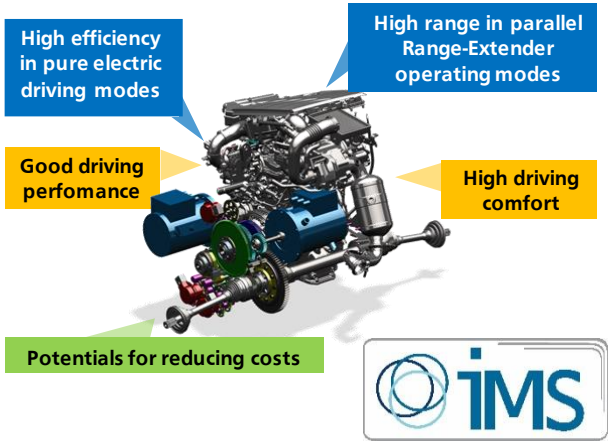
TDT Powertrain Concept

The Two-Drive-Transmission (*TDT*) is an innovative and modular powertrain concept for pure electric and hybrid vehicles developed at the TU Darmstadt. The powertrain concepts are characterized by using two smaller electric motors (*EM*) instead of one powerful electric motor. The electric motors are coupled to the drive shafts via a multi-speed transmission. The *TDT* concepts aim at achieving high overall efficiency based on shifting the load points by operating only one or both electric motors and using multiple gear ratios. Gear shifts are performed without interruption of traction force by using dog clutches instead of friction elements.
Based on the idea of multi-speed transmissions for pure electric vehicles, hybrid powertrain concepts are derived by adding an internal combustion engine (*ICE*) to the system resulting in a combined parallel-series hybrid powertrain configuration.
The concrete design of the *TDT* with Range-Extender (*DE-REX*) is classified as dedicated range-extender transmission (*DRT*) combining the benefits of series hybrid extended-range electric vehicles (*EREV*) and parallel plug-in hybrid electric vehicles (*PHEV*).



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Doppel-E-Antrieb mit Range-Extender (DE-REX)

Two-Drive-Transmission with Range-Extender: Innovative Parallel-Series Hybrid Powertrain Concept

DE-REX

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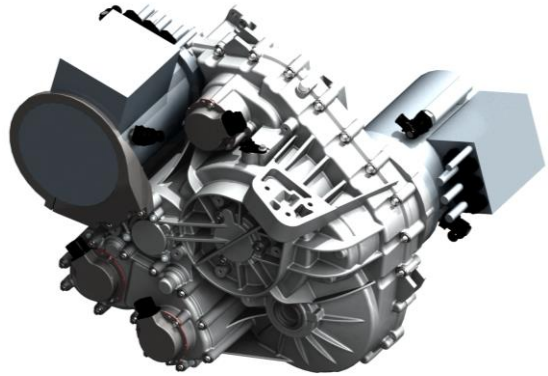

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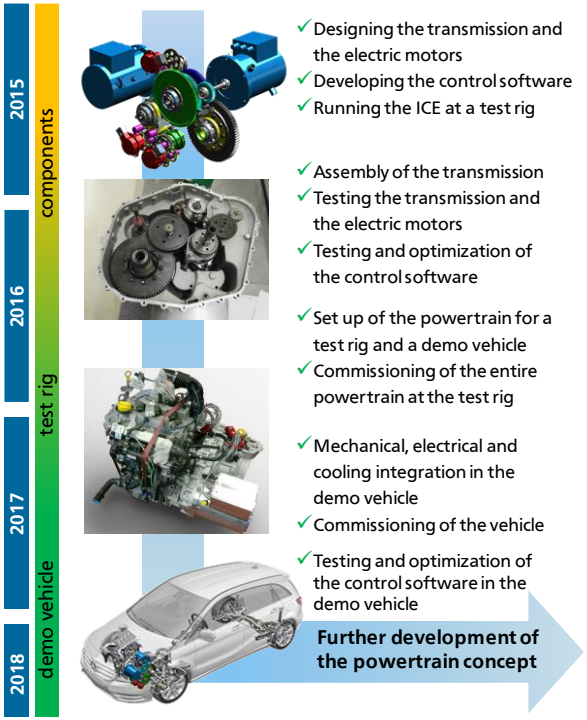
DE-REX Project

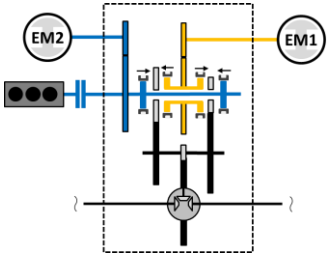
In the course of the publically funded project “DE-REX”, the Institute for Mechatronic Systems in Mechanical Engineering (IMS) heads the consortium partners Institute for Electrical Energy Conversion, Institute for Internal Combustion Engines and Powertrain Systems (all of them TU Darmstadt), *Daimler*, *MAGNA GETRAG* and *AKKA*. The *DE-REX* transmission system and the electric motors were designed and two complete powertrain prototypes were manufactured and set up: one prototype is running at a powertrain test rig and the other one was integrated into a demonstrator vehicle.

Time Schedule



DE-REX Powertrain Layout

The layout of the *DE-REX* powertrain is based on the coaxial arrangement of two subtransmissions (STM) with two gears each. One permanent magnet synchronous motor is connected to each two speed STM. Additionally, an ICE is coupled to one STM leading to the gearset layout and transmission hardware shown in the following.



The parameters of the *DE-REX* powertrain were determined by applying a multi-objective optimization method developed at the *IMS*.

Vehicle	***Segment***	C		
	Integration	Front-transverse		
Trans-mission	***Type***	Dedicated Range-Extender Transmission (DRT)		
	Gears		2 x 2	
	Output Torque	$T_{TM,max}$	> 2.500	Nm
	System Power	P_{max}	163	kW
	Shifting System	Electromechanical actuation of dog clutches		
Driving Motors	***2x EM (PMSM)***	$T_{EM,max}$	110	Nm
		$n_{EM,max}$	10.000	rpm
		$P_{EM,max}$	48	kW
	ICE (3 cyl. TC)	$T_{ICE,max}$	130	Nm
		$P_{ICE,max}$	65	kW

Gear Shifts in the DE-REX Demo Vehicle

The DE-REX powertrain performs pure electric and hybrid gear shifts using dog clutches without interruption of traction force. In case of a gear change in one STM, the driving motor of the other STM is still propelling the vehicle. The synchronization of speeds is executed by active speed control of the electric motors. The entire control software was commissioned, tested and optimized in the demo vehicle at the testing area at the TU Darmstadt.

Subjective assessment as well as objective evaluation criteria for shift comfort show a high level of shifting comfort for both pure electric and hybrid gear changes. The diagram shows a measurement of a seamless electric power upshift.