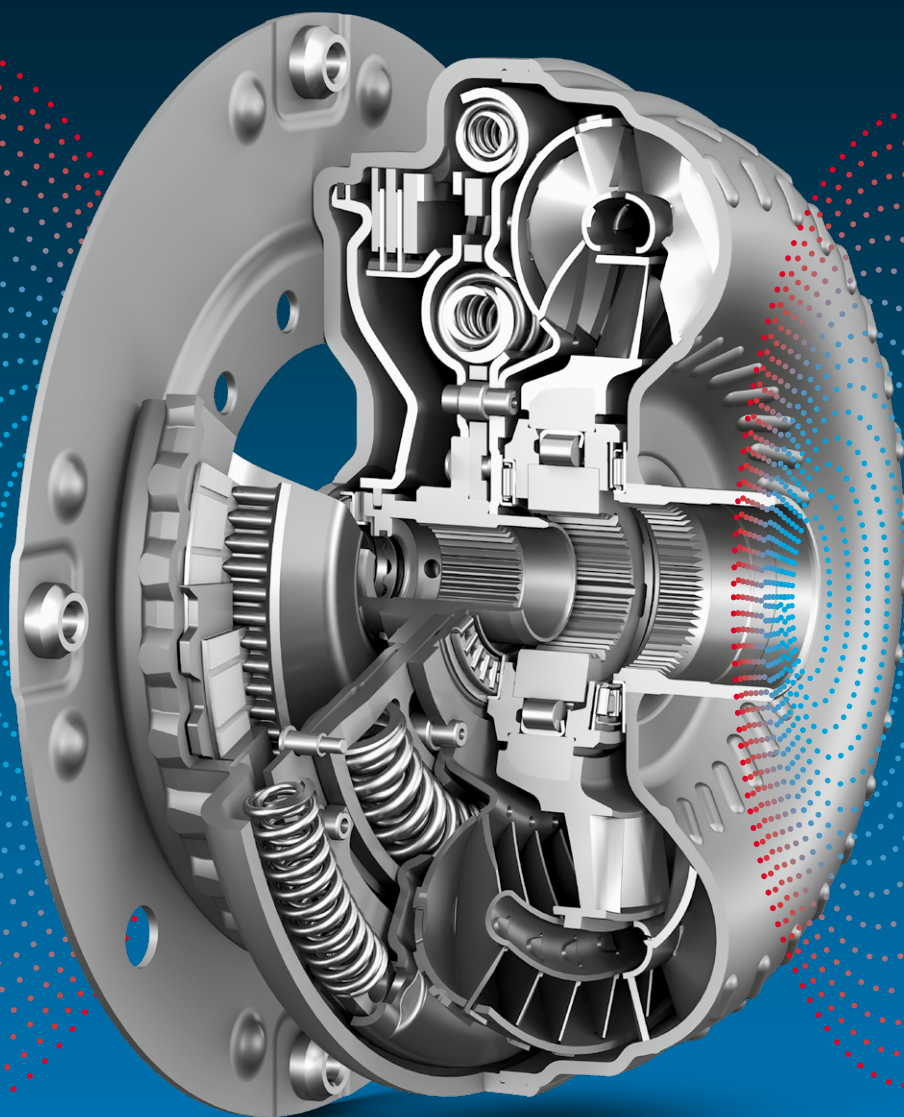


Active launch systems

For passenger cars up to 1,000 Nm



Powertrain components and systems for passenger cars and LCV

Performance – comfort – environmental protection. Powertrain components and systems for passenger cars and light commercial vehicles, developed and delivered by ZF, meet the widespread challenges of the highly complex interface between engine and transmission.

The demands placed on suppliers in the automotive sector are changing dramatically. Increasingly, suppliers are being called upon to integrate components into complex systems – a development task that can only succeed on the basis of close partnerships with vehicle manufacturers. The future will bring continued demands for reduced fuel consumption, emissions, weight and installation space, along with enhanced comfort, safety, and driving dynamics. To meet these goals, innovative solutions and new products are essential.

ZF has taken responsibility here, demonstrating expertise in generating comprehensive solutions with its integrated powertrain systems. In doing so, it consistently pursues a systems approach in developing and manufacturing new products and technologies that represent real advances. ZF provides overall solutions that meet the demands of overall systems.

One example: As a powertrain specialist and manufacturer of electric drives, ZF can also provide superior integration for the full spectrum of hybrid powertrain designs and thus offer production-ready solutions that are already reducing fuel consumption and emissions for the vehicles of tomorrow.



Dual wet clutch

The Dual Clutch Transmission System has two clutches at its disposal. The advantage here is that two gears can be engaged at the same time. One of the clutches serves the odd-numbered gears, and the other the even-numbered ones. The complete shift process takes a few hundredths of a second – without interruption of traction. In combination with a torsional damper a significantly reduced fuel consumption is reached as well as better characteristics in driving comfort. A dual clutch system can be used in all passenger cars, especially high-performance vehicles.

Torque converter

The new generation of torque converters of ZF for automatic transmissions in passenger cars features numerous new developments that ensure superior driving comfort, high driving dynamics, and a significant reduction in fuel consumption. One example: The torsional damping system minimizes torsional vibrations to such an extent that early shift points are possible,

with a consequent reduction in fuel consumption. In the chart on page 7, the central performance data of the new converter generation of turbine-torsional damper (TTD) and twin-torsional damper (TwinTD) are presented.

Hydrodynamically cooled clutch – HCC®

The hydrodynamically cooled clutch (HCC®) is a newly developed start-up element. This clutch is designed for use in strongly motorized vehicles with stepped automatic transmissions or CVTs. The low mass inertia torque and the compact design make the HCC® an ideal startup element – not merely for sportive uses, but also for vehicles with a distinct start-up deficiency (due to i.e. turbo lag). The shifting of gears in an automatic transmission equipped with HCC® can be performed just as rapidly as in dual clutch transmissions. The HCC® converts a conventional stepped automatic transmission to a sportive transmission.

Dual clutch system – Powerful shifting

The task

Development work on the driveline aims to enhance power transmission and to reduce energy loss as much as possible. Important criteria include lower fuel consumption combined with improved comfort and driving dynamics. The Dual Clutch Transmission System is an excellent solution to accomplish all of the above. Two interlocking transmission shafts, each linked to a separate clutch, allow for powershifting without torque interruption. The central module in this transmission is the dual clutch from ZF.

The technology

The dual clutch system consists of two separate clutches, which allow two gears to be engaged at the same time. One of the gears is transferring torque, while the next is already pre-selected. The entire shift process takes only a few hundredths of a second, without any interruption of torque and with minimal loss of power. A specially developed electronic control unit regulates the dual clutch system and the transmission actuation. It monitors all relevant parameters such as speed, rpm and transmission ratios, and adjusts shifting depending on the driving situation. Dual clutch systems from ZF combine the comfort of an automatic transmission with the sporty handling of a manual transmission. The result is a faster, smoother acceleration and superb shifting dynamics. A dual clutch system can be used in all passenger cars, especially high-performance vehicles.



Benefits

- Torque ranges from 350 to 750 Nm, peak torque of up to 1,000 Nm
- Very high thermal resistance
- Smaller space claim
- High speed stability
- Low friction torque
- Outstanding driving dynamics
- Reduced fuel consumption

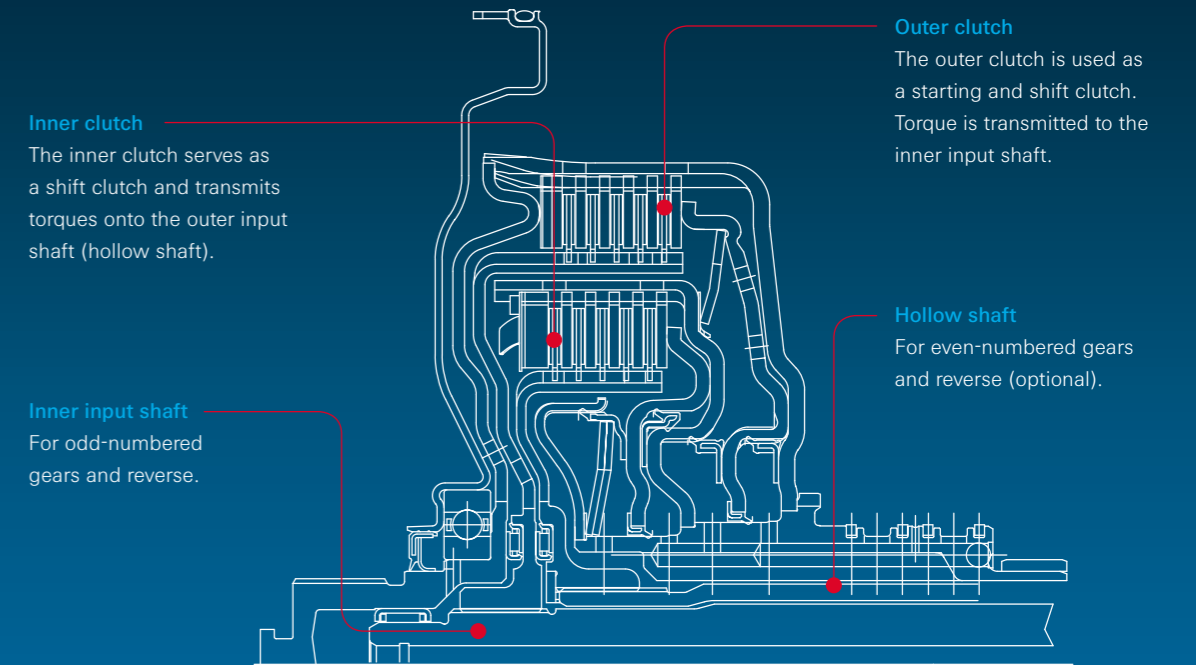


Dual wet clutch with dual mass flywheel (DMF)

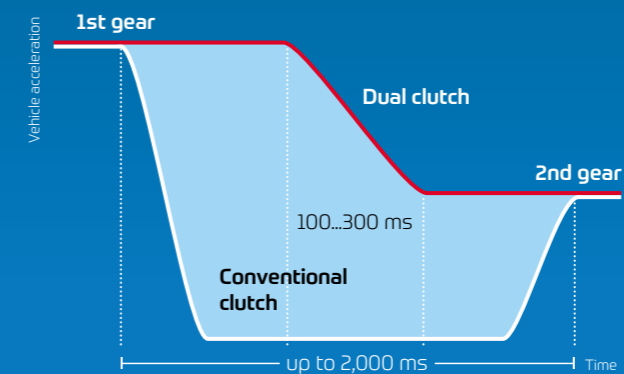
Designs of the dual wet clutch

	Power range [Nm]	Diameter [mm]	Mass [kg]	Inertia [kgm ²]	Engine/Drive arrangement
ND2015	350 - 750	250	11.7	0.0579	Front drive Rear drive
ND2216	500 - 1000	270	13.0	0.0820	Front drive Rear drive

System design



Comparison of shift process



Ensure both: ultra-dynamic and economic driving! Dual clutches have shorter shift times than standard clutches. The shift strategy in dual clutches is variable from extremely sporty to very comfortable within a range of 100 ms to 300 ms. In dual clutches, there are no losses in driving performance during shifts as they occur in standard clutches. This makes the entire powertrain more efficient.

Torque converter – More comfort and less fuel consumption

The task

Hydrodynamic torque converters are used in modern passenger cars with automatic transmissions – both stepped and continuous. They eliminate wear when the vehicle starts up, and ensure superb driving comfort. Together with a lock-up clutch and a torsional damper system adapted to the individual powertrain, they improve both driving dynamics and fuel consumption. The new generation of torque converters from ZF represents the ideal solution for modern automatic transmissions.

The technology

Torque converters from ZF feature superior performance density for torsional dampers and hydrodynamic circuits as well as adaptable lock-up clutches and variable damping systems. Compared to conventional converters, the lock-up clutch of a torque converter equipped with

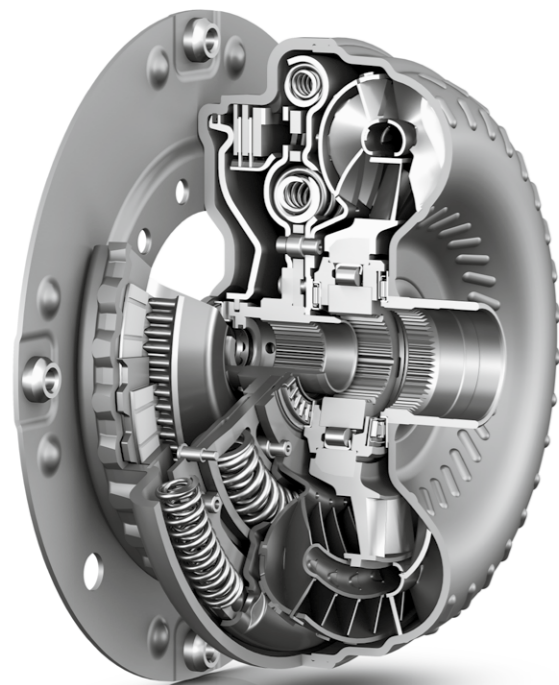
the new twin-torsional damper TwinTD can be applied very early on, which improves driving comfort especially at low engine speeds. This feature of the new twin-torsional damper also significantly reduces fuel consumption.

A further optimization of the system was achieved through an intelligent modular design of the lock-up clutches. It allows for 2, 4, or 6 friction surfaces with hydraulic circuit diameters of 235, 250, or 270 mm, which makes it easy to adapt the system to individual customer needs. In addition, more effective cooling of the lockup clutch, which ensures lower wear and higher heat losses, is achieved by implementing a three-path system for these new generation torque converters. Despite the considerably enhanced performance density, the system requires less installation space. Very short high-performance axial solutions are available for applications with extremely limited installation space.



Benefits

- Higher efficiency
- High hydrodynamic performance density
- Lower inertia
- OEM-specific lock-up clutches
- High efficiency for start-up and shift operations
- Torsional damper systems reduce fuel consumption



TwinTD – Twin-torsional damper

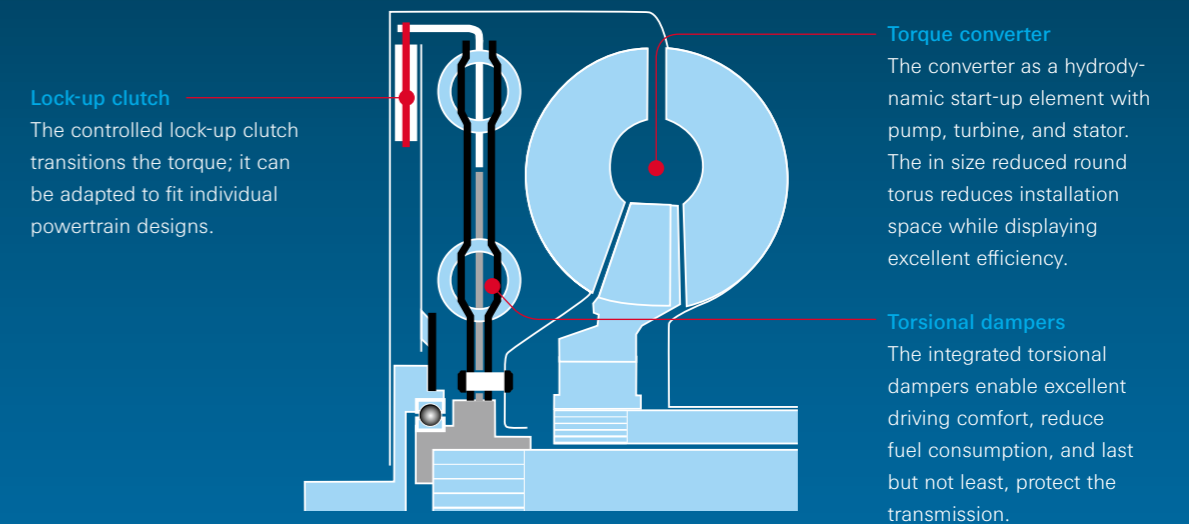
6%

Superior comfort for high-end cars and good for the environment as well. In fact, the newly developed torque converter from ZF benefits the environment in two ways: It reduces both fuel consumption up to 6 per cent and CO₂ emissions.

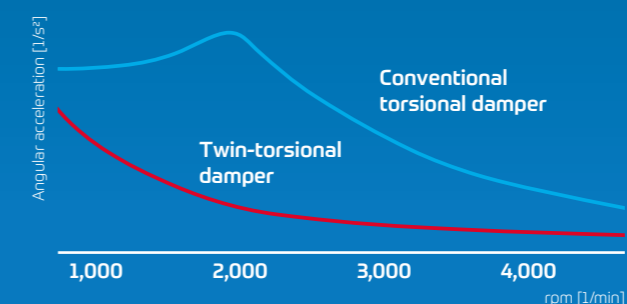
Designs of the torque converter

	Power range [Nm]	Diameter [mm]	Mass [kg]	Inertia [kgm ²]	Engine/Drive arrangement
NW235 TTD II	300-500	235	13.8 15.3	0.1186 0.1310	Front drive All-wheel drive
NW250 TTD II	400-700	250	16.2 17.6	0.1590 0.1689	Front drive All-wheel drive
NW270 TTD II	600-900	270	17.4 18.8	0.1843 0.1938	Front drive All-wheel drive
NW235 ZDW II	300-500	235	15.5	0.1471	Front drive
NW250 ZDW II	400-700	250	18.0 19.3	0.2005 0.2079	Front drive All-wheel drive

System design



Comparison of vibrational damping



Compared with conventional torque converters, the new twin-torsional torque converter significantly reduces engine irregularities, even at low rotational speeds. This is why gears can be changed earlier with no impact on driving comfort and dynamics.

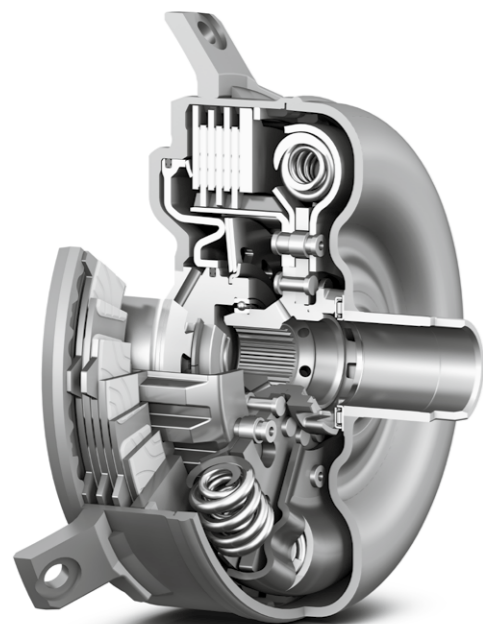
Hydrodynamically Cooled Clutch HCC® – Cool cruising all times

The task

An appropriate start-up element is needed to perfectly map vehicle dynamics at high engine output. The start-up elements used in the past have limited capabilities to meet the demands: Wear, weight, mass moment of inertia and engine irregularities must equally be mastered.

The technology

The hydrodynamically cooled clutch (HCC®) is a wet running start-up clutch with a unique, autonomously generated internal oil circulation – the “HCC® effect”. This clutch is designated for use in conventional stepped automatic transmission or CVTs. The use of identical interfaces along with hardware – analogous to the torque converter – enables a “Plug and Play” application. Only the transmission’s software must be adjusted to the gain in strategy capability. Due to the significantly improved cooling, the HCC® can be utilized in vehicles with high thermal demand. As a result of its structure (multi-fin clutch), this clutch is outstandingly suited to vehicles with a high torque level.



HCC® – Hydrodynamically Cooled Clutch

The low mass inertia torque and the compact design make the HCC® an ideal start-up element – not merely for sportive uses, but also for vehicles with a distinct start-up deficiency (due to i.e. turbo lag). The shifting of gears in an automatic transmission equipped with HCC® can be performed just as rapidly as in dual clutch transmissions. The HCC® converts a conventional stepped automatic transmission to a sportive transmission.

Due to the small space claim, the HCC® can ideally be combined with other components, such as i.e., electrical engines. The transmissible torque of the HCC® is determined by the pressure applied to the clutch pistons. The torque transmission between the engine and the transmission itself is therefore independent of the respective rpm. This property makes the HCC® to a strategy-capable start-up element.



Benefits

- Improved driving dynamics due to low mass inertia torque and weight
- Significantly improved heat transfer due to autonomously generated internal cooling circulation
- Decoupling of torsional vibrations by integrated torsional dampers
- Optimized gear shifting times and high start-up performance
- Especially suitable for vehicles designed to emphasize dynamic-sportive attributes – with AT or vehicles with deficiencies in start-up (due to turbo lag)
- Plug & Play: existing automatic transmission’s structure is utilizable

Optimized heat dissipation

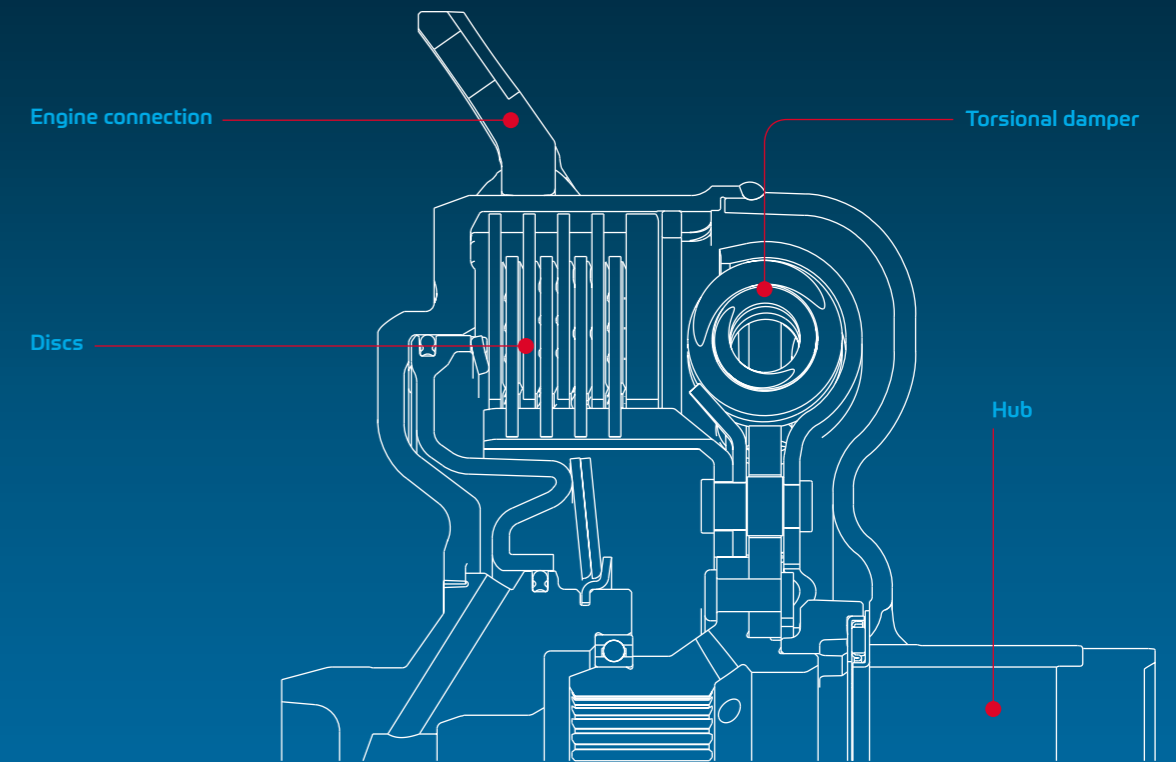
One of the specific features over multi-disc clutches is the fact that the cooling flow is spirally guided in the plate packages of the HCC®. Thus, most heat is dissipated during the heat generation process. As a result, the HCC® operates with a significantly lower pumping performance.



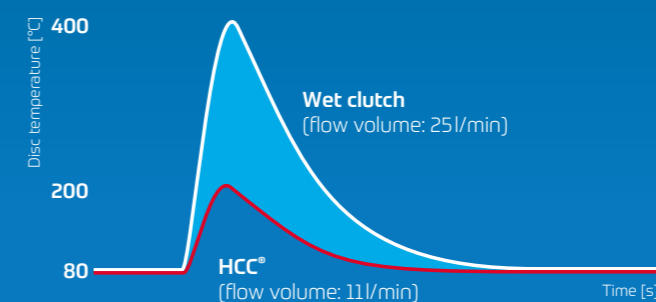
Designs of the HCC®

	Power range [Nm]	Diameter [mm]	Mass [kg]	Inertia [kgm ²]	Engine/Drive arrangement
HCC 185-6-TTD	200 - 700	185	13.4	0.0823	Front drive Rear drive
HCC 185-8-TTD	500 - 1000	185	13.5	0.0830	Front drive Rear drive

System design



Comparison of thermal capacity



The high efficiency of the HCC® is clearly proven in direct comparison with a conventional wet clutch. Optimized heat dissipation, here shown under full load, directly ensures a longer product life under extreme loads.

Research and development to secure mobility

Innovations are not an end in themselves, they must pay off: For manufacturers, fleet owners, and drivers, but also for the environment and society. Each new development must prove itself among the conflicting priorities of these criteria.

The ZF Group draws upon an international network of development centers. Each year, ZF invests approximately five percent of its sales in R&D. With success, because innovative products from ZF set the standards for state-of-the-art technology – again and again.

Development work at ZF is organized according to decentralized and corporate functions. The divisions and business units focus on markets and product expertise, ensuring customer-centered, competitive technological product development. Corporate R&D works with a strong emphasis on basic research and theory, and supports the operational development departments in the divisions.

Groundbreaking innovations

Over the past years, this partnership has produced product innovations that have since become benchmarks in the industry: Just some examples are the 8-speed automatic transmission for cars as well as hybrid transmissions and hybrid management for cars and commer-

cial vehicles, or the modular TraXon transmission system for commercial vehicles. Groundbreaking innovations from ZF are in use today not just in passenger cars and commercial vehicles on the road, but also in all kinds of craft on the water and in the air.

What's more, the innovative power of ZF is set to increase in the future. Proof of this is already provided by the number of patents pending: A look at the statistics of the German Patent and Trademark Register shows that ZF is among the top ten applicants for patents – at eye level with many large automotive manufacturers. Each year, the research departments successfully complete more than 10,000 projects, covering the full range from basic research to product applications. This high project volume is necessary to ensure mobility in the future. The trend toward hybrid solutions already shows that green drive technology is very complex. The same goes for pure electric drives and lightweight design engineering. Currently, ZF engineers are conducting pioneering work on alternative materials, broader approaches in design and testing, and new production processes.



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