Highly Efficient: ZF’s Nine-Speed Automatic Passenger Car Transmission

- Efficient dynamics for vehicles with front-transverse drive
- Fuel savings between 10 and 16 percent
- Stop-start and four-wheel drive capable

In 2013, ZF Friedrichshafen AG was launching the world's first nine-speed automatic transmission (9HP) for passenger cars with front-transverse drive. With the two planned model ranges, the compact innovation covers a torque range between 200 and 480 Nm. Thanks to its modular concept, the basic transmission can be upgraded as required. This allows different starting elements and four-wheel drive applications can also be implemented cost-efficiently given the restricted installation space conditions with front-transverse passenger cars.

The potential reduction in fuel consumption and, in turn, CO$_2$ emissions, is one of the outstanding characteristics of the ZF 9HP: When traveling at a steady 120 km/h, fuel consumption is up to 16 percent lower than compared to today’s six-speed automatic transmissions with front-transverse installation. The 9HP’s efficiency is due largely to its great gear ratio total spread of 9.81. Nevertheless, extremely small gear steps can be realized thanks to the nine speeds. This enhances driving comfort while also ensuring the engine always runs in the optimal speed range: In the standard configuration of the 9HP there are only 2,170 revolutions per minute in the ninth speed at 120 km/h — instead of 2,890 with transmissions featuring six speeds. The wide range of applications is also a testament to transmission innovation: On the one hand, around 75 percent of all passenger cars worldwide are front-transverse engine vehicles — with numbers increasing sharply; on the other, the 9HP is ideal for numerous vehicle segments, ranging from subcompact cars to compact SUVs.
Revolutionary transmission concept
ZF realized the high number of speeds in the 9HP with the help of four individual gearsets and six shifting elements. Accommodating the components in the transmission proved to be a major challenge – design constraints associated with the vehicle width severely limit the transmission installation space in front-transverse passenger cars. For this reason, the gearsets have not been arranged one behind the other on the 9HP’s longitudinal axis, but were intelligently nested. ZF has supplemented this concept by using hydraulically operated constant mesh elements, since these can be integrated without major impact on the transmission length and feature a high level of efficiency. While multidisk shift elements create drag torque when open, these losses are very low in dog clutches. This aspect is particularly important with regard to the multi-speed concept of the 9HP: Thus, enhanced efficiency is not lost again via drag losses from the more complex design.

In fact, ZF’s 9HP is so well developed and impactful that it won a 2014 Automotive News Premier Automotive Suppliers’ Contribution to Excellence (PACE) Award — recognized around the world as the industry benchmark for innovation.

Enhanced performance and less fuel consumption
A torque converter is used in the 9HP as the standard starting element: Customers in the U.S. and Asia, in particular, value its quick launch capability and maneuvering comfort. Here, a multi-level torsion damping system minimizes hydraulic losses by quickly closing the torque converter clutch already at low speeds. With its direct engine connection, it reduces fuel consumption and enhances comfort as well as driving dynamics. For an even more direct driving experience, ZF has designed all control components for short shift times and response times that are below the threshold of human perception.

Direct multiple gearshifts are also possible with the 9HP and give the automatic transmission its sporty character. Thus, the transmission control unit can be influenced by the automaker and
the end customer: Shifting points and dynamics are highly variable and can be tuned from having an emphasis on comfort and optimized fuel consumption to being extremely sporty.

**Modular approach**
The new 9HP has been prepared as a modular kit so that it can be used in as many vehicle applications as possible: For example, an additional transfer case can be connected for the four-wheel drive operation. To this end, ZF developed the ECOnnect all-wheel drive that can be decoupled. It actuates the rear axle drive only when needed and, thus, saves up to five percent fuel compared to a permanent all-wheel drive. The standard 9HP also supports a start-stop function without the need for an additional oil pump. Since only one friction element needs to be closed in the case of restarting, response times are instantaneous.

Finally, thanks to its open software and interface structure as well as the powerful electronic control unit, it is possible to integrate the unit flexibly into disparate vehicle concepts. This diversity of the 9HP modular kit, including the optional shift-by-wire gearshift systems, makes the transmission especially efficient for automakers.

**Captions:**
1.) ZF’s new nine-speed automatic transmission (9HP): flexible, powerful, and efficient.
2.) The new ZF 9HP for passenger cars with front-transverse drive covers a torque range between 200 and 480 Nm.
3.) Land Rover Evoque with 9HP.
4.) Jeep Cherokee with 9HP.

Images: ZF (1, 2), Land Rover (3), Jeep (4)
ZF is a global leader in driveline and chassis technology with 113 production companies in 26 countries. In 2014, the Group achieved a sales figure of €18.4 billion with approximately 71,400 employees. In order to continue to be successful with innovative products, ZF invested about 5 percent of its sales (2014: €891 million) in research and development. ZF is one of the ten largest automotive suppliers worldwide.

In 2015, the company will celebrate its centennial. Originally named Zahnradfabrik GmbH, ZF was founded in Friedrichshafen in 1915 by Luftschiffbau Zeppelin GmbH among others. In its early years, the company developed, tested and manufactured aircraft transmissions. After 1919, the company's focus shifted to the automotive and commercial vehicle industry under Alfred Graf von Soden-Fraunhofen, the first general manager and later head of the company. In this sector, the company registered numerous patents for innovative transmission technology and established itself once and for all as a major technology supplier. ZF grew outside of Europe in 1958 with a location in Brazil, launching a globalization drive that still continues. In addition, through product innovations and acquisitions, ZF constantly expanded its range of expertise. In 1984, ZF acquired the majority share in Lemförder Metallwaren & Co. KG, a move that extended the product portfolio to include chassis technology. In 2001, ZF took over the former Mannesmann Sachs AG to strengthen its value added product offering with driveline and chassis components. It adopted the current name of ZF Friedrichshafen AG in 1992. Today's product range includes driveline and chassis technology such as transmissions, driveline and chassis components, as well as complete axle systems and modules. ZF products are used in passenger cars, commercial vehicles, construction and agricultural machinery, rail vehicles and marine applications. The company also focuses on the wind power and electronic components business. In addition, ZF Services represents the company on the international aftermarket. In 2014, ZF announced its intention to acquire U.S. automotive supplier TRW.
The shareholders of ZF Friedrichshafen AG are the Zeppelin Foundation, administered by the City of Friedrichshafen, holding a share of 93.8 percent, and the Dr. Jürgen and Irmgard Ulderup Foundation, Lemförde, with 6.2 percent. "Motion and Mobility," ZF’s tagline, clearly states the company’s core mission: Right from its foundation, ZF has developed and manufactured innovative products for all people around the globe who want to move things reliably, comfortably and safely all while experiencing the ultimate in efficient mobility. Quality, technological leadership and innovative power have always defined the company’s identity – today as much as ever.

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