48V eco-Hybrid Systems

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www.continental-corporation.com

European Conference on Nanoelectronics and Embedded Systems for Electric Mobility
Powertrain Clean Power
The desire for Individual Mobility drives our business

Main Drivers for our Business

- Legislation
- Emissions

Sustainable Mobility

Technology Diversity

- Combustion
- E-Mobility

Consumer Demand
- Driving Performance
- Value 4 Money
Prioritization of CO₂ reduction measures
Powertrain – Systematic Proceeding

Understand Energy Efficiency ➔ Energy Pyramid of the Vehicle

Collection of External Energy (e.g. Solar power & cells)

Energy recuperation

Demand controlled Energy Supply (Energy Management)

Transport of Energy without losses (Focus: Efficiency)

Optimization of Overall Power Economy by reducing energy consumption & kinetic losses (Reduced Spending & Drag Elimination)

Electrification, Battery Systems, Predictive Energy Management, ...

Thermal Management, Stop-Start, Predictive Energy Management, Demand controlled Actuation, ...

Combustion, Turbocharging, Hybridization, Electrification, .....

Weight, Rolling resistance, Aerodynamics, .....

DRAFT
CO2 Challenge Legislation is one of the Key Drivers for Clean Power

- Worldwide fleet emission regulations require continuous CO2 reductions
- Each OEM has an individual baseline
BU Hybrid Electric Vehicle
Powertrain 2025 Scenario

More than 30% of the vehicles worldwide will have an electrified powertrain.
BU Hybrid Electric Vehicle
Powertrain 2025 Scenario - Shares with Electrified Powertrain

More than 30% of the vehicles worldwide will have an electrified powertrain.

Global Passenger Vehicles / Light Vehicles Engine Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Electric Vehicle</th>
<th>Plug in Hybrid</th>
<th>Full Hybrid</th>
<th>Mild Hybrid</th>
<th>48V</th>
</tr>
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<tbody>
<tr>
<td>2013</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
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<tr>
<td>2014</td>
<td>0.4</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.3</td>
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<tr>
<td>2015</td>
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<td>0.2</td>
<td>0.3</td>
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<td>2016</td>
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<td>0.3</td>
<td>0.5</td>
<td>0.4</td>
<td>0.2</td>
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<td>2017</td>
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<td>0.9</td>
<td>0.7</td>
<td>0.7</td>
<td>0.2</td>
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<tr>
<td>2018</td>
<td>1.3</td>
<td>1.3</td>
<td>1.6</td>
<td>1.8</td>
<td>1.1</td>
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<td>2019</td>
<td>1.5</td>
<td>2.2</td>
<td>5.3</td>
<td>6.8</td>
<td>6.0</td>
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<tr>
<td>2020</td>
<td>1.8</td>
<td>2.5</td>
<td>8.6</td>
<td>10.4</td>
<td>6.0</td>
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<tr>
<td>2021</td>
<td>2.1</td>
<td>2.2</td>
<td>12.2</td>
<td>14.1</td>
<td>8.0</td>
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<tr>
<td>2022</td>
<td>2.2</td>
<td>3.2</td>
<td>16.2</td>
<td>15.9</td>
<td>9.8</td>
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<tr>
<td>2023</td>
<td>2.5</td>
<td>3.2</td>
<td>19.7</td>
<td>17.2</td>
<td>11.4</td>
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<tr>
<td>2024</td>
<td>2.9</td>
<td>3.6</td>
<td>23.1</td>
<td>18.7</td>
<td>12.9</td>
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<td>2025</td>
<td>2.9</td>
<td>3.6</td>
<td>26.9</td>
<td>20.3</td>
<td>14.1</td>
</tr>
</tbody>
</table>

Production Volumes [million units]
BU Hybrid Electric Vehicle
Electrification tailored to fit

- Fuel saving with low voltage technology
- Fuel saving and electric driving
- 100% electric driving

CO\textsubscript{2} Reduction

12 V Start-Stop
48 V Eco Drive
Full Hybrid
Plug-in Hybrid

Electrification

Continental
BU Hybrid Electric Vehicle
Product Portfolio for 48V and High Voltage

HEV - Electric drivetrain systems and components from one source

48V Eco Drive
- Motor
- Power Electronics
- Energy Storage

HEV and PHEV

All Electric Vehicle
BU Hybrid Electric Vehicle
48V Eco Drive – System Overview

48V – a valuable complement to the high voltage electrification

- Two voltage levels: 48V and 12V
- Additional 48 V consumers like high power application, e.g. A/C compressor
- Stop-Start, coasting, recuperation & boosting, electric driving
- Demo car with 48V System available
- Simulation results have been confirmed with test drives
BU Hybrid Electric Vehicle
48V DCDC Converter

Passive air cooled 48V-12V DC/DC converter

› Passive air cooled
› High efficiency
› Scalable design for different output powers
› Pre-charge of DC link capacitor from 12V battery

› 210 A at 12 Volt power net
› Bi-directional operation
  › 3 kW buck mode
  › 6 V…16 V output buck mode
  › 3 kW boost mode
  › 24V…54 V output boost mode

› Options:
  › 3kW, 8 phases, high efficiency
  › 1.8kW, 4 phases, high efficiency
  › 3kW, 4 phases
BU Hybrid Electric Vehicle
Battery for Twin 48V Rear Axle Drive

48V Li-Ion Battery

- 48V Li-ion battery system in A-sample status
- 13 pouch cells (10Ah) in VDA format
- Mechanical layout with H9/LN6 length and width
- Active air-cooling with integrated fan
- High performance and compact build with distinct weight advantage
  - Performance: 14 / 11 kW (Charge / Discharge)
  - Energy: 460 Wh
  - Volume: 8 Liters
  - Weight: < 9 kg
- Further serial development offers potential for reduction in height and weight, increased solidity etc.
BU Hybrid Electric Vehicle
48V Belt Starter Generator with integrated Inverter

Technical benefits

› Inverter and Motor integrated in one housing
› No external cables and connectors between Inverter and Motor
› High performance:
› 60 Nm start torque
› 14 kW peak power mech. (2s)
› 4.2 kW cont power mech. (1h)

› Robust and reliable design
› Water cooled design
› Induction Machine
BU Hybrid Electric Vehicle
48V Eco Drive – Cost efficient hybrid for high volumes

Around 13% less fuel consumption *
Due to the functions start-stop, recuperation, coasting and sailing

E-machine with integrated inverter

48 V/ 12V DCDC converter

Li-ion battery

* Measurement of NEDC drive cycle compared to VW Golf VI BlueMotion, 4 Cyl. Gasoline engine, 1.2 l TSI, 77 kW
BU Hybrid Electric Vehicle
48V Eco Drive

Significant savings in all driving cycles
Customer Benefits of 48V Systems

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Comfort</th>
<th>CO2 Emission Reduction</th>
<th>Feasibility with 12V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Start/Stop</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 warm start (start/stop)</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1.2 cold start (first start)</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>1.3 noise reduction at start</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2 Regeneration / Recuperation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 high efficient generator</td>
<td>x</td>
<td></td>
<td>(x)</td>
</tr>
<tr>
<td>2.2 recuperation during deceleration</td>
<td>x</td>
<td></td>
<td>(x)</td>
</tr>
<tr>
<td>2.3 engine operating point shift (load incr./decr.)</td>
<td>x</td>
<td></td>
<td>(x)</td>
</tr>
<tr>
<td><strong>3 Boost / Electric Driving</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 boosting (beyond ICE limit)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 electric creeping / drive off</td>
<td>x</td>
<td></td>
<td>(x)</td>
</tr>
<tr>
<td>3.3 electric hill hold support</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4 Board Net / 48V Consumer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1 additional board net supply via DC/DC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2 12V board net stabilisation</td>
<td></td>
<td></td>
<td>(VSS)</td>
</tr>
<tr>
<td>4.3 48V components (steering, pumps, HVAC)</td>
<td></td>
<td></td>
<td>x</td>
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<tr>
<td><strong>5 Combustion Engine Support</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 different functions</td>
<td>x</td>
<td></td>
<td></td>
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</tbody>
</table>
48V-BSG-Systems offer a high potential for the realization of the CO$_2$-emission reduction targets and further mild-hybrid functions.

System solutions with an optimum cost-benefit ratio request the following development steps:

- Discussion of requested mild-hybrid functionalities (and flexibilities),

- Proper system definition/parameter, component harmonization, system optimization, reduction of single component costs

Future work should focus on the development of standard technical solutions, which are capable for large series production and flexible for customer applications.
Thank you for your Attention!