



## ZF Intelligently Designs New Generation 8-speed Automatic Transmission for Hybrid Drives

- **New modular construction system allows for both 48-volt mild hybrids and plug-in hybrids with electric power of up to 160 kilowatts**
- **Integrated power electronics simplify flexible production**
- **All components and control software have been intelligently developed for hybrid operation**

**Friedrichshafen. Traditionally, hybrid transmissions are built by taking an efficient automatic transmission and replacing the torque converter with an electric motor with a higher power density. The technology company ZF has now turned the tables by intelligently designing its new generation 8-speed automatic transmission for hybridization from the start. The modular construction system enables mild, full, and plug-in hybrid drives to achieve top performances between 24 and 160 kilowatts. The power electronics are no longer designed as a separate unit, but instead are fully integrated into the transmission housing without increasing the outer dimensions of the transmission. With a new, significantly smaller hydraulic control unit, ZF has created the required installation space for the electric and electronic components.**

### **Plug-in Hybrid: New Electric Motor Equals Higher Power Density**

ZF estimates that at least 70 percent of all new vehicles in 2030 will still have an internal combustion engine. Nevertheless, a plug-in hybrid drive could considerably lower the engine's CO<sub>2</sub> emissions. This is contingent on electric range and electric power, both of which must allow for driving in everyday traffic with battery power only. ZF has laid the foundation for this with the plug-in model of the new generation 8-speed automatic transmission. The electric motor has a maximum power of 160 kilowatts and a continuous output of 80 kilowatts. The maximum torque, which can be attained without actuating the internal combustion engine, is 450 newton meters, thus allowing for swift passing, even in e-mode. This does not require a significant increase of



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the packaging size since ZF relies on a new generation of internally developed electric motors and uses welded copper rods instead of coiled copper wire. This technology, known as the “hairpin technique,” allows the copper fill level to be significantly increased, which has a decisive impact on the power density.

**Mild Hybrids: Variety Is Key**

In addition to plug-in hybrids with high voltages of around 300 volts, mild hybrids will also play a big role in the coming decade. They have a voltage level of 48 volts and allow for considerable CO<sub>2</sub> savings by generating power through regenerative braking recovery that can later be used as drive power. Furthermore, mild hybrids lower pollutant emissions by providing additional power during launch and acceleration processes – driving conditions in which conventional internal combustion engines emit a relatively high amount of pollutants in a short amount of time. Forty-eight-volt drives can be installed on several locations in the driveline. Installation on the crankshaft at the engine output (“Position 1”) and on the input shaft (“Position 2”) are particularly efficient. The new generation from ZF is suitable for both installation types. The electric motor can reach a maximum power of up to 25 kilowatts and thus optimally support the internal combustion engine in virtually all operating parameters.

**Power Electronics: Active Involvement**

Electric motors must be controlled via power electronics, which both convert the direct current from the battery into the required alternating current and control the power and speed of the electric motor. Until now, these power electronics were housed in a separate, shoebox-sized box for all series hybrid transmissions. However, with the fourth generation, ZF has integrated the complete power electronics into the transmission housing for the first time ever. This is a great advantage to automotive manufacturers since hybrid drive assembly is no longer considerably more complex than that of a conventional transmission. In addition, fewer high-voltage cables are needed in the vehicle, which enhances safety. The engineers at ZF were faced with the challenge of fully integrating the power electronics into the transmission without



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increasing the outer dimensions. They achieved this through an ingenious cooling concept, as well as through several other developments. The power semiconductors, especially the IGBTs for the high-volt model, produce a relatively high amount of waste heat. This is dissipated by connecting the power electronics to the refrigerant circuit of the vehicle's air conditioning system. However, the most important development was the considerable decrease in the size of the hydraulic control unit, which triggers mechanical shifts in the transmission. The hydraulic control unit in the current generation of the 8-speed automatic transmission requires a volume of 3.1 liters, but in the next generation, it will shrink to 1.8 liters. This is made possible primarily by using direct shifting valves. In contrast to the electric pressure actuators that were previously used, these electromagnetic actuators no longer require additional pistons and bushings.

### **Intelligent Adaptation to Hybrid Versions**

Each additional component of the new 8-speed construction kit was also intelligently designed for hybrid operation. This is clearly evident when it comes to the oil circuit. Previously, two oil pumps were used: a very efficient vane cell pump driven directly by the internal combustion engine and a second electric pump and/or pulse memory for electric operation. In the future, a single power-split pump will be used. When the internal combustion engine is shut down, it is driven by a small, directly attached electric motor. The mechanics of the new transmission system also contribute to efficient hybrid operation. Although the body remains the same with four planetary gear sets and five shift elements, efficiency was further increased by fine-tuning the friction power. Thanks to this, CO<sub>2</sub> emissions were lowered by one gram per kilometer during operation with the internal combustion engine. During electric operation, the range has increased accordingly.

### **Comfort Is Crucial**

The new generation 8-speed automatic transmission is designed for lengthwise installation of the engine and transmission – a drive configuration that will be successful especially in the premium segment because it satisfies the high demand for comfortable operation and



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noise reduction. Achieving this during hybrid operation is partly due to the solid mechanical foundation. Eight gears allow for transmission stepping of up to 8.6 with low gear steps, and thus low speed steps, over a wide speed range. In addition, the ZF-developed, centrifugal pendulum vibration absorber was optimized such that the driver barely feels the switch from electrical operation to operation with the internal combustion engine. In the future, the transmission control module will no longer be based on characteristic maps, but rather on mathematical models of all system components. This is an important prerequisite for satisfying the growing complexity of future drivelines.

**Ready for the Drives of the Next Decade**

ZF will begin manufacturing the new generation 8-speed automatic transmission in Saarbrücken, Germany, in 2022. The market launch in China and the United States will follow shortly thereafter. ZF can thus make significant strides toward ensuring that hybrid drives gain quick acceptance while reducing vehicle CO<sub>2</sub> emissions in market segments where electrification cannot be fully implemented immediately.

Press photos can be downloaded at <https://www.zf.com/gtd>

Images: ZF

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**#MobilityLifeBalance**

For most of us, mobility originally meant personal, self-determined freedom. More recently, due to congestion, emissions, accidents, and a lack of availability, it can now



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be an ever more present cause of stress. It is becoming more and more challenging to determine the best solution for each individual among the range of mobility solutions currently available. ZF is highlighting this challenge with its **#MobilityLifeBalance** campaign and featuring its range of solutions that contribute to a better and more sustainable mobility offering. The objective is to enable clean, safe mobility that is automated, comfortable, and affordable. For virtually everyone, everywhere.

Find out more about the topic through the **#MobilityLifeBalance** hashtag in social media, or online at <http://www.mobilitylifebalance.com>.

**ZF Friedrichshafen AG**

ZF is a global technology company and supplies systems for passenger cars, commercial vehicles and industrial technology, enabling the next generation of mobility. With its comprehensive technology portfolio, the company offers integrated solutions for established vehicle manufacturers, mobility providers and start-up companies in the fields of transportation and mobility. ZF continually enhances its systems in the areas of digital connectivity and automation in order to allow vehicles to see, think and act.

In 2018, ZF achieved sales of €36.9 billion. The company has a global workforce of 149,000 with approximately 230 locations in 40 countries. ZF invests over six percent of its sales in research and development annually.

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