(Cost)-Efficient System Solution for the 48V Vehicle Power Supply

Integrated Battery Management, Module Supply and Communication

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Introduction
Semiconductors enabling new automotive technologies

Integrated Circuits (IC) technology underpins many of the innovations we will see in the next generation vehicles, offering:

- Reliability,
- Cost efficiency and
- High integration.

Semiconductor technologies already provide the basis for many cost-effective, reliable automotive solutions.

The dual storage / voltage power supply is the next area in which ICs will play the dominant technological role.
Why a new voltage supply?
High energy, high power loads in vehicles

<table>
<thead>
<tr>
<th></th>
<th>P_{MAX} [kW]</th>
<th>P_{AVG} [kW]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Conditioning</strong></td>
<td>3 - 5</td>
<td>1.5 - 2</td>
</tr>
<tr>
<td><strong>Active Chassis</strong></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Electrical Brake</strong></td>
<td>2</td>
<td>0.2</td>
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<tr>
<td>(brake-by-wire)</td>
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<tr>
<td><strong>Electrical Steering</strong></td>
<td>1.4</td>
<td>0.03</td>
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<tr>
<td>(drive-by-wire)</td>
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</tbody>
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Efficient supply of vehicle systems

New storage systems

(Very) high volume vehicles
- Small and mid-sized cars
  - Dual storage system 14V
    - Usage of Li-Ion and Lead-Acid batteries

Lower volume vehicles
- High segment cars
  - Dual voltage system 14V / 48V
    - Usage of 48V Li-Ion and 14V Lead-Acid batteries
Dual-storage architecture
Components overview

System layout of a dual-storage power supply

Low Voltage Domain 14V
14V Integrated Battery Management System
System solution with ams components

Advantages:

• Very low bill-of-material

• Full synchronous voltage and current measurement → highest accuracy for SoC and SoH calculation

• No fast communication to microcontroller required → low noise and high immunity

• Accuracy: 0,2% on pack and cell voltage
Dual-voltage architecture
Components overview

System layout of the dual-voltage power supply without galvanic decoupling
48V Integrated Battery Management System
System solution with ams components

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Battery Management System Comparison

Supplier A

- Battery Mainboard
- Cell Measurement Board
- High-voltage current sensor

ams
48V power supply
Specification according LV148

Voltage levels according LV148

Load Dump requirement
Voltage capability higher 90V required

Simulation of real environment for critical conditions

Representation of the 14V / 48V dual-voltage supply in co-simulation

Co-simulation enables the prediction of the maximum voltage peak in the power supply

Note: Voltage peaks > 90V can be avoided with reasonable effort on system level

Simulated voltage peak during load dump
Dual-voltage Architecture and Communication
Communication among the voltage domains

- >70V capability
- <60V capability

48V

Communication
CAN, FlexRay™

14V
Dual-voltage Architecture and Communication

Critical failure modes

Communication devices connected to the 14V supply can get damaged!
Dual-voltage architecture
ams solution for communication between the voltage domains

48V

>70V capability

>70V

Communication
CAN, FlexRay™

<60V capability

14V

Loss of Ground!

ams transceivers prevents damage of the 14V communication devices!
CAN communication on remaining network guaranteed.
Voltage operating areas of 48V devices

- **Not operational**
  - Up to $V_{ESD_{max}}$
- **Operational with higher leakage**
  - 70V (66V reverse)
- **Fully operational**
  - 90V

Device protection
- **Active. No operation.**
- **Fully operational but with higher current**
- **Module supply and communication devices are fully operational within the specification.**

Device state
- **ESD Clamp state**
  - Under voltage
  - Operational with higher leakage
  - Fully operational

ESD Clamp state
Dual-voltage architecture
ams solution for communication between the voltage domains

ams transceivers prevents damage of the 14V communication devices!
CAN communication on remaining network guaranteed.
Conclusion
14V dual-storage and 14V / 48V dual-voltage supply

- Dual-storage and dual-voltage systems with Li-Ion based batteries are providing enhanced dynamic charge acceptance (DCA).
- The 48V power supply offers a fast and cost efficient way to save up to 30g / km CO2 for passenger cars.
- 90V voltage capability is a basic requirement of ICs used in power supply and communication modules.
- ams provides a chipset for 14V and 48V Li-ion systems including current/voltage/temperature measurement and cell supervision.

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Thank you

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