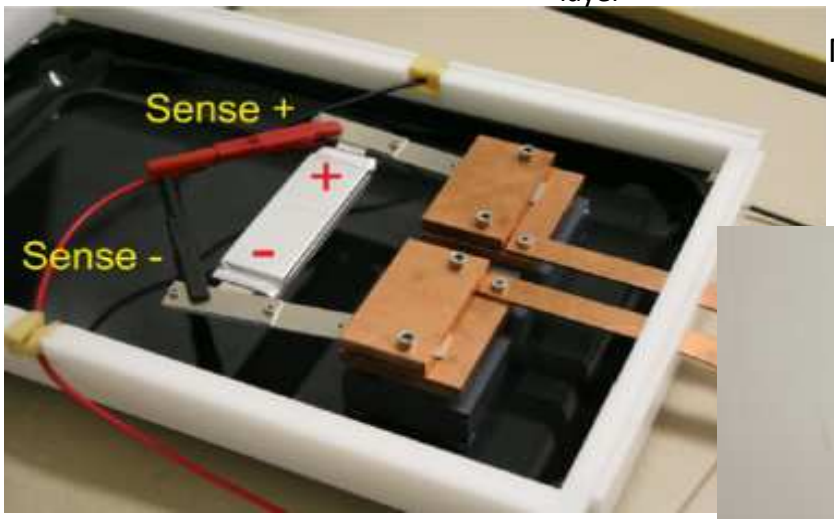
New gas sensor for Li-Ion battery monitoring

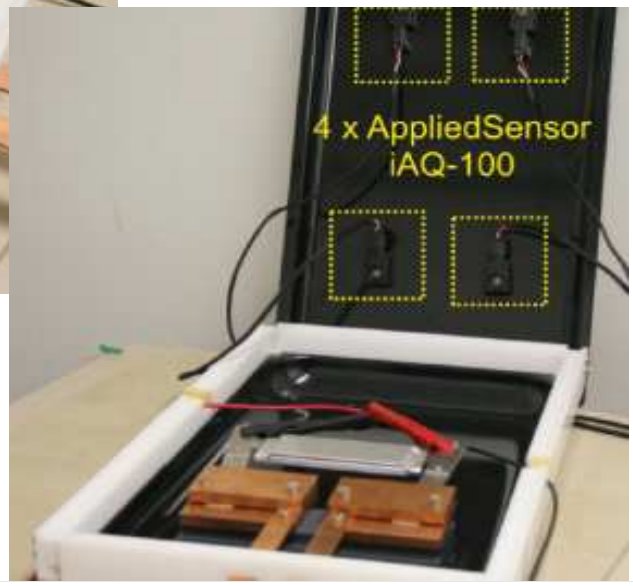


Membrane with electrodes and sensitive layer

MEMS gas sensor

Li-cell tests





Stress Tests
- -Nail penetration test
- -Overcharging
- -Short-circuit

Automotive pouch cells
- -$LiFePO_4$, 10Ah
- -$LiMnO_2$, 20Ah
- -$LiCoO_2$, 5Ah

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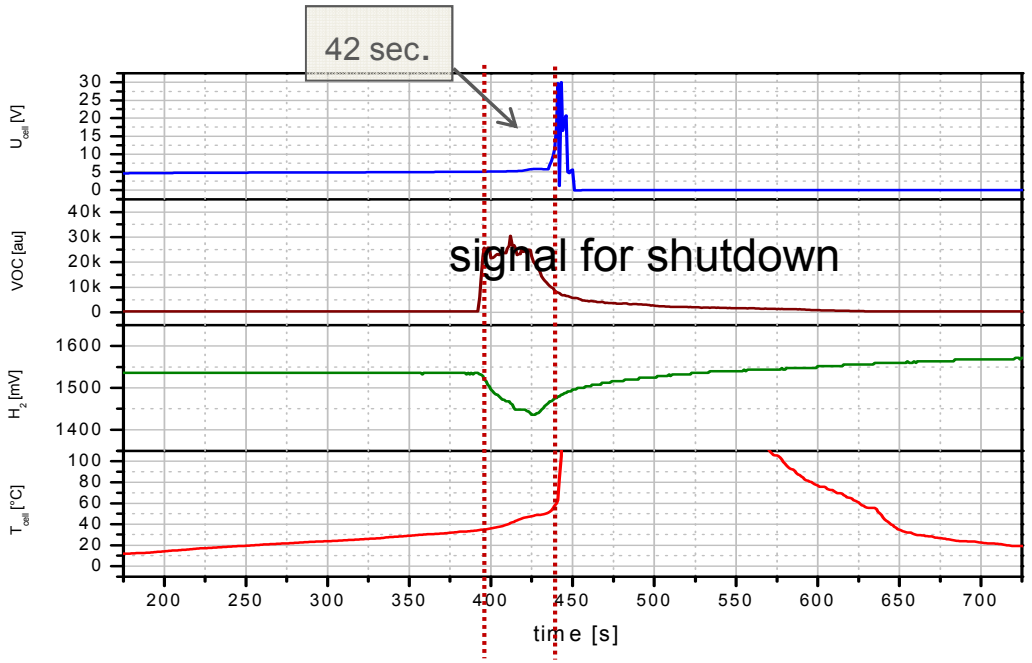
VOC emission in Li-Ion tests

Overcharging

$LiCoO_2$ pouch cell, 5Ah, I=60A



cell voltage

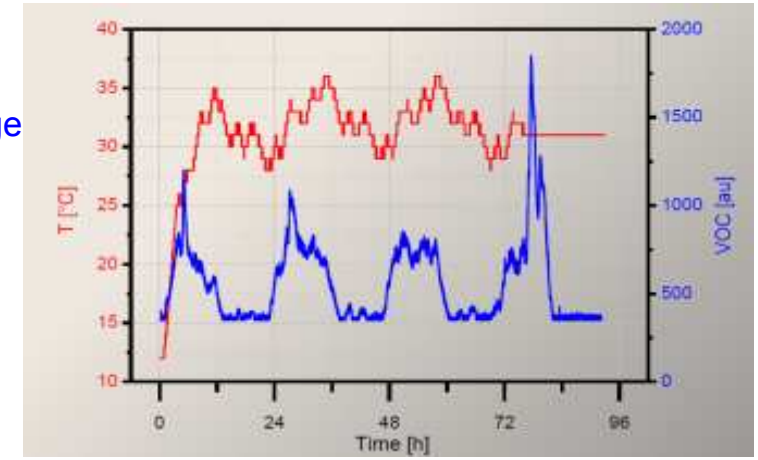
VOC

Hydrogen

cell temp.

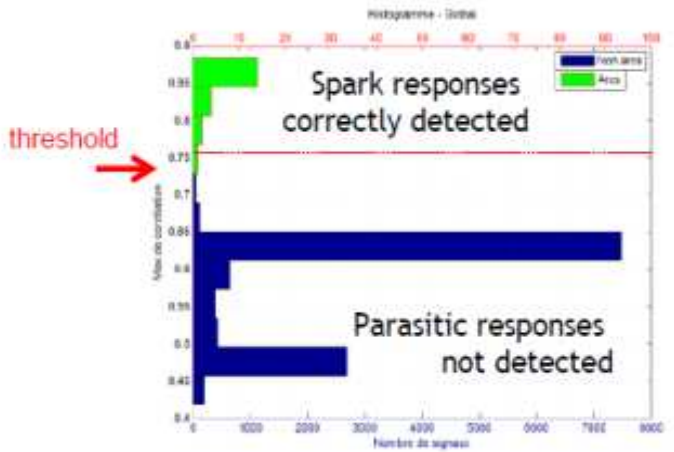
310^0C max

LFP 40 Ah cycling

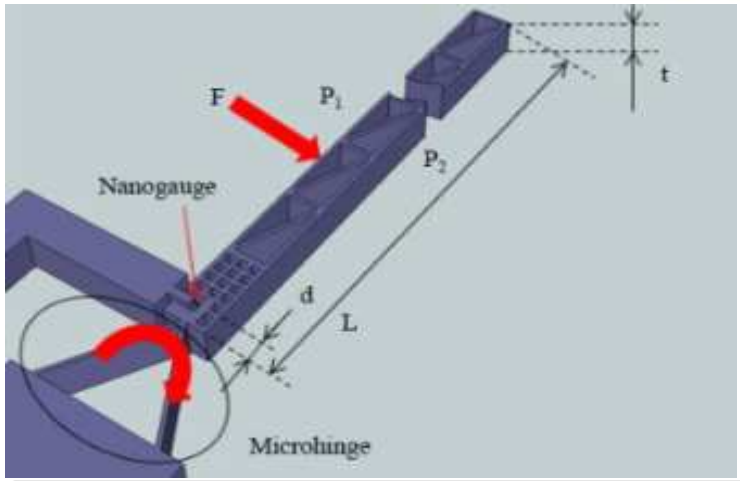


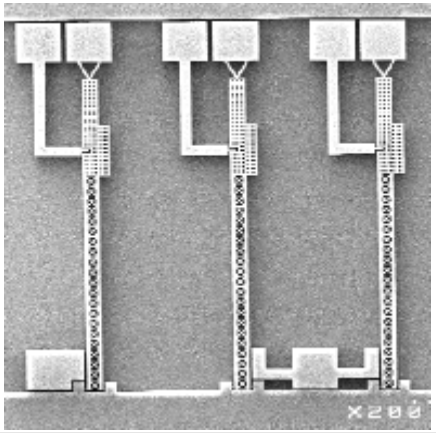
Threshold set to 12k [au]

Development of new Spark Sensor



- Commercial MEMS microphone up to 70 kHz are not good enough for spark detection
- MEMS sensor targeting for up to 300 kHz BW to increase the gap to parasitic responses

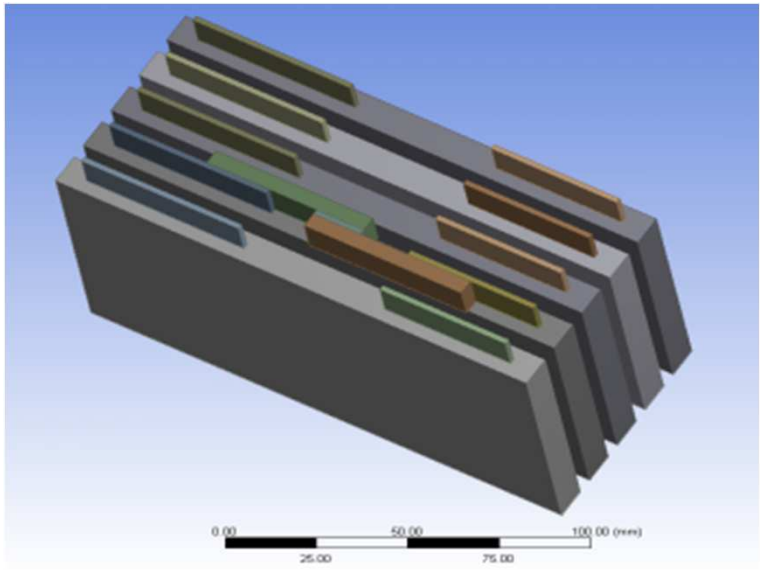




Development of new antifuse devices

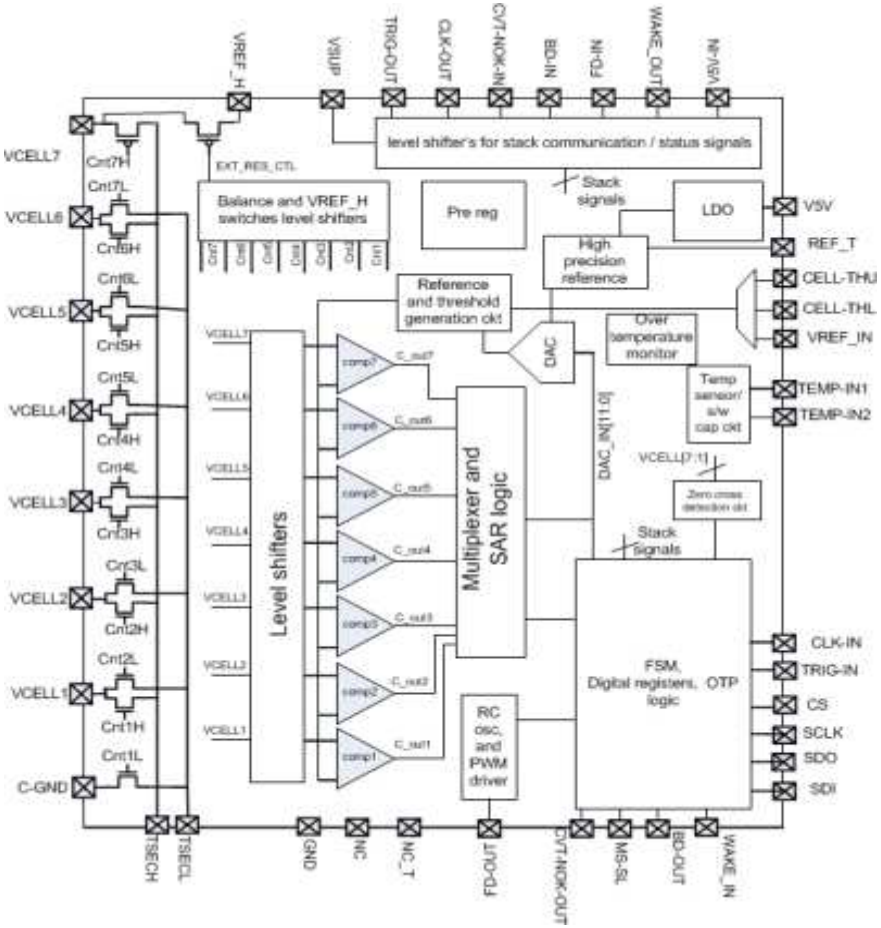
To short faulty cells for FEV limp home function

- Self triggered or external trigger
- First samples under test:



Category	Value	Comment
Maximum current	100 A	
Maximum series resistance	1 mOhm	10 W dissipation at 100 A
Untriggered antifuse fusing technology		Aluminum spiking
Externally triggered antifuse fusing technology		Exothermic reaction
Material costs	< 0.20 €	

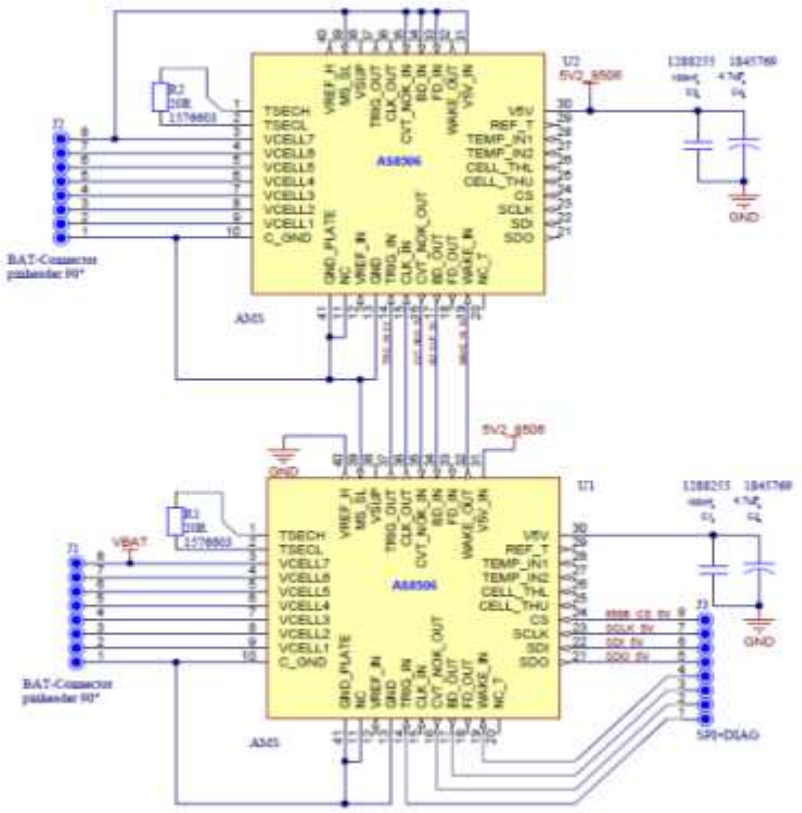
New Cell Monitor and Balancer IC



- Supports 3-7 cells, cell voltages from 1,8V to 4,5V
- Chainable up to 32 IC's
- Simultaneous cell monitoring
- Autonomous balancing on trigger
  - Small balancing currents up to 150 mA, all switches integrated
  - simultaneous cell voltage capture and compare with a reference
  - Sequential passive balancing through one external discharge resistor or active balancing through an external fly back converter
- Split in fast direct action communication and slow, EMC robust serial communication through shared pins

BMS BOM for monitoring and balancing

14 Cells, passive balancing



Distributed topology

- Local compare for fast monitoring
- Sequential and autonomous balancing on trigger

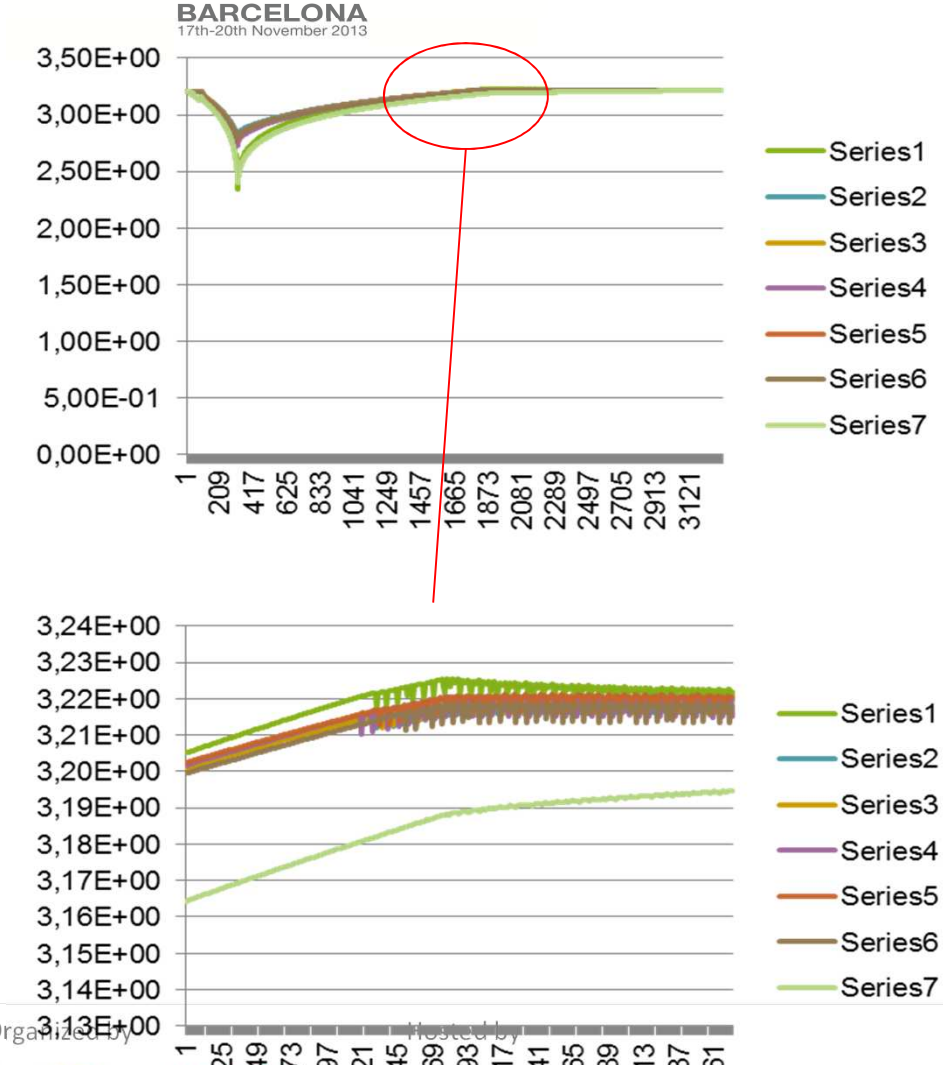
It moves functions which are today in software to hardware

Shared pin communication

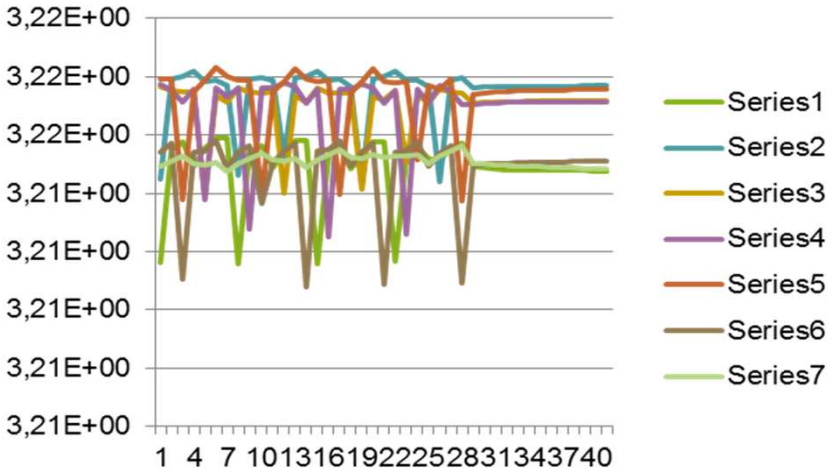
- Fast direct action diagnosis
- EMC robust low speed serial daisy chain communication - no need for galvanic isolation

Optional stand alone operation without micro

New cell monitor and balancer IC



Passive autonomous balancing of LFP cells at ~50% SOC on trigger => no software needed



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Electro kart: daisy-chain communication demonstrated!

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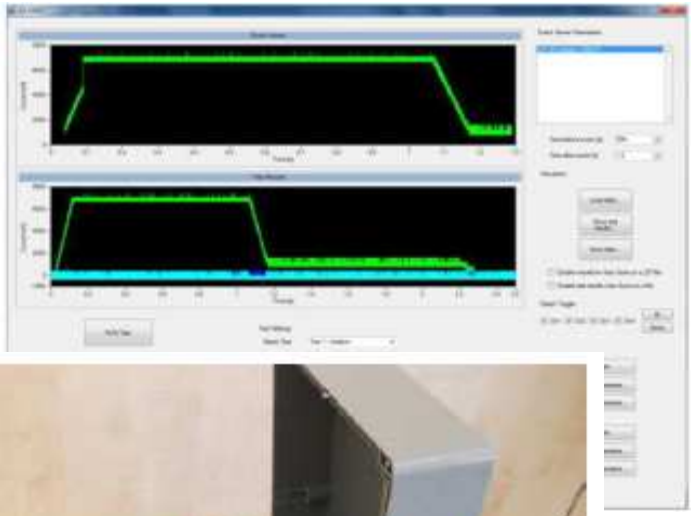
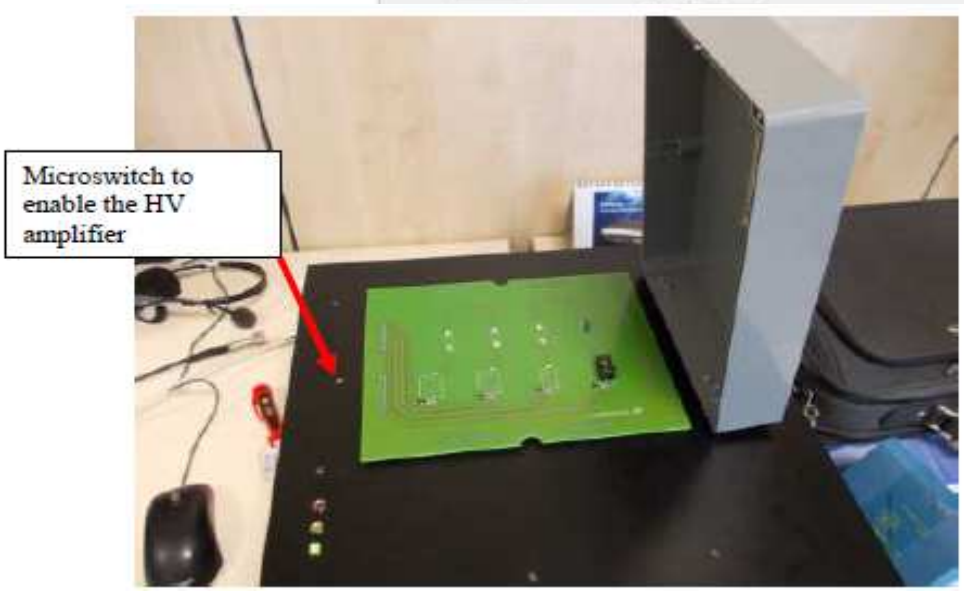
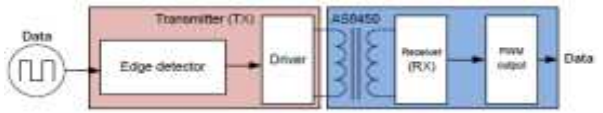
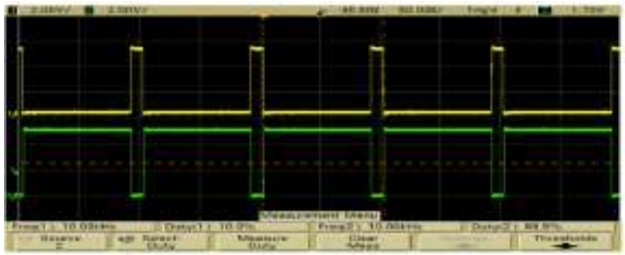
Development of Isolation device test equipment





- Absolute charge measurement for partial discharge test => 5 pC
- Wave form generator according VDE V 880-10 requirements up to 4,2 kV stress signal



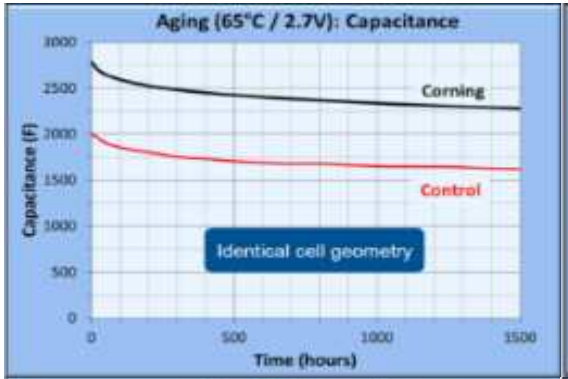


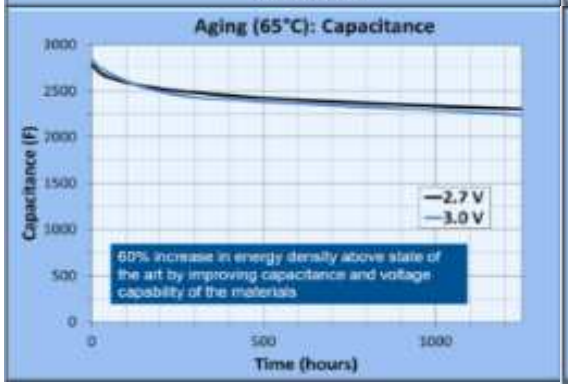
Development of Ultra Caps

	Capacitance	Diameter	Height
Units	F	cm	cm
Corning lot Average	**>2700**	**6.07**	**10.2**
Commercially Available	**2000**	**6.07**	**10.2**

New Ultra Cap cells delivering energy densities in the range of 7-9 Wh/l

Development of Ultra Caps





ESTRELIA Test profile

- Current: Peak = 300 A; Average = 84 A
- Cycle voltage between 2.7 V and 1.3 V
- Cycle time = 60 seconds
- Simultaneous temperature cycling
  - -40°C t0 +40°C, 9 hour cycle

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Li-Ion battery demonstrator with BMS, sensors & fuses cells

Module assembly

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Estrelia summary

- **New ICs** for cell monitoring and **autonomous cell balancing** for ultra capacitors and Li-Ion cells: System level operation demonstrated
  Product available to market
- new cost effective **power Antifuse** for dynamical configuration of energy storage units:
  prototype versions available, performance optimization on going
- **Safety sensors**: new **gas sensor** with high sensitivity and fast response and new MEMS based **spark detection sensor** to improve safety monitoring of energy storage systems: tests demonstrating early sensing capability, threshold for demo energy pack fixed
  Spark sensor in development
- **LFP Energy pack:** at drive cycle tests
- New **ultra capacitor power cell** with 40% higher energy density:
  prototypes available
- new high voltage test equipment, **galvanic isolated** CMOS driver:
  available, verification tests ongoing

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test