

Bosch Parallel-Hybrid vor der Serieneinführung

Bosch Parallel Hybrid before Start of Production

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Agenda

- **Hybrid System Comparison**
- Electric Drive System
- Results
- Technical Challenges
- Future Outlook



Fig. 1: Agenda

Parallel Hybrid (P2) or Power Split Hybrid (PS)

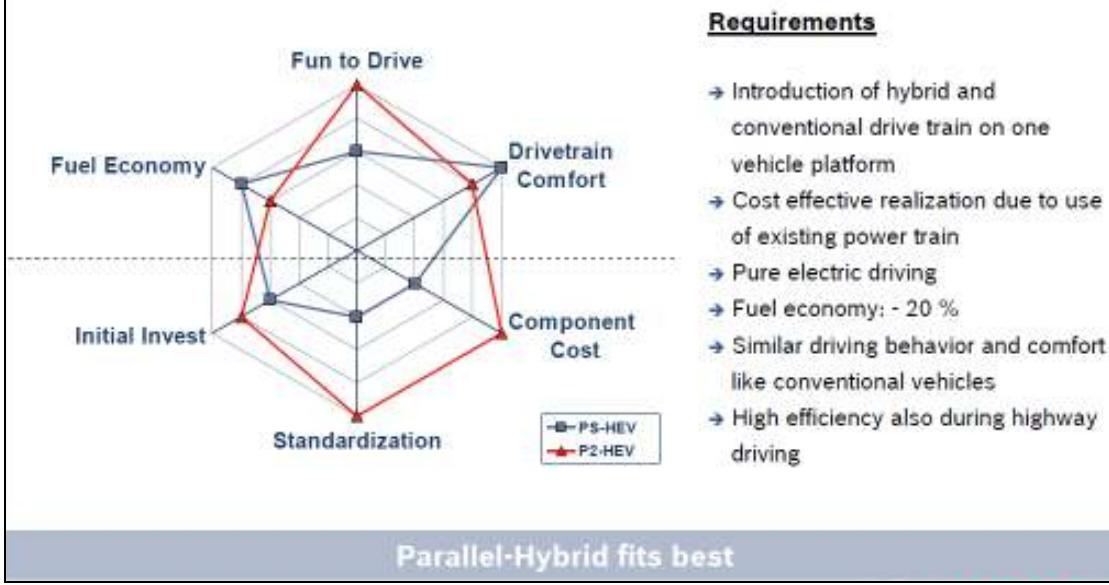


Fig. 2: Parallel Hybrid (P2) or Power Split Hybrid (PS)

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Fig. 3: Agenda

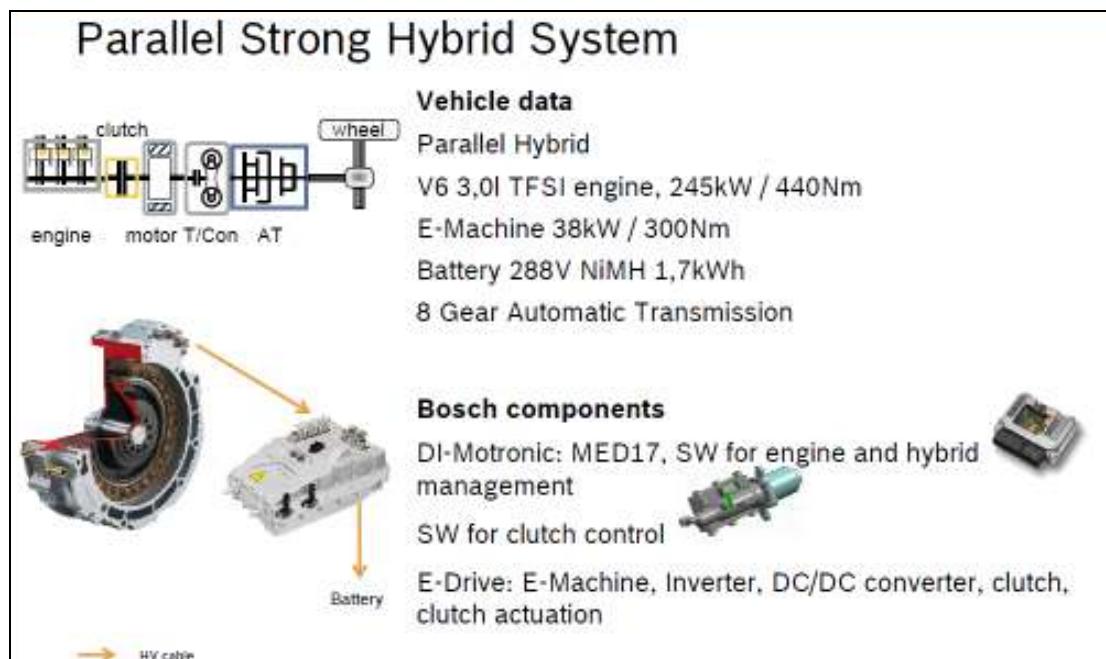


Fig. 4: Parallel Strong Hybrid System

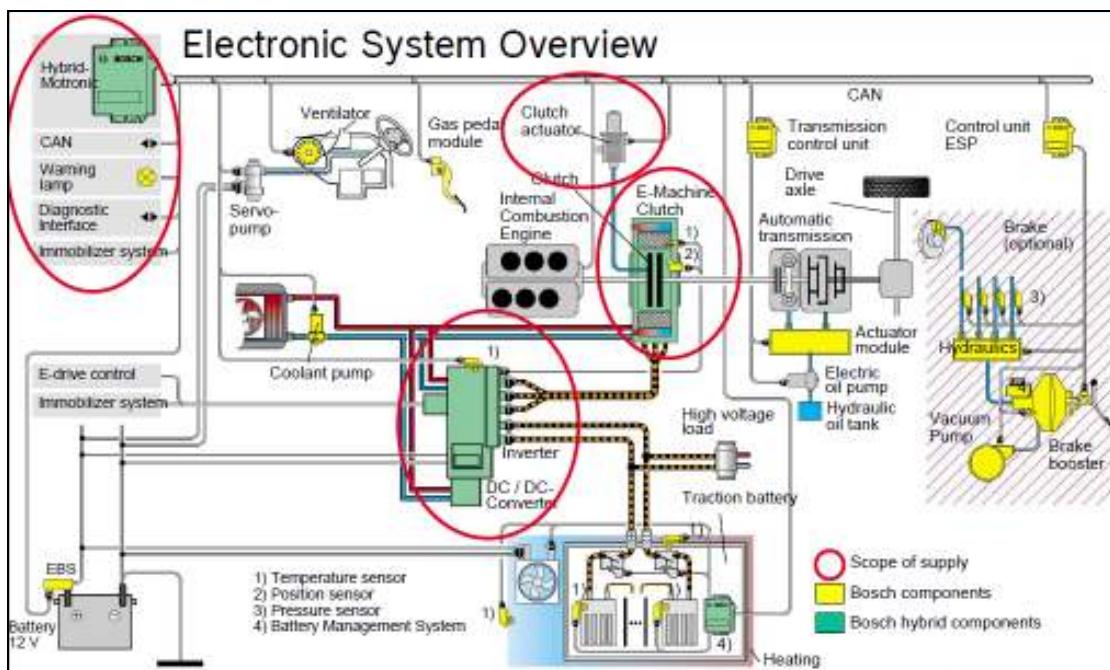


Fig. 5: Electronic System Overview

Parallel Hybrid Components



Electric Motor (IMG)

- Diameter: 300 mm, Length: 55 mm (active parts)
- Liquid cooling (combustion engine cooling circuit)
- Permanent magnet excitation for high efficiency
- Concentric windings for minimum axial length
- Power: 38 kW, Torque: 300 Nm
- Integrated Clutch



Power Electronic

- Inverter current: 300 Arms (370 Arms peak)
- Voltage range: up to 400 VDC
- Liquid cooling 65 °C; temporary 85°C
- Integrated DC/DC converter 3.0 kW
- Power density: 26 kVA/l

Fig. 6: Parallel Hybrid Components

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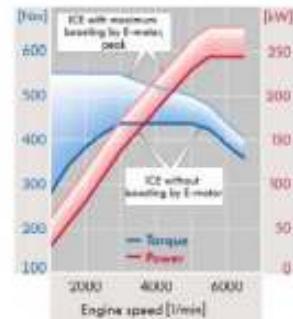
Fig. 7: Agenda

Driving Performance

1. Comfort

High comfort of re-start due to central coordination of e-machine and clutch torque.

Different gear shift maps for hybrid and electric driving.



2. Electric Driving

Pure electric driving up to 70km/h

Typical 30 to 50 km/h

3. Special

ICE disconnection up to 156km/h feasible (Gliding)

4. Fuel consumption

Measurements cover simulation results and will meet customer expectations.

Fig. 8: Driving Performance

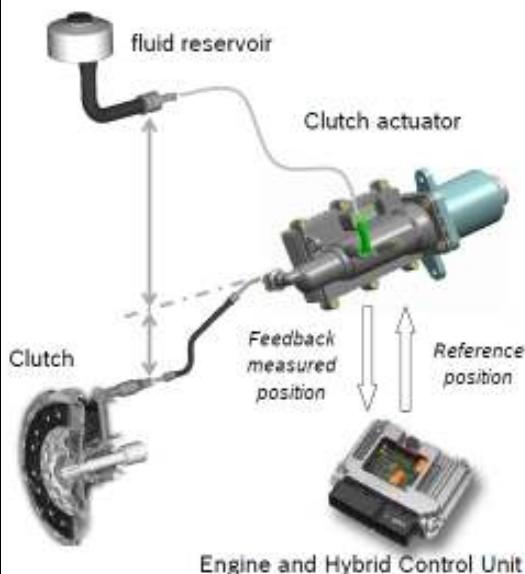
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Fig. 9: Technical Challenges

The Start Clutch System



Requirements

- Jerk-free combustion engine cranking by transmitting the torque of the electric machine (clutch torque control)
- Disconnection of the combustion engine in E-Drive-mode (clutch open)
- Opening & closing time < 150 ms

Challenges

- Reduced installation space
- Accuracy of the torque indication using clutch actuator position sensor
- Physical SW-models to compensate environment influence on the system
- Adaptive SW-algorithms to learn the clutch characteristics through lifetime

Fig. 10: The Start Clutch System

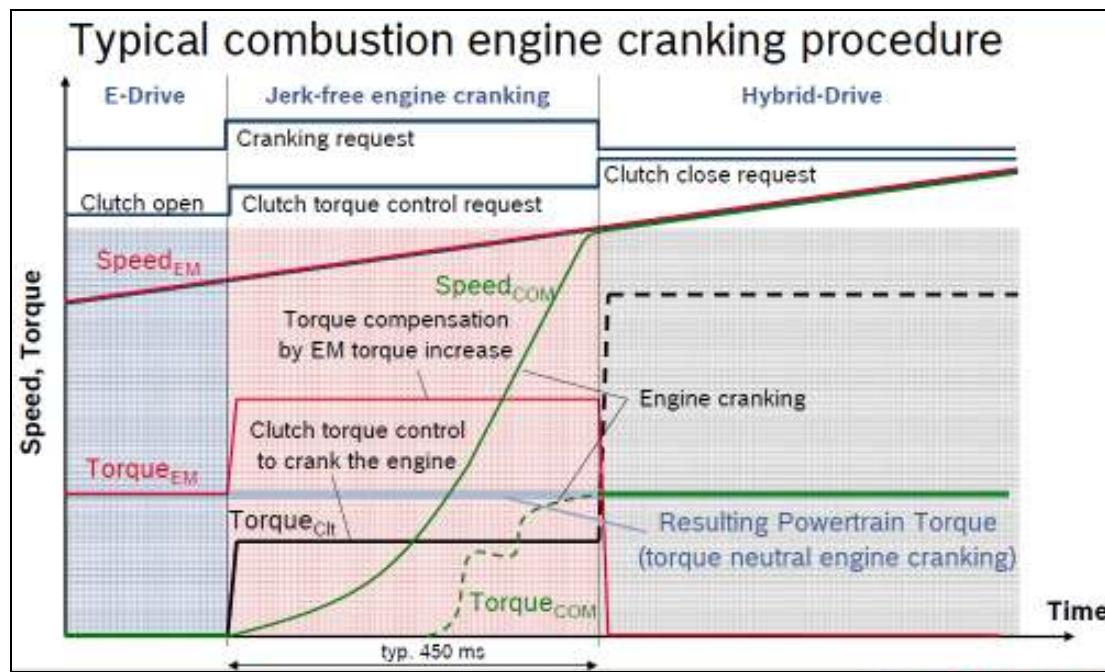


Fig. 11: Typical combustion engine cranking procedure

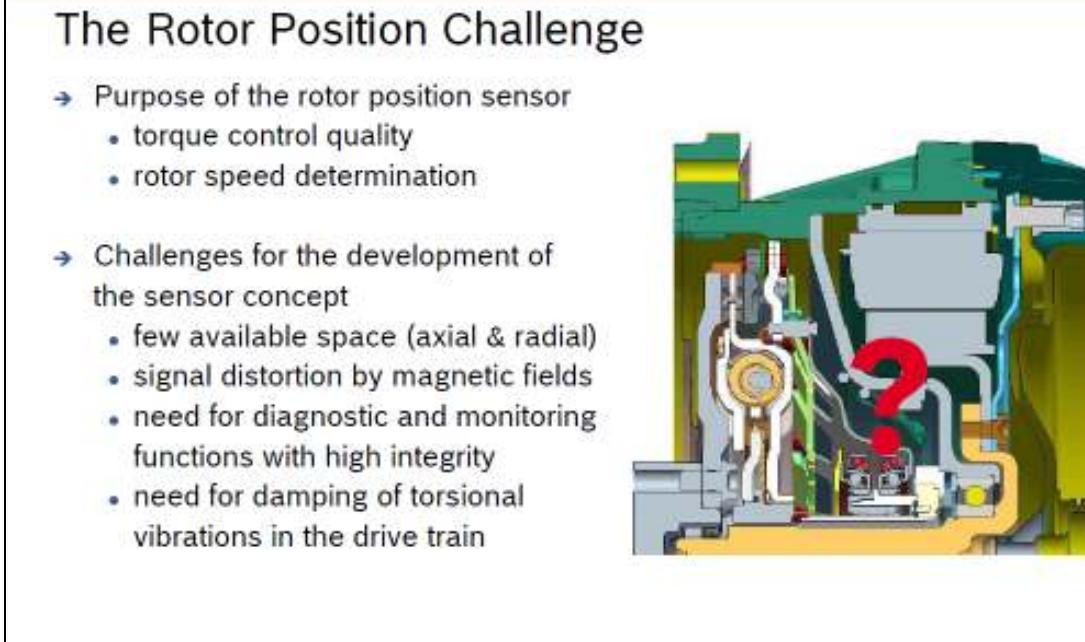


Fig. 12: The Rotor Position Challenge

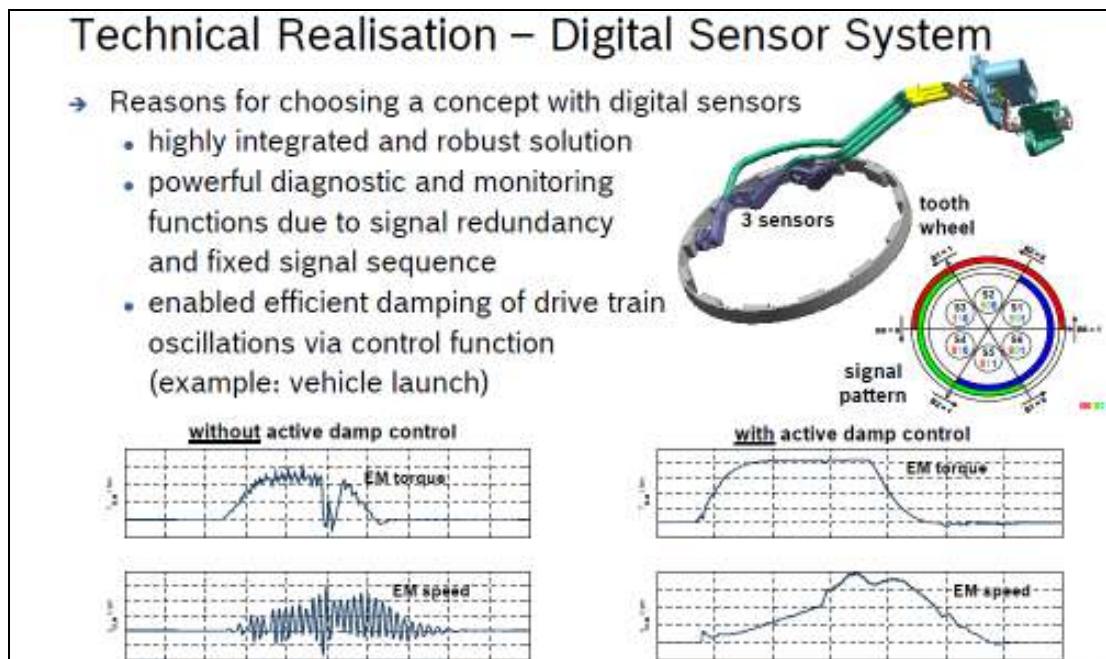


Fig. 13: Technical Realisation – Digital Sensor System

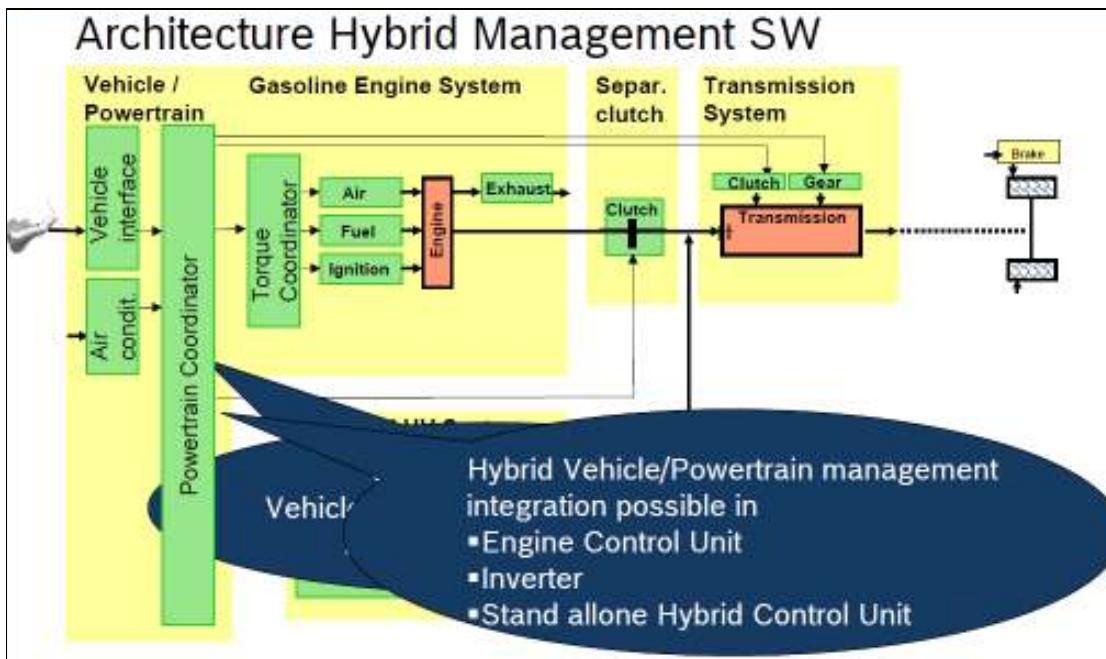


Fig. 14: Architecture Hybrid Management SW

MED17 – Integrated Powertrain Control Unit

Usage of BOSCH Standard Hardware for Hybrid control



- Infineon 32 bit-CPU (METIS TC1797)
 - Memory
 - Flash 4 MB
 - RAM 100 kB
 - NVRAM 11,5 kB
 - 2 CAN interfaces
 - Complete engine control
 - Used for all hybrid functions
 - Driver demand
 - Torque Structure
 - Hybrid Operation Strategy
 - High voltage energy management
 - Clutch coordination, clutch control
 - Thermal management

Fig. 15: MED17 – Integrated Powertrain Control Unit

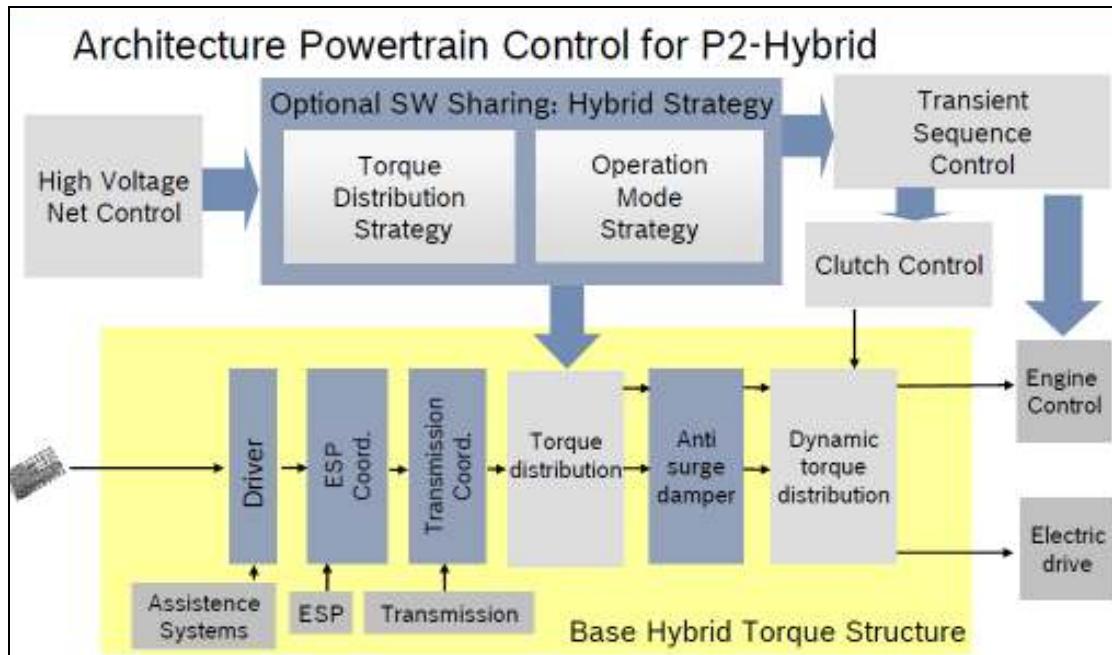


Fig. 16: Architecture Powertrain Control for P2-Hybrid

Agenda

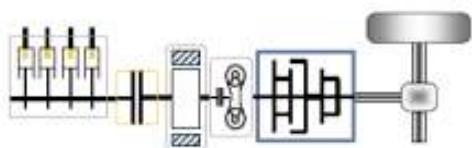
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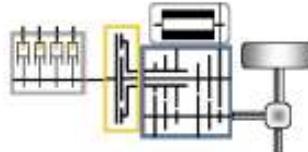
Fig. 17: Agenda

System Strategy HEV, PHEV, EV

P2 Parallel Hybrid (AT w/ 2 clutches)
AT with clutch as launch element



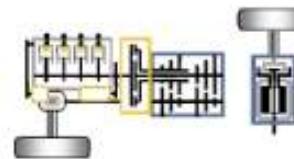
TS Torque Split Hybrid (eDCT)*
DCT w/ integrated electric drive



EV Electric Vehicle
Electric axle drive



AS Axle Split (eAD)*
Conventional drive train plus
electric axle drive (eAD)



* in Cooperation with Getrag

Fig. 18: System Strategy HEV, PHEV, EV

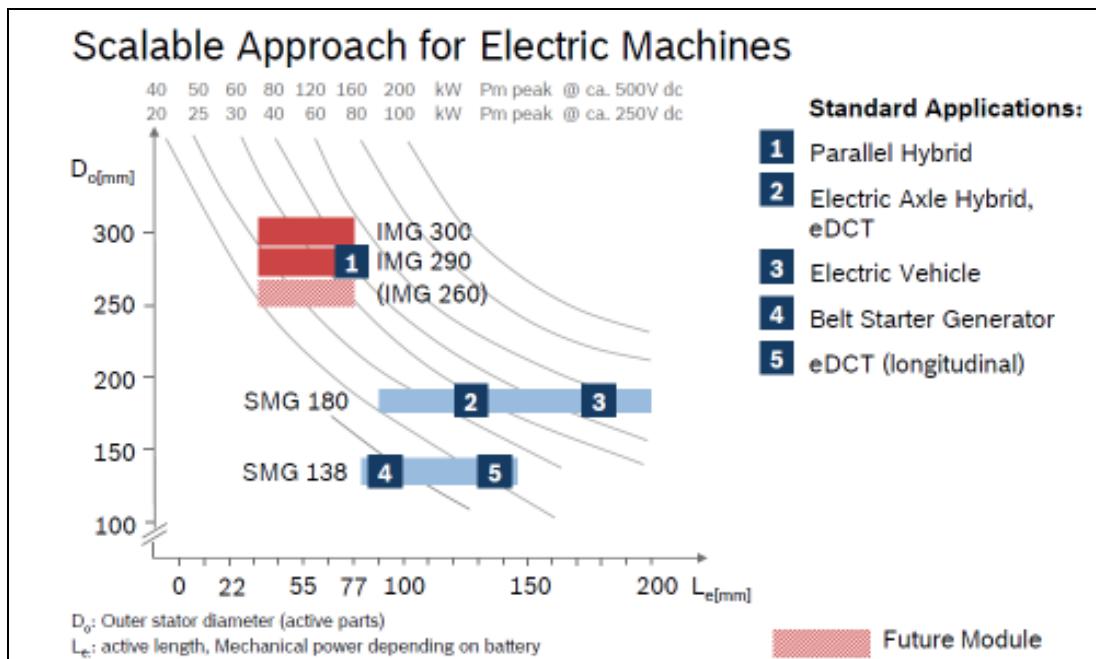


Fig. 19: Scalable Approach for Electric Machines

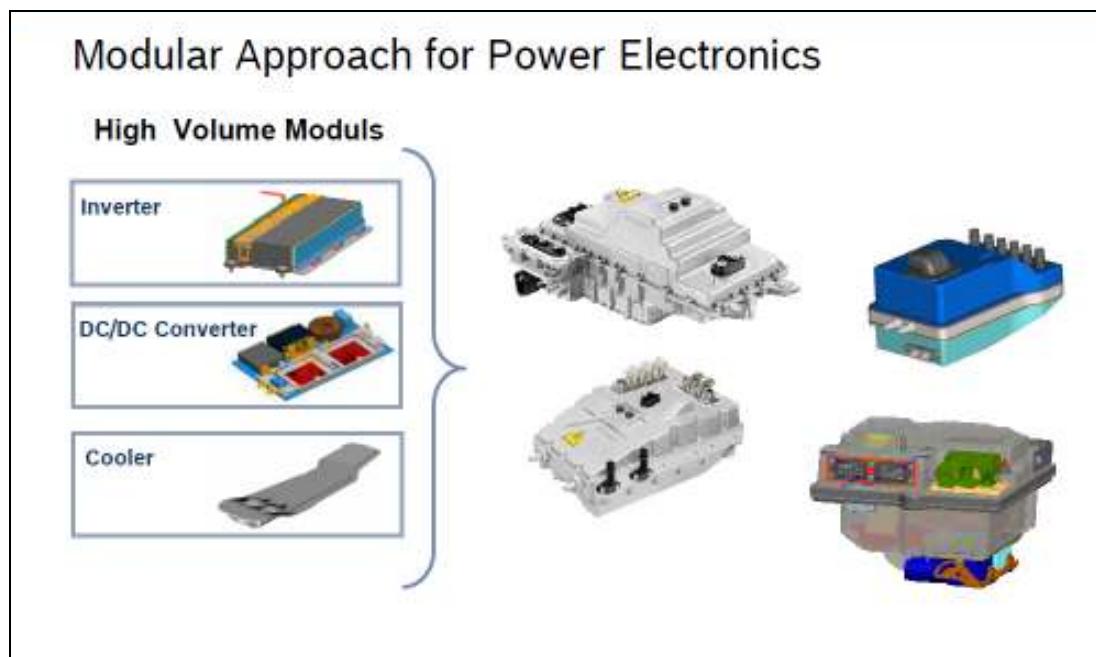


Fig. 20: Modular Approach for Power Electronics

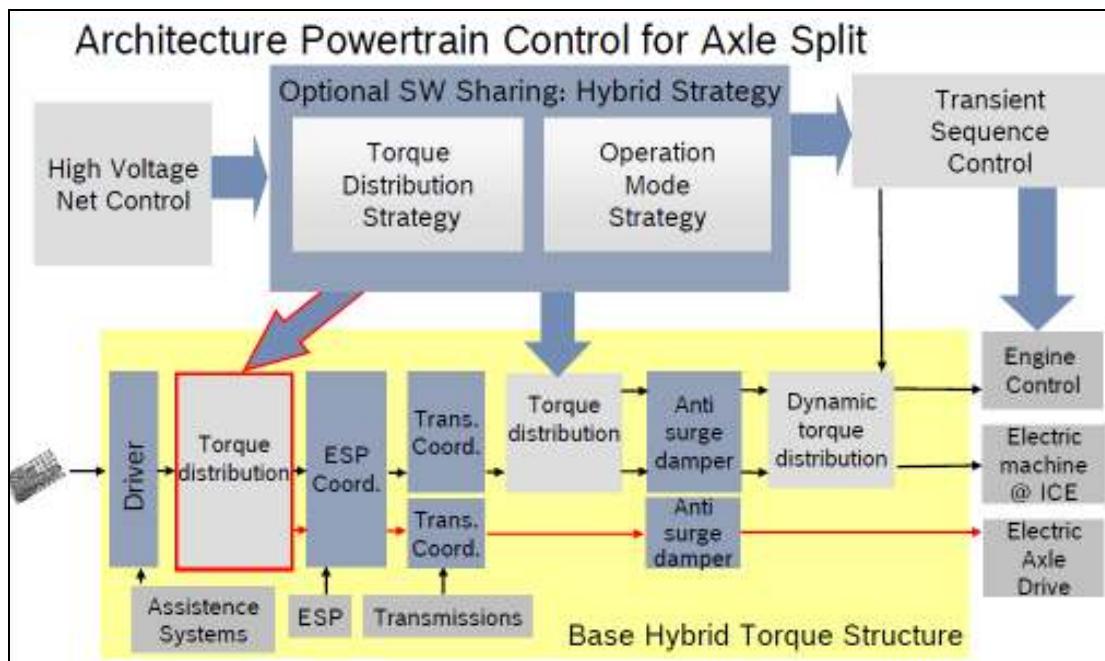


Fig. 21: Architecture Powertrain Control for Axle Split