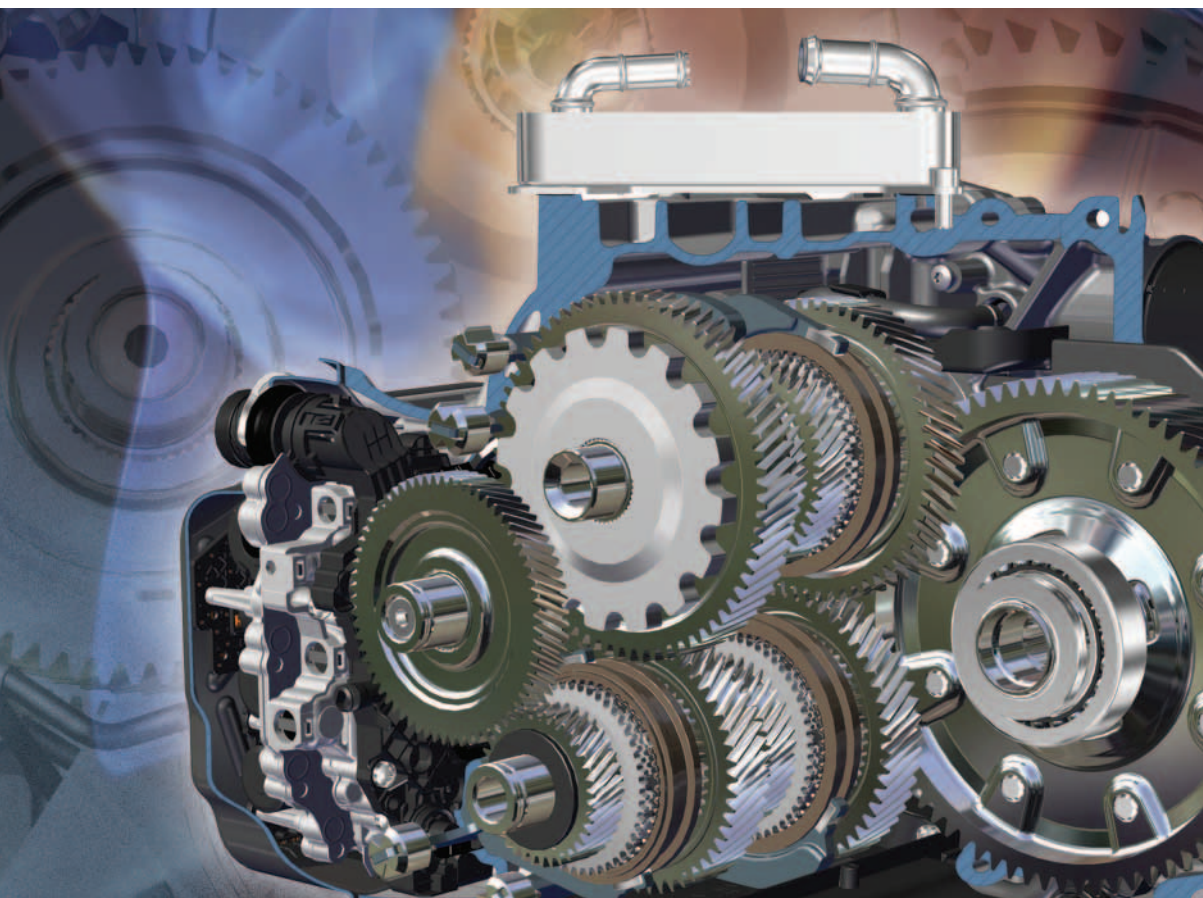


Self-Study Programme 556

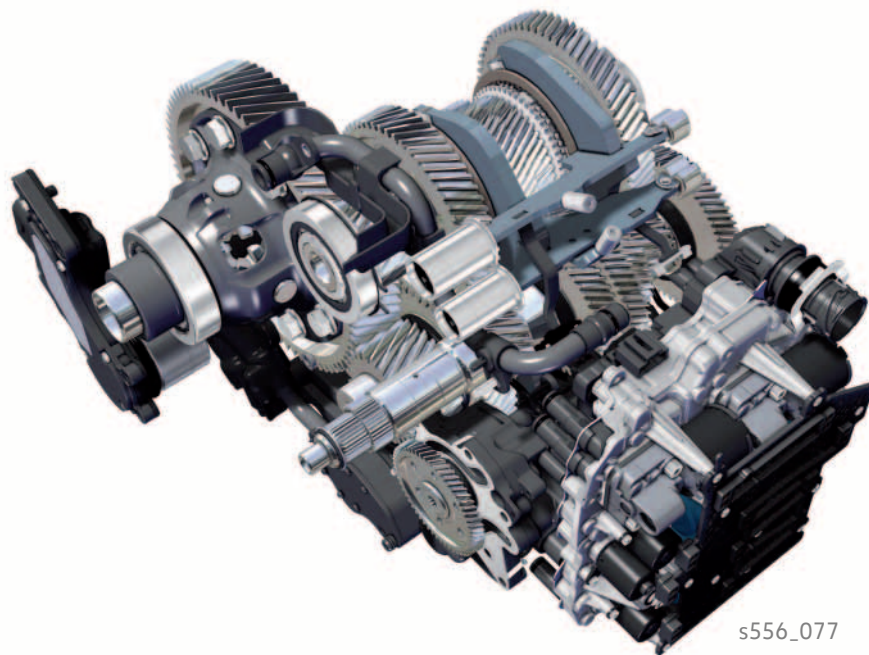
The 7-speed Dual Clutch Gearbox 0GC

Design and function



The development story behind the new 7-speed dual clutch gearbox OGC

- The dual clutch gearbox OBT made its debut at Volkswagen Commercial Vehicles with the T5 model year 2010. As the forefather of this gearbox development, it has provided the basis for the design and function of a new gearbox generation.
- At Volkswagen Passenger Cars, the dual clutch gearbox OBT featured in the Tiguan model year 2011 with the designation OBH.
- A new gearbox production site was set up in China.
The gearbox OBH was further developed for that factory and was given the designation ODE.
- The aim of continuously reducing consumption and CO₂ emissions has given the impetus to develop a more efficient gearbox from that transmission. The result is the dual clutch gearbox OGC.



This gearbox is based on the dual clutch gearbox OBH/OBT. Please refer to SSP 454 "The 7-speed dual clutch gearbox OBT in the T5 2010" for information on the design and function.

The measures to reduce CO₂ are described in this SSP.

**The Self-study Programme shows the design and function of new developments.
The contents will not be updated.**

For current testing, adjustment and repair instructions, refer to the relevant service literature.



**Important
Note**

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Introduction

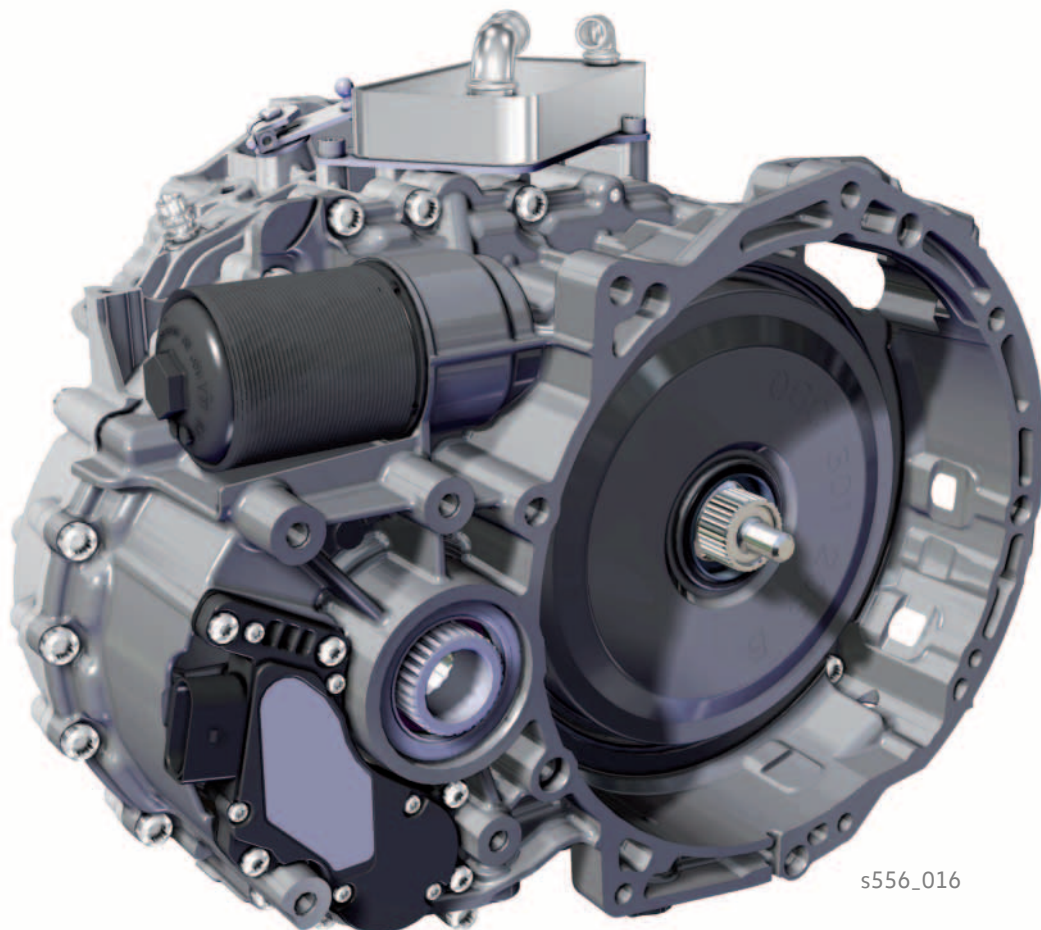
The development goal for the 7-speed dual-clutch gearbox OGC

The main priority during the development of the 7-speed dual clutch gearbox OGC was reducing CO₂ emissions. The following technical modifications have cut CO₂ emissions by 6 g/km compared with the dual clutch gearbox ODE:

- Low-friction shaft bearings and differential bearings
- Low-friction seals on the shafts
- A new oil pump concept
- A low-leakage hydraulic system
- Low-friction gearbox oil

A further 1 g/km of CO₂ is saved with the start/stop system.

Compared with the dual clutch gearbox O2E/OD9, an additional CO₂ reduction of 3 g/km is achieved thanks to the 7th forward gear in the OGC.

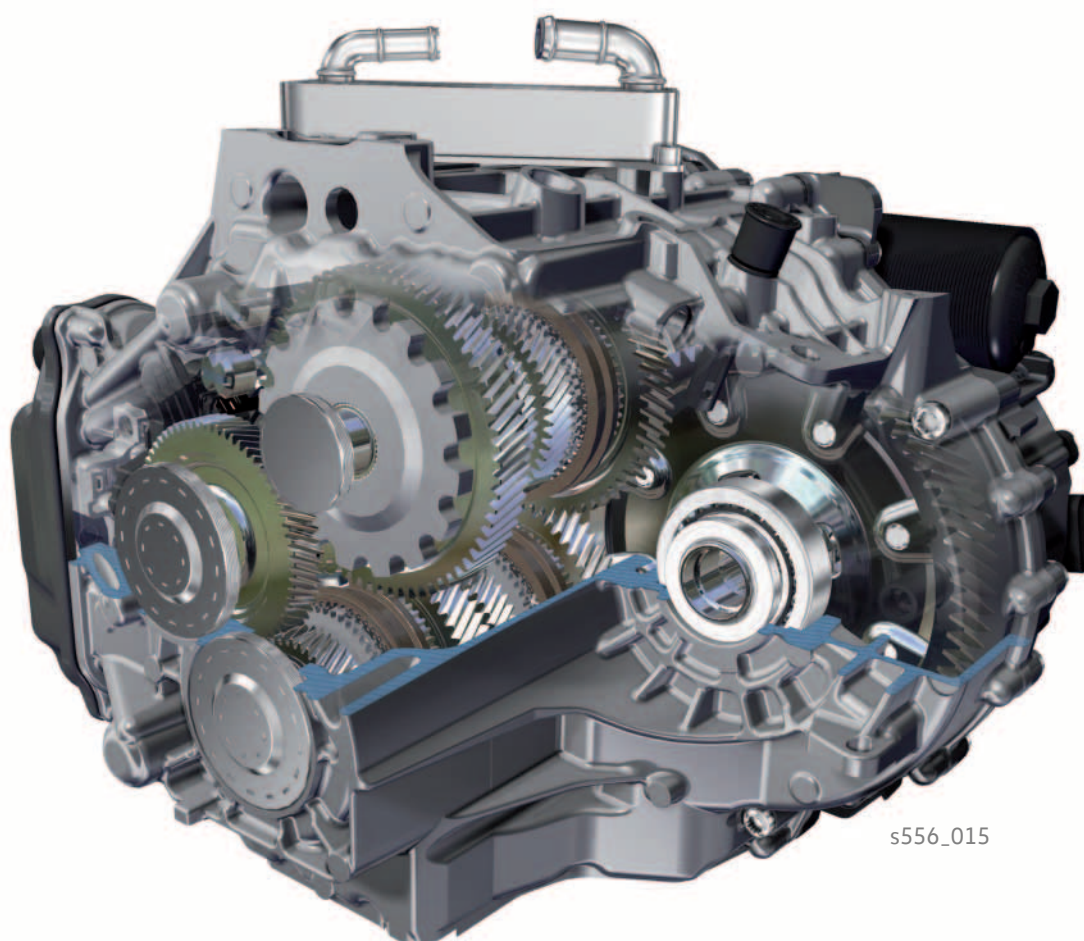


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Technical data

The following technical data characterise the 7-speed dual clutch gearbox OGC:

Type of gearbox	Hydraulic dual clutch gearbox
Number of gears	7 forward gears and 1 reverse gear
Number of drive shafts	2 concentric drive shafts
Number of output shafts	2 output shafts
Number of clutches	2 wet clutches
Maximum torque	420Nm
Weight	85kg (+ 2kg auxiliary hydraulic pump)
Number of hydraulic pumps	2 hydraulic pumps
Oil volume	7 litres of low-friction gearbox oil
Oil specification	See ELSA
Oil change interval	See ELSA



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Gearbox design

Gearbox bearings

Fixed and floating bearings are used for the output shafts in the dual clutch gearbox OGC.

The shafts are installed in way that ensures low friction and no preload.

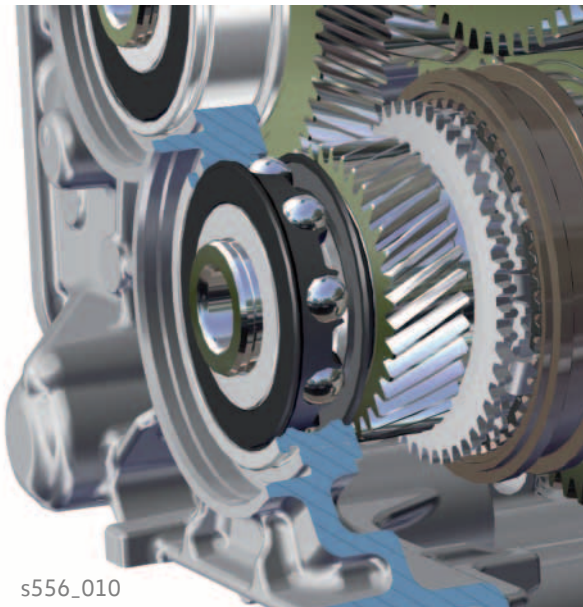
Advantages of using fixed and floating bearings:

- Heat expansion of the shaft is not critical
- Changing axial loading is not critical

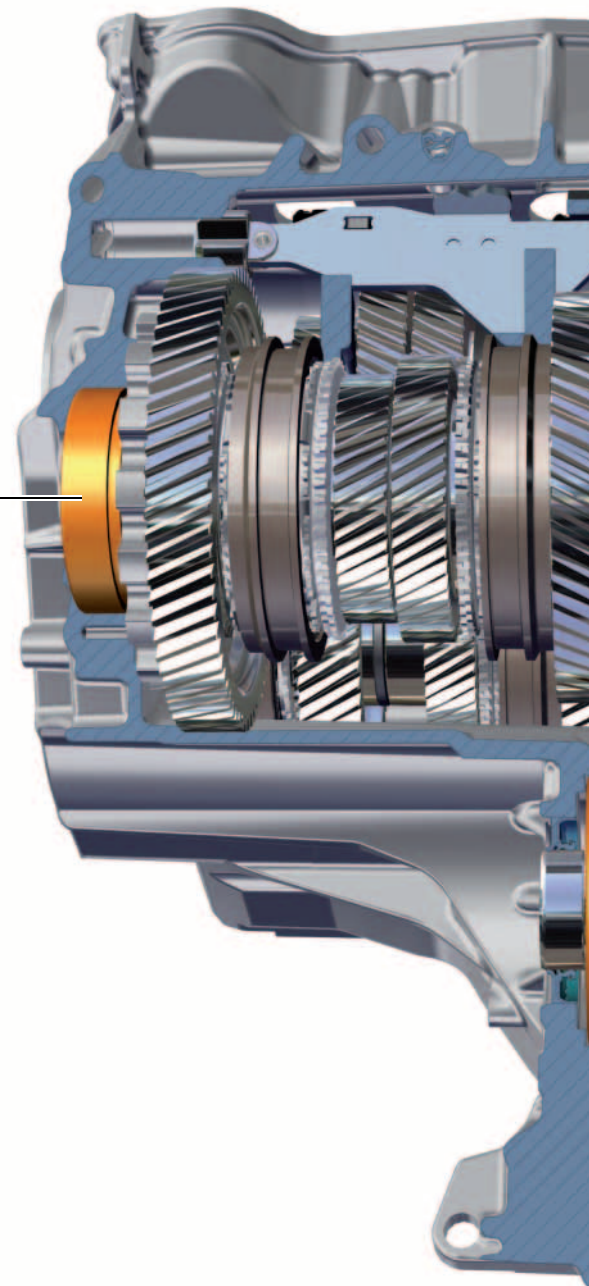


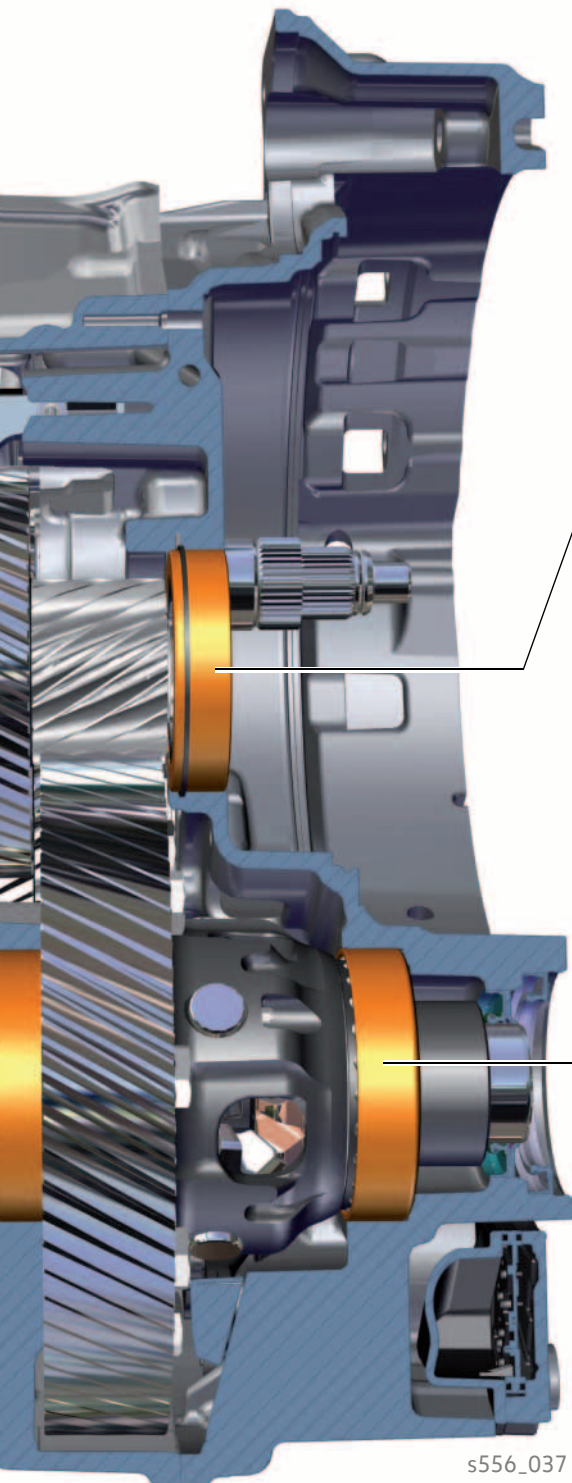
All gears use single synchromesh and are carbon-coated.

Fixed bearings



The fixed bearings are deep groove ball bearings and are located in the gearbox housing. The deep groove ball bearings can absorb radial and axial forces.





Floating bearings



The floating bearings are cylindrical roller bearings and are located in the clutch housing. The cylindrical roller bearings can absorb radial forces.

Double groove ball bearings



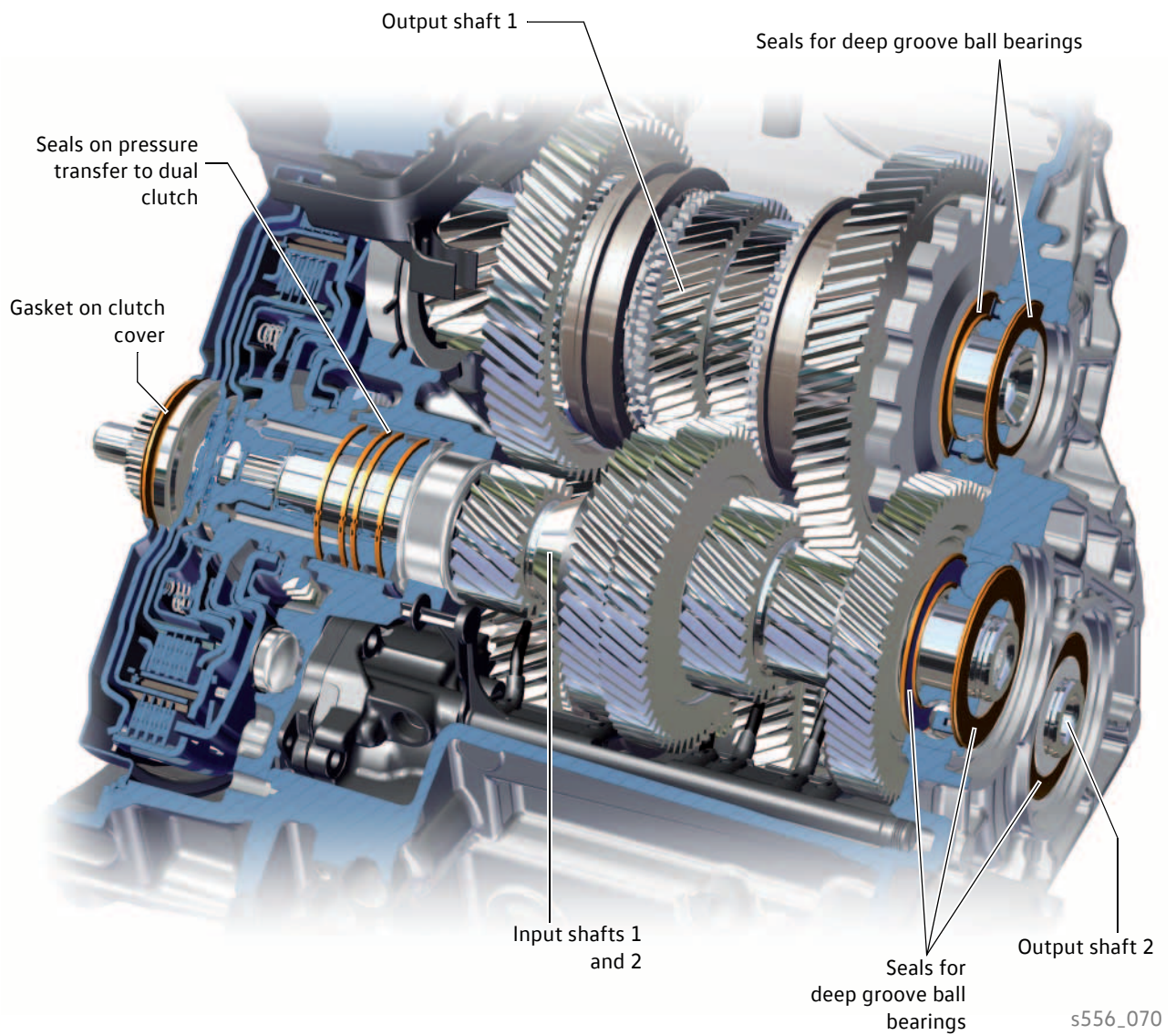
The double groove ball bearings in the differential can absorb radial and axial forces. The small contact surfaces between the balls and the bearing races reduce the rolling resistance.

Gearbox design

Seals

The following seals on all shafts are now low-friction following the switch to fixed and floating bearings:

- Gasket on clutch cover
- Seals on pressure transfer to dual clutch
- Seals for deep groove ball bearings



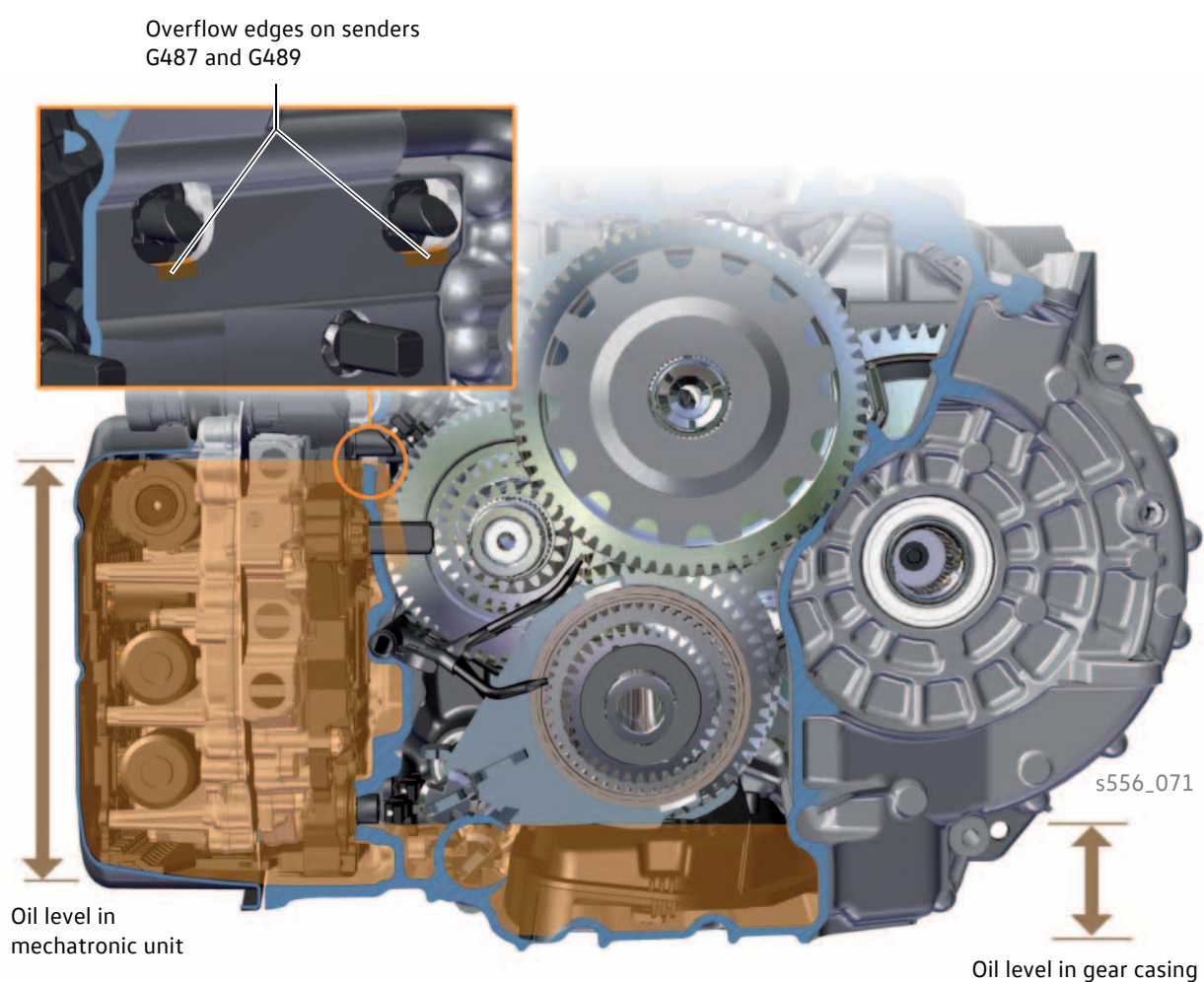
Oil management

Oil levels

A low-friction gear oil is supplied to the gear set, the dual clutch and the mechatronic unit J743.

The mechatronic unit has its own oil chamber that is filled with oil up to the overflow edges.

The oil cools the valve coils, reduces the operating noise and ensures that the mechatronic unit is vented. The oil level in the gear casing is reduced to a minimum to avoid unnecessary churning/drag losses.



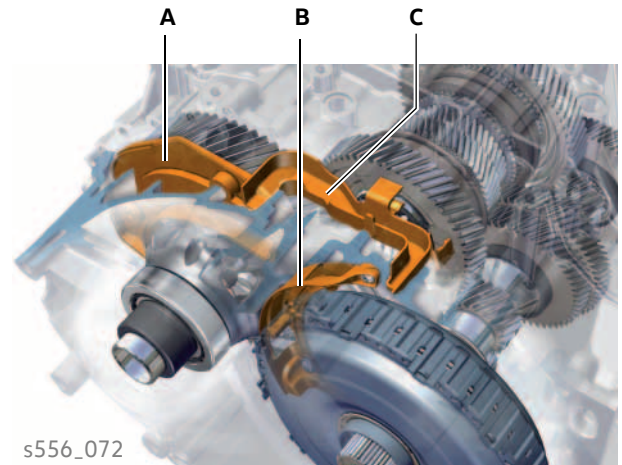
Oil circuit

Oil distribution in the gear casing

The oil is distributed in the gear casing by the following components:

- Baffle plate (A)
- Oil guide with oil pick-ups (B)
- Oil channel (C)

The baffle plate and the oil channel ensure a consistently low oil level in the gear casing. An oil guide ensures lubrication of the bearings on the output shafts.



Baffle plate

The baffle plate is located in the gearbox on the clutch housing.

Design

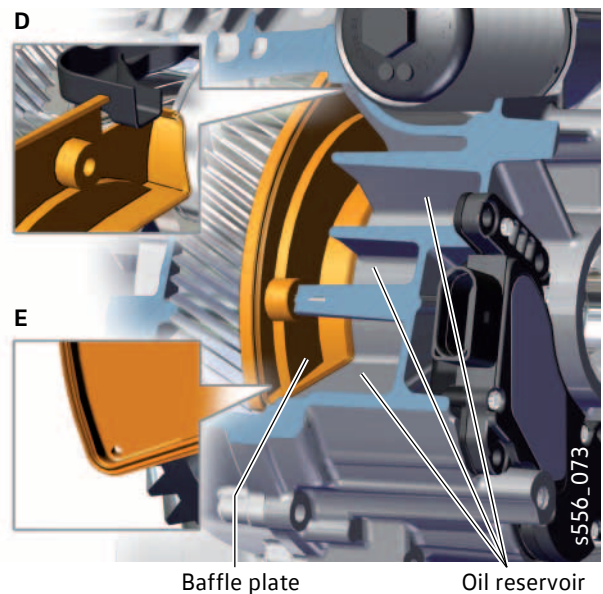
The baffle plate is a plastic cover plate with an inlet opening and a drain hole.

It is bolted onto the clutch housing creating an oil reservoir.

Task

The baffle plate ensures a low oil level when the vehicle is moving and at higher gearbox temperatures. This reduces oil churning by the gear wheels and increases the efficiency.

The oil level is increased by the baffle plate being empty when the gearbox is cold and the vehicle moves off. This aids the intake of oil by the pumps.



Function

The oil for the clutches is supplied to the baffle plate via an oil channel. The oil temperature influences the filling quantity in the oil reservoir. If the oil is warm, more oil flows in, than can drain out of the drain hole.

The oil level in the baffle plate increases thus compensating for the expansion of the oil in the gear casing.

Result

Unnecessary oil churning losses are avoided.

Oil guide

The oil guide is located in the clutch chamber of the gearbox.

Design

The oil guide is made of plastic. It has three oil pick-ups and two integrated channels to the output shafts.

Task

It leads the oil from the clutches into the gear casing and directs part of the oil into the interior of the output shafts.

Function

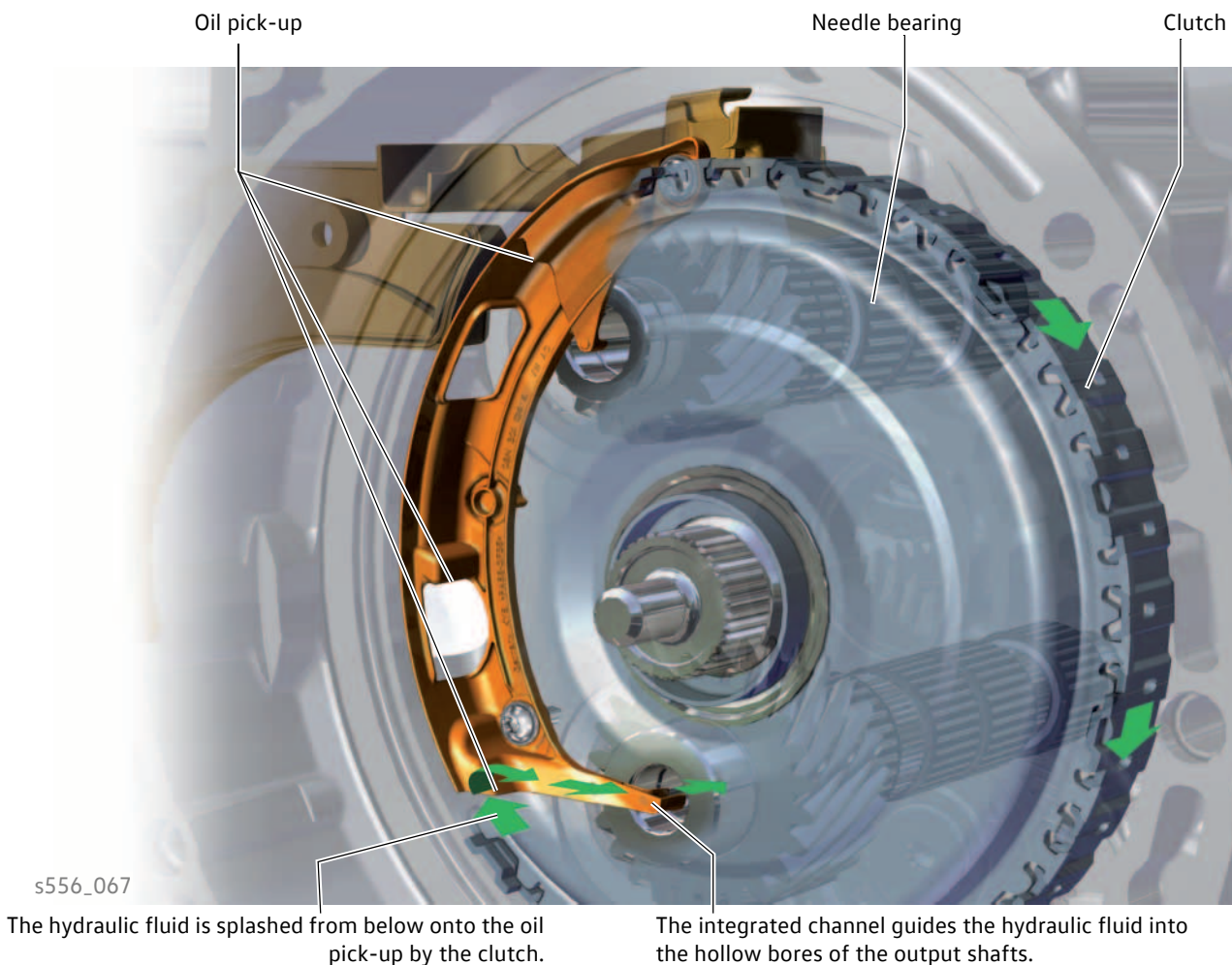
The outer oil pick-ups with integrated channels carry the oil escaping from the clutches into the output shafts. The oil flows through bores to the needle bearings.

The oil from the middle oil pick-up is fed into the gear casing.

Result

The needle bearings on the output shafts are lubricated.

The warm oil is returned to the oil circuit.

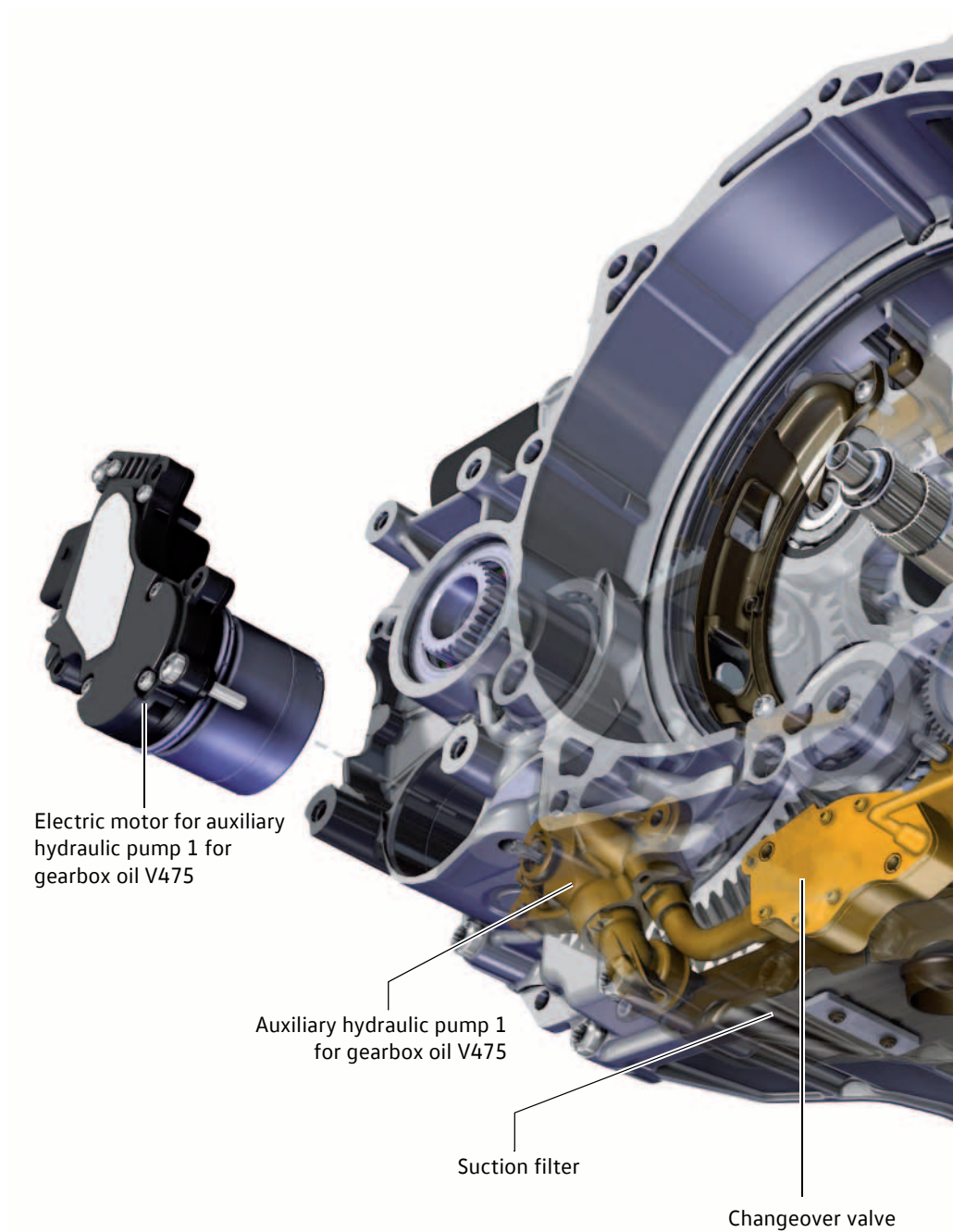


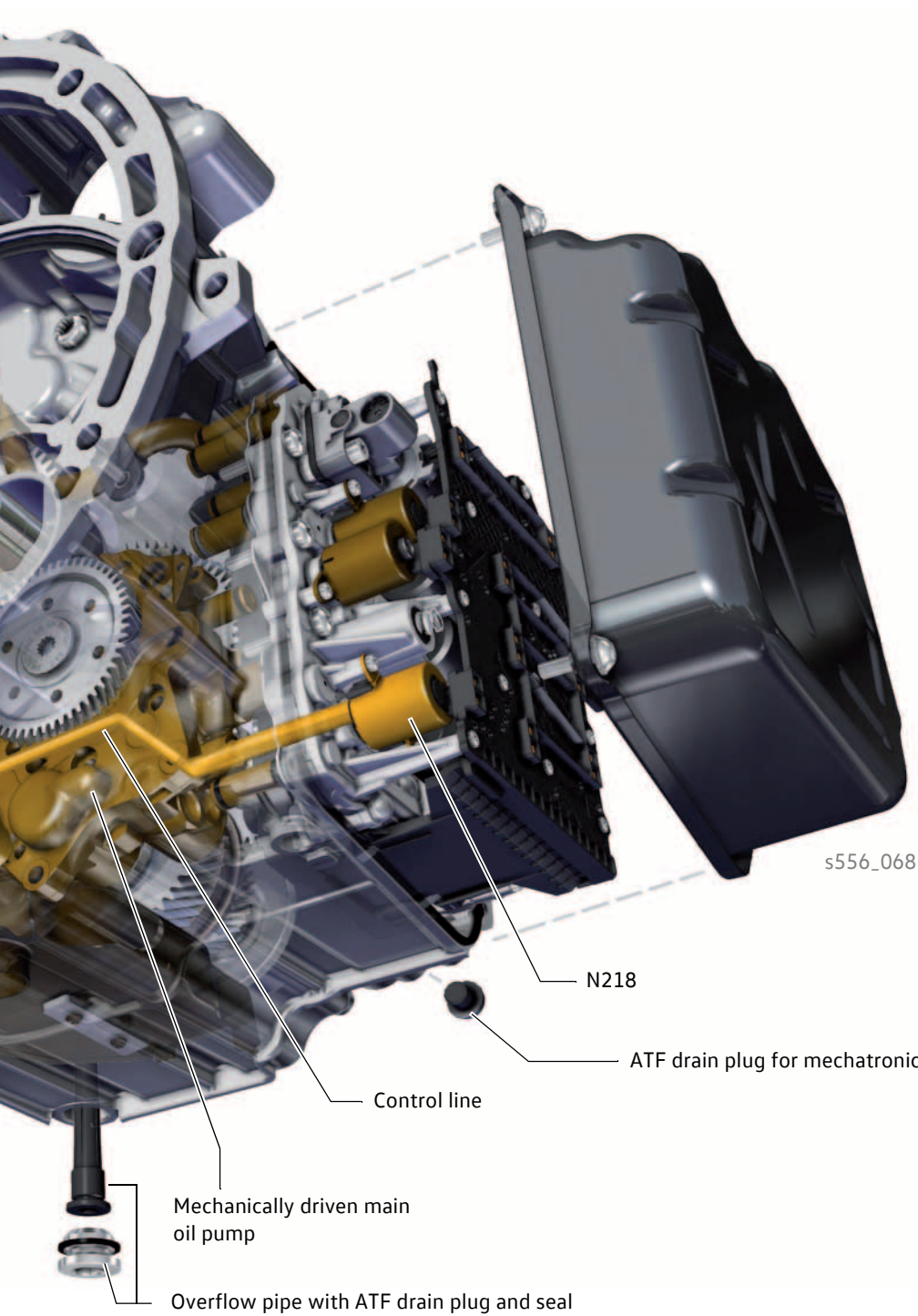
Oil circuit

Oil pumps

The 7-speed dual clutch gearbox has one mechanically driven hydraulic pump and one electrically driven hydraulic pump. The electrically driven hydraulic pump is the auxiliary hydraulic pump V475. It is driven by a brushless direct current motor. There is a changeover valve between the pumps.

The pressure regulating valve N218 regulates the position of the piston in the changeover valve via a control line.





Mechanically driven main oil pump

The mechanically driven main oil pump (MOP) is a vane pump. It is driven by gear teeth on the clutch pack.

Task

Supply of low-friction gear oil for:

- Oil supply to the mechatronic unit
- Cooling and actuation of the dual clutches
- Cooling and lubrication of shafts and gears

Design

There are movable vanes on the rotor. The vanes create 12 chambers inside a magnetic cam ring.

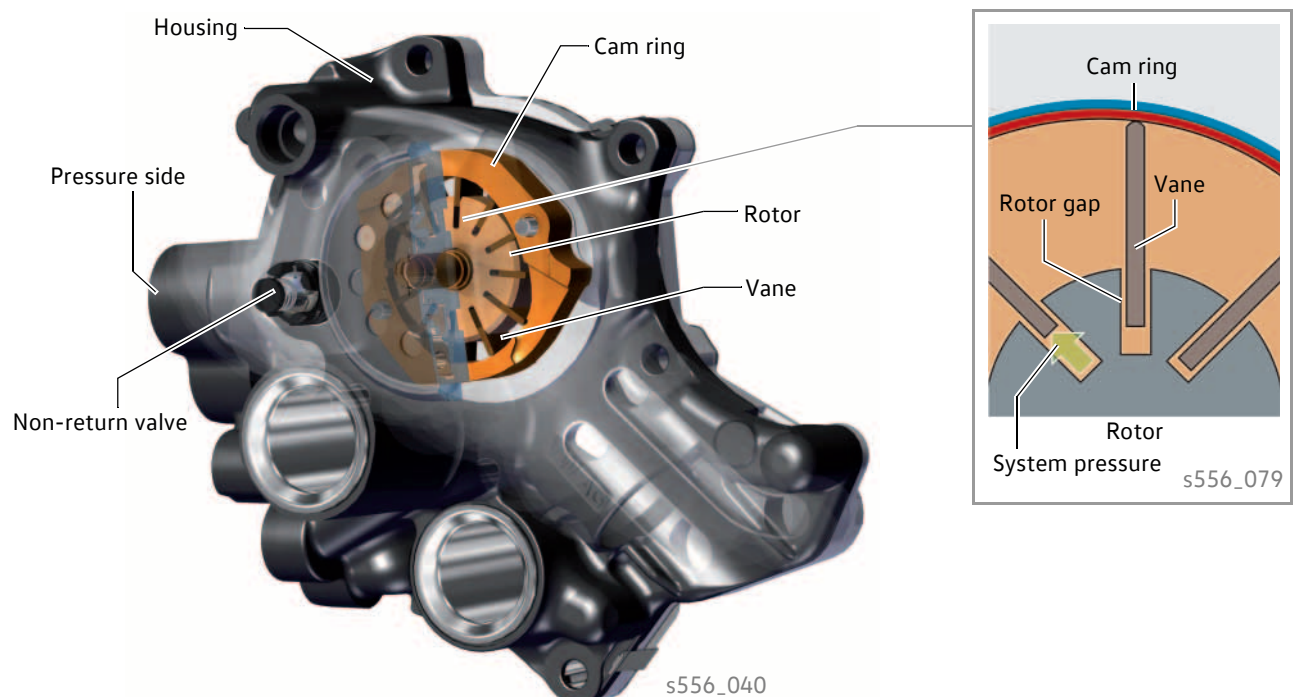
There is a non-return valve in the pump housing.

Function

During pumping operation, the vanes are pressed against the cam ring by the system pressure. The centrifugal forces on the vanes help seal the individual chambers. The chamber sealing is thus controlled according to the pump load and optimises the efficiency of the main oil pump.

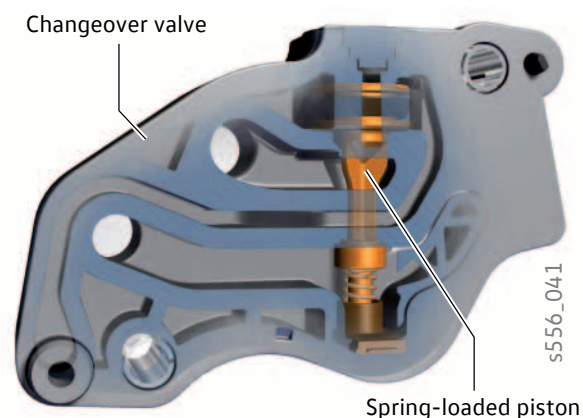
There is no system pressure yet when the engine is started. The slightly magnetic cam ring pulls the vanes outwards and improves the pump start-up and pressure build-up.

The delivery rate per revolution is 8 ccm.



Changeover valve

The changeover valve is located between the main oil pump and the auxiliary hydraulic pump V475.

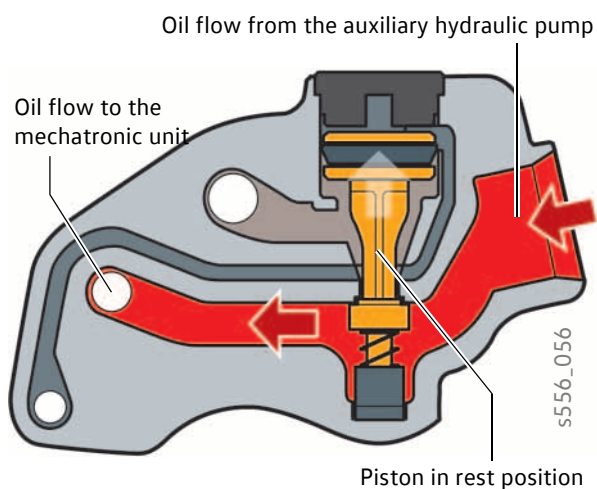


Task

The changeover valve distributes the oil flow from the auxiliary hydraulic pump.

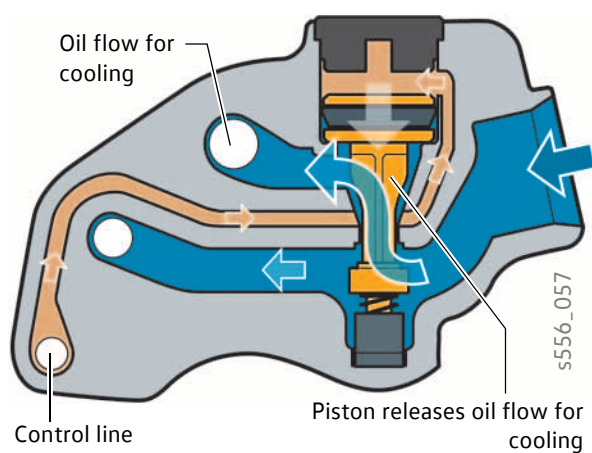
Design

There is a spring-loaded piston in the changeover valve.



Function

When the piston is in the rest position, the oil flow is used to supply the mechatronic unit.



If oil is forced against the piston via the control line, the oil flow is directed to cool the clutches. The non-return valve in the main oil pump (see page 14) prevents oil flowing to the pressure supply.

Auxiliary hydraulic pump 1 for gearbox oil V475

The auxiliary hydraulic pump 1 for gearbox oil V475 is an annular gear pump (duocentric pump). It is activated on-demand and driven by an electric motor.

Task

The auxiliary hydraulic pump supports the mechanically driven main oil pump with the pressure supply and with cooling, e.g.:

- When there is a high load requirement in the low rev range
- In stop-and-go traffic
- In start/stop mode
- During idling drag

Design

The outer ring has one more tooth than the inner gear.

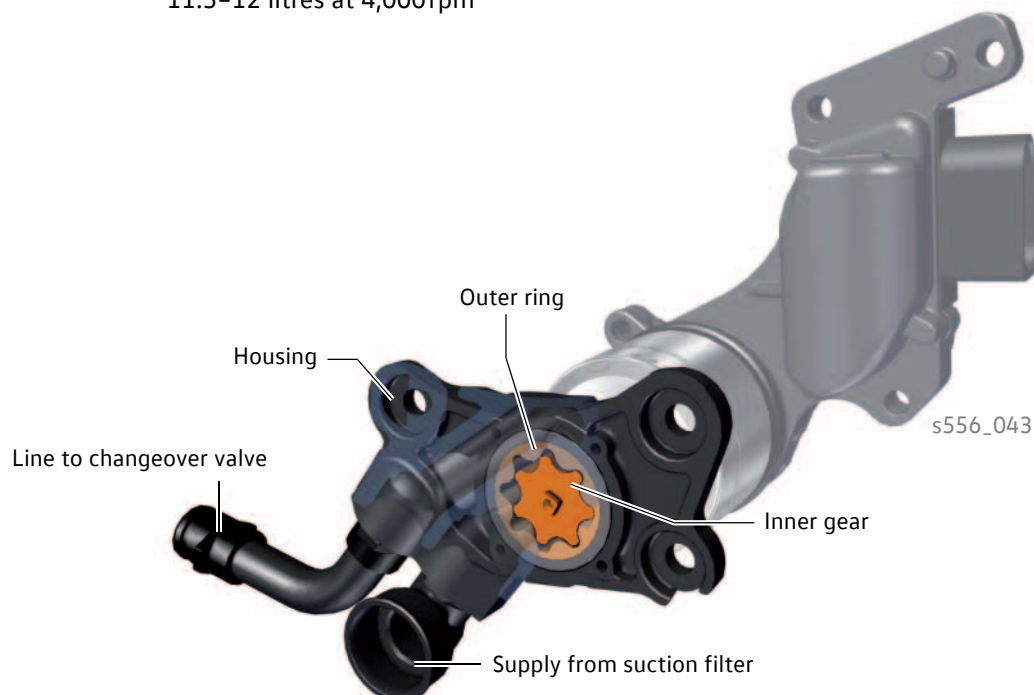
The inner gear and outer ring have different centering points.

Function

The outer ring and the inner gear rotate in one direction. The cavity varies during rotation due to the offset centering of the inner gear to the outer ring. The cavity becomes larger past the suction opening. The oil is drawn in. The cavity is reduced as the pump turns towards the outlet. The oil is pushed out of the pump at the outlet and is delivered to the changeover valve.

Technical data

Delivery rate: approx. 3ccm per revolution
11.5–12 litres at 4,000rpm



Electric motor for auxiliary hydraulic pump V475

This electric motor is bolted to the outside of the clutch housing. It can be renewed without opening the gearbox.

Task

The motor drives the auxiliary hydraulic pump.

Design

The motor is a brushless direct-current motor with control electronics and a position sensor on the rotor.

There are cooling oil bores in the motor housing.

The voltage supply and the powertrain CAN bus are assigned to the connector.

Function

The speed requirement signal is transmitted by the mechatronic unit via the powertrain CAN bus to the motor.

Control electronics activate the motor and measure the speed via the rotor position sensor. Among other things, this allows a motor seizure to be detected.

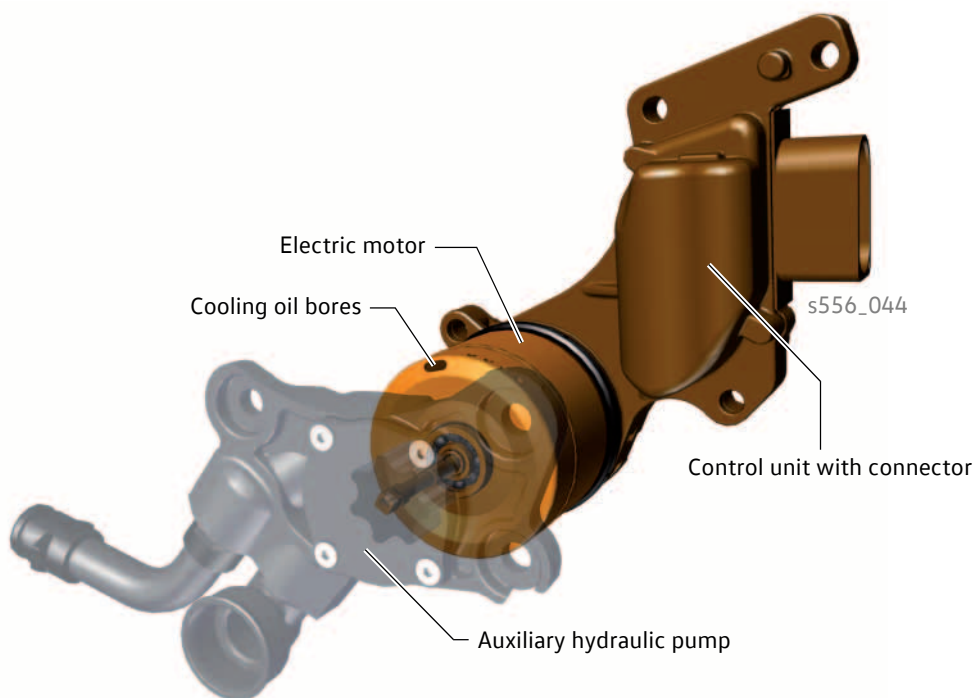
Low-friction gear oil flows through the bores in the motor housing to the inside and cools the motor.

Technical data

Max. speed: 4,000rpm

Control range: from 100 to 4,000rpm

Start-up time: 50 ms



Oil circuit

Interaction of hydraulic pumps

While you drive, the mechatronic unit recognises the oil requirement in the different driving situations. It regulates the interaction of the pumps so that the requirement is sufficient at all times.

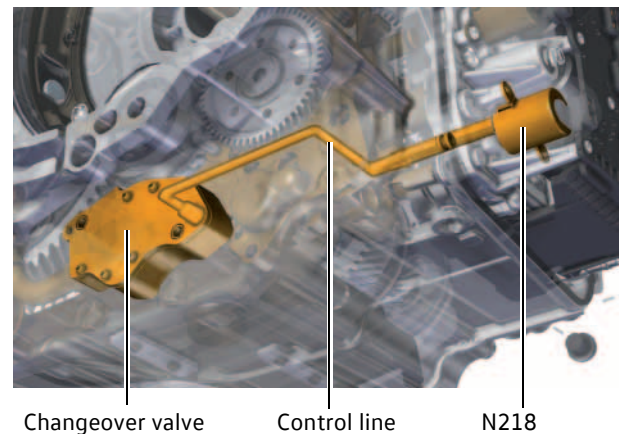
Four operating states are distinguished here:

- Oil supplied by the mechanically driven main oil pump
- Support of the oil supply by the auxiliary hydraulic pump
- The cooling function of the auxiliary hydraulic pump
- Activation of the auxiliary hydraulic pump in start/stop mode

The mechatronic unit controls the changeover valve with the pressure regulating valve N218. The position of the piston in the changeover valve is varied via the control line.



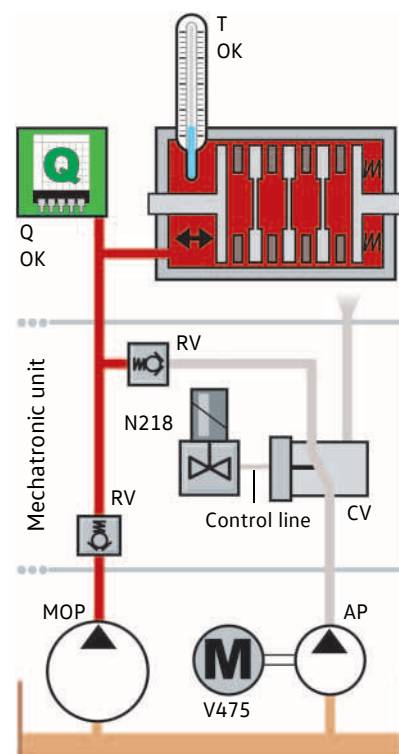
The following applies to all regulating modes:
the oil supply to the clutches and gear actuators always takes priority over the cooling of the clutches and the gear set.



s556_045

Oil supply from the mechanically driven main oil pump

The mechanically driven main oil pump (MOP) delivers the oil flow (Q) for the mechatronic unit.



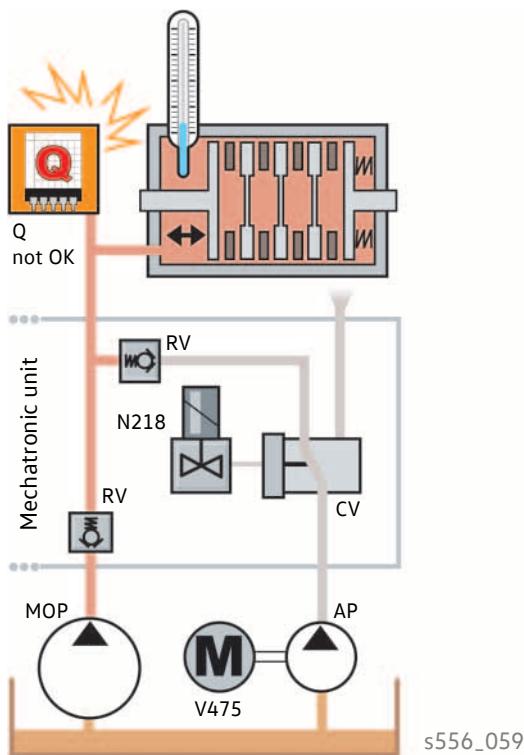
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Support of the oil supply by the auxiliary hydraulic pump

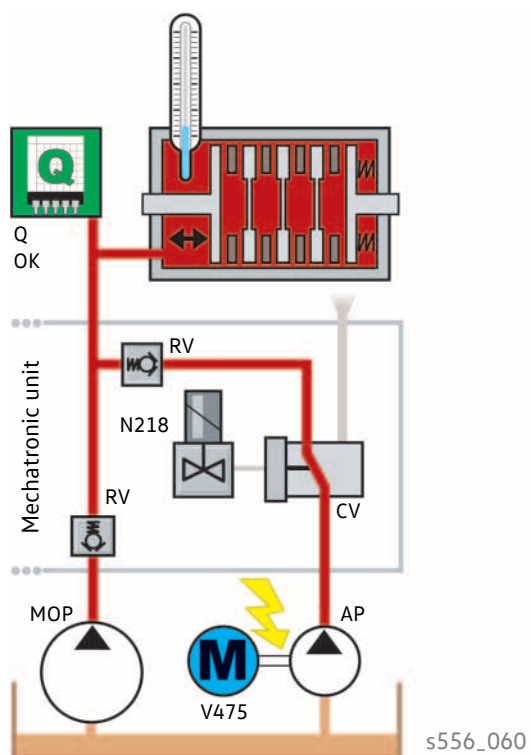
The auxiliary hydraulic pump is activated when the mechanically driven main oil pump (MOP) is not delivering enough oil. This can occur in the following driving situations:

- When there is a high load requirement in the low rev range
- In stop-and-go traffic
- In start/stop mode

The additionally delivered oil flow passes through the changeover valve (CV) to the non-return valve (RV). The non-return valve is lifted and the oil flow from both pumps is used to supply oil.



The mechatronic unit detects when the oil flow rate through the mechanically driven main oil pump is too low.

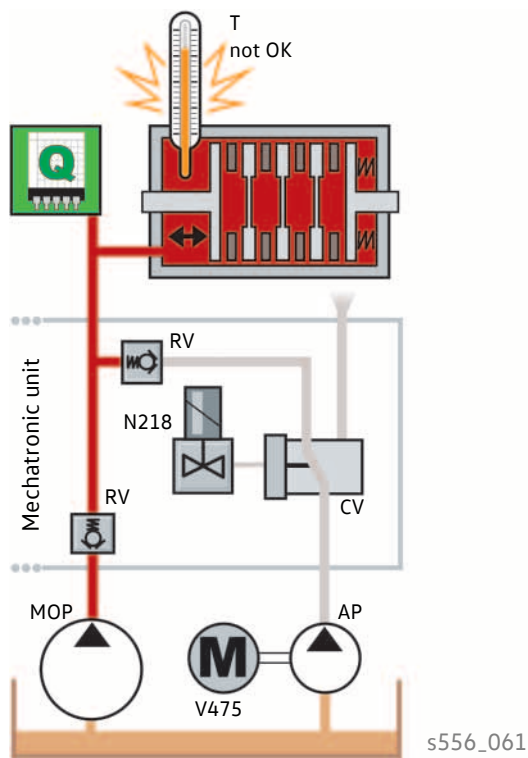


The motor drives the auxiliary hydraulic pump. The oil supply is safeguarded together with the mechanical main oil pump.

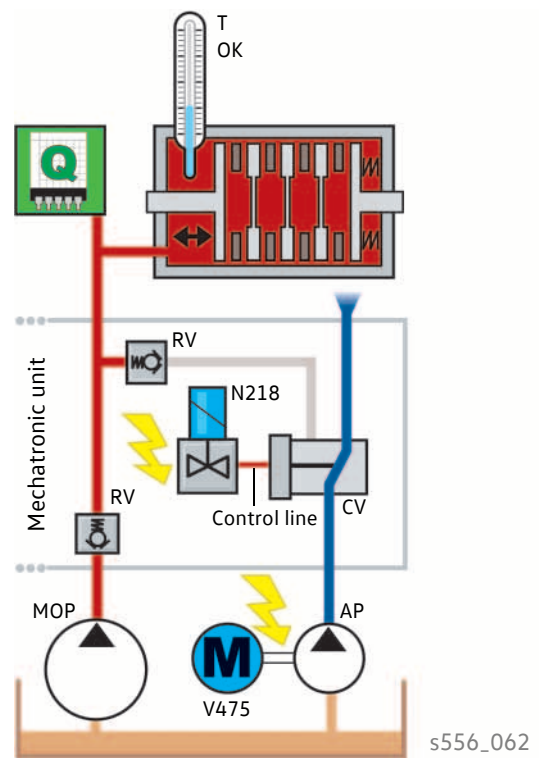
Oil circuit

Cooling function of the auxiliary hydraulic pump

If, at low engine speeds, the mechatronic unit calculates a high temperature at the clutches, it will activate the auxiliary hydraulic pump (AP) and the pressure regulating valve N218. The changeover valve (CV) is operated via the control line. The oil delivered by the auxiliary hydraulic pump now cools the clutches.



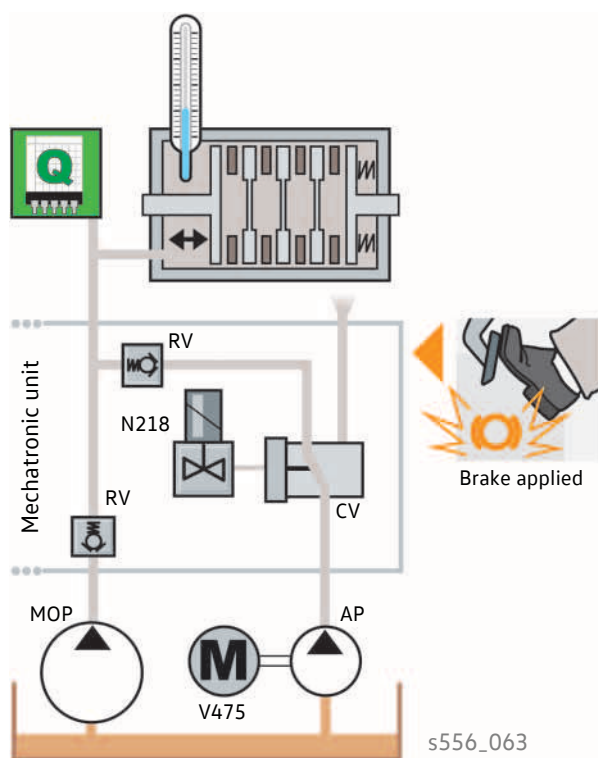
The mechatronic unit calculates a temperature that is too high at the clutches (T not OK).



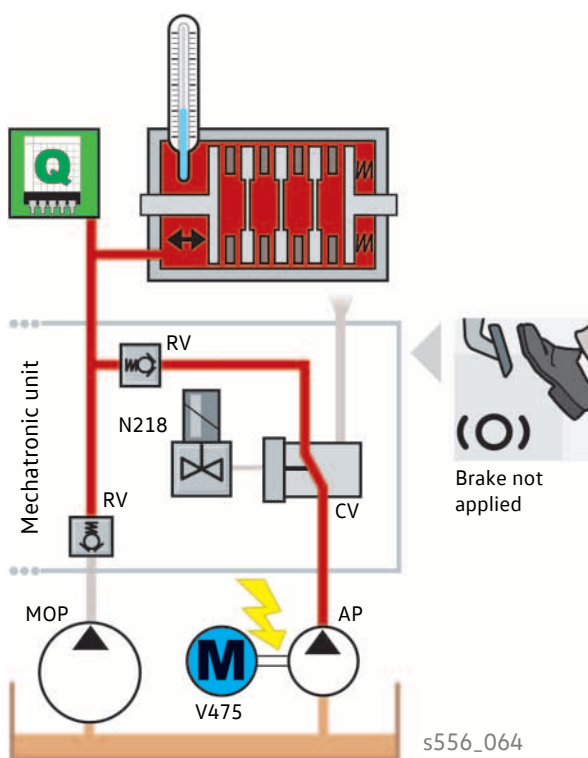
Activating the auxiliary hydraulic pump (AP) and the pressure regulating valve N218 ensures additional cooling of the clutches (T OK).

Activation of the auxiliary hydraulic pump in start/stop mode

Before the combustion engine starts, the auxiliary hydraulic pump supplies the mechatronic unit with oil. The vehicle is quickly made ready to drive. The auxiliary hydraulic pump (AP) fills the mechatronic unit lines and builds up the initial pressure.



No oil is pumped when the combustion engine is switched off.



When the driver releases the brake, the auxiliary hydraulic pump (AP) is activated during the starting procedure.

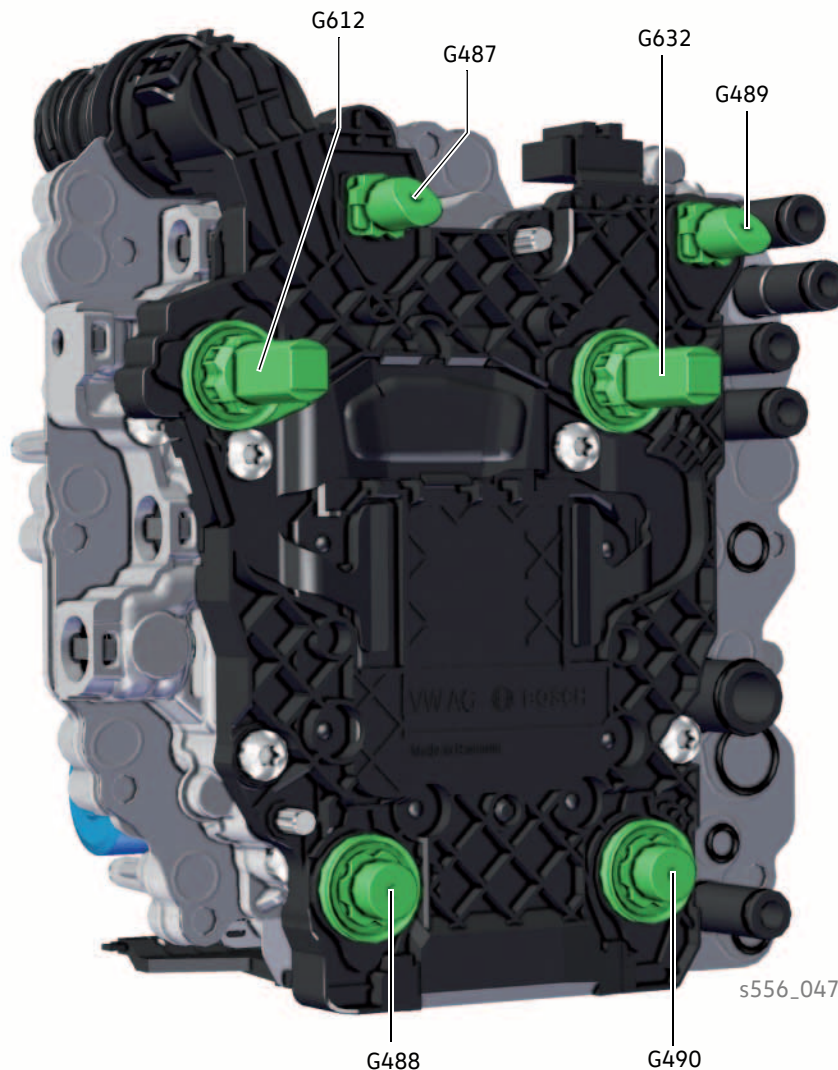
Mechatronic unit

Overview of mechatronic unit

The design of the mechatronic unit corresponds with the design of the mechatronic unit from OBT/OBH. The designations for the gearbox input speed sender have changed. G501 has become G612 and G502 has become G632.

The following illustrations show the design of the mechatronic unit with the sensors and actuators.

Sensors



G487 Gear selector movement sensor 1

G488 Gear selector movement sensor 2

G489 Gear selector movement sensor 3

G490 Gear selector movement sensor 4

G612 Gearbox input speed sender 2
(drive shaft 2)

G632 Gearbox input speed sender 1
(drive shaft 1)

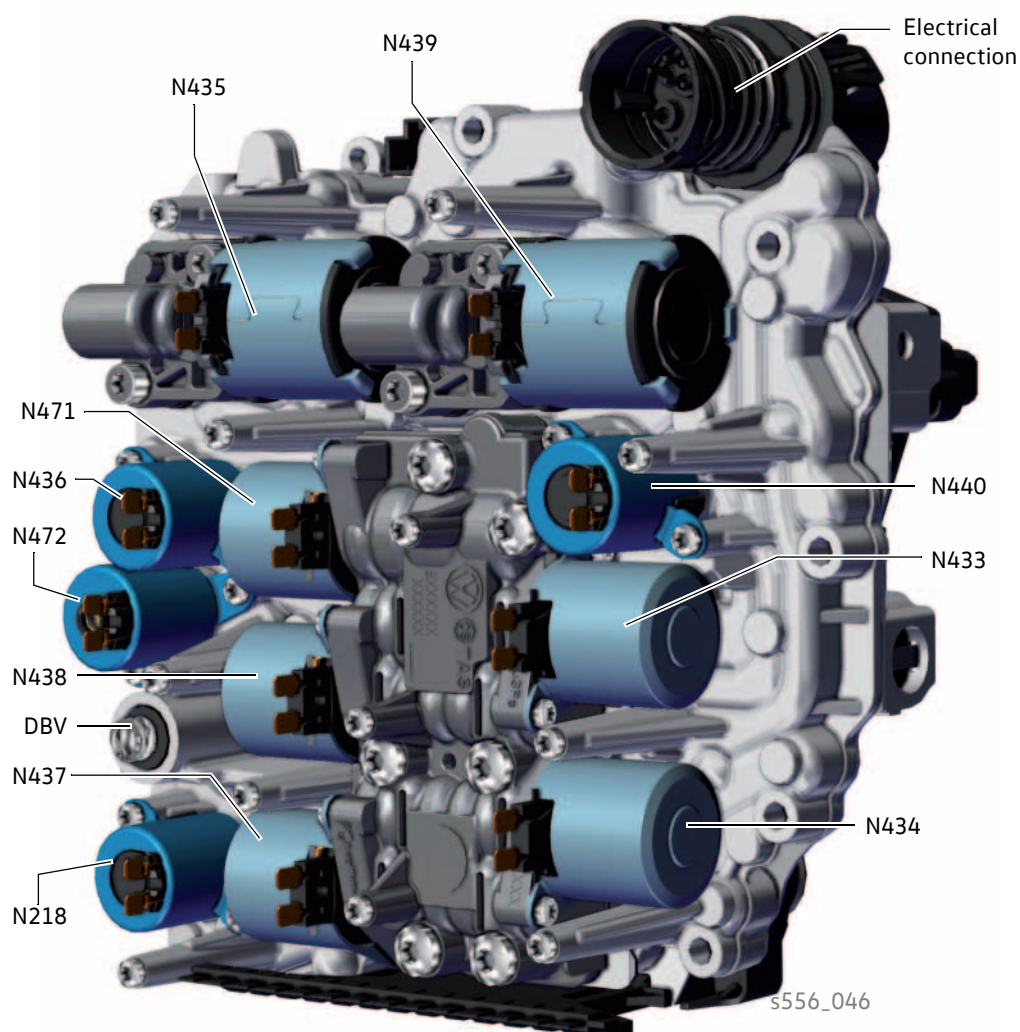
The following two senders have been integrated into the mechatronic unit and are not visible from the outside:

G545 Hydraulic pressure sender 1
(measures the actuation pressure on clutch K1)

G546 Hydraulic pressure sender 2
(measures the actuation pressure on clutch K2)

Actuators

The pressure regulating valves N436, N440 and N472 are pilot valves. They regulate the position of a downstream modulating piston. The pressure regulating valve N218 is new and influences the direction of the oil flow from the auxiliary hydraulic pump in the changeover valve.

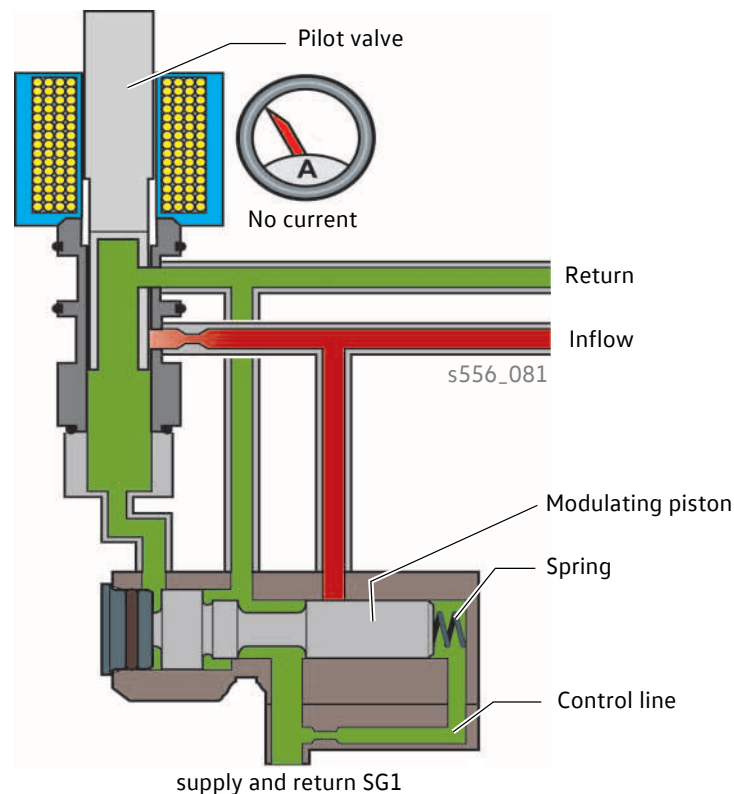


N218	Automatic gearbox pressure regulating valve 4 (actuates the changeover valve)	N438	Valve 2 in sub-gearbox 2 (operates the gear actuator for gears 4 and R)
N433	Valve 1 in sub-gearbox 1 (operates the gear actuator for gears 1 and 5)	N439	Valve 3 in sub-gearbox 2 (actuates clutch K2)
N434	Valve 2 in sub-gearbox 1 (operates the gear actuator for gears 3 and 7)	N440	Valve 4 in sub-gearbox 2 (safety valve 2)
N435	Valve 3 in sub-gearbox 1 (actuates clutch K1)	N471	Cooling oil valve (regulates the flow rate for cooling oil requirements)
N436	Valve 4 in sub-gearbox 1 (safety valve 1)	N472	Main pressure valve (regulates the working pressure)
N437	Valve 1 in sub-gearbox 2 (operates the gear actuator for gears 2 and 6)	DBV	Pressure relief valve

Low-leakage valve control

The low-leakage valve control is a combination of a 3/3-way proportional valve (pilot valve) with a downstream modulating piston.

When no current is supplied to the pilot valve, the modulating piston opens the return for sub-gearbox 1 (SG1).



The working pressure is regulated by a low pressure in this combination.

Advantages:

- We have been able to make the solenoid in the 3/3-way proportional valve smaller as only a low control pressure is required to operate the modulating piston. This saves space and weight.
- The solenoid has a low power consumption.

Further explanation

The term oil pressure (control pressure) is used in a closed hydraulic system.

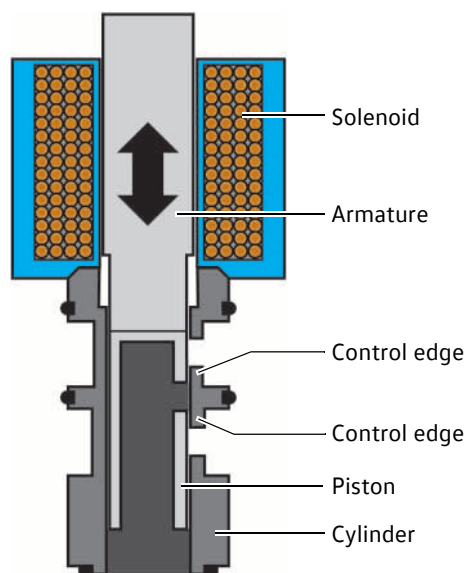
If a valve (gear actuator valve) opens the hydraulic system, the term oil flow rate is used.

The delivered oil flow rate thus maintains the oil pressure in the opened system.

In physics, pressure is the product of a force acting vertically on an area.

The force is thus calculated from the pressure multiplied by the area.

Pilot valve (valve 4 in sub-gearbox 1 N436)



s556_049

Task

The pilot valve regulates the position of the modulating piston (safety valve SV1).

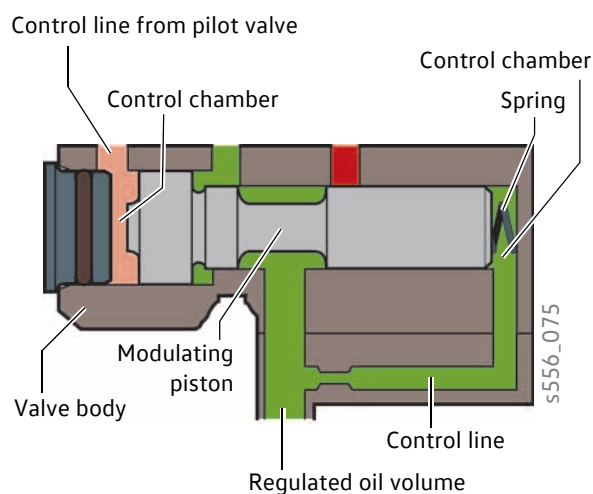
Design

The pilot valve contains a solenoid, an armature and a piston.

Function

A magnetic field is created when the solenoid is energised. This moves the armature with the piston up and down inside a cylinder. The position of the piston is set by means of an equilibrium of forces between the strength of the magnetic field and the pressure applied to the modulating piston. The control edges on the cylinder modulate the control pressure acting on the modulating piston.

Modulating piston (safety valve 1 SV1)



s556_075

Task

The modulating piston supplies the gear and clutch actuators in sub-gearbox 1 with low-friction gear oil.

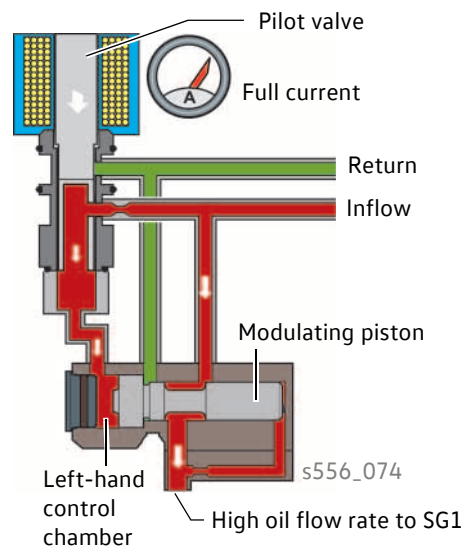
Design

The spring-loaded modulating piston is fitted in the valve body of the mechatronic unit. The modulating piston is located between two control chambers.

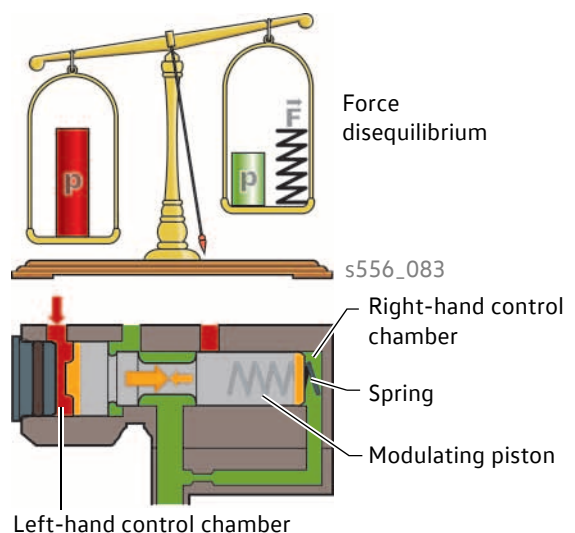
Mechatronic unit

Function

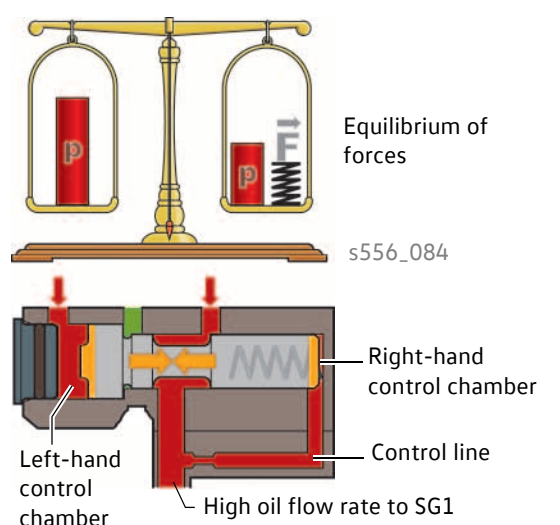
When a stronger current is supplied to the solenoid, the armature moves downwards with the piston. The supply is opened by the restrictor and the control pressure passes from the pilot valve to the left-hand control chamber of the modulating piston.

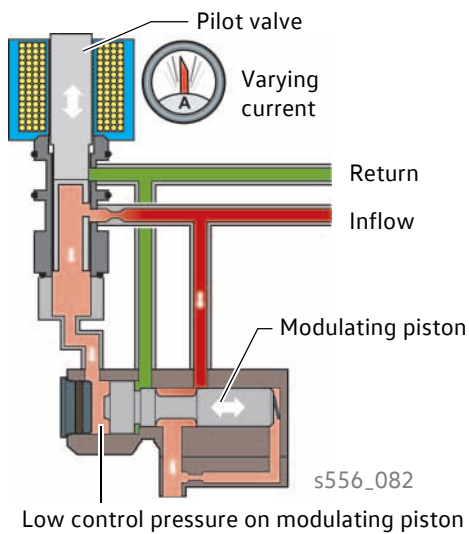


The modulating piston is pushed against the spring because a force disequilibrium exists between the left-hand control chamber and the right-hand control chamber.

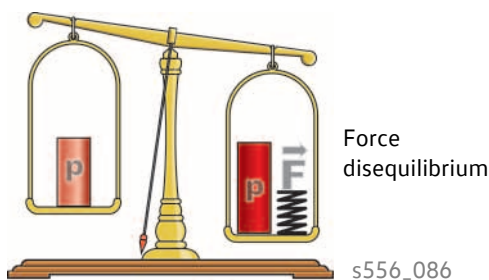


The regulated oil flow reaches sub-gearbox 1 (SG1) through the open modulating piston. At the same time, part of the oil flows through the control line to the right-hand control chamber. Together with the spring, the oil pushes the modulating piston against the control pressure from the pilot valve. It establishes an equilibrium of forces.

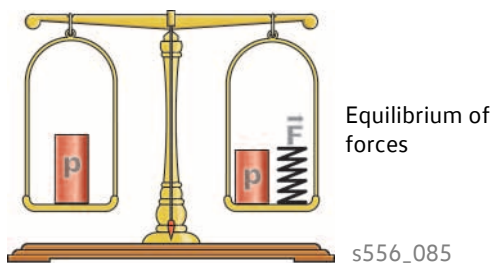
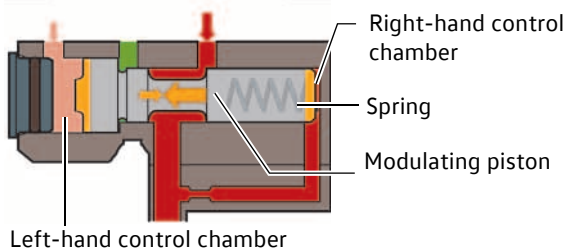




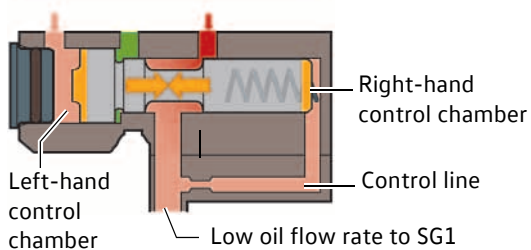
If the current to the solenoid is reduced, the control pressure from the pilot valve to the regulating valve is also reduced.



The modulating piston will be moved to the left by the spring reducing the oil flow to sub-gearbox 1. At the same time, less oil flows to the right-hand control chamber.



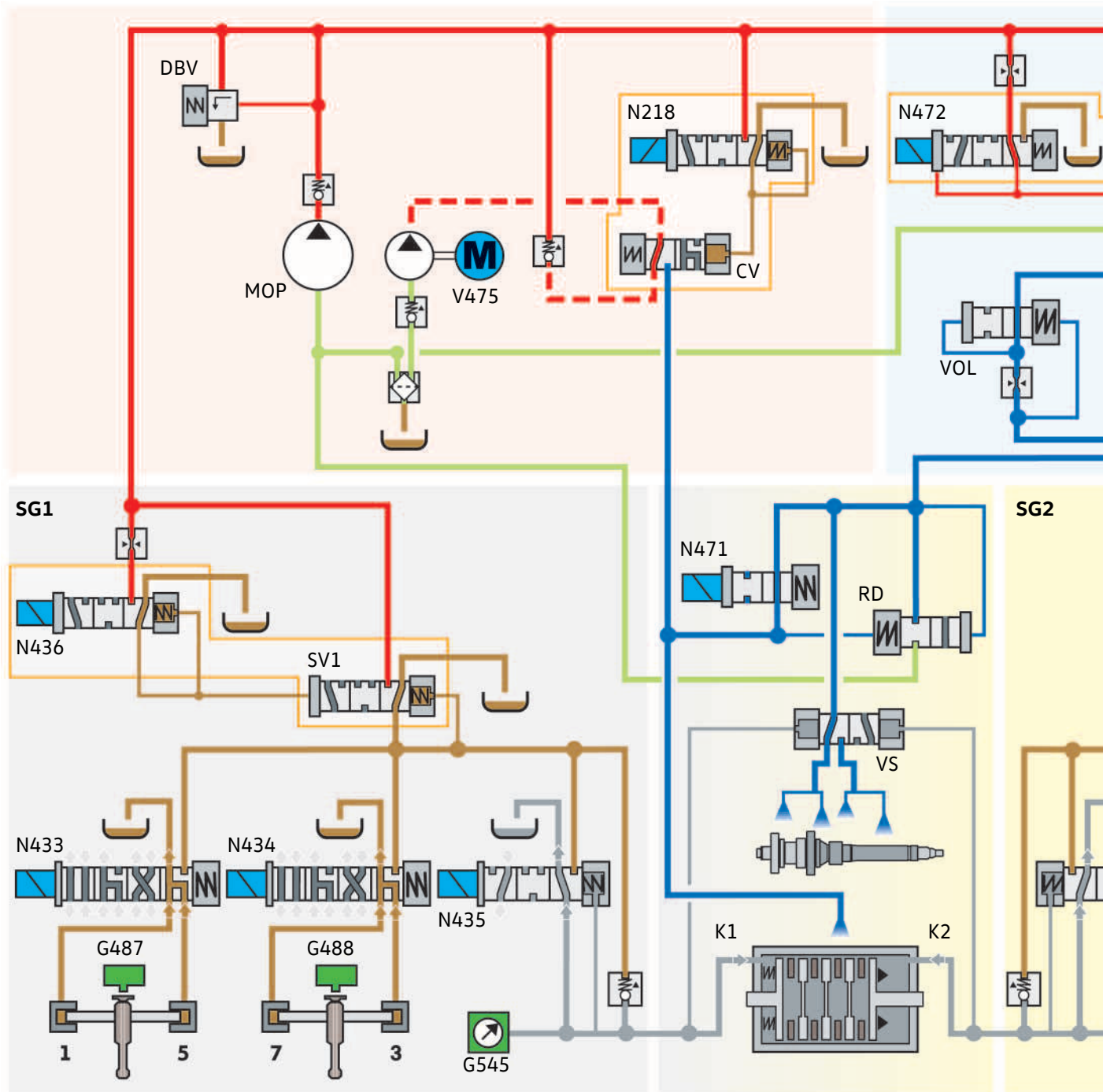
An equilibrium of forces between the left-hand and right-hand control chamber is established again.



The oil flow rate to sub-gearbox 1 (working pressure) is regulated by applying a low control pressure to the modulating piston (low pressure) in the way described here.

Mechatronic unit

Hydraulics diagram



G487 Gear selector movement sensor 1

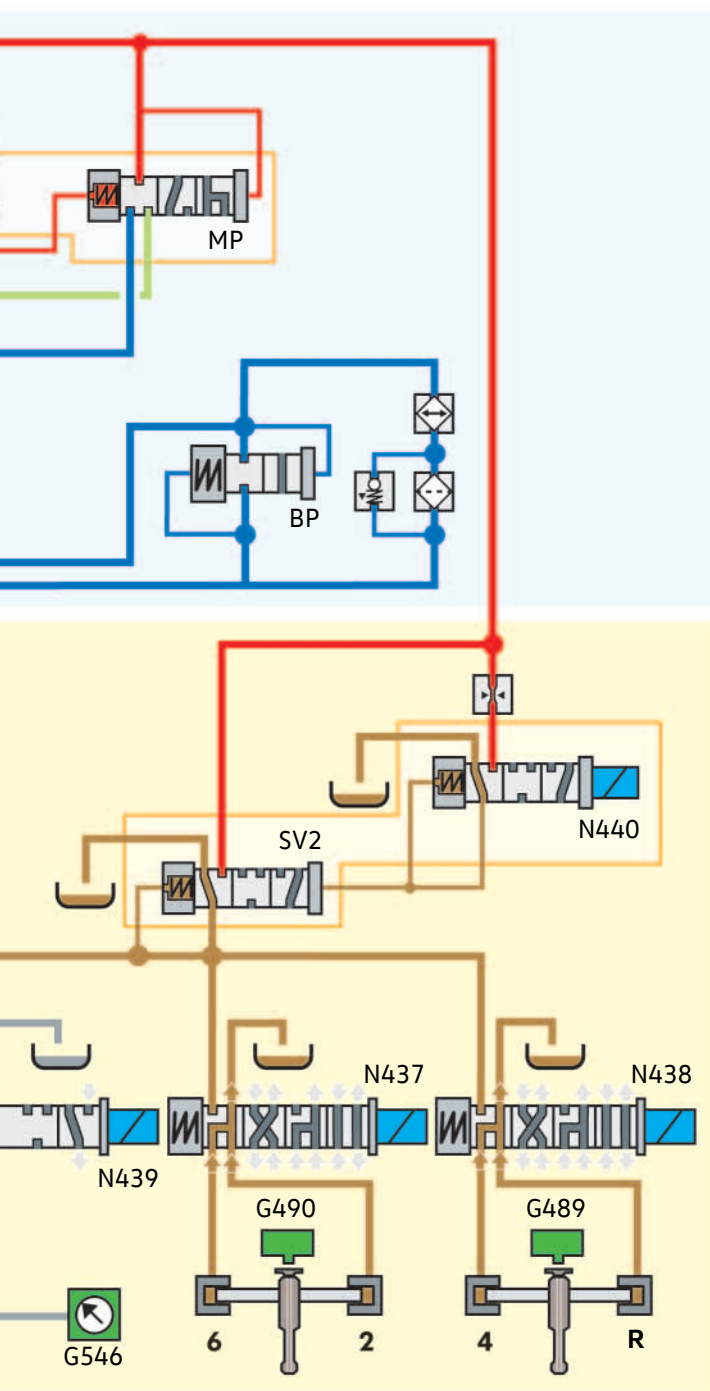
G488 Gear selector movement sensor 2

G489 Gear selector movement sensor 3

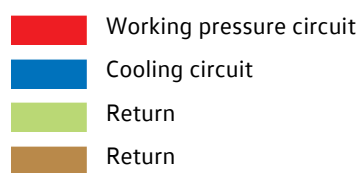
G490 Gear selector movement sensor 4

G545 Hydraulic pressure sender 1
(measures the actuation pressure on clutch K1)

G546 Hydraulic pressure sender 2
(measures the actuation pressure on clutch K2)



s556_078



- N218** Automatic gearbox pressure regulating valve 4 (actuates the changeover valve)
- N433** Valve 1 in sub-gearbox 1 (operates the gear actuator for gears 1 and 5)
- N434** Valve 2 in sub-gearbox 1 (operates the gear actuator for gears 3 and 7)
- N435** Valve 3 in sub-gearbox 1 (actuates clutch K1)
- N436** Valve 4 in sub-gearbox 1 (safety valve 1)
- N437** Valve 1 in sub-gearbox 2 (operates the gear actuator for gears 2 and 6)
- N438** Valve 2 in sub-gearbox 2 (operates the gear actuator for gears 4 and R)
- N439** Valve 3 in sub-gearbox 2 (actuates clutch K2)
- N440** Valve 4 in sub-gearbox 2 (safety valve 2)
- N471** Cooling oil valve (regulates the flow rate for cooling oil requirements)
- N472** Main pressure valve (regulates the working pressure)
- V475** Auxiliary hydraulic pump 1 for gearbox oil

BP Bypass valve

CV Changeover valve

DBV Pressure relief valve

K1 Clutch 1

K2 Clutch 2

MOP Main oil pump

MP Main pressure valve

RD Residual pressure valve (regulates the cooling oil pressure to 3 bar)

SG1 Sub-gearbox 1

SG2 Sub-gearbox 2

SV1 Safety valve 1

SV2 Safety valve 2

VOL Volume regulating valve

VS Valve, spray pipe

Maintenance

The gear oil is changed at the maintenance intervals specified in ELSA.

You drain the gear oil via the drain plug on the gear casing and the mechatronic unit.

There is no need to change the oil filter. The filter has been designed for lifetime use.

The following should be observed when changing the oil:

- Oil temperature of 35°C–45°C
- Switch off the engine
- Set the selector lever to the "P" position
- Wait 4–5 minutes before draining



The reason for the waiting time is:
the oil in the baffle plate needs time to drain into the gear casing.

You will find exact details on the gear oil change in the repair manual.

Information about towing

If a vehicle with the OGC gearbox has to be towed, the usual restrictions for automatic gearboxes need to be observed:

- Switch on ignition
- Activate the manual release mechanism for the parking lock
- Move the selector lever to the "N" position
- The maximum towing speed is 50km/h
- The maximum towing distance is 50km
- If you tow the vehicle with a raised axle, then only raise the front axle.

Reason

If the engine is not running, the oil pump will not be driven and certain parts in the gearbox will not be lubricated.

If you do not observe the towing requirements, serious gearbox damage may result.



Please observe the further descriptions and information on the topic of tow-starting and towing in the owner's manual.

Which answers are correct?

One or several of the given answers may be correct.

1. When is the pressure regulating valve N218 actuated?

- ☐ a) During pressure build-up with the mechanical main oil pump.
- ☐ b) For additional cooling of the clutches
- ☐ c) In start/stop mode

2. How does the mechatronic unit receive information about the flow rate or the temperature at the clutches?

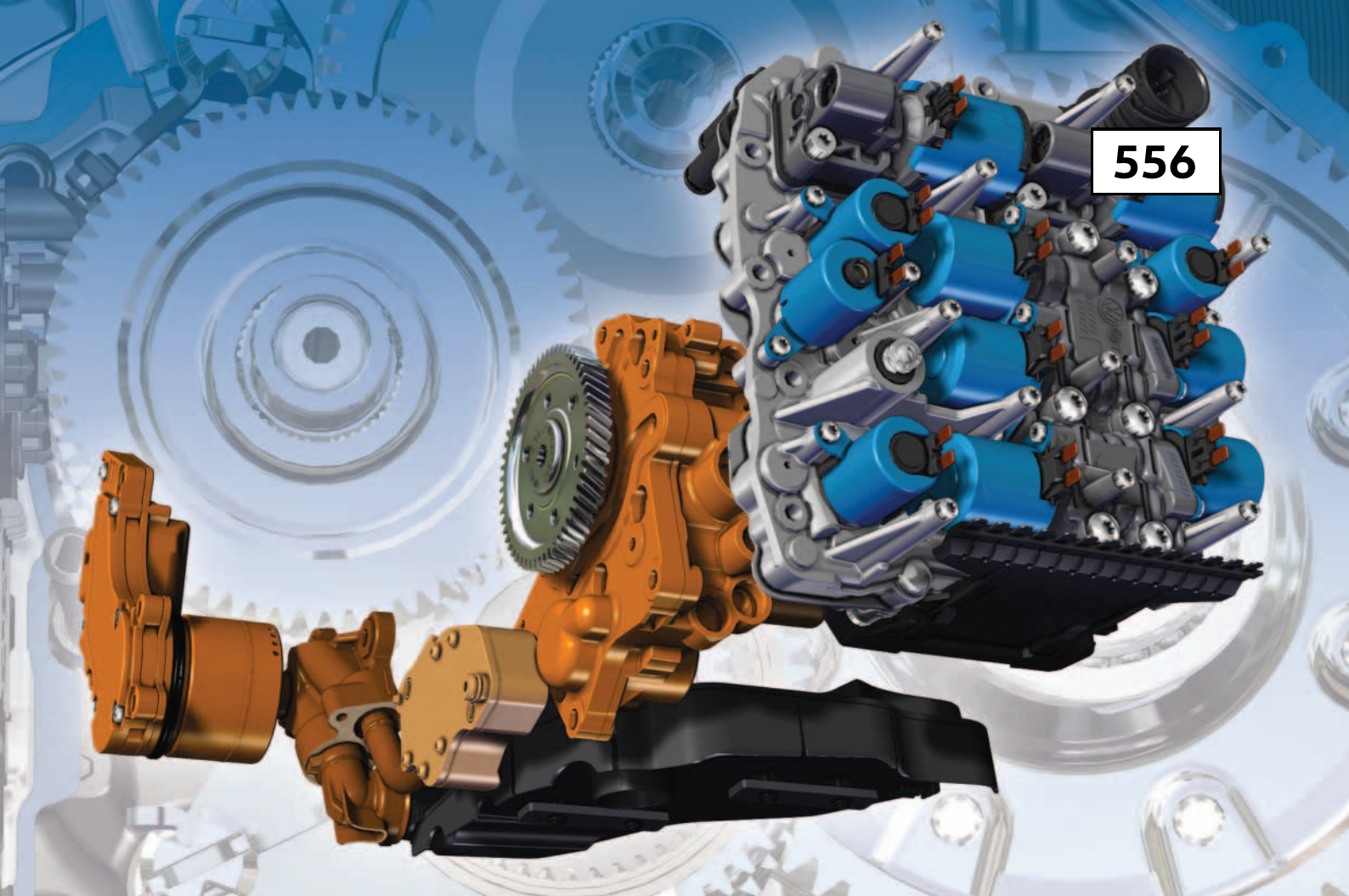
- ☐ a) From sensors
- ☐ b) From the pressure regulating valve N218
- ☐ c) By means of a calculation model in the mechatronic unit

3. What enabled us to configure the mechanically driven main oil pump with a lower oil delivery output?

- ☐ a) The auxiliary hydraulic pump V475
- ☐ b) A low-leakage valve control system
- ☐ c) A low-friction oil

4. What measures were implemented to reduce CO₂ emissions?

- ☐ a) A new pump concept with low-leakage hydraulics
- ☐ b) Eight forward gears
- ☐ c) Low-friction bearings for the shafts and low-friction seals



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⚙ This paper was manufactured from pulp that was bleached without the use of chlorine.