eSelf Study Program 950143

The Audi 0B5 7-speed S-tronic transmission

quattro drive with crown-gear center differential and torque vectoring

Audi Academy

Audi of America, LLC
Service Training
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Always check Technical Bulletins and the latest electronic service repair literature for information that may supersede any information included in this booklet.

Contents

eMedia

This eSSP contains video links which you can use to access interactive media.

This eSelf Study Program teaches a basic knowledge of the design and functions of new models, new automotive components or technologies.
It is not a Repair Manual! All values given are intended as a guideline only.
For maintenance and repair work, always refer to the current technical literature.

Note

Reference

Introduction

The seven-speed S tronic 0B5 transmission is similar in function to other DSG transmissions used by Audi. Its design characteristics and strength are well suited for many S and RS Audi models.

The transmission consists of two sub-transmissions, whose clutches actuate different gears. Drivers can operate the dual-clutch transmission like an automatic in D and S modes, or they can shift themselves using the gear selector lever or the paddles on the steering wheel for particularly sporting driving. The direct shifts are executed by switching clutches; they take just a few hundredths of a second and are so smooth and comfortable that the driver barely notices. With its high efficiency and its long top gear, the seven-speed S-tronic also contributes to improved fuel economy.

The crown-gear limited slip differential works in conjunction with the torque vectoring system, which acts on all four wheels. During normal driving, it distributes the power between the front and rear axles with a sporty 60:40 rear bias. It can instantly vary this distribution if necessary, sending up to 70 percent of the torque to the front and as much as 85 percent to the rear.

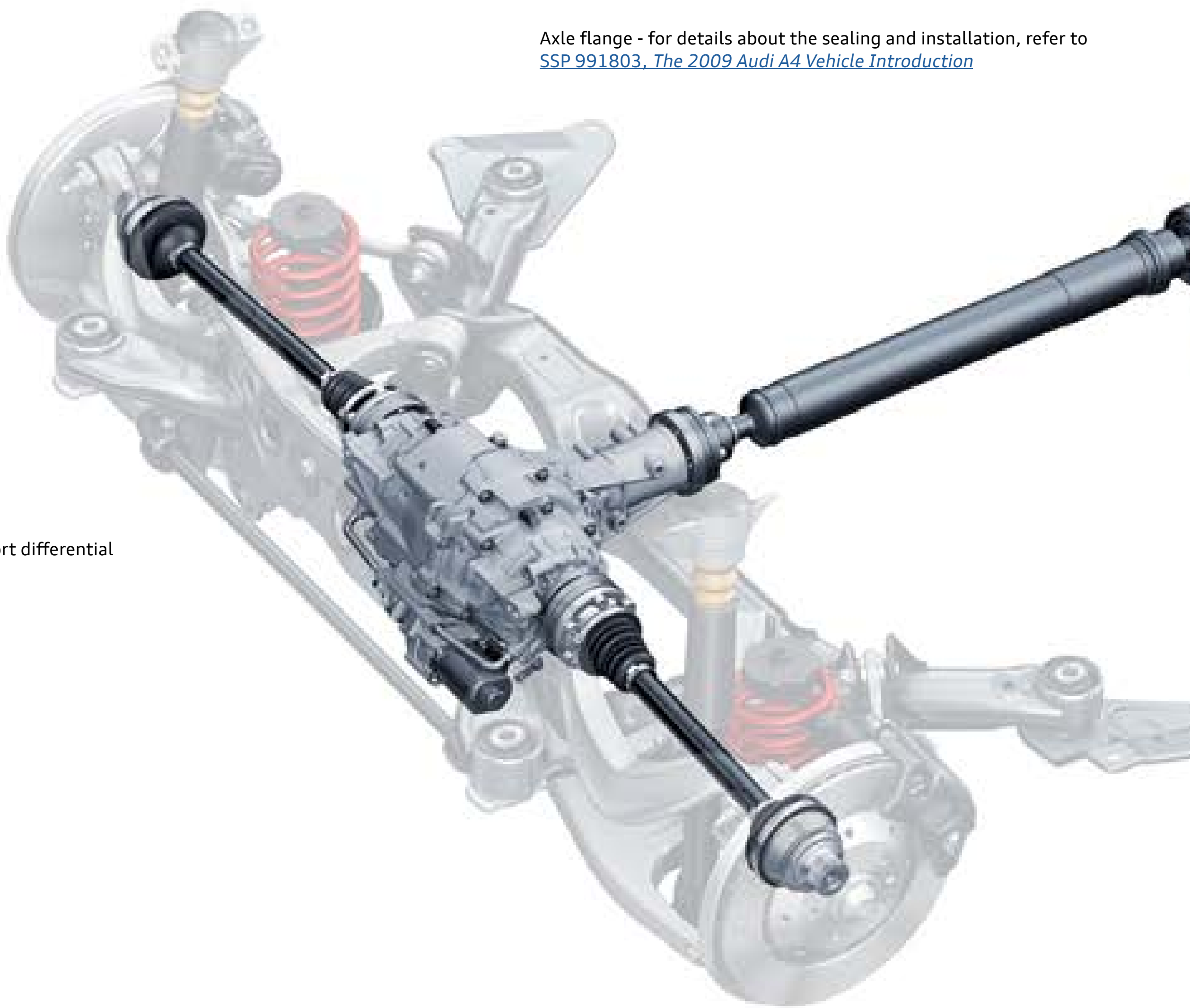
If a wheel on the inside of the curve loses too much traction under dynamic driving conditions, the torque vectoring system brakes the wheel before unwanted levels of slip occur.

Audi also offers the Sports differential option. This innovative differential uses two overlapping ratios to actively distribute the power between the rear wheels.

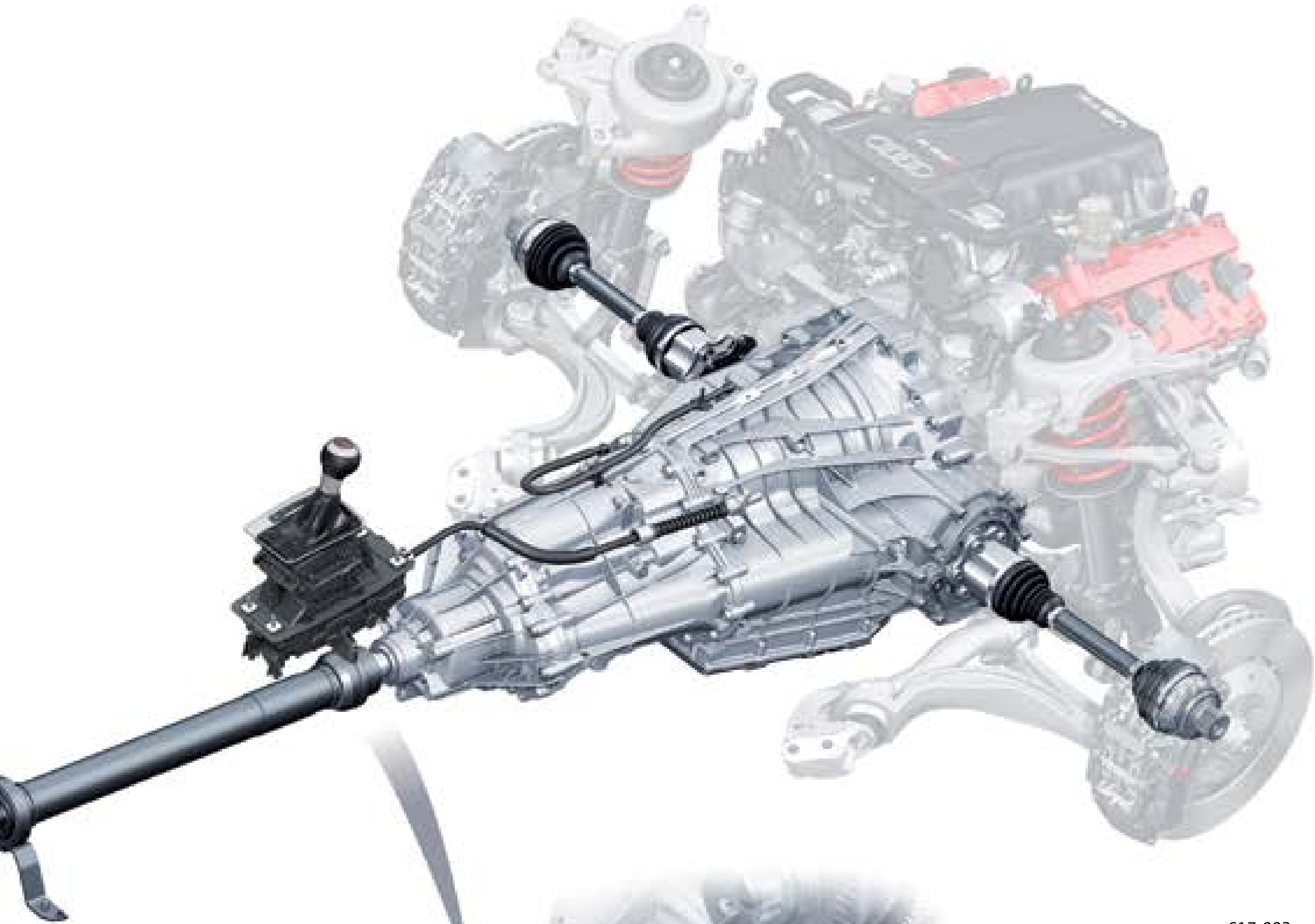
Power transmission overview

The 7-speed S tronic 0B5 DSG transmission combines sportiness, dynamics and drive comfort with excellent overall efficiency. Used together with the latest generation of quattro drive with the crown gear differential and torque vectoring, it is the ideal transmission for Audi S and RS models.

Axle flange - for details about the sealing and installation, refer to SSP 991803, *The 2009 Audi A4 Vehicle Introduction*



Standard rear axle: 0DC
Optional rear axle: 0BF - Sport differential
(see page 5)



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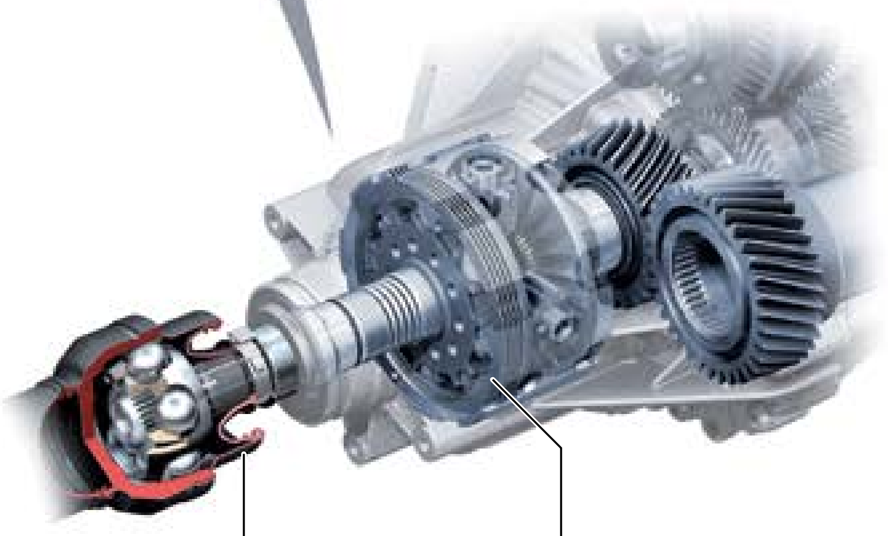


Splined prop shaft
– refer to page 39

Limited slip center differential
– refer to page 41

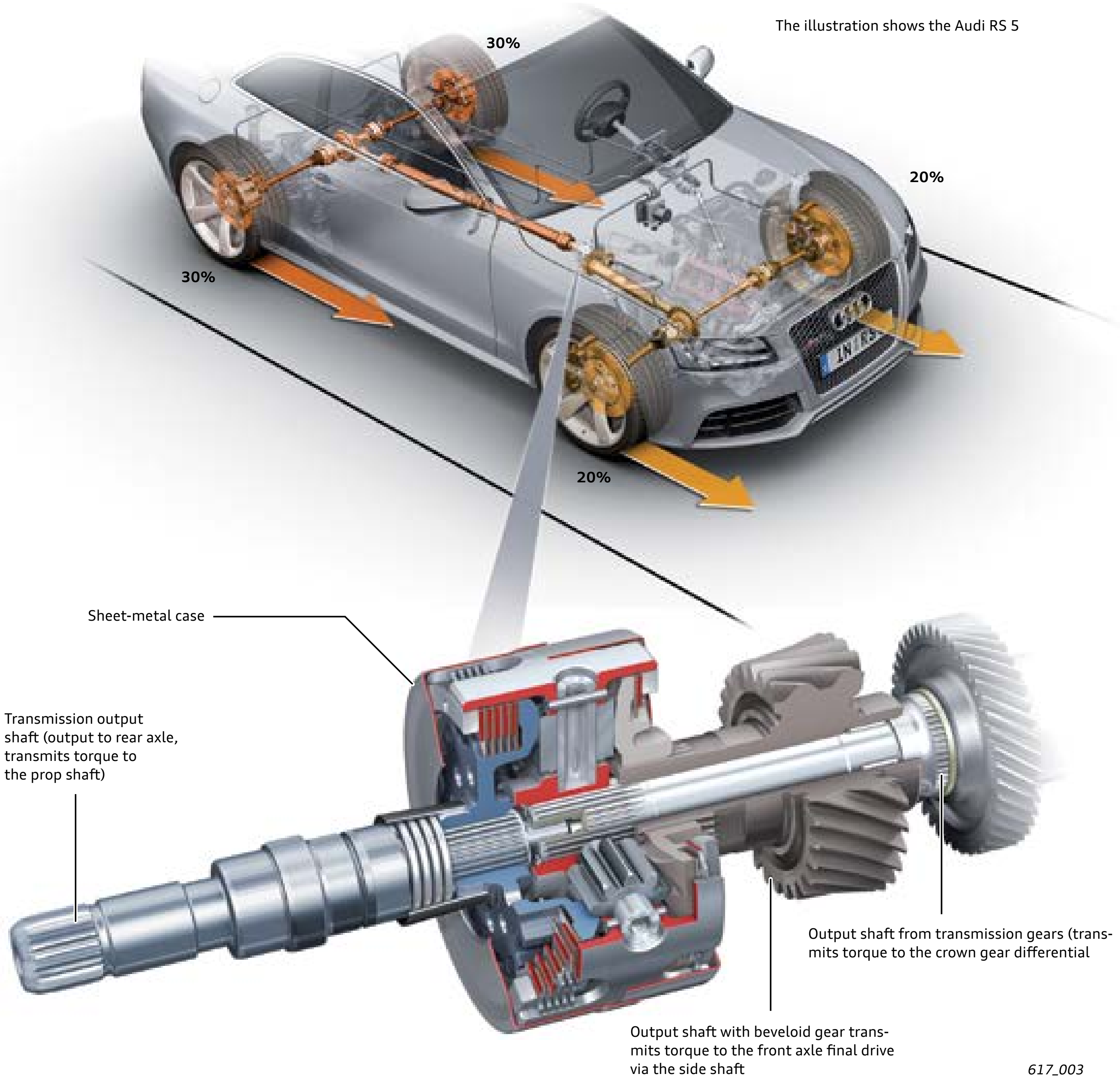
quattro drive

To celebrate the 30th anniversary of quattro drive in 2010, Audi unveiled two innovative technologies: the crown gear differential and torque vectoring.

Crown-gear differential – torque vectoring

The crown gear differential belongs in the category of limited slip, asymmetric/dynamic torque spit differentials. It provides excellent traction and integrates easily with electronic brake control systems (ABS, ESP, etc.). Other strong points include its compactness and low weight. At 10.5 lb (4.8 kg), it is approximately 4.4 lb (2.0 kg) lighter than previous units.

The basic torque split is 60 percent to the rear axle and 40 percent to the front axle. In the dynamic operating range (asymmetric/dynamic torque split), the differential distributes up to 85 of torque to the rear axle and up to 70 percent to the front axle.



617_003

Torque vectoring

Audi pairs the crown-gear differential with a torque vectoring system. This software, specially developed by Audi, is integrated in the ABS/ESP Control Module. Torque vectoring is an evolutionary form of the electronic differential lock (EDL) as seen on front wheel drive models.

A new feature is that each of the four wheels can be correctively braked. When cornering at high speeds, the ABS/ESP Control Module determines the reduced load on the wheels on the inside of the curve and the increased load on the wheels on the outside of the curve.

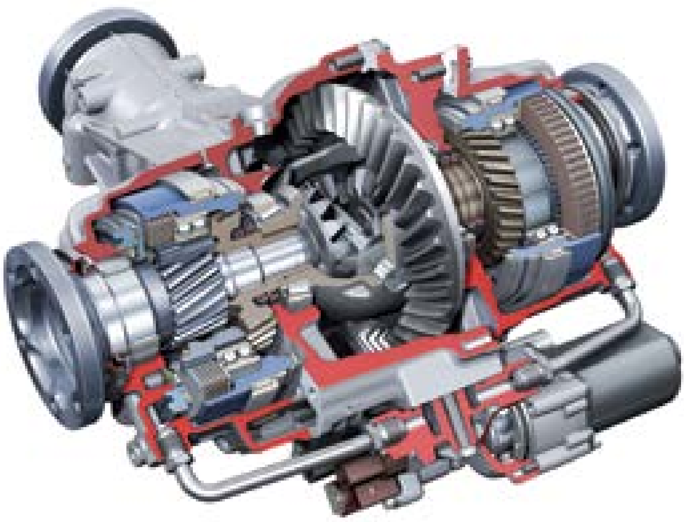
From this information, it can determine the possible drive power for each individual wheel with a relatively high degree of accuracy.

Drive torque is transferred to the wheels on the outside of the curve by controlled braking intervention. The result is improved driving dynamics. The vehicle's response remains neutral for longer, that is, understeer is largely prevented when turning into corners and accelerating, and the system intervenes later – assuming it is even needed.

617_004

Optional Rear axle final drive unit 0BF – sports differential

Everyone defines "driving" differently. Those who want to experience the full driving dynamics of the Audi RS 5, the sports differential is a good choice in addition to other optional systems designed for enhanced driving dynamics.



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Changing the ATF and axle oil

RS models often have to withstand aggressive driving. In such cases, not only the components but also the oils are put under enormous stress. For that reason, special guidelines apply to RS models regarding servicing work and intervals.

The following guidelines are currently valid for the sports differential on the Audi RS models with the 0BF sports differential:

- The oil change interval for axle oil is every 40,000 m (60,000 km).
- The ATF must be changed every 40,000 m (60,000 km) or earlier if monitored MTF temperature thresholds have been exceeded.

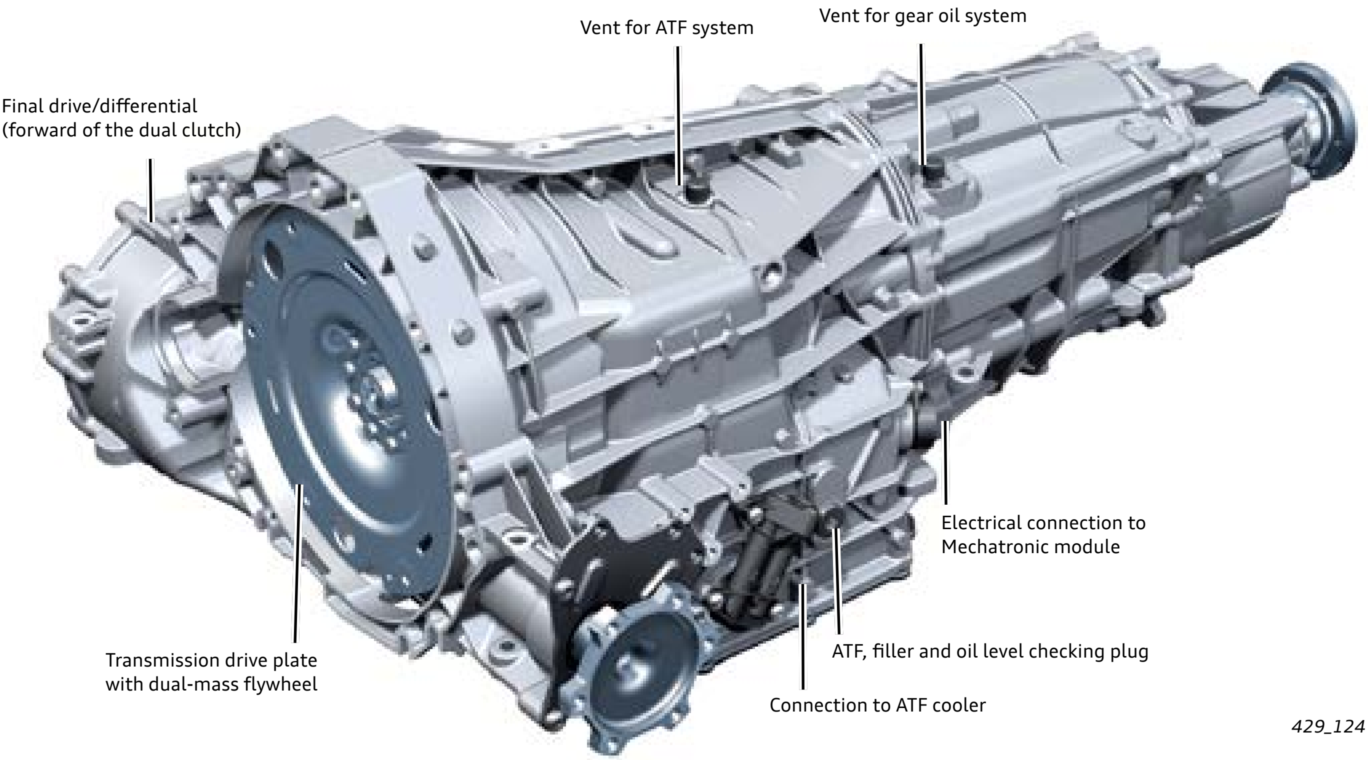
Reference
For detailed information on the sports differential, please refer to eSelf-Study Program 990193, Audi New Technology 2009 - 2010.
Please refer to ElsaPro for detailed information about the oil change intervals.

OB5 S Tronic Transmission

Specifications of the 0B5 gearbox

Designations	Manufacturer: DL501-7Q Service: 0B5 Distribution: S tronic
Development production	Audi AG Ingolstadt VW plant, Kassel
Transmission type	Seven-speed dual-clutch gearbox; full synchromesh, seven-speed transmission, electro-hydraulically controlled
Dual clutch	dual oil-cooled multi-plate clutches, electro-hydraulically controlled
Control	Mechatronic system – integrating the hydraulic control unit, the TCM and some of the sensors and actuators; sport program and “tiptronic” shift program for manual gear shifting (optionally available with steering wheel tiptronic controls)
Ratio spread	up to 8.1 : 1*
Shaft spacing	3.50 in (89 mm)
Torque capacity	up to 405.6 lb ft (550 Nm) at 9000 rpm
Weight	approximately 313.0 lb (142 kg) (incl. dual-mass flywheel and oil filling)

* The 7th gear is configured as an overdrive (6 + E). Top speed is in 6th gear.
At present, the gasoline engines use a ratio spread of approximately 6 : 1 and the diesel engines approximately 8 : 1.



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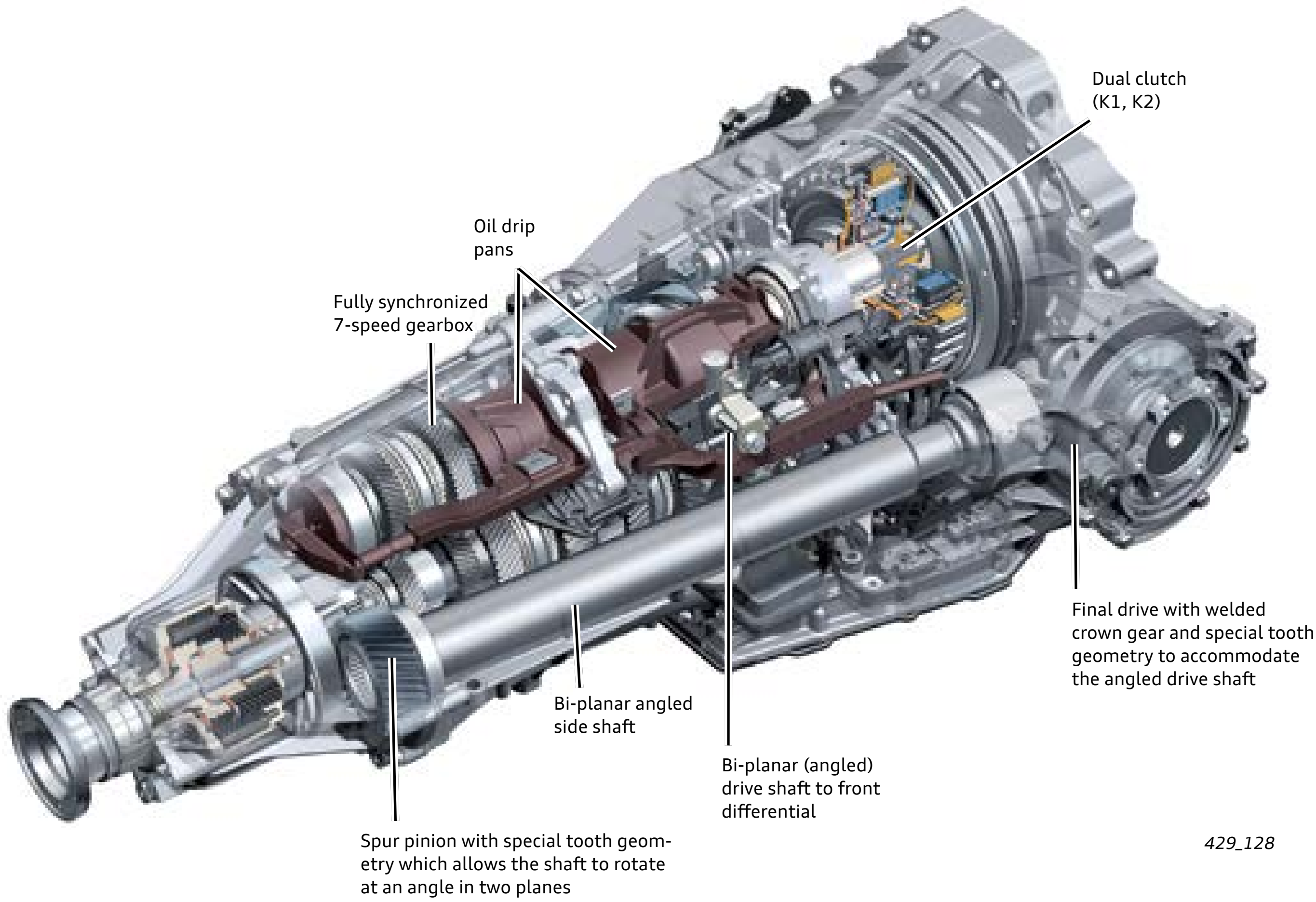
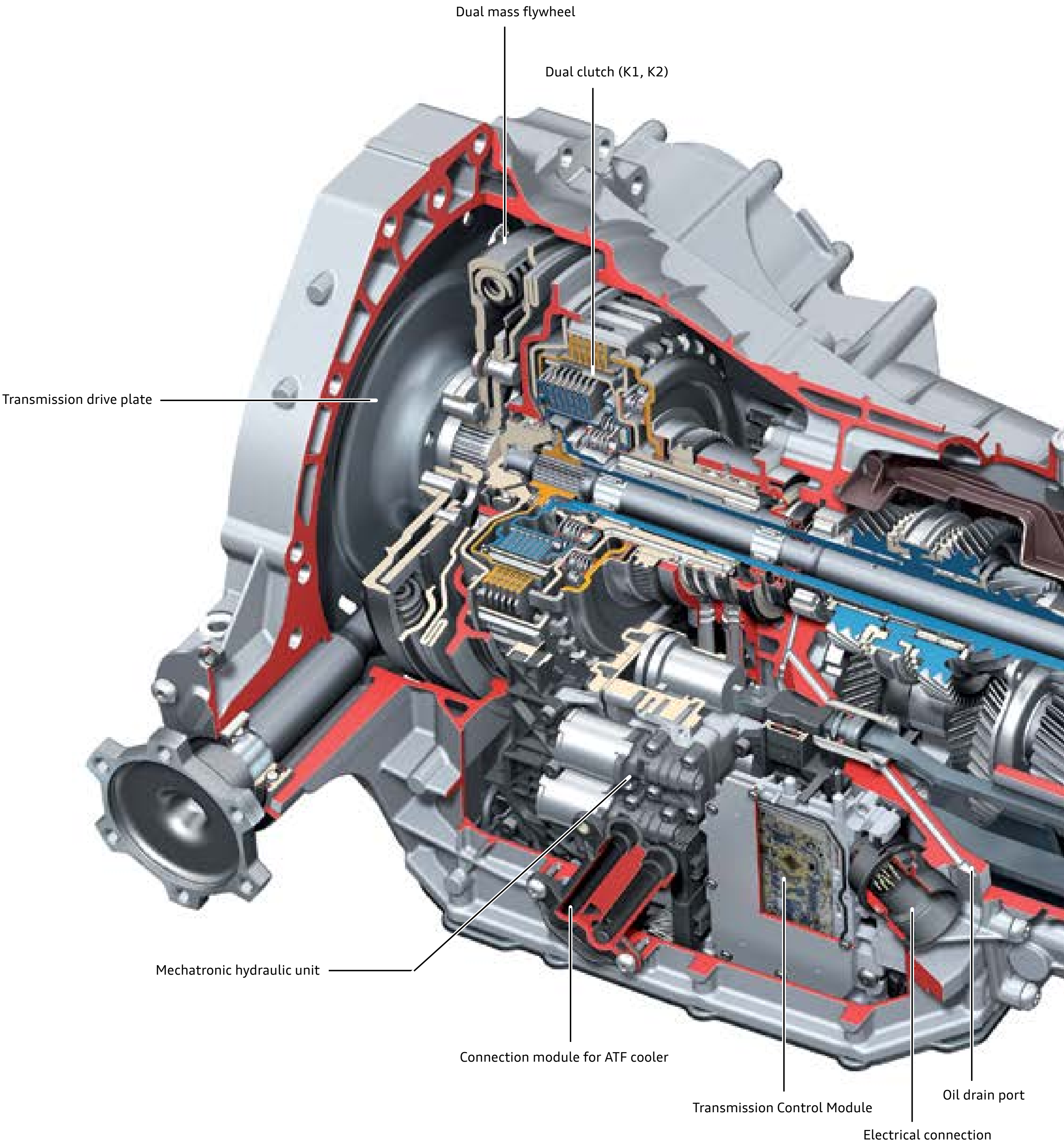


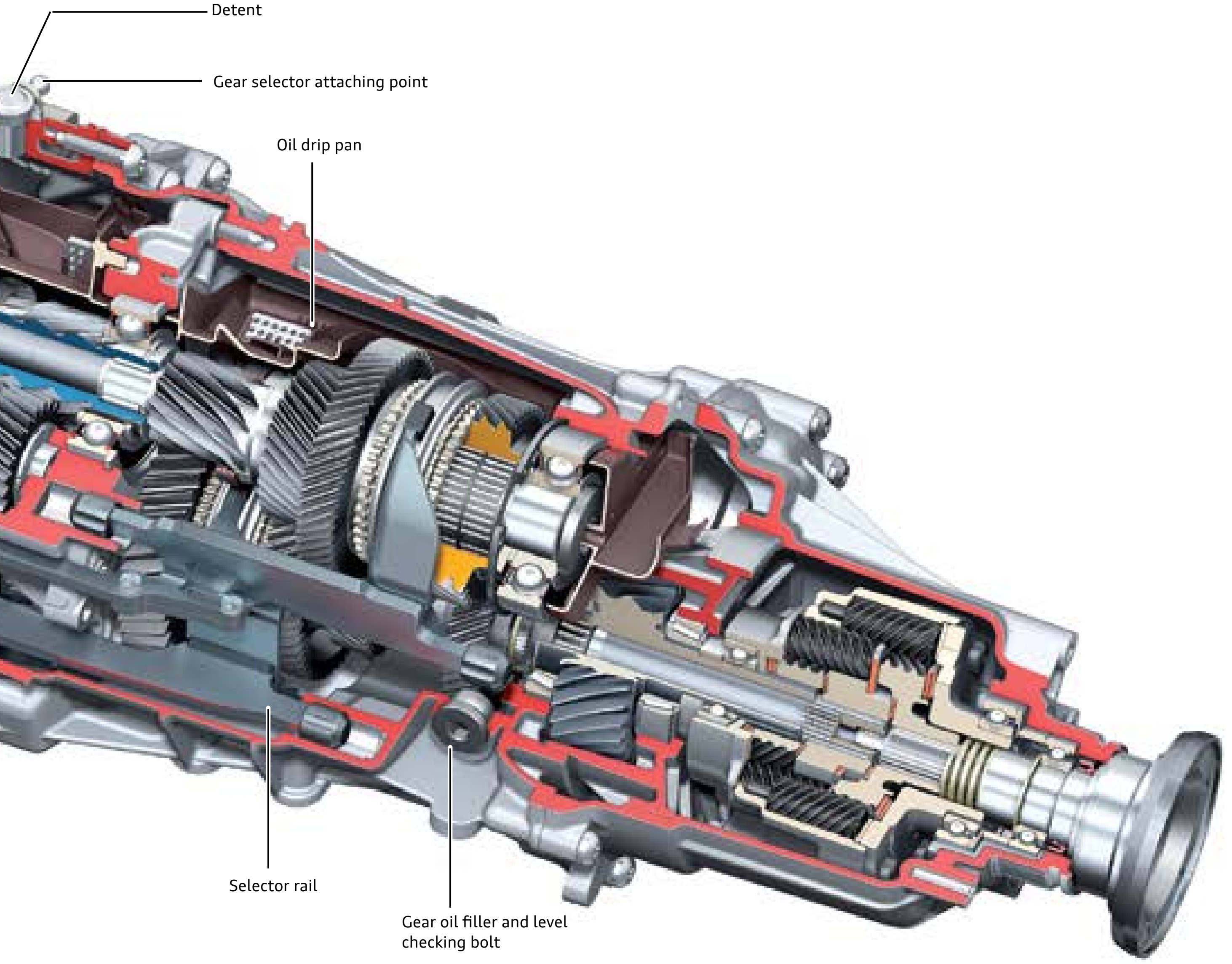
429_128

Note

Illustrations 429_124 and 429_128 on this page show a parallel axis Torsen differential. For complete information on the crown gear differential please refer to page 41.

Sectional view of transmission





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Note
Illustrations 429_124 and 429_128 on this page show a parallel axis Torsen differential. For complete information on the crown gear differential please refer to page 41.

Design — Function

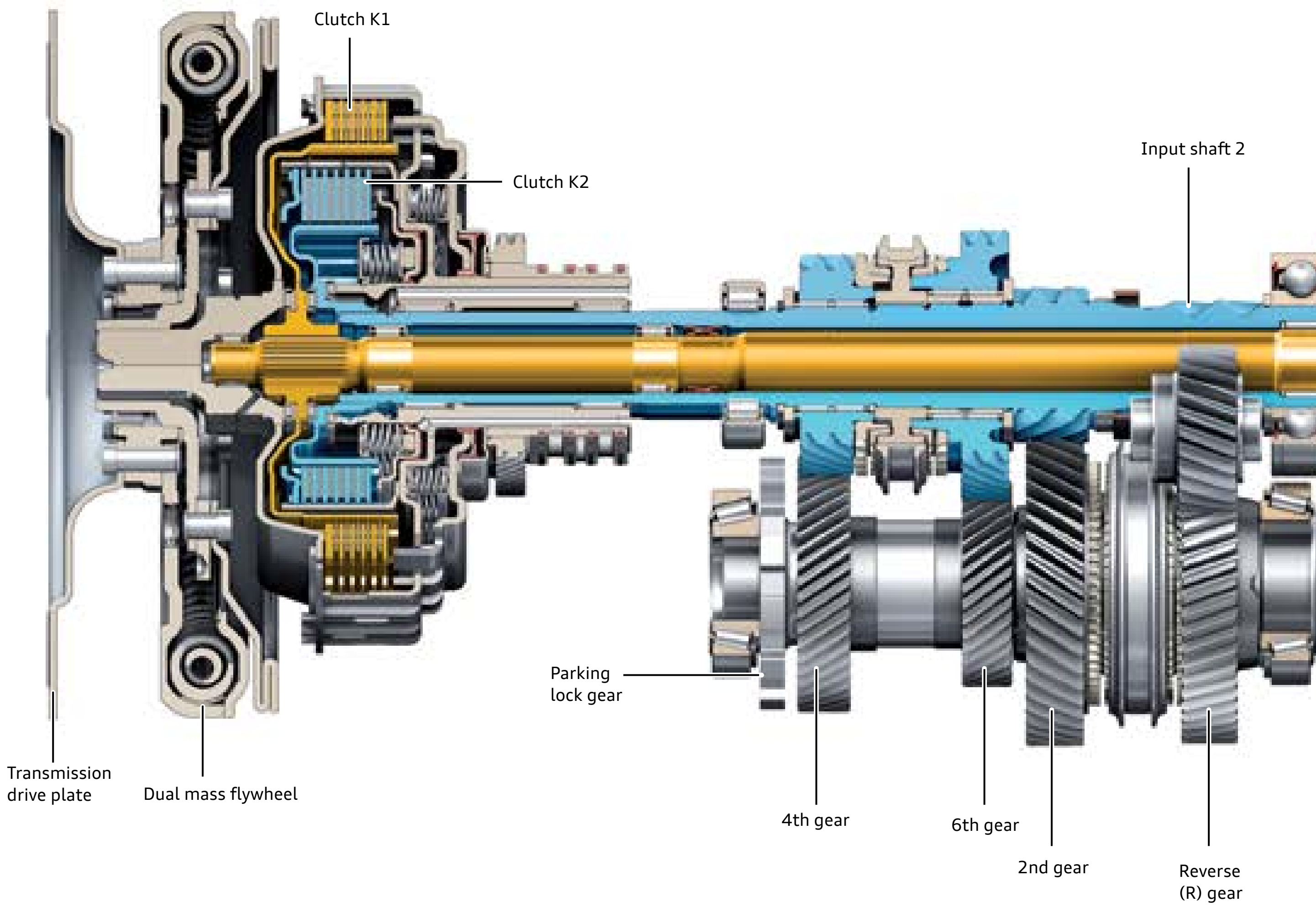
Drive is transmitted to the dual mass flywheel through the transmission drive plate. From there, torque is transmitted to the hydraulically controlled dual clutch which engages and disengages the shafts for the odd and even numbered gears. The gearbox section of the transmission is divided into two sub-gearboxes.

Sub-Gearbox 1

Odd numbered gears (1, 3, 5, 7) are driven through central input shaft 1 by clutch K1.

Sub-Gearbox 2

Even numbered gears (2, 4, 6) and the reverse gear are driven through input shaft 2 (a hollow shaft) by clutch K2. Power output is through the common output shaft. From there it is transmitted directly to the center differential. Approximately 60% of the torque is distributed to the rear axle and approximately 40% to the spur pinion and through the side shaft connecting it to the front axle drive.



Design Features of the Dual Clutch

Clutches K1 and K2 form a single unit and perform two main tasks:

- To engage/disengage the engine when starting from a stop or when coming to a stop
- To shift gears (changeover from one sub-gearbox to another)

Clutch K1 is larger and located on the outside of the clutch unit. It meets the higher torque demand of driving the vehicle away from a standing start.

Small pressure cylinders and coil spring assemblies on both clutches provide good controllability when driving from a standing start and when changing gears.

Hydraulic pressure equalization within the clutch unit is no longer required. The Mechatronic unit corrects the dynamic pressure build-up caused by centrifugal forces at high engine speeds.

Gear shifting sequence

From a standing start

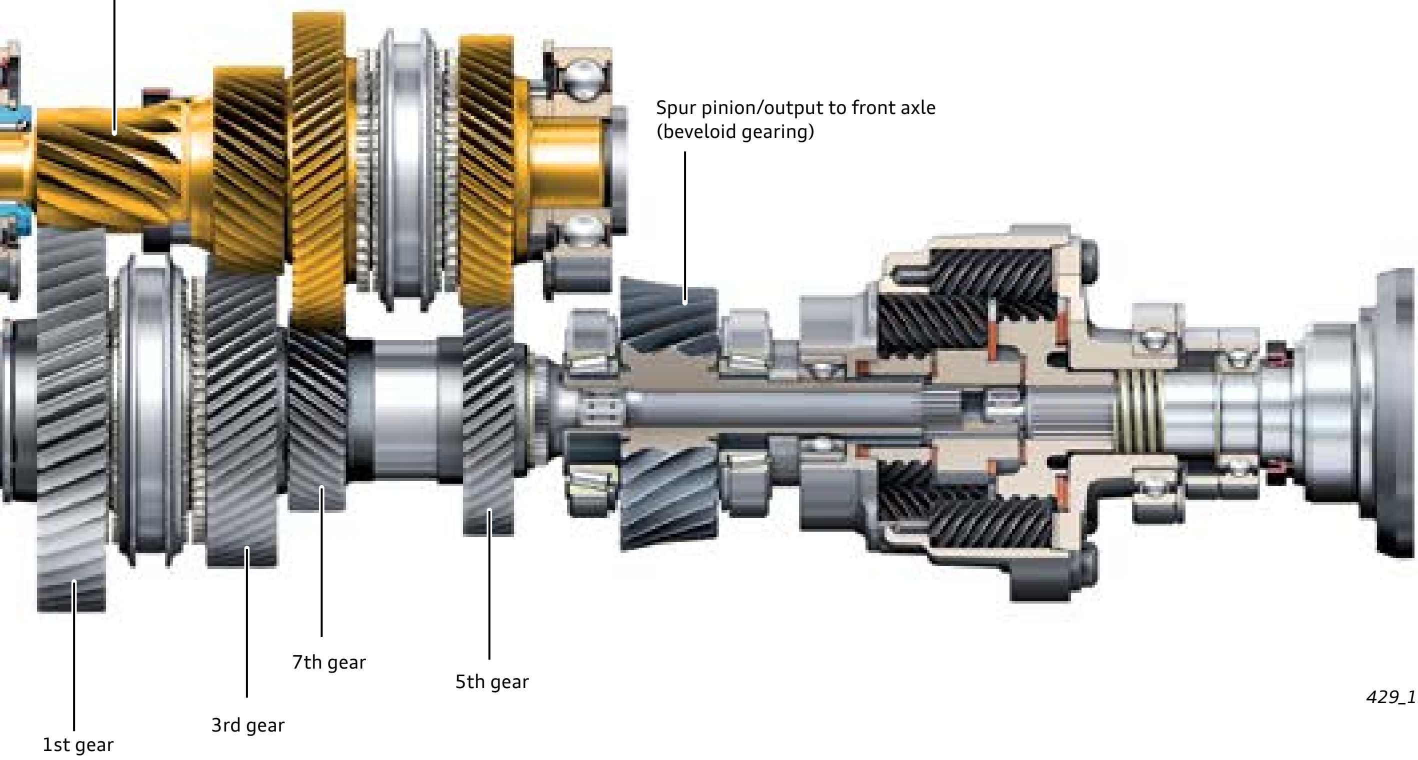
In selector lever position P or N, only 1st gear and reverse are engaged. This allows immediate acceleration from a standing start. Regardless of whether the driver decides to drive in reverse or to go forward, the correct gears are already pre-selected.

During gear shifts

To drive forward, the driver shifts the selector lever into D and drives away in 1st gear. When a defined speed threshold of approximately 10 mph (15 km/h) is exceeded, 2nd gear is engaged in sub-gearbox 2 (reverse was previously engaged).

When the shift point for upshifting from 1st to 2nd gear is reached, the gearshift is made by the rapid opening of clutch K1 and simultaneous rapid closing of clutch K2 without any interruption in tractive power. To enhance shift comfort and preserve the clutch, engine torque is reduced during the gearshift.

The gear shifting process is completed within a few hundredths of a second. 3rd gear is now pre-selected in sub-gearbox 1. The process described above repeats itself alternately during the subsequent gearshifts from 2-3 up to 6-7.



429_134

Synchromesh

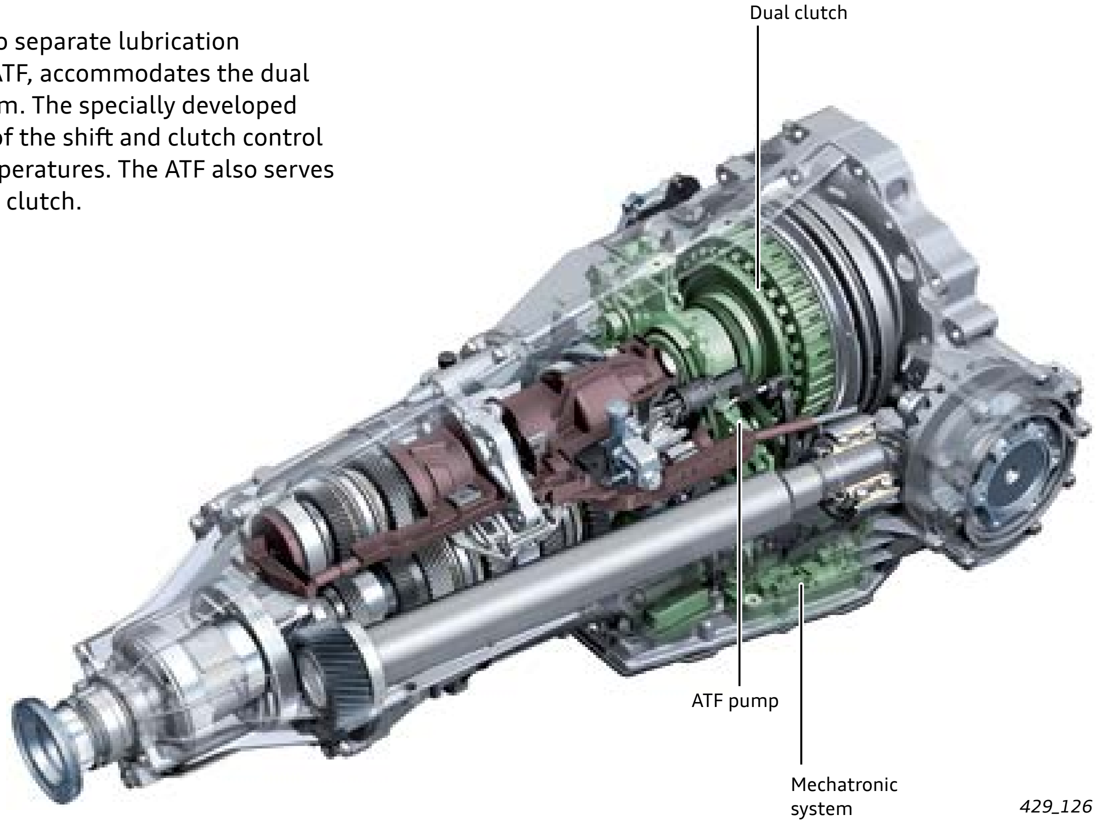
To facilitate extremely short shift times, all gears have carbon coated synchronizer rings. Gears one to three and reverse have triple cone synchronizers due to the high stresses they encounter. Gears four to seven use single cone synchronizers.

Note
Illustrations 429_124 and 429_128 on this page show a parallel axis Torsen differential. For complete information on the crown gear differential please refer to page 41.

Lubrication

ATF System

The 0B5 transmission has two separate lubrication systems. One system, using ATF, accommodates the dual clutch and Mechatronic system. The specially developed ATF provides rapid response of the shift and clutch control mechanisms even at low temperatures. The ATF also serves to lubricate and cool the dual clutch.

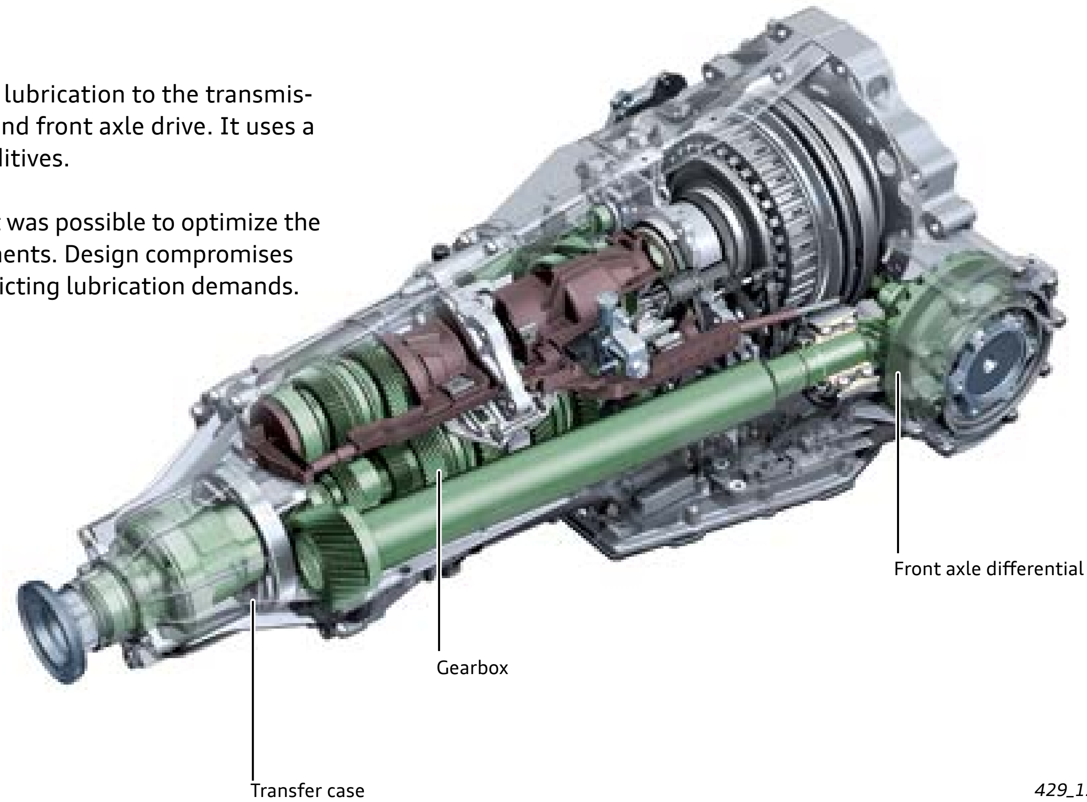


429_126

Gear oil system

The second oil system provides lubrication to the transmission gears, center differential and front axle drive. It uses a hypoid gear oil with special additives.

By separating the oil systems, it was possible to optimize the design of the individual components. Design compromises were not necessary due to conflicting lubrication demands.



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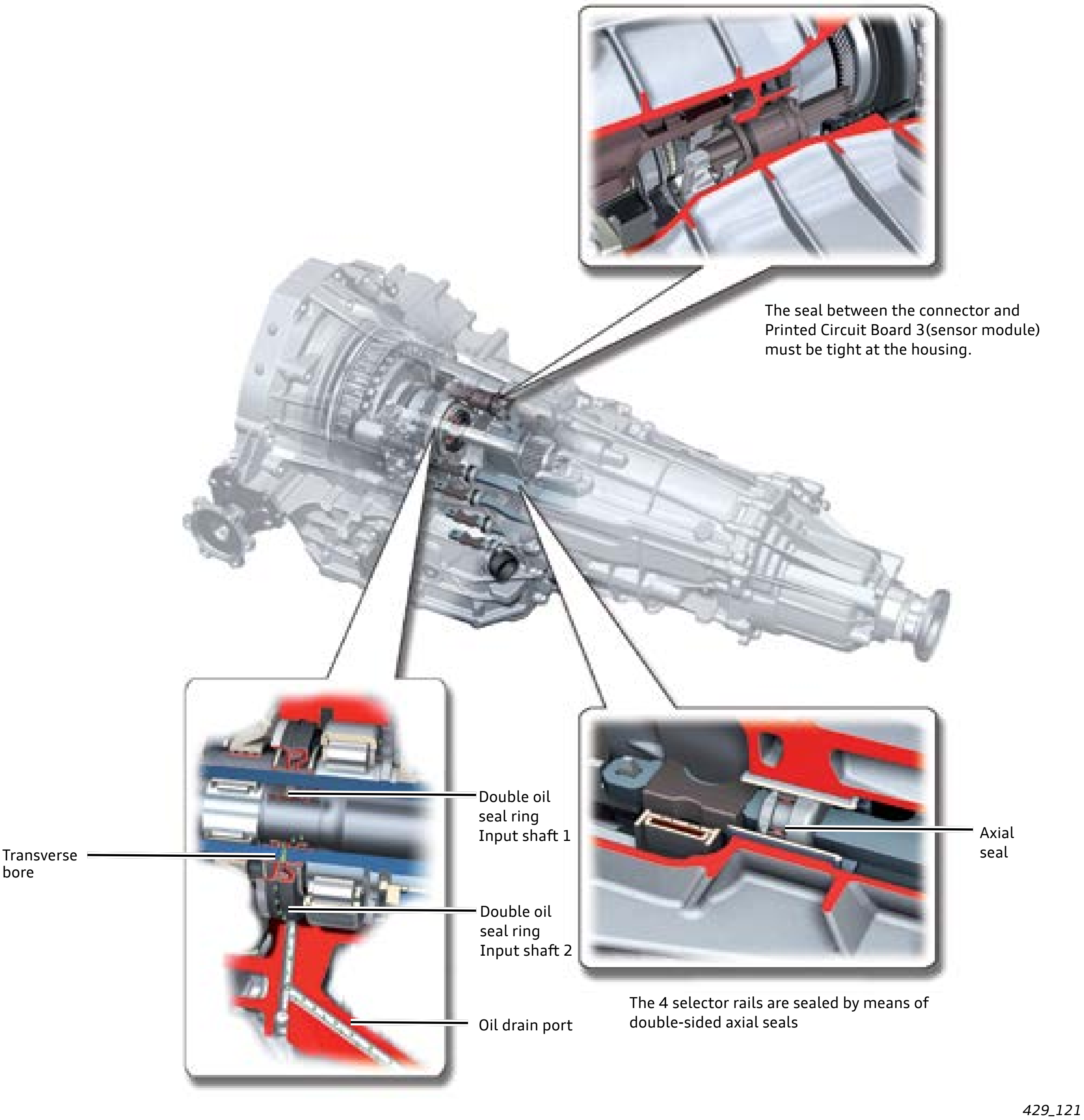
Separating the oil systems

The oil system chambers must be sealed off from one another. If the ATF and gear oil should mix, it would adversely affect the performance of the dual clutch. To prevent this from occurring, special seals are required.



Input shafts 1 and 2 are sealed by a double oil seal ring. In total, four radial sealing rings are used. If a radial seal is leaking, the oil drain port allows the leaking oil to drain off and prevents it from entering the other oil chamber. The transverse bore in input shaft 2 establishes a connection between input shaft 1 and the oil drain port.

ATF supply — lubrication

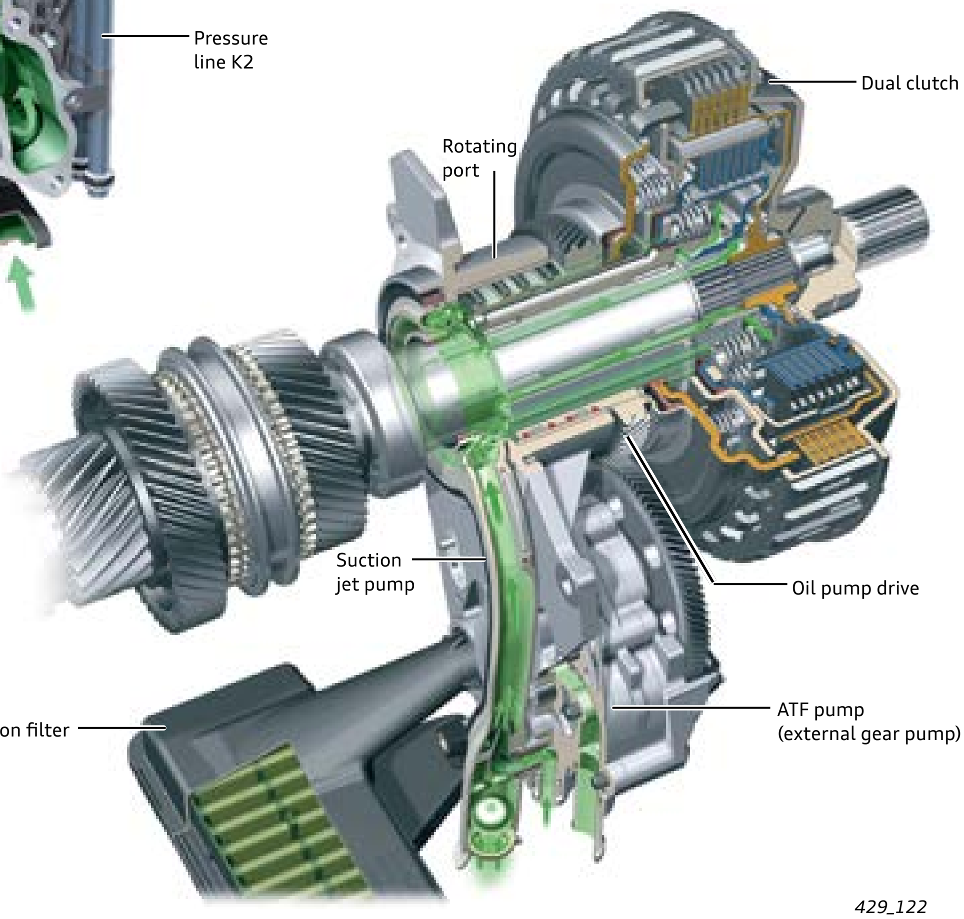
An external gear pump driven by the dual clutch via a gear step provides the required ATF flow and pressure.

The ATF pump supplies the Mechatronic system with the oil pressure required to perform the following functions:

- Control of the multi-plate clutch (engagement and disengagement)
- Cooling and lubrication of the multi-plate clutch
- Control of gearbox hydraulics

ATF pump with rotating port and dual clutch bearing

429_138

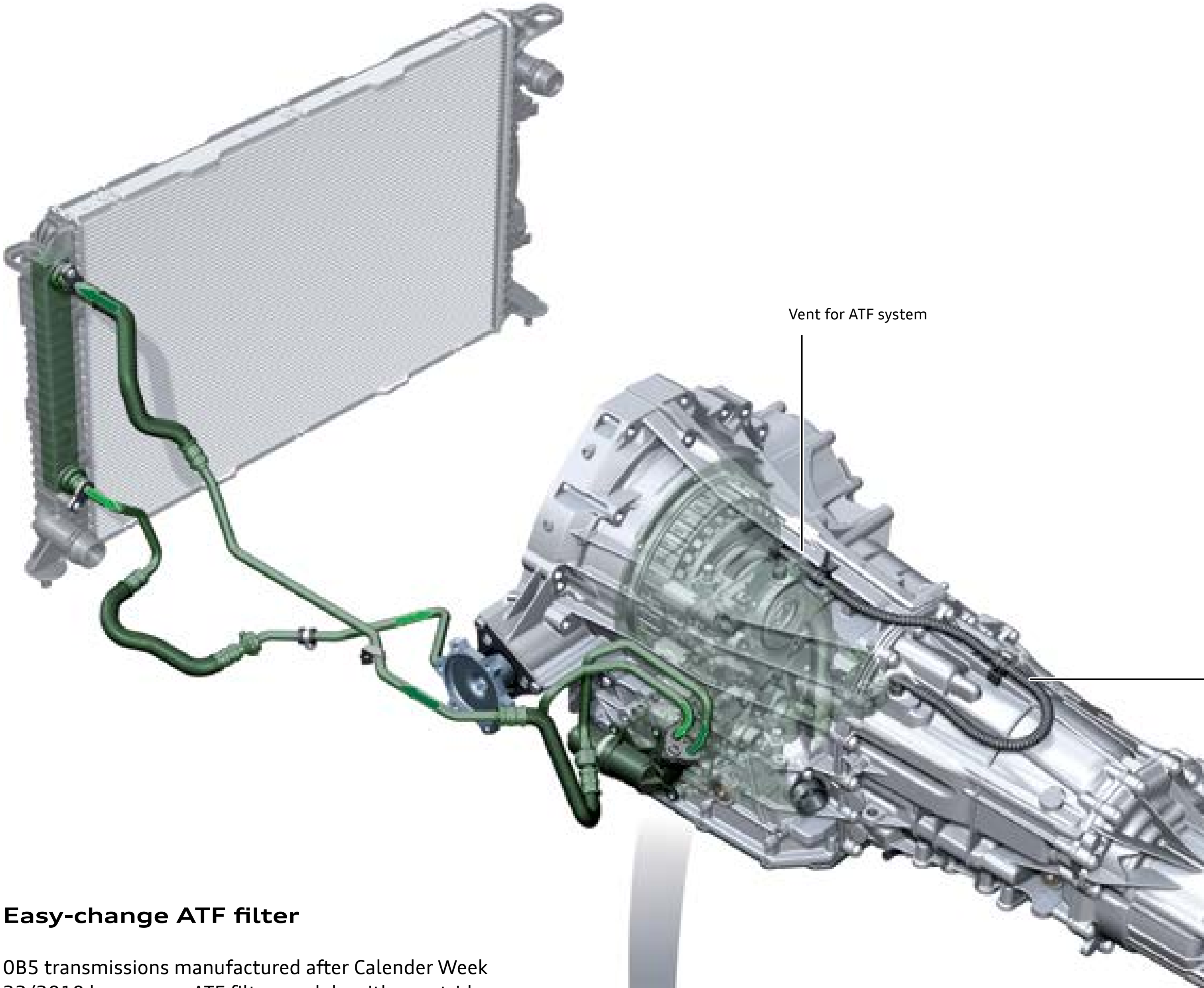


429_122

A suction jet pump increases the cooling oil flow for the clutch cooling system. The suction jet pump operates on the Venturi principle. It doubles the cooling oil flow rate without the need for increasing oil pump capacity. This allows the oil pump to be downsized, enhancing the efficiency of the transmission.

Notes

ATF filter (pressure filter)

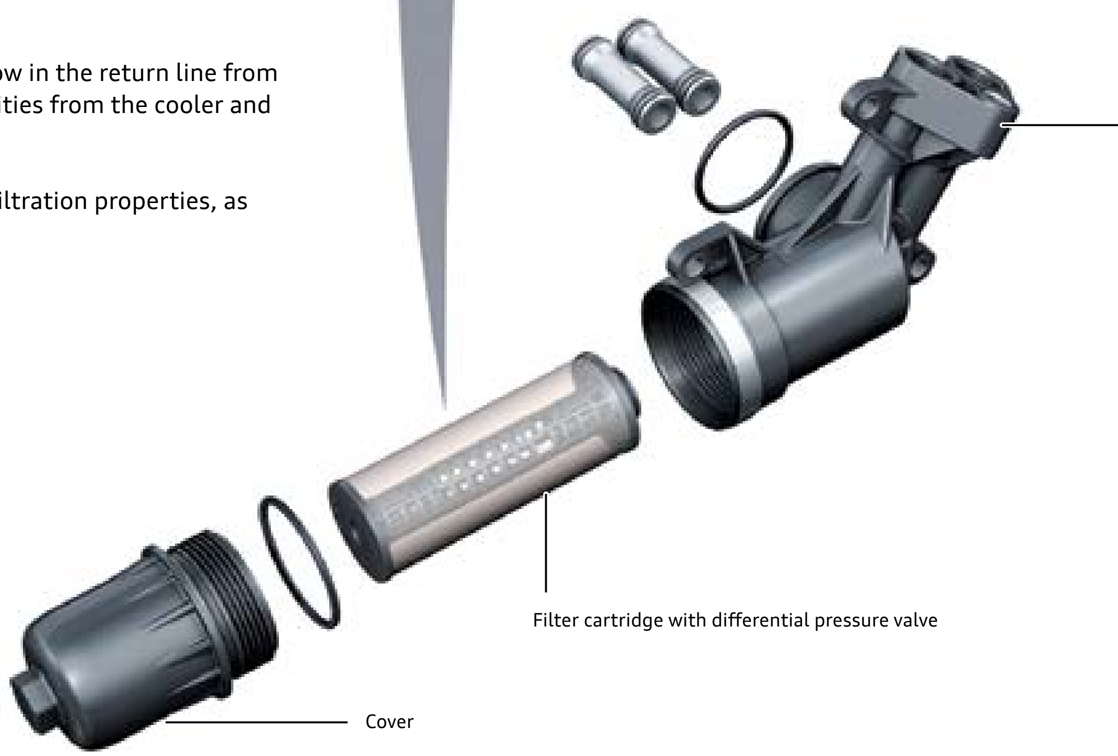


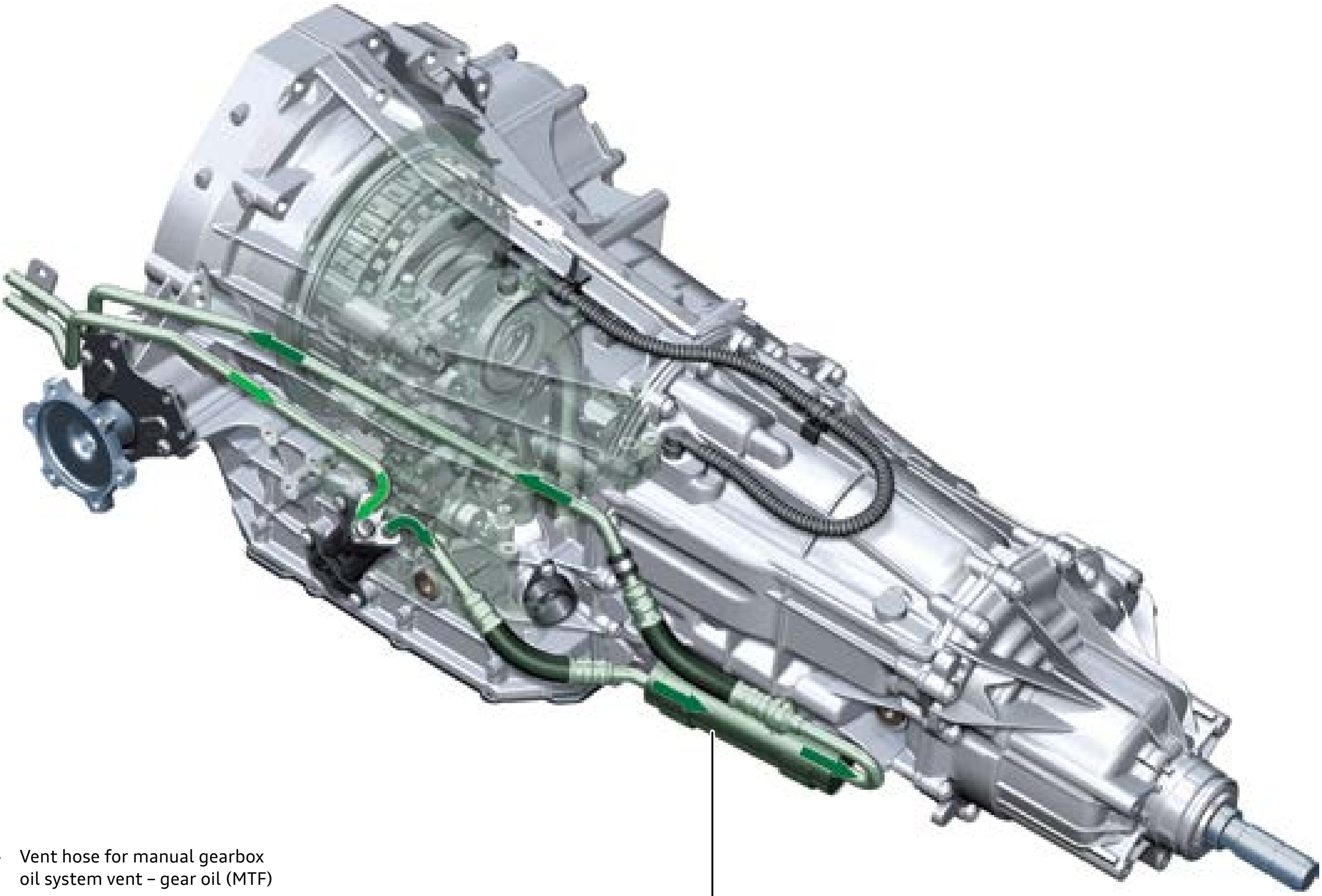
Easy-change ATF filter

0B5 transmissions manufactured after Calender Week 22/2010 have a new ATF filter module with a cartridge-type filter.

The ATF filter (pressure filter) is now in the return line from the ATF cooler. It filters out impurities from the cooler and its lines.

The new filter module has better filtration properties, as well as saving weight and space.





617_017

Vent hose for manual gearbox
oil system vent – gear oil (MTF)

617_016

Connections for ATF lines

ATF line filter (old version)

On 0B5 transmissions manufactured prior to Calendar Week 22/2010, the ATF filter (pressure filter) is integrated in the supply line to the ATF cooler. The filter does not have a fixed maintenance interval.

eMedia

For more information about the ATF filter module with filter cartridge, please refer to the Audi Service TV program “7-speed Dual Clutch Gearbox 0B5: Servicing the ATF Filter”.

Caution

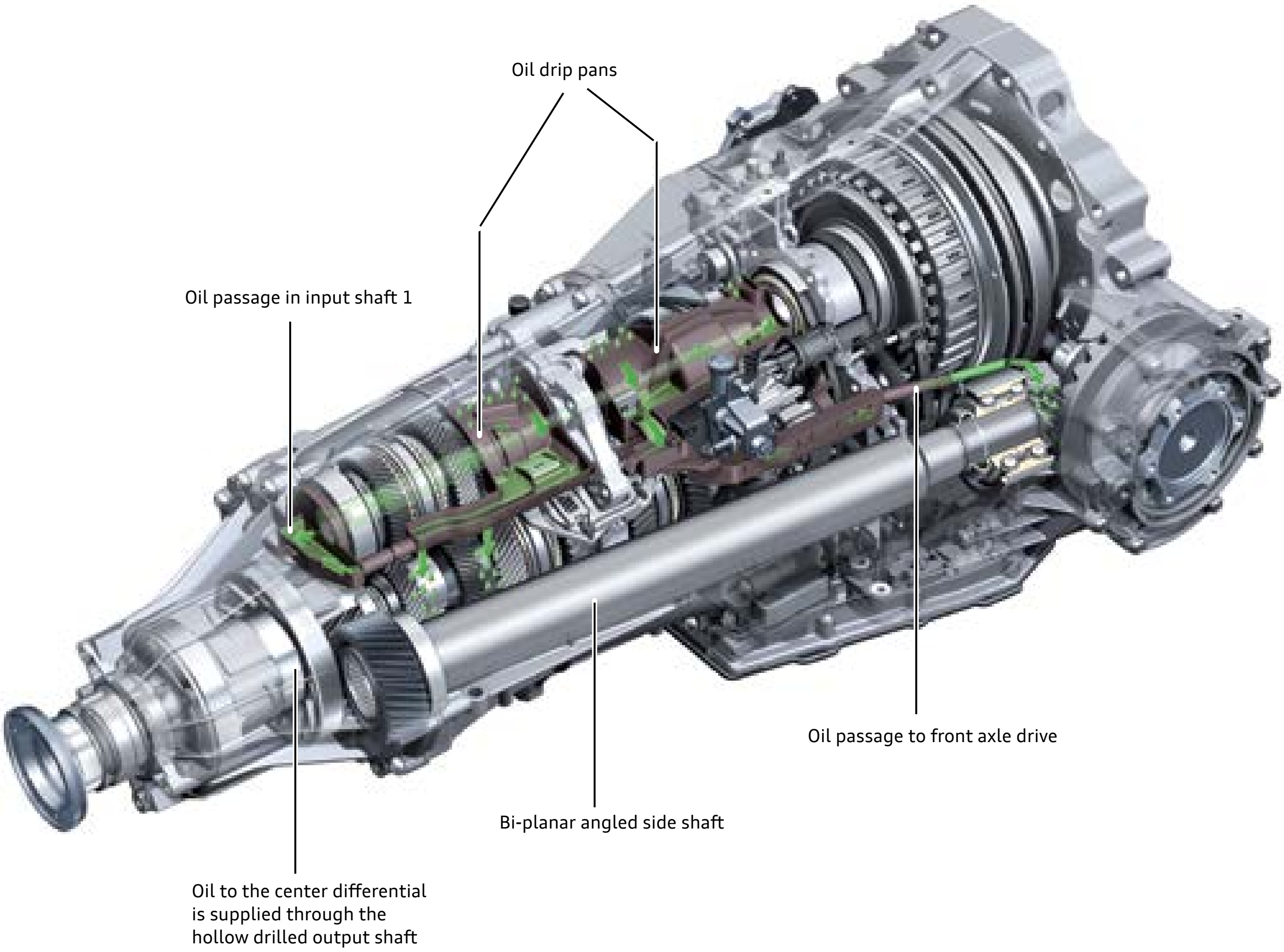
Protect the filter cartridge from coming into contact with water. Even small amounts of moisture can cause the filter fleece to separate. Fleece particles could then travel to the Mechatronics unit and cause it to malfunction.

There are various versions of the filter housing and the cover. Please read the information given in the ETKA and ElsaPro.

Manual gearbox lubrication

Directed lubrication using oil drip pans and special oil passages allows a lower overall oil level to be used in the transmission. This reduces churning losses and enhances transmission efficiency.

The bearings for the input shaft change gears are lubricated through the hollow drilled input shaft 1. Transverse bores in the shafts direct the oil to the bearing points.



429_125

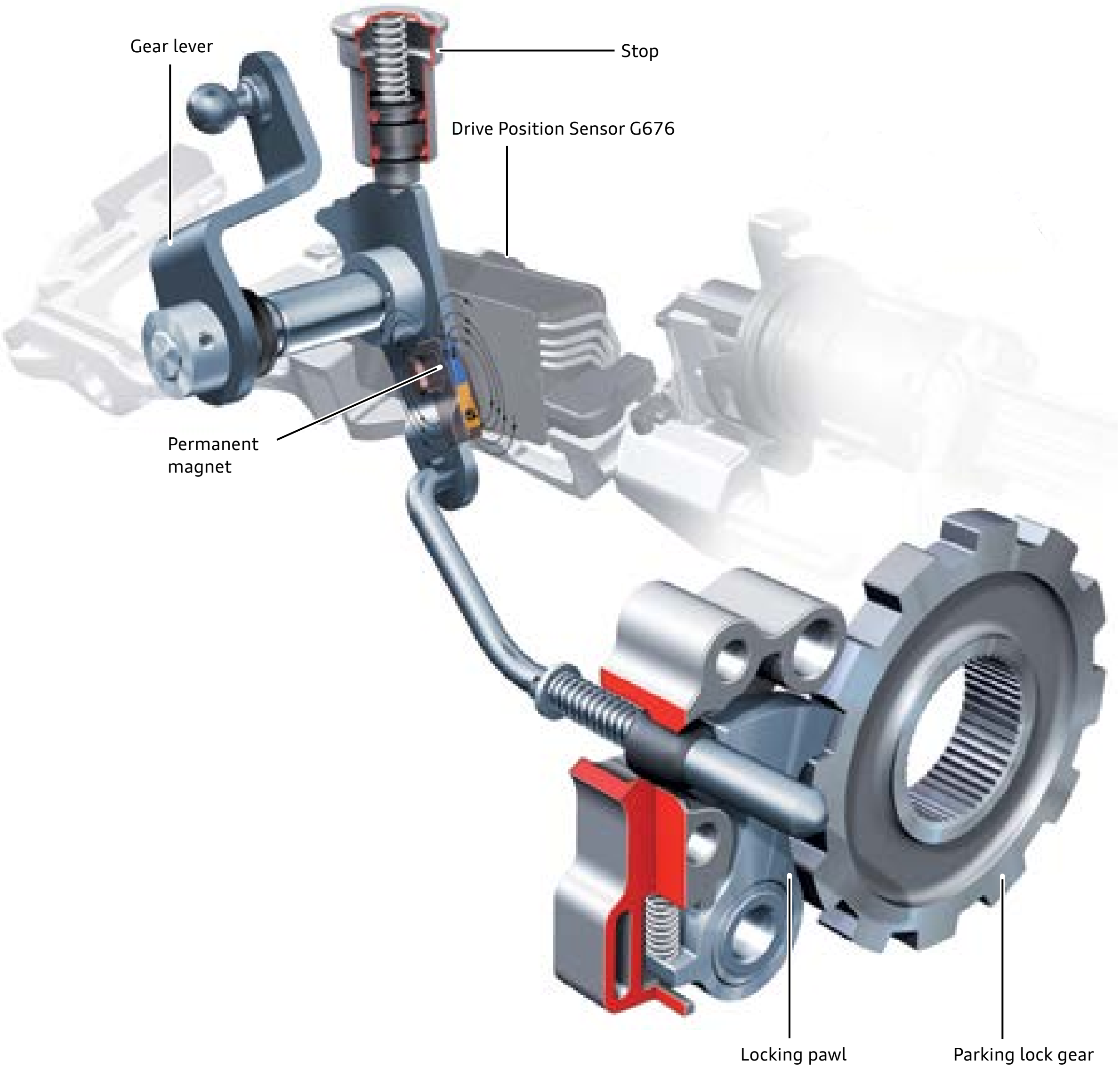
Parking lock

The 0B5 transmission requires the use of a mechanical parking lock. This is because both clutches are disengaged whenever the engine is not running.

The parking lock gear is connected to the output shaft. The pawl is actuated mechanically by the gearshift mechanism (selector lever) via a selector lever cable.

Drive Position Sensor G676 is also actuated through the selector shaft and parking lock lever. A permanent magnet exerting a magnetic field on the sensor is located on the parking lock actuator.

Using the signals generated by the G676, J743 recognizes the position of the selector lever (P,R,N,D or S).



Parking lock in selector lever position P
(locking pawl engaged)

429_117

Caution
Even though the parking lock locks all four gears through the center differential, a raised wheel is capable of turning freely, for example, when changing a wheel. Therefore, always apply the parking brake when changing wheels.

Changing the MTF

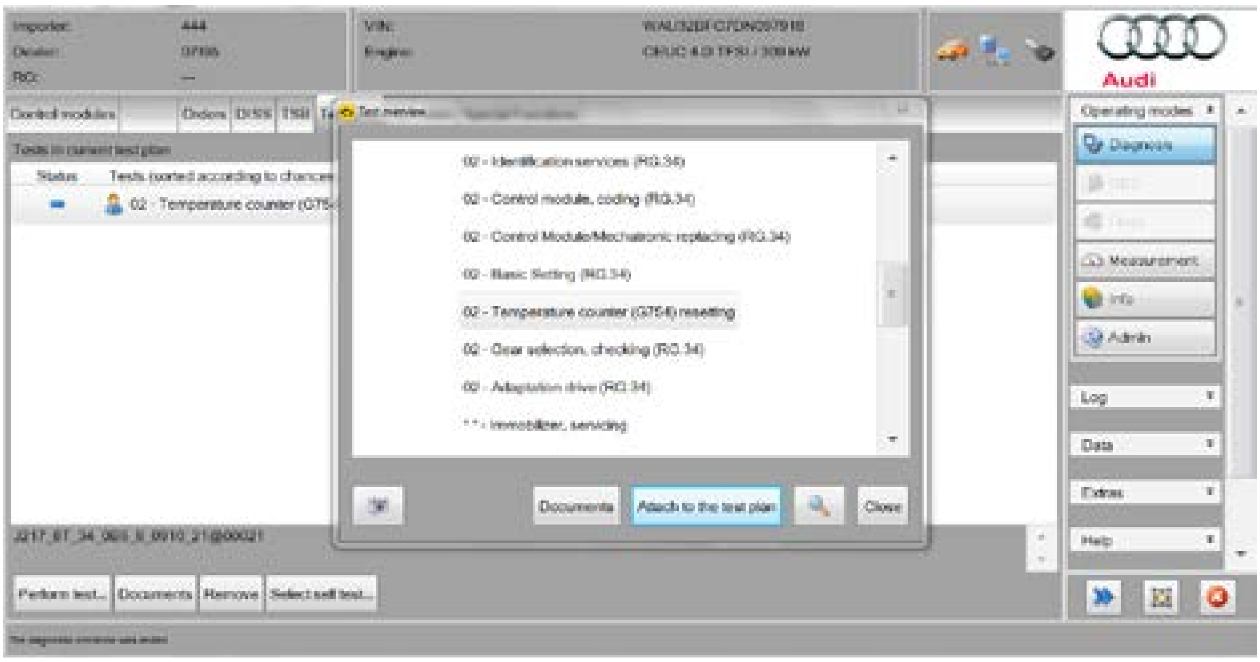
The MTF used in the 0B5 transmission contains special additives to withstand the stresses on the oil. These additives degrade at high temperatures causing the oil to lose its essential lubricating properties. That is why the MTF must be changed after it has been subjected to high thermal loads.

To determine the thermal load on the 0B5 transmission in RS models, there is an MTF temperature monitoring function. The data from the transmission can be read using the VAS Scan Tool.

If the MTF temperature monitoring function determines there is a high thermal load on the MTF, DTC P0897 "gear oil deterioration" is generated. In this case, it is necessary to change the gear oil. Even if the vehicle has covered less mileage than the last required change interval.

Resetting the temperature meters after changing the MTF

After changing the MTF, it is important to reset the temperature meters of the temperature monitoring function. The "Temperature counter (G754) resetting" function is available for this purpose using the VAS Scan Tool. Temperature meters are also referred to as temperature intervals.



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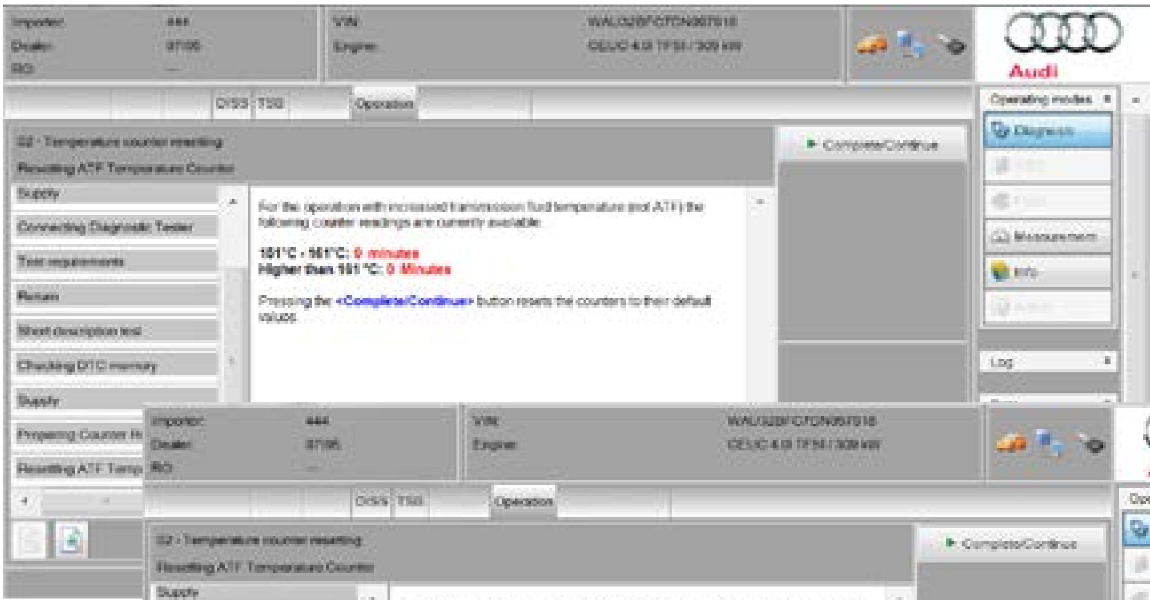
After the function is started, the system displays two temperature ranges and the time in minutes the MTF temperature was within each temperature range. In this example, 0 minutes is displayed which means that the MTF temperature has not yet reached a critical level. The temperature meters for the lower temperature ranges are not displayed here. In the course of the Test Plan, all temperature meters (including non-visible meters) are reset.



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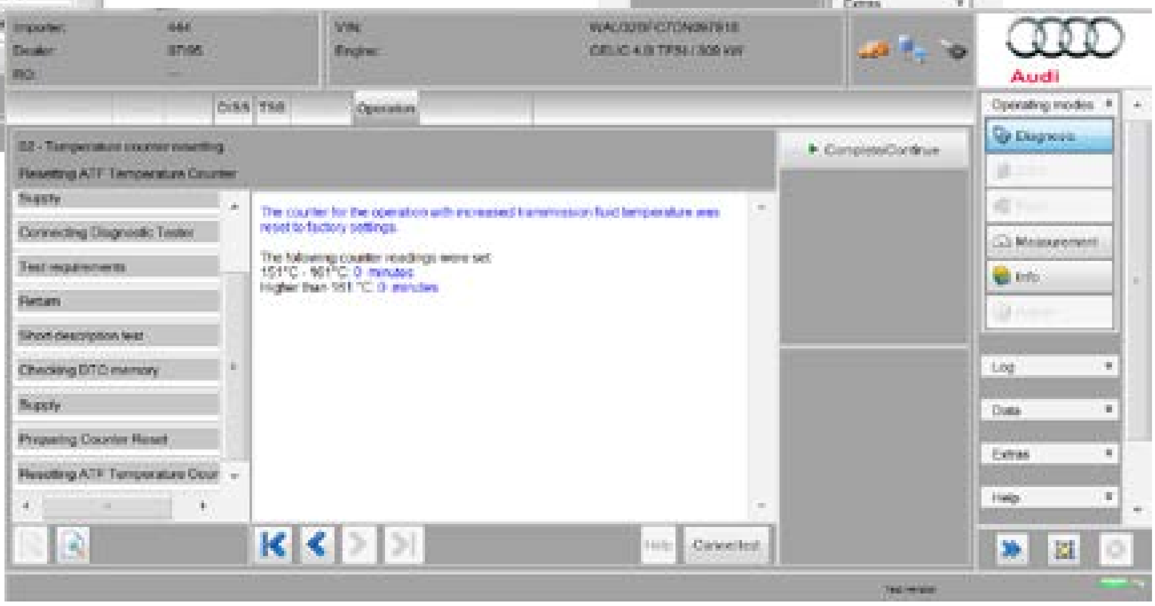
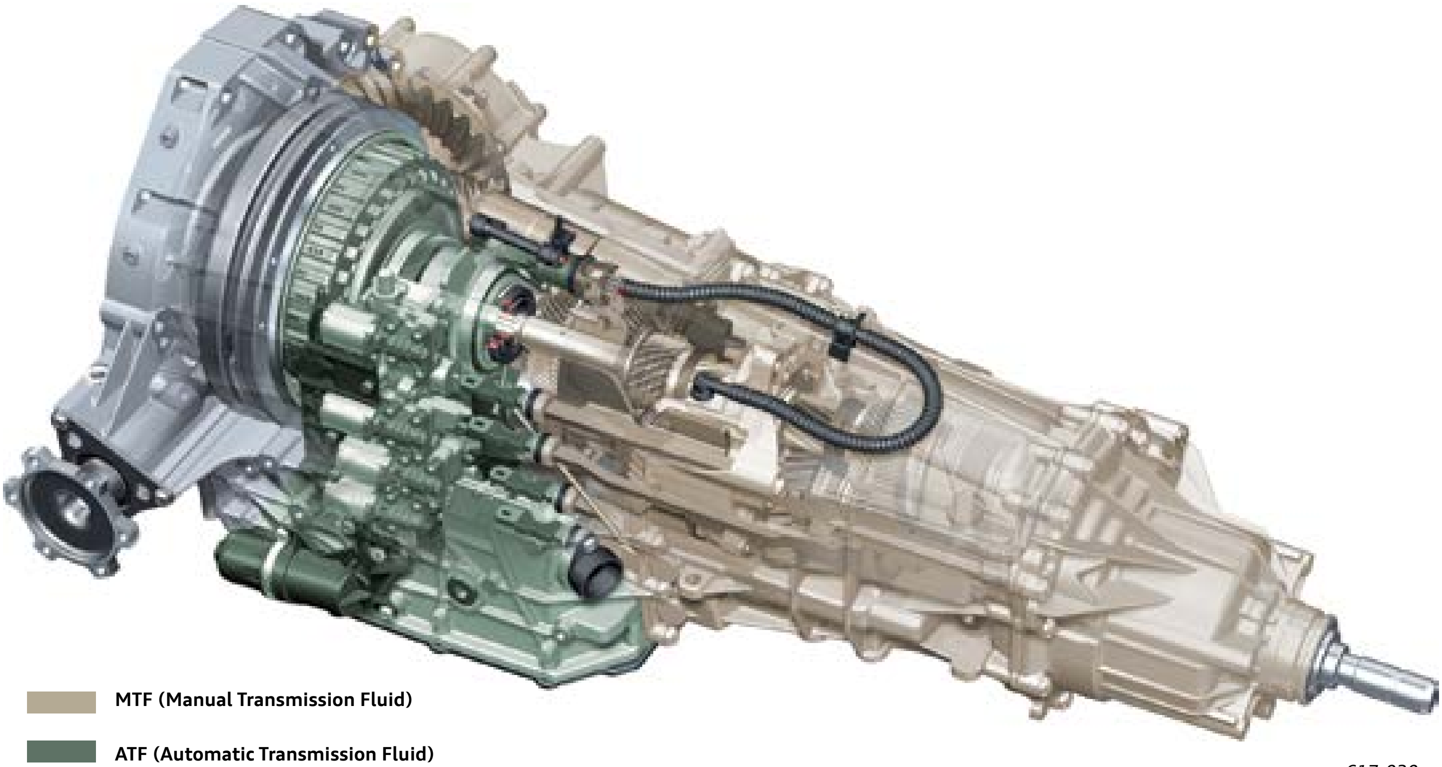
617_019b



617_019c

Oil system drain plugs



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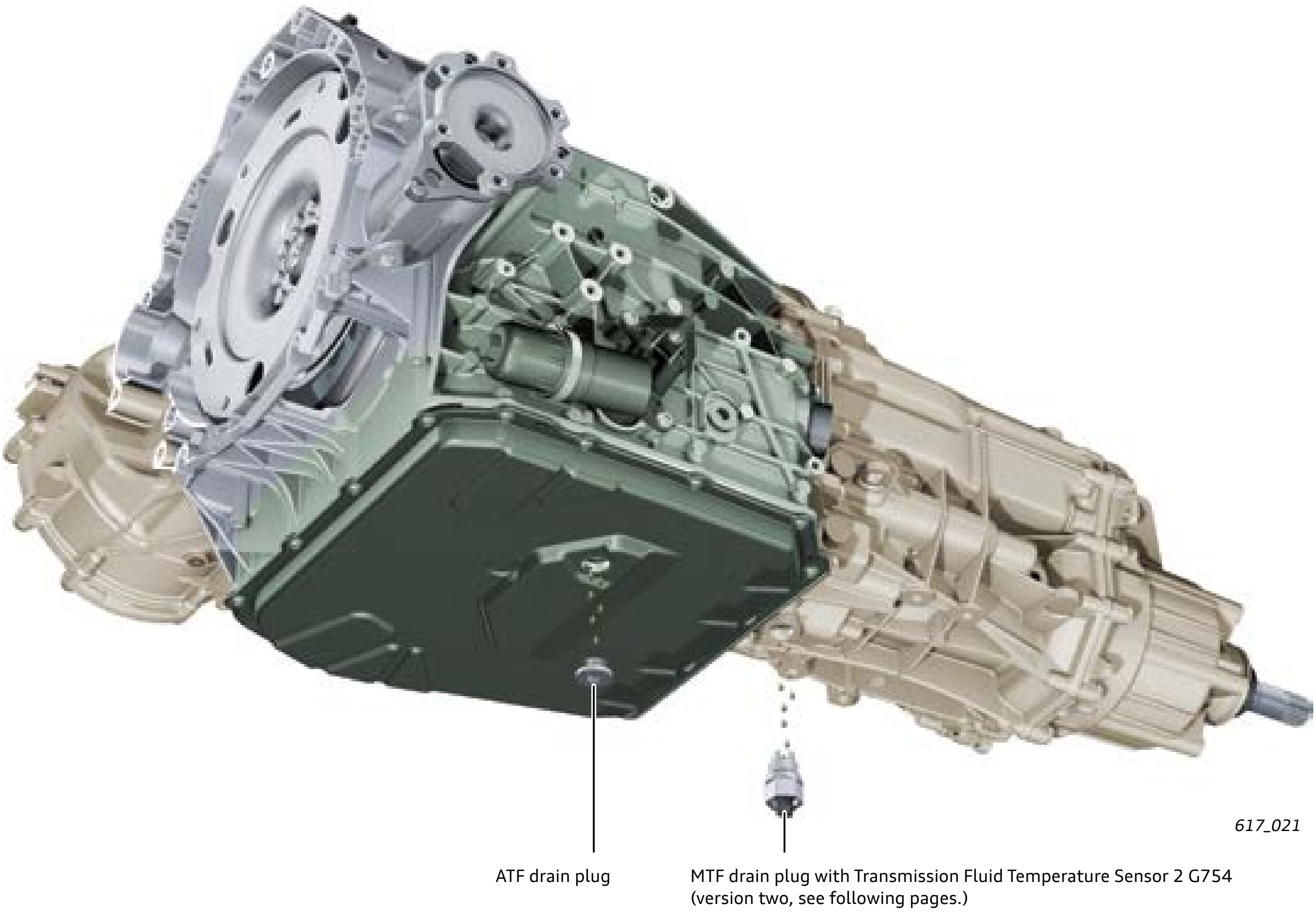


617_021

Note

MTF contains phosphates that can cause corrosion to the electrical contacts of the Transmission Fluid Temperature Sensor. If the sensor contacts are exposed to MTF, they must be thoroughly cleaned.

MTF temperature monitoring

As noted earlier, because of the high performance characteristics of the vehicles using the 0B5 transmission, the TCM is programmed with an MTF temperature monitoring function. Transmission Fluid Temperature Sensor 2 G754 monitors the gear oil temperature.

MTF temperature monitoring is necessary for two reasons:

1. To determine the heat input into the MTF and determine if it is aging. (Refer to Changing the MTF).

2. Many plastic and electrical components such as gear sensors and input speed sensors are located in the transmission case. These components can be damaged and possibly fail if exposed to excessively high temperatures.

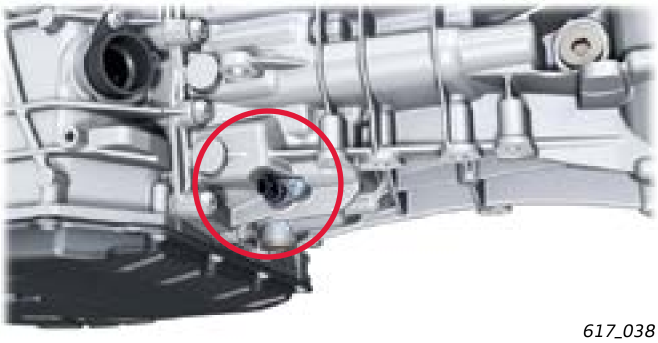
   When defined temperature limits are exceeded, a cooling function is activated by the TCM to prevent MTF temperature from rising any further. DTCs are generated and displayed to notify the driver via the DIS.

Transmission Fluid Temperature Sensor 2 G754

There are two versions of G754 and its installation location:

Version 1:

In vehicles manufactured prior to 2011, G754 is installed in the intermediate gearbox housing.



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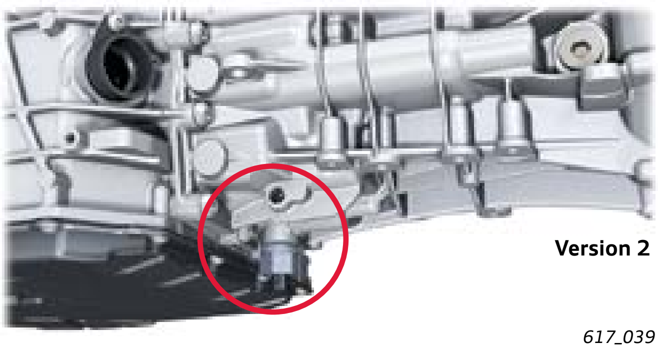
Version 2:

In vehicles manufactured after 2011, G754 is integrated in the MTF drain plug.

G754 consists of an NTC resistor. NTC stands for "**N**egative **T**emperature **C**oefficient" and refers to a resistor (component) whose electrical resistance (ohm) decreases as the temperature rises (thermistor).

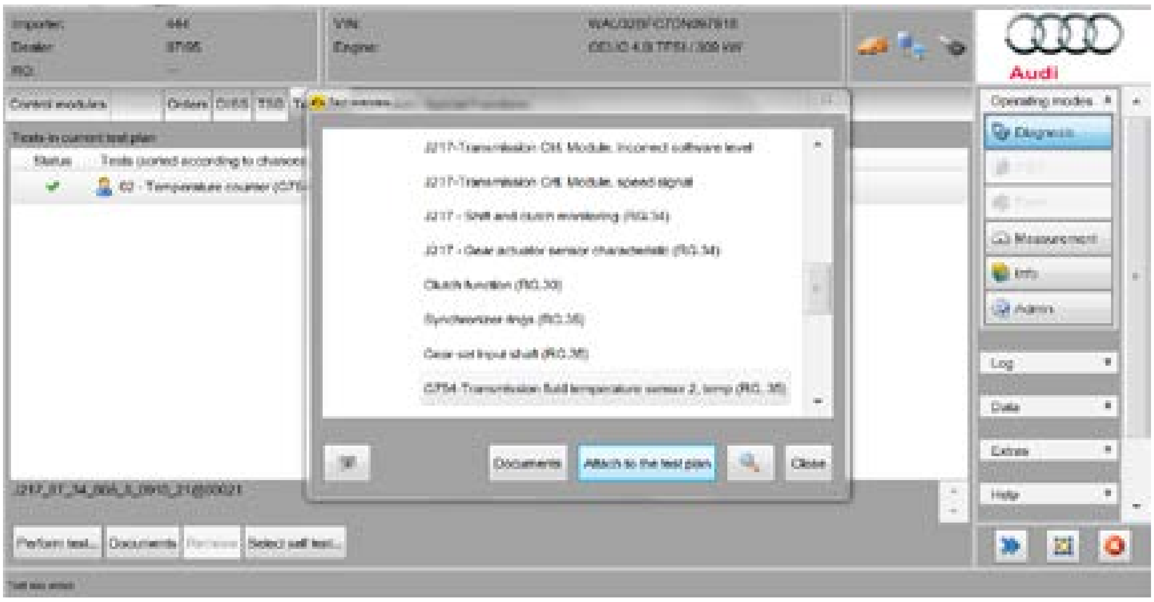


617_039

Note
MTF contains phosphates that can cause corrosion to the electrical contacts of the Transmission Fluid Temperature Sensor. If the sensor contacts are exposed to MTF, they must be thoroughly cleaned.

Measured value - MTF temperature

It is possible to read the MTF temperatures using the VAS Scan Tool. For better assessment of the measurement results, three temperatures are displayed by accessing Test Plan: G754 - Transmission fluid temperature sensor 2, temperature (Rep.Gr. 35) No extreme deviations should occur between the three temperature values; they should be mutually plausible. For example, it is not plausible for an MTF temperature of 80 °C to be displayed at the same time as an ATF temperature of 25 °C.



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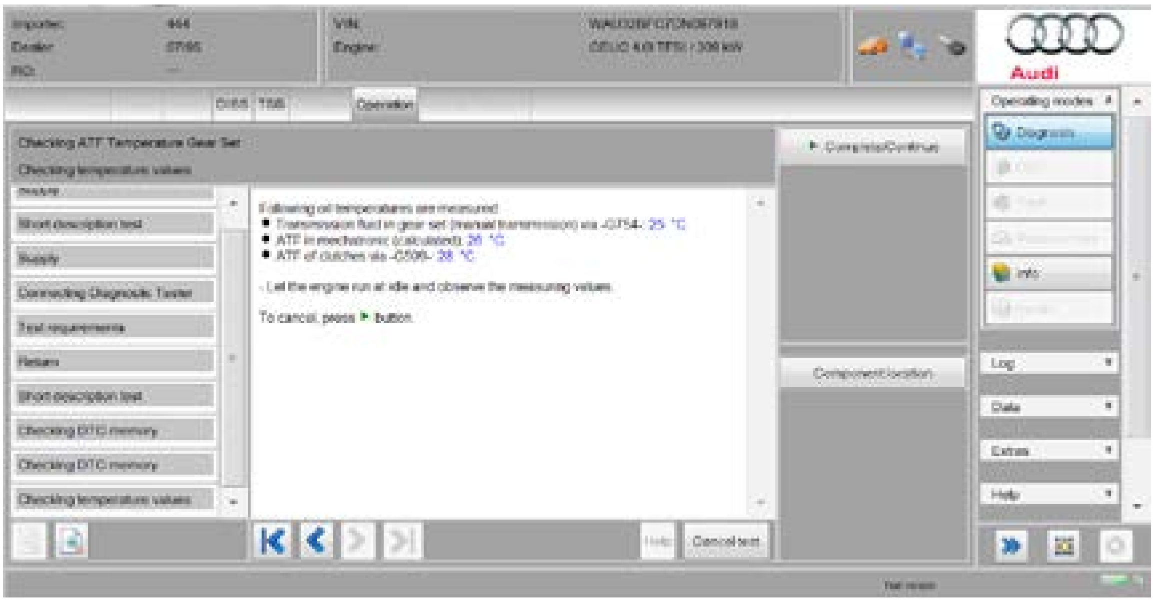

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"Transmission fluid in gear set (manual transmission)" is the temperature of the oil in the gear set.

"ATF in mechatronic (calculated)" is calculated by the TCM from signals generated by Clutch Oil Temperature Sensor G509 and Temperature Sensor in Control Module G510. G510 is located directly on the Printed Circuit Board of the TCM.

"ATF of clutches" is measured by G509. It is the ATF temperature of the fluid ejected from the dual clutches.

MTF temperature collective

As noted earlier, the TCM for the 0B5 S tronic transmission has an additional software-based MTF temperature monitoring function. The program records and evaluates all measured values generated by Transmission Fluid Temperature Sensor 2 G754.

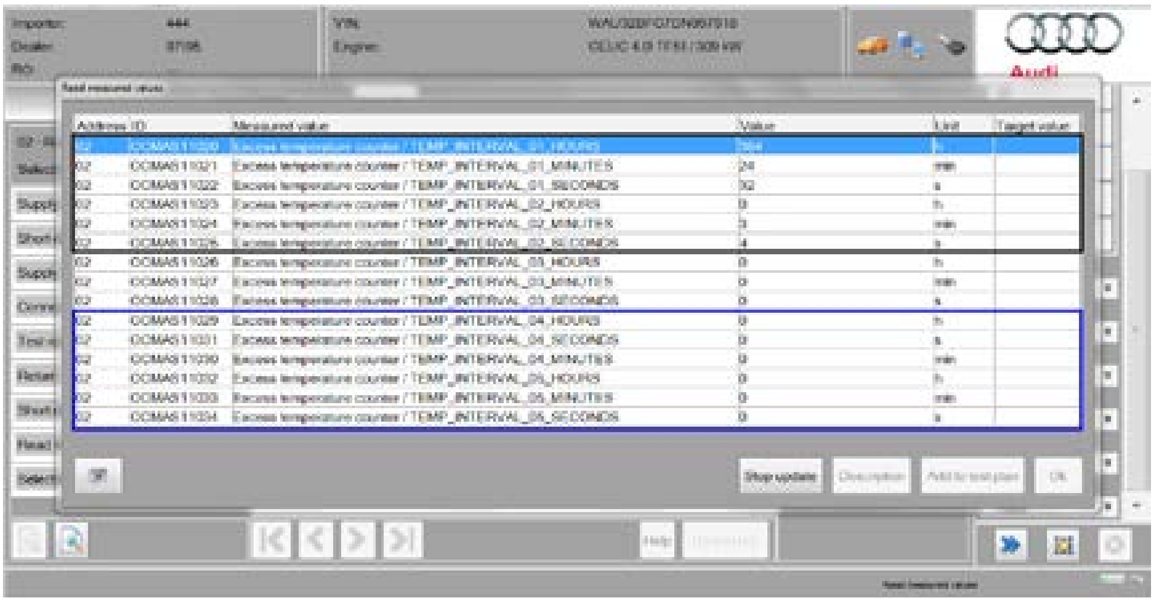
These measured values are evaluated statistically in an MTF temperature collective. Five temperature ranges assigned to temperature intervals are defined for the purposes of evaluation.

Each temperature interval has an elapsed-time meter which records the time the MTF temperature was in each temperature range. This provides a good indication of the extent to which the MTF and the components have been subjected to thermal load and/or stress.

Temperature intervals

The temperature intervals are displayed in ODIS Service in “Read measured values.” There are allowable temperature ranges for each interval.

Temperature Intervals	
Temp_Interval_01	−60 °C – 120 °C
Temp_Interval_02	121 °C – 130 °C
Temp_Interval_03	131 °C – 150 °C
Temp_Interval_04	151 °C – 161 °C
Temp_Interval_05	>162 °C



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In this example, the MTF temperature was within temperature range 1 between −60 °C and 120 °C for 384 hours, 24 minutes and 32 seconds and within temperature range 2 between 121 °C and 130 °C for 3 minutes and 4 seconds. The gearbox temperature has not exceeded 130 °C since the last time the temperature intervals were reset (refer to Resetting the temperature meter on page 20).

Temperature intervals 04 and 05 are important for temperature monitoring. A time limit is defined for each of these temperature intervals.

The time limits are 2 hours for temperature interval 04 and 10 minutes for temperature interval 05. If the time limit for either of these temperature intervals is exceeded, a DTC is generated by the TCM. No message or warning is issued via the instrument cluster. If a DTC is generated, it is necessary to change the MTF. Don’t forget! The temperature meters (temperature intervals) must be reset after changing the MTF.

If the DTC “Gear oil deterioration” is generated, the cooling function becomes active when an MTF temperature of 151 °C is exceeded instead of > 163 °C. (refer to page 26).

Cooling function

If the MTF temperature reaches a critcal level, the TCM initiates a “cooling function” to reduce the temperature or prevent it from increasing any further.

When the cooling function is active, the vehicle's maximum speed is decreased in order to reduce heat input into the MTF.

This is how the cooling function works:

If an MTF temperature of 163 °C is exceeded, the maximum travel speed (V max.) is initially reduced by 12.4 mph (20 km/h). This corrective adjustment is made by reducing the engine power output when the speed limit threshold is reached. The vehicle's speed is gradually reduced in increments of 0.6 mph (1 km/h) per second (12.4 mph [20 km/h] in 20 seconds) per second (20 kph in 20 seconds).

For example, we’re driving on the Autobahn:

A vehicle is travelling at 161.5 mph (260 km/)h and the MTF temperature exceeds 163 °C. The maximum velocity (V max.) is now limited to 149.1 mph (240 km/h) as described above.

The MTF temperature is monitored at two-minute intervals and should decrease by at least 3.6 °F (2 °C) within these two minutes. If this is not the case, V max. is reduced by a further 12.4 mph (20 km/h). In this example, V max. is 136.7 mph (220 km/h).

If the MTF temperature decreases by more than 3.6 °F (2 °C) within two minutes, the actual speed limit threshold is initially maintained. The temperature is monitored at two-minute intervals. At the end of the two-minute cycle, the system decides whether to further reduce or maintain the vehicle's current speed.

When the MTF temperature drops below approx. 147 °C, the limit on maximum speed is canceled again.

V max. is only limited down to a speed of 130.4 mph (210 km/h) (lowest speed reduction threshold).

If the cooling function is active, DTC "P06AA – Internal temperature sensor 2, temperature too high" is generated. No fault message is displayed in the instrument cluster.

Drivers will normally notice the restrictions on maximum speed with the possible complaint: no power at times, vehicle is not achieving top speed, or similar descriptions.

If the fault memory contains the above-mentioned DTC, it is the task of the dealership service personnel to check the following points and explain the cooling function to the driver.

A distinction is made between two cases:

Case 1:

Temperature interval 04 or 05 has been utilized by less than 50% (refer to page 25).

In this case, all that need be done is clear the DTC and explain the cooling function to the driver.

Case 2:

Temperature interval 04 or 05 has been utilized by more than 50%.

In addition to informing the driver and clearing the DTC, it is recommended that the MTF be changed. The next point to clarify is whether it make sense to change the MTF immediately.

If the normal MTF change interval or another service event is due anyway, the MTF can also be changed at this time.

Safety function

If the MTF temperature continues to increase despite the fact that the cooling function is active and exceeds 180 °C for more than 30 seconds, DTC "P0218 Maximal gear oil temperature exceeded" is generated. The yellow gearbox icon and the fault message "Gearbox malfunction: you can continue driving (limited functionality)" appear in the instrument cluster.

In this case, a thermal overload has occurred rendering the MTF unusable. It must also be assumed that the electrical gearbox components and plastic parts have been damaged.

Gearbox malfunction:
you can continue driving (limited functionality)

617_030

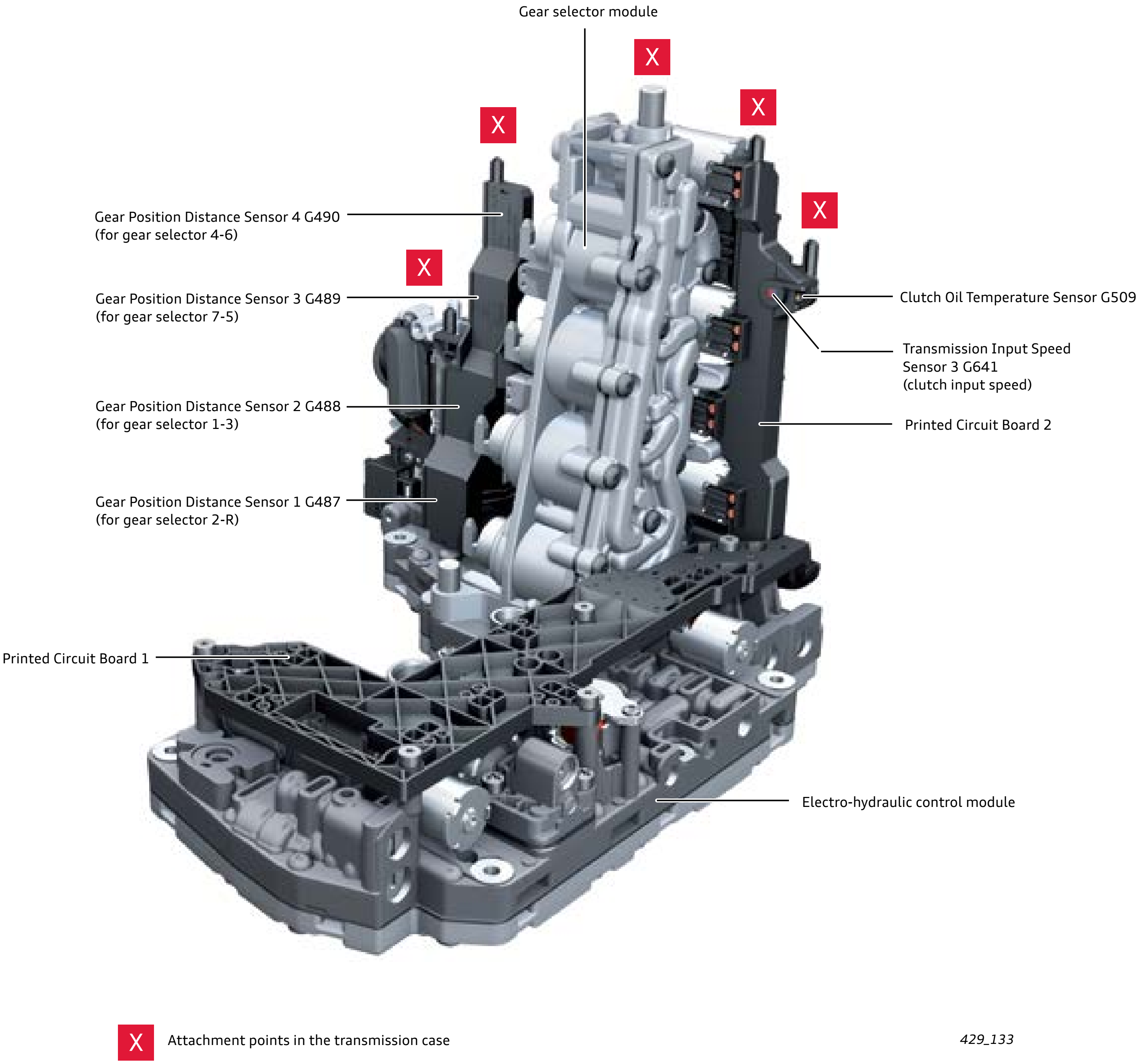
Notes

Transmission control

DSG Transmission Mechatronic J743

The transmission is controlled by DSG Transmission Mechatronic J743. The Mechatronic system acts as the central transmission control module. It combines the electro-hydraulic control unit (actuators), Transmission Control Module J217 and some of the required sensors into a single unit.

Because of the longitudinal configuration of the 0B5 transmission, the rpm sensors for both gearbox input shafts and gear sensor are mounted on a separate bracket (Printed Circuit Board 3.)



429_133

The Mechatronic system controls, regulates, and performs the following functions:

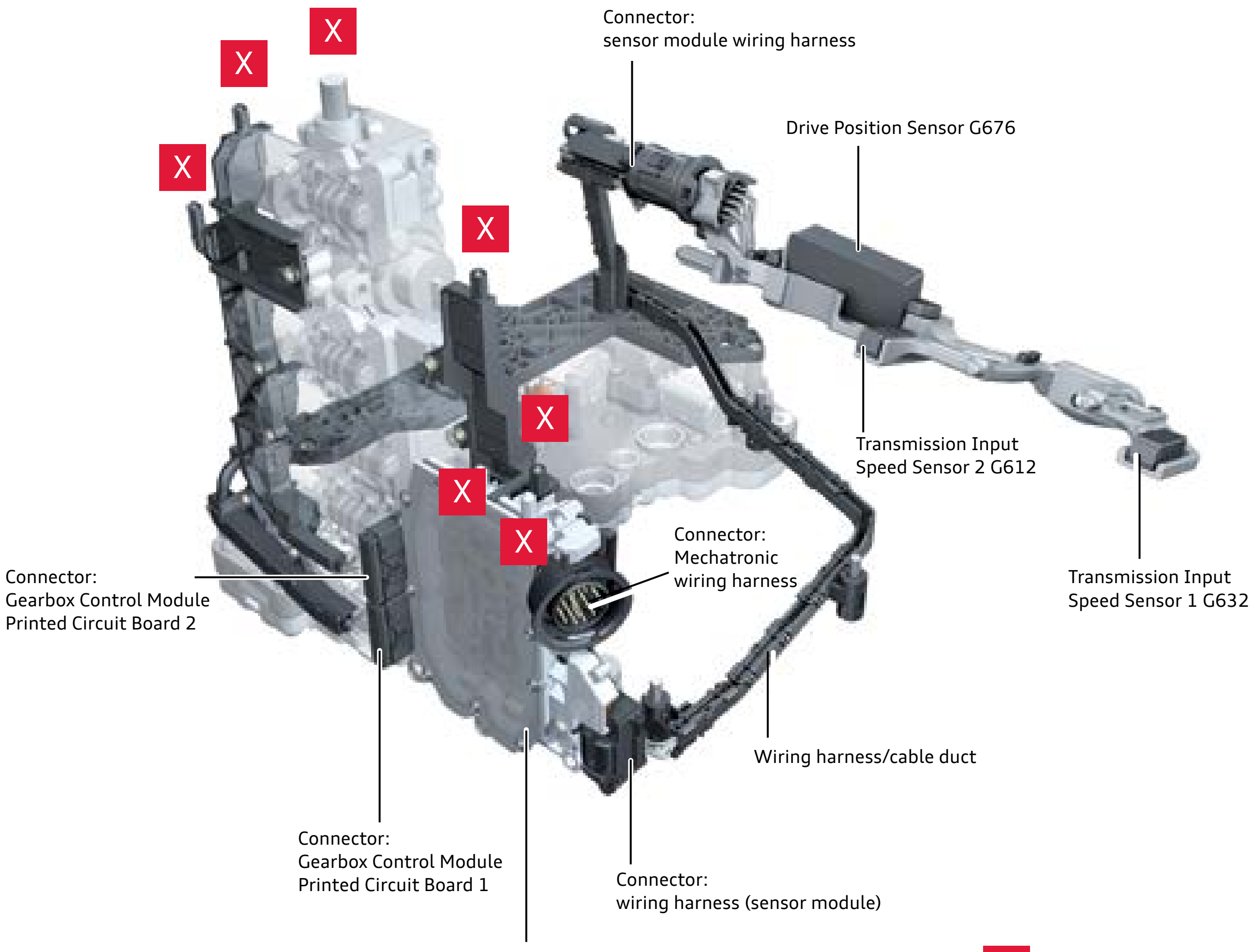
- Adaptation of oil pressure in the hydraulic system to requirements
- Dual clutch regulation
- Clutch cooling regulation
- Shift point selection
- Transmission control and regulation
- Communication with other control modules
- “Limp home” program circuitry
- Self-diagnostics

Note

After replacing the Mechatronic system, or the TCM, various adaptations must be made using the VAS Scan Tool.

When handling the Mechatronic system, it is important to pay close attention to the working guidelines regarding electrostatic discharge!

Mechatronic system with sensor module (Printed Circuit Board 3)



429_130

X Mounting points in the transmission case

Hydraulic component overview

This illustration shows the electro-hydraulic control module, together with all components activated by the actuators.

N433 Sub-transmission 1 Valve 1 (for gear selector 1-3)

N434 Sub-transmission 1 Valve 2 (for gear selector 7-5)

N435 Sub-transmission 1 Valve 3 (for clutch valve K1, activation)

N436 Sub-transmission 1 Valve 4 (for pressure regulation in sub-gearbox 1)

N437 Sub-transmission 2 Valve 1 (for gear selector 2-R)

N438 Sub-transmission 2 Valve 2 (for gear selector 4-6)

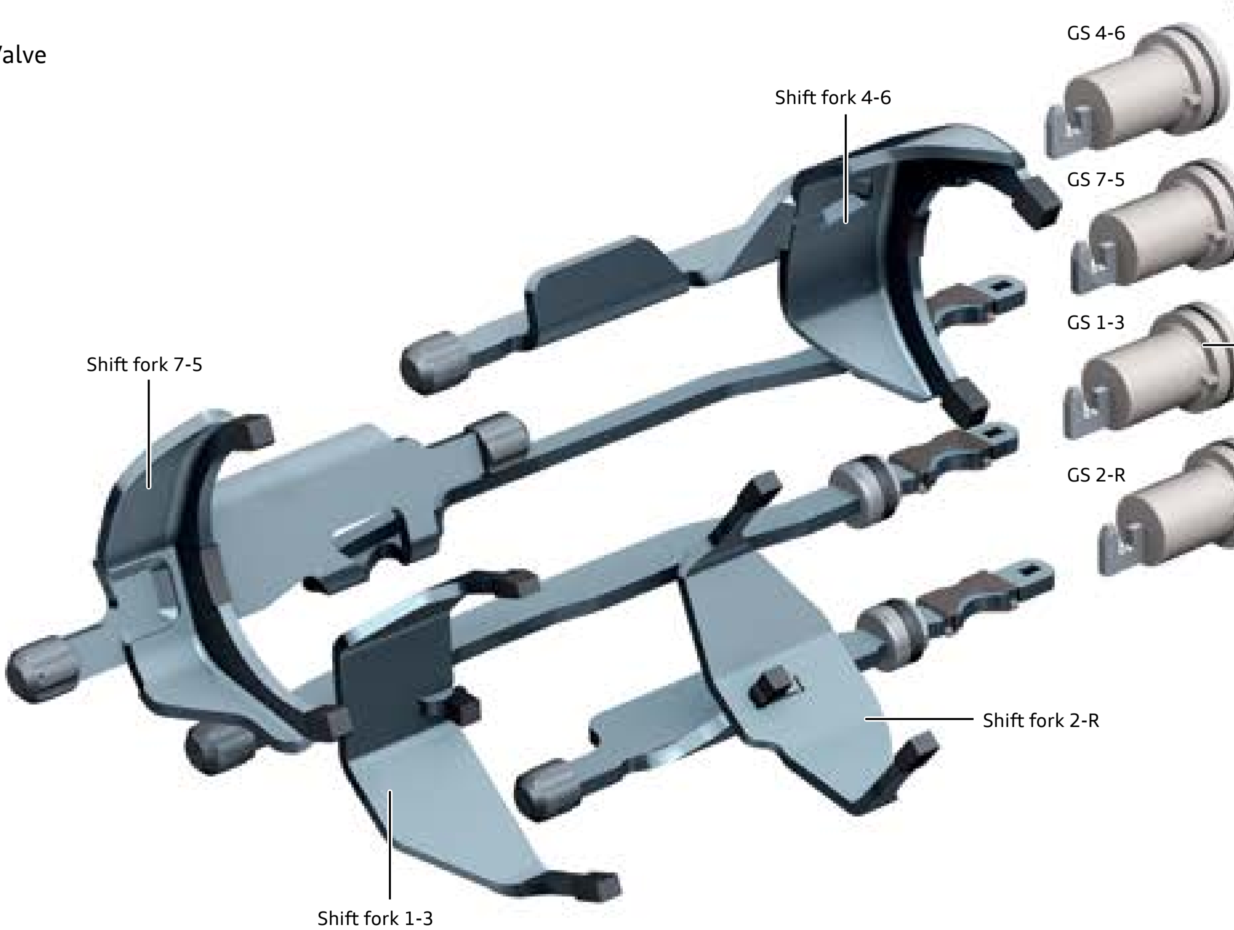
N439 Sub-transmission 2 Valve 3 (for clutch valve K2, activation)

N440 Sub-transmission 2 Valve 4 (for pressure regulation in sub-gearbox 2)

N471 Cooling Oil Valve

N472 Main Pressure Valve

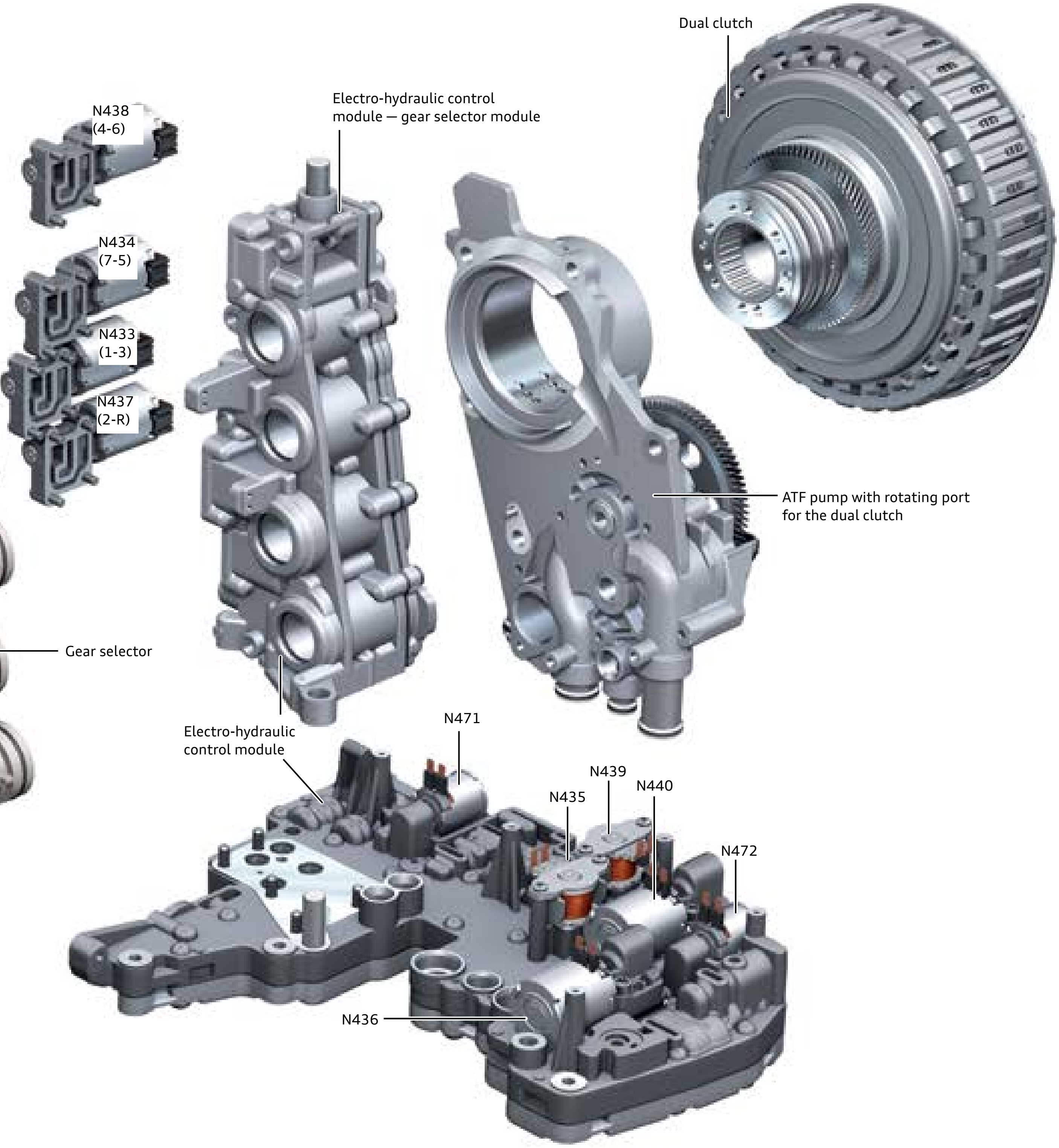
GS Gear Selector



The selector rails/shift forks have no stops, with the shift forks held in position by gear selectors. The only stops are in the gear change sleeve and the synchronizer assembly.

!

Note
Before installing the Mechatronic system into the transmission, the gear selectors and selector rails must be brought into alignment with each other. Refer to ElsaPro for the latest information.


Dual clutch
N438
(4-6)
Electro-hydraulic control
module — gear selector module
N434
(7-5)
N433
(1-3)
N437
(2-R)
ATF pump with rotating port
for the dual clutch
Gear selector
Electro-hydraulic
control module
N471
N439
N440
N435
N472
N436

429_129

Electronics

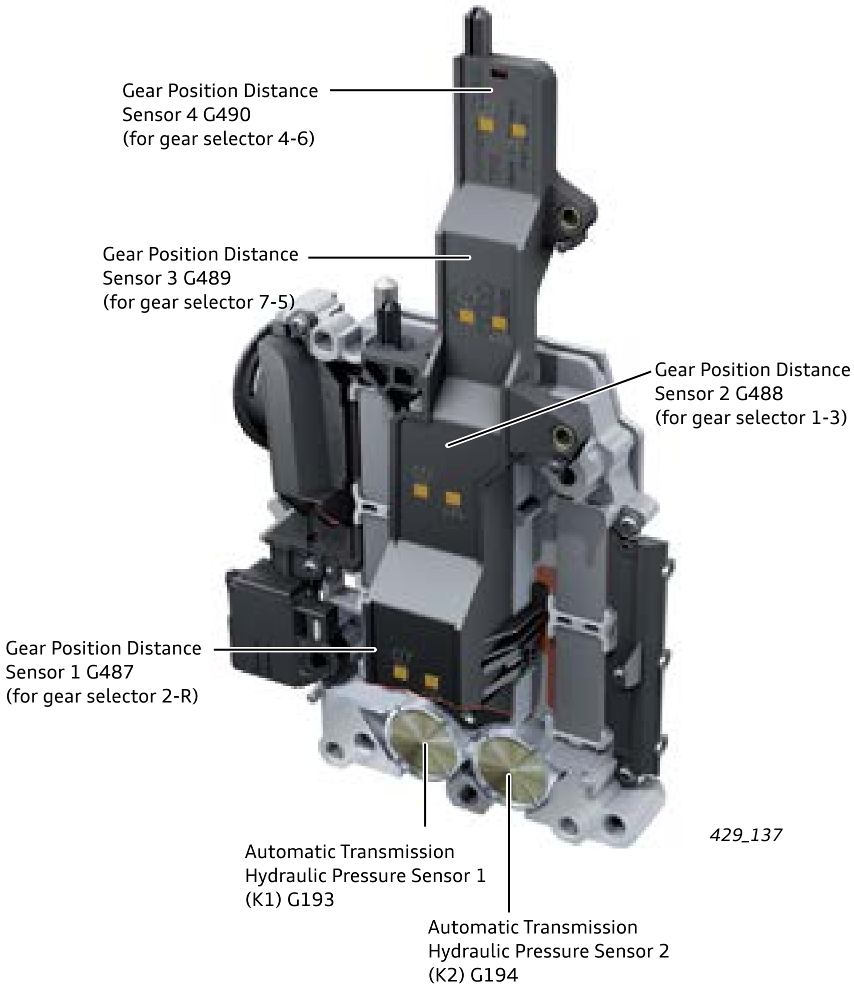
Integrated sensors

Transmission Control Module J217, the four distance sensors, and the two hydraulic pressure sensors are configured as a non-separable unit.

Two temperature sensors are integrated with TCM J217. One sensor is positioned to measure the exact temperature of the ATF. The other sensor is integrated in the TCM processor and measures the temperatures of critical components. The sensors are also monitored for plausibility between each other.

In addition to safety aspects, the ATF temperature is relevant to both clutch control and hydraulic control. For this reason, the ATF temperature is also a key factor in the control and adaptation functions.

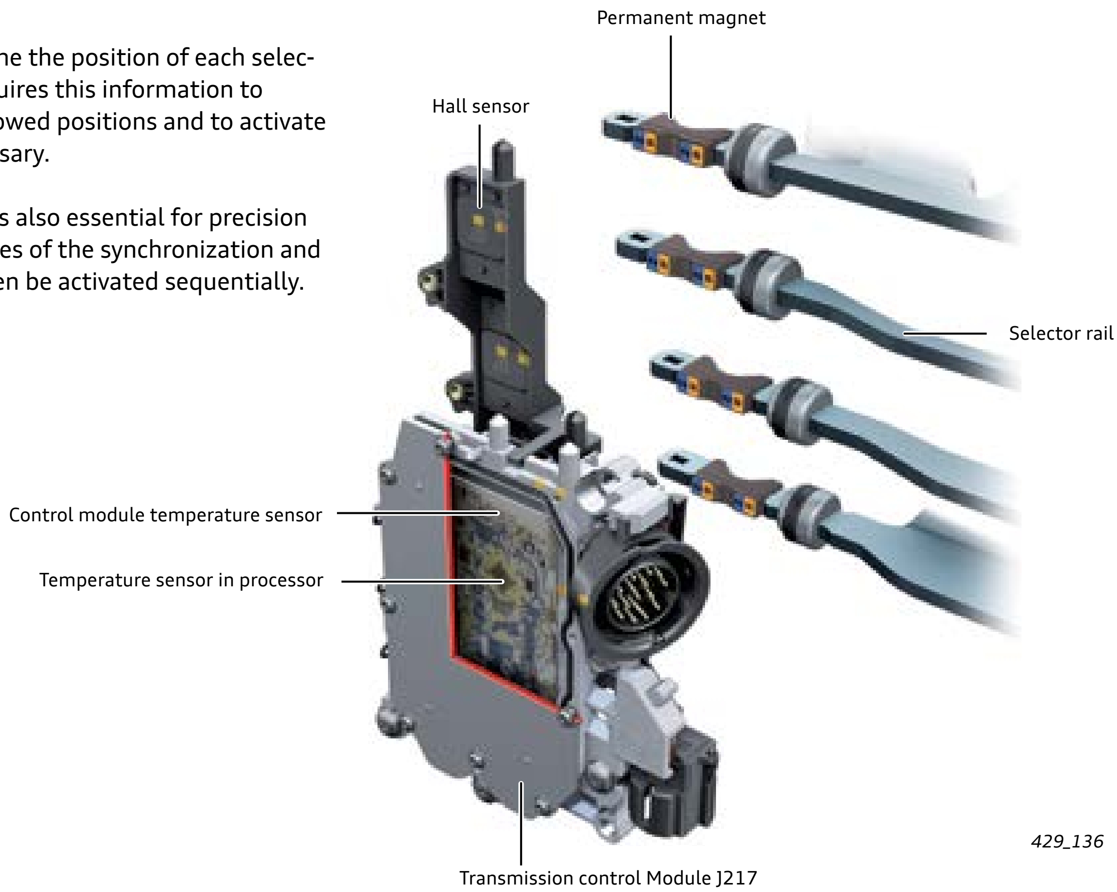
Hydraulic pressure senders 1 and 2 are utilized for clutch pressure monitoring and for adaptation of the primary pressure and sub-gearbox pressures.



429_137

Four distance sensors determine the position of each selector rail/shift fork. The TCM requires this information to immediately diagnose non-allowed positions and to activate a limp home program, if necessary.

An exact travel measurement is also essential for precision gear shifting. The various phases of the synchronization and gear-shifting processes can then be activated sequentially.



429_136

Each distance sensor consists of two Hall sensors. Permanent magnets are attached to the selector rail. Depending on the position of the magnets in relation to the Hall sensors, the Hall sensor will send a voltage output which corresponds to the distance traveled.

429_171

Note
To exactly measure the distance traveled by the gear selector, the shift mechanism must be adapted to the the TCM using the VAS Scan Tool.

Separate sensors

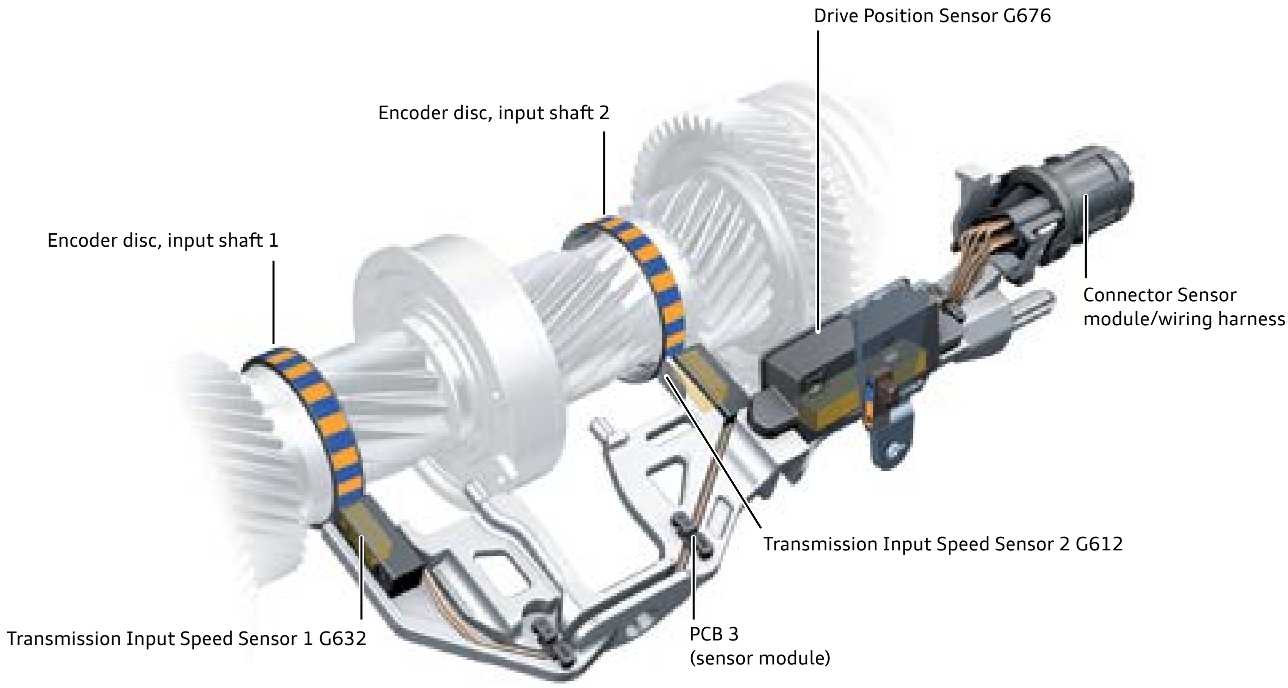
Transmission Input Speed Sensors 1 and 2 as well as Drive Position Sensor G676 are mounted on a common bracket with Printed Circuit Board 3.

The speed sensors are "intelligent sensors." With three Hall sensors and the corresponding evaluation electronics, it is possible to distinguish between driving forwards, driving in reverse and a weak magnetic field. The TCM receives the information from the senders pre-evaluated in the form of a pulse width modulated signal.

The various states are indicated to the TCM by different pulse widths. This means that driving forward produces a different pulse width than when driving in reverse.

Signal utilization

- Determination of the clutch output speed for computing clutch slip
- Determination of the synchronization speed for shift control

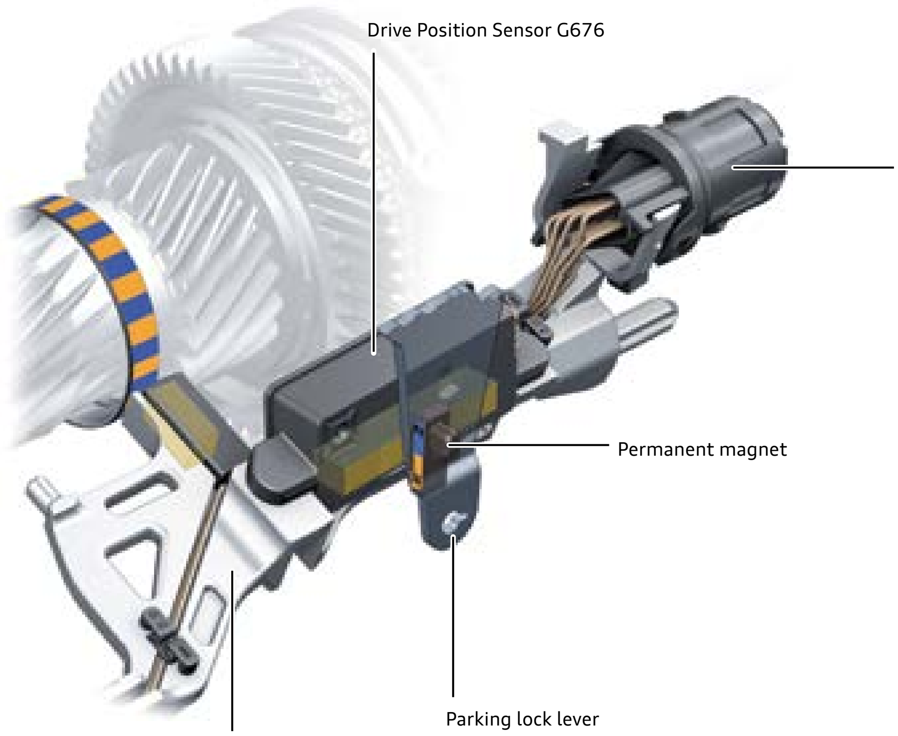


429_173

Drive Position Sensor G676

Drive Position Sensor G676 is a contactless travel sensor which is used to determine the selector lever positions (P, R, N, D, and S).

A permanent magnet exerting a magnetic force on the gear sensor is located on the parking lock lever. The parking lock lever is connected to the gear lever by a shaft. It is actuated by the selector lever by means of a selector lever cable.



429_167

The TCM requires data on selector lever position to perform the following functions and generate the following information:

- Information on driver input/vehicle operating state (forward, reverse, neutral) for activation of the clutches and gear selectors
- Information for selection of shift program “D” or “S”
- Signal for controlling the starter inhibitor
- Signal for controlling the P/N lock (shift-lock)
- Information for reverse gear (for example, back-up lights, Park Assist System, etc.)
- Control of the selector lever position indicator in the instrument cluster and gearshift mechanism

The position sensor is a PLCD travel sensor. The abbreviation PLCD stands for Permanent Magnetic Linear Contactless Displacement sensor and describes a contactless sensor which measures linear travel using a permanent magnet.

The signal generated by the gear sensor is very important for transmission control and is safety-critical. For this reason, there are two sensors (for redundancy). G676 therefore consists of two sensor elements arranged in parallel.

The TCM always evaluates both sensors.

Note
The gear sensors must be adapted to the TCM using the VAS Scan Tool.

Transmission Input Speed Sensor 3 G641 and Clutch Oil Temperature Sensor G509

Transmission Input Speed Sensor 3 G641 is a Hall sensor. It measures the input speed of the dual clutch (engine speed after the dual-mass flywheel). The outer plate carrier of clutch K1 serves as an encoder disc.

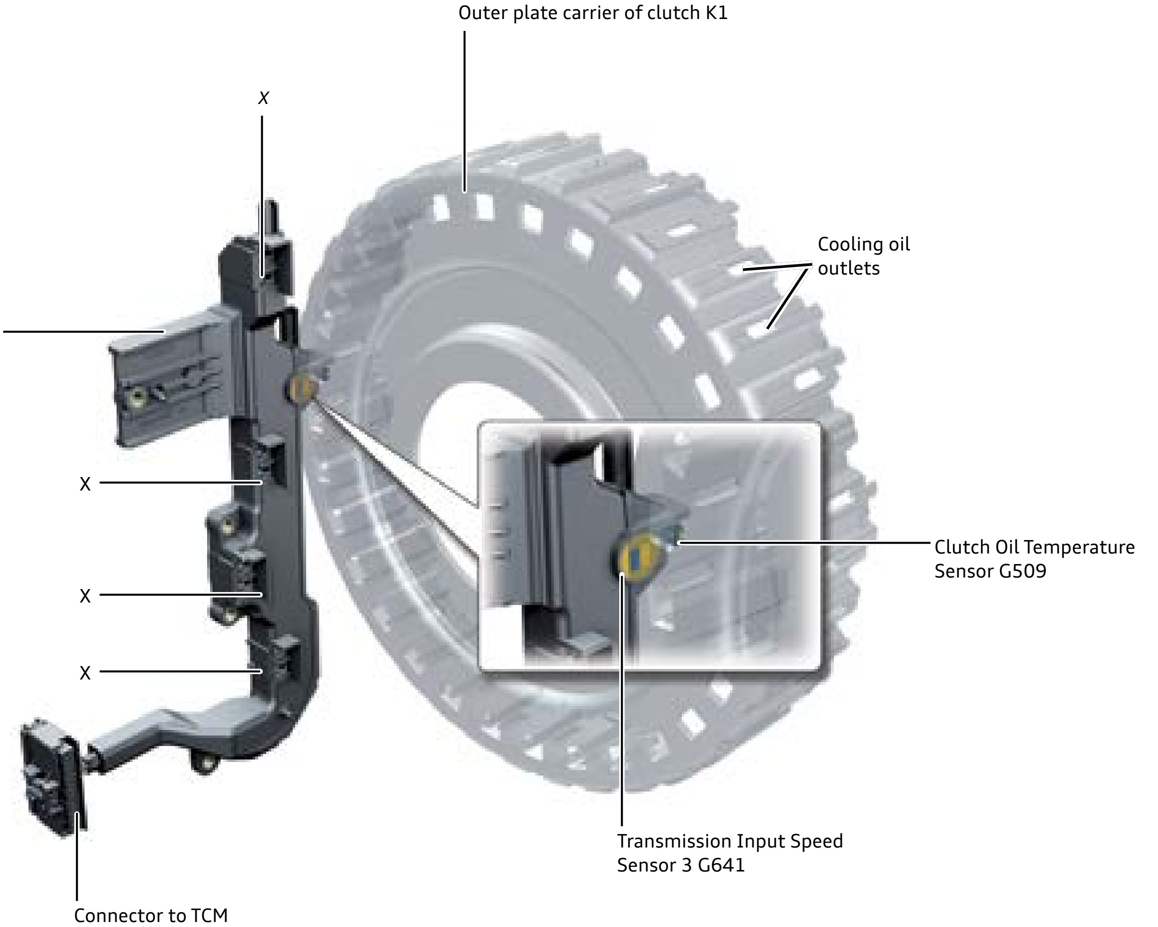
The clutch input speed signal:

- Allows more precise clutch control
- Is used for adapting the clutches
- Is used for regulating micro-slip

Clutch Oil Temperature Sensor G509 measures the temperature of the cooling oil emerging from the dual clutch. The clutch temperature can be derived from this information.

G509 is used to monitor the clutch temperature. When a defined oil temperature is reached, safety precautions are taken in order to prevent a further rise in temperature.

Both G641 and G509 are integral parts of Printed Circuit Board 2.



429_175

X = electrical connections

Selector mechanism

To shift from D to S (or from S to D), the selector is flicked back out of D once only. The selector always springs back to the D/S position. The shift schematic has been adapted to a new operating logic.

Advantages for the driver:

- On models equipped with Audi drive select, the S program can now be selected irrespective of the mode selected in Audi drive select
- Tiptronic mode can now also be selected in the S program

The shift schematic with gearshift indicator is integrated in the console trim frame. Selector Lever Transmission Range Position Display Unit Y26 is installed from below as a separate component..

617_037

Reference
For more information about the selector mechanism, please refer to eSelf-Study Program 991803, *The 2009 Audi A4 Vehicle Introduction.*

Additional protection functions

Control Module Temperature Monitoring

High temperatures have a negative impact on the useful life and performance of electronic components. Because the TCM is integrated with the gearbox it is critical to monitor its temperature and that of the ATF.

When one of the two temperature sensors in the TCM reads a temperature of approximately 275 °F (135 °C), actions are taken to protect against a further rise in temperature. If the threshold value is exceeded, the TCM initiates a reduction in engine torque (via the ECM) to reduce heat input.

Up to a temperature of approximately 293 °F (145 °C), engine torque can be reduced gradually until the engine is at idle. When the engine is at idle, the clutches are open and there is no power transmission to the drive wheels. When the protective function is activated, a DTC is generated and the following text is displayed in the DIS: “You can continue driving to a limited extent.”

Clutch protection

If Clutch Oil Temperature Sensor G509 detects a value of approximately 320 °F (160 °F), the clutch is within a temperature range in which it can be damaged. In addition to G509, the clutch temperature is also calculated using a computer model.

These excessive temperatures can occur, for example, if driving from a standing start on an extreme gradient (possibly when towing a trailer) or when the vehicle is held stationary on an uphill slope using the accelerator pedal rather that using the brakes.

As a safety precaution, engine torque is reduced when cooling oil temperature exceeds 320°F (160 °C.) If the cooling oil temperature continues to rise, engine torque is gradually reduced, sometimes to idle. When the engine is at idle, the clutches are open and there is no power transmission to the drive wheels.

When the protective function is activated, a DTC is generated and the following text is displayed in the DIS: “You can continue driving to a limited extent.”

Additional information

Data transfer protocols

In later models of the B8 series, the UDS data transfer protocol is used for the TCM, ECM and Airbag Control Module.

Therefore, the previous data blocks and numberings are no longer used. Individual measured data (MVBs) are now available and listed in full text in an alphabetical order. The required MVBs can be specifically selected.

Clearing DTCs

The DTCs of the ECM and TCM are always cleared jointly. If the fault memory of the TCM is cleared, the fault memory of the ECM is also cleared and vice versa.

Towing

It is always recommended that a vehicle with an S tronic transmission only be towed using a flatbed tow truck. Serious damage can occur if this is not observed.

“Limp Home” programs

In addition to protective functions which prevent certain components from overload, limp home programs can also initiated to prevent consequential damage while preserving limited mobility.

In the event of certain pre-defined system malfunctions, the TCM shuts down the sub-gearbox in question and activates the relevant “limp home” program (driving with intact sub-gearbox).

1. Driving with sub-gearbox 1, sub-gearbox 2 shut down:
- Only gears 1, 3, 5, and 7* can be engaged (with interruption in tractive power)
- Backing up is not possible

2. Driving with sub-gearbox 2, sub-gearbox 1 shut down:
- Only gears 2, 4, 6, and R* can be engaged (with interruption in tractive power).

3. Complete transmission shutdown:
- In the case of serious faults, for example, a faulty Powertrain CAN, no identification by the immobilizer, recognition of an incorrect ration in the gear steps or the final drive, the transmission is shut down completely.

*The nature of the fault dictates which gears are still available. To be sure that components do not over-speed, certain gears are disabled depending on fault type. After ensuring that no gear is engaged in the deactivated gearbox, all gears of the intact sub-gearbox are shifted without any further restrictions.

Displays/Warnings

The following warnings are displayed:

Display 1 appears in the event of faults which the driver may not notice because the TCM can utilize a suitable substitute signal.

These faults result in no, or only negligible, loss of performance. The purpose of the warning is to prompt the driver to take the vehicle to an Audi dealer at the next opportunity.

Display 2 appears to indicate protection functions and faults which result in loss of performance.

This can have the following effects:

- Limp home program: “Driving with sub-gearbox 2” is active. For example, gearshifts have interruptions in tractive power (even-numbered gears only)
- Protective function is active, but engine power is reduced because the engine torque reduction function is also active
- No power transmission to the driving wheels after stopping
- The engine can no longer be started

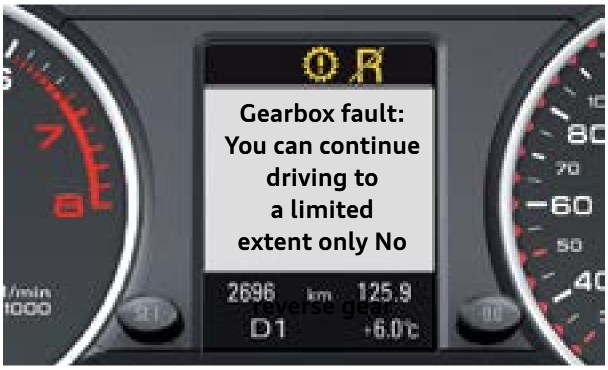
Display 3 appears when the limp home program, “Driving with sub-gearbox 1,” is active because reverse gear cannot be selected at the same time.

Text messages disappear after five seconds, and are displayed again for five seconds at “ignition ON.” Yellow warning symbols are permanently displayed.

Display 1

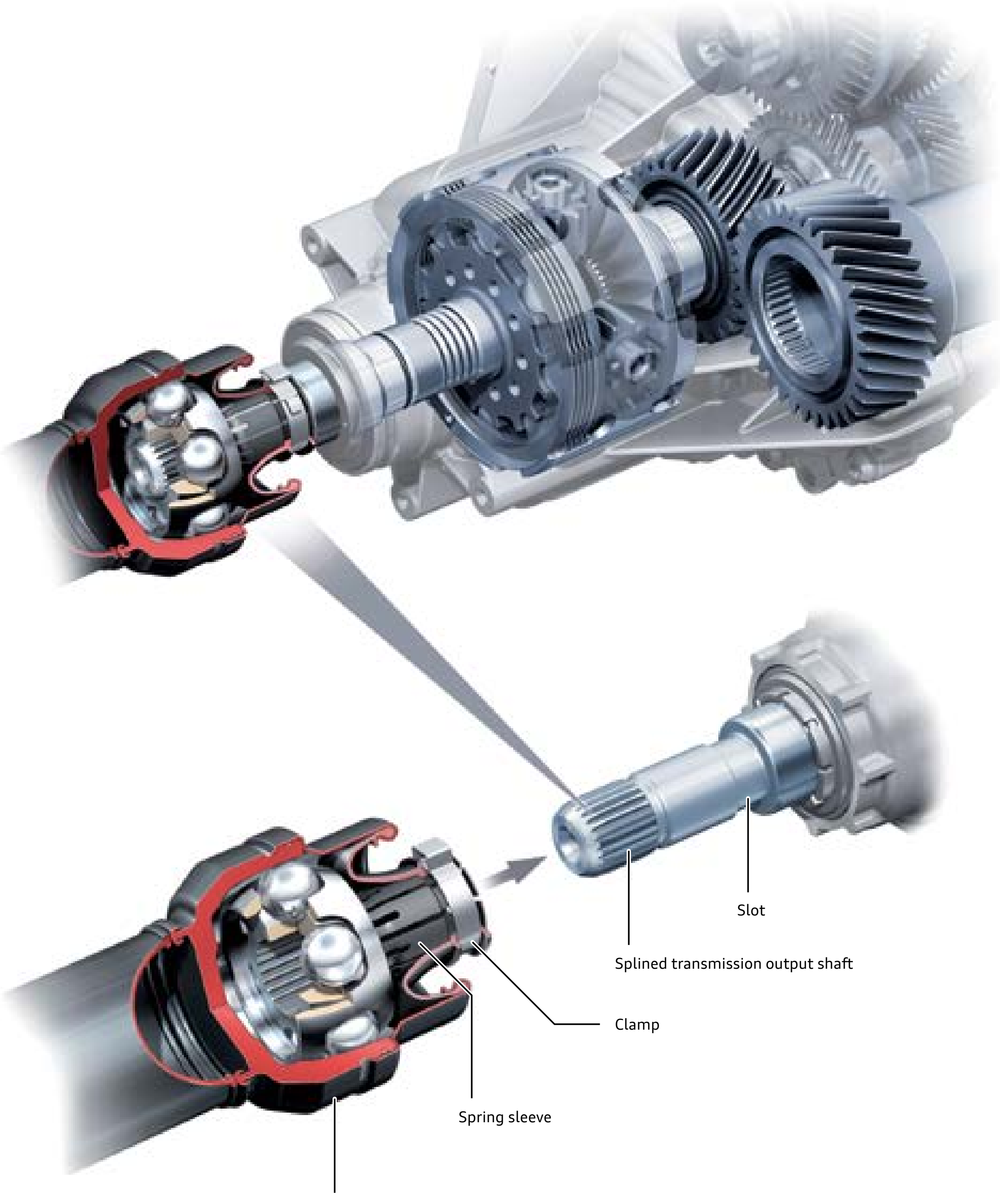
Display 2

Display 3



Splined Prop Shaft

The 0B5 transmission has a splined output shaft. This allows the prop shaft to be installed by sliding it into position rather than being bolted to a flange. The joint is secured by an integral spring sleeve and locking clamp. This system is approximately 1.3 lb (0.6 kg) lighter compared to a flanged type connection and saves time both during production assembly and service repairs.



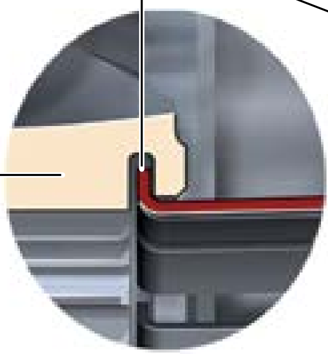
617_012

Note
The joint is an integral component of the propeller shaft and cannot be replaced separately. The rubber boot can be replaced using a special tool.

Design and function

The spring sleeve made of spring steel. On one side of the sleeve are spring elements with locking hooks. The locking hooks hold the sleeve in place in a slot in the joint hub.

On the other side of the spring sleeve, there are angled spring elements. They snap into the slot in the transmission output shaft when installing the prop shaft.

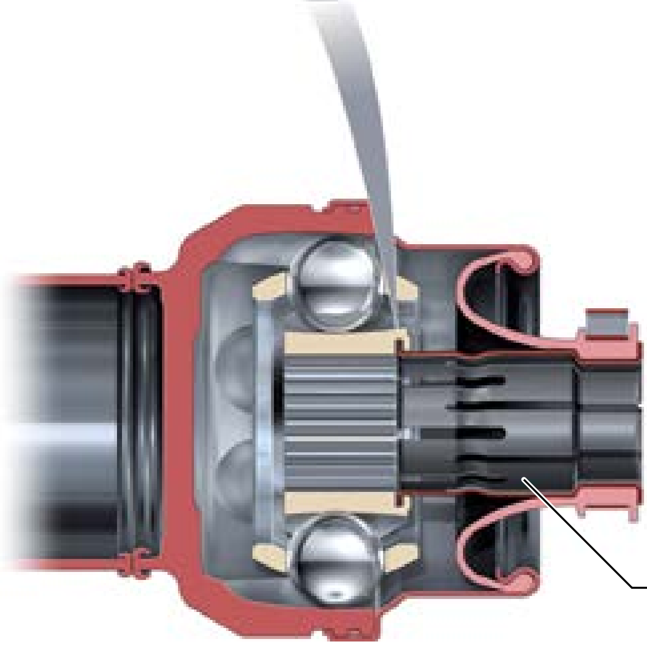


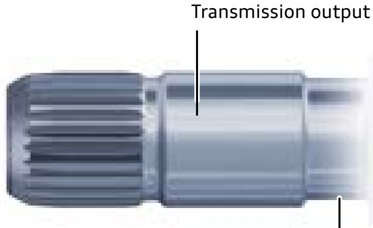
617_013

When the prop shaft is removed, the spring sleeve is held inside the joint hub by the spring force of the spring elements.

To make sure that the spring sleeve does not become detached from the joint hub, special attention must be given to correct positioning during prop shaft installation.

Once the output shaft of the transmission has passed the locking hooks they are fixed in place and cannot slide out of the slot.





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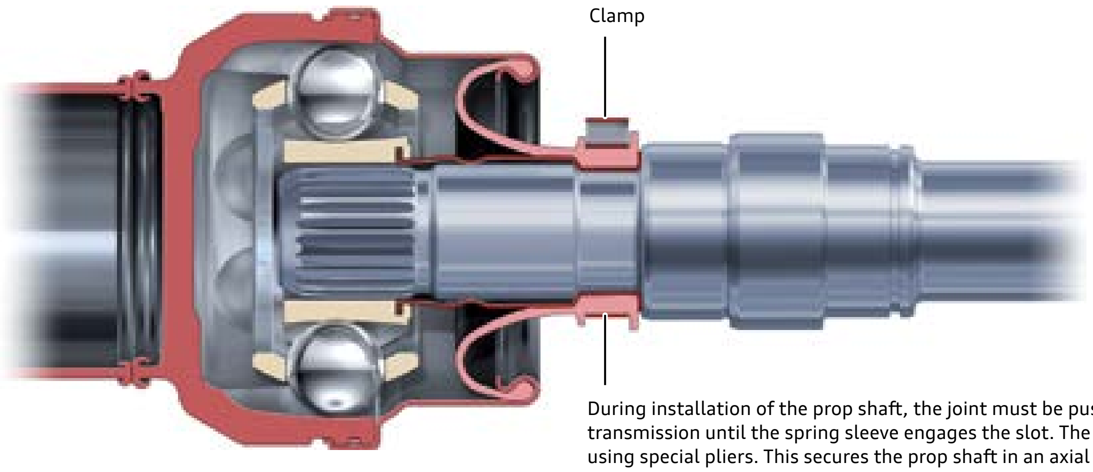


617_015

During installation of the prop shaft, the joint must be pushed onto the output shaft of the transmission until the spring sleeve engages the slot. The spring sleeve is then clamped using special pliers. This secures the prop shaft in an axial direction and also seals the joint.

eMedia

For more information and instructions for assembly of the splined prop shaft, please refer to the Audi Service TV program – “*Audi A8 Power Transmission Part 2*”.

Crown-Gear Differential

Design and function

The crown gear differential is comprised of two crown gears and four cylindrical gears which transmit drive torque and act as differential gears. This configuration closely resembles that of the bevel gear differential used in the final drive of a transmission.

A special feature of this differential is that both crown gears have different reference diameters[1]. This provides the desired asymmetric torque split. The differential gear shafts are mounted in bearings in the differential case.

On the back of both crown gears there is a multi-plate clutch which meshes with the corresponding crown gear. The inner plates of both multi-plate clutches engage the crown gears while the outer plates engage the differential casing.

Threaded rings act as the counter-bearings of the multi-plate clutches and close the crown-gear limited slip differential.

The transmission output torque is transferred to the differential case. Four shafts transmit the torque to the differential gears, which in turn transmit torque to both crown gears; one sends the torque to the front axle and the other to the rear axle. The displacement forces in the gearing travel through the crown gears to produce an axial force which acts on the multi-plate clutches. The multi-plate clutches produce the desired lock-up effect in the differential.

Background

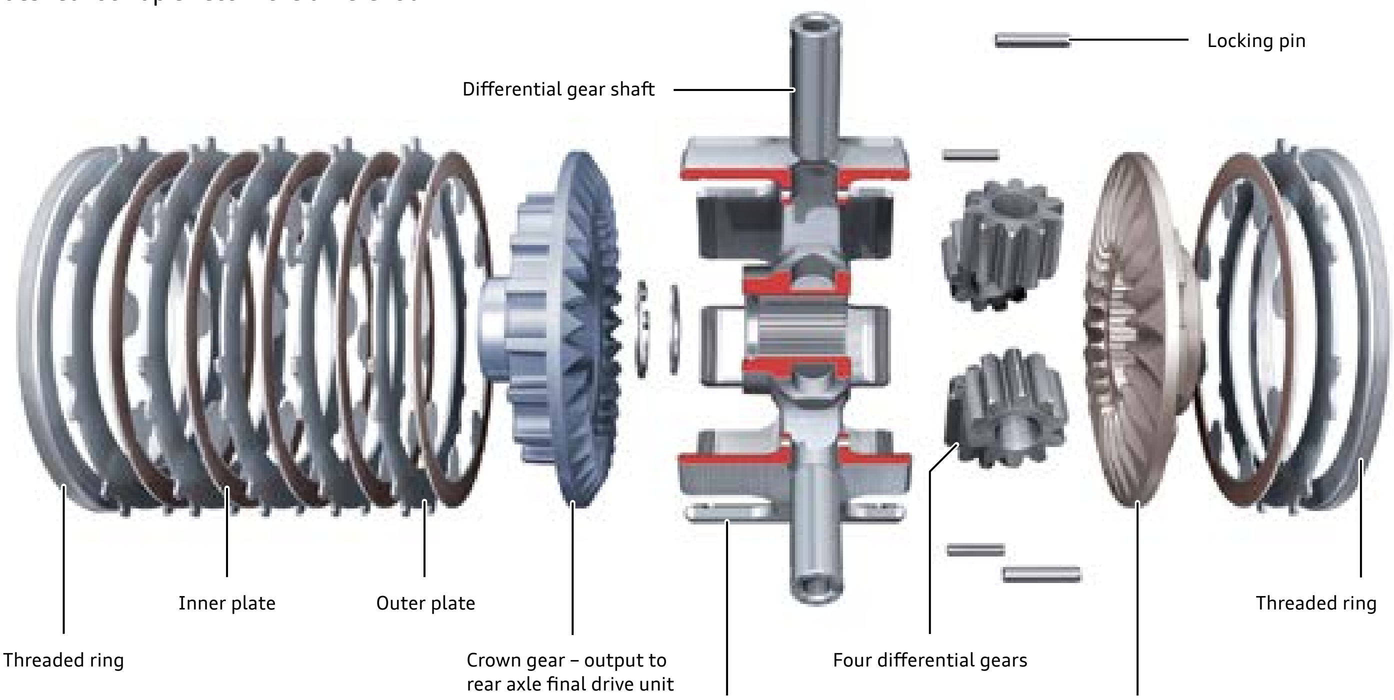
To understand the power distribution scheme of the crown-gear limited slip differential, one must think about two effects – **basic torque split** and **dynamic torque split**. When driving, the dynamic torque split is always superimposed on the basic torque split.

The crown-gear differential is designed in such a way that different amounts of drive power are transmitted to the differential outputs (front axle and rear axle). This is referred to as an "asymmetric torque split".

An asymmetric limited slip center differential is defined by four operating states:

- Maximum distribution to the front axle under throttle
- Maximum distribution to the front axle during over-run
- Maximum distribution to the rear axle under throttle
- Maximum distribution to the rear axle during over-run

In each of the four operating states, the differential displays a different lock-up effect. The torque split of each operating state is defined during the design stage to provide the desired handling characteristics under throttle application and during over-run



617_006

[1] The term "reference diameter" is used to describe the effective working diameter of a gear.

Note

The differential manufacturer uses threaded rings to eliminate clutch backlash and set a defined amount of clutch torque. The threaded rings are secured by spot welds to prevent twisting and cannot be detached. The sheet-metal housing is also welded, which means that non-destructive separation of the crown gear is not possible.

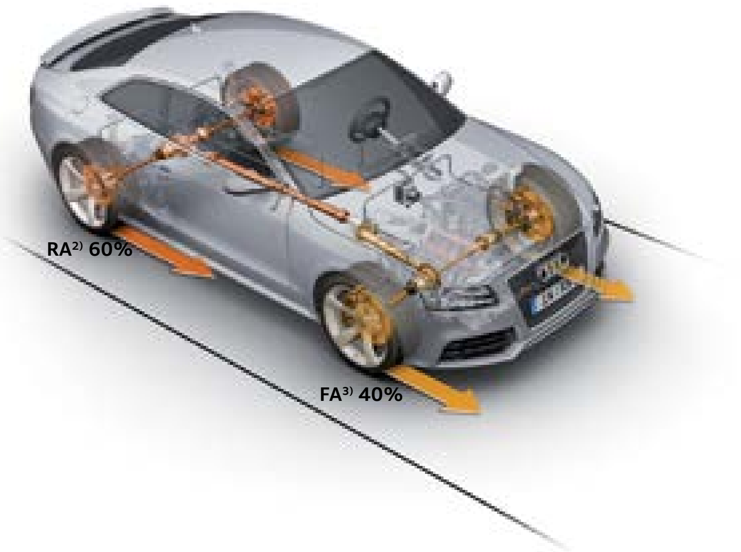
Asymmetric basic torque split

The different reference diameters of the crown gears result in an asymmetric torque split. The number of teeth ratio is approximately 40 : 60, resulting in an asymmetric torque split of approximately 40 : 60 in favor of the rear axle. We refer to this torque split, which is defined by the geometry of the components, as the "asymmetric basic torque split".

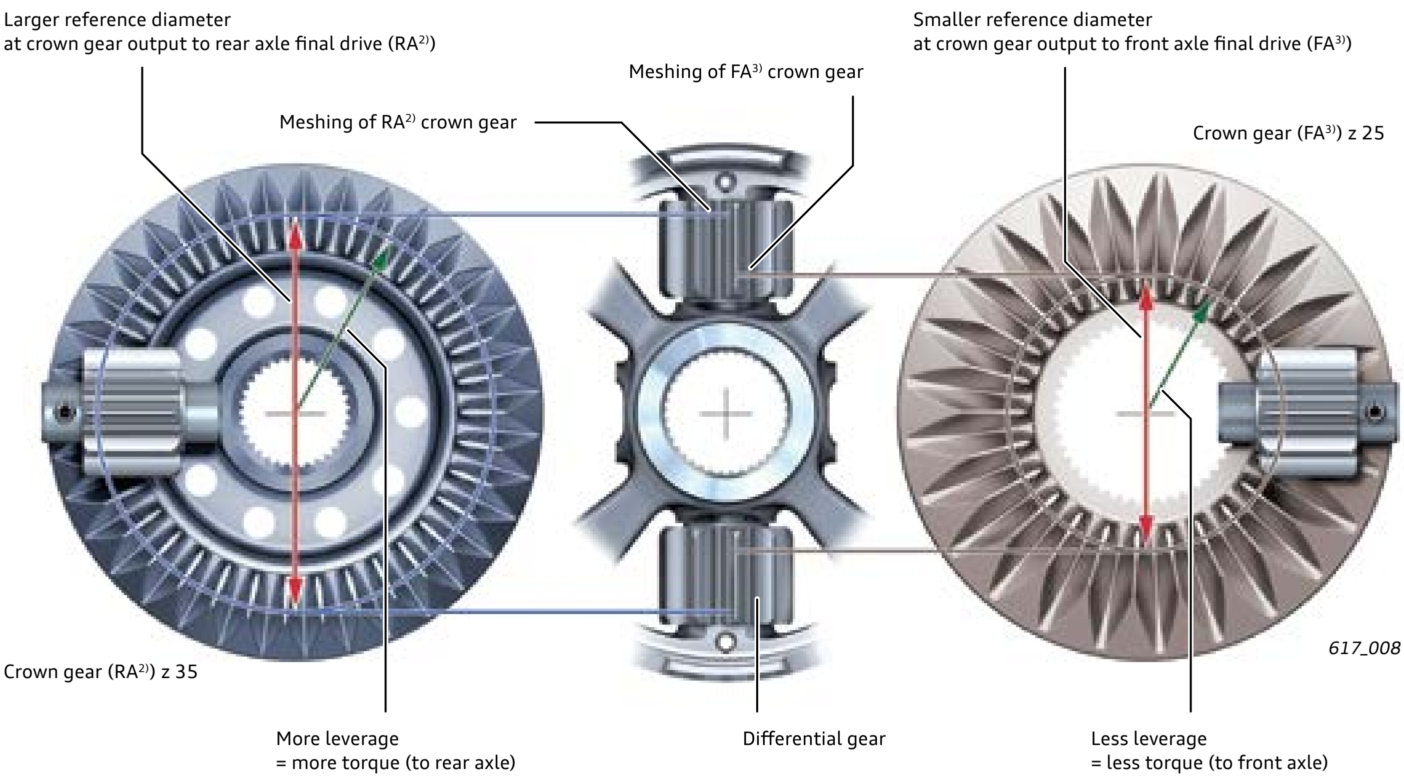
The different reference diameters result in different leverages; input torque is transmitted with a ratio of approximately 60 : 40.

This means that approximately 40% of total drive torque is sent to the front differential and approximately 60% to the rear differential.

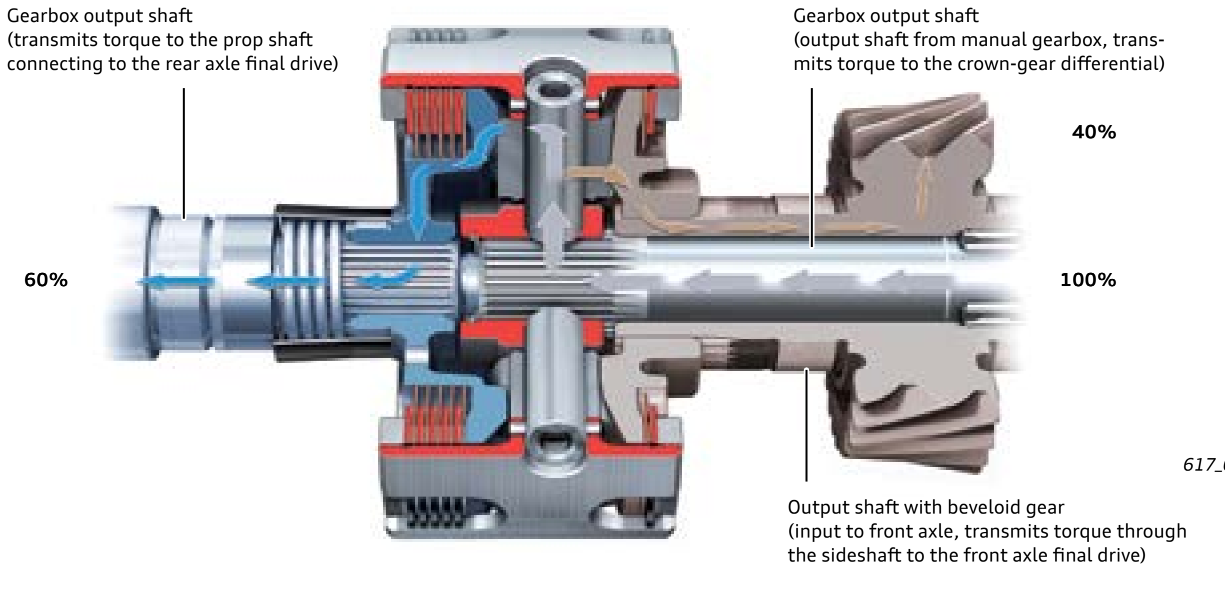
The basic torque split is, in principle, effective in all operating states and is superimposed by the dynamic torque split. Together, they result in the asymmetric-dynamic torque split.



617_007



617_008



617_009

[2] Rear axle
[3] Front axle

Asymmetric-dynamic torque split

In addition to the asymmetric basic torque split of approximately 40 : 60, a locking torque proportional to the drive torque is produced in the differential. This locking torque plus the basic torque split gives the possible torque distribution to both axles.

Thus, the crown-gear differential locks up before any changes in traction between axles take effect. If an axle loses traction, drive torque is immediately diverted to the other axle within the allowable lock-up range and according to how much traction the wheels have. If the working range is exceeded, ESC intervention provides additional torque and, therefore, forward thrust.

Function

As soon as torque is input into the crown-gear differential, an axial force occurs between the differential gears and the crown gears due to the tooth shape and the design of the differential. The tooth geometry gives rise to axial forces of differing magnitude at both crown gears.

Both crown gears are thrust in an axial direction and close the clutch plates. Depending on the axial force, this produces a clutch torque which positively connects the crown gears with the differential case.

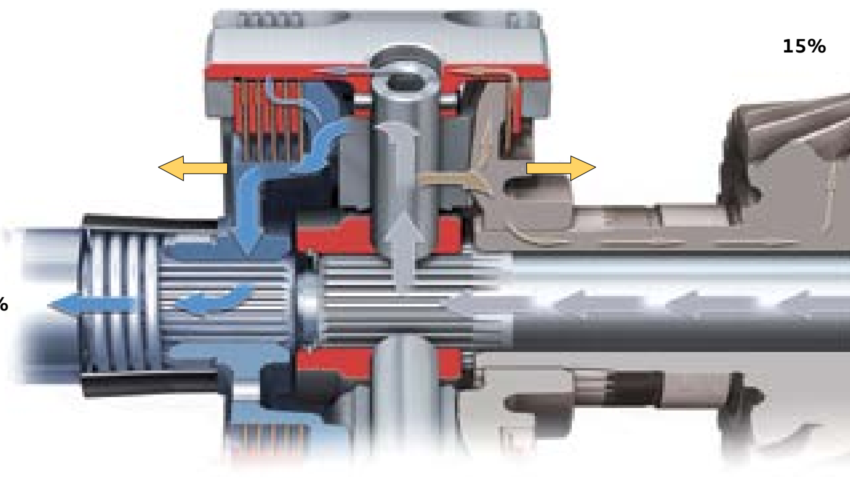
This means that the clutch plate assembly is preloaded depending on the drive torque, and produces a corresponding lock-up effect. The lock-up effect is defined by the lock-up value. The lock-up value describes the output torque differential at both outputs resulting from the lock-up effect of the differential.

15 : 85 torque split

If the front axle loses traction without yet exceeding the traction limit, the rear axle can transmit up to 85% of drive torque.

If the traction limit is exceeded, more slip occurs at the wheels on the front axle.

When wheel slip exceeds a defined level, the ESC intervenes and provides additional torque. The additional torque, basic torque split and lock-up effect produce a corresponding drive torque at the rear axle.



617_010

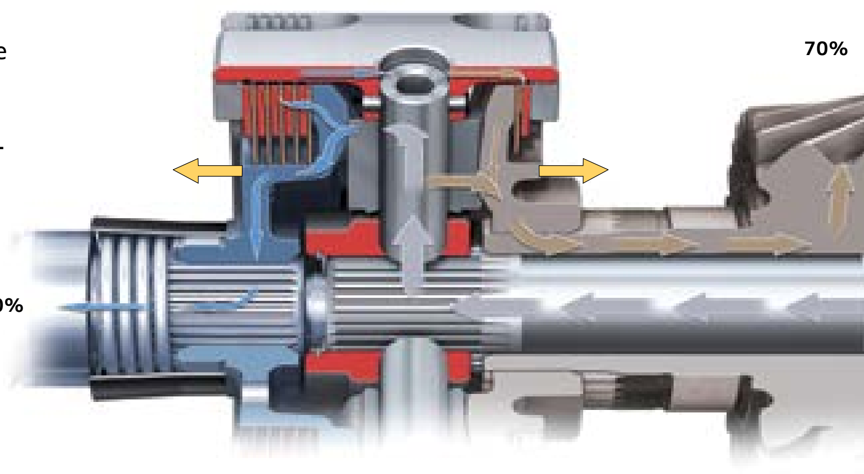
Axial forces

70 : 30 torque split

If the rear axle loses traction without yet exceeding the traction limit, the front axle can transmit up to 70% of drive torque.

If the traction limit is exceeded, more slip occurs at the wheels on the rear axle.

When wheel slip exceeds a defined level, the ESC intervenes and provides additional torque. The additional torque, basic torque split and lock-up effect produce a corresponding drive torque at the front axle.



617_011

Operational notes

The crown-gear limited slip differential operates fully independently, is maintenance-free and requires no input on the part of the driver.

In conjunction with torque vectoring, the quattro drive offers drivers a high standard of driving dynamics, safety and comfort. Nevertheless, there are a few points to note regarding the quattro powertrain.

- The crown-gear limited slip differential cannot be compared to a 100% mechanical differential lock. If an axle or a wheel begins to spin, no drive will be available until the ESC has produced additional torque by brake intervention (EDL intervention). ESL does not intervene until it detects a defined engine speed differential and a corresponding engine torque. The driver must apply throttle selectively until ESC produces additional torque by brake intervention. The additional torque results in a drive torque at the tractive wheels. The crown-gear differential assists torque distribution in the way described above. To prevent the brake from overheating during heavy and prolonged ESL intervention, the EDL function is deactivated when the brake disc temperature exceeds a value computed by the ABS/ESP Control Module. As soon as the brake has cooled down, the EDL function engages automatically.

- Continuous synchronization of high differential rotation speeds between the front and rear axles coupled with high engine load is harmful to the crown-gear differential.

- In the case of the Audi RS 5, snow chains may only be used on certain rim-tire combinations and only on the front axle. Please note the guidelines and specifications in the Owner's Manual.

- If the prop shaft has been removed, there is no or only minimal drive because sufficient additional torque cannot be developed in the center differential.

- A performance test can/may only be performed on a four-wheel roller dynamometer.

- A brake test can be safely performed on a low-speed test bench (maximum 3.7 mph [6 km/h]). Drive must be provided by the dynamometer.

- The vehicle must not be towed with the front or rear axle of the ground. (refer to Owner's Manual).

Torque Vectoring

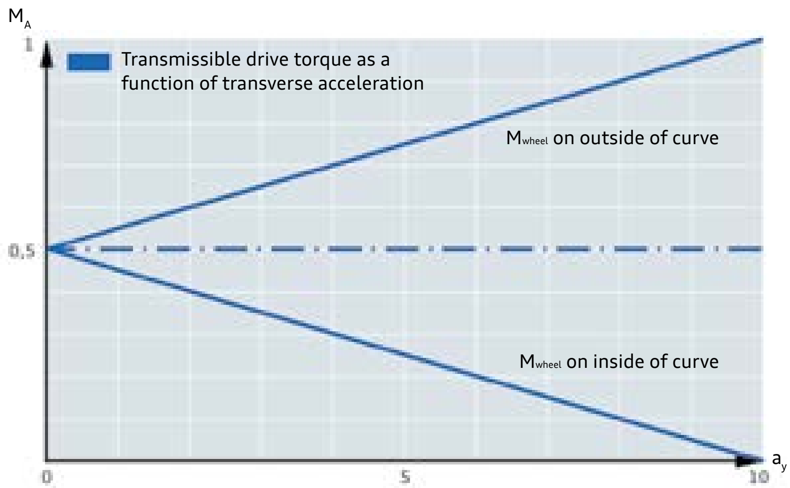
Introduction

Torque vectoring is a software function of the ABS/ESP Control Module that improves traction when cornering.

It evolved from the EDL function first used on front wheel drive models In the case of the quattro drive train, torque vectoring allows torque controlling brake intervention at all four wheels.

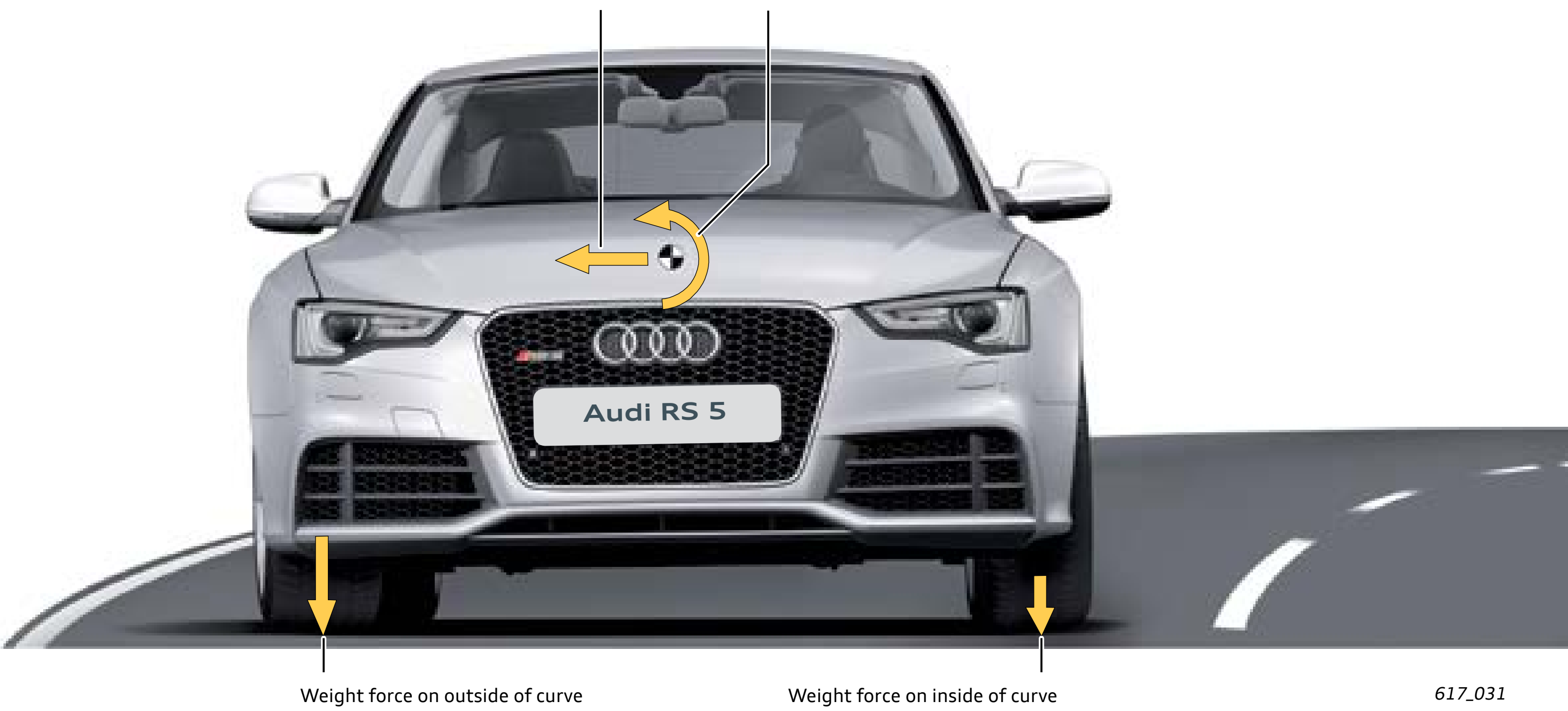
Background

The principles of driving dynamics dictate that the maximum drive torque $\mathbf{M_A}$ transmissible to the wheels on the outside of the curve increases with increasing transverse acceleration $\mathbf{a_y}$, while the maximum drive torque transmissible to the wheels on the inside of the curve decreases by the same amount. The adjacent diagram illustrates this behavior.



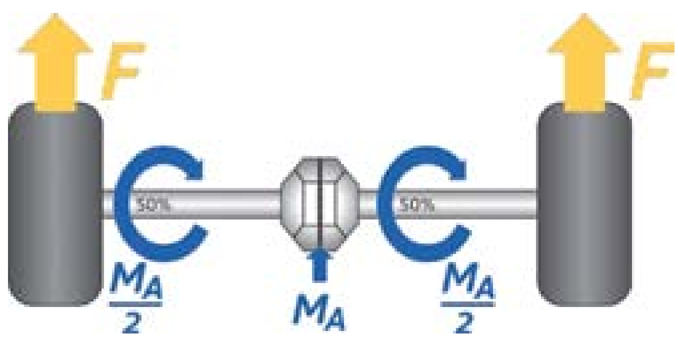
617_029

This is caused by the effect of centrifugal force, which acts at the vehicle's center of gravity with its line of action running towards the outside of the curve. This produces what is known as roll torque, which is stabilized by the wheels. This roll torque reduces the load on the inside wheels and increases the load on the outside wheels. This means that the wheels on the inside of the curve cannot transmit as much torque as the wheels on the outside of the curve.



617_031

The open axle differentials always distribute drive torque to both wheels of an axle at a ratio of approximately 1 : 1 (refer to illustration 617_033). If the maximum drive torque transmissible to the wheel on the inside of the curve decreases while cornering, only the same amount of torque is transmissible to the wheel on the outside of the curve even if the higher effective load on this wheel would allow a much higher drive torque. The wheel on the inside of the curve dictates how much drive torque is transmissible. If loss of drive torque occurs at the wheel on the inside of the curve, the flow of drive torque through the driveline will be interrupted.



617_033

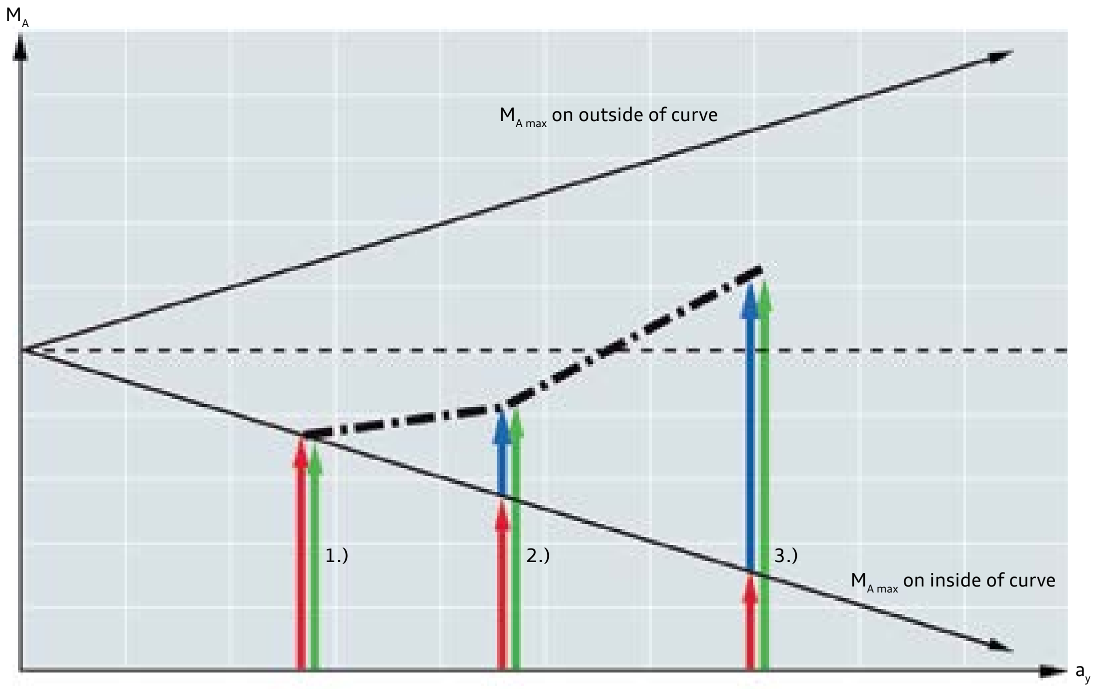
Working principle and function

Additional torque is developed by controlled braking of the wheels on the inside of the curve. In this way, additional drive torque is transferred to the wheels on the outside.

The system reacts to changes in wheel load, and not to wheel slip. It is active during cornering and intervenes **before** a state of critical slip occurs at the wheels. The system calculates the reduction in load on the wheels on the inside of the curve, and the increase in load on the wheels on the outside of the curve while cornering. This calculation is based mainly on the measured data generated by the steering angle and transverse acceleration sensors.

From this, the ABS/ESP Control Module determines the braking pressure required for the wheels on the inside of the curve. The required braking pressure is relatively low at approximately 72.5 - 217.5 psi (5 - 15 bar) minimizing brake load.

Torque vectoring provides a high level of driving dynamics while at the same time minimizing system complexity.



617_032

- Red: Drive torque on inside of curve
- Green: Drive torque on outside of curve
- Blue: Braking torque

M_A	Drive torque
$M_{A\,max}$	Max. transmissible drive torque
a_y	Transverse acceleration

1. Cornering without braking intervention

As the amount of transmissible drive torque is dependent on the wheels on the inside of the curve, the amount of torque transmissible to the wheels on the outside of the curve cannot exceed this value.

2. and 3. Cornering with braking intervention

Braking torque is developed at the wheels under reduced load on the inside of the curve by active braking intervention. This braking torque acts as an additional torque and thus increases the total torque transmitted to the wheels on the inside of the curve, because more drive torque is needed in order to overcome the braking torque.

It follows that higher drive torque can also be applied to the wheels on the outside of the curve. This torque is equal in magnitude to the total torque transmitted to the wheels on the inside of the curve.

Straight-line driving

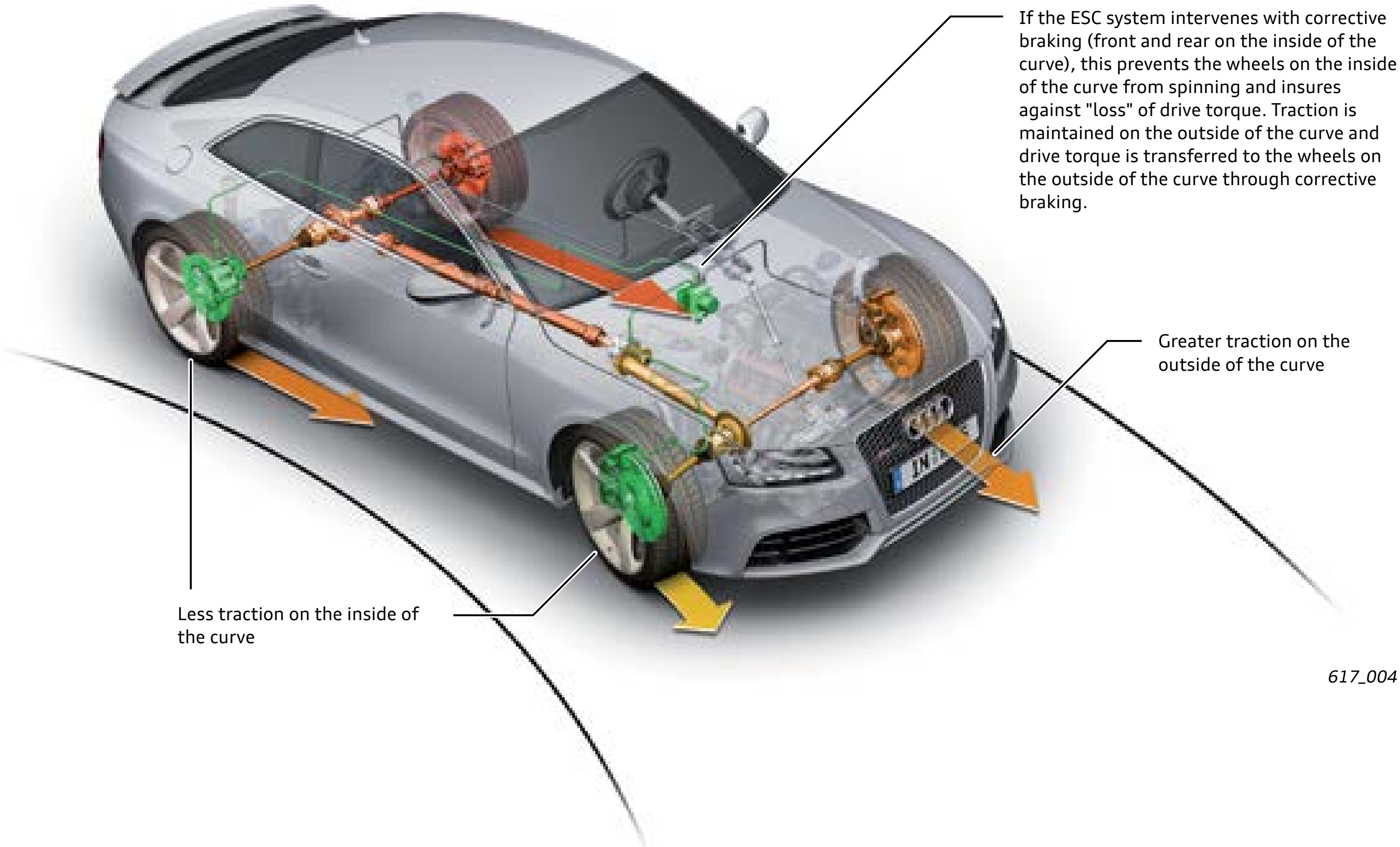
Wheel load and drive torque are evenly distributed on both sides.

617_007

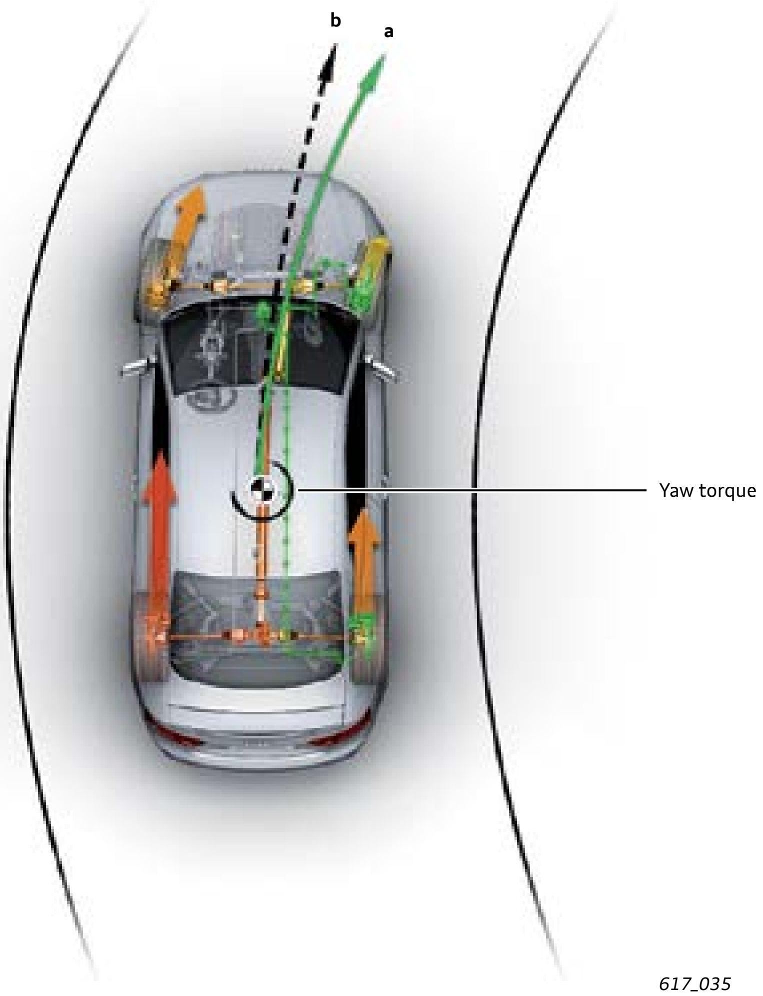
617_034

Cornering under load

The wheel load shifts towards the outside of the curve due to the action of centrifugal force.



617_004



617_035

The higher drive torque on the outside wheels results in additional torque about the vehicle's vertical axis (yaw torque). This yaw torque has the effect of steering the vehicle into the curve. The vehicle achieves higher cornering speeds and is provided with precise, agile and more pin-point handling (driving dynamics). The result is a noticeable improvement in driving dynamics.

a) If the system intervenes with corrective action, the vehicle travels the curve radius with less steering lock than would be the case without corrective intervention.

b) If no corrective action is taken by the system, the vehicle travels the curve radius under the same conditions and at the same steering angle as in a). This means that more steering lock would have to be applied to negotiate the corner at the same speed. A condition is that this is physically possible within the given constraints.

Note

Torque vectoring is always engaged if required and cannot be deactivated by the driver.

Torque vectoring is not activated on road surfaces with very low coefficients of friction.

In the case of vehicles with rear axle final drive unit 0BC (the standard final drive) torque vectoring is engaged on the front and rear axles. In the case of vehicles with rear axle final drive unit 0BF (sport differential), torque vectoring is engaged on the front axle only.

Knowledge Assessment

An On-Line Knowledge Assessment (exam) is Available for this eSelf-Study Program.

The Knowledge Assessment is required for Certification.

You can find this Knowledge Assessment at:
www.accessaudi.com

From the accessaudi.com Homepage:

- Click on the "ACADEMY" tab
- Click on the "Academy site" link
- Click on the Course Catalog Search and select "950143 - The Audi 0B5 7-speed S-tronic transmission"

Please submit any questions or inquiries via the Academy CRC Online Support Form which is located under the "Support" tab or the "Contact Us" tab of the Academy CRC.

Thank you for reading this eSelf-Study Program and taking the assessment.

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