Shift Pointers

Subject:

Theory and principles of operation

Unit:

ZF 6HP

Essential Reading:

- [x] Rebuilder
- [ ] Shop Owner
- [ ] Center Manager
- [x] Diagnostician
- [x] R & R

Author:

Niel Speetjens,
ATSG Technical
Field Adviser

To 6HP or not to 6HP – Is That a Question?

ZF Friedrichshafen (meaning Zahnradfabrik Friedrichshafen) is a leading supplier of automobile transmissions. The company was founded in 1915 in Friedrichshafen, Germany, to produce gears for zeppelins and other airships but moved into the automobile market by 1918. The company helped produce the airship Hindenburg as well as truck parts for Hitler's war effort. ZF is also known for designing and manufacturing the transmissions for most German Panzers of Word War II.

After the war, the company was allowed to resume business producing automobile transmissions and other parts.

In 1961 ZF introduced the 3HP12, a fully automatic transmission for passenger cars. HP stands for Hydrodynamic - Planetary and still stands today.

The company nowadays operates 119 plants in 25 countries and has nearly 53,000 employees including around 20,000 working at locations outside Germany.

ZF Saarbrucken works with 4,500 employees and pushes out a cool million automatic passenger-car transmissions every year at this moment.

Introducing the new 6HP26

The 6HP26 was the first six-speed

continues page 22

Figure 1

ZF tag for a 6HP 19

automatic transmission in a production passenger car, released by ZF in 2000 and manufactured in Saarbrucken, Germany.

The six-speed went from development to the production stage in just under four years.

The 6HP26 was used first in the BMW E65 7 Series for 2001, and other car manufacturers followed as Audi, Jaguar, Bentley, Rolls Royce, Astin Martin and even Ford have agreements to use 6HP transmissions.

ZF engineers have developed a new transmission concept based on the Lepelletier gear train and achieving improvements in the production process as well as in the Mechatronic, the transmission control system. It is a completely new generation of transmission that also will noticeably change driving characteristics of cars for the better. These characteristics range from lower fuel consumption and weight reduction at improved performance levels to a very innovative Mechatronic, E-shifting and standby control.

The Lepelletier gear train

Lepelletier is a French engineer who has worked at Valeo, a big French automotive company that wanted to get a foot in the door in the automatic-transmission business. When he retired from Valeo and the company no longer was pursuing automatic-transmission business, he asked to have the patent as part of his retirement. The company gave it to him, and guess what. He sold the rights to ZF to be used in the new six-speed. Isn't that a nice present?

As we have seen in the 4HP22, ZF put a Simpson gearset in front of a simple planet and three OWCs to obtain four forward gears.

In the 5HP19, ZF constructed a Ravigneaux gearset in front of a simple planet with the use of two OWCs to obtain five forward gears.

Well, Lepelletier turned the world around. His gear train uses a simple planet with the sun gear fixed on the stator support in front of a Ravigneaux gearset to obtain six speeds forward. With the addition of an extra clutch it can easily be made a seven-speed, and – you guessed it – it is the Lepelletier seven-speed. To get input and holding power to the planetaries it uses only five clutches, three input clutches and two brakes.

Gear ratios of a 6HP transmission are 1st, 4.171; 2nd, 2.340; 3rd, 1.521; 4th, 1.143; 5th, 0.867; 6th, 0.691; and reverse, 3.403.

Notice that this transmission doesn't have a direct drive anymore and uses no freewheeling features of any type in the transmission. Their functions are carried out by a substantially improved electronic control system.

continues page 24

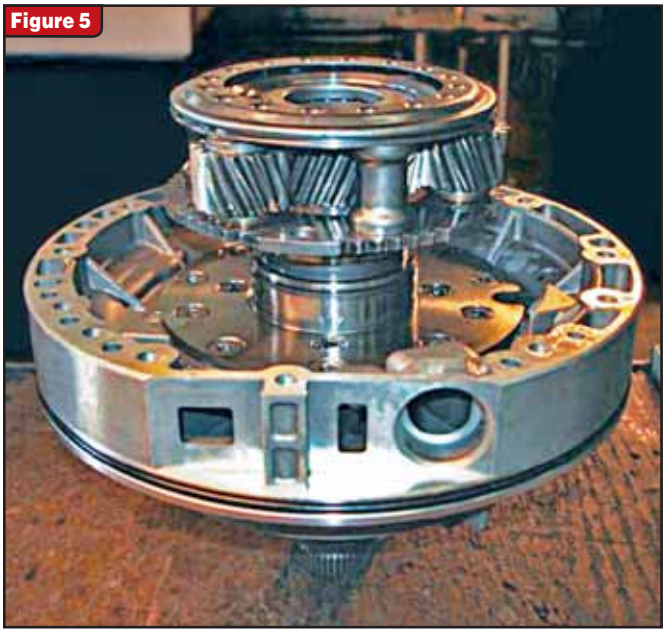
Figure 2

The Mechatronic assembly consists of both the valve body and the electronic control module.

Figure 3

Another Mechatronic view

Pump showing how the front planetary sun gear is held stationary



Pump with front planetary

At this moment there are three versions of the 6HP product family for rear-wheel-drive and 4x4 application.

6HP19 – 400 Nm (295 lb.-ft.) maximum engine torque

6HP26 – 600 Nm (444 lb.-ft.) maximum engine torque

6HP32 – 750 Nm (555 lb.-ft.) maximum engine torque

Hydrodynamic Torque Converter

Engine torque passes through the hydrodynamic torque converter equipped with a lockup clutch that can apply from first gear depending on software and user mode. Lockup never occurs completely, and the clutch when applied is designed to have a constant slip, preventing engine vibrations from entering the car. This also improves the acoustics coming from the transmission. This has been made possible through the use of newly designed oil and clutch materials.

Two brands of converters are being used – ZF-Sachs and LuK – depending on application and whether the torque converter uses a torsion-damper clutch. A smaller oil pump could be used through numerous methods of sealing improvements in the transmission as well as in the valve body.

Mechatronic

The Mechatronic is a combination of the hydraulic valve body and electronic control module. Hydraulics, electric and electronics are aggregated into one. The main goal here is to get rid of the hassle with cable connectors and to have a universal hardware component for all applications.

TCM, speed sensors, temp sensor and MLPS are all integrated into one and cannot be serviced separately. High-frequency closed-end solenoids are fed through connectors but cannot be interchanged or changed in any way. ZF calibrates and adjusts the hydraulic-pressure curve that the new solenoids have into the software to compensate for differences in newly produced solenoids. This ensures that the pressure curve will be correct at all times through the compensation in software.

So you can service the Mechatronic only as a unit. Where did I hear that before?

There are two versions of the Mechatronic, the E-Module and the M-Module.

BMW uses shift-by-wire (E-shifting) in the new 7 series, using a pushbutton for gear selection.

To accomplish this, there are two extra solenoids mounted in the valve body to engage and disengage the park-pawl device. If the car is left in neutral the park pawl will be engaged automatically after 30 minutes. Imagine if you are towing this BMW in neutral for half an hour and Park engages. Have you ever seen a BMW dance the Lambada? Then you will. To prevent this kind of situation there is a lever under the dash so the Park device can be disengaged manually. See the car manual for the precise location.

Another novelty used on the BMW models is a synthetic oil pan made of Polyamide Durethan AKV 35 that also functions as oil filter. Transmission service means changing the oil pan. You should use extreme caution when removing and reinstalling these transmissions, because the plastic is not designed

continues page 26

to carry the weight of the transmission and damage can occur; a special tool is available.

The TCM is constantly talking with the engine control module, E-gas, ABS, ASR and the body of the car through the CAN (controller area network) system. This high-speed train of data is constantly running through the car in circles, making data interchange considerably faster.

A new shift-strategy software named ASIS (Adaptive Shift Strategy) has been developed for optimum performance and transmission behavior and to adjust to driver action and sudden topographical changes. ASIS is uploaded in the computer at the plant in Saarbrucken; the car manufacturer loads the control module with software for the second time with its own program and specifications and marries the transmission with the vehicle at the same time. Audi uses the transmission electronics in its anti-theft system, which doesn't allow pressure to build up through the pressure-control solenoid if the car is started in an unconventional manner. So it's no-go for the car thief if he gets the engine running.

New synthetic low-viscosity ATF has been developed for better low-temperature characteristics and ability to handle the heat from the constant regulated slip of the TCC clutch. Dispatching heat from the TCM – 160° C (320° F) – is a new additional priority of the ATF.

Standby control is a new way to disconnect the A clutch, providing true electronic control of clutch pressure when the car is standing still. This will lower fuel consumption and eliminate drag of the car. As soon as you step on the accelerator, pressure will go up to the clutch to ensure takeoff without hesitation.

Electrostatic Discharge (ESD)

ESD is the sudden and momentary electric current that flows between two objects at different electrical potentials (such as ground). The term is used to describe momentary unwanted currents that may cause damage to electronic equipment.

One of the causes of ESD events is static electricity. Static electricity is often generated through tribocharging, the separation of electric charges that occurs when two materials are brought into contact and then separated. Examples of tribocharging include walking on a rug, descending from a car or removing some types of plastic packaging. In all these instances, the friction between two materials results in tribocharging, thus creating a difference of electrical potential that can lead to an ESD event.

ESD is a hazard for the Mechatronic of a 6HP transmission. Touching the pins in the connector directly is not allowed, and ZF recommends the use of special anti-ESD shoes, a wristband that grounds the person working on the Mechatronic, and grounding of the working area including the table and floor mat. The grounding function should be tested daily. If you were to subject the Mechatronic to an ESD, the micro wires could fry instantly or sustain damage that would result in a failure later.


Figure 6

The Lepelletier gear train

All these improvements and innovations combined have led this transmission into the new millennium. With the use of 30% fewer parts, a 13% weight reduction, a 5% acceleration-value increase and 6% less fuel consumption compared with previous models, the ZF engineers really made a state-of-the-art piece of technology that is here to stay. TD

Niel Speetjens is an ATSG technical field adviser.

The Bottom Line:

Tell us your opinion of this article:
Circle the corresponding number on the free information card.

93 Useful information.
94 Not useful information.
95 We need more information.