12V / 48V Hybrid Vehicle Technology

Steven Kowalec

www.continental-corporation.com
Powertrain Electrification Technology

Micro-hybrids to BEVs

Fuel saving with low voltage technology

- 12V Mild Hybrid
  - <5 kW
  - 3 – 4%
  - 5 – 13 kW
  - 13 – 21%

Fuel saving and electric driving

- 48V Full Hybrid
  - 20 – 40 kW
  - 20 – 30%

- Plug-in Hybrid
  - 50 – 90 kW
  - 50 – 75%

100 % electric driving

Electric Vehicle
- 50 – 90 kW
- 100%

System Costs

CO₂ Reduction

Electrification

Continental
# Electrification Tailored-to-Fit

## Mild Hybrids - True Fit With Every Segment

<table>
<thead>
<tr>
<th>Technology</th>
<th>Power Range (kW)</th>
<th>CO₂ Saving Potential in NEDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Vehicle</td>
<td>60 - 150</td>
<td>100%</td>
</tr>
<tr>
<td>Plug-in Hybrid</td>
<td>60 - 120</td>
<td>50 - 75%</td>
</tr>
<tr>
<td>Full Hybrid</td>
<td>20 - 40</td>
<td>20 - 30%</td>
</tr>
<tr>
<td>48V Mild Hybrid</td>
<td>5 - 15</td>
<td>13 %</td>
</tr>
<tr>
<td>12V Micro Hybrid</td>
<td>&lt; 5</td>
<td>3 - 4 %</td>
</tr>
</tbody>
</table>

- **E-Motor Power**
- **Vehicle Segment**: A, B, C, D, E
- **Indicates segments in which the technology is most often applied.**

![High Voltage Axle Drive](image)
![High Voltage Power Electronics](image)
![48 V DC/DC Converter](image)
![48 V Belt Starter Generator](image)
![Voltage Stabilization System](image)
Micro-hybrid Technology

Voltage Stabilization System (VSS) and Dual Battery Manager (DBM)
**Powertrain Outlook 2030**

**Peak Combustion Expected in 2025 - 2027**

- **Vehicle Electrification** is making a decisive step forward.
  - Cost optimized 48V solutions will be found in each Mid class car in mature markets.
  - Long term…pure EV will win the race against hybrid solutions.

---

**Global PV/LV Production**

- **Propulsion Split**

---

**Global PV/LV Production**

- **Electrification View**

---

**69%** of all vehicles in mature markets will be electrified by 2030*

---

* Source: IHS, own estimates
Powertrain Outlook

Global PV/LV Engine Production (2015-2030)

World – Combined View

Source: Continental, IHS

Rounding may cause percentages not to sum up exactly to 100%
48V Technology – More than a Mild Hybrid

Strategies Over and Above CO₂ Reduction

› 48V electrification is primary driven by CO₂ reduction

› Future powertrain topologies with 48V enable even higher CO₂ savings

› Regenerated energy can be utilized for safety, comfort and efficiency functions

› Allocation of electric components to the 12V and 48V board net must be considered

› Maximum benefit can be achieved with a predictive driving strategy via connected energy management
48V Hybrid Vehicle Technology
12V \(\rightarrow\) 48V Adaptation

› Conventional 12V boardnet

› 12V with additional 48V boardnet

› P0 implementation shown
48V Topology

*BMS, DCDC Converter, Inverter, Motor/Generator*
48V Technology

48V Battery Management System (BMS)

› Protect the energy storage system against over-current, over-discharge, over-load
› 14 Cell measurements and balancing
› Battery pack and 48V DC link measurements
› Current and thermal measurements
› Contactor(s) and Fan control circuitry
› State-of-Charge (SOC)
› State-of-Health (SOH)
› State-of-Function (SOF)

500Wh battery used in Conti 48V demonstration vehicles
48V DC/DC Scalability

Modular Concept

48V/12V DC/DC  800W to 3.2kW

<table>
<thead>
<tr>
<th></th>
<th>800W</th>
<th>1600W</th>
<th>2400W</th>
<th>3200W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phases</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

› Bi-directional operation (voltage/current controlled)

› Precharge functionality for 48V DC link
# 48V Technology

## Belt Starter Generator (BSG)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Motor 1 60mm</th>
<th>Motor 2 40mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Start Torque Typ. &amp; (@-25°C, 0.5s)</td>
<td>~50Nm</td>
<td>~30Nm</td>
</tr>
<tr>
<td>Max. peak power</td>
<td>~13 kW mot</td>
<td>~13 kW mot</td>
</tr>
<tr>
<td></td>
<td>~14 kW gen</td>
<td>~14 kW gen</td>
</tr>
<tr>
<td>Cont. Power</td>
<td>~6 kW mot</td>
<td>~6 kW mot</td>
</tr>
<tr>
<td></td>
<td>~7 kW gen</td>
<td>~7 kW gen</td>
</tr>
<tr>
<td>Cooling Fluid Temperature</td>
<td>-40°C…+115°C</td>
<td>-40°C…+115°C</td>
</tr>
<tr>
<td>Communication Interfaces</td>
<td>CAN, LIN, FlexRay</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>~13kg</td>
<td>~10kg</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Length: &lt;200mm Diameter: &lt;180mm</td>
<td>Length: &lt;180mm Diameter: &lt;180mm</td>
</tr>
</tbody>
</table>
48V Technology

Belt Starter Generator (BSG)

General Functions:

› Combustion engine start (standard cold and warm start)
› Boost (electrical assistance)
› Recuperation (regenerative braking)
› Generator
› IC Engine Shaft positioning
› IC Engine Operating point shift
48V Technology

*Belt Starter Generator (BSG) Configurations*

- **CO₂ potential:** -13%
- 48 volt introduction
- Integration in existing belt drive architecture

- **CO₂ potential:** -22%
- Maximum recuperation capability
- Electrified auxiliaries, eParking, eCreeping,..
48V System

BSG Operating States

- eLaunch
- Charge
- Boost
- Sailing
- Coasting
- Recuperation
Connected Energy Management (cEM)

Driver Guiding Functions

- Deceleration Assist
- Traffic Light Assist
- Slope Assist
- Curve Assist
## 48V In the Real World

**Coasting as significant fuel-savings strategy**

<table>
<thead>
<tr>
<th></th>
<th>Driving time</th>
<th>Driving distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban (city)</td>
<td>37%</td>
<td>20 km</td>
</tr>
<tr>
<td>Non urban</td>
<td>46%</td>
<td>38 km</td>
</tr>
<tr>
<td>Highway</td>
<td>16%</td>
<td>34 km</td>
</tr>
<tr>
<td>Total hours</td>
<td>1:35</td>
<td>92 km</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mild hybrid functions</th>
<th>Average active time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine-off coasting</td>
<td>22%</td>
</tr>
<tr>
<td>Recuperation</td>
<td>9%</td>
</tr>
<tr>
<td>Start/stop</td>
<td>6%</td>
</tr>
<tr>
<td>Change of mind</td>
<td>6%</td>
</tr>
<tr>
<td>Driver change behavior</td>
<td>6%</td>
</tr>
<tr>
<td>Load point shift</td>
<td>5%</td>
</tr>
</tbody>
</table>

### CO₂ emission

<table>
<thead>
<tr>
<th>NEDC New European Driving Cycle</th>
<th>Real driving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recuperation</td>
<td>-13%</td>
</tr>
<tr>
<td>+ coasting</td>
<td>-8%</td>
</tr>
<tr>
<td>Total CO₂ reduction:</td>
<td>-21%</td>
</tr>
</tbody>
</table>
48V Technology

Additional fuel-saving strategies

Due to the limitations on the existing 12V boardnet strategies, the market may soon decide that adoption of 48V consumers is necessary to provide customers with features desired.

<table>
<thead>
<tr>
<th>Component</th>
<th>Peak Power [W]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTC Heater</td>
<td>≤ 4 kW</td>
</tr>
<tr>
<td>AC Compressor</td>
<td>≤ 3.5 kW</td>
</tr>
<tr>
<td>Electronic Roll Control (ERC)</td>
<td>≤ 3 kW</td>
</tr>
<tr>
<td>Smart Cooling Pump</td>
<td>≤ 400 W</td>
</tr>
<tr>
<td>Fluid Pumps</td>
<td>~ 200 W</td>
</tr>
<tr>
<td>Front Windshield Heating</td>
<td>≤ 700 W</td>
</tr>
<tr>
<td>EH-Brake System</td>
<td>≤ 900 W</td>
</tr>
<tr>
<td>E-Compressor</td>
<td>3 kW - 7kW</td>
</tr>
<tr>
<td>E-Steering</td>
<td>≤ 2 kW</td>
</tr>
</tbody>
</table>
48V Hybridization and Electrification

Summary

› 48 volt technology is entering the mass market

› 48V P0 architecture offers significant efficiency improvements with acceptable cost and integration effort

› Additional efficiency improvement and electric launch capability with 48V P2 architecture

› Much better efficiency potential in urban driving comparison to FTP and WLTC

› Advanced functions available like boosting, sailing, coasting, electrical parking

› Electric torque assist for significant improvement of acceleration

› Optimization of Electrical Architecture 12 V vs. 48 V
Thank you!