

Review on Direct Shift Gearbox

Akshada D. Padwal, Tejas Pawar, Pratik R. Vishwakarma, Asif H. Shaikh, Satish S. Chinchankar

Abstract—At the time of launch in 2003- DSG became the world's first dual clutch transmission in a series production car, in the German-market .Automatic gear boxes are becoming popular today in most of the vehicles due to number of benefits like high efficiency, better fuel economy, smoother operation, consistent downshift time etc. Direct shift gearbox is one of them .By using two independent clutches, a DSG can achieve faster shift times,^{[2][5]} and eliminates the torque converter of a conventional epicyclic automatic transmission.^[2]This paper gives detailed insight into the different features of DSG i.e. variations ,controls, operation, advantages applications and why its use should be encouraged

Index Terms— DSG controls, ECU, Operation, Upshift.

I. INTRODUCTION

DSG stands for Direkt-Schalt-Getriebe or direct shift gearbox. There are two manual gearboxes working alternatively but packed inside one housing and therefore it uses two clutches and two gear shafts to deliver power to the wheels. There are five major components to this gearbox - two clutches, two gear shafts and finally an **electronic control unit** or **ECU** that controls the gear shifts by analysing throttle position, engine load conditions and road speed among others. The clutches are mounted concentric to each other and therefor the two gear shafts. Unlike a regular gearbox which carries all the gears on one shaft, the DSG has the even numbered gears - 2nd, 4th and 6th - on the first shaft (with a dedicated clutch), and the remaining - 1st, 3rd, 5th and now 7th as well as the reverse gear - on the second, again with a dedicated clutch. It was designed by BorgWarner,^[4] and is licensed to the Volkswagen Group.

II. VARIATIONS IN DSG

NAME	SPEED TYPES	MAX TORQUE (N.m)	TYPE
DQ200	7	250	Dry
DQ250	6	400	Wet
DQ380	7	380	Wet
DQ500	7	550	Wet
DQ511	10	550	Wet
DL501	7	550	Wet

Table no.2.1

III. OPERATION

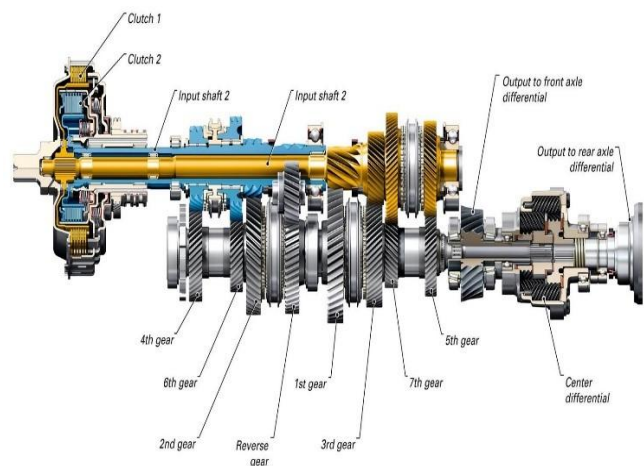


Fig.3.1. DSG Gearbox ^[11]

The internal combustion engine drives two clutch packs.^{[2][4]} The outer clutch pack drives gears 1, 3, 5^{[2][4]} (and 7 when fitted), and reverse^[2] — the outer clutch pack has a larger diameter compared to the inner clutch, and can therefore handle greater torque loadings. The inner clutch pack drives gears 2, 4, and 6.^{[2][4]} The transmission of torque is simply switched from one clutch-pack to the other.^[2] This means that the DSG takes only about 8 milliseconds to upshift.^{[3][4]} In comparison, the sequential manual transmission (SMT) takes 60 milliseconds to shift, or 150 milliseconds. The quoted time for upshifts is the time the wheels are completely non-powered. When the driver puts the car into D, the first clutch selects the reverse gear while the other selects the second gear and engages just short of the bite point. This is because when starting from standstill, the ECU doesn't know if the driver is trying to park or if he will drive away. A sensible compromise is to preselect the second gear and reverse gear.

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* Correspondence Author

Ms. Akshada D. Padwal*, Mechanical engineering department, Savitribai Phule Pune University, Vishwakarma Institute of Information Technology, Pune, India

Mr. Tejas R. Pawar, Mechanical engineering department, Savitribai Phule Pune University, Vishwakarma Institute of Information Technology, Pune, India

Mr. Pratik R. Vishwakarma, Mechanical engineering department, Savitribai Phule Pune University, Vishwakarma Institute of Information Technology, Pune, India

Mr. Asif H. Shaikh, Mechanical engineering department, Savitribai Phule Pune University, Vishwakarma Institute of Information Technology, Pune, India

Prof. Dr. Satish S. Chinchankar, (Head Of Department) Mechanical engineering, Savitribai Phule Pune University, Vishwakarma Institute of Information Technology, Pune, India

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In case there is a need for aggressive acceleration, the driver just has to give more gas and the ECU instantly tells the first clutch to drop the reverse gear and pick up and engage first. In normal driving conditions, when the ECU senses that throttle input is constant and that the car is accelerating steadily, the next higher gear is preselected and when the shift point arrives, one clutch disengages and the other engages. This happens within 8 milliseconds making it one of the fastest gearboxes.

IV. DSG CONTROLS

The direct-shift gearbox uses a floor-mounted lever, similar to that of a conventional automatic transmission.^[10] The lever is operated in a straight 'fore and aft' plane (without any 'dog-leg' offset movements), and uses an additional button to help prevent an unintended selection of an inappropriate shift lever position.

- **P** position of the floor-mounted gear shift lever means that the transmission is set in "Park". Both clutch packs are fully disengaged, all gear-sets are disengaged, and a solid mechanical transmission 'lock' is applied to the crown wheel of the DSG's internal differential. This position must only be used when the motor vehicle is stationary.
- **N** position of the floor-mounted shift lever means that the transmission is in "neutral". Similar to **P** above, both clutch packs and all gear-sets are fully disengaged; however, the parking lock is also disengaged.
- **D** position .When the vehicle is stationary and in neutral (**N**), the driver can select **D** for "drive" (after first pressing the foot brake pedal). The transmission's reverse gear is selected on the first shaft K1,^[3] and the outer clutch K2 engages at the start of the 'bite point'. At the same time, on the alternate gear shaft, the reverse gear clutch K1 is also selected^{[2][3]} (pre-selected), as the gearbox doesn't know whether the driver wants to go forward or reverse. The clutch pack for second gear (K2) gets ready to engage. When the driver releases the brake pedal, the K2 clutch pack increases the clamping force, allowing the second gear to take up the drive through an increase of the 'bite point', and thereby transferring the torque from the engine through the transmission to the drive shafts and road wheels, causing the vehicle to move forward.
- **S** position: The floor selector lever also has an **S** position.^[2] When **S** is selected, "sport" mode ^[2] is activated in the DSG. Sport mode still functions as a fully automatic mode,^[3] identical in operation to "**D**" mode, but upshifts and downshifts are made much higher up the engine rev-range.^{[2][3][10]} This gives a more sporty driving manner,^[2] utilising considerably more of the available engine power, and also maximising engine braking. This mode may not be ideal to use when road conditions are very slippery, due to ice, snow or heavy rain — because loss of tire traction may be experienced. On vehicles having 4 motion this may be partially offset by the drivetrain maintaining full-time engagement of the rear differential in 'S' mode, so power distribution under loss of front-wheel traction may be marginally improved.
- **R** position of the floor-mounted shift lever means that the transmission is in "reverse". This functions in a similar

way to **D**, but there is just one 'reverse gear'. When selected, **R** is highlighted in the instrument display.

- **Manual mode:** The floor shift lever also has another plane of operation, for manual ^{[3][5]} mode, with spring-loaded "+" and "-" positions. This plane is selected by moving the stick away from the driver (in vehicles with the driver's seat on the right, the lever is pushed to the left, and in left-hand drive cars, the stick is pushed to the right) when in "D" mode only. When this plane is selected, the DSG can now be controlled like a manual gearbox.

V. ADVANTAGES

- One of the most important advantages is speed of shifting. For a regular gearbox, the clutch has to disengage from one gear then move to the next gear and then engage.
- In comparison, in a dual clutch gearbox, when the first clutch is engaged with one gear, the second clutch has already preselected the next gear and is primed to engage making the transition between gears instant.
- Torque will not drop significantly in between gearshifts aiding smoother and more unified acceleration.
- A DSG also helps in increasing the efficiency compared to a conventional torque convertor unit with minimal slippage.
- Better fuel economy.

VI. DISADVANTAGES

- The biggest disadvantage is that dual clutch gearboxes are more expensive.
- There is no part repair or part replacement of parts for such a gear box. A DSG is a sealed unit and if there's a problem with the 'box, the complete unit needs to be replaced.
- These are also heavier than conventional gearboxes.
- Another small disadvantage is that in unexpected situations that the ECU is not able to anticipate, the gearshifts can take longer than usual.

VII. APPLICATIONS

Used in VOLKSWAGEN, BUGGATI, SKODA, AUDI.

- Audi A3
- Audi S3
- Audi A4 (B8)^[7]
- Bugatti Veyron EB 16.4^[6]
- SEAT León
- SEAT Altea
- Škoda Fabia
- Škoda Octavia
- Volkswagen Polo
- Volkswagen Golf, GTI, GTE, TDI, R32, R^{[2][6]}
- Volkswagen Jetta GLI, TDI, TSI(Brazil)

VIII. CONCLUSION

DSG'S excellent features like **high speed of shifting, good fuel economy** etc. have made it popular today. There is lot of scope to minimize the drawbacks stated above. New materials could be an alternative to the existing ones for weight reduction and cost minimization. With few modifications DSG can surely replace the current gear boxes and is a promising innovation in the automotive sector.



Prof. (Dr.) Satish S. Chinchankar, HOD (Mechanical Engineering), VIIT PUNE, 48 in International peer reviewed Journals and Conferences And National Conferences, Internal Auditor ISO 9001:2008, member of ISTE and ASME.

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AUTHORS PROFILE



Ms. Akshada D. Padwal, Mechanical engineering department, Savitribai Phule Pune University, Vishwakarma Institute of Information Technology, Pune, India



Mr. Tejas R. Pawar, Mechanical engineering department, Savitribai Phule Pune University, Vishwakarma Institute of Information Technology, Pune, India



Mr. Pratik R. Vishwakarma, Mechanical engineering department, Savitribai Phule Pune University, Vishwakarma Institute of Information Technology, Pune, India



Mr. Asif H. Shaikh, Mechanical engineering department, Savitribai Phule Pune University, Vishwakarma Institute of Information Technology, Pune, India