Active launch systems

For passenger cars up to 1,000 Nm
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.

**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.

**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.
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

Designs of the dual wet clutch

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ND2015</td>
<td>260</td>
<td>11.7</td>
<td>0.0679</td>
<td>Front drive / rear drive</td>
</tr>
<tr>
<td>ND2216</td>
<td>270</td>
<td>13.0</td>
<td>0.0820</td>
<td>Front drive / rear drive</td>
</tr>
</tbody>
</table>

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.

Dual wet clutch with dual mass flywheel (DMF)
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 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.

The benefits of the new generation of torque converters from ZF include:

- 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

### Designs of the torque converter

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NW235 TTD II</td>
<td>235</td>
<td>13.8</td>
<td>0.1186</td>
<td>Front drive</td>
</tr>
<tr>
<td>NW250 TTD II</td>
<td>250</td>
<td>16.2</td>
<td>0.1590</td>
<td>Front drive</td>
</tr>
<tr>
<td>NW270 TTD II</td>
<td>270</td>
<td>17.4</td>
<td>0.1843</td>
<td>Front drive</td>
</tr>
<tr>
<td>NW235 ZDW II</td>
<td>235</td>
<td>15.5</td>
<td>0.1471</td>
<td>Front drive</td>
</tr>
<tr>
<td>NW250 ZDW II</td>
<td>250</td>
<td>18.0</td>
<td>0.2005</td>
<td>Front drive</td>
</tr>
</tbody>
</table>

### System design

- **Lock-up clutch**: The controlled lock-up clutch transitions the torque; it can be adapted to fit individual powertrain designs.
- **Torsional dampers**: The integrated torsional dampers enable excellent driving comfort, reduce fuel consumption, and last but not least, protect the transmission.

### 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.
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.

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 utilisable

Hydrodynamically Cooled Clutch

HCC® – Cool cruising all times

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.
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 commercial 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.