

6.5 million RWD vehicles

### Market

- ▶ 6.5 million vehicles
- ▶ Electrification: series hybrids
- ▶ Fleet and niche solutions
- ▶ Small percentage of electrification

?

- ▶ Using existing transmissions
- ▶ Gaining efficiency
- ▶ Increasing performance

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Hybrid Modules  
Supporting  
Many Needs

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6.5 million RWD vehicles

### Hybrid Module

ICE drive

ICE drive

E-drive / regen.

Engine start


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**P2 RWD Architecture**

- ▶ Combustion-engine driving
- ▶ RWD architecture space
- ▶ Electric driving
- ▶ Electric boost and recuperation
- ▶ Engine start

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6.5 million  
RWD vehicles

### The Appeal of Hybrids

What do drivers like about hybrids?



**Features**


- ▶ Electric drive
- ▶ High power
- ▶ High torque
- ▶ Instantaneous powertrain feedback


**Properties**

- ▶ Improved fuel economy
- ▶ Smooth launch
- ▶ Adequate price

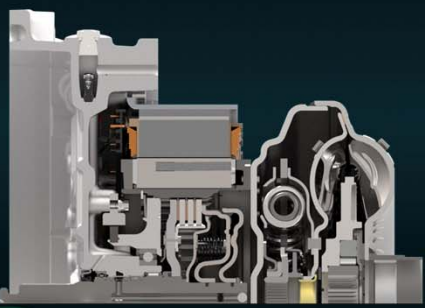
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### Hybrid Module



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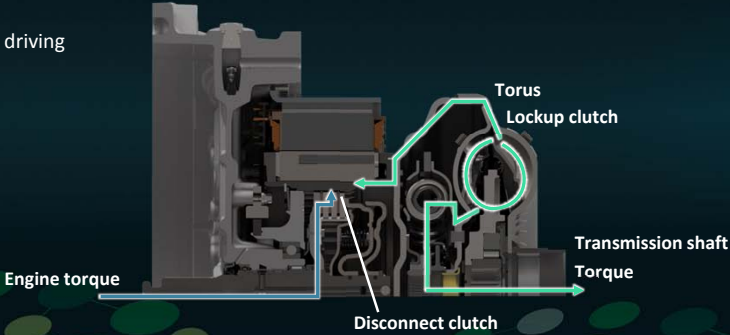
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### Hybrid Module

- ▶ Combustion-engine driving



Engine torque

Disconnect clutch


Torus Lockup clutch


Transmission shaft Torque

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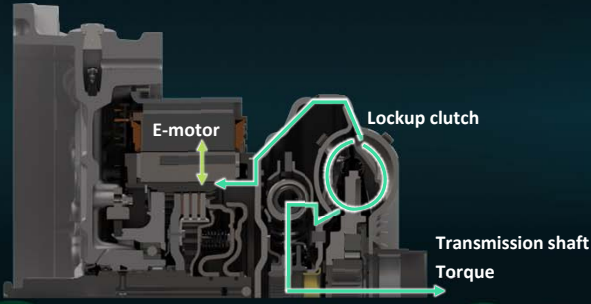
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### Hybrid Module

- ▶ Combustion-engine driving
- ▶ Electric driving



E-motor


Lockup clutch


Transmission shaft Torque

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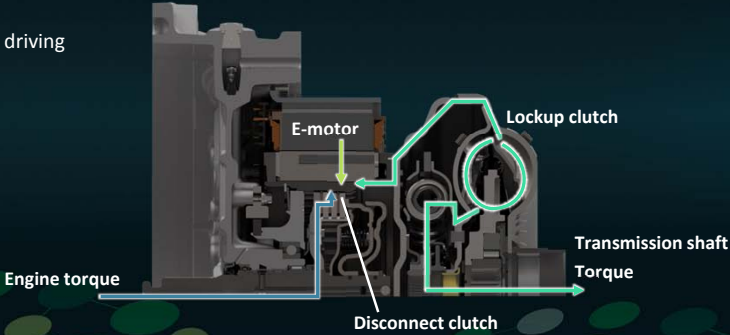
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### Hybrid Module


- ▶ Combustion-engine driving
- ▶ Electric driving
- ▶ Electric boost



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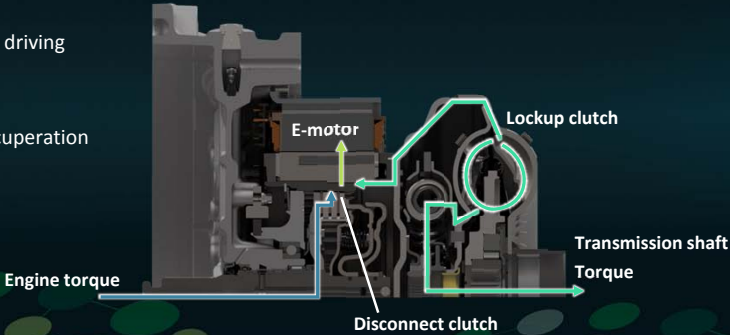
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### Hybrid Module

- ▶ Combustion-engine driving
- ▶ Electric driving
- ▶ Electric boost
- ▶ Battery charge / recuperation




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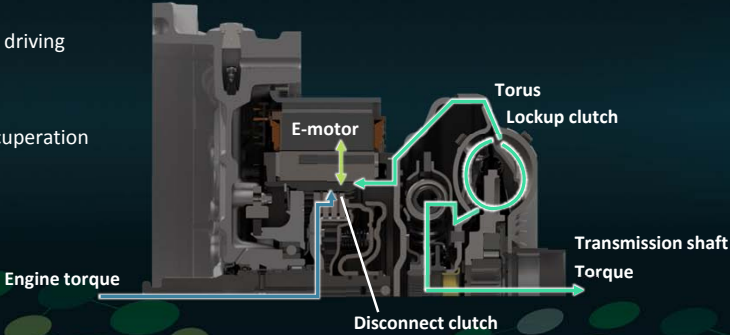







### Hybrid Module


- ▶ Combustion-engine driving
- ▶ Electric driving
- ▶ Electric boost
- ▶ Battery charge / recuperation
- ▶ Engine start



### Hybrid Modules Supporting Many Needs


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Modular actuation


### Hybrid Module



Dry clutch with  
Hydrostatic Clutch Actuator



Wet clutch with  
Electric Pump Actuator





Wet clutch controlled by  
valve body

Disconnect-clutch  
alternatives

### Hybrid Modules Supporting Many Needs

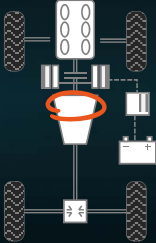
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Modular actuation  
Modular attachment

### Hybrid Module Sub-Assemblies





P2 Hybrid launch element

Double clutch	Single-face clutch	Torque converter
Front DCT	Minimal towing	Towing
Minimal towing	Low weight	High torque
Low weight	Dynamic feel	Smooth launch
Dynamic feel		

Hybrid Modules Supporting Many Needs


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Modular actuation  
Modular attachment

### Hybrid Module Sub-Assemblies



Advantage of TC in P2 RWD

- ▶ High-slip capacity
- ▶ High-towing capacity
- ▶ Torque ratio
- ▶ No change over lifetime
- ▶ No sensors or actuators
- ▶ Smooth launch

P2 Hybrid launch element

Torque converter

Towing

High torque


Smooth launch

↓


RWD application

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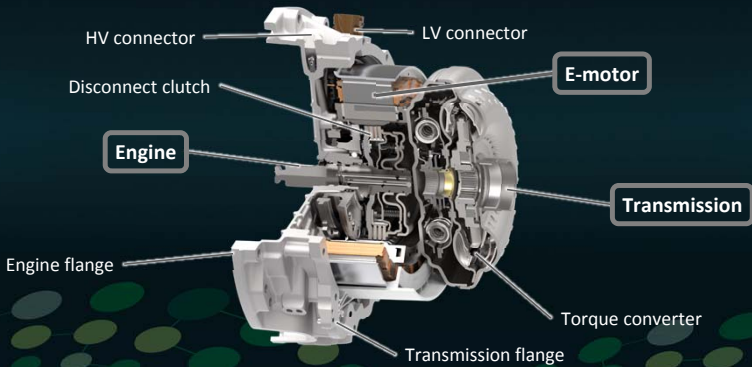






Modular actuation  
Modular attachment

### Hybrid Module – Sub-Assembly





Labels: HV connector, LV connector, Disconnect clutch, Engine, E-motor, Transmission, Engine flange, Torque converter, Transmission flange

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Modular actuation  
Modular attachment

### Hybrid Modules – Voltage


 <b>48V</b>	 <b>300V</b>	 <b>800V</b>
<ul style="list-style-type: none"><li>▶ Recuperation</li><li>▶ Fuel efficiency</li></ul>	<ul style="list-style-type: none"><li>▶ Electric drive</li><li>▶ Fuel efficiency</li><li>▶ Performance</li></ul>	<ul style="list-style-type: none"><li>▶ Electric drive</li><li>▶ Fuel efficiency</li><li>▶ Performance</li><li>▶ Power density</li></ul>


**Electrical alternatives**

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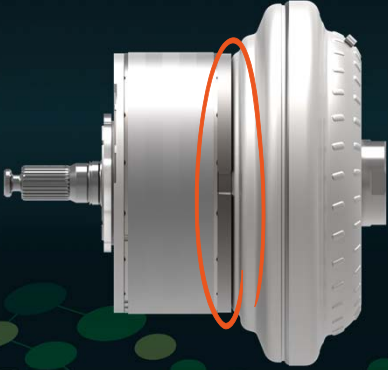




Modular actuation  
Modular attachment  
Space saving

### Hybrid Module – Integrated E-Motor


E-motor is attached to torque converter shell




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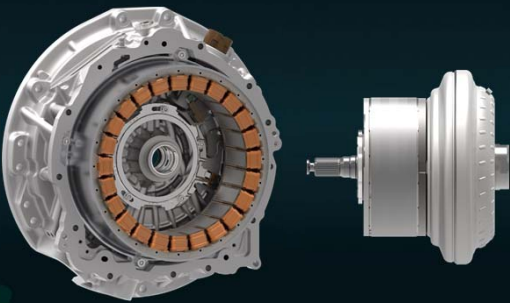




Modular actuation  
Modular attachment  
Space saving

### Hybrid Module – Integrated E-Motor


E-motor is attached to torque converter shell




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Modular actuation  
Modular attachment  
Space saving

### Hybrid Module – Integrated E-Motor




**Removed parts:**


- Shaft
- Seals
- Bearings
- Flexplate
- Aluminum wall
- Bolts
- Flexplate bolting



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Modular actuation  
Modular attachment  
Space saving

### Hybrid Module – Integrated E-Motor

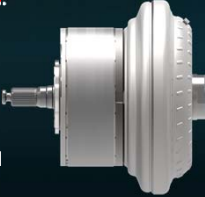


**Integrated E-motor allows reduced**

- ... number of components
- ... number of drag sources
- ... space by  $\approx 50\text{ mm}$
- ... inertia


**Removed parts:**


- Shaft
- Seals
- Bearings
- Flexplate
- Aluminum wall
- Bolts
- Flexplate bolting



Hybrid Modules Supporting Many Needs

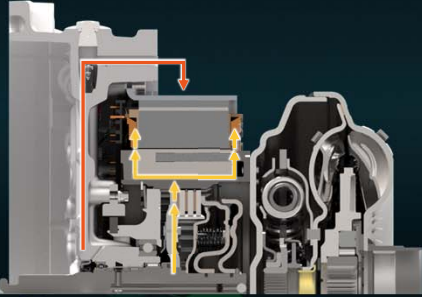
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Modular actuation  
Modular attachment  
Space saving  
Durability


### Hybrid Module - Cooling




- ▶ **Primary cooling circuit**  
Disconnect clutch  
Rotor  
Stator
- ▶ **Secondary cooling circuit**  
Stator

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Modular actuation  
Modular attachment  
Space saving  
Durability


### P2 Module

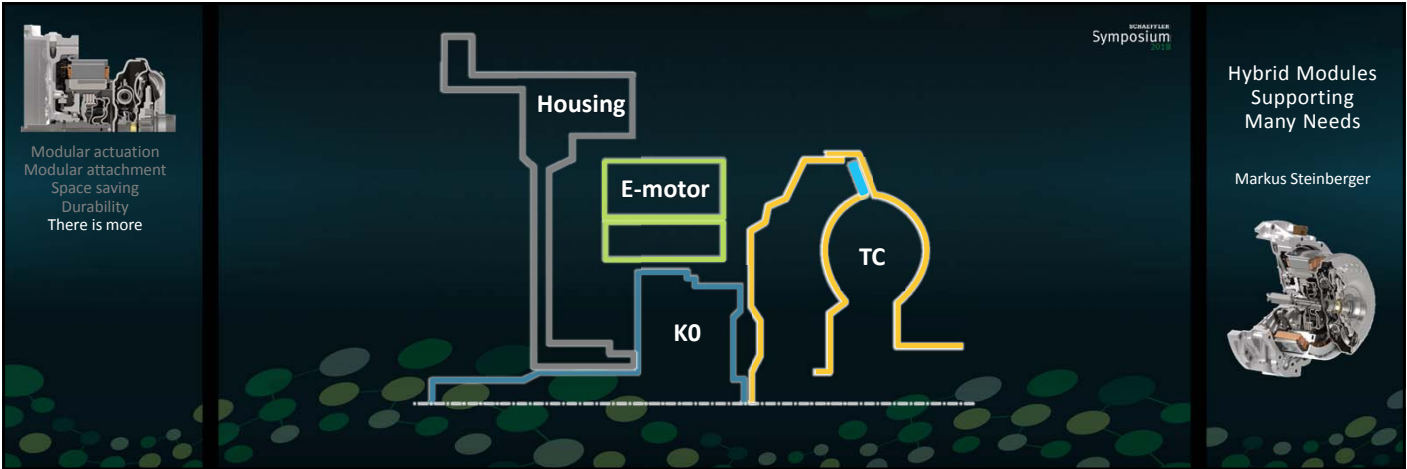
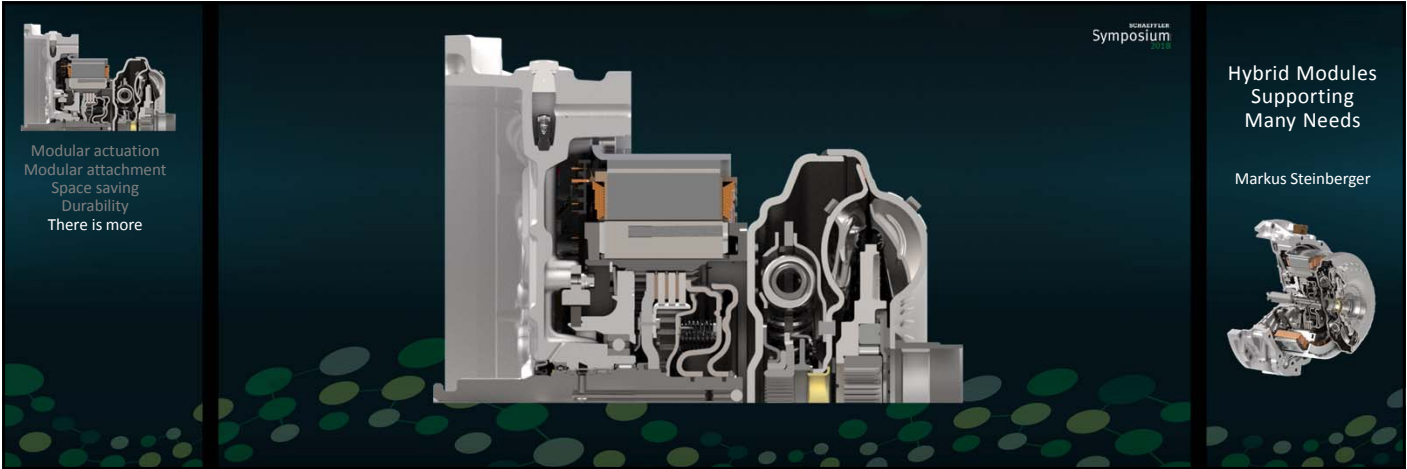


- Better fuel economy ✓
- Instantaneous feedback ✓
- Higher performance ✓
- Smooth launch ✓

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FWD design

### P2 Front-Wheel Drive




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FWD design

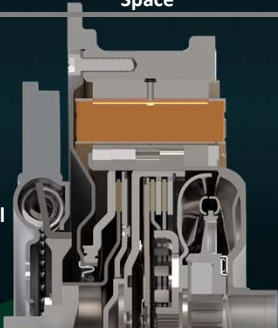
### P2 Front-Wheel Drive

Engine space:  
Power  
Number of cylinders

Space

Transmission space:  
Frame  
Number of gears


P1 design: space neutral  
P2 design: +20 mm



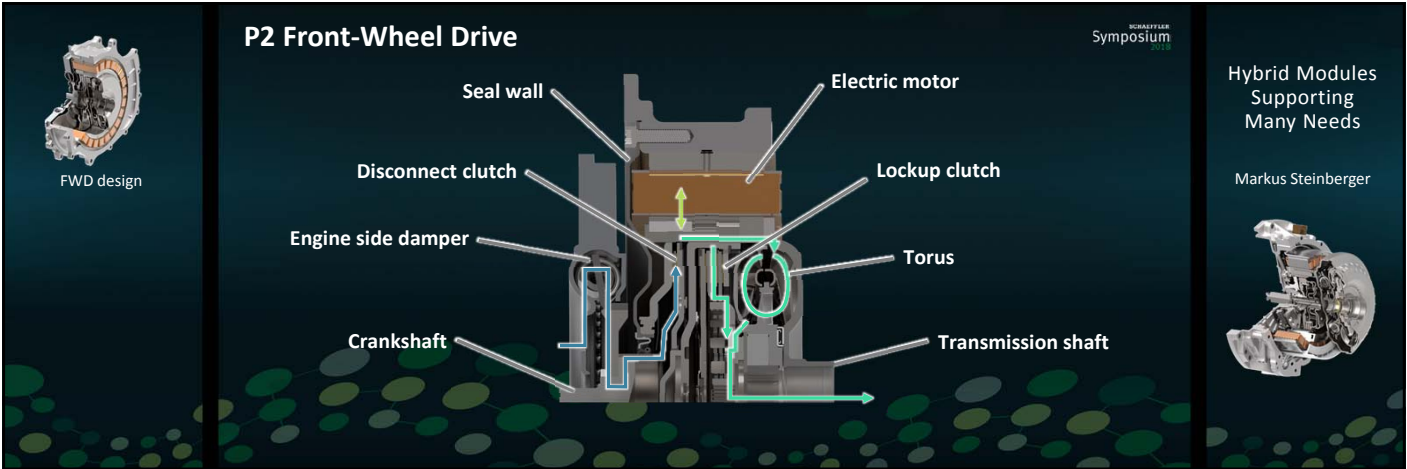
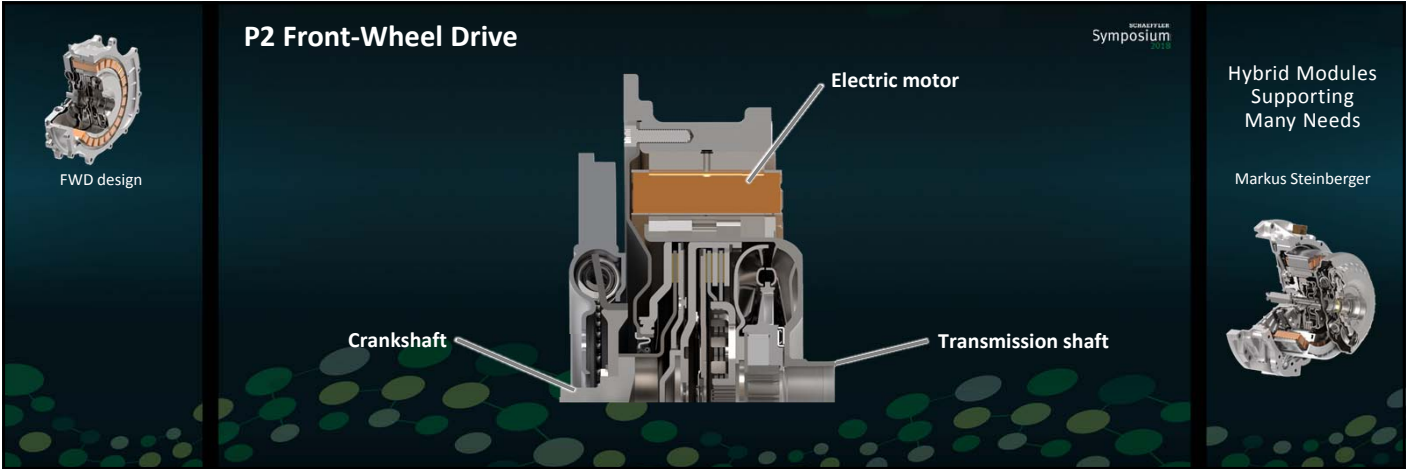
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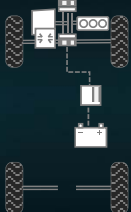




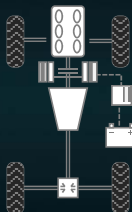


FWD design  
RWD and FWD P2

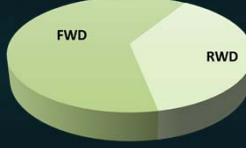
### P2 Drives



FWD P2 module



RWD P2 module




17.2 million vehicles

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