Challenges for Standardization of 48V Battery Packs

SAMSUNG SDI
SAMSUNG SDI - Overview

Product Portfolio SAMSUNG SDI Battery Systems

Overview of 48V battery packs

Standardization potential of 48V battery pack
  - Cells
  - Mechanical design
  - Cooling
  - Electrics/electronics

SAMSUNG SDI platform solutions

Conclusion and outlook
## Current Battery Packs & Portfolio

<table>
<thead>
<tr>
<th></th>
<th>12V</th>
<th>48V</th>
<th>PHEV</th>
<th>BEV Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Content</strong></td>
<td>0,15 – 0,5 kWh</td>
<td>0,2-3 kWh</td>
<td>6 – 18 kWh</td>
<td>36 – 100 kWh</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>3 - 6 kW</td>
<td>12 - 25 kW</td>
<td>50 - 120 kW</td>
<td>100 – 500 kW</td>
</tr>
<tr>
<td><strong>Voltage</strong></td>
<td>12 V</td>
<td>48 V</td>
<td>400 V</td>
<td>400 V / 800 V</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>4 - 5 kg</td>
<td>&lt; 10 kg</td>
<td>80 - 210 kg</td>
<td>400 - 600 kg</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>passive</td>
<td>passive / air / liquid</td>
<td>liquid</td>
<td>passive / liquid</td>
</tr>
<tr>
<td><strong>SOP</strong></td>
<td>2013</td>
<td>2018</td>
<td>2013</td>
<td>2010</td>
</tr>
</tbody>
</table>
Overview 48V-battery system solutions

- **Applications**
  - 48 V systems are designed to support cranking and restarting of the ICE, brake energy recuperation and electrical high power loads
  - In premium vehicle segment additional energy content is requested to support comfort functions

- **Performance - 3 classes of 48V applications**
  - Standard 48V pack
  - High power 48V pack
  - 48V pack with integrated DC/DC converter

- **Packaging**
  - In 2020 current solutions specific to OEM’s and application
  - Vision for 2025+ for standardized 48V pack sizes

- **Cooling**
  - Air cooling considered for 48V systems in most applications
  - High performance: cooling media liquid / refrigerant
  - Design target for next cell generations to omit active cooling

- **Electronics/Battery management**
  - Full integrated solutions: BMU, CSC, current sensor on one PCB
  - “Down sized” with less functionality compared to PHEV/HEV electronics
# 48V Battery pack main requirements

<table>
<thead>
<tr>
<th></th>
<th>48V Standard Pack</th>
<th>48 V Performance Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy content [Wh]</strong></td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Voltage range [V]</strong></td>
<td>36 - 52</td>
<td>36 - 52</td>
</tr>
<tr>
<td><strong>Max. Current [A]</strong></td>
<td>+/- 400</td>
<td>+/- 600</td>
</tr>
<tr>
<td><strong>Charge Power BOL [kW]</strong> (50% SOC, 25°, 1 Sec)</td>
<td>12-16</td>
<td>20-25</td>
</tr>
<tr>
<td><strong>Discharge Power BOL [kW]</strong> (50% SOC, 25°, 1 Sec)</td>
<td>12-16</td>
<td>20-25</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>&lt; 8l</td>
<td>&lt; 10l</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>&lt; 10 kg</td>
<td>&lt; 15 kg</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>No cooling / Air cooled</td>
<td>Air / liquid cooled</td>
</tr>
<tr>
<td><strong>Housing Technology</strong></td>
<td>Depending on crush requirements plastic or aluminum</td>
<td>Depending on crush requirements plastic or aluminum</td>
</tr>
<tr>
<td><strong>Packaging</strong></td>
<td>Specific to OEM's and application</td>
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</table>
Energy & power requirements & cells for 48V packs

Energy / power requirements of different 48V programs worldwide

- Power / Energy performance requirements of different OEM's and applications can be covered with two classes of 48V battery packs
  - “Standard” 48V battery pack applications satisfied with 15kW/500Wh-battery pack
  - For high-power applications up to 25kW/1000Wh battery packs are requested
- Mostly active air-cooling required, liquid-cooling approach for specific applications.
- 48V pack with integrated DC/DC converter as option

Power/Energy requirements are very similar for different OEM's and applications ➔ standardization of cell size
Samsung SDI offers standard cells for 48V applications
Due to different vehicle requirements mechanical designs are specific for different 48V applications.

For harmonizing 48V battery packs OEM’s will have to cooperate closely

Vision 2025+ → standardized 48 V battery systems?
Air cooling can be critical in matter of cooling capability and temperature gradient. Besides cooling performance, safety- (venting) and comfort (noise) aspects have to be considered.

For high power 48V systems liquid cooling is the best solution. Cooling media has to be separated from HV path to avoid risk from leakage.

Refrigerant cooling as an option to avoid separate liquid cooling circuit.

Intelligent thermal management and specific pack design required to avoid aggressive cooling and condensation of humidity.

Requirements for cooling are different depending on application

- size and packaging of battery pack, safety and comfort aspects, cooling requirements, load cycles, power requirements, cell design and chemistry, after sales aspects…

In general there is no optimal cooling concept and/or cooling medium!

Choice of cooling depends on vehicle requirements and architecture.

Standardization of cooling components is not feasible, but scalable cooling concept can be applied
Electronics for 48V applications

- **Battery management functions:**
  - Operation / Battery management function
  - Control & interface function
  - Safety function
  - Diagnose function

- **Specific electronics (BMU+CSC) and relays for 48V**

- **Modular software to be flexible for different pack requirements and cell technologies**

- **Safety requirements up to ASIL C requested.**
  - Conformity to safety standards (ISO 26262)
Samsung SDI has platform solutions for “standard” and “high power” packs.

- Standard cells for 48V
- Platform for 48 V electronics, sensors and relays
- Adaptable cooling designs for air and liquid cooling
- Specific mechanical design
## Samsung SDI platform for 12/48 V battery systems

<table>
<thead>
<tr>
<th>12V</th>
<th>48V</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="11Ah Hi-Cap" /></td>
<td><img src="image2" alt="Liquid Cooled Type" /></td>
</tr>
<tr>
<td>12.6Ah Hi-Cap (4.2Ah x 3p)</td>
<td><img src="image3" alt="Air Cooled Type" /></td>
</tr>
</tbody>
</table>

### Dual (Vertical)
- 11Ah Hi-Cap
  - SOP 2017

### Dual (Horizontal)
- 8.4Ah Hi-Cap (4.2Ah x 2)
  - SOP 2020

### Standard
- 5Ah HEV x 2p
  - SOP 2018

### Power
- Air Cooled Type
  - 6.5Ah HEV x 3p
    - SOP 2019
  - 10Ah HEV (Gen2 : 19.5Ah HEV)
    - SOP 2017

### DCDC integrated
- SOP 2017
OEM’s are currently targeting an additional 48V vehicle power supply, mainly to reduce CO₂ emission and fuel consumption and for supporting electrical high power loads.

Market introduction for 48V Systems for specific applications is ongoing. High volume approach is targeted for 2020+

The main challenges for high volume market introductions are:
- Development of specific cells in matter of design and size for 48V
- Standardization of 48V systems overall OEM’s
- System cost reduction

Platform approach for 48V applications is feasible.
Fully standardized 48 V battery systems needs close cooperation between OEM's
The Power behind Electromobility

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