Powertrain

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The new Polo is being launched with a range of optimised, low-consumption gasoline engines – all of which already meet the new EU5 exhaust standard – as well as the 1.6 l common rail diesel engine. VW is offering the new seven-speed dual clutch gearbox as a gearbox variant for the Polo. Later on, the engine range will be increased by a completely newly developed 1.2 l TSI gasoline engine.

1 The Two Three-cylinder Engines

The entry-level engine for the new VW Polo remains the tried-and-tested three-cylinder gasoline engine with a cubic capacity of 1.2 l and performance values of 44 or 51 kW, **Figure 1**. This engine is characterised by the familiar advantages of modern three-cylinder engines. Consequently, a high level of torque is available even at low rpm values, thereby permitting a frugal driving style. It goes without

Figure 1: 1.2 l three-cylinder gasoline engine

Table 1: Gasoline engines – overview of technical data

	1.2l 44 kW MPI	1.2l 51 kW MPI	1.4l 63 kW MPI
Engine design	I3 petrol	I3 petrol	I4 petrol
Mixture formation	Manifold injection	Manifold injection	Manifold injection
Engine management system	Simos 9	Simos 9	MM 4HV
Cubic capacity	1198 cm^3	1198 cm^3	1390 cm^3
Bore/stroke	76.5/86.9 mm	76.5/86.9 mm	76.5/75.6 mm
Compression ratio	10.3 : 1	10.5 : 1	10.5 : 1
Max. power	44 kW/ 5200 min^{-1}	51 kW / 5400 min^{-1}	63 kW / 5000 min^{-1}
Max. torque	108 Nm / 3000 min^{-1}	112 Nm / 3000 min^{-1}	132 Nm / 3800 min^{-1}
Fuel	Roz 95/91	Roz 95/91	ROZ95/91
Emissions class	EU5	EU5	EU5
Consumption, urban	7.2 l/100 km	7.2 l/100 km	8.0 l/100 km
Consumption, extra-urban	4.5 l/100 km	4.5 l/100 km	4.7 l/100 km
Consumption, combined	5.5 l/100 km	5.5 l/100 km	5.9 l/100 km
CO_2 emission	128 g/km	128 g/km	139 g/km
Gearbox	M5	M5	M5

saying that these two engines also feature a flexible service interval display as standard, and that they are further characterised by straightforward maintenance and long-term quality. This is reflected in the low running costs in particular.

The engines have been reworked in terms of weight, engine acoustics and the requirements for the EU5 exhaust standard in order to be used in the new Polo. For example, one new feature is a toothed chain with optimised acoustic properties that is used for the timing gear and oil pump drive. The engine management system has been equipped with new functions and, in combination with a newly adapted precious metal coating, it reliably achieves the new, strict exhausts limit values of EU5. All of this, in combination with a new gearbox setup and optimised features in the vehicle, has led to a reduction in fuel consumption by 0.4 l or 10 g CO_2/km for both versions compared to the previous model.

2 The 1.4 l Four-cylinder Gasoline Engine

The new Polo also uses the 1.4 l gasoline engine with intake manifold injection from the familiar EA-111 package, now with a maximum power of 63 kW. For the first time, this engine is available not only with a manual gearbox but also in combination with the seven-speed DSG dual clutch gearbox. As well as appealing driving performance, the low-maintenance design of the engine also achieves low running costs. The timing belt and auxiliary unit drive have been designed for the service life of the vehicle. The flexible service interval display allows an oil change interval of up to two years or 30,000 km.

The basic low-friction architecture of the engine has not been changed for use in the Polo. With four valves per cylinder and valve actuation by roller rocker fingers, the fully aluminium engine can fight its corner very effectively in the competitive environment with its very good fuel consumption figures. Consistent use of plastics and alloys have resulted in an engine that weighs only 94 kg (DIN70020-GZ).

The engine electronics have been fundamentally reworked for the EU5 exhaust standard, and the injection system has been equipped with new injectors for improved mixture preparation. An improved precious metal coating for the catalytic converter system means that the strict limit values of the new exhaust standard are reliably complied with. Detailed optimisations have been made, such as improved engine control and reduced driving resistance, thereby allowing fuel consumption to be reduced in the manual gearbox version by 0.4 l or 11 g CO_2/km compared to the previous Polo generation, resulting in 5.9 l/100 km or 139 g CO_2/km. The consumption reduction in conjunction with the Volkswagen DSG gearbox is significantly greater, with fuel consumption cut by 1.1 l/100 km or 29 g CO_2/km to 5.8 l /100 km or 138 g CO_2/km compared to the previous model with automatic gearbox and torque converter, **Table 1** and **Figure 2**.

Figure 2: 1.4 l four-cylinder gasoline engine

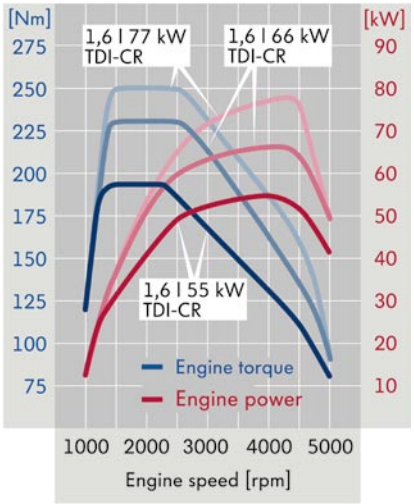

Figure 3: Engine power graphs 1.6 l TDI-CR engines

3 The New 1.6 l TDI Engine

Following the successful launch of 2.0 l common rail diesel engines by Volkswagen, common rail technology is now being used in the Polo for the first time as well. This heralds the premiere of a completely new 1.6 l common rail diesel engine which is phasing out the familiar 1.4 l and 1.9 l TDI engines with their pump/nozzle injection system. The totally new concept of the four-cylinder diesel engine will form the basis for all future four-cylinder diesel engines from Volkswagen. The most important development objective was to reduce fuel consumption at the same time as improving performance, offering greater comfort and achieving low exhaust emissions. It meets the standards of the EU5 exhaust standard and is extremely well equipped with regard to future requirements on emissions behaviour.

In the Polo in its first development stage, the engine develops a maximum power of 55 kW at 4000 rpm from its 1.6 l cubic capacity. The maximum torque of 195 Nm is available within a speed range from 1500 to 2250 rpm. This means the TDI engine allows for enjoyable driving in the Polo, combined with convincing economy values. Two more powerful variants with 66 kW and 230 Nm as well as 77 kW and 250 Nm will follow subsequently as the series progresses, **Figure 3**.

Fuel is supplied by a common rail injection system from Continental. The system has been developed further in cooperation with Volkswagen and operates at 1600 bar injection pressure. It is characterised by an optimum ratio between power, driving comfort, acoustic properties and emissions. Piezoelectric actuators permit flexible injection sequences and a highly accurate mixture addition. The multiple injections that are precisely timed in relation to one another have reduced the pressure gradients and achieved a significant reduction in acoustic excitation. The entire system helps to assure maximum precision and reproducibility.

Development work focused on reducing the friction power. The crankshaft, valve and oil pump drive were systematically optimised in this regard. At the same time, a quadratic stroke-to-bore ratio provides minimum friction losses on the cylinder liners. Furthermore, throttle losses in the oil and coolant circuit have been reduced, as they have also been in the induction and charge air tracts. The oil circuit has been totally revised for this purpose. In addition, optimisations in the coolant circuit have allowed the engine to operate with optimum efficiency.

The targets of optimum mixture preparation and improved efficiency combined with the lowest possible sustained exhaust emissions in all operating ranges, have been achieved. Good experience with the 2.0 l common rail engine had an important role to play in this. This was taken into account in the design of the 1.6 l engine and the knowledge gained was consistently developed further, **Table 2** and **Figure 4**.

Table 2: Technical data 1.6 l TDI-CR engine 55 kW

	1.6l TDI-CR
Engine design	four-cylinder diesel
Mixture formation	Common-rail
Engine management system	Simos PCR2
Cubic capacity	1598 cm^3
Bore/stroke	79.5/80.5 mm
Compression ratio	16.5 : 1
Max. power	55 kW / 4000 min^{-1}
Max. torque	195 Nm / 1500 - 2250 min^{-1}
Fuel	Diesel EN 590
Emissions class	EU5
Consumption, urban	5.1 l/100 km
Consumption, extra-urban	3.6 l/100 km
Consumption, combined	4.2 l/100 km
CO_2 emission	109 g/km
CO_2 emission	M5

Figure 4: 1.6 l four-cylinder TDI engine

4 The Seven-speed Dual Clutch Gearbox

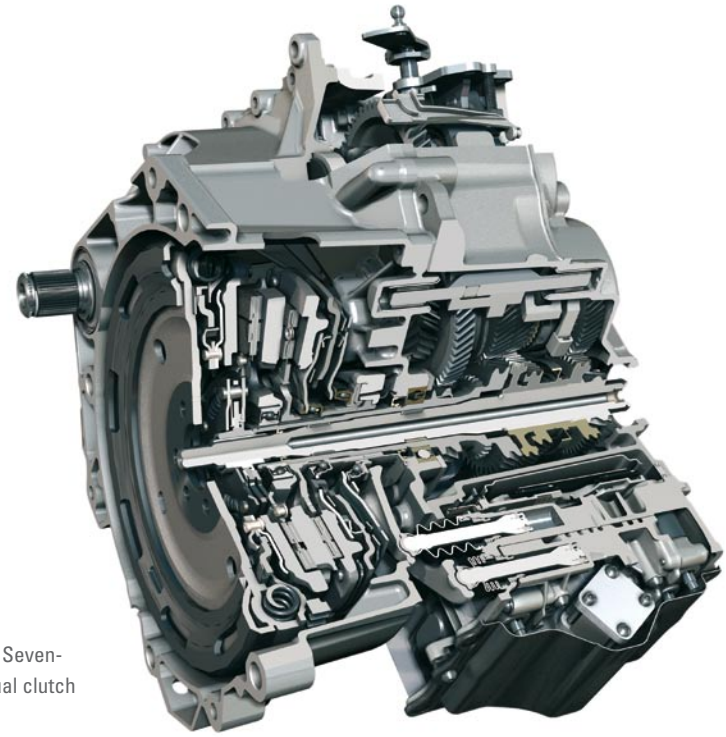

Figure 5: Seven-speed dual clutch gearbox

The world's first seven-speed DSG for front-transverse installation from Volkswagen is now being used in the small car segment – which is something really unique in the world, **Figure 5**. Its use in the Polo represents VW pursuing its dual clutch strategy in a consistent manner. The DSG which is already familiar from the Golf combines the comfort of an automatic transmission with torque converter and the dynamic properties of a manual gearbox.

The dry clutch technology allows the powertrain to achieve a further increase in overall efficiency. The clutch does not require oil cooling, therefore 1.7 l gear oil is sufficient for lubricating the gearing and bearings – approximately corresponding to the amount used in a comparable manual gearbox. This means churning losses are significantly reduced. In conjunction with seventh gear configured as an overdrive, an optimised gear compartment and the electrohydraulic actuator unit with power supply on a demand basis – the mechatronic unit – it has been possible to improve consumption and emissions by a further significant amount. The gearbox weighs only 77 kg including the dual-mass flywheel which accounts for 7 kg. As a result, it also makes an important contribution to reducing the vehicle weight. In spite of its design that has been tuned for efficiency, the gearbox offers enjoyable driving and sportiness. This makes it clear what advantages are offered by the seven gears in conjunction with close ratio spacing and a short first gear.

The driver can select the driving mode to influence the gearshift programme. The Polo offers optimum consumption in D mode. The gearshift rpm values are nudged upwards in S mode – lending the vehicle further improved dynamic values and emphasising its sporty aspect. In Tiptronic mode, the driver can also select the gear manually like in a manual gearbox.

The new seven-speed dual clutch gearbox represents a milestone in modern gearbox technology. The dry dual clutch in combination with seven driving gears offers fuel consumption that is low on resource use at the same time as delivering a high standard of driving comfort and exciting driving thanks to the smooth gear changes without any interruption in traction, and a spontaneous response. The gearbox is offered in the new Polo in conjunction with the 1.4 l gasoline engine with 63 kW and the 1.6 l TDI engine with 66 kW, and further combinations will follow.

Dual clutch gearboxes are characterised by having two coaxially arranged input shafts. In this case, gears 1, 3, 5 and 7 are allocated to input shaft 1 whilst input shaft 2 transmits the input torque into gears 2, 4, 6 and R. This arrangement of two subgearboxes makes it possible to pre-engage the next gear so that the actual gear shift can be performed in a few hundredths of a second by opening one clutch and closing the other with no interruption in tractive force. Three drive shafts permit a short and light construction method, whilst also enabling the ratios of all gears to be optimally adapted to the engine.

Both clutches are based on the tried-and-tested manual shift technology, with the units being integrated into a dual clutch. However, the significant difference is that the individual clutches are engaged actively, whereas in manual gearboxes they have to be disengaged actively by pressing the clutch pedal. An adapted design with a shorter gear ratio in the moving-off gears and automation makes the dual clutch, as well as the entire gearbox itself, designed for lifetime application. It does not need any maintenance whatsoever.

The mechatronic unit of the DSG have their own oil circuit which is separate from the gearbox. This means the hydraulic oil can be optimally adapted to the requirements of the control unit. Low-temperature properties are significantly improved, because low-leakage cartridge valves with narrow gap sizes are used. Compressed oil for the control system is provided based on requirements using an electrically driven pump in an accumulator. A gear pump driven permanently by the internal combustion engine can therefore be dispensed with.

The mechatronics are configured as an independent unit and are inspected separately. This has a positive effect on the reliability of the entire system. They control the complex gearshift procedures within fractions of a second, whilst remaining permanently in communication with the engine and brake control unit, amongst others, via CAN bus. Approximately 6000 individual parameters, 600 characteristic curves and 150 characteristic maps are available for calibrating the system. ■