Volkswagen

DSG – the intelligent automatic gearbox from Volkswagen

International presentation of the new 7-speed DSG
in Barcelona / Spain, January 2008

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Note:

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The 7-speed DSG

To the Point

DSG – the intelligent automatic gearbox from Volkswagen

World's first 7-speed DSG for high-volume production – starting in the Golf
Significantly improved fuel economy and lower emissions thanks to DSG
From Polo to Passat – new DSG for all TDI and TSI engines up to 250 Nm

- Wolfsburg / Barcelona, January 2008. Five years ago Volkswagen presented the first production dual-clutch transmission in the world: the 6-speed DSG. An intelligent automatic, a transmission of superlatives. The winning move of dual clutch transmissions had begun at Volkswagen. Since then over one million 6-speed DSGs have been sold! In just the first eleven months of last year 364,000 were sold. This is now being followed up by another transmission sensation: the world's first 7-speed DSG to be produced in high-volume. For many car drivers this could signify the final turn away from conventional transmissions. Because the new DSG can do everything better than a manual gearbox. It is more fuel efficient, sporty and comfortable.

DSG for the "small" high-volume engines

- The new 7-speed DSG makes the revolutionary transmission technology available for smaller engines too, engines that develop up to 250 Newton-meter torque. The 7-speed DSG will be initially introduced on the Golf, Golf Variant and Golf Plus – paired with the latest TSI (90 kW / 122 PS) and the bestselling TDI (77 kW / 105 PS) of the model series.

New "dry" dual clutch improves efficiency

- The most prominent component of the DSG is its dual clutch. In comparison to the 6-speed DSG, there is no "wet" clutch in the new transmission – that is a clutch immersed in an oil bath – rather a "dry" clutch. That too is a world first for DSG

technology. This and other engineering modifications led to significant improvements to the DSG's efficiency. The result: Further reduced fuel consumption and emissions values, even greater convenience and driving fun.

The 122 PS TSI in the Golf consumes just 5.9 liters/100 km with DSG. A record

- A look at the fuel economy and driving performance data of the Golf, with and without 7-speed DSG, underscores the progress made. This much can be said right away: The new 122-PS TSI on the Golf is a masterpiece of fuel efficiency. Shifted by a manual 6-speed gearbox, the charged gasoline engine in the Golf consumes just 6.3 liters of fuel per 100 kilometers – and this is even less than that of models with lower PS output. However, when the same Golf TSI is paired with the new 7-speed DSG, average fuel consumption (95 ROZ octane Super) is reduced even further: to just 5.9 liters. Similarly, CO_2 emissions are reduced from 149 g/km to 139 g/km. These are data that just a short while ago would have been considered inconceivable for a gasoline engine in this performance class. Especially for an automatic: Compared to a conventional automatic with torque converter, the new DSG even consumes up to 20 percent less fuel!

DSG market share up to 28 percent. Trend is upward

- Since the 7-speed DSG can now also serve on smaller engines, another jump in volume can be expected for DSG. In the final months of 2007, the DSG share in the Golf class – even without 7-speed DSG – already rose to above nine percent. The year's average for the new Golf Variant came in at over ten percent. On the Golf Plus the average for 2007 was greater than twelve

percent. The Jetta had a DSG share of over 13 percent, and the Eos over 14 percent. 24 percent of all Touran buyers chose a dual-clutch transmission in the past year. It was about 22 percent on the Passat sedan and over 28 on the Passat Variant. The trend toward automatics – when they have DSG – is therefore clearly evident.

Before production start the new DSG covered two million test kilometers

- Both DSGs are built at the VW Transmission Plant in Kassel. The light 70 kilogram 7-speed DSG is built with about 400 parts. The new transmission is like an old friend to employees in Kassel as production volume is being ramped up these days: as early as September 2005 a die-casting machine was used to produce the first prototype case. While the many DSGs had to prove their qualities on stationary test benches for far more than 60,000 hours of durability testing, developers sent the other DSG prototypes aboard Golf and Co. to run test trial routes in the real world. They covered about two million kilometers. Afterwards the findings were clear: the new DSG is extremely durable and extremely efficient too.

Pilot production started in November 2007 in Kassel

- In the last week of November 2007, series production of the new DSG was finally started. Plans already call for increasing output up to 750 7-speed DSGs per day over the course of this year. If demand rises even more, production could be ramped up to 1,500 7-speed DSGs per day by implementing a second assembly line. In parallel, 1,500 units of the 6-speed DSG are being produced daily in Kassel. Demand is booming!

Interesting Figures from the DSG World

- 0.4 liters fuel per 100 kilometers fuel savings on Golf TSI (122 PS) plus 7-speed DSG compared to identically powered counterpart with 6-speed manual transmission
- 1.7 liters of oil are at work in the 7-speed DSG
- 6 models can currently be ordered with 7-speed DSG
- 6.5 liters of oil are at work in the 6-speed DSG
- 70 kilograms is the weight of the 7-speed DSG
- 93 kilograms is the weight of the 6-speed DSG
- 105 PS is the power output of the currently “smallest” Volkswagen engine with DSG
- 140 degrees (maximum) hot oil surrounds the control module (mechatronics) on the 6-speed DSG
- 226 employees work in DSG production
- 250 Newton-meter is the maximum torque of engines that are paired with Volkswagen’s 7-speed DSG
- 300 PS is the power output of the currently “largest” Volkswagen engine with DSG
- 350 Newton-meter is the maximum torque of engines that are paired with Volkswagen’s 6-speed DSG
- 750 7-speed DSGs are already being produced every day at transmission plant in Kassel
- 1,500 6-speed DSGs leave the Kassel transmission plant daily
- 2003: first 6-speed DSG is introduced (on the Golf R32)

- 2004: 6-speed DSG is used in combination with a turbodiesel for the first time (on Golf TDI and Touran TDI with 105 PS and 140 PS, respectively)
- 2004: new Golf GTI offers a TSI paired with DSG for the first time
- 2005: first Bugatti Veyron 16.4 with DSG is delivered
- 2007: new Golf TSI with 122 PS and 7-speed DSG already places 2nd in Environmental Automobile List of the Verkehrsclub Deutschland (VCD; “German Travel Club”) for the compact class
- 2007: Golf GT Sport with 170 PS strong TSI plus 6-speed DSG wins Technological Innovation of the Year award in Barcelona
- 2007: at the end of this year series production was started for the 7-speed DSG
- 2008: new Golf TSI with 122 PS and 7-speed DSG earns “Yellow Angel 2008” award by ADAC in “Innovation and Environment” category
- 150,000 6-speed DSGs – this DSG production milestone was surpassed at the Kassel transmission plant in 2005
- 400,000 is the number of Volkswagens sold worldwide with DSG in 2007
- 1,000,000 6-speed DSGs – this DSG production milestone was surpassed at the Kassel transmission plant in 2007
- 2,000,000 is the number of test kilometers covered by the 7-speed DSG over the course of its development

The 7-speed DSG

Key Aspects

The intelligent automatic from Volkswagen

- New dual clutch provides for even greater efficiency
- 7-speed DSG was designed for engines produced in high-volume at Volkswagen
- Up to 20 percent lower fuel consumption compared to conventional converter automatics

Wolfsburg / Barcelona, January 2008. The new 7-speed DSG, like its counterpart with six forward gears, is a pure Volkswagen development. First and foremost, in designing this intelligent automatic transmission the goal was to combine the convenience of a conventional automatic with the fuel efficiency and dynamics of a manual transmission.

DSG saves fuel. Worldwide

Over the course of DSG development, it continually became evident that this system – more than any other automatic – has the potential of reducing emissions significantly. Compared to a manual transmission, reductions may be up to 12 percent, depending on the specific engine; compared to an automatic with lock-up torque converter this can be as much as 20 percent. When one considers a typical automatic transmission stronghold like the USA, the immense significance of the DSG's fuel-saving potential quickly becomes evident. So, similar to Europe, Volkswagen is also offering 6-speed DSG in many countries across the globe. In North America it is already on the Golf (plus GTI and R32), Jetta and Eos. In Europe 6-speed DSG can additionally be ordered on the Golf Plus, Golf Variant, Touran, Caddy, Passat and Passat Variant as well as the new Passat CC – the four-door coupé of Volkswagen. Worldwide, Volkswagen is selling about 400,000 vehicles with DSG annually.

7-speed DSG for high production volume engines

Another version of this intelligent automatic is now being launched: the new 7-speed DSG. Since it was specially developed for engines with up to 250 Newton-meter torque, for the first time now the worldwide savings potential is available on engines produced in high volume such as a 77 kW TDI – the bestselling turbo-diesel on the million bestselling Golf – or the new 90 kW TSI – which will be an engine with enormous production volume among the gasoline engines for the Golf and Passat classes.

The transmission is 369 millimeters long and weighs just 70 kilograms (6-speed DSG: 93 kilograms). Technically speaking, the new 7-speed DSG differs from its well-known counterpart in features such as:

- Seven instead of six forward gears;
- Dry instead of wet dual clutch.

The dual multi-plate clutch of the 6-speed DSG runs with oil cooling. On the new 7-speed DSG a dry clutch has now been implemented for the first time. This leads to a whole series of advantages; in sum they are expressed as a significant gain in efficiency. On the new DSG it was possible to eliminate a suction filter, an oil cooler and pressurized oil lines in the transmission case, for example, since oil is no longer needed to cool the plates. What remains is the “normal” transmission oil for lubricating and cooling the gears and bearings. The bottom line here is that eliminating clutch cooling lowered oil volume from 6.5 liters in the 6-speed DSG to 1.7 liters in the 7-speed DSG.

Two DSG systems that complement one another

Meanwhile, it must be stated that both DSG variants are each specialists for specific uses. While the 6-speed DSG, thanks to its broad torque range, is brilliant – especially when paired with very large and torque-strong engines (up to 350 Newton-meter) – the 7-speed DSG is specifically intended to be used in tandem with smaller engines (up to 250 Newton-meter). This is precisely where the new DSG comes up with ideal answers to its duty conditions, since it:

- Provides the energy for clutch activation and control as needed;
- Offers increased gear spread for improved start-off performance and lower engine speed, as well as reduced fuel consumption in the highest gear;
- Has a modular structure that leads to further improvement in its robustness.

6-speed and 7-speed DSGs together cover a torque range that makes it possible for any of the TDI and TSI engines to be paired with a superior DSG automatic transmission.

Seventh gear as overdrive

The new DSG differs technically from its 6-speed counterpart, not only in the type of clutch, but also in its seven forward gears. The choice of seven gears was made for the following reasons:

- In the 7-gear configuration it was possible to lay out the first gear to be shorter; this improves start-off dynamics.
- Despite its shorter starting gear ratios, the transmission is characterized by gear steps that are comfortable and tightly

spaced overall, as well as an overdrive. This seventh gear with a long gear ratio has a positive effect on fuel economy, emissions and low-noise comfort.

General transmission layout

its most prominent design characteristics – two dry clutches whose pressure is regulated hydraulically. Engine power is transmitted to the dual clutch via the crankshaft and a dual-mass flywheel. Clutch I handles the odd-numbered gears, and clutch II the even gears plus reverse gear. The results of this sophisticated clutch management: when shifting, there are no gaps in propulsive power. Its excellent comfort properties convey a shifting feeling that is incomparably dynamic as well as comfortable.

Responsible for this – besides an intelligent electro-hydraulic transmission control (mechatronics) – are two clutches as well as two drive shafts and three final drive shafts. This network makes it possible to continually “lie in wait” to become active at the next higher driving level. And indeed lightning-fast. Example: while the car is driven in sixth gear, the seventh gear is already engaged, but is not yet “active”. As soon as the ideal shifting point has been reached, the clutch responsible for the sixth gear automatically opens, while the other one closes, and this “pre-shifts” to the seventh gear. This results in an overlap between opening and closing of the two clutches, which leads to the comfortable shifting described above. The entire shifting process is completed within just a few hundredths of a second.

Dual clutch

The dual clutch consists of two dry friction clutches – similar to those of manual transmissions – and a central plate. It transfers the torque to the drive shaft via the relevant clutch. In general, the dry dual clutch assumes somewhat larger dimensions than the wet running version. This is due to the layout of the two clutches and the material usage required to absorb the frictional energy. Since the dual clutch is larger, the rest of the transmission was designed to be that much more compact, so that it could be used even on small cars the size of the Polo.

Drive shafts

The two drive shafts are arranged centrally on a single axis. Their design assumes a key function. Both drive shafts are located, as described, on a common axis. The outer driveshaft II was designed as a hollow shaft, in which driveshaft I is integrated as a solid shaft. The two shafts are mounted concentrically, one below the other, on needle bearings.

Assigned to drive shaft I are the odd gears (1, 3, 5 and 7), while the even gears (2, 4, and 6) and reverse gear reside on drive shaft II. The distribution of the “1” and “R” gears permits quick changes between forward and reverse in parking maneuvers, simply by controlling two clutches. The clutches are controlled by hydraulics, and solenoid valves regulate the contact pressures of the two clutches. The solenoid valves are directly connected to a mechatronics module that coordinates everything.

Mechatronics

The brains of Volkswagen's dual clutch transmission lie in its mechatronics. As a control center it regulates shifting processes that are as fast as they are complex. In its basic configuration, the mechatronics consist of a control module and the so-called control valve assembly with individual sensors (sensor: converts physical values into electrical values) and actuators (actuator: this converts electrical signals into actuating motions). Specifically, the mechatronics module acquires and manages the data for controlling clutches, the individual gears, pressures and various safety stages. In addition, modulator valves, switching valves and a large number of hydraulic valve spools are used. The transmission data is exchanged between the control module and the vehicle's electrical system via a plug-in communications interface; in the reverse direction, information flows from the vehicle and engine via this interface to the transmission's computer.

While the mechatronics of the 6-speed DSG utilize the transmission's oil circulation, the mechatronics of the 7-speed DSG are laid out as an autonomous unit with oil circulation separate from the transmission. Right away, this yields a whole series of advantages:

- The hydraulic fluid can be specially tuned to the needs of the mechatronics, while a normal oil is used for the transmission that is similar to the oil used in conventional manual trans missions. Properties of the mechatronics are very good at low temperatures, since no compromises need to be made in terms of oil viscosity.

- The high purity of the hydraulic oil enables the use of so-called cartridge valves with very small gap dimensions. This significantly reduces leakage quantities, and use of an electrically-driven pump is economical.
- Compared to open hydraulics, the pressure level can be elevated, the sizes of actuators can be reduced due to the higher performance density, and the gross weight of the transmission is reduced.
- The mechatronics can be fully assembled and fully tested outside of the transmission.
- It is possible to actuate the dual clutch and shift gears independent of the combustion engine. This fulfills a precondition for a hybrid drive with start/stop function.