

Long version: Volkswagen DSG

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Concept/Positioning

Volkswagen DSG - Automatically shifting 6-speed gearbox for more driving fun

- Dynamics and fuel consumption superior to manual gearbox
- To be used for the first time in the top Golf model, the sporty R32

Wolfsburg. Volkswagen presents a world-wide technical innovation: the sporty and economical automatic gearbox "DSG". This gearbox with integrated dual clutch will be used for the first time in the Golf R32. In the course of the year 2003, its use will be extended to other production series - primarily in conjunction with high-torque engines. With the new dual-clutch gearbox, Volkswagen continues its powertrain offensive across all classes.

Volkswagen was one of the first manufacturers to offer manual 6-speed gearboxes as optional equipment in the volume segment for certain production series and models. In the luxury class, a new 6-speed automatic for the Touareg V10 TDI will be introduced in mid-September. Early in October, with the New Beetle Cabriolet, Volkswagen became the first manufacturer to offer a transversally installed 6-speed automatic gearbox in the compact class – a configuration long considered impossible. With the DSG, the company now extends this spectrum by a technically completely new type of gearbox.

Volkswagen invested 150 million Euro in the DSG production system; up to 1,000 units can be produced daily in the gearbox factory in Kassel.

The DSG will be manufactured at the Volkswagen plant in Kassel, where 150 million Euro were invested in production. At full capacity, up to 1,000 DSG can be produced per day.

The gearbox has been designed to fulfil the demands of European customers for sporty driving and fuel economy. One significant difference to the familiar automatic gearboxes which are established especially in the USA in all classes: The DSG does not employ a torque converter for a standing start. Nor is the DSG a derivative of the automated manual transmission used in the Lupo 3L TDI. Rather, the DSG engineers took a technically completely new and revolutionary path by harmonising the agility of a manual transmission with the ease of a conventional automatic gearbox.

The DSG is significantly superior to the manual gearbox regarding fuel economy and performance, speed and ease of shifting as well as driving fun.

This new Volkswagen gearbox offers a genuine alternative in particular to those drivers who up to now have preferred manual gearboxes, because the DSG suffers no disadvantage in terms of fuel economy or performance. On the contrary: with identical acceleration and top speed, it shifts as smoothly as the best conventionally built automatic gearboxes; in addition, manual shifting is possible using the Tiptronic function or, in the Golf R32, buttons in the steering wheel. And shifting occurs faster and more "crisply" than possible up to now with either manual or automatic gearboxes, and without interrupting tractive power.

Technology overview

Volkswagen DSG - Gearshifts take only a few hundredths of a second

- In the DSG, the next gear is permanently engaged and ready for activation
- DSG matches revs in the finest sporting fashion during downshifts

As one of its outstanding design characteristics, the transversally installed DSG gearbox possesses two wet clutches (greater thermal capacity and better regulation than dry clutches), the pressure of

which is hydraulically regulated. The so-called clutch 1 (C1) serves the odd gears (plus reverse) and clutch 2 (C2), the even ones. Therefore, for all intents and purposes, one must speak of two parallel gearboxes in one. A consequence of this elaborate clutch management: during a shift, there is no more interruption of tractive power, typical of an automated manual transmission. Consequently an incomparably dynamic and, at the same time, smooth shift feeling with a high degree of comfort is conveyed. The high efficiency of this gearbox is very close to that of the classic manual gearbox. Together with Mechatronic, an intelligent hydraulic and electronic gearbox control, the two wet clutches with two input and output shafts are responsible. This interconnection enables the next higher gear permanently to be engaged and ready for activation. And like lightning, to be sure. For example: While the car is being driven in third gear, fourth gear is already engaged, but is not yet active. As soon as the ideal shift point is reached, the clutch for third gear opens while the other closes, activating fourth gear. The opening and closing of the clutches coincide in the process, producing the smooth shift already mentioned above. The entire shift process is completed in the especially short time of 3 to 4 hundredths of a second.

Alternatively, the driver can shift the gearbox crisply using Tiptronic; the Golf R32 with DSG offers additional switch buttons in the steering wheel.

Parallel to the fully automatic shift programs "D" and "S", the DSG has a Tiptronic function which enables manual shifting. Beyond that, the driver of a Golf R32 can select gears using shift buttons in the steering wheel. In both cases, the result is a shift feeling marked not only by superior comfort but also by extreme fun when shifting. Drivers with sporty ambitions will experience for the first time that gears can be changed as with the press of a button. And what's more: In the even sportier mode (position "S"), the engine and gearbox control units even activate a form of rev-matching, which further enhances the shift dynamics: Using wheel speeds provided by the ABS, the gearbox control unit ensures that no unintended up-shift occurs in the middle of a curve.

DSG stands for a new generation of gearboxes offering the maximum of agility; better fuel economy and acceleration better than a manual gearbox

It is generally true that an engine coupled to the DSG is always in the position spontaneously to have the desired tractive power available due to the fast, independent gear change. No less decisive is the fact that the new gearbox provides the great agility of a manual transmission but undercuts the latter substantially in fuel economy. The R32 with DSG consumes only 10.2 litres Super Plus petrol per 100 km, undercutting the manual version by about one and a half litres (11.5). Such extreme fuel reduction can otherwise be achieved only through the use of extremely lightweight building materials. Acceleration is tangibly better than for a manual. Equipped with DSG and an integrated launch control (an electronic start program), the Golf R23 sprints to 100 km/h (about 61 mph) in only 6.4 seconds (with manual gearbox in 6 seconds). The top speed of 247 km/h (about 151 mph) is the same.

Volkswagen is the first manufacturer to develop a production-ready gearbox of this type; without the Mechatronic module, the DSG in this form would be unimaginable.

With the DSG, Volkswagen is the first manufacturer to develop a dual-clutch gearbox ready for production. Such gearboxes have already been used in motor sports, but the uncomfortable shifting due to inadequate means of mechanical and electronic control made them unacceptable for use in production cars. In its own undertaking, Volkswagen solved the problem of exacting demands in design; in addition to numerous new hydraulic components, a complex Mechatronic was developed which first made possible the DSG as it is now being introduced in the Golf R32.

Technology in detail

Volkswagen DSG - Mechanics and electronics are perfectly united in the DSG

- Two clutches, two input shafts, two gearboxes in one**
- Mechatronic module as intelligent shift nerve centre of the gearbox.**

The new automated 6-speed gearbox was designed for a maximum torque capacity of 350 Newton metres. Including 6.4 litres of oil, it weighs 90 kilogrammes. Viewed from the engine side, the aluminium clutch housing with splines and pilot journal pin of the gearbox input shaft, the gear teeth of the differential and, in the upper section, the parking lock actuator can be seen.

From the side away from the engine, one sees the entire gearbox housing with a heat exchanger for optimising the thermal balance, a pressure filter for cleaning oil, the outer cover for the Mechatronic integrated in the gearbox and the oil pump as well as a socket serving as interface to the vehicle electronics.

**The two input shafts divide the DSG into two gearboxes;
the Mechatronic, the shift nerve centre, is located in the forward section of the gearbox**

The cross section through the inner gearbox construction can be fundamentally divided into front and rear sections; this also explains again the definition of “two parallel gearboxes in one”. The Mechatronic module, the shift nerve centre of the DSG, is located in the extreme front of the gearbox housing. Behind that, the reverse gear shaft and output shaft 2 (for gears 5, 6 and R) connect in the so-called drive gearbox.

Input shafts 1 and 2 and dual clutch, with a spring damper element, driven by the engine via a dual-mass flywheel, are located in the centre. The clutches are controlled by a hydraulic system; solenoid valves designed especially for this purpose regulate the pressure exerted by the pair of clutches. The solenoid valves are directly connected to the Mechatronic module, which co-ordinates everything.

The driver of the Golf R32 experiences a new and fascinating “drive train feeling” through the use of the new dual clutch

The dual clutch, comprising the so-called C1 and C2, represents a complex and innovative component which has matured over many years of development. The initial requirement, to attain stressability comparable to that of a hydrodynamic, or conventional, torque converter was fulfilled without restriction. The unique dual clutch represents a “standing start” element with characteristics which cannot be matched by conventional automatic gearboxes with torque converters. In particular, through the use of this clutch and the good controllability of the system, the driver experiences a new, direct and consequently fascinating “drive train feeling”.

The oil pump is also located on the side away from the engine; it is driven at engine speed by a shaft running through the inner drive shaft. The output shaft 1 (for gears 1, 2, 3 and 4) and the differential with integrated parking lock gear are located in the lower section of the gearbox.

An interesting technical overlapping between the worlds of manual and automatic gearboxes: Every gear of the DSG is associated with a conventional synchro shift unit, just as they are known in Volkswagen manual gearboxes. The performance of these synchronisers is substantially enhanced further by the friction layers in order to achieve minimal synchronisation times. Thanks to the use of these shift units, which can be operated independently of each other, the engineers could fulfil all requirements for free choice of gears. The reason for this is that the development and continuing optimisation of shifts free of tractive force interruption between even gears as well as from odd to even gears is of eminently important significance. For the result enables the DSG to make shifts – for example the fast change from 6th to 2nd gear – which as yet no other automatic gearbox can do.

**Manufacturing tolerances in the range of precision engineering;
hydraulic components with gaps of 3 µm**

All components of the DSG are manufactured with extreme precision. The tolerances are decidedly low and are comparable to the precision engineering of the finest watches. In the case of hydraulic components, the gaps, for example, are merely 3 µm. Nevertheless, all components can be heavily stressed.

**A shaft with two shafts: drive shaft 1 is located inside drive shaft 2;
this innovative component connects lightning fast with the dual clutch**

The two input shafts of the gearbox are an exceptional example of innovative manufacturing technology; they assume a key function in the design. Both input shafts share a common axis. The outer input shaft 2 is designed as a hollow shaft in which input shaft 1 is integrated. The concentric shafts rest on two needle bearings and are so constructed that individual components from existing Volkswagen manual gearboxes could be employed.

Considered as one shaft, the 5th-gear wheel is located on the side away from the engine, followed by the wheels for reverse and 1st gear. The impulse wheel (for determining rotational speed for synchronising shift procedure) for drive shaft 1 is located after that. The wheels for 3rd, 4th and 6th gear as well as 2nd gear are located behind it. The impulse wheel for input shaft 2 is located directly behind the 2nd gear wheel. At the same time, this arrangement reflects a unique quality of the dual-clutch

gearbox: Other than in conventional manual gearboxes, here one shift unit each is allocated to gears 1 and 3, 2 and 4 as well as reverse gear. In conjunction with an elaborately designed synchronisation (multi-code systems of gears 1, 2, 3 and reverse gear), one result is the especially short shift times.

**The Mechatronic module connects the world of mechanics wit the world of electronics;
control unit bathes in gearbox oil up to 140 degree Celsius hot**

The most complex component of the DSG is the Mechatronic module for controlling the gearbox. It is located directly in the gearbox, that is, in oil up to 140 degrees Celsius hot. Special for the protection of semi-conductor elements of the high-performance computer, the heat exchanger bolted on the outside of the gearbox ensures healthy thermal conditions under all operating conditions.

The basic design of the Mechatronic comprises a control unit and a so-called valve chest with twelve individual sensors (a sensor converts physical or chemical quantities into electrical quantities) and actuators (an actuator is an interface between electrical signal processing and a mechanical process). In detail, the Mechatronic module determines and manages, among other things, data for controlling the clutches, the input and output shafts, the cooling, the individual gears, the pressures as well as various malfunction security levels. Five modulation valves, five shift valves and numerous hydraulic slider valves serve this purpose. Gearbox data are transmitted from the control unit to the onboard network via a connector, while information from the vehicle and engine flow through this interface in the other direction to the gearbox computer. And this all functions so perfectly that this gearbox could be the breakthrough for the automatic in Europe, in the volume segment where today the manual gearbox still dominates.

Note:

All data and specifications given in this press information apply to the range of models supplied to Germany. Models supplied to other countries may differ from these. For fuel consumption MVEG values according to standard 99/100/EG are given. All information is subject to change or correction.

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