Electrification of the Drive Train

EFFICIENT FUTURE MOBILITY
Electrification in the automobile industry is constantly advancing, driven by the megatrends of sustainability, energy revolution, scarcity of raw materials, and urbanization. The emission and fuel consumption regulations worldwide are an essential driving force in the development of new technical solutions that reduce vehicles’ fuel consumption (for example engine start-stop systems). Laws on the reduction of vehicle emissions promote the development of energy-efficient drive solutions and electric vehicles, e.g. through supercredits for electric vehicles.

According to many automotive manufacturers, it will not be possible to achieve emissions targets without hybrid and electric vehicles. Schaeffler therefore offers solutions covering the whole scope of electrified drive trains. The portfolio includes components and systems for drive trains, including those in hybrid and range extender vehicles (REEV) as well as battery-powered (urban) vehicles.
CO₂ Reduction Through the Use of Start-Stop Systems

The use of start-stop systems allows CO₂ reductions of up to 4.5% to be achieved in the New European Driving Cycle (NEDC). In a purely urban cycle, even greater CO₂ reductions are possible.

**Example for fuel consumption**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel consumption in the NEDC without a start-stop system</td>
<td>6.08 L/100 km</td>
</tr>
<tr>
<td>Idling fuel consumption</td>
<td>0.60 L/h</td>
</tr>
<tr>
<td>Fuel consumption in the NEDC with a start-stop system</td>
<td>5.81 L/100 km</td>
</tr>
</tbody>
</table>
Schaeffler Offers Solutions Across the Entire Drive Train Electrification Spectrum

- Emission-free mobility
- New vehicle concepts
- Electric driving
- Recuperation
- For PHEV: Charging from the grid
- E-creeping
- Emission-free mobility
- New vehicle concepts

Degree of electrification

<table>
<thead>
<tr>
<th>HYBRID VEHICLES WITH 48 V</th>
<th>HYBRID VEHICLES (HEV, PHEV)</th>
<th>ELECTRIC CARS (BEV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Recuperation</td>
<td>• Electric driving</td>
<td>• Emission-free mobility</td>
</tr>
<tr>
<td>• E-creeping</td>
<td>• For PHEV: Charging from the grid</td>
<td>• New vehicle concepts</td>
</tr>
</tbody>
</table>
## 48V as Entry-Level Electrification

### 48V hybrid module for manual transmissions

**DESCRIPTION AND CUSTOMER BENEFITS**

- Hybridization of vehicles with manual transmissions
- Attractive CO\(_2\) reduction potential and entry-level electrification
- Comfortable restart of internal combustion engines with impulse clutch
- One actuation system controls both the startup and disconnect clutch
- No additional damper required

### 48V electric axle

**DESCRIPTION AND CUSTOMER BENEFITS**

- Developed for all vehicle segments, both for FWD and RWD
- 2-speed planetary transmission with dog clutch
- Neutral position to disconnect the electric motor
- Standardized electromechanical actuator
- Power electronics integrated into the motor
- Optional torque vectoring functionality

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**Diagram:**

- **Housing**
- **Stator**
- **Resolver**
- **Disconnect clutch**
- **Startup clutch**
- **Double CSC**
**Hybrid Modules**

**Description**
- P2 Hybrid module with clutch system integrated into the rotor
- Includes electric motor, DMF damper, dry disconnect clutch, and electromechanical actuator in an extremely compact design
- Developed for both full and plug-in hybrids with N/S or E/W configurations

**Product benefits**
- High flexibility with regard to adaptation to suit various engines and transmissions
- High energy efficiency due to the dry disconnect clutch with reduced drag losses and self-locking electromechanical clutch actuator
- Suitable for application in transmissions of every kind

**ADVANTAGES**
- CO₂ reduction
- Comfort during restarting of the internal combustion engine
- Additional drive train performance
Electric Axles

Description
- Modular electric axle with neutral position that allows one or two gear stages and the option of torque vectoring
- Integrated control unit for actuation and power electronics for torque vectoring

Product benefits
- Compact coaxial design based on Schaeffler’s planetary transmission and lightweight differential technology
- Developed for both hybrid vehicles and battery-electric vehicles
- Integrated torque vectoring for sporty driving and increased safety

ADVANTAGES
- CO₂ reduction
- Good packaging
- High performance
- Improved driving dynamics
E-Wheel Drive

Description
Highly-integrated wheel hub drive with all components required for drive and braking installed inside the wheel rim, i.e. electric motor, power electronics, brake, and cooling system.

Product benefits
Drive system for new vehicle concepts – specifically designed for urban use:
- Space-saving drive train concept
- Increased maneuverability due to the larger wheel steering angle
- Improved driving agility due to electric torque vectoring
- Cooperative wheel slip control and expanded ESP/ABS functions for increased safety

ADVANTAGES
- Emission-free mobility
- New vehicle platforms
- Driving dynamics
### Recommended Applications for Schaeffler’s Electric Mobility Products

<table>
<thead>
<tr>
<th>FUNCTIONALITY</th>
<th>MICRO HYBRID</th>
<th>MILD HYBRID</th>
<th>FULL HYBRID</th>
<th>PLUG-IN HYBRID</th>
<th>ELECTRIC VEHICLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-stop</td>
<td></td>
<td>Boosting,</td>
<td>E-creeping,</td>
<td>Electric driving</td>
<td>Electric driving in all operating conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>recuperation</td>
<td>stop and go,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>e-sailing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charging from grid</td>
<td></td>
<td></td>
<td></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Electric motor output</td>
<td>0.5 ... 8 kW</td>
<td>8 ... 20 kW</td>
<td>10 ... 50 kW</td>
<td>30 ... 125 kW</td>
<td>30 ... 125 kW</td>
</tr>
<tr>
<td>Voltage</td>
<td>12 ... 48 V</td>
<td>48 ... 280 V</td>
<td>48 ... 400 V</td>
<td>200 ... 400 V</td>
<td>200 ... 400 V</td>
</tr>
<tr>
<td>Range of electric operation</td>
<td>0.1 ... 5 km</td>
<td>0.1 ... 5 km</td>
<td>10 ... 50 km</td>
<td>&gt; 75 km</td>
<td></td>
</tr>
<tr>
<td>CO₂ reduction</td>
<td>4 ... 6 %</td>
<td>12 ... 16 %</td>
<td>15 ... 25 %</td>
<td>&gt; 50 %</td>
<td>up to 100 %</td>
</tr>
<tr>
<td>Electric wheel drive</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Electric axle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hybrid module</td>
<td></td>
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</table>
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