

Audi A8 '10 Power Transmission

Eight-speed Automatic Gearboxes OBK and OBL
Rear Axle Drives OBF and OBE – Sport Differential

The world of Audi gearboxes

With the innovative new developments in the field of power transmission, such as the multitronic gearbox and the dual-clutch gearbox, Volkswagen and Audi have radically revised the requirements profile for modern multistep automatic gearboxes.

In addition to better fuel economy, now a major issue in view of the ongoing debate on CO₂ emissions, both dynamics and responsiveness top the list of requirements for sporty premium vehicles. These demands have already been satisfied with the launch of the second-generation six-speed automatic gearboxes by ZF Getriebe GmbH (refer to Self-Study Programme 385 covering the OB6 gearbox).

Vibration damping has been improved with the help of new torque converters, giving better fuel economy and a more direct driving feel. Thanks to neutral idle control, which reduces torque input when the vehicle is stationary with the foot brake applied, and a marked reduction in shift and reaction times, the user-friendly automatic torque converters have evolved into modern, highly efficient sport gearboxes.

"When developing the new automatic gearbox we did not focus on the number of gears, but on markedly improved fuel economy and enhanced performance."

Dr. Michael Paul,

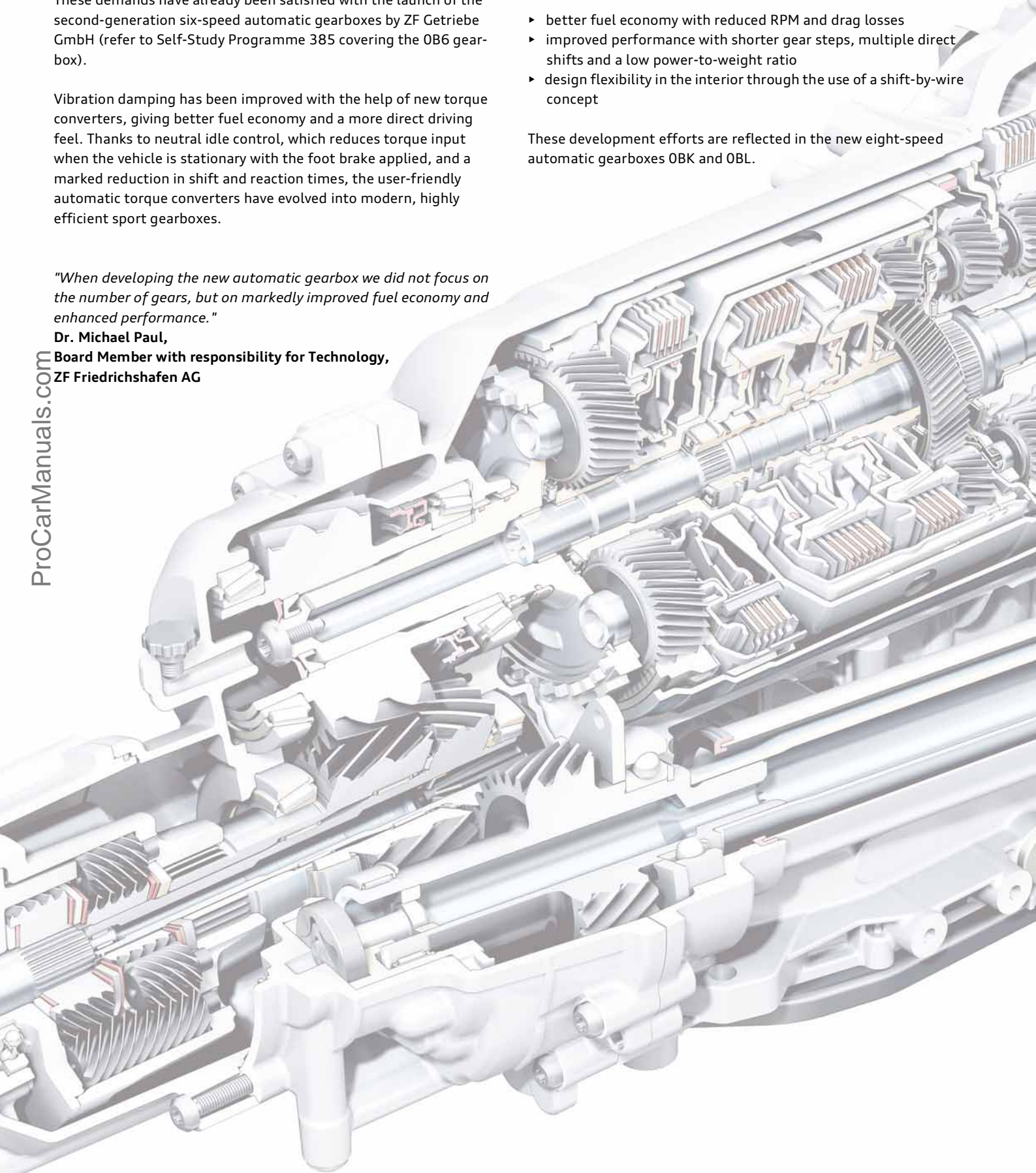
**Board Member with responsibility for Technology,
ZF Friedrichshafen AG**

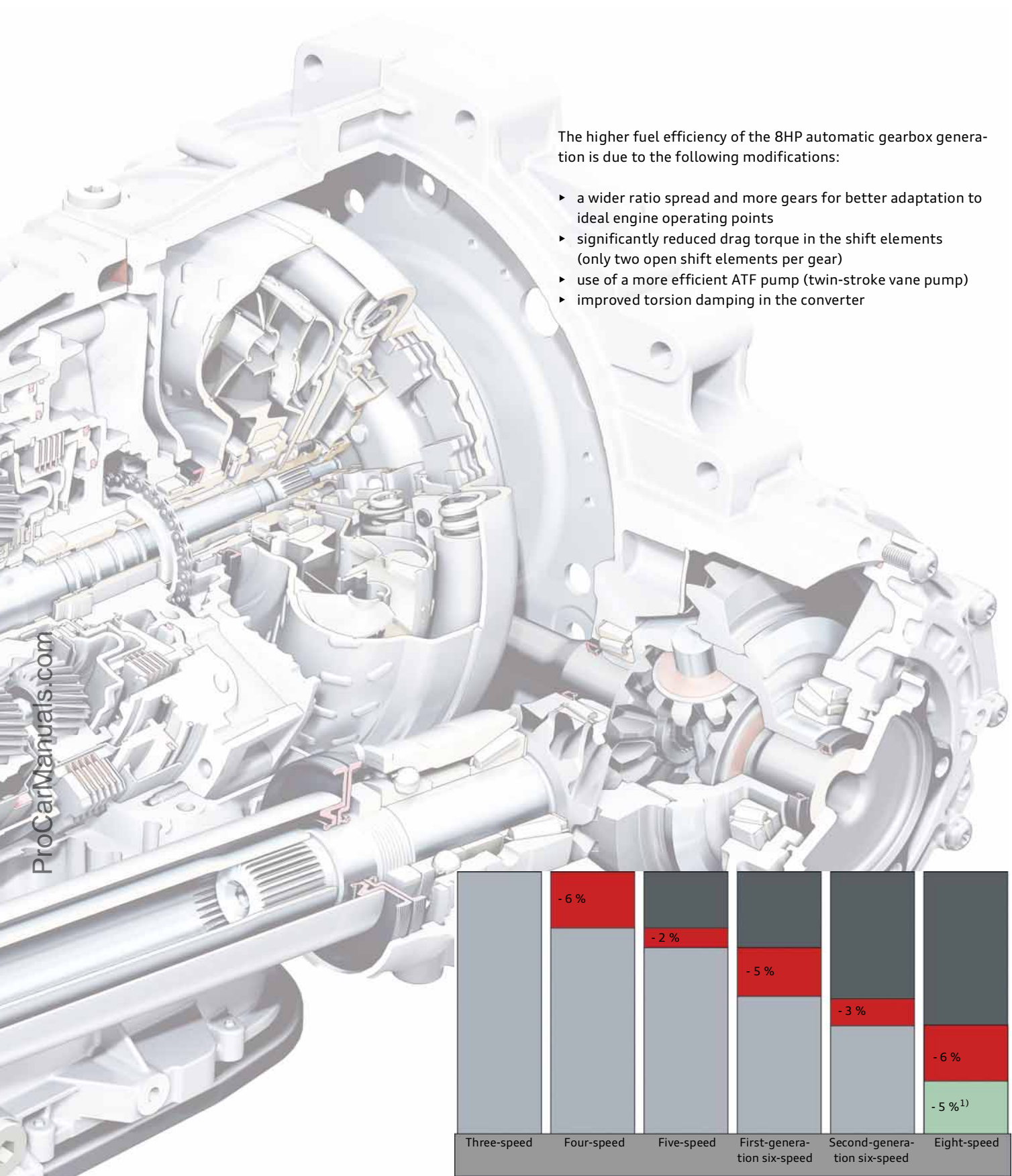
A detailed system analysis carried out by ZF Getriebe GmbH has shown that the ever-growing list of customer wishes can no longer be satisfied by further enhancement of the existing six-speed automatic gearboxes. For this reason, a gearbox series based on an entirely new gearbox concept has been developed for the new Audi A8 '10 in collaboration with ZF Getriebe GmbH.

The main focus of development was on:

- ▶ better fuel economy with reduced RPM and drag losses
- ▶ improved performance with shorter gear steps, multiple direct shifts and a low power-to-weight ratio
- ▶ design flexibility in the interior through the use of a shift-by-wire concept

These development efforts are reflected in the new eight-speed automatic gearboxes OBK and OBL.

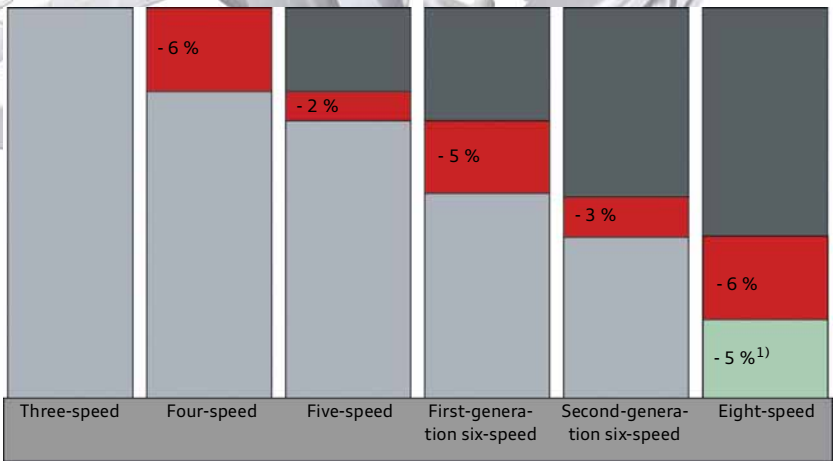




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The higher fuel efficiency of the 8HP automatic gearbox generation is due to the following modifications:

- ▶ a wider ratio spread and more gears for better adaptation to ideal engine operating points
- ▶ significantly reduced drag torque in the shift elements (only two open shift elements per gear)
- ▶ use of a more efficient ATF pump (twin-stroke vane pump)
- ▶ improved torsion damping in the converter



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Improving the fuel efficiency of ZF automatic gearboxes

457_007

Another potentially effective way of improving fuel efficiency is to eliminate idling fuel consumption in the internal combustion engine while the vehicle is at a standstill. This has a very positive impact in city traffic.

To exploit this potential, the 3.0 V6 TDI uses the start-stop function in combination with an automatic gearbox for the first time. Other applications are currently being developed.

¹⁾ Potential fuel savings in start-stop mode as determined in NEDC simulations (New European Driving Cycle)

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Eight-speed automatic gearboxes 0BK and 0BL belong to the category of conventional multistep torque converter automatic gearboxes. They have many design and functional features in common with the six-speed automatic gearboxes described in Self-Study Programmes 283, 284 and 385.

These SSPs represent, as it were, the basis for SSP 457. Hence where the technology is identical, reference is made to SSPs 283, 284 and 385. It is, therefore, advisable to have all three booklets ready to hand.

► The Self-Study Programme teaches the basics of the design and function of new models, automotive components or technologies.

It is not a Repair Manual. Figures given are for guidance purposes only and refer to the software version valid at the time of preparation of the SSP.

For further information about maintenance and repair work, always refer to the current technical literature.



Note



Reference

Power transmission in the Audi A8 '10

New features at a glance

The drive concept with set-back engine-gearbox layout was previously implemented in the Audi A8 '03. The Audi A8 '03 therefore pioneered the concept of setting forward the centre of the front axle, later improved in the B8 series. This new engine-gearbox layout is now also the basis for the Audi A8 '10.

The new eight-speed automatic gearboxes are without doubt one of the highlights. They take the Audi A8 '10 into a new dimension in driving dynamics, comfort and efficiency.

In conjunction with the latest generation of the quattro all-wheel drive system, these gearboxes provide a maximum in driving dynamics. The Audi A8 '10 will be available exclusively with quattro drive at market launch and later.

To include a model optimised for fuel economy in this vehicle class, a version with front-wheel drive is planned.



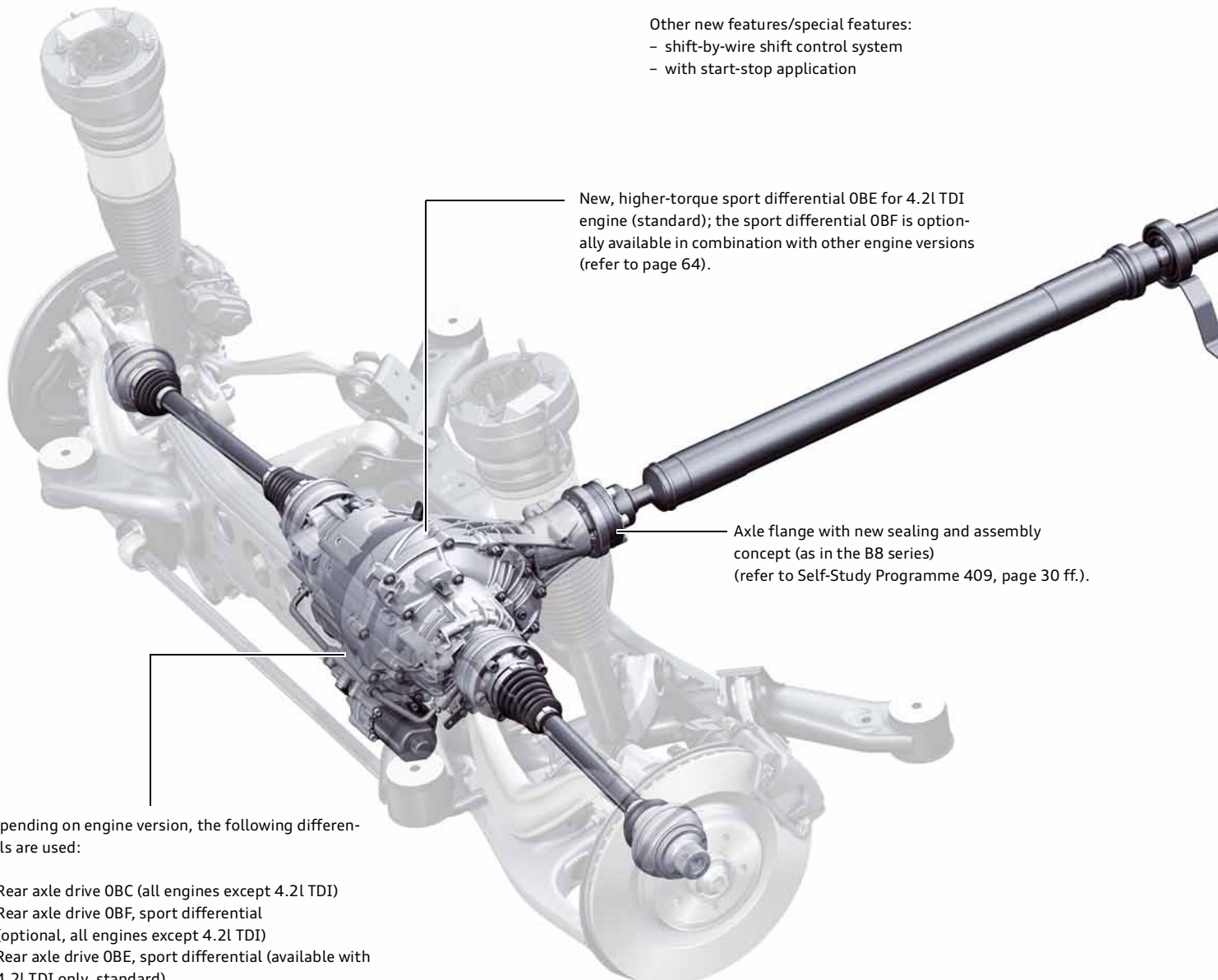
Two newly developed automatic gearboxes:

Eight-speed automatic gearbox OBK for all engine versions except 4.2l TDI

Eight-speed automatic gearbox OBL (for 4.2l TDI only) – exclusively available with quattro drive

Other new features/special features:

- shift-by-wire shift control system
- with start-stop application

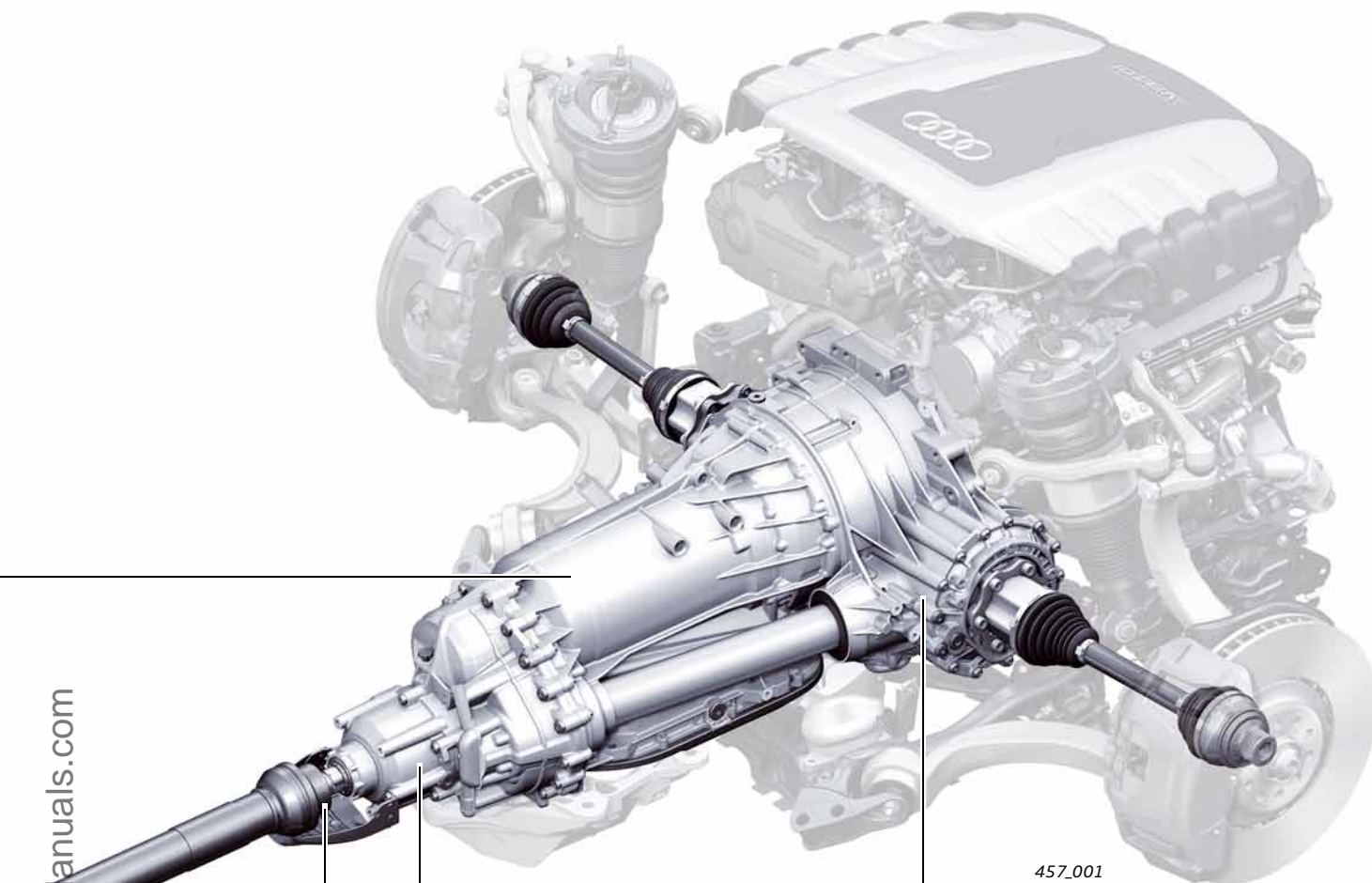


New, higher-torque sport differential OBE for 4.2l TDI engine (standard); the sport differential OBF is optionally available in combination with other engine versions (refer to page 64).

Axle flange with new sealing and assembly concept (as in the B8 series) (refer to Self-Study Programme 409, page 30 ff.).

Depending on engine version, the following differentials are used:

- Rear axle drive OBC (all engines except 4.2l TDI)
- Rear axle drive OBF, sport differential (optional, all engines except 4.2l TDI)
- Rear axle drive OBE, sport differential (available with 4.2l TDI only, standard)



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Set-forward axle gear (as in the B8 series)
(refer to Self-Study Programmes 392 and 409)

quattro with asymmetrical/dynamic torque split and intelligent torque distribution

For information about the intelligent torque distribution system (refer to page 66).

Splined prop shaft - weight has been significantly reduced by eliminating the screw flange coupling (refer to page 23)



Reference

The drive concept of the Audi A8 '10 is identical to that of the B8 series (Audi A4/A5) in several respects. A large amount of information, to which reference is made in this booklet, has been previously published in Self-Study Programmes 392 and 409.

Other special features of the power transmission system in the Audi A5 were presented in the Audi iTV broadcast of 04.07.2007. The information relating to the axle configuration equally applies to the Audi A8 '10 and represents a basic knowledge of this subject.

shift-by-wire shift control system

Introduction

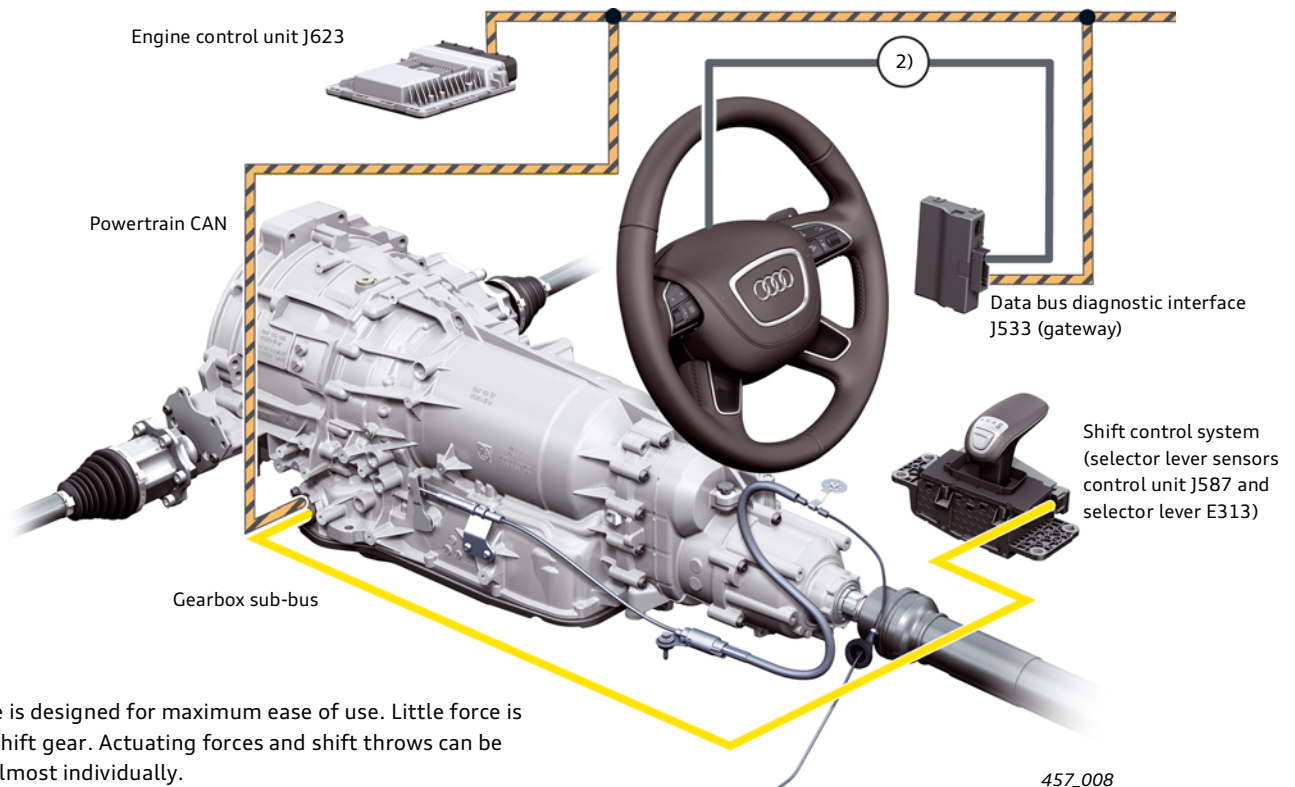
An innovative feature is the new operating and gearshift actuation concept called shift-by-wire. It is basically an electrical selector control system and has been fully implemented in the Audi A8 '10 for the first time to provide what could be called "full" shift-by-wire. This means that:

- ▶ there is no mechanical connection between the selector lever and the gearbox
- ▶ the system works by processing driver inputs and does not have a mechanical fallback level
- ▶ the parking lock is electro-hydraulically actuated; a mechanical emergency release device allows the parking lock to be released in the event of a fault so that the vehicle can be moved (refer to page 18)

Advantages of the "full" shift-by-wire concept

- ▶ new scope for configuring the shift control system, e.g. design, size, positioning in vehicle and operating concept
- ▶ scope for new comfort and safety functions, e.g. automatic parking lock engagement
- ▶ simplified assembly of the shift control system and gearbox, no setting work required
- ▶ improved acoustics in the vehicle interior by separation of the shift control system and gearbox¹⁾

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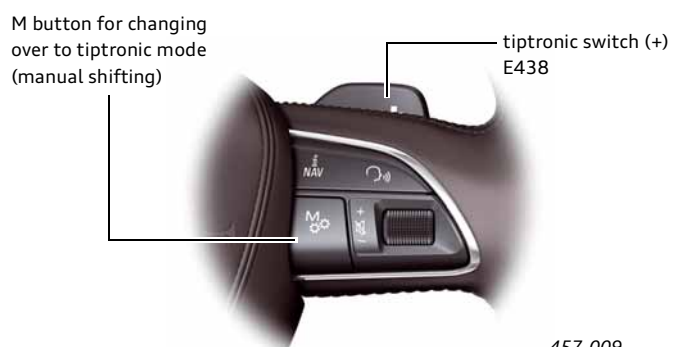
Shift-by-wire is designed for maximum ease of use. Little force is required to shift gear. Actuating forces and shift throws can be configured almost individually.

¹⁾A shift cable, which usually interconnects the gearbox and the shift control mechanism, transmits sound waves into the vehicle interior. Sound waves can also pass through the shift cable bushing and into the body relatively easily. The sound-insulating measures are in part highly complex and their effectiveness depends on stree-free installation of the shift cable.

²⁾Signal characteristic:
M button and tiptronic switch E438/439 > Multifunction steering wheel control unit J443 > by LIN bus > Steering column electronics control unit J527 > by convenience CAN > Data bus diagnostic interface J533 > by powertrain CAN > Gearbox control unit J217

tiptronic function

The tiptronic gate is no longer required. The driver can change to tiptronic mode and back to Auto mode using the M button in the right steering wheel spoke. Otherwise, the tiptronic function is as previously described (tiptronic in D or S). The system also changes over from tiptronic mode to Auto mode when the selector lever is moved back. Gearshifts can only be performed using the paddles on the steering wheel.



Features of the shift control system

The new design and operating concept of the shift control system are an innovation. The overview shows you the components, special features and innovations in summary form.

Integrated selector lever position indicator unit (gear) Y26.

It indicates the currently selected gear (not the selector lever position).

Selector lever release button E681 (electrical switch), replaces the previously known mechanical locking and release mechanism used for shifting in and out of certain gears.

Intuitive operating logic, selector returns automatically to centre position.

Short throw shifting for maximum ease of use (max. travel 23 mm).

Selector lever travel is dependent on the current gear, maximum 3 positions forwards and 3 back (refer to page 11).

12-way plug-in connector from selector lever control unit to gear knob

Selector gate cover/masking panel, with flexible mounting for self-centring with respect to the console

Shift mechanism with locking device and 5 locking solenoids. Movement of the selector lever (forwards or back) is limited according to gear by means of multiple locking solenoids in lieu of a shift gate. In addition, shift-locking is implemented in the P and N positions by means of locking solenoids (refer to page 11).

Conductor strip

Ergonomic selector lever in "yacht lever design" with various applications in leather or wood.

The "yacht lever" serves as a comfortable handrest and makes the MMI input unit easier to operate (in the Audi A8 '10 the MMI is located in front of the shift controls).

Shift control without tiptronic selector gate, tiptronic mode can be selected using the M button in the right steering wheel spoke (refer to page 8).

Separate control unit with integrated sensors for selector lever movement and position recognition.

The system communicates with the gearbox control unit via the local CAN bus (refer to page 13).

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Easy assembly of the shift control by means of centring pins on the housing.

If the shift control does not fit despite centring, the centring pins can be cut off and the shift control aligned within the hole clearance.

Operating concept

The shift-by-wire shift control of the Audi A8 '10 is not only a visually striking feature, but is also an innovation in terms of its operation and function.

The shift-by-wire concept has made possible a new shift control design. Another new aspect is that the selector lever does not, as previously, follow a shift gate depending on what gear is selected, but always returns to its original position (normal position) in much the same way as a joystick.

This means that the selector lever position and the gear or function mode do not match up like before.

For example: the gearbox is in the "Park" position (P), but the selector lever is in its normal position.

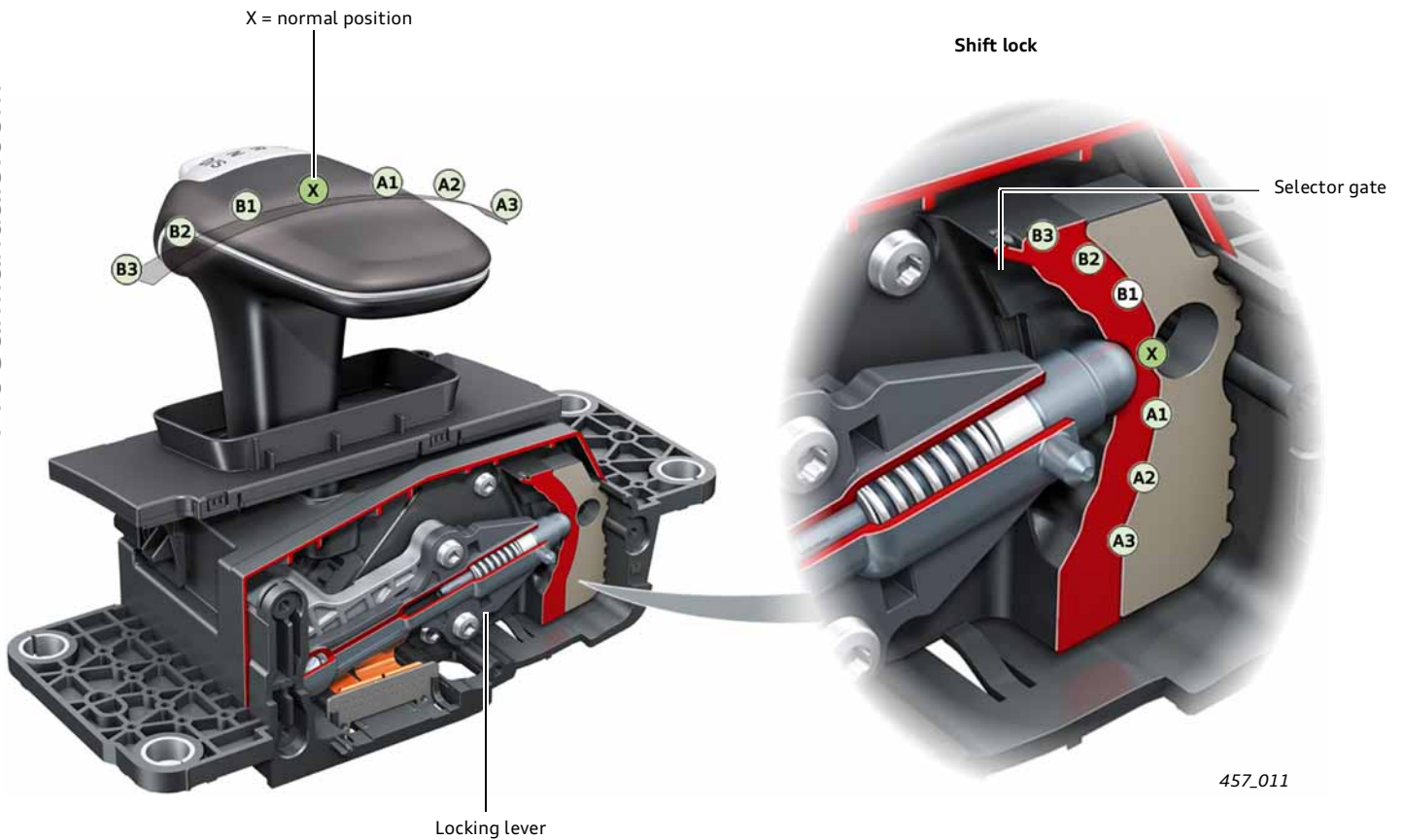
To avoid confusion between the terms "selector lever position", "gear" and "function mode", we call this normal position "X".

A logical operating concept was developed so that the shift control can be operated comfortably and intuitively.

From its normal position "X", the selector lever has three positions forward and three positions back. The locking device applies defined actuating forces and provides short, precise shift throws.

Five locking solenoids suppress illogical selector lever movements and make for logical and intuitive operation.

For example: If the gearbox is in "Park", the selector lever cannot be moved forward but can be moved up to 3 positions back, e. g. when the driver wants to shift from P to D (1st step P > R, 2nd step R > N, 3rd step N > D). This corresponds to the actuation logic of a conventional shift control system.



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For the following gearshifts, the button must be pushed and/or the foot brake applied:

- P > button and foot brake
- R > P button
- N > D foot brake¹⁾
- D/S > N button
- N > R button and foot brake¹⁾

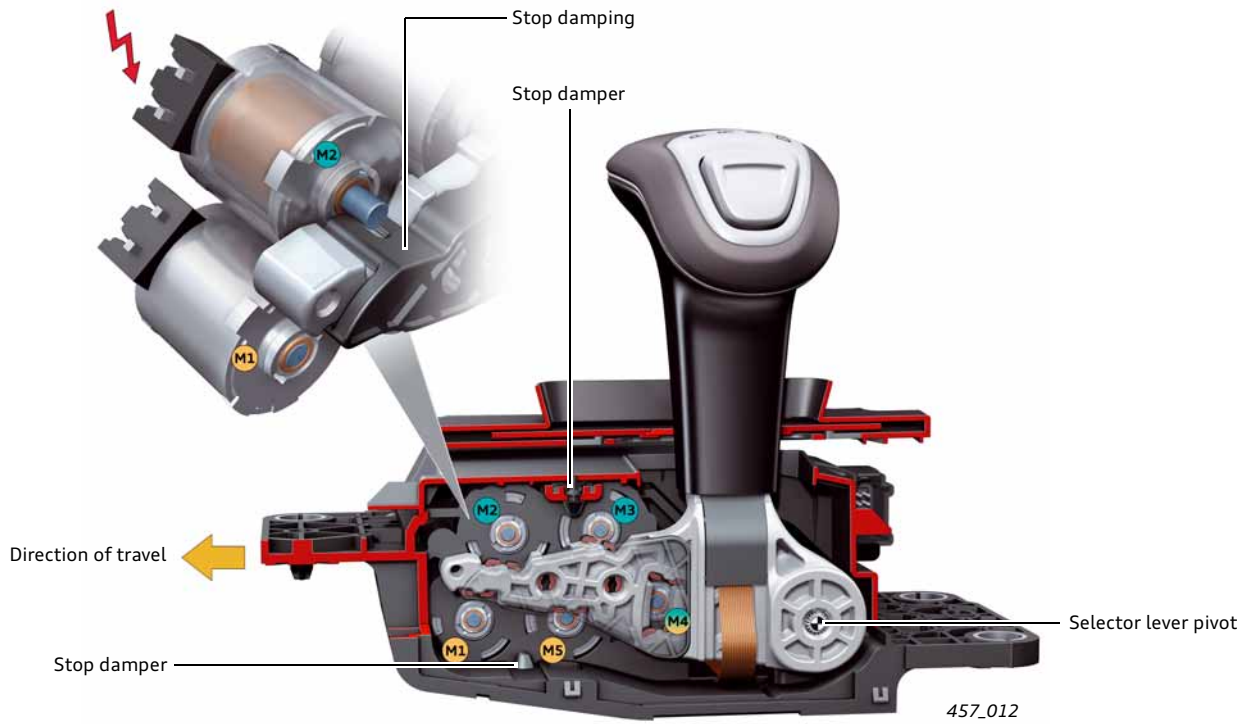
¹⁾ The N lock is active approx. 1 second after "N" is selected.

Shift schematic – function

As mentioned, the shift movements of the selector lever are limited by 5 locking solenoids, resulting in logical and intuitive operation for the driver.

The locking solenoids are activated by the selector lever sensors control unit J587 in accordance with the selected gear.

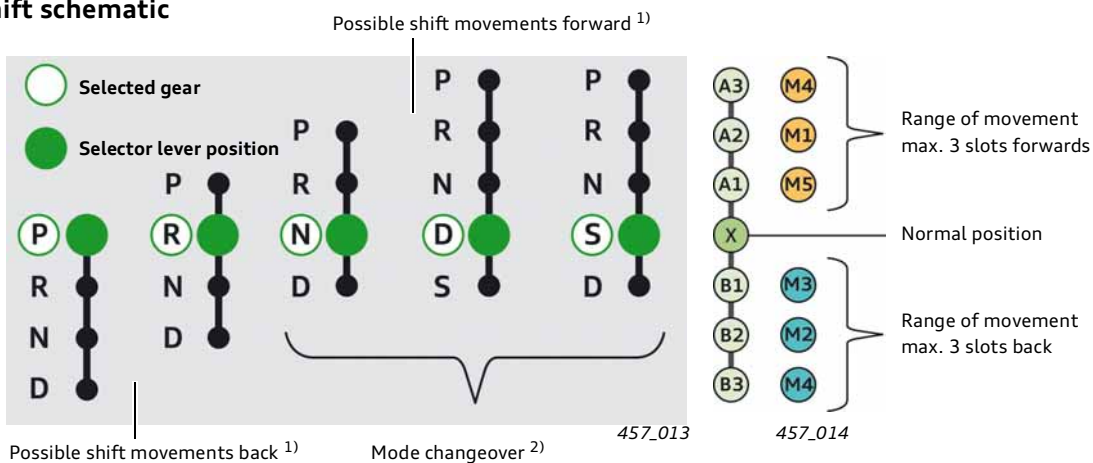
As before, the unlock button must be pushed and/or the foot brake applied to shift out of certain gears, e.g. the button must be pushed and the foot brake applied when shifting out of "P".



- M1 Selector lever lock solenoid 1 N496
- M2 Selector lever lock solenoid 2 N497
- M3 Selector lever lock solenoid 3 N498
- M4 Selector lever lock solenoid 4 N499
- M5 Selector lever lock solenoid 5 N500

- M1 suppresses shift movements to A2 and A3 (only A1 is enabled)
- M2 suppresses shift movements to B2 and B3 (only B1 is enabled)
- M3 + M5 lock the selector lever in normal position X (with P lock and N lock)
- M4 suppresses shift movements to A3 and B3 (A1, A2 and B1, B2 are enabled)
- M5 + M3 lock the selector lever in normal position X (with P lock and N lock)

Shift schematic



¹⁾ Gears can be selected either by repeatedly flicking the selector lever slot by slot in the desired direction or directly by moving the selector lever up to three slots (as per the previous operating logic).

²⁾ The S gear can be selected from gear D. To change from D to S or from S to D, select B1 (pull selector lever 1 notch back). If the "dynamic" mode is selected with "Audi drive select", "S" is automatically engaged.

Selector lever sensors control unit J587

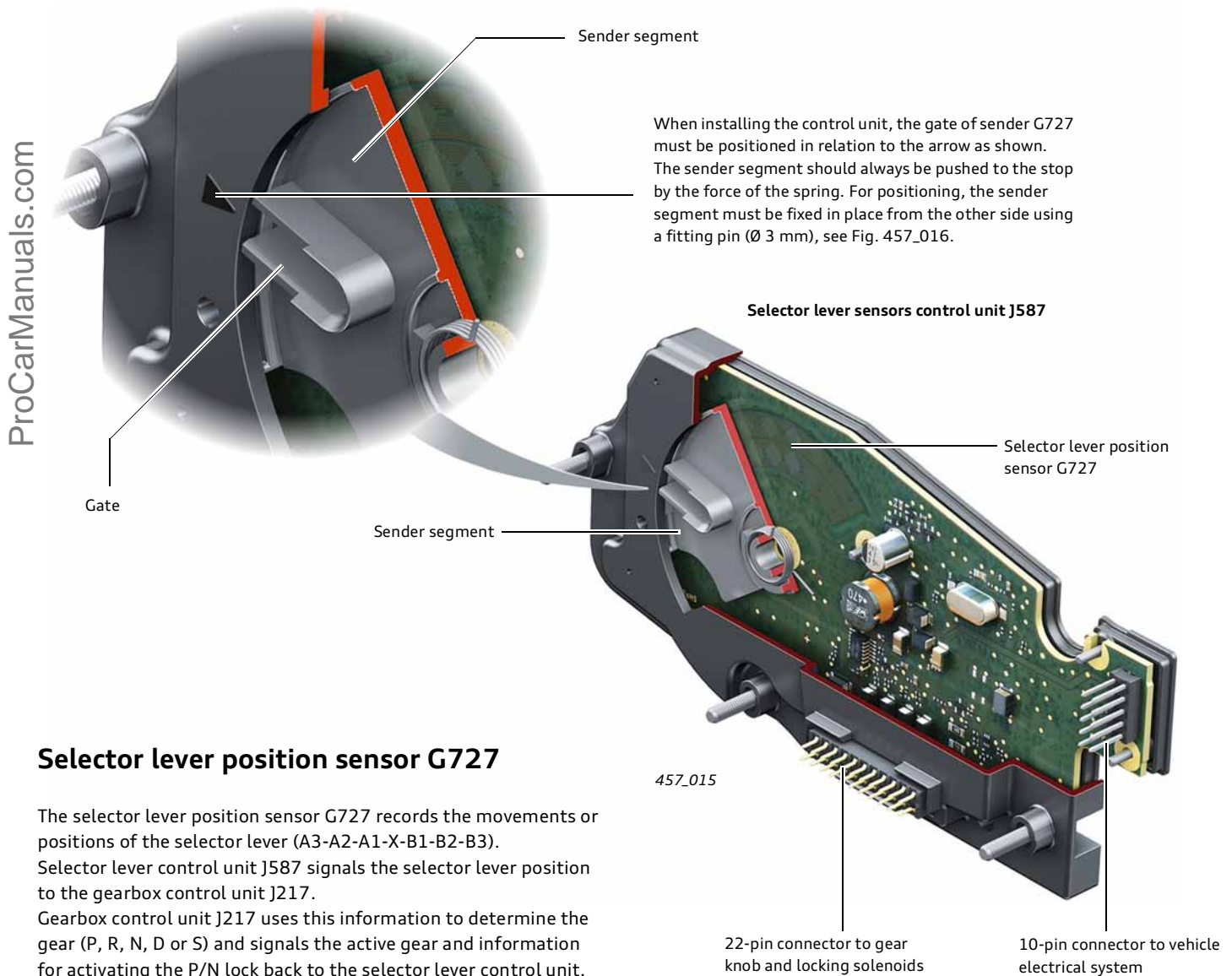
The selector lever sensors control unit J587 forms a functional unit together with the selector lever position sensor G727. This functional unit is responsible for detecting driver inputs, evaluating signals and communicating with the gearbox control unit J217, and for all control and diagnostic functions of the shift control system.

Characteristics and special features at a glance:

- ▶ Address word 81
- ▶ Data protocol UDS
- ▶ Separate CAN connection to gearbox control unit
- ▶ Independent event logger (max. 8 entries)
- ▶ 24 measured values are available for diagnostics
- ▶ Actuator test (in self-diagnostics mode only)
- ▶ the control unit can be replaced separately
- ▶ no programming/encoding needed
- ▶ updatable with the vehicle diagnostic tester

The selector lever sensors control unit J587 has the following tasks:

- ▶ To determine the shift movements and position of the selector lever (together with G727) and relay the sensor signal to the gearbox control unit
- ▶ To select and activate the 5 locking solenoids for the P/N lock and for shift throw limitation according to the gear signalled back by the gearbox control unit
- ▶ To communicate with the gearbox control unit via a separate CAN bus
- ▶ To process the signal from the selector lever release button E681 and relay this information to the gearbox control unit
- ▶ To activate the display unit Y26 according to the gear signalled back by the gearbox control unit



Selector lever position sensor G727

The selector lever position sensor G727 records the movements or positions of the selector lever (A3-A2-A1-X-B1-B2-B3). Selector lever control unit J587 signals the selector lever position to the gearbox control unit J217.

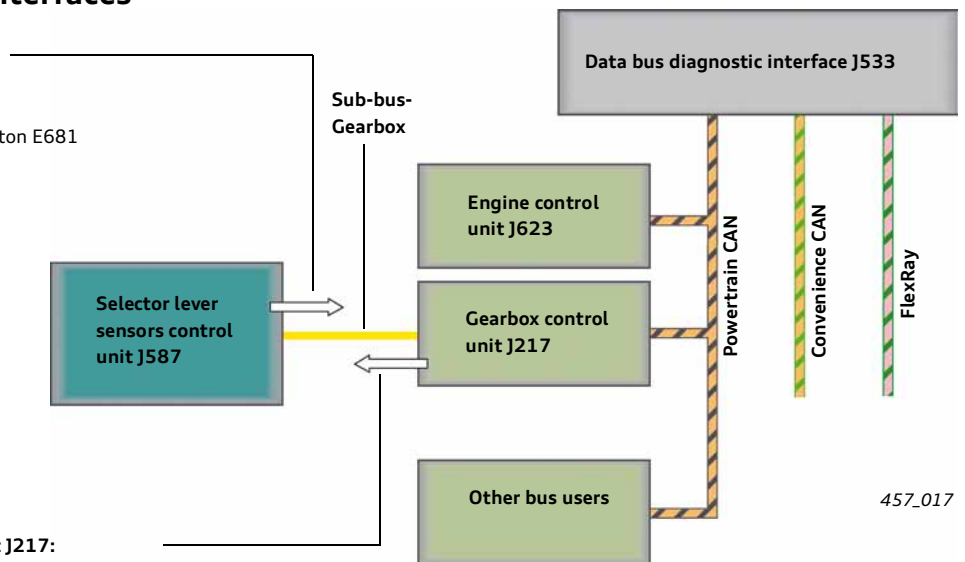
Gearbox control unit J217 uses this information to determine the gear (P, R, N, D or S) and signals the active gear and information for activating the P/N lock back to the selector lever control unit. Locking solenoids N496 to N500 and the display unit Y26 are activated based on this feedback.

The speed signal and the brake signal which are required to generate the P/N lock signal are processed by the gearbox control unit.

Functions, networking and interfaces

Information to gearbox control unit J217:

- Selector lever positions A3-A2-A1-X-B1-B2-B3
- Operating condition of selector lever release button E681
- Status of selector lever lock
- Status of event logger

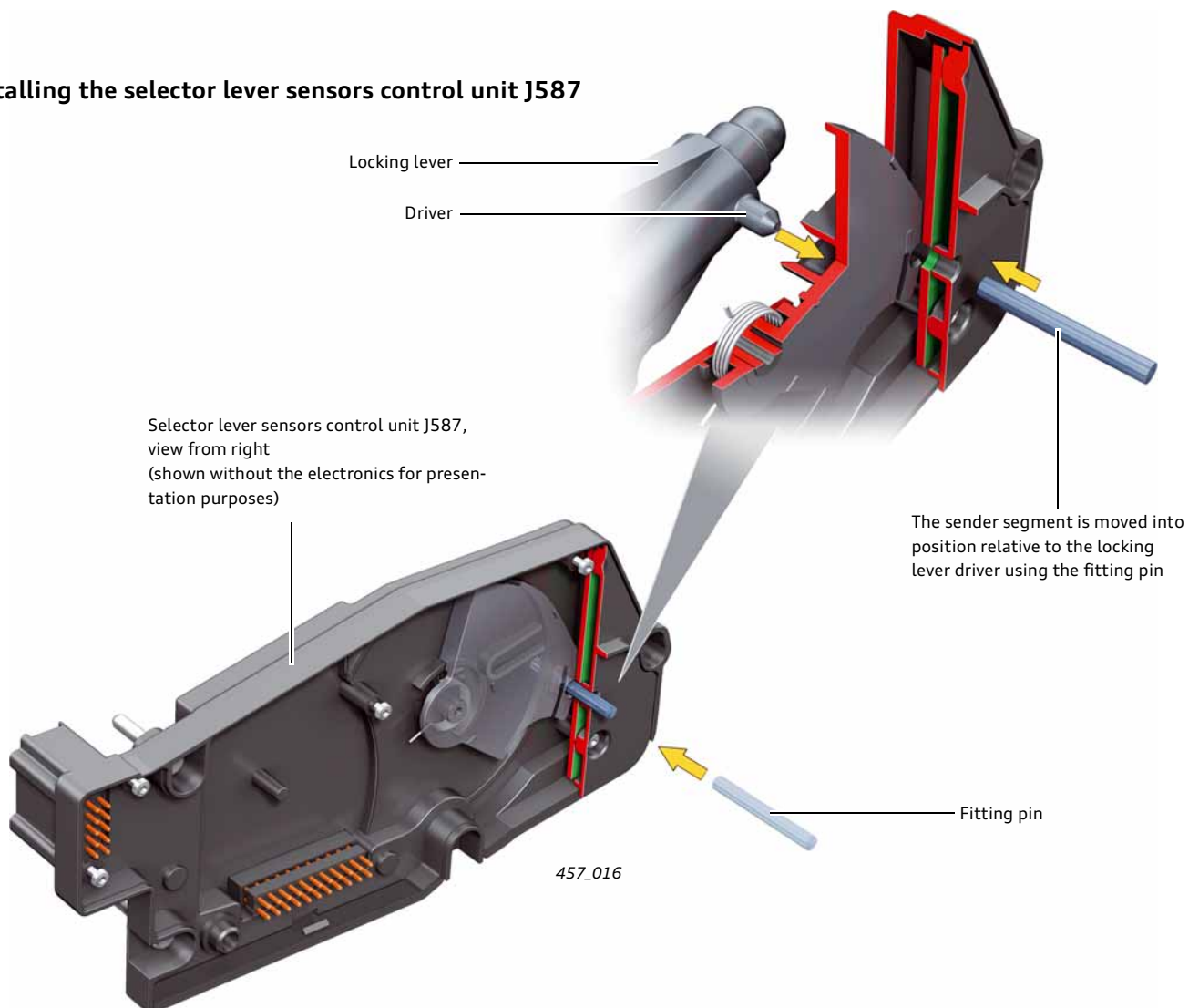


Information from automatic gearbox control unit J217:

- Information - gear (P, R, N, D, S)
The automatic gearbox control unit J217 determines the gears based on the "selector lever position information". The selector lever sensors control unit J587 uses this information to activate the locking solenoids and display unit Y26
- Information - activation and enabling of selector lever lock (P/N lock)
The automatic gearbox control unit J217 decides whether to enable the selector lever lock or not based on the information "foot brake applied", the speed signal and "button E681 pushed".

The automatic gearbox control unit J217 has a simple gateway function. The diagnostic services of the selector lever sensors control unit J587 are selected directly using address word 81, but communications are handled as a background task by the automatic gearbox control unit J217.

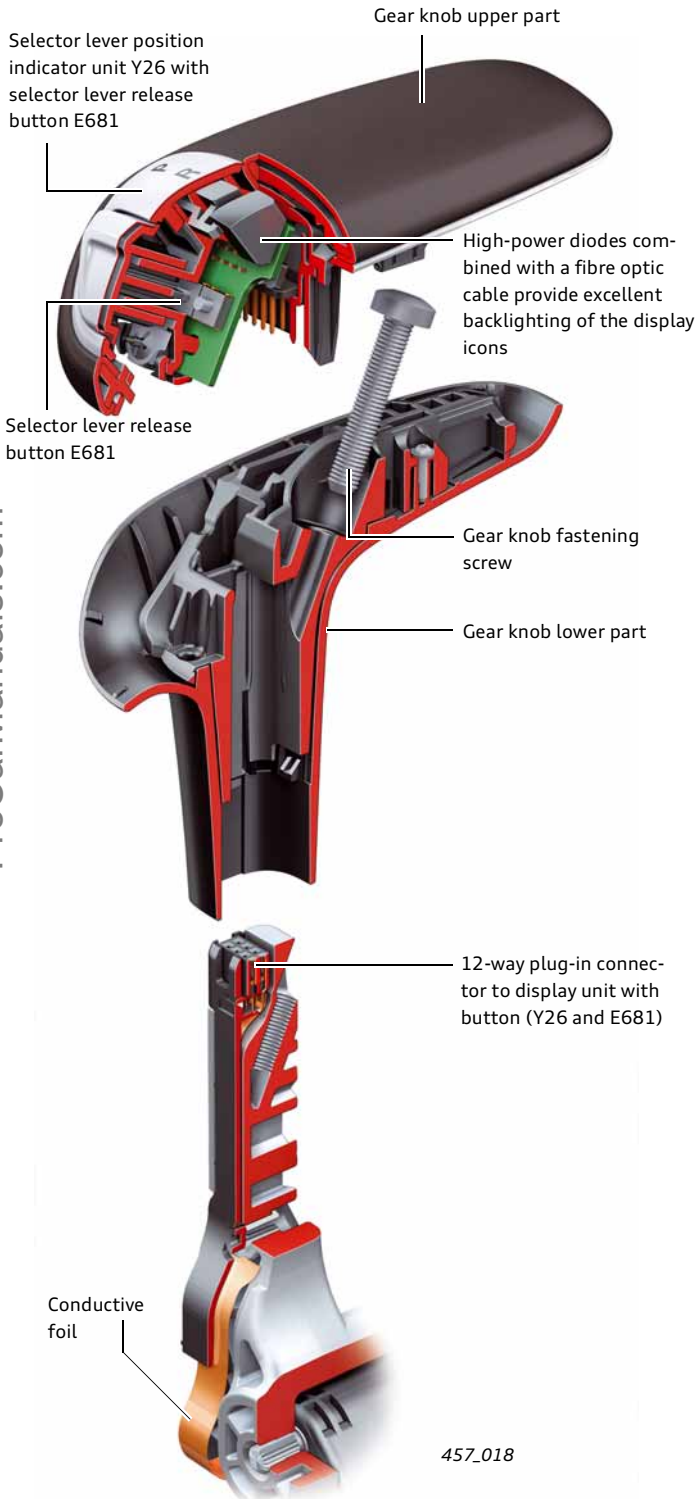
Installing the selector lever sensors control unit J587



Gear knob/selector lever release button E681

Button E681 is used for unlocking the selector lever. The selector lever is now unlocked electrically, and not mechanically.

To improve reliability, the button is configured as a circuit with two microswitches.



Both switches are monitored by the self-diagnostics. If a switch is faulty, a fault will be indicated. However, the selector lever can still be actuated as long as a switch is still working.

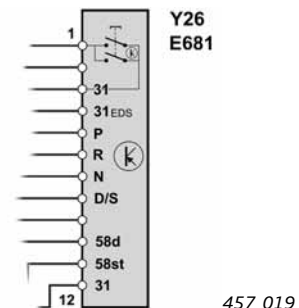
Selector lever position indicator unit Y26

The display unit is integrated into the gear knob and indicates the **current gear**. To give the driver better information, the gear indicator (function lighting) stays on for approx. 10 s after turning the ignition off. The locating light (see below) is switched by the onboard power supply control unit J519.

To protect the electronics of the shift control mechanism and the gear knob against excess voltage due to electrostatic discharge, electrostatic discharges caused by the driver are diverted to the selector lever control unit via a separate ground connection (refer to terminal 31_{ESD} in function diagram).

To remove the gear knob, unclip the upper part of the knob and undo the fastening screw. Care should be taken during installation to ensure that the masking panel is not damaged. Make sure that the masking panel is correctly aligned.

Function diagram (cut-out)



Legend of wiring diagram

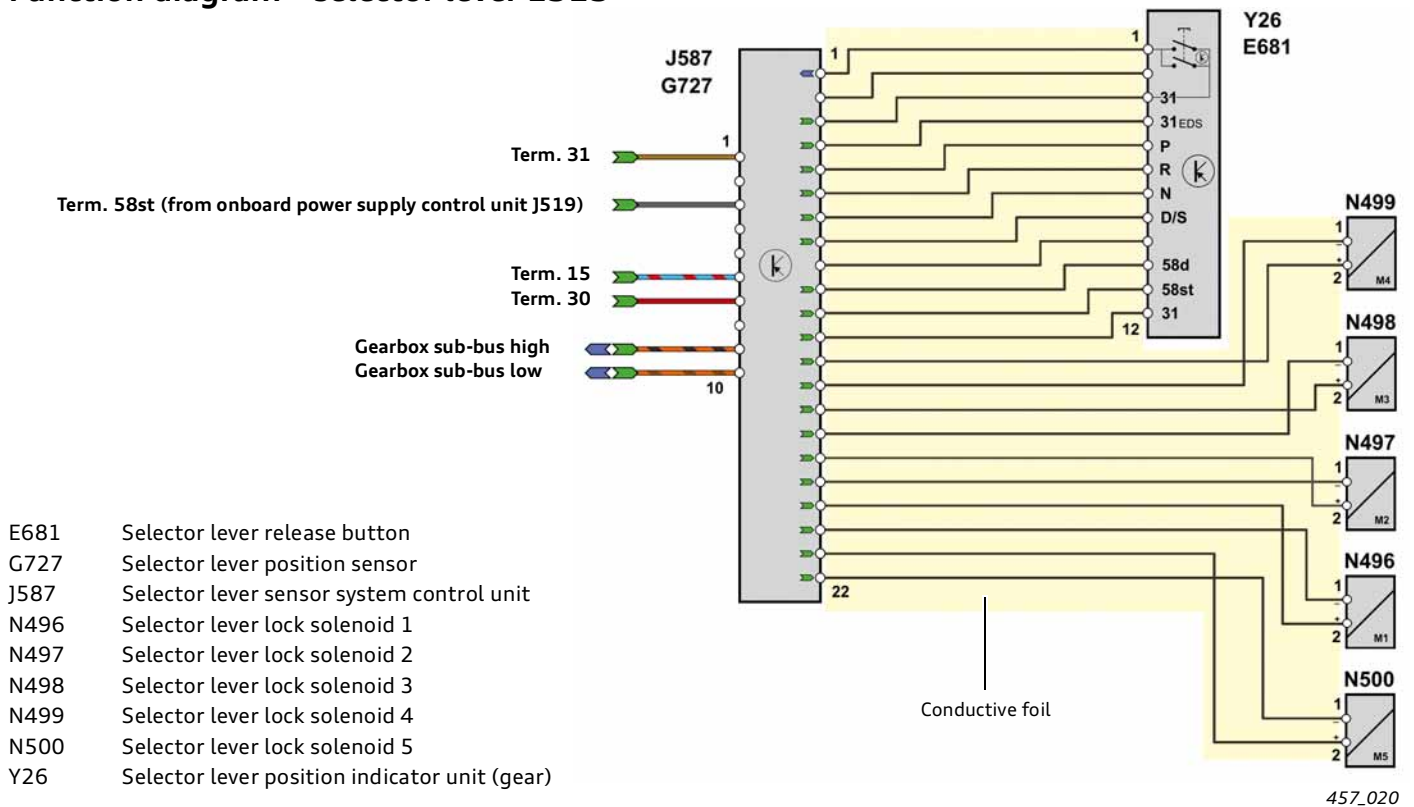
58st	Locating light with defined dimming, all LEDs in Y26 are activated with low luminosity (so that the selector lever can also be easily located in the dark (without term. 15 and/or term. 58d))
58d	Dimming of the LEDs for the function lighting (P, R, N, D/S). Information on dimming level is sent by data bus to the selector lever control unit, which in turn drives the display unit accordingly.
31_{ESD}	Ground connection for diverting electrostatic discharges
ESD	Electrostatic Discharge



Note

If the upper part of the gear knob is not or incorrectly inserted, all locking solenoids will be deactivated. As a result, all selector lever positions can be selected. A diagnostic trouble code is stored in the fault memory and a warning is displayed in the dash panel insert.

Function diagram – selector lever E313



Gear shift indicators

Altogether, three displays inform the driver of the gears and, if adapted in the gearbox control unit, the actual gear position.

1. Display in gear knob (Y26)
2. Continuous display in dash panel insert (bottom centre)
3. Pop-up window in dash panel insert (centre)

Displays in the dash panel insert



Pop-up display of shift schematic for 5 s when the selector lever or the unlock button is operated

Info that Auto mode can be restored by pulling back on the selector lever (or by pushing the M button on the steering wheel)

M = manual shifting (tiptronic mode)

Gear indication in "D" can be activated or deactivated using the adaption function of the vehicle diagnostic tester (refer to page 63). In Manual mode "M" (tiptronic mode) the actual gear position is always displayed.

shift-by-wire functions/operation

Auto P function (automatic parking lock)

The parking lock in the new Audi A8 '10 is actuated electro-hydraulically. This design allows the parking lock to be operated automatically for enhanced ease of use.

A description of how the parking lock works is given on page 48. It is recommended that you read the description of how the parking lock works in order to gain a better understanding of the Auto P function.

The Auto P function engages the parking lock automatically, i.e. without the driver's intervention, when the engine is turned off (either using the ignition key or the START ENGINE STOP button).

The parking lock is engaged automatically when ...

- ▶ the vehicle is stationary (speed < 1 kph),
- ▶ gear D, S, or R is active,
- ▶ and the engine is turned off (Term. 15 off (0)).

To put the gearbox into neutral, move the selector lever into "N" when the engine is running or operate the emergency release device for the parking lock.

Possible ways of putting the gearbox into neutral:

1. Select position "N" with the shift control when the engine is running. Please note there are certain differences between vehicles with and without advanced key system (refer to functional schematics of "Auto P function").

- Active selection of position "N" is intended for briefly pushing the vehicle because gear "N" is only available **for a limited time**. This can, for example, be used for going through a car wash or for pushing the vehicle inside a workshop or garage.

- When position "N" is actively selected, the gearbox control unit and the selector lever control unit remain active (without term. 15) and hold "N" for up to 30 minutes while the vehicle is stationary¹⁾.

2. Engage position "N" using the emergency release device.

- If position "N" is to be engaged...

... for a lengthy period of time, ...

... continuously, ...

... when the engine is not running ...

... or if the electro-hydraulic

parking lock mechanism fails, the emergency release device must be operated.

This is the case, for example, if the vehicle needs to be towed or parked in neutral.

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Functional schematic/Auto P function

Turn off engine in the current gear (D/S/M or R)

v signal = 0 kph
Term. 15 = 0
Term. S = 1 or 0



457_021

Functional schematic/active selection of gear "N" in vehicles without advanced key

Engine running, select N, turn off engine, leave key in ignition

v signal = 0 kph
Term. 15 = 0
Term. S = 1



Driver information in the dash panel insert:
"Vehicle may roll. Selector lever not in P" + continuous tone

If the ignition key is removed, the parking lock will engage
Term. S = 0

¹⁾ The gearbox engages the parking lock automatically if the vehicle is stationary (v = < 1 kph) for more than approx. 30 minutes. If a speed signal is detected (v = > 1 kph), the time is extended accordingly until either a standstill time of at least 5 minutes expires or the vehicle battery goes flat.

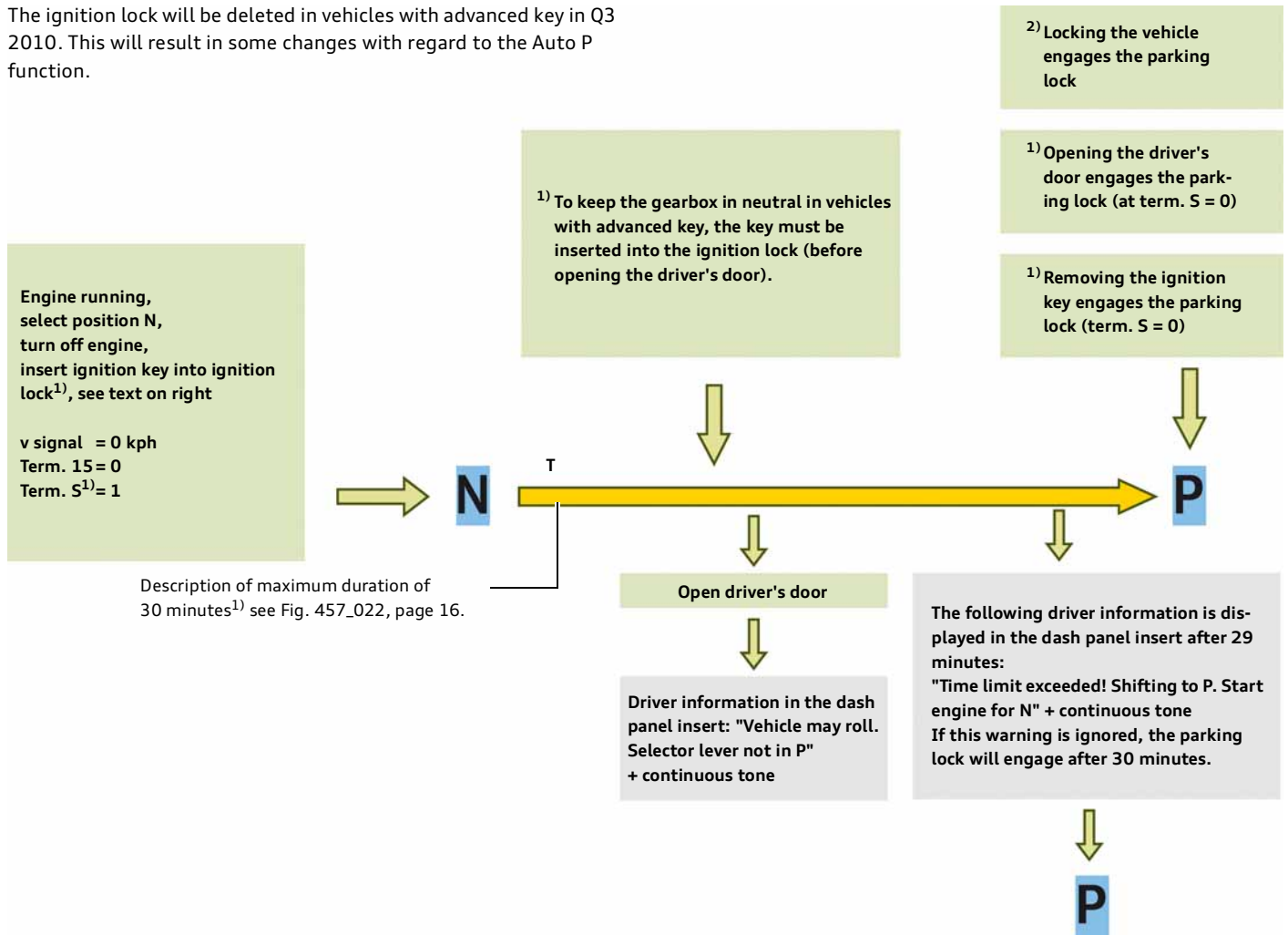
The following driver information will be displayed in the dash panel insert after 29 minutes:
"Time limit exceeded! Shifting to P. Start engine for N" + continuous tone
If this warning is ignored, the parking lock will engage after 30 minutes¹⁾.

457_022



Functional schematic/active selection of gear "N" in vehicles with advanced key

The ignition lock will be deleted in vehicles with advanced key in Q3 2010. This will result in some changes with regard to the Auto P function.



Legend	
Term. 15	Voltage at "ignition on" (1)
Term. S	Indicates whether ignition key is in ignition lock (1) or not (0)
v signal	Speed signal (from automatic gearbox)
T	Duration in neutral position
	Driver action/other conditions
	Action in gearbox
	Display in dash panel insert

457_023

¹⁾Vehicles with advanced key **until** Q3 2010

²⁾Vehicles with advanced key **from** Q3 2010

A new advanced key system will be introduced. The new advanced key system does not have an ignition lock.



Important information

Information for vehicles without advanced key and vehicles with advanced key until Q3 2010²⁾.

When using automated conveyor-type car wash systems, the neutral position must be selected and the ignition key left inserted in the ignition lock so that the gearbox stays in neutral.

To tow the vehicle or after leaving the gearbox in neutral for lengthy periods of time, the emergency release device for the parking lock must be operated.

Do not forget to protect vehicle against unintentional rolling away (using the parking brake, wheel chocks etc.) if you have selected position "N" or if the emergency release device for the parking lock has been operated.

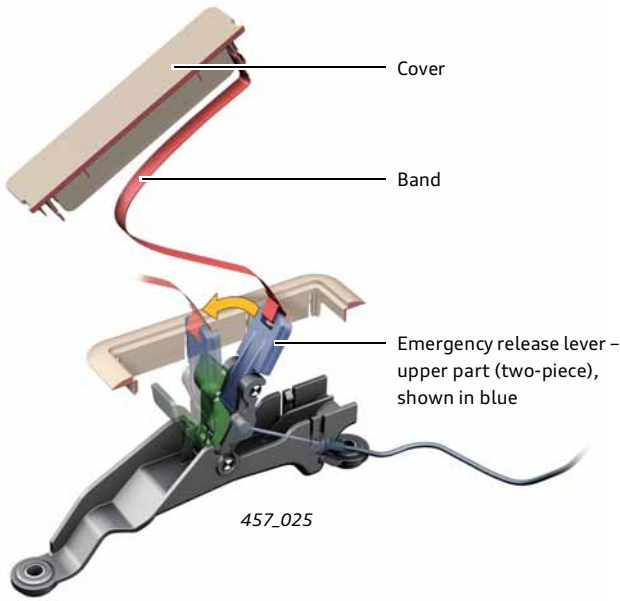
Emergency release device for the parking lock

During normal operation the parking lock is actuated / unlocked electro-hydraulically. As described on page 16, the engine must be running to release the parking lock and a sufficient supply of power is required to hold the gearbox in neutral (N holding phase). In addition, the so-called N holding phase is limited in duration. For these reasons, full implementation of the shift-by-wire system (without selector lever cable) requires an emergency release device for the parking lock. This is the only way to move the vehicle in certain situations.

The emergency release device serves to temporarily release the parking lock and must be actuated in the following situations:

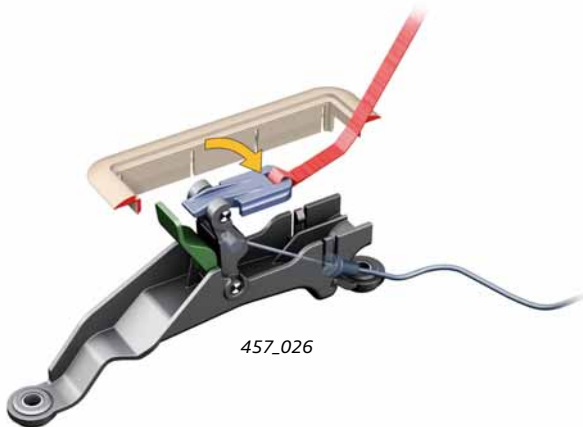
- ▶ for towing the vehicle,
- ▶ if the parking lock cannot be released electro-hydraulically due to a malfunction,
- ▶ to manoeuvre or move the vehicle if there is not enough battery power to start the engine,
- ▶ to manoeuvre or move the vehicle when the engine is not running (e.g. in the workshop)
- ▶ after assembly work on components of the emergency release device, the emergency release device must be checked (see information on right-hand side).

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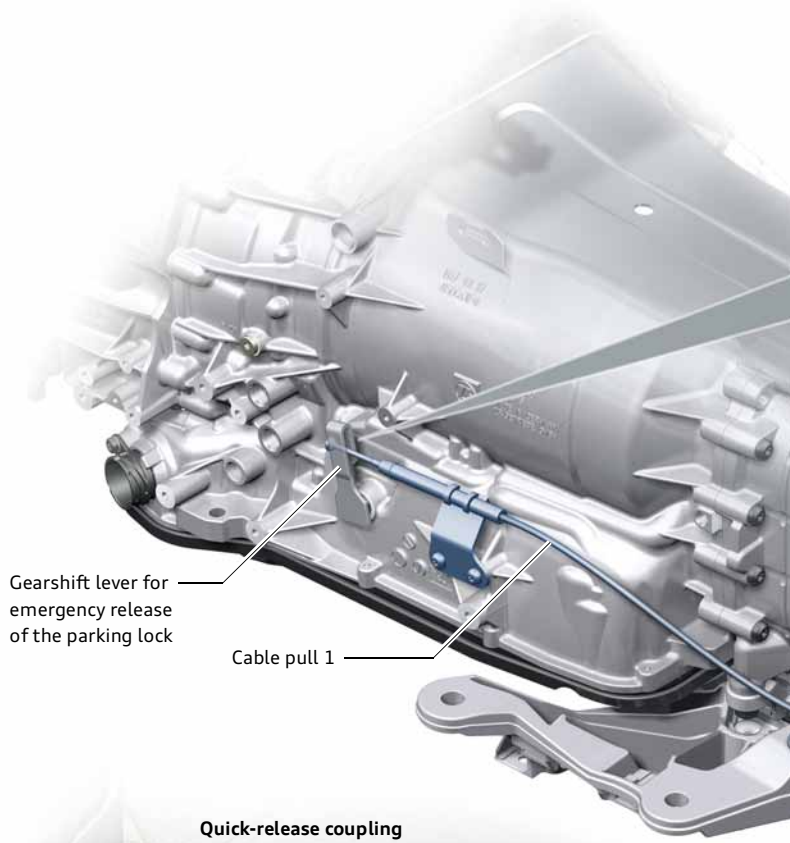


Releasing the parking lock

1. Remove the cover using the tool kit. Pull out the emergency release lever with the band until it engages and locks in the upright position.



2. The emergency release lever is comprised of two parts. The upper part has to be folded down so that the lever cannot be unintentionally actuated with the feet. The cover is designed so that it cannot be installed in this condition and should be set aside.



Quick-release coupling

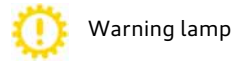
To simplify installation, the emergency release cable comprises two parts connected by a quick-release coupling. When removing and installing the gearbox, the emergency release cable need only be disconnected or connected here. The cable pull does not have to be adjusted.

Isolating element

The quick-release coupling and the mounting of the emergency release device for the parking lock are attached using special isolating elements. This helps to minimise structure-borne sound transmission.

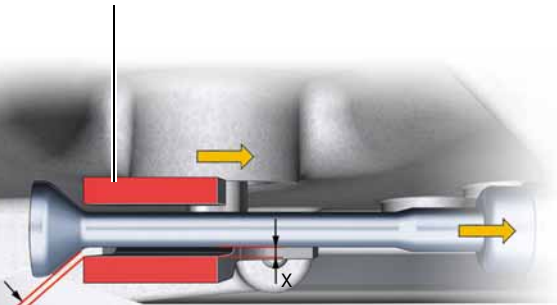
For detailed information on the parking lock, refer to page 16 (Auto P function) and page 48 (Parking lock).

When the emergency release device for the parking lock is operated, the warning lamp and gear indicator "N" light up in the dash panel insert. The driver warning "Vehicle may roll!! Cannot shift to P. Please apply parking brake."



Warning lamp

Gearshift lever for emergency release of the parking lock



Contactless emergency release cable connection
X = circumferential clearance (play) (in non-actuated state only)

Reduction of structure-borne sound transmission

A special feature is the connection between the emergency release cable and the gearshift lever. A rigid rod and a conical nipple are fitted on the end of the emergency release cable. The rod is guided virtually backlash free and contactlessly by the gearshift lever. The rod and the gearshift lever do not come into contact unless the emergency release device is operated. This largely eliminates transmission of structure-borne sound from the gearbox to the cable pull (i.e. vehicle interior).

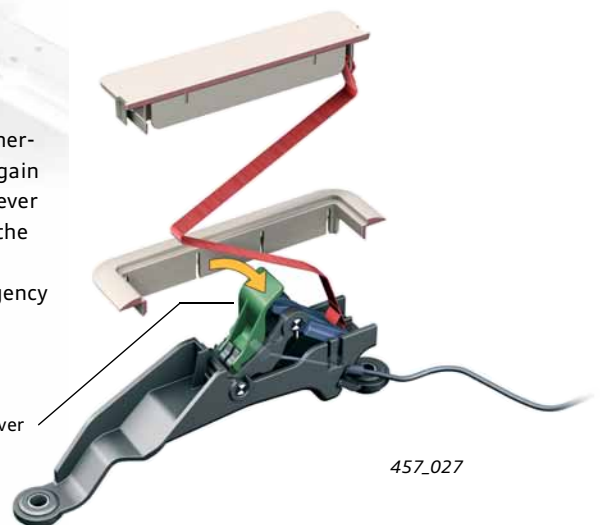
Emergency release cable

The illustration shows the emergency release device in a left-hand-drive model. In a right-hand-drive model, the emergency release control is located on the right-hand side.

Releasing the parking lock

The release lever (shown in green) unlocks the emergency release lever so that the parking lock can again be engaged. This is done by pushing the release lever against the emergency release lever and moving the lever back into its normal position. The cover is designed so that it can only be fitted if the emergency release lever is folded down.

Release lever



457_024

457_027



Note

Do not forget to protect vehicle against unintentional rolling away (using the parking brake, wheel chocks etc.) if you have selected gear "N" or if the emergency release device for the parking lock has been operated.

After removing and installing the gearbox or after assembly work on components of the emergency release device, a functional check should be carried out as described in the Workshop Manual.

Eight-speed automatic gearbox OBK/OBL

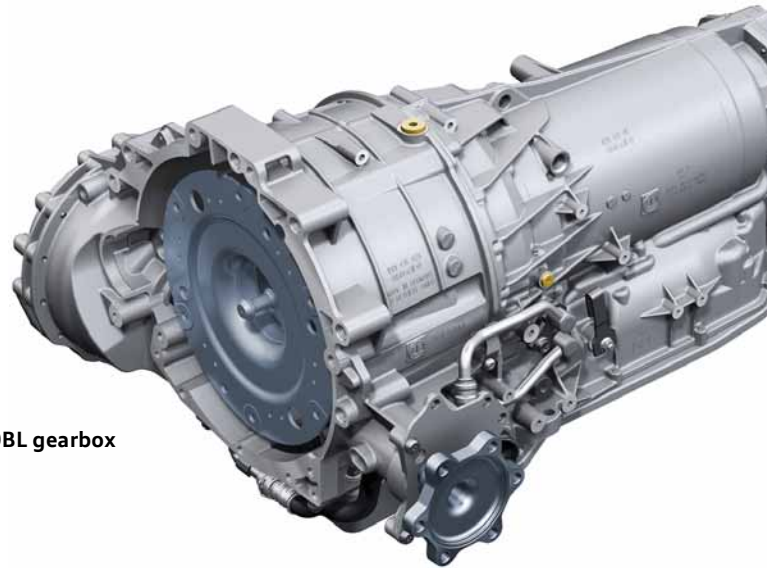
Introduction

The OBK gearbox and the OBL gearbox are the first representatives of the latest eight-speed multistep automatic gearbox generation. Common features are:

- ▶ differential in front of the torque converter
- ▶ the 8 forward gears and reverse are implemented using 4 planetary gearsets and 5 shift elements
- ▶ minimised drag losses because three shift elements are closed in every gear
- ▶ mechatronics for "shift-by-wire" system with electro-hydraulic parking lock
- ▶ 8 gears with a ratio spread of 7 allow short gear shifts, a powerful starting ratio and high speed at low engine RPM
- ▶ ATF oil supply by means of a chain driven vane pump
- ▶ lubrication of the transfer case by the oil pump
- ▶ the gearbox shifts into neutral when the vehicle is stationary and the engine is idling (neutral idle)

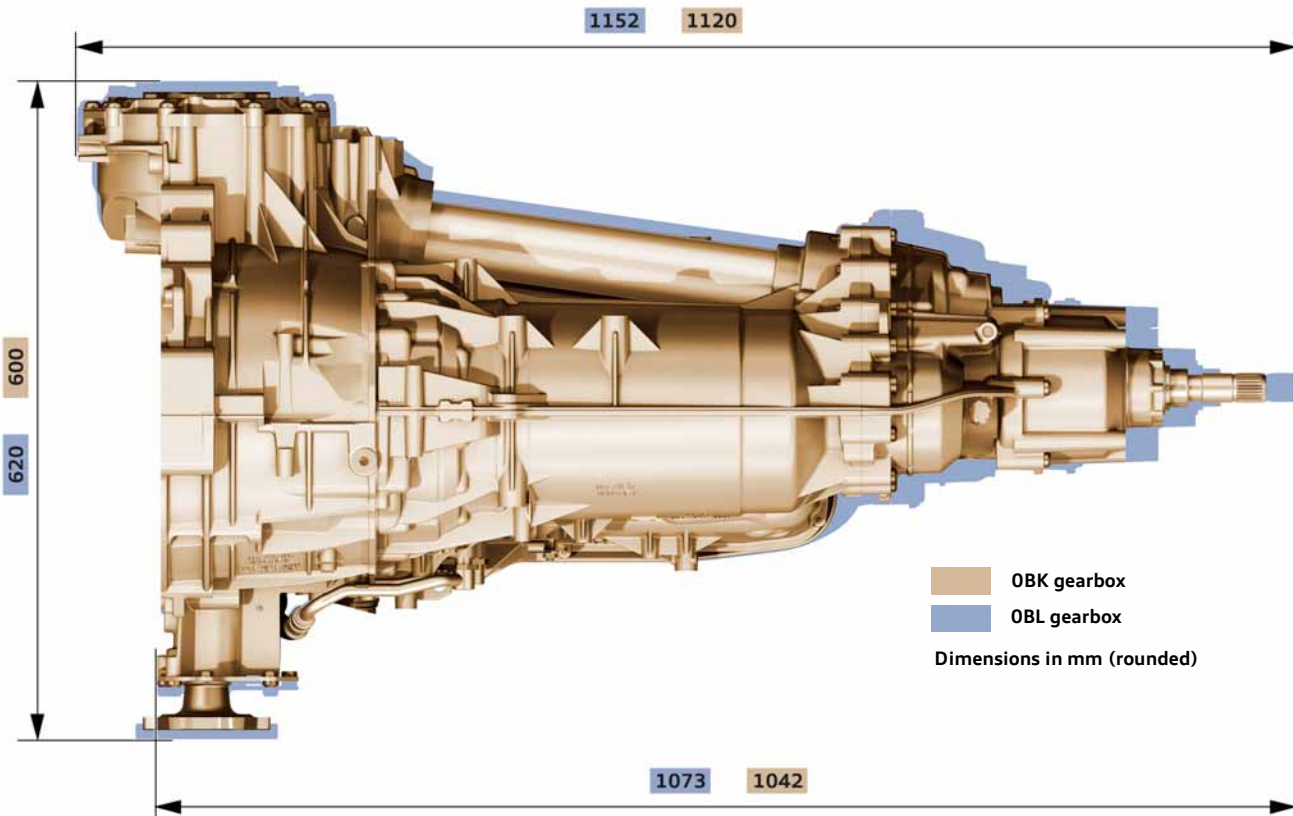


OBK gearbox



OBL gearbox

Dimensions compared



Specifications

	OBK gearbox	OBL gearbox
Developer/manufacturer	ZF Getriebe GmbH Saarbrücken	
Service designation	OBK	OBL
ZF designation	8HP-55AF	8HP-90AF
Audi designation	AL551-8Q	AL951-8Q
Gearbox type	electro-hydraulically controlled 8-speed planetary gearbox with a hydrodynamic torque converter and slip-controlled converter lockup clutch	
Control	<ul style="list-style-type: none"> ▶ Mechatronics (integration of the hydraulic control unit and the electronic control system unit) ▶ Dynamic shift program with separate sport program "S" and "tiptronic" shift program for manual gear shifting ▶ shift-by-wire shift control system with electro-hydraulic parking lock function 	
Engine type	<ul style="list-style-type: none"> ▶ Longitudinally-mounted gearbox and all-wheel drive ▶ Final drive/front axle in front of torque converter 	
Power distribution	Self-locking centre differential with asymmetrical/dynamic torque split	
Weight including oil	141 kg – 146 kg ¹⁾	
Gear ratio	1st gear: 4.71; 2nd gear: 3.14; 3rd gear: 2.11; 4th gear: 1.67; 5th gear: 1.29; 6th gear: 1.00; 7th gear: 0.84; 8th gear: 0.67; Reverse: 3.32	
Ratio spread	7.03	7.03
Max. torque	700 Nm ¹⁾	1000 Nm ¹⁾

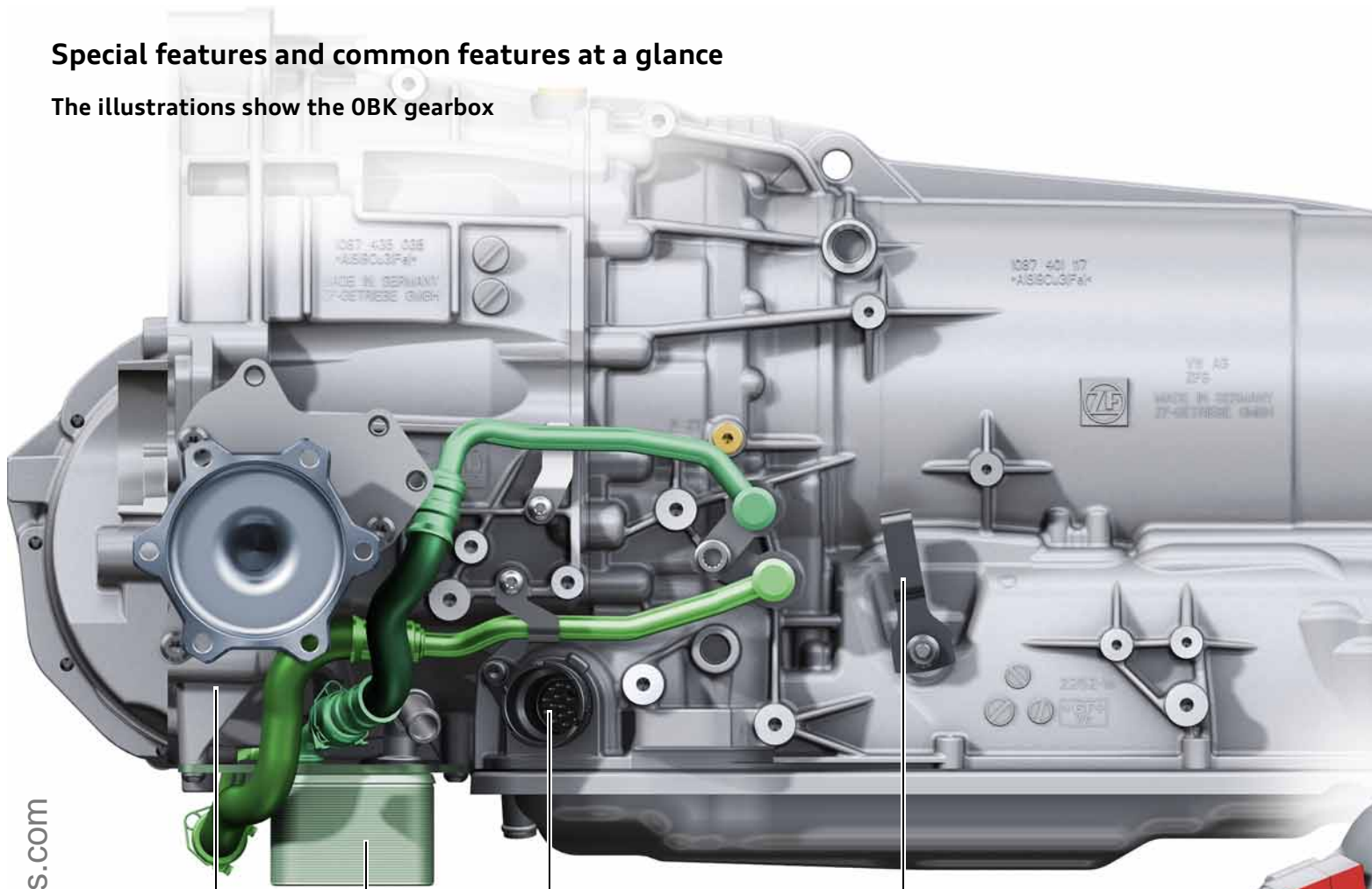
¹⁾ depending on engine version

Seen from the exterior, there is hardly any difference between the OBK and OBL gearboxes. Because the OBL gearbox is rated for a maximum torque of 1000 Nm, most components of the OBL gearbox are accordingly larger in size.

This also applies to the exterior dimensions of the gearbox, as illustrated in Fig. 457_004 on page 20.

Special features and common features at a glance

The illustrations show the OBK gearbox



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Connector to vehicle electrical system

Gearshift lever for emergency release of the parking lock

ATF cooler (heat exchanger) mounted on gearbox

Primary drive



The rating plate is located below the flange shaft (visible from below)

Gearbox output shaft with stub shaft spline

Splined prop shaft

Spring sleeve

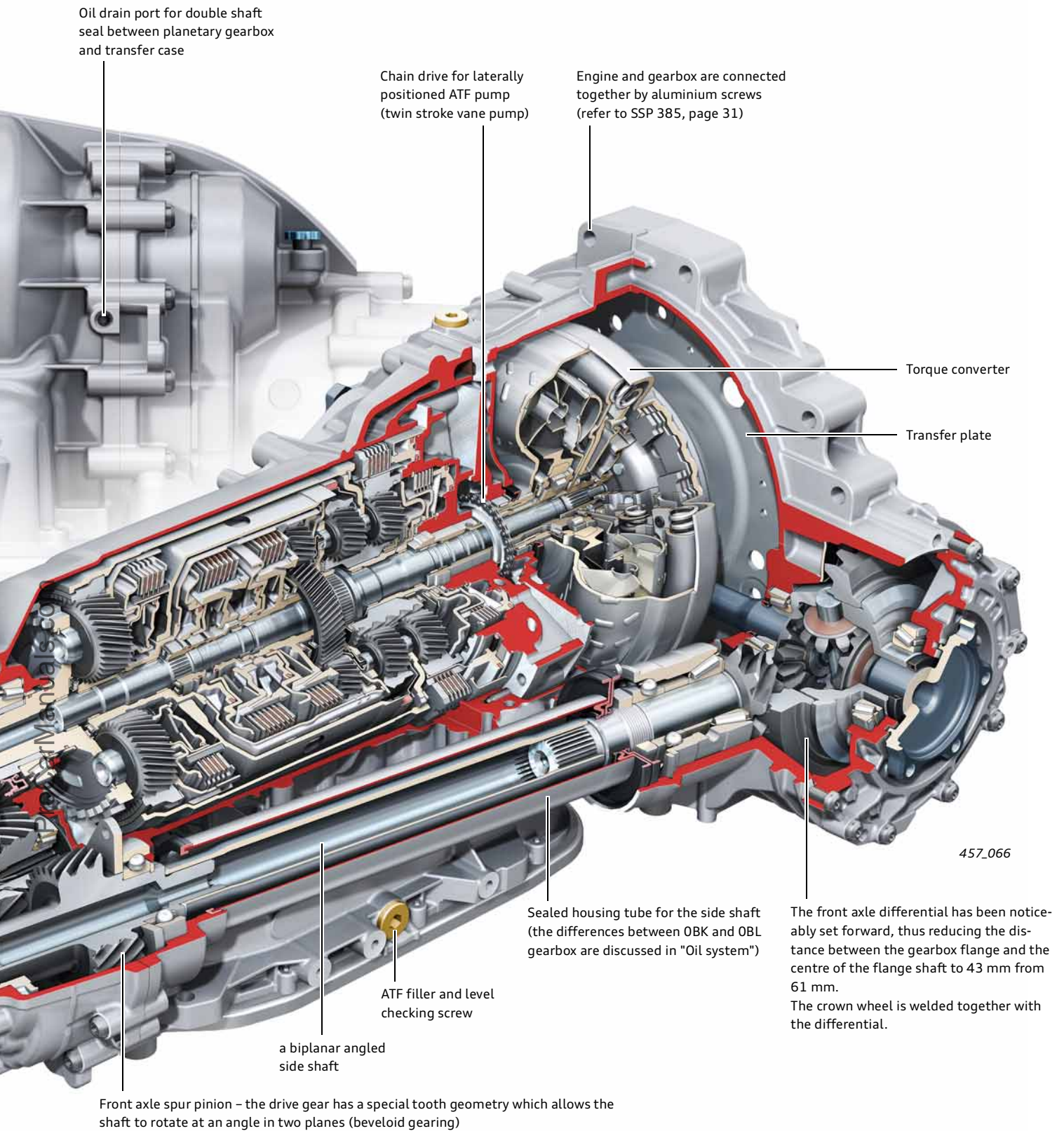
Slot

Centre differential

Transfer case oil pump (refer to page 37)

Clamp

The joint is an integral part of the prop shaft and cannot be replaced separately. The rubber sleeve can be replaced using a special tool.



Splined prop shaft

For the first time, an innovative, new prop shaft coupling is used. The prop shaft mated to the gearbox output shaft and locked into a slot by means of a spring sleeve. The connection is secured axially by the clamping force exerted by the clamp. The new connection system provides a weight saving of 0.6 kg. The new connection system will be phased in for all gearboxes in the course of further development.

Centre differential

The self-locking centre differential with asymmetrical/dynamic torque split used in the OBK/OBL gearbox. It is similar in terms of its design and function to the centre differential in the OB2 and OB5 gearboxes (refer to SSP 429, page 22 ff.). The intelligent torque distribution (refer to page 66) is an innovation.

Torque converter

The parameters (e.g. dimensions and torque conversion factor) of the torque converter and the lockup clutch are adapted for each engine. To effectively dampen the torsional vibration of the engine, various torsion damper systems are used depending on engine version. Use is made of turbine torsion dampers (on all engines except the 3.0 V6 TDI) and dual-damper converters (3.0l V6 TDI engine only).

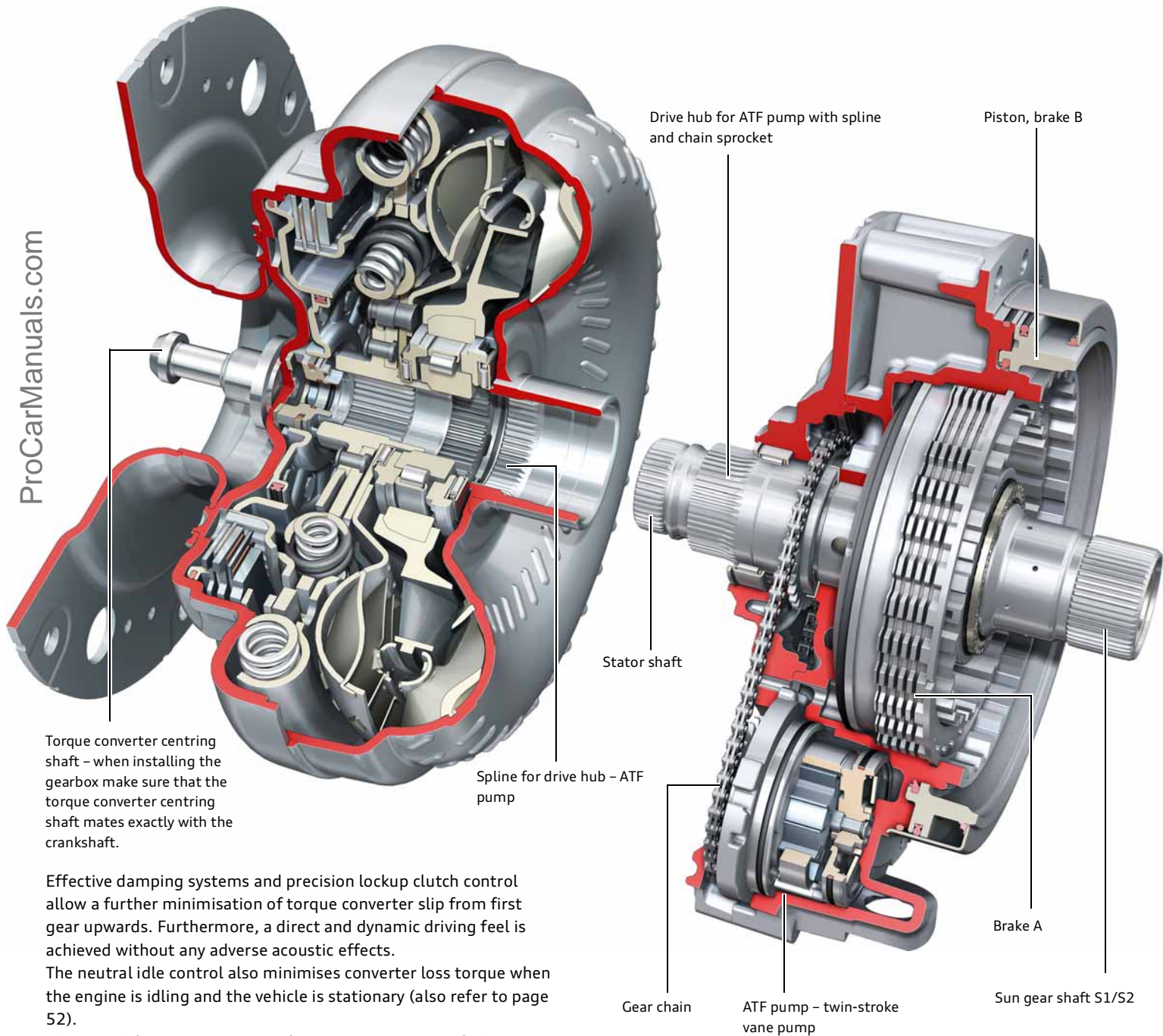
For further information on the torque converters, refer to SSP 283 and 385.

The illustration shows a dual-damper converter.

The torque converters of the OBK and OBL gearboxes are configured as so-called "three line converters". This means that the turbine chamber is supplied by two lines and the lockup clutch is activated by a separate line (third line). The lockup clutch closes and opens independently of and separately from the turbine chamber.

This design offers advantages in terms of controlling the lockup clutch.

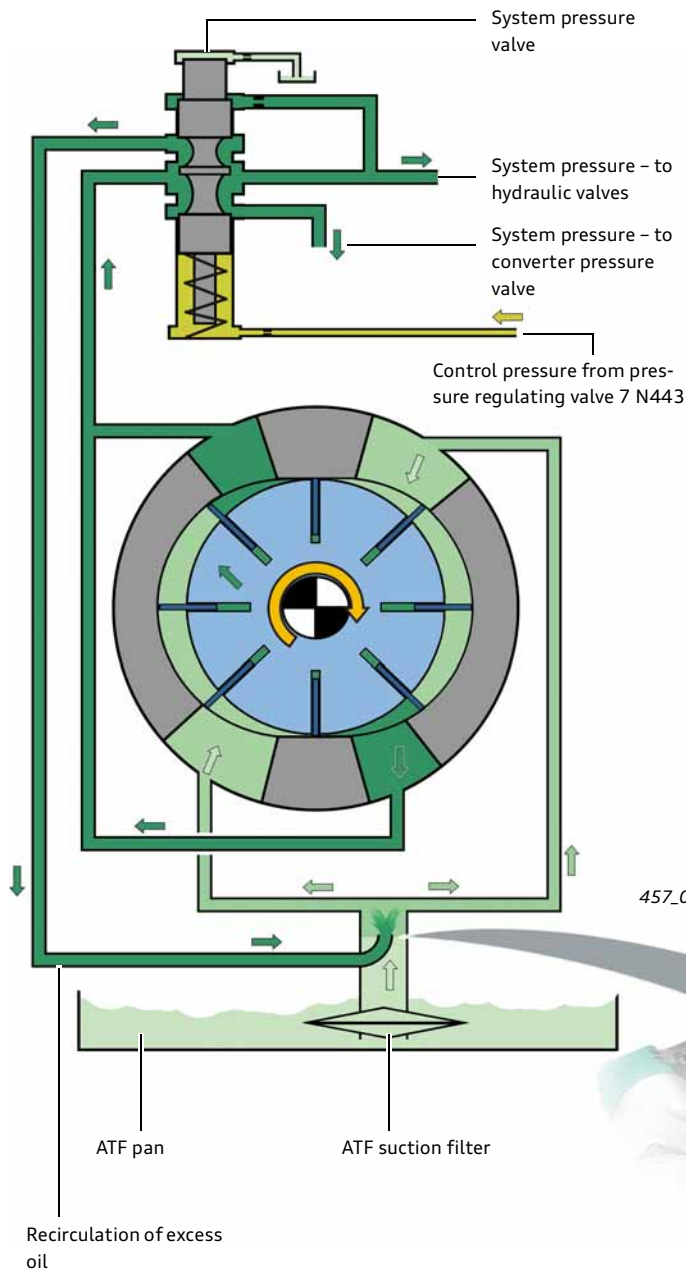
The pressure of the lockup clutch is controlled by the pressure regulating valve 6 N371 (refer to page 43) and the associated hydraulic control valves.



Effective damping systems and precision lockup clutch control allow a further minimisation of torque converter slip from first gear upwards. Furthermore, a direct and dynamic driving feel is achieved without any adverse acoustic effects.

The neutral idle control also minimises converter loss torque when the engine is idling and the vehicle is stationary (also refer to page 52).

These modifications give a significant improvement in fuel economy compared to the previous six-speed gearboxes.



ATF supply/ATF pump

One of the key components of an automatic gearbox is the ATF pump.

No gearbox can function without a sufficient supply of oil. Special features are the lateral, axle-parallel configuration and the chain drive. The different ratios of the chain drive allow the delivery rate of the pump to be adapted to meet various requirements.

The ATF pump is a highly efficient **twin-stroke vane pump**. It also makes a contribution to improving fuel economy.

The ATF pump takes in the ATF through a filter and conveys pressurised oil to the system pressure valve in the hydraulic unit. Here the system pressure is adjusted to the level required for operation of the gearbox. Excess oil is returned to the ATF pump through the intake duct, which provides ideal conditions of flow. The energy liberated in this way is utilised to charge the intake side. In addition to increased efficiency, noise emission is reduced by avoiding cavitation.

ATF (Automatic Transmission Fluid)

The ATF is a "hightech product". The special requirements with respect to shift quality, functional reliability and freedom from maintenance (lifetime service) mean that the ATF needs to satisfy very exacting standards. The ATF has a major impact on the friction in the clutches and brakes. This is why the ATF is codeveloped during the design and testing phases.

Always make sure that the correct ATF is used and pay attention to cleanliness and grade purity.

The ATF pump is installed in the gearbox as an assembly, the so-called "oil supply". The assembly includes the following components:

- ▶ Pump housing
- ▶ ATF pump drive hub
- ▶ ATF pump chain drive
- ▶ ATF pump
- ▶ Housing of brake A
- ▶ Brake A
- ▶ Piston and piston chambers of brake B
- ▶ Stator shaft (fixed)

A new feature is that power is transmitted from the torque converter housing to the ATF pump drive hub through a spline. Again, care must be taken to ensure that the converter and the drive hub are correctly mated when installing the converter.

Important: when installing the converter, pay attention to fitting dimensions.

Planetary gearbox

The 8 forward gears and the reverse gear are produced by a combination of four simple single-carrier planetary gearsets. The front two gearsets share a common sun gear. Power is output always through the planetary carrier of the fourth gearset.

Resetting spring (diaphragm spring), brake A

Shift elements

Only 5 shift elements are used to shift 8 gears.

- 2 multidisc brakes – A and B
- 3 multi-plate clutches – C, D and E

The shift elements, clutches or brakes close hydraulically. Oil pressure compresses the clutch plate assembly and engages the clutch.

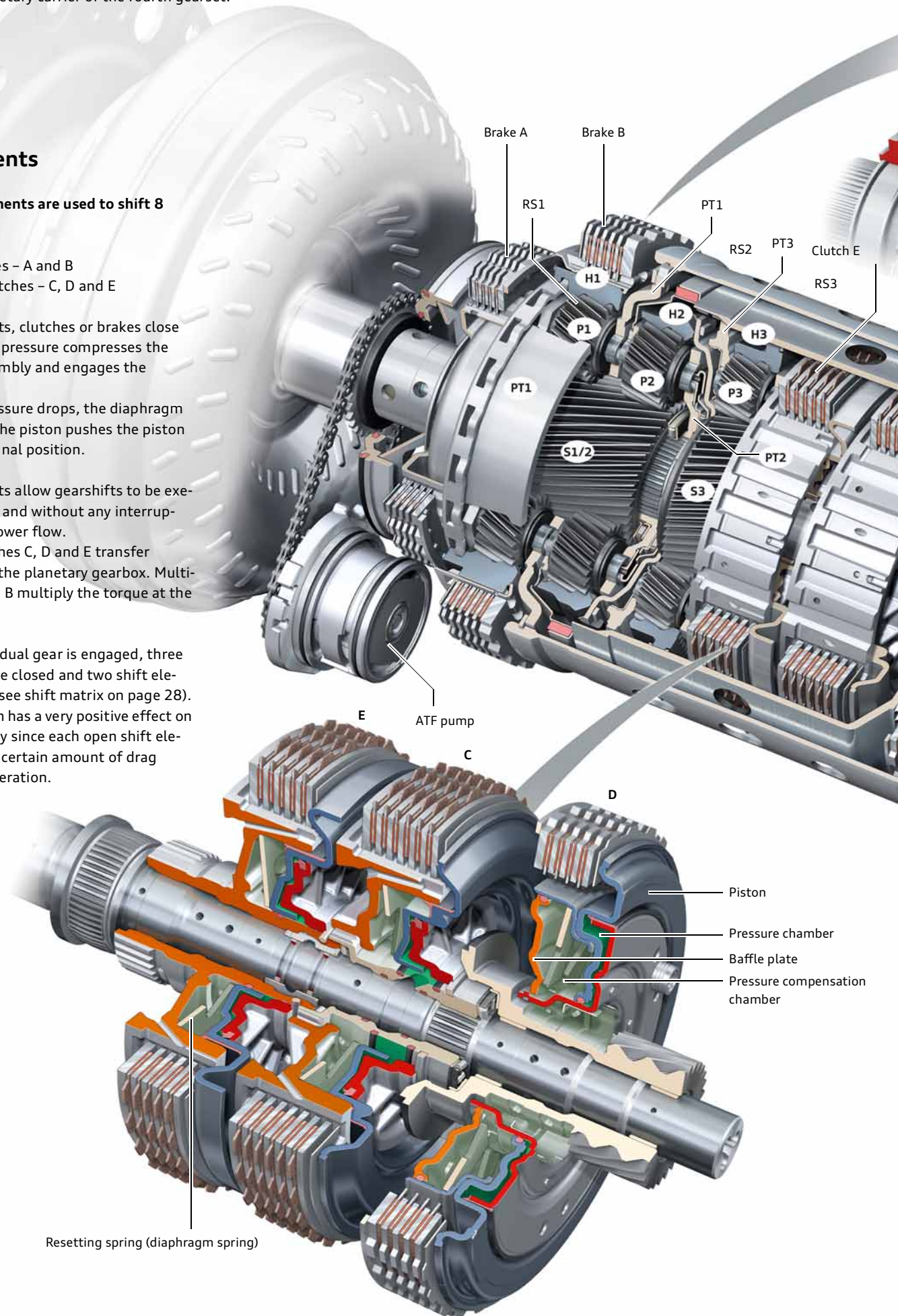
When the oil pressure drops, the diaphragm spring abutting the piston pushes the piston back into its original position.

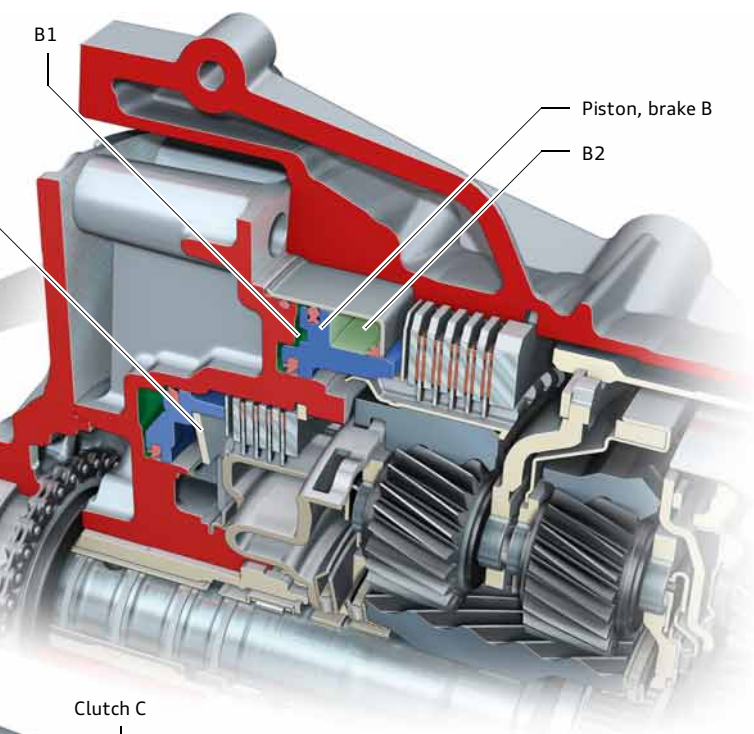
The shift elements allow gearshifts to be executed under load and without any interruption in tractive power flow.

Multi-plate clutches C, D and E transfer engine power to the planetary gearbox. Multi-disc brakes A and B multiply the torque at the gearcase.

When each individual gear is engaged, three shift elements are closed and two shift elements are open (see shift matrix on page 28). This constellation has a very positive effect on gearbox efficiency since each open shift element produces a certain amount of drag torque during operation.

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Brakes

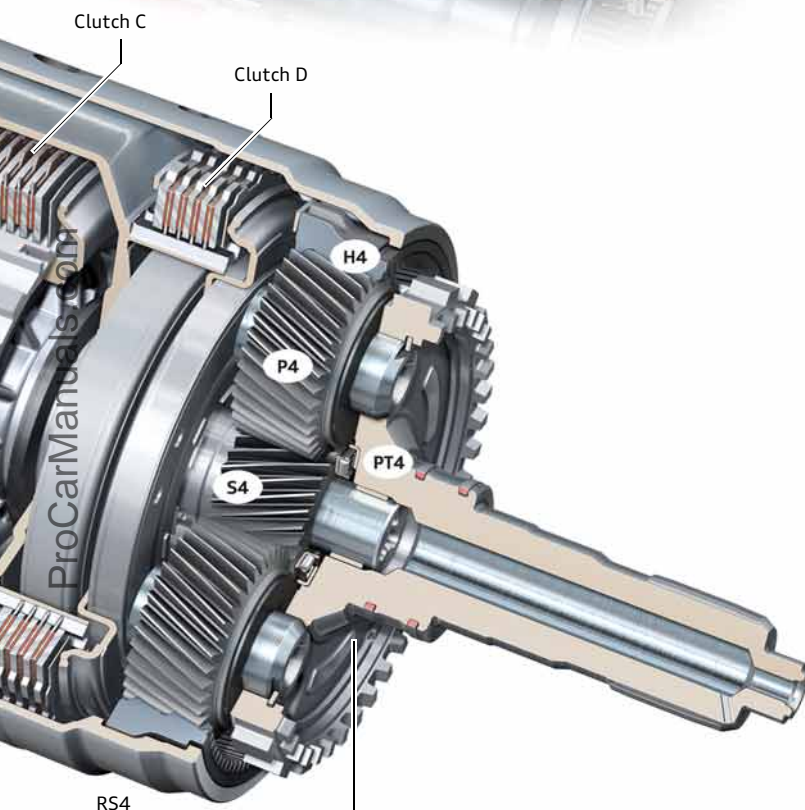
Brake B has a special design. The piston of brake B does not have a resetting spring. This task is performed by a second piston chamber (piston chamber B2).

Brake B has a piston chamber (cylinder) on both sides (piston chamber B1 and piston chamber B2).

Piston chamber B1 is for closing the brake and piston chamber B2 functions as a resetting spring (opening the brake). When brake B is vented, a certain amount of oil pressure is retained inside piston chamber B2 in order to push the piston back into its rest position.

Brake B is operated with slip in neutral idle mode (refer to page 52). Brake B is specially rated for continuous duty in neutral idle mode. It is also cooled in a controlled fashion when activated by the hydraulic unit.

Brake A is fitted with a resetting spring.



Legend of planetary gearbox

RS1 (2, 3, 4)	Planetary gearset 1 (2, 3, 4)
PT1 (2, 3, 4)	Planet carrier 1 (2, 3, 4)
S1 (2, 3, 4)	Sun gear of planetary gearset 1 (2, 3, 4)
P1 (2, 3, 4)	Planetary gears of planetary gearset 1 (2, 3, 4)
H1 (2, 3, 4)	Ring gear of planetary gearset 1 (2, 3, 4)

Clutches

Clutches E, C and D are dynamically pressure-equalised. This means that the clutch piston is swept by oil on both sides in order to avoid any speed-related increase in pressure in the clutch. This pressure-equalising effect is achieved by using a second piston chamber - the pressure equalisation chamber. In the case of clutch D, the pressure equalisation chamber is created by means of a baffle plate. In the case of clutches C and E, the clutch plate carrier acts as a barrier. Oil is pressurelessly supplied to the pressure equalisation chamber through lubrication ducts.

Advantages of dynamic pressure equalisation are:

- ▶ reliable opening and closing of the clutch at all engine speeds
- ▶ greater ease of shifting

Planet carrier PT4 also acts as the gearbox output shaft, the parking lock gear and the encoder wheel for the gearbox output speed sender G195

457_032

To illustrate the shift elements and the planetary gearsets more clearly, several parts are not shown (e.g. the outer plate carriers of the shift elements).



Reference

The function of the shift elements and the dynamic pressure equalisation system is described in detail in SSP 283 and SSP 367.

Shift schematic/shift matrix

All gearshifts from 1 > 8 and from 8 > 1 are so-called "overlap shifts", i.e. during a gearshift one clutch must remain capable of transmitting torque at reduced main pressure until the other clutch is ready to accept the torque (refer to SSP 283, page 52).

In the case of gearshifts which are not (or cannot be) performed directly (e.g. 7 > 3), the longer gear shifts (direct shift) always take priority over the individual downshifts (see examples).

Shift schematic

(possible direct shifts)

Notes on the examples:

the shift schematic shows the technically possible shifts.

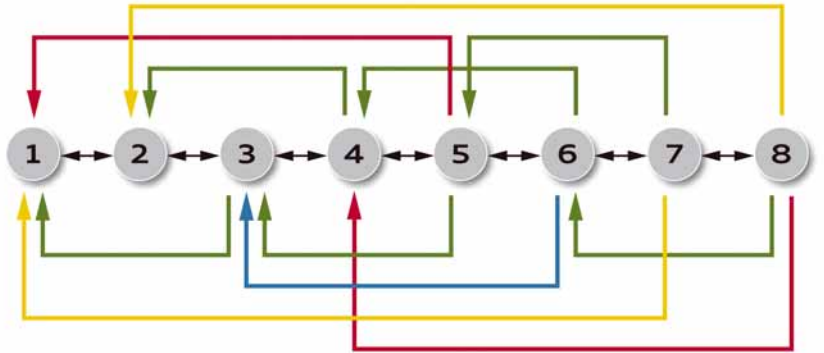
yellow 6 gear change (direct shift)

red 4 gear change (direct shift)

blue 3 gear change (direct shift)

green 2 gear change (direct shift)

In examples 1 and 2, the variations currently not in use are highlighted in grey.



457_053

Example 1: gear shift from 8 > 2:

- ▶ 8-7-6-5-4-3-2
- ▶ 8-6-5-4-3-2
- ▶ 8-4-3-2
- ▶ 8-4-2
- ▶ 8-2

Example 2: gear shift from 7 > 3:

- ▶ 7-6-5-4-3
- ▶ 7-5-4-3
- ▶ 7-6-3
- ▶ 7-5-3

Example 3: gear shift from 6 > 3:

- ▶ 6-5-4-3
- ▶ 6-4-3
- ▶ 6-3

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Shift matrix

	Shift elements/pressure regulating valves/solenoid valves							
	A EPC-A N215	B EPC-B N216	C EPC-C N217	D EPC-D N218	E EPC-E N233	SV-Pos N510	EPC-Sys N443	EPC-LC N371
Parking lock	1	1	1	0	0	0	X	0
Neutral	1	1	1	0	0	1	X	0
Reverse gear	1	1	1	1	0	1	X	0
1st gear	1	1 ¹⁾	0	0	0	1	X	X
2nd gear	1	1	1	0	1	1	X	X
3rd gear	0	1	0	0	1	1	X	X
4th gear	0	1	1	1	1	1	X	X
5th gear	0	1	0	1	0	1	X	X
6th gear	0	0	0	1	1	1	X	X
7th gear	1	0	0	1	0	1	X	X
8th gear	1	0	1	1	1	1	X	X

457_054

- Clutch closed
- Brake closed

Pressure regulating valves/solenoid valve

- 1 active
- 0 not active (a low basic control current is always present)
- X active – control current is dependent on operating state

¹⁾ apart from a small amount of residual torque, brake B is open in neutral idle mode (refer to page 52).

- EPC electric pressure control valve (pressure regulating valve)
- SV solenoid valve

For further information, refer to "Mechatronics" on page 42.

Legend of planetary gearbox – description of gears/torque characteristic (see also figure on page 26)

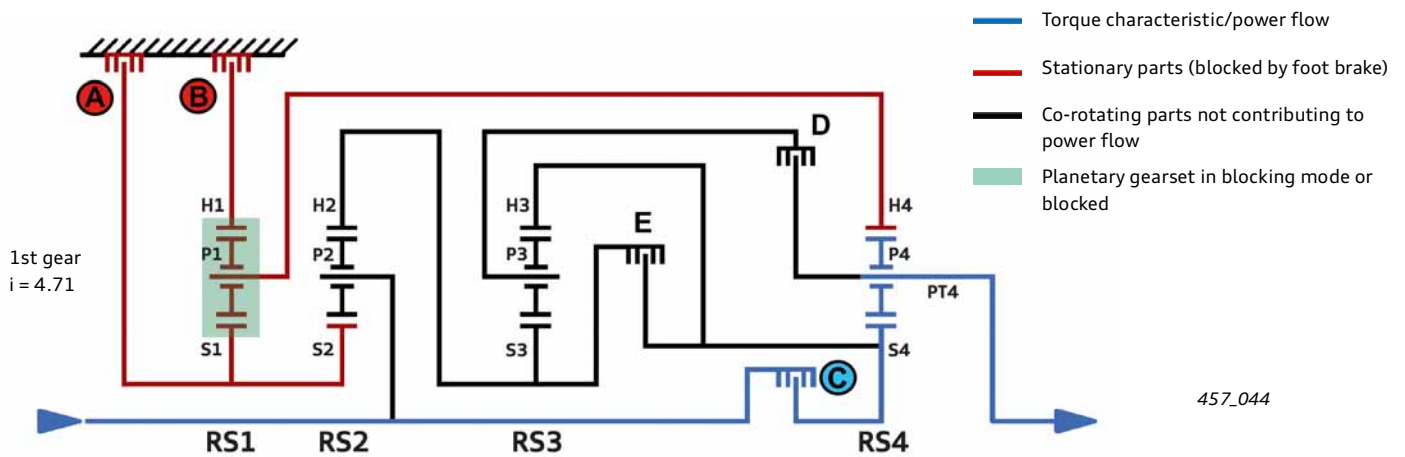
RS1 (2, 3, 4)	Planetary gearset 1 (2, 3, 4)
PT1 (2, 3, 4)	Planetary carrier 1 (2, 3, 4)
S1 (2, 3, 4)	Sun gear of planetary gearset 1 (2, 3, 4)
P1 (2, 3, 4)	Planetary gears of planetary gearset 1 (2, 3, 4)
H1 (2, 3, 4)	Ring gear of planetary gearset 1 (2, 3, 4)



Reference

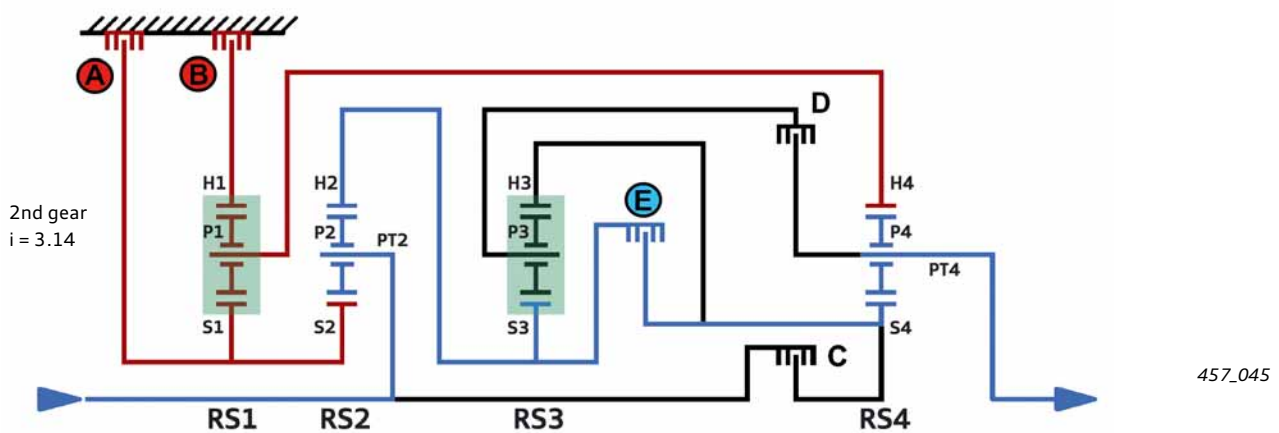
For further explanatory notes on the schematic of the planetary gearbox and the torque characteristic, refer to Self-Study Programme 283, page 55.

Description of gears – torque characteristic



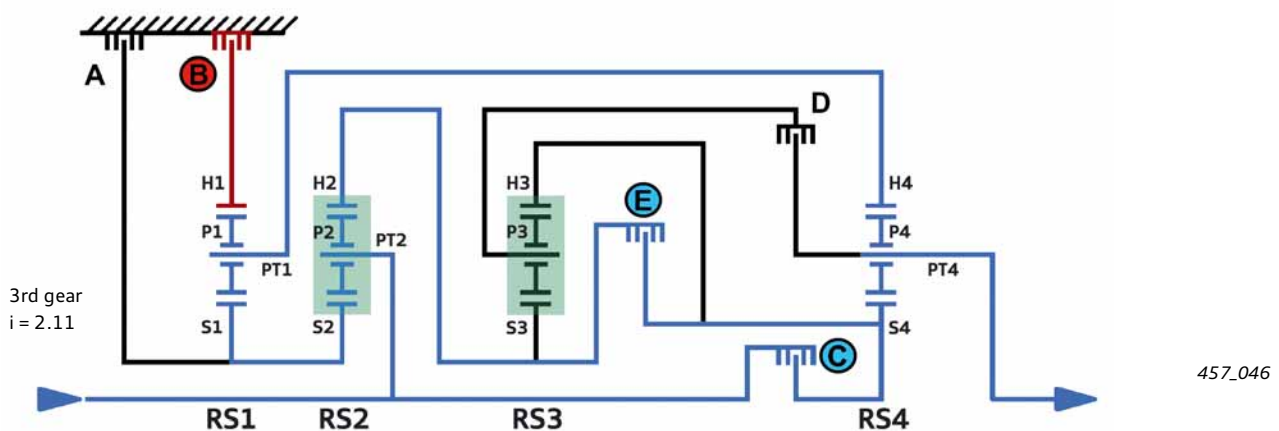
Power flow in 1st gear – activated shift elements: A, B, C

Turbine shaft > clutch C > S4 > P4 > PT4 (> output shaft > transfer case ...)



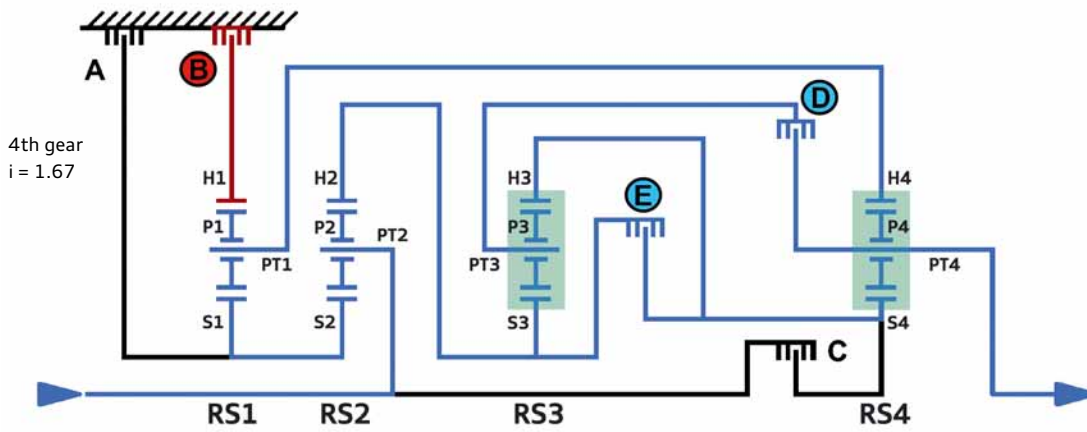
Power flow in 2nd gear – activated shift elements: A, B, E

Turbine shaft > PT2 > P2 > H2 > clutch E > S4 > P4 > PT4 (> output shaft > transfer case ...)



Power flow in 3rd gear – activated shift elements: B, E, C

1. Turbine shaft > clutch C > S4 > P4 > PT4 (> output shaft > transfer case ...)
2. Clutch C > clutch E > H2 > P2 (RS2 blocks power transmission, because H2 and PT2 are connected through clutches C and E)
3. Turbine shaft > PT2 > S2 (PT2 in blocking mode) > S1 > P1 > PT1 > H4
The connection between PT1 and H4 produces a corresponding ratio in RS4 (compare to power flow in first gear)

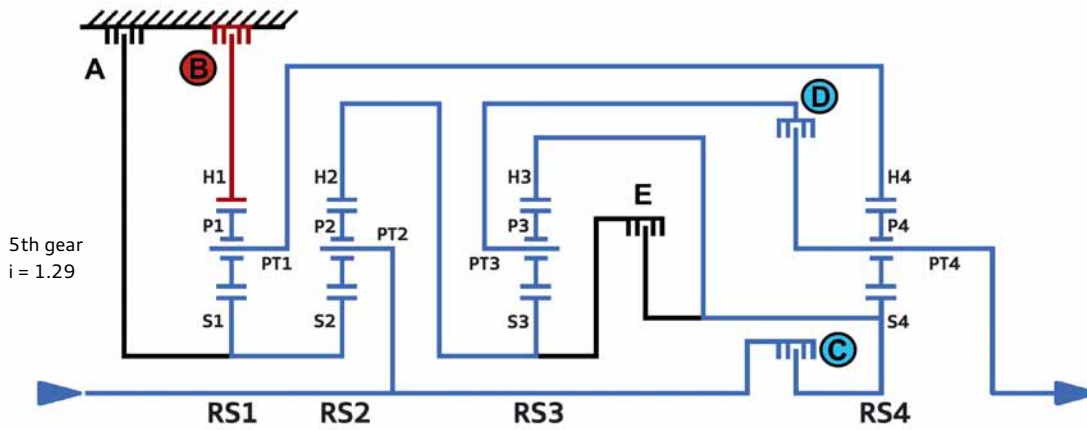


457_047

Power flow in 4th gear - activated shift elements: B, E, D

1. Clutch E blocks power transmission in RS3, and clutch D and the blocking mode of RS3 block power transmission in RS4 (gearsets 3 and 4 rotate at the same speed = output speed)
2. Turbine shaft > PT2 > P2 > S2/S1 > P1 > PT1 > H4 > P4 > PT4 (= output shaft > transfer case ...)

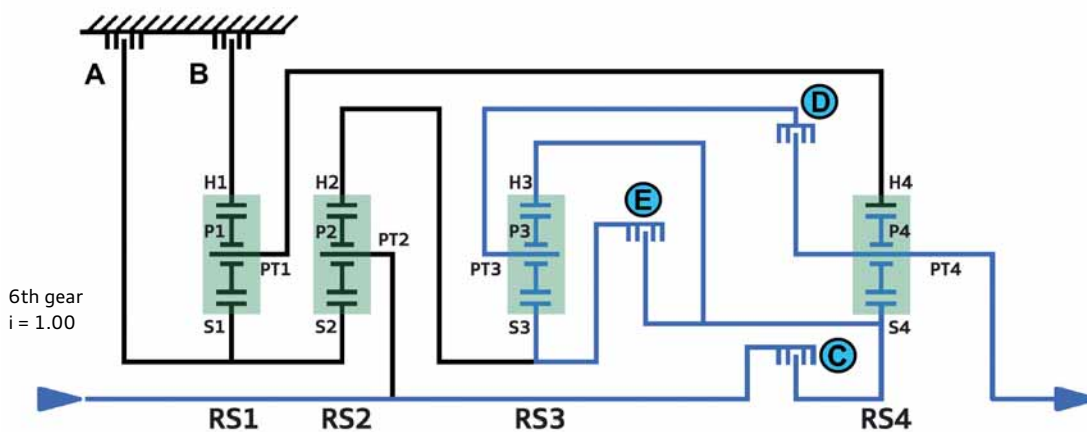
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457_048

Power flow in 5th gear - activated shift elements: B, C, D

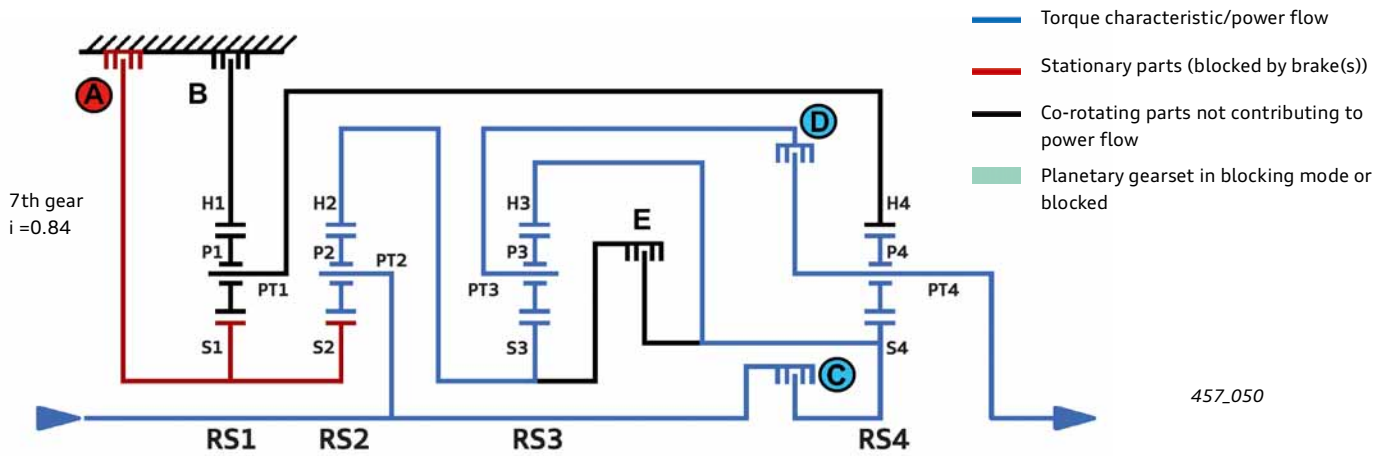
1. Turbine shaft > clutch C > S4 + H3 (PT2, H2 and S4 = turbine speed)
2. Clutch D connects PT3 to PT4 (= output shaft)
3. Turbine shaft > PT2 > P2 > S2/S1 > P1 > PT1 > H4 > results in a speed ratio between S4 (=turbine speed) and H4 with corresponding speed at PT4 (= output shaft > transfer case ...)



457_049

Power flow in 6th gear - activated shift elements: C, D, E

- Clutches E and D block power transmission in RS3 and RS4.
Torque is transmitted to the planetary gearbox through clutch C.
The complete planetary gearbox rotates at turbine speed (blocking mode).

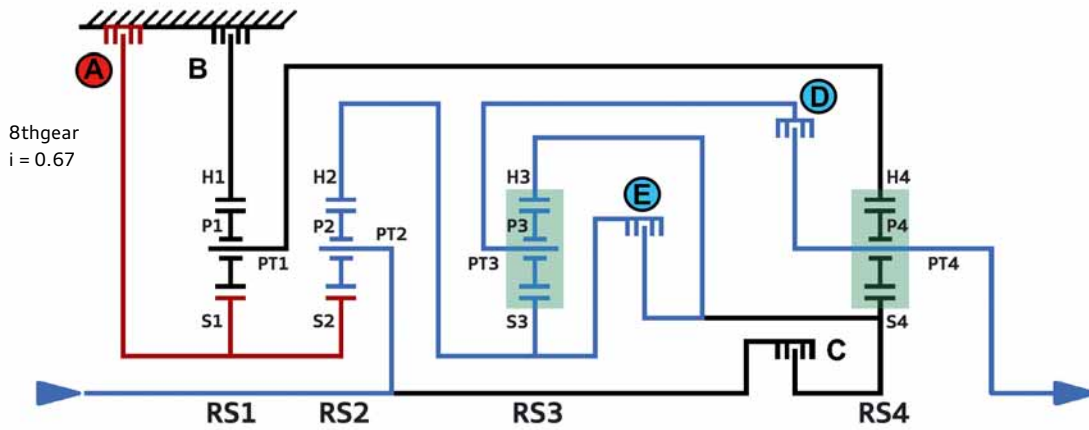


457_050

Power flow in 7th gear – activated shift elements: A, C, D

1. Turbine shaft > clutch C > S4 + H3 (= turbine speed)
2. Turbine shaft > PT2 > P2 > H2 > S3 > P3 > PT3 > clutch D > PT4 (= output shaft > transfer case ...)
Clutch D connects PT3 to PT4 (= output shaft)

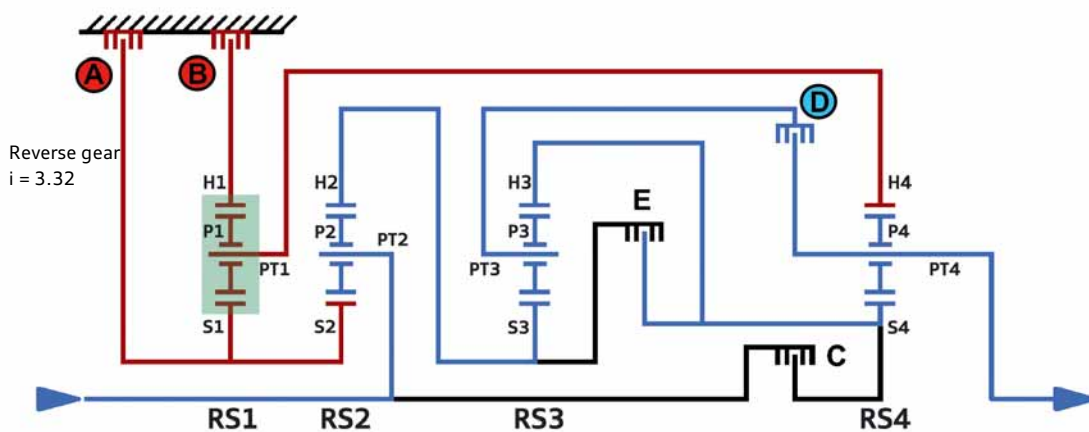
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457_051

Power flow in 8th gear – activated shift elements: A, E, D

1. Clutch E blocks power transmission in RS3
2. Turbine shaft > PT2 > P2 > H2 > RS3 (blocking mode) > clutch D > PT4 (= output shaft > transfer case ...)
Clutch D connects PT3 to PT4 (= output shaft)

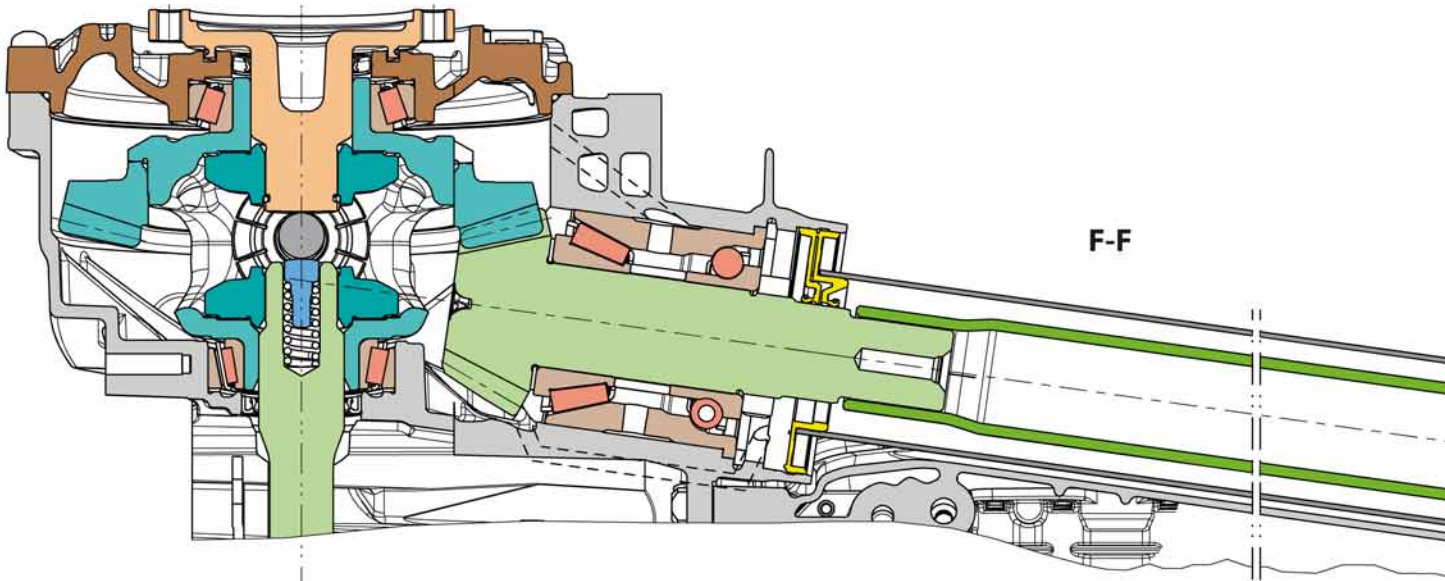


457_052

Power flow in reverse gear – activated shift elements: A, B, D

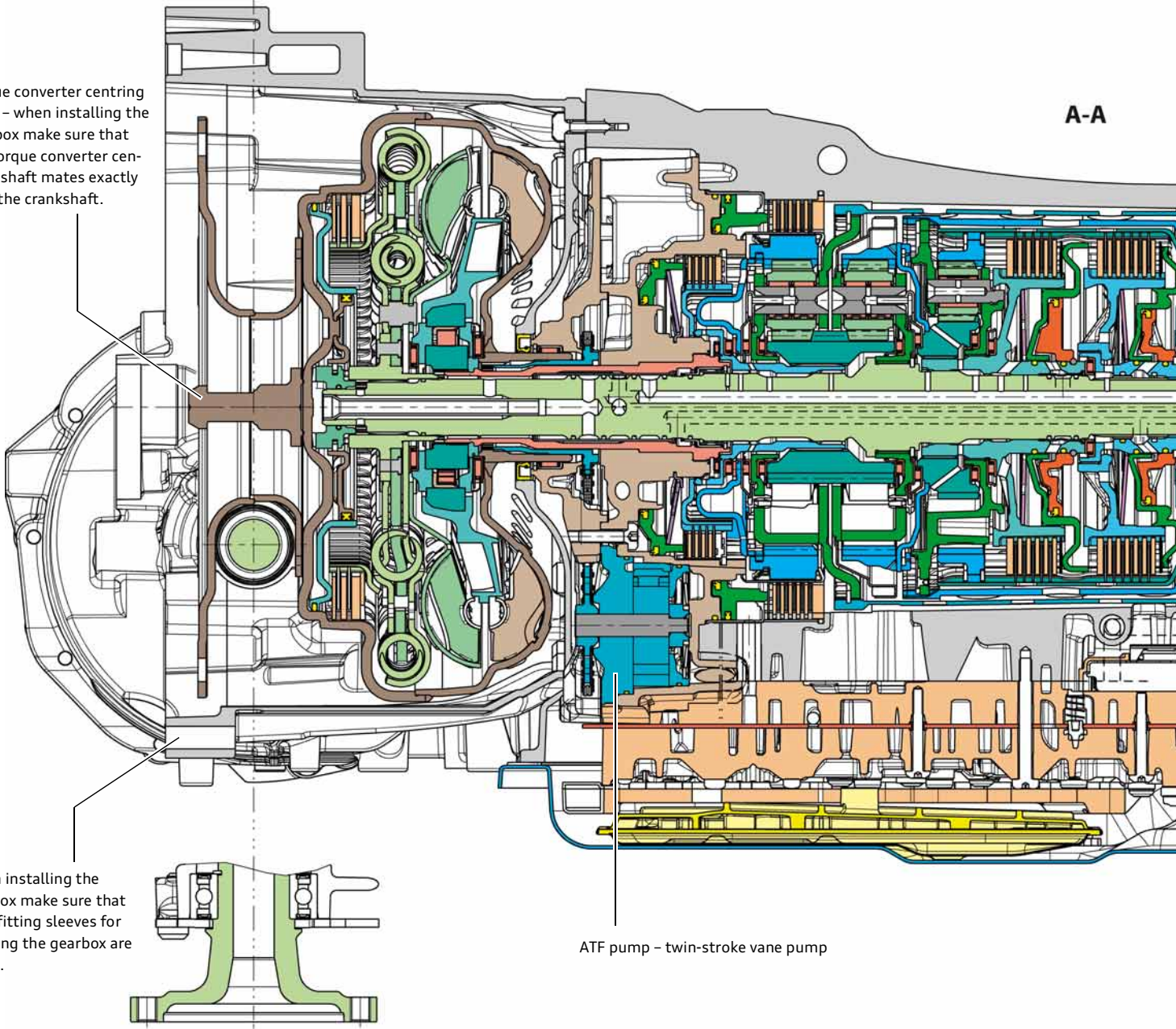
1. Clutch D connects PT3 to PT4 (= output shaft)
2. Turbine shaft > PT2 > P2 > H2 > S3 > P3 > PT3 > clutch D > PT4 (= output shaft > transfer case ...)
H3 is permanently connected to S4. S4 drives P4 in the opposite direction of rotation to that of the engine.
Gears P4 roll against fixed gear H4 and rotate PT4 in the opposite direction of rotation to that of the engine and at the specified ratio.

Sectional view of OBK gearbox



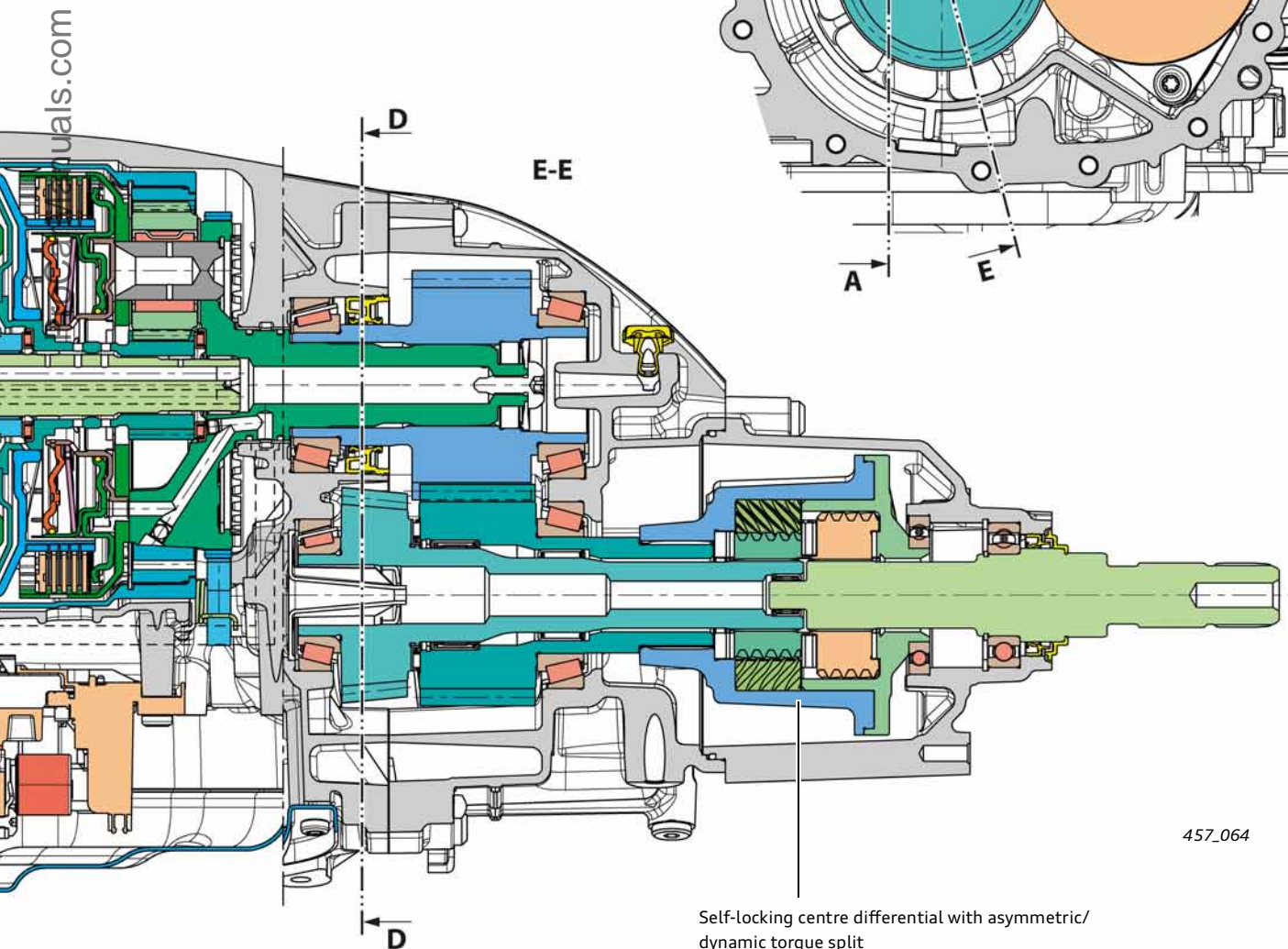
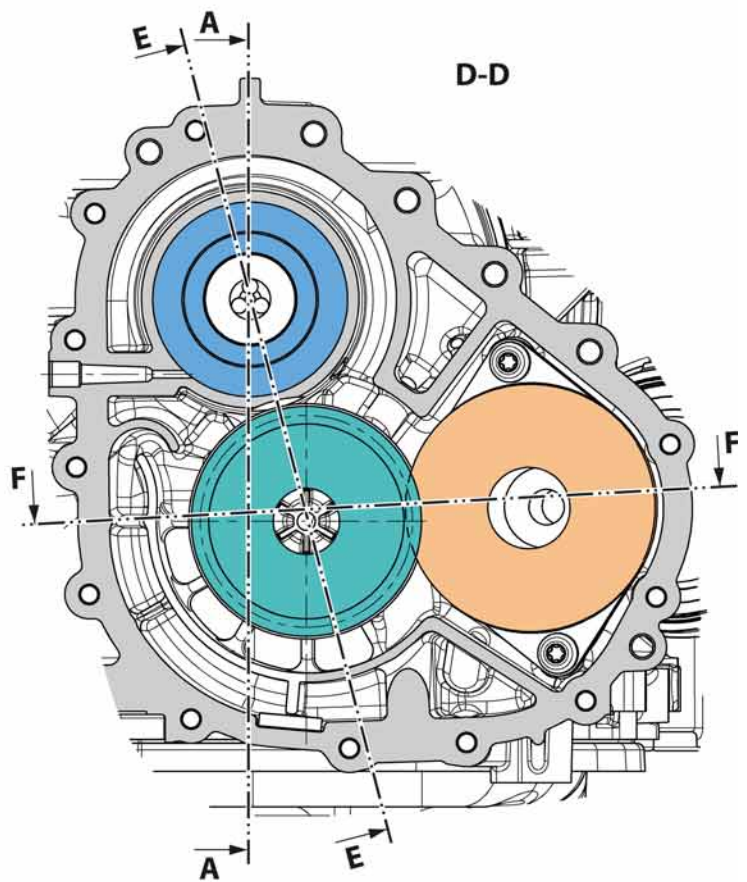
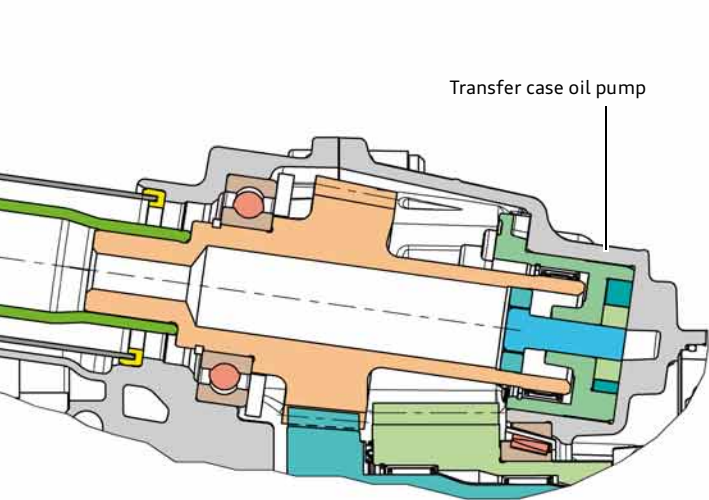
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Torque converter centring shaft - when installing the gearbox make sure that the torque converter centring shaft mates exactly with the crankshaft.



When installing the gearbox make sure that both fitting sleeves for centring the gearbox are fitted.

ATF pump - twin-stroke vane pump



457_064

Self-locking centre differential with asymmetric/
dynamic torque split
Refer to SSP 429, page 22 ff., and SSP 363

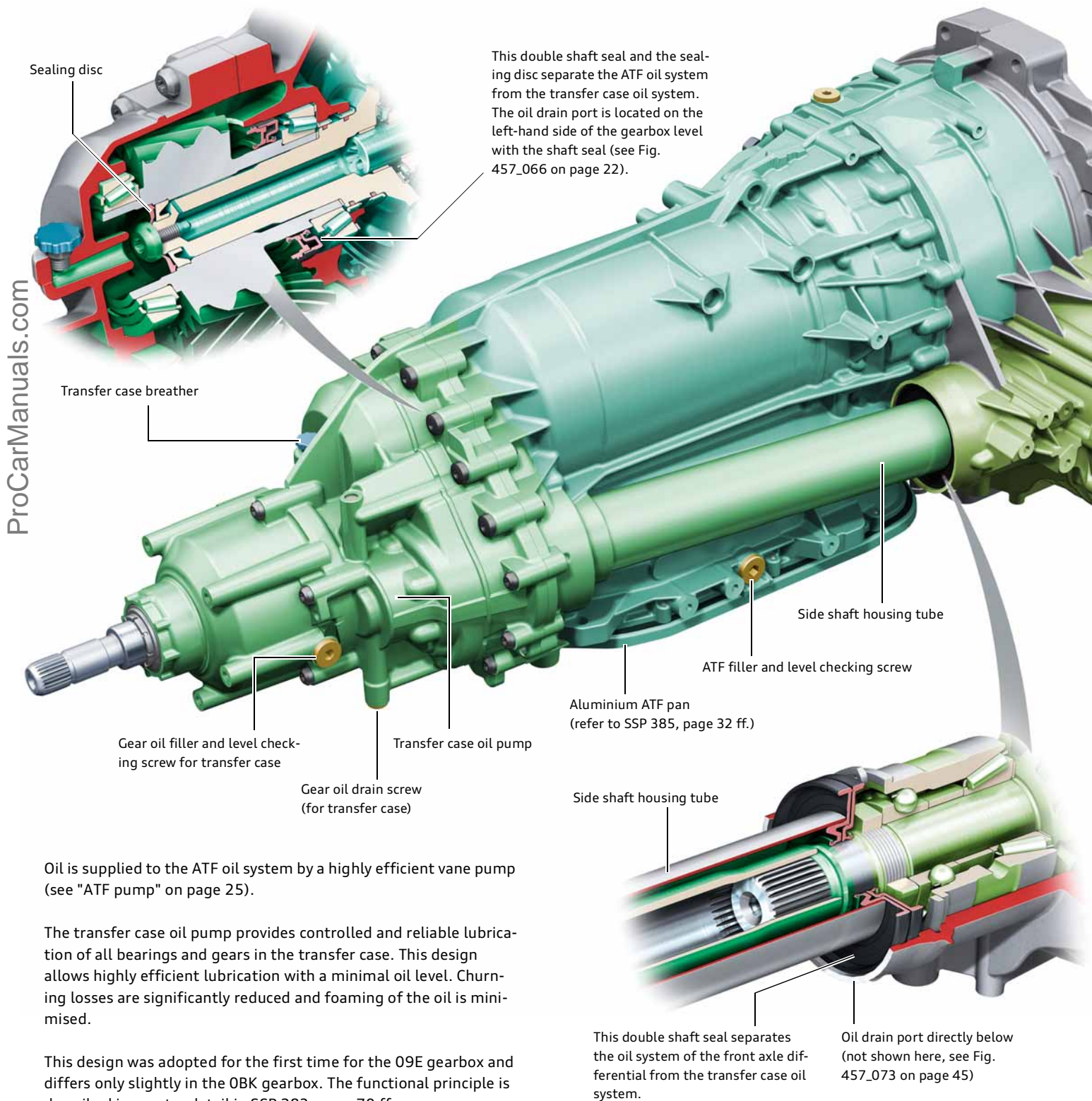
Oil system/lubrication/sealing of OBK gearbox

There are two versions of the oil system in the OBK gearbox:

1. Separate oil systems

The oil chambers (oil systems) of the transfer case and front axle differential are separate. The gearbox has a total of three separate oil systems (oil chambers) filled with different types of oil:

- ATF oil system for the planetary gearbox, the hydraulic control unit and the torque converter
- Oil system for the transfer case (gear oil with STURACO¹⁾)
- Oil system for the front axle drive (gear oil without STURACO¹⁾)



This double shaft seal and the sealing disc separate the ATF oil system from the transfer case oil system. The oil drain port is located on the left-hand side of the gearbox level with the shaft seal (see Fig. 457_066 on page 22).

Oil is supplied to the ATF oil system by a highly efficient vane pump (see "ATF pump" on page 25).

The transfer case oil pump provides controlled and reliable lubrication of all bearings and gears in the transfer case. This design allows highly efficient lubrication with a minimal oil level. Churning losses are significantly reduced and foaming of the oil is minimized.

This design was adopted for the first time for the O9E gearbox and differs only slightly in the OBK gearbox. The functional principle is described in greater detail in SSP 283, page 70 ff.

This double shaft seal separates the oil system of the front axle differential from the transfer case oil system.

Oil drain port directly below (not shown here, see Fig. 457_073 on page 45)

1) STURACO is an oil additive which reduces excessive stresses within the centre differential and thus helps to enhance ride comfort. Pay attention to correct allocation of gear oils as per the part numbers in the Electronic Parts Catalogue (ETKA).

2) In gearboxes with a common oil system, the front axle differential is vented through the transfer case vent. There is no longer a breather on the front axle differential.



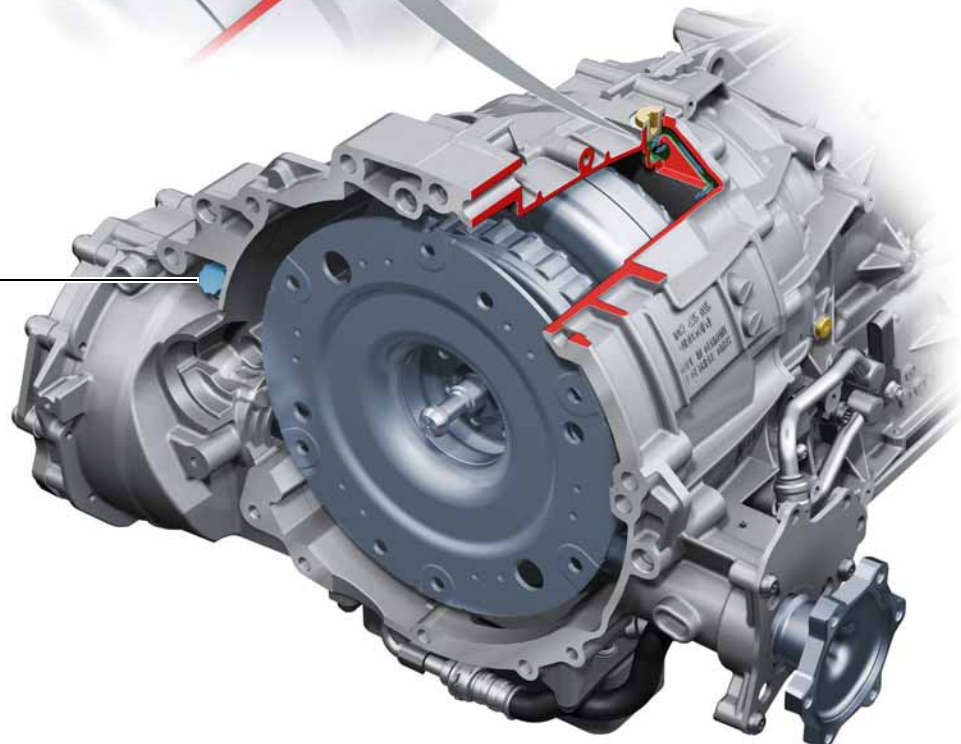
The ATF system ventilates into the converter bell housing via ducts inside the gearcase.



Front axle differential breather²⁾ (only in gearboxes with separate oil systems)

457_037

Axle oil filling and check screw



457_038

2. Common oil system

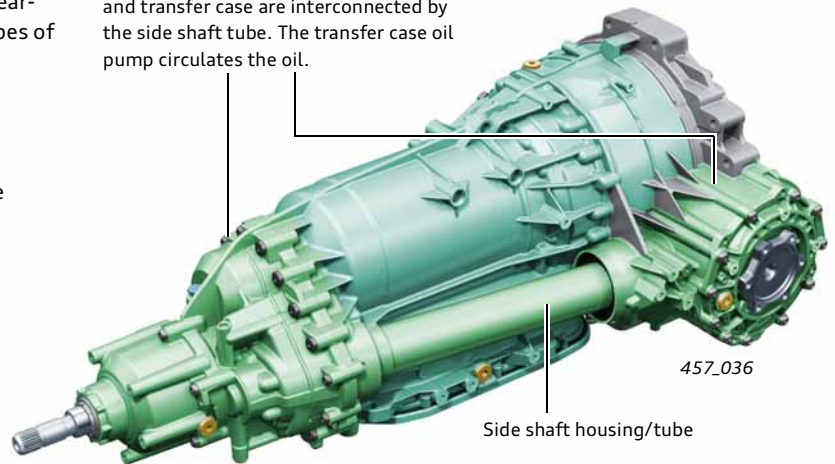
To provide better cooling of the front axle differential, the oil chambers (oil systems) of the transfer case and front axle differential are interconnected and form a common oil system. The gearbox has a total of two oil systems containing two different types of oil:

- ATF system for the planetary gearbox, the hydraulic control unit and the torque converter
- An oil system for the transfer case and the front axle differential (gear oil with STURACO¹⁾)

The OBK gearbox with common oil system is only used in combination with high-output engines (4.0 V8 TFSI and 6.3 W12 FSI).

This gearbox can also be fitted out with a gearbox oil cooler if required (depending on power output and country).

The oil chambers of the front axle drive and transfer case are interconnected by the side shaft tube. The transfer case oil pump circulates the oil.



457_036

Side shaft housing/tube

For further information and notes on the common oil system, refer to page 36.

Oil system/lubrication/sealing of OBL gearbox

Basically, the OBL gearbox has only two oil systems - an oil system filled with ATF and an oil system filled with gear oil (axle oil).

- ATF system for the planetary gearbox, the hydraulic control unit and the torque converter
- Gear oil system for the transfer case and the front axle differential (gear oil with STURACO¹)

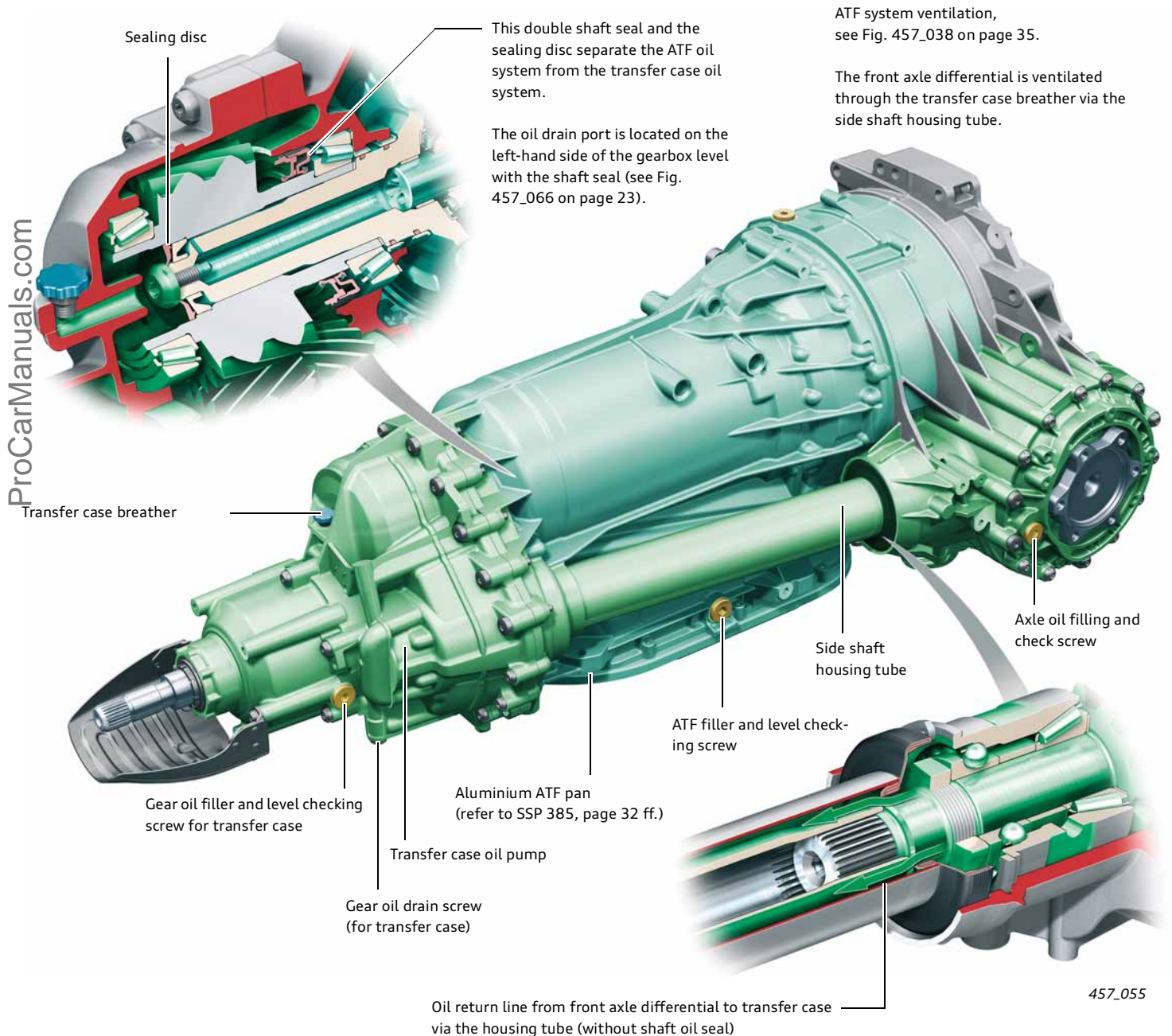
Oil is supplied to the **ATF oil system** by a highly efficient vane pump (see "ATF pump" on page 25).

Gear oil system (common oil system)

To provide better cooling of the front axle differential, the oil chambers (oil systems) of the transfer case and the front axle differential are interconnected and form a common oil system.

The oil pump in the transfer case provides efficient and reliable lubrication of the transfer case and conveys cooler gear oil to the front axle drive.

This design was adopted for the first time for the 09E gearbox and differs only slightly in the OBL gearbox. The functional principle is described in greater detail in SSP 283, page 70 ff.



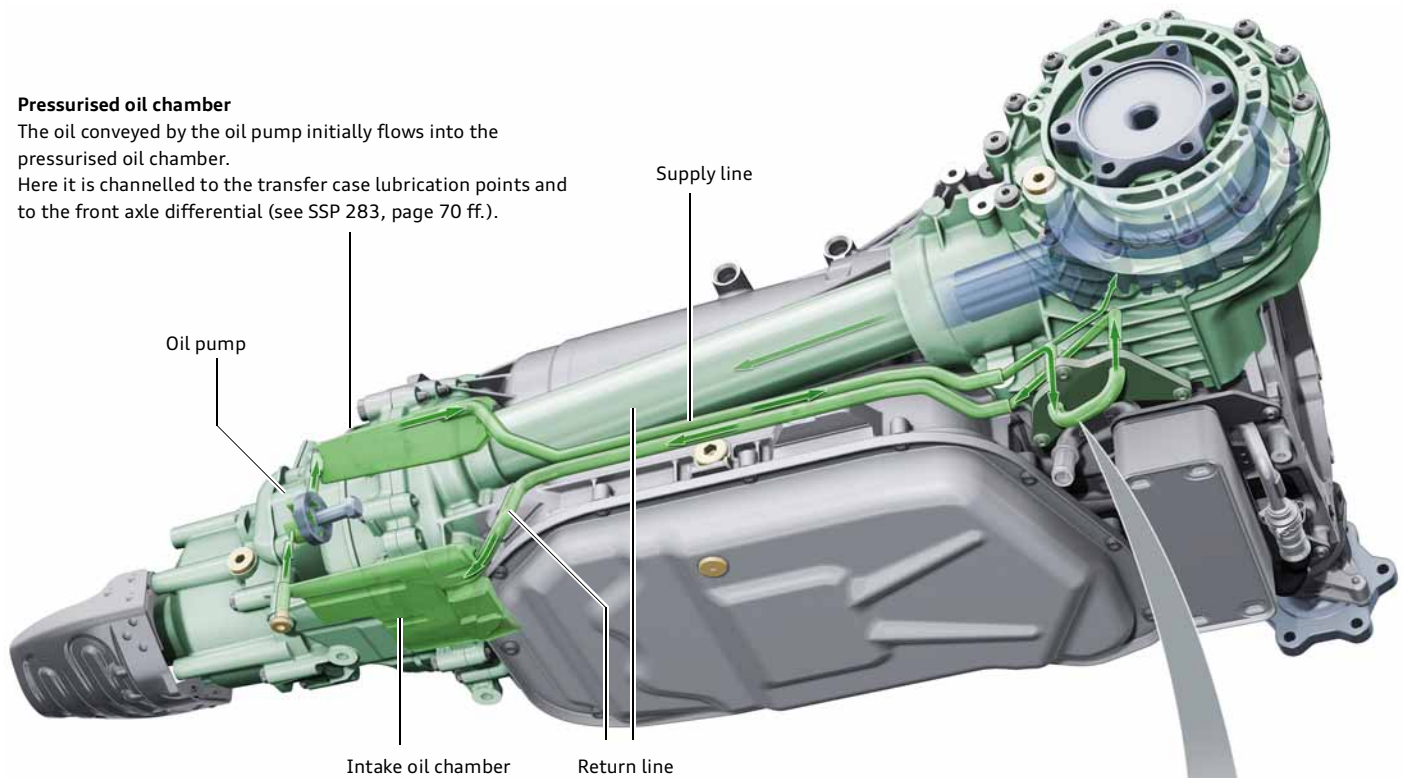
Note

Because of the common oil system, there is a special procedure for filling and checking the gear oil in the front axle differential and transfer case. Different levels are possible depending on the driving situation. When checking the oil level, therefore, the oil level must always be adjusted at both check-points. Refer to the Workshop Manual.

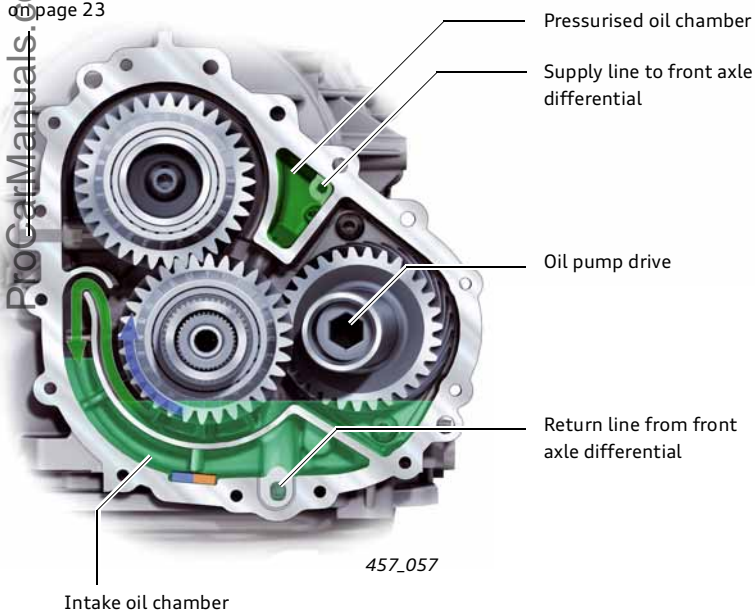
Common oil system – gear oil circuit

Pressurised oil chamber

The oil conveyed by the oil pump initially flows into the pressurised oil chamber. Here it is channelled to the transfer case lubrication points and to the front axle differential (see SSP 283, page 70 ff.).



Position of oil drain port, see Fig. 457_066 on page 23



Connecting tube

No additional gear oil cooling is needed for the current engine version.

To keep the temperature level low enough, it is sufficient to combine both oil systems (transfer case and front axle differential) and circulate the oil.

For this reason, an integrated connecting tube is used in place of a gearbox oil cooler.

Gear oil circuit – function

The oil pump is driven by the side shaft and runs only when the vehicle is travelling (see sectional view of gearbox 457_064 on page 32 and 457_066 on page 23). The intake oil chamber is intelligently separated off from the other part of the transfer case oil chamber. The oil circulated into the intake oil chamber by the intermediate drive sprocket. Here it collects, settles and cools before being drawn in by the oil pump and pumped into the oil chamber. From the pressurised oil chamber, the oil is distributed in a controlled fashion to the bearings and gearing of the transfer case. A portion of the oil is conveyed through a duct to the front axle differential (supply line).

A portion of this oil is, in turn, channelled to the front axle differential, while the other portion is returned to the intake oil chamber via the connecting tube. From here, it is pumped back into the circulation system.

The oil pumped into the front axle differential is recirculated via the side shaft housing tube (see Fig. 457_055). The oil also transfers heat from the front axle differential to the transfer case. The oil temperature drops here because the transfer case is not subjected to as much thermal stress.

Innovative Thermal Management (ITM)

The gearbox cooling system is a part of the Innovative Thermal Management system – or ITM for short.

The aim of the Innovative Thermal Management system is to improve fuel economy by shortening the warm-up phase of the engine and gearbox.

The "Heat Manager" – a newly developed software module in the engine control unit – provides optimal distribution of the heat generated by the engine within the engine cooling circuits (engine heating) to the air conditioning system (interior heating) and to the gearbox (gearbox heating).

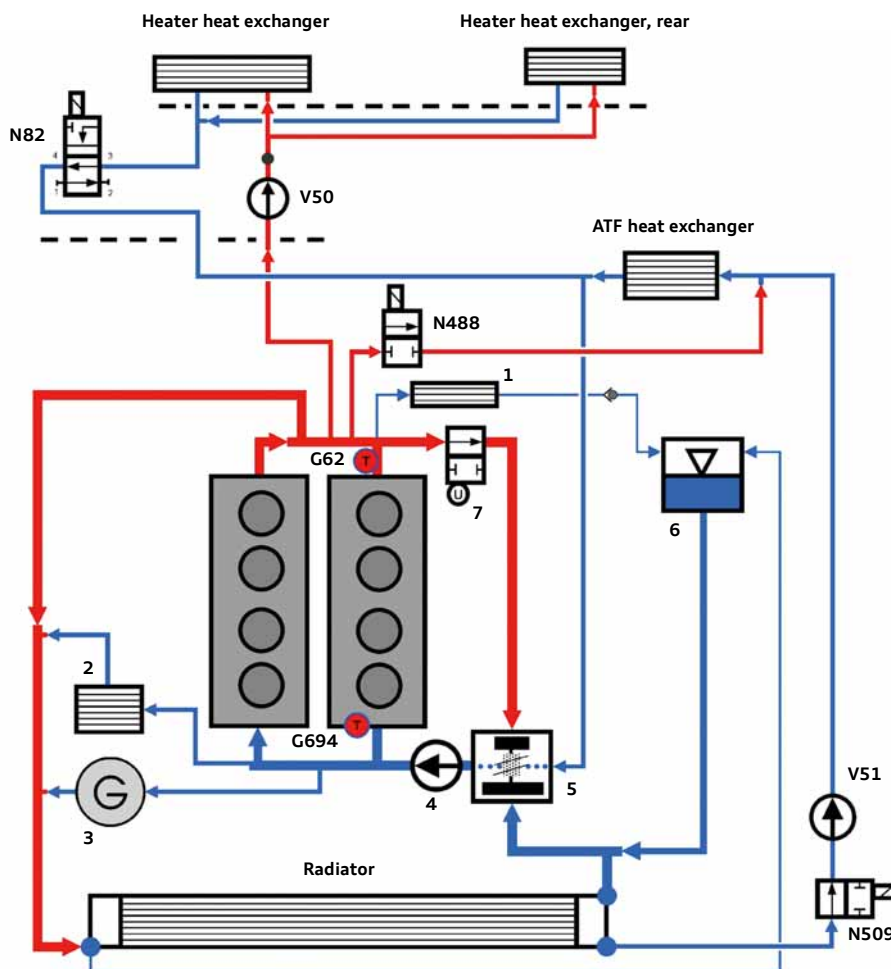
The air conditioner and gearbox control unit indicate their heating requirements to the engine control unit via CAN bus. This information, together with the engine heating requirements, is then weighted, prioritised and used to generate activation signals for the ITM components (valves and controls).

By way of example, the function and design of the gearbox heating and cooling system are discussed here in combination with the 4.2l V8 FSI engine. Other engine combinations differ from one another. Refer to "ATF cooling - OBL gearbox" (4.2l V8 TDI engine) on page 40.

For further information on the ITM system, refer to SSP 456.

Gearbox heating/gearbox cooling – V8 FSI engine

Function diagram – coolant system of Audi A8 '10 with 4.2l V8 FSI engine and OBK gearbox



457_040

G62	Coolant temperature sender	1	Crankcase breather heater
G694	Engine temperature control temperature sender	2	Heat exchanger for engine oil cooling
N82	Coolant shutoff valve (activated by Climatronic J255)	3	Alternator
N488	Gearbox coolant valve (activated by engine control unit J623)	4	Coolant pump
N509	Gearbox cooling valve (activated by gearbox control unit J217)	5	Coolant thermostat (F265 map-controlled engine cooling thermostat)
V50	Coolant circulation pump (activated by Climatronic J255)	6	Coolant expansion tank
V51 ¹⁾	Coolant run-on pump (activated by engine control unit J623)	7	Coolant shutoff valve (vacuum controlled) is activated by cylinder head coolant valve N489, which, in turn, is activated by engine control unit J623

¹⁾ V51 runs in ATF cooling and after-cooling modes

Gearbox heating function

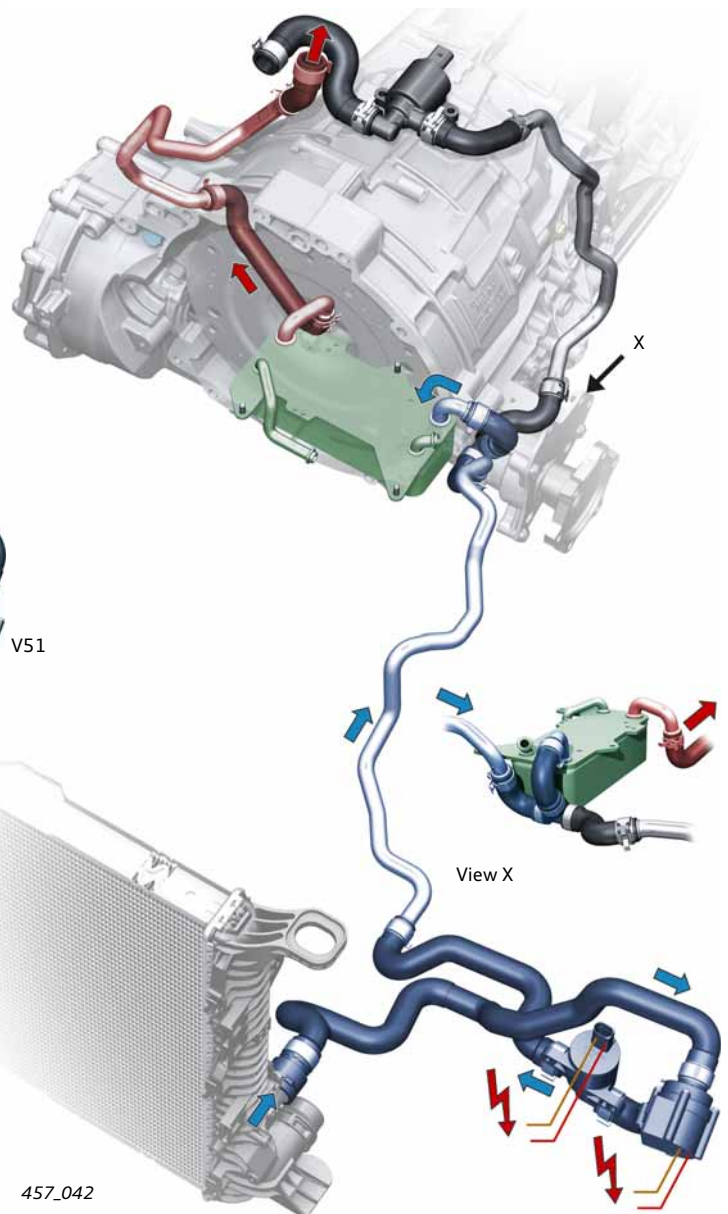
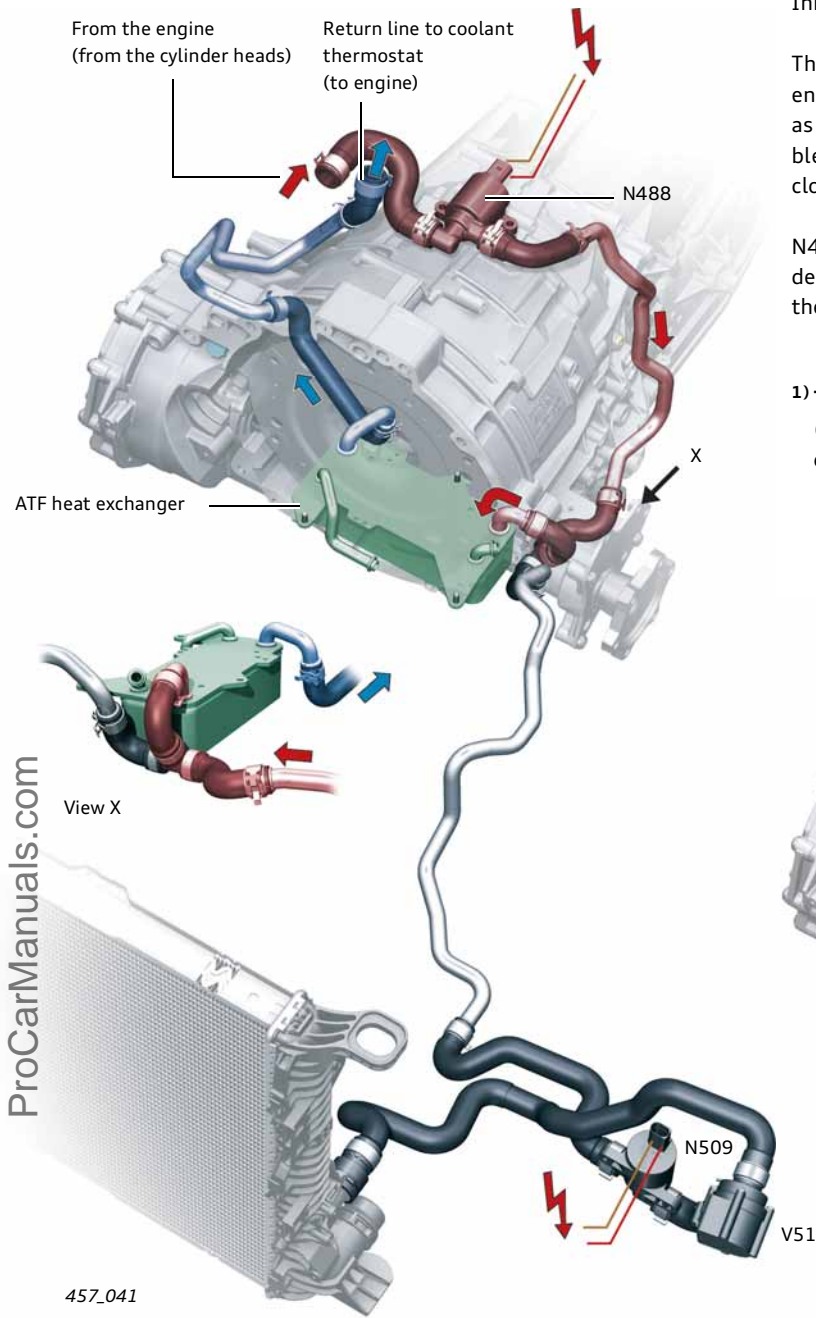
(Fig. 357_041)

Initial situation – engine/gearbox cold

The gearbox control unit signals its heating requirements to the engine control unit ¹⁾ (the objective is to heat up the ATF as quickly as possible). The engine first tries to heat up as quickly as possible. Solenoid valves N509 (energised) and N488 (deenergised) are closed.

N488 is not opened (energised) until the engine has reached a pre-determined target temperature. Warm coolant now flows from the cylinder heads to the ATF heat exchanger. The ATF is heated.

¹⁾ The heating requirements of the air conditioning system (interior heating) have the highest priority. In this case, engine and gearbox heating are secondary.



Gearbox cooling function

(Fig. 357_042)

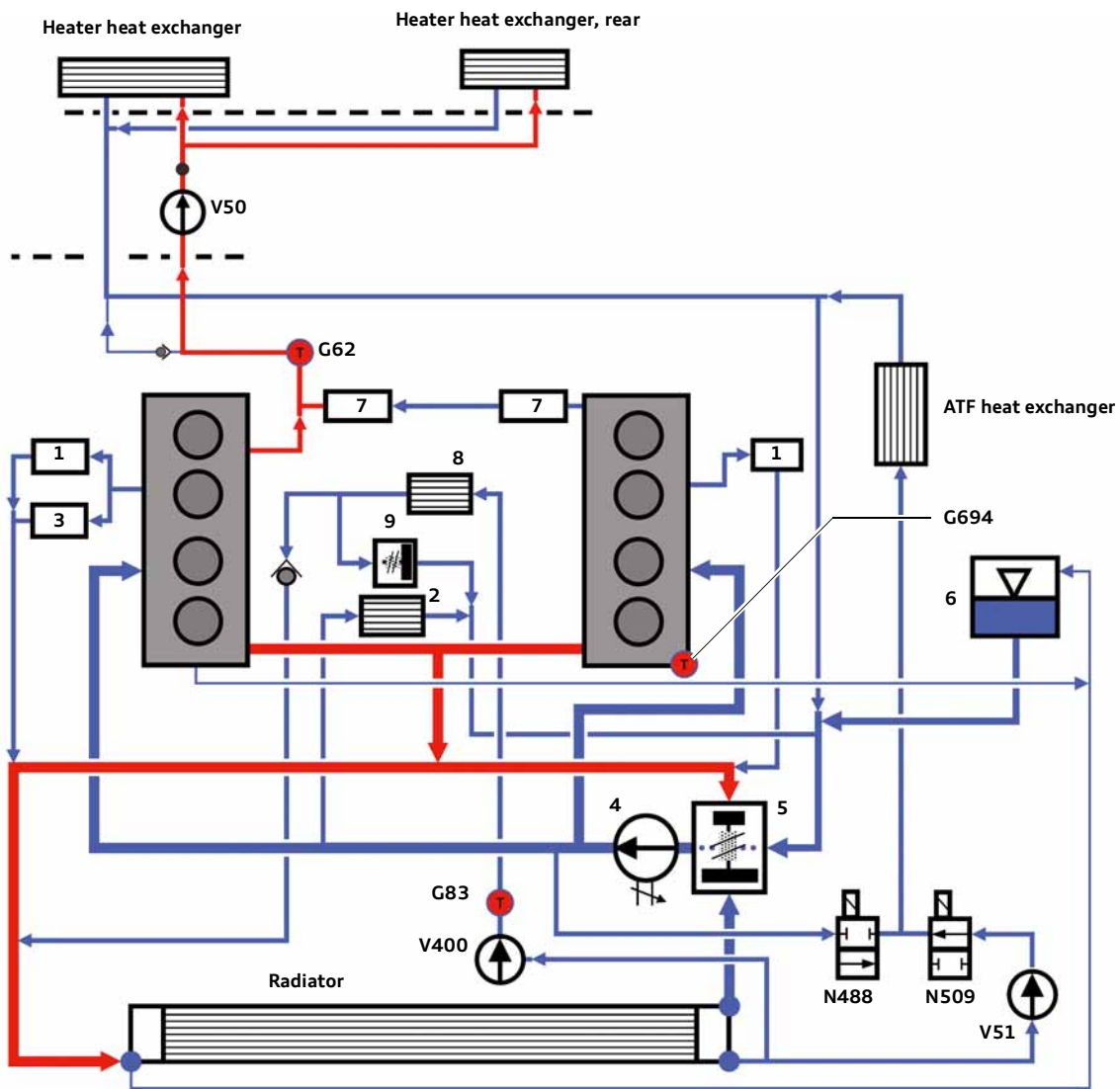
Initial situation – engine/gearbox at operating temperature

The gearbox heating phase ends when a defined ATF temperature is exceeded and N488 is closed (turned off). If the ATF temperature continues to increase, N509 is opened (**deenergised**) and cooled coolant flows from the radiator to the ATF heat exchanger.

If the ATF temperature rises to 96 °C, pump V51 is activated to increase cooling capacity.

Gearbox heating/gearbox cooling – V8 TDI engine

Function diagram – coolant system of Audi A8 '10
with 4.2l V8 TDI engine and OBL gearbox



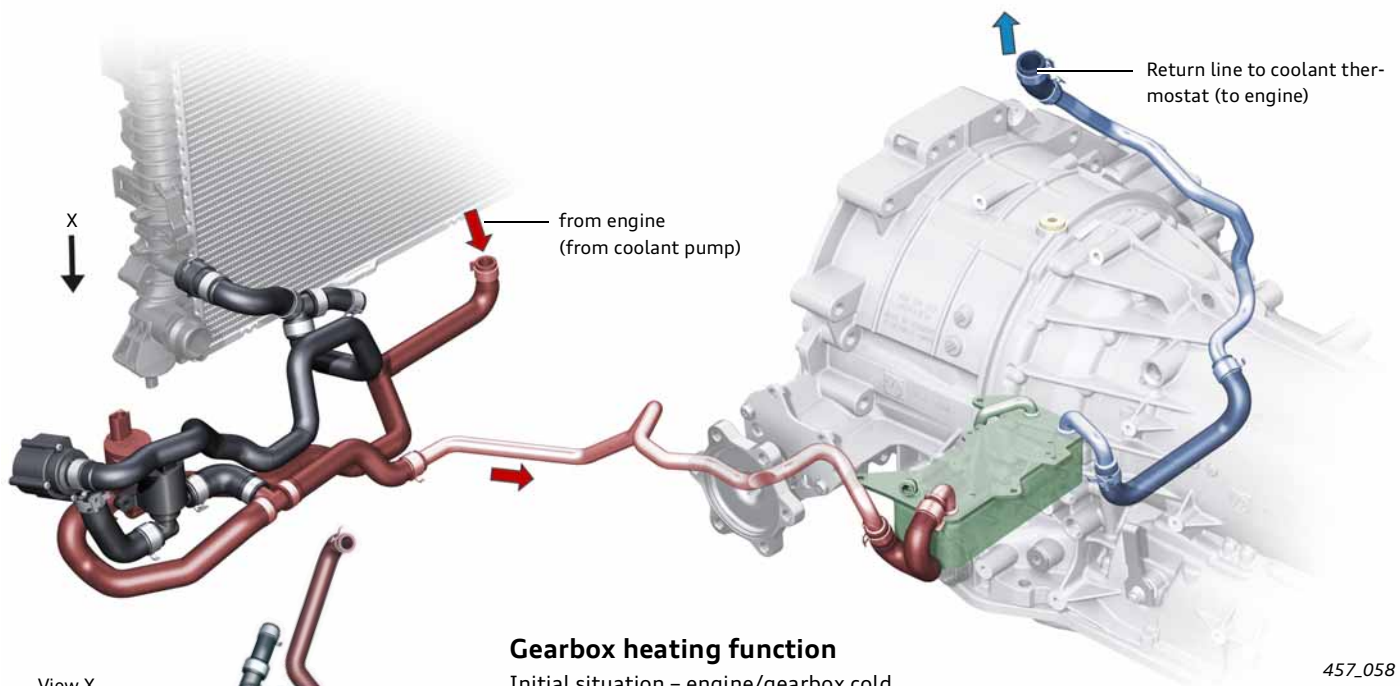
457_039

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- | | | | |
|-------------------|--|---|---|
| G62 | Coolant temperature sender | 1 | Exhaust turbocharger |
| G83 | Radiator outlet coolant temperature sender | 2 | Heat exchanger for engine oil cooling |
| G694 | Engine temperature control temperature sender | 3 | Alternator |
| N488 | Gearbox coolant valve (activated by engine control unit J623) | 4 | Switchable coolant pump – vacuum controlled (by N492 coolant circuit solenoid valve, activated by engine control unit J623) |
| N509 | Gearbox cooling valve (activated by gearbox control unit J217) | 5 | Coolant thermostat (with F265 map-controlled engine cooling thermostat) |
| V50 | Coolant circulation pump (activated by Climatronic J255) | 6 | Coolant expansion tank |
| V51 ¹⁾ | Coolant run-on pump (activated by engine control unit J623) | 7 | Exhaust gas recirculation valve, cylinder bank 1/2 |
| V400 | EGR cooler pump | 8 | Exhaust gas recirculation cooler |
| | | 9 | Exhaust gas recirculation coolant thermostat |

¹⁾ V51 runs in ATF cooling and after-cooling modes

²⁾ applies to page 41 – The heating requirements of the air conditioning system (interior heating) have the highest priority. In this case, engine and gearbox heating are secondary.



View X

457_058

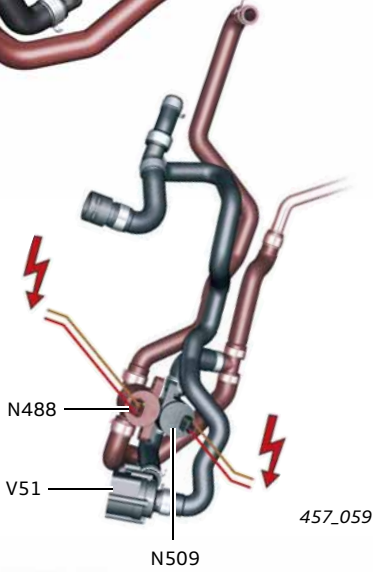
Gearbox heating function

Initial situation – engine/gearbox cold

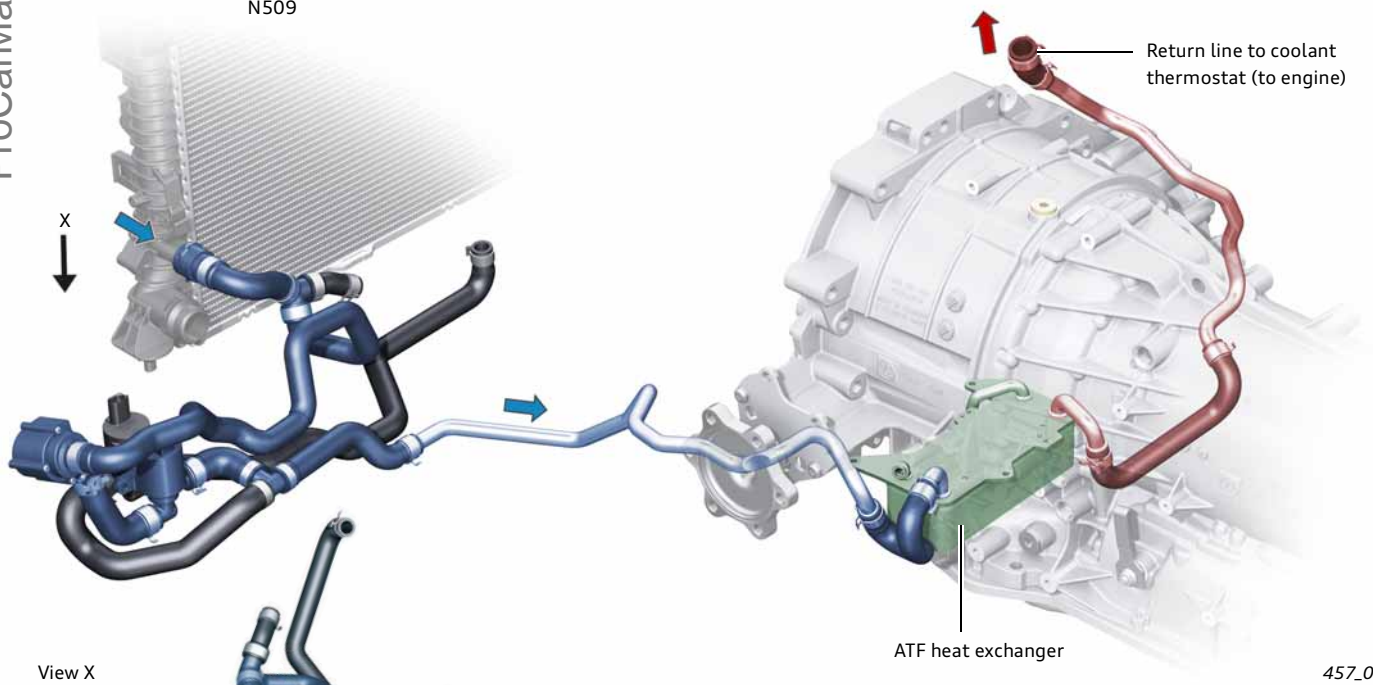
The gearbox control unit signals its heating requirements to the engine control unit ²⁾ (the objective is to heat up the ATF as quickly as possible).

The engine first tries to heat up as quickly as possible. Solenoid valves N509 (energised) and N488 (not energised) are closed and coolant pump 4 (Fig. 457_039) is off (not shown).

Coolant pump 4 (Fig. 457_039) is not activated and N488 is not opened (energised) until the engine has reached a predetermined target temperature. Warm coolant now flows from the coolant thermostat and the coolant pump to the ATF heat exchanger via N488. The ATF is heated.



457_059



View X

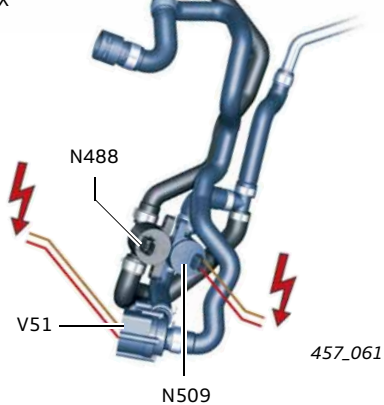
457_060

Gearbox cooling function

Initial situation – engine/gearbox at operating temperature

The gearbox heating phase ends when a defined ATF temperature is exceeded. First of all, N488 is closed (turned off). If the ATF temperature continues to increase, N509 is opened (turned off) and cooled coolant flows from the radiator to the ATF heat exchanger.

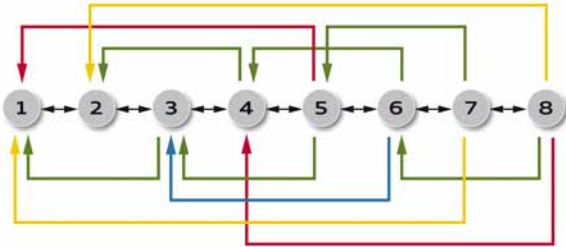
If the ATF temperature rises to approx. 96 °C, pump V51 is activated to increase cooling capacity.



457_061

Mechatronics – electro-hydraulic control system

The increased number of gears has drastically increased the complexity of the clutch control mechanism. This means that an 8-2 downshift can be achieved in various ways. The shift schematic shows the variety of possible shift sequences.



457_053

The shift program selects a suitable shift sequence based on the driver's reaction, driving situation and driving program. The aim is to execute as direct a shift as possible (refer to page 28).

A major innovation contributing to improved gear selection is the inclusion of route data from the navigation system.

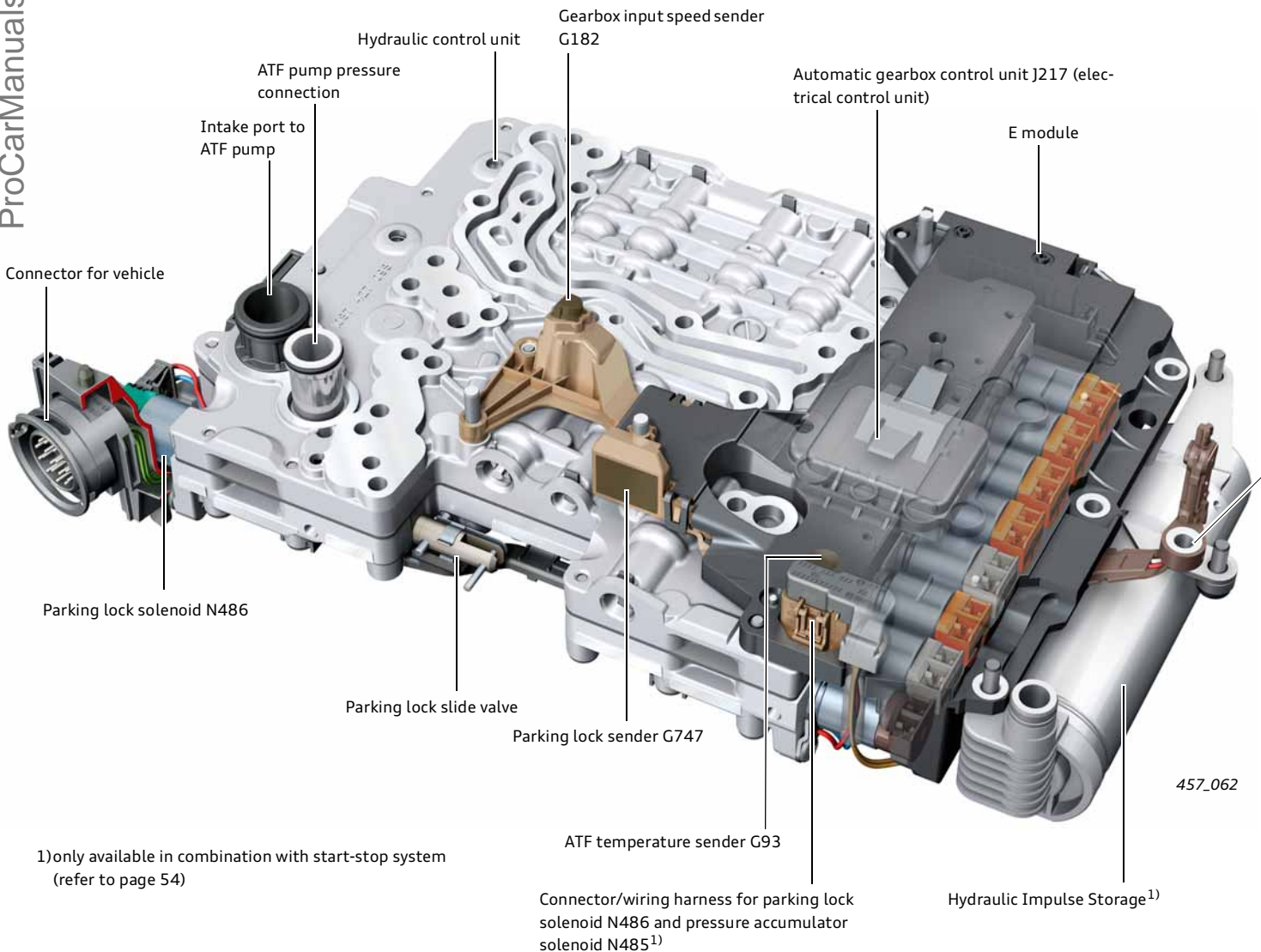
This supplementary information, which provides the driver with a view of the road ahead, makes possible an anticipatory shift strategy with matching gear selection.

Refer to "Navigation-based gear selection", page 58 ff.

The neutral idle control, which minimises torque converter loss when the vehicle is stationary (e.g. when waiting at traffic lights), was previously introduced in the OB6 gearbox (refer to SSP 385). Thanks to systematic further development of the hardware and software, the neutral idle control system in the OBK and OBL gearboxes sets new standards in terms of comfort and fuel economy (refer to page 52).

To enable the mechatronics to perform these tasks in a highly dynamic fashion, the electrical control unit has been fundamentally reworked. The hydraulic control unit and the gearbox mechanism have to be able to react to electrical commands very quickly. In this case too, shift dynamics and control quality have been further improved by enhancing component design.

Mechatronics (E26/6)



457_062

¹⁾ Only available in combination with start-stop system (refer to page 54)



Special care must be taken to ensure that the electronics are protected against electrostatic discharge. Please follow the guidelines and instructions given in SSP 284 (page 6) and in the Workshop Manual.

Mechatronics (E26/6)

Wiring harness from vehicle to E module

Connection for ATF suction filter (for ATF pump)

Wiring harness from E module to parking lock solenoid N486 (refer to page 48)

457_063

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Gearbox output speed sender G195

N88	Solenoid valve 1 (SV-Pos)
N215	Pressure regulating valve 1 (EPC-A)
N216	Pressure regulating valve 2 (EPC-B)
N217	Pressure regulating valve 3 (EPC-C)
N218	Pressure regulating valve 4 (EPC-D)
N233	Pressure regulating valve 5 (EPC-E)
N371	Pressure regulating valve 6 (EPC-LC)
N443	Pressure regulating valve 7 (EPC-Sys)
N486	Parking lock solenoid

Mechatronics/automatic gearbox control unit J217

The mechatronics are integrated into the immobiliser system, which means that there is no hydro-mechanical limp-home function (see SSP 385, page 52 ff.).

Due to the special demands on and complexity of the self-diagnostics, the OBK and OBL gearboxes have adopted the diagnostic data description (to ASAM/ODX standard) which Audi used for the first time in the OB6 gearbox (refer to SSP 385, page 35).

To achieve high shift dynamics and a variety of shift sequences, a separate electrical pressure regulating valve (EPC) is assigned to each shift element.

Replacing the mechatronics

Care must be taken to ensure that the control unit and electronic components are not damaged by electrostatic discharges when replacing the mechatronics.

After a gearbox software update or after replacing the mechatronics, the following points must be checked and carried out:

- ▶ Control unit coding (refer to page 63)
- ▶ Adaption of the gear indicator (refer to page 63)
- ▶ Adaption of the shift elements (refer to page 53)



Reference

For general information and notes on the mechatronics and the sensors, refer to Self-Study Programme 284 and 385.

Mechatronics – actuators

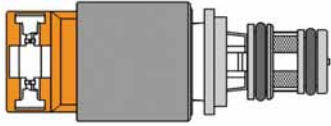
Pressure regulating valves, also referred to as EPCs (electric pressure control valves), convert a control current to a hydraulic control pressure. They are activated by the gearbox control unit and control the hydraulic valves (slide valves) belonging to the shift elements.

Two types of electronic pressure regulating valve are fitted:

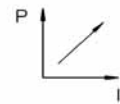
- ▶ EDC with rising characteristic – deenergised – no control pressure (0 mA = 0 bar)
- ▶ EDC with falling characteristic – deenergised – maximum control pressure (0 mA = approx. 5 bar)

Pressure regulating valves – solenoid valves

Pressure regulating valves 1, 2, 4, 5, 6 (orange)



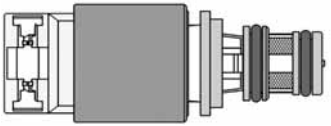
457_067



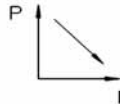
Pressure range 0 to 4.7 bar
 Operating voltage 12 V
 Resistance at 20 °C 5.05 ohms
 Characteristic rising

- 1 N215 pressure regulating valve 1 – brake A
- 2 N216 pressure regulating valve 2 – brake B
- 4 N218 pressure regulating valve 4 – clutch D
- 5 N233 pressure regulating valve 5 – clutch E
- 6 N371 pressure regulating valve 6 – lockup clutch

Pressure regulating valves 3, 7 (white)



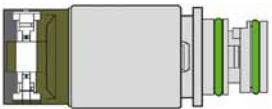
457_068



Pressure range 4.7 to 0 bar
 Operating voltage 12 V
 Resistance at 20 °C 5.05 ohms
 Characteristic falling

- 3 N217 pressure regulating valve 3 – clutch C
- 7 N443 pressure regulating valve 7 – system pressure

Solenoid valve 1 – N88 (black/brown)



457_069

Operating voltage < 16 V
 Pick-up voltage > 6 V
 Dropout voltage < 5 V
 Resistance at 20 °C 11 ohms +/- 2 ohms

N88 is an electrically operated solenoid valve. It is a so-called 3/2 valve, i.e. it has 3 terminals and 2 switching positions (open/close or on/off).

N88 is activated by the gearbox control unit and controls both the position valve and the parking lock valve. The position valve replaces the previous gear selector valve for selector lever cable operated shift controls. The position valve regulates the system pressure for the various clutches and brake control operations.

The parking lock valve controls the system pressure for the parking lock slide valve. The parking lock slide valve operates the parking lock - a task it has taken over from the selector lever cable. The task of the parking lock slide valve is to disengage the parking lock (refer to "Parking lock", page 48 ff.).

Shift matrix

	Shift elements/pressure regulating valves/solenoid valves							
	A EPC-A N215	B EPC-B N216	C EPC-C N217	D EPC-D N218	E EPC-E N233	SV-Pos N510	EPC-Sys N443	
Parking lock	1	1	1	0	0	0	X	0
Neutral	1	1	1	0	0	1	X	0
Reverse gear	1	1	1	1	0	1	X	0
1st gear	1	1 ¹⁾	0	0	0	1	X	X
2nd gear	1	1	1	0	1	1	X	X
3rd gear	0	1	0	0	1	1	X	X
4th gear	0	1	1	1	1	1	X	X
5th gear	0	1	0	1	0	1	X	X
6th gear	0	0	0	1	1	1	X	X
7th gear	1	0	0	1	0	1	X	X
8th gear	1	0	1	1	1	1	X	X

- Clutch closed
- Brake closed

Pressure regulating valves/solenoid valve

- 1 active
- 0 not active (a low basic control current is always present)
- X active – control current is depending on operating condition

¹⁾ apart from a small amount of residual torque, brake B is open in neutral idle mode (refer to page 52).

- EPC Electric pressure control valve (pressure regulating valve)
- SV Solenoid valve

457_070

Parking lock solenoid – N486 (green)

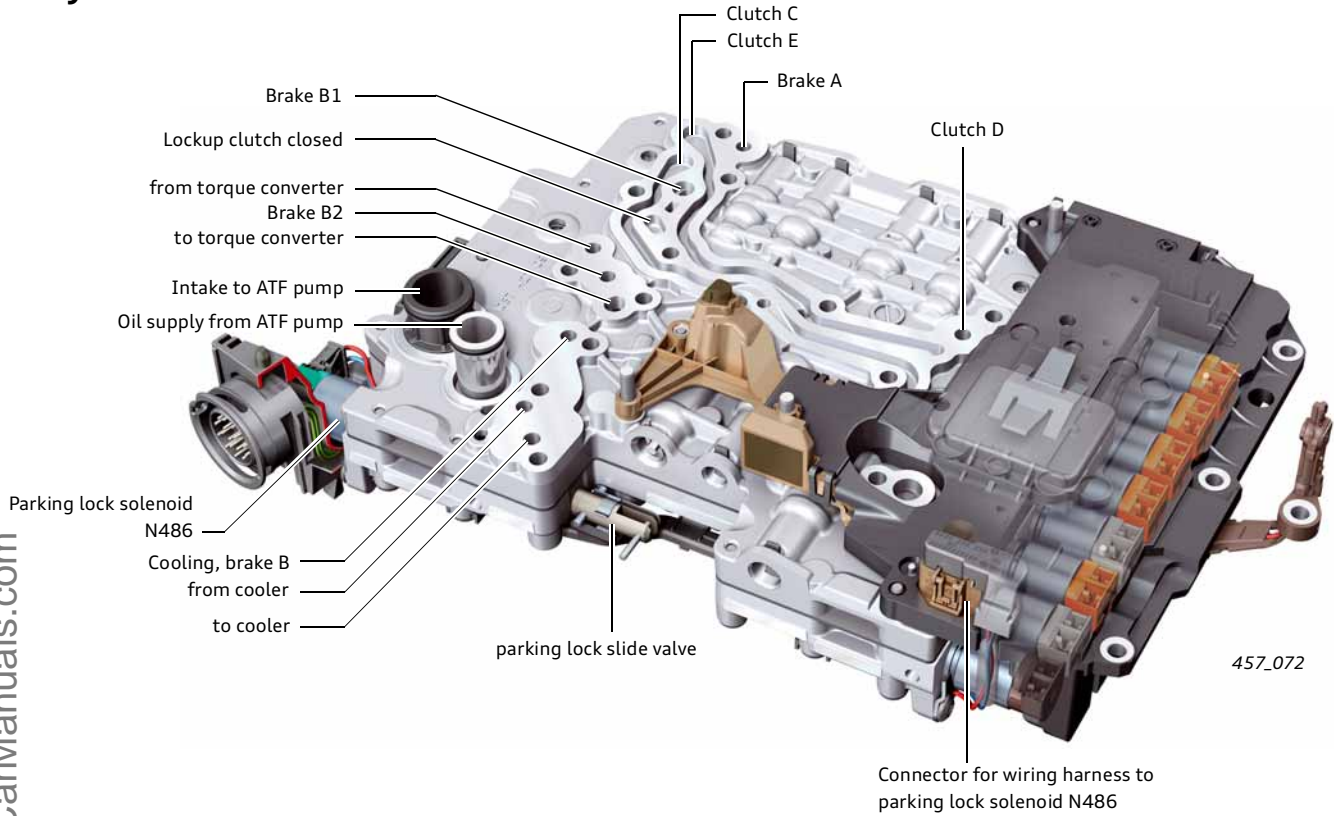


Operating voltage < 16 V
 Pick-up voltage > 8 V
 Resistance at 20 °C 25 ohms +/- 2 ohms

The parking lock solenoid N486 serves to hold of the parking lock slide valve in the "parking lock disengaged" position (refer to "Parking lock", page 48 ff.).

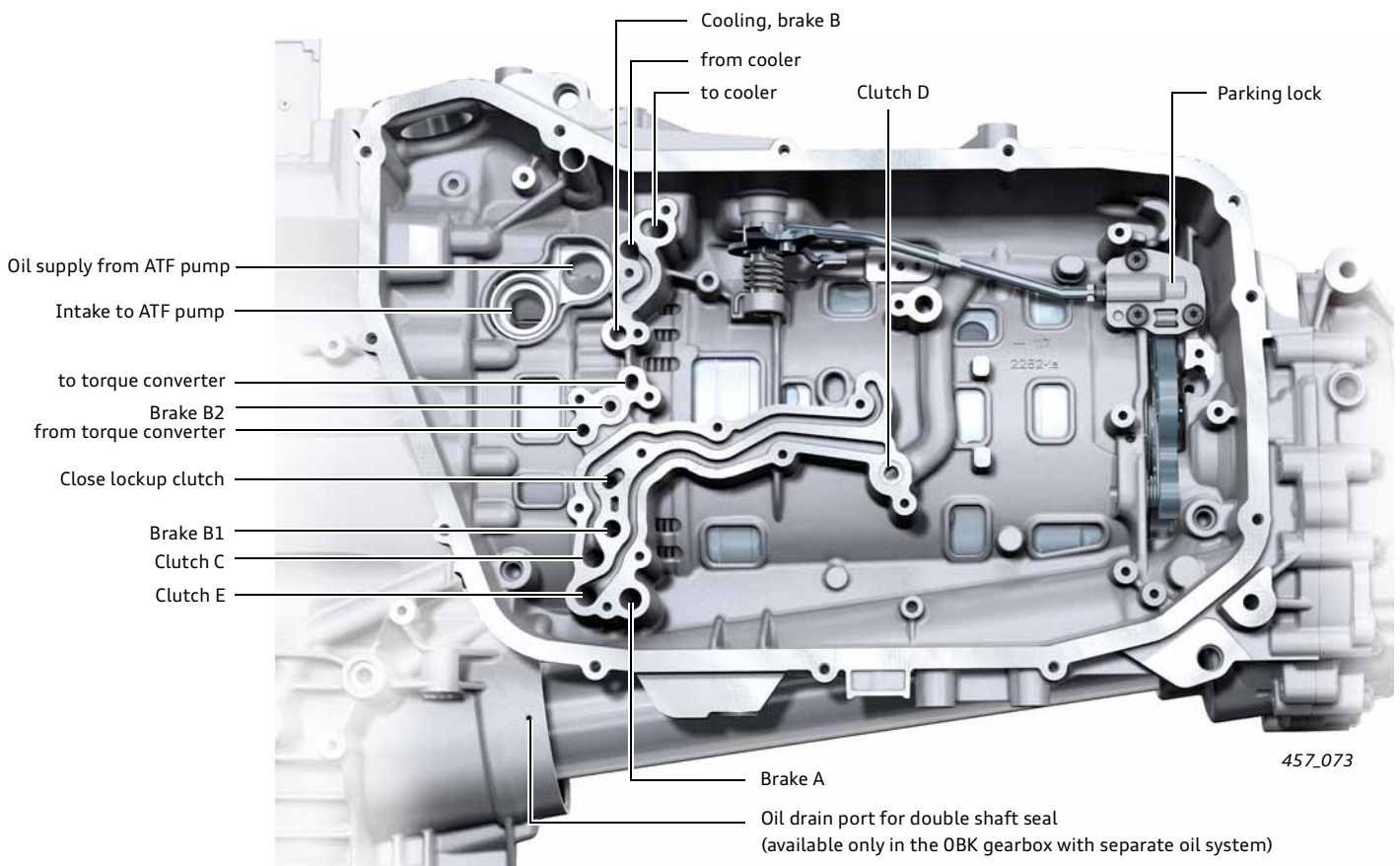
457_071

Hydraulic interfaces



457_072

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457_073

Monitoring of temperature in J217

Due to the integration of the electronics into the (ATF-lubricated) gearbox, it is very important to monitor the control unit temperature, i.e. the ATF temperature.

High temperatures have a significant impact on the service life and performance of electronic components.

Temperatures over 120 °C shorten the service life of electronic components in the control unit. At temperatures over 150 °C, it is no longer possible to rule out damage to components, and hence malfunctioning of the whole system.

To provide protection against overheating, countermeasures are taken when predetermined threshold temperatures are exceeded. The DSP (dynamic shift program) has separate programs specifically for this purpose (refer to SSP 284, page 41 Hotmode programs).

Hotmode

Hotmode is subdivided into 3 stages:

Stage 1 > 124 °C substrate temperature
(126 °C ATF temperature, G93)

The shift points are adjusted to higher RPM using the DSP function. The operating range within which the lockup clutch is closed is extended.

Stage 2 > 139 °C substrate temperature
(141 °C ATF temperature, G93)

Engine torque is significantly reduced depending on the extent to which the temperature continues to increase.

To measure the temperature of the microprocessor (main processor of J217) as accurately as possible, a so-called substrate temperature sensor is integrated into the substrate¹⁾ of the semiconductor blocks.

¹⁾ "substrate" is the base ceramic of the semiconductor components or microprocessor. The substrate temperature sensor is integrated directly in the substrate adjacent to the microprocessor and measures the substrate temperature directly in situ.

Stage 3 > 145 °C substrate temperature
(147 °C ATF temperature, G93)

For protection against overheating of the control unit (associated with malfunctioning and component damage), the power supply to the solenoid valves is disconnected. The gearbox loses positive engagement. A fault is stored in the event logger.

All temperature specifications refer to the software version valid at the time of preparation of the SSP. The temperature specifications for other software versions can differ.

Monitoring of the oil temperature spectrum

The control unit J217 checks the current gearbox temperature range at regular intervals using the gearbox oil (ATF) temperature sender G93. The measurement data is stored. From this data it is possible to determine the thermal load on the gearbox throughout its life cycle. This is referred to as an oil temperature spectrum²⁾.

The oil temperature spectrum is used by the manufacturer for analysing component damage to the E module of the mechatronics.

²⁾ A spectrum is a collection of measured data or readings of any size which can be used for statistical evaluation by means of weighting and quantification.

Mechatronics – sensors

Speed senders G182, G195 and the parking lock sender G747 are configured as Hall sensors.

For information on the parking lock sender G747, refer to page 51.

For further information on the speed senders and the ATF temperature sender G93, refer to SSP 283, page 16 ff.

For further information on the functional principle of Hall sensors, refer to SSP 268, page 34 ff.

Sensors G93, G182, G195 and G747 are integral to the E module. The E module cannot be replaced separately. In the event of a fault in one of the specified components, the complete mechatronics must be replaced.

Gearbox input speed sender G182 Gearbox output speed sender G195

Contrary to the information given in SSP 268, the gearbox input speed sender G182 has an encoder wheel with a magnetic ring. The encoder wheel is connected to planetary carrier 2. G182 measures the rotational speed of the planetary carrier of the second planetary gearset (PT2). Planetary carrier 2 is interlockingly connected to the turbine shaft. (turbine input speed = gearbox input speed).

The cylinder connecting the planetary carrier 1 to the ring gear 4 is located above the magnetic ring encoder wheel. The cylinder is made of a high-strength aluminium alloy. The material is therefore non-magnetic and the magnetic fields produced by the magnetic ring act upon the sensor G182 through the cylinder. Metal swarf on the encoder wheel can affect the performance of the encoder wheel to a greater or lesser extent.

The gearbox input speed sender G182 and the gearbox output speed sender G195 are so-called intelligent sensors. They recognise the direction of rotation and changes in the magnetic field strength, and adapt the tolerances of the gap between the sensor and the encoder wheel.



457_075

Gearbox input speed sender G182

Gearbox output speed sender G195

Parking lock

The parking lock in the new Audi A8 '10 is electro-hydraulically operated. The parking lock is controlled by the mechatronics. It can be controlled either manually by the driver (using the shift control) or automatically by the Auto P function (refer to page 16). The parking lock mechanism in the gearbox derives from the previous mechanism.

The parking lock is engaged by spring force. It is electro-hydraulically operated and protected electromagnetically.

The following components engage, disengage and hold the parking lock:

1. Engaging the parking lock:

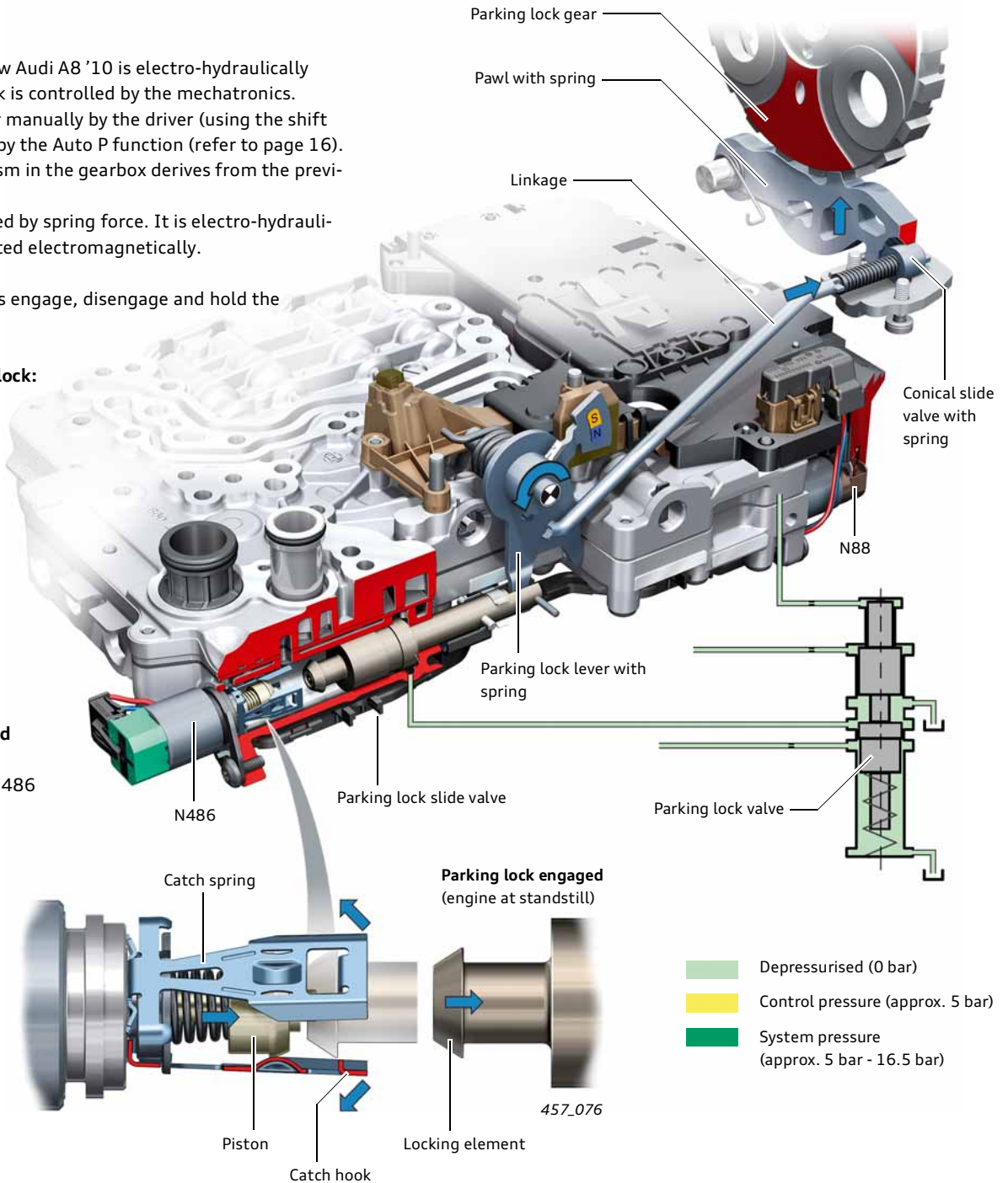
- ▶ Parking lock spring
- ▶ Parking lock lever
- ▶ Linkage
- ▶ Conical slide valve with spring
- ▶ Pawl

2. Disengaging the parking lock:

- ▶ Solenoid valve N88
- ▶ Parking lock valve
- ▶ Parking lock slide valve

3. Holding the disengaged parking lock:

- ▶ Parking lock solenoid N486



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Parking lock – function

Engaging the parking lock

If solenoid valve N88 and solenoid N486 are deenergised, the parking lock is engaged (e.g. when the engine is turned off or when gear P is selected - refer to "Auto P function" on page 16). The parking lock valve moves into its normal position and the cylinder chamber of the parking lock slide valve is depressurised and evacuated.

When solenoid N486 is deenergised, the piston of N486 pushes the catch springs apart. The catch hooks release the locking element and hence also the parking lock slide valve.

The spring of the parking lock lever pushes the pawl into the parking lock gear. The parking lock is engaged.

Disengaging the parking lock

Basically, the parking lock is disengaged by electro-hydraulic activation of the parking lock slide valve. The hydraulic force is several times greater than the spring force of the spring on the parking lock lever. The necessary hydraulic pressure is produced by the ATF pump.

Note: to disengage the parking lock, the engine must be running.

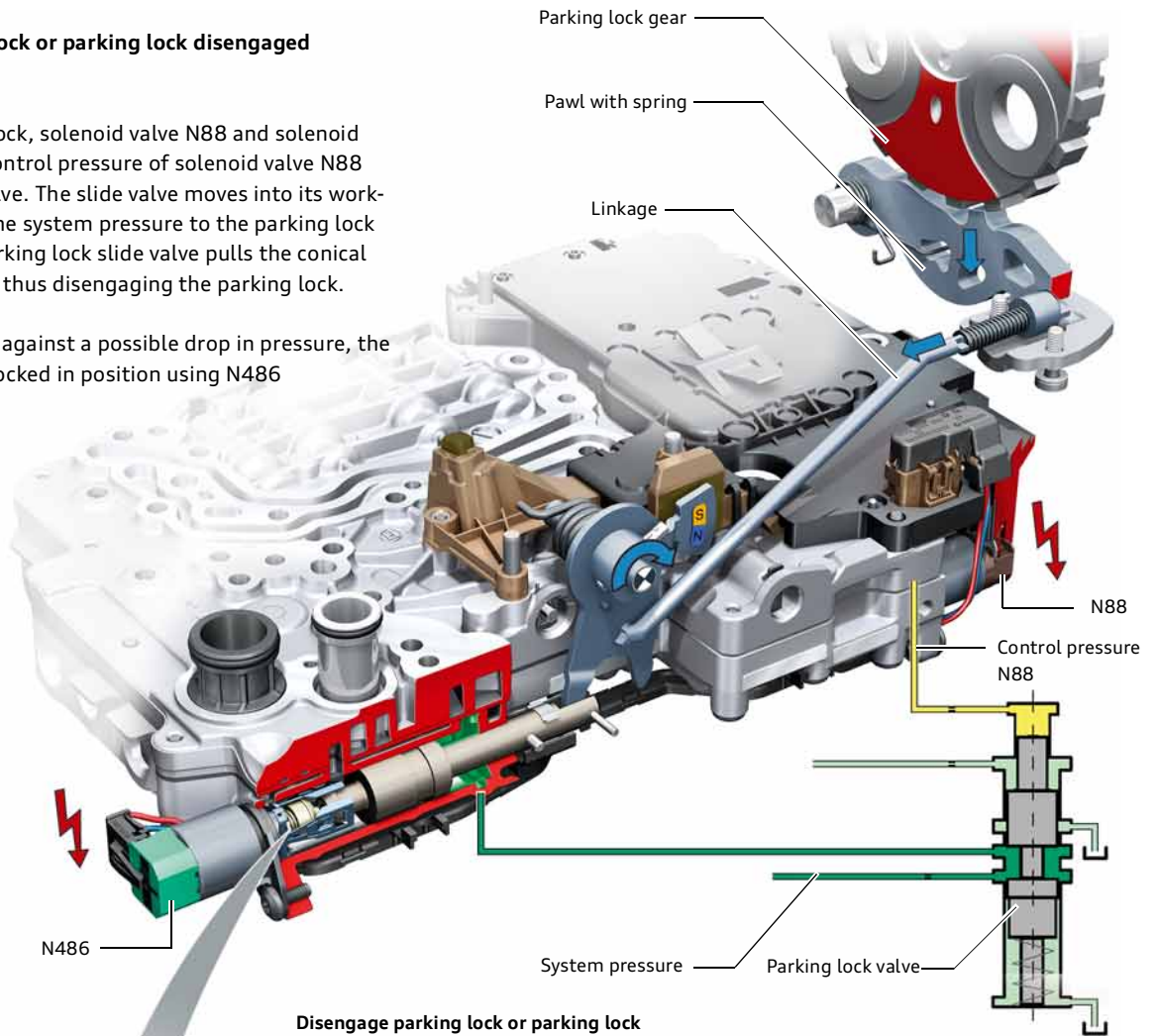
If the engine is not running, the parking lock can be disengaged using the parking lock emergency release (refer to "Parking lock emergency release", page 18 ff.).

Disengaging the parking lock or parking lock disengaged (engine running)

To disengage the parking lock, solenoid valve N88 and solenoid N486 are energised. The control pressure of solenoid valve N88 acts on the parking lock valve. The slide valve moves into its working position and releases the system pressure to the parking lock slide valve cylinder. The parking lock slide valve pulls the conical slide valve out of the pawl, thus disengaging the parking lock.

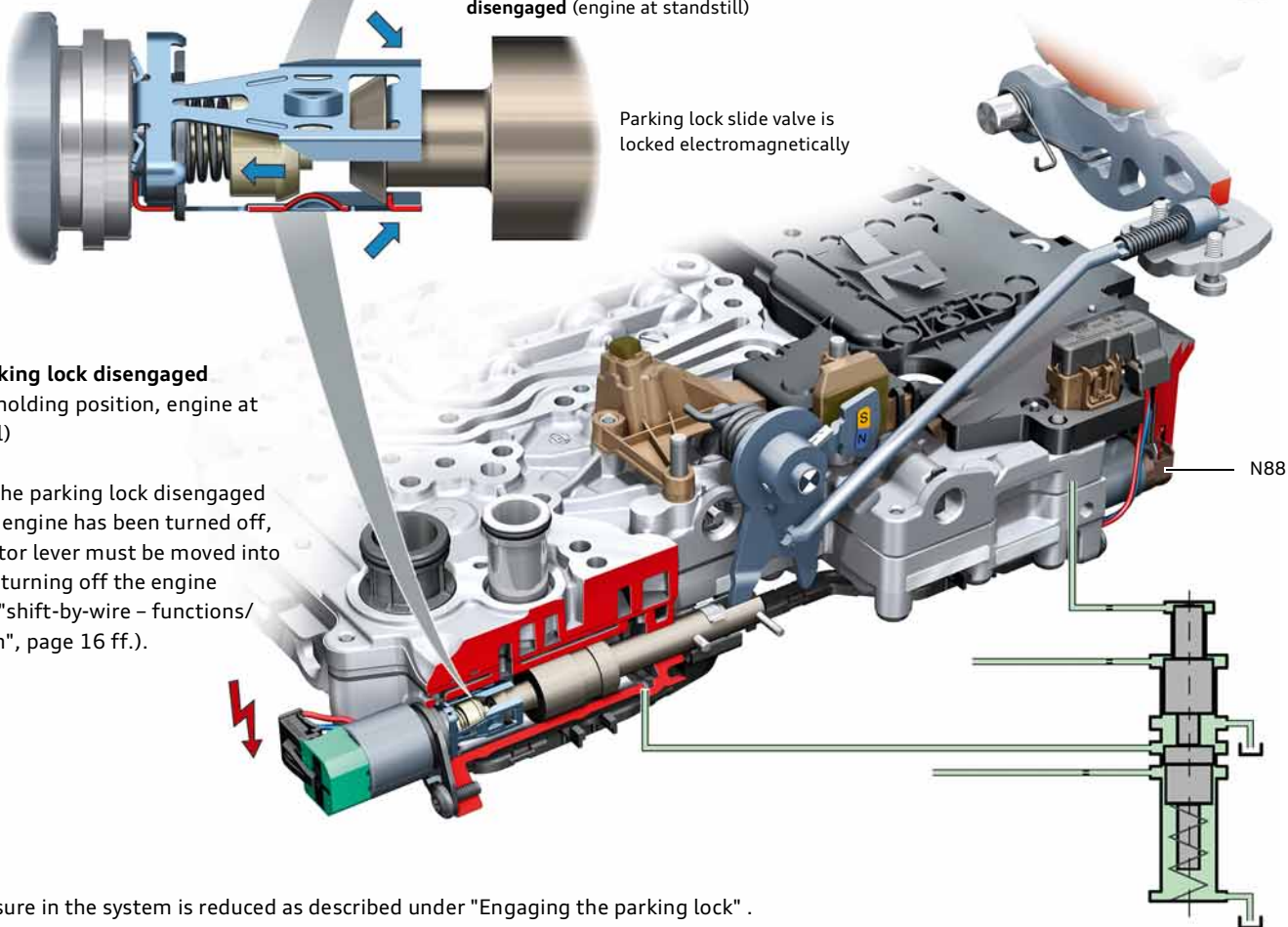
As an additional safeguard against a possible drop in pressure, the parking lock slide valve is locked in position using N486 (see next page).

If the solenoid N486 is energised, the piston is retracted. The catch springs now return to their normal position and the catch hooks engage the shoulder of the locking element.



Disengage parking lock or parking lock disengaged (engine at standstill)

Parking lock slide valve is locked electromagnetically



Hold parking lock disengaged (neutral holding position, engine at standstill)

To keep the parking lock disengaged after the engine has been turned off, the selector lever must be moved into N before turning off the engine (refer to "shift-by-wire - functions/operation", page 16 ff.).

The pressure in the system is reduced as described under "Engaging the parking lock". The solenoid N486 stays energised. The parking lock slide valve is now held in position by the catch springs. This neutral holding position is maintained for a limited time only because it uses up battery power (refer to "shift-by-wire - functions/operation", page 16 ff.).

457_077

Parking lock – limp-home functions

The purpose of the parking lock limp-home function is to prevent unwanted engagement of the parking lock while driving should a malfunction occur. Safeguards are provided for the following three situations:

1. Failure of solenoid valve N88 or insufficient oil pressure

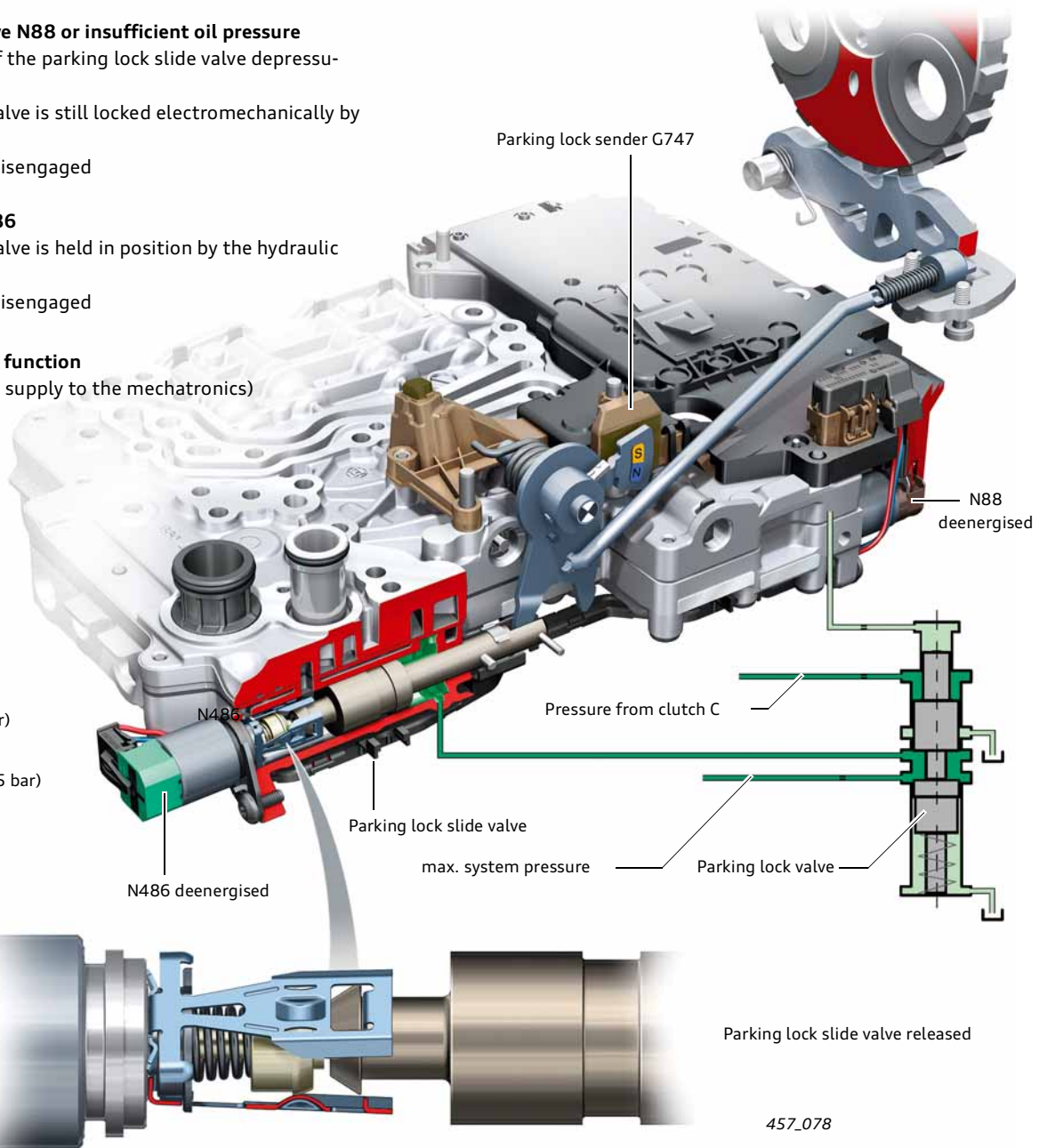
- ▶ the cylinder chamber of the parking lock slide valve depressurises
- ▶ the parking lock slide valve is still locked electromechanically by solenoid N486
- ▶ the parking lock stays disengaged

2. Failure of solenoid N486

- ▶ the parking lock slide valve is held in position by the hydraulic pressure
- ▶ the parking lock stays disengaged

Parking lock – limp-home function

(interruption of the power supply to the mechatronics)



3. Interruption of the power supply to the mechatronics (while driving)

If the power supply to the mechatronics is interrupted while driving, all electrically controlled functions of the gearbox will fail. In this case, the gearbox does not have positive engagement for power transmission.

As long as the engine is running, system pressure is provided by the ATF pump. System pressure is fed to clutch C by means of a hydraulic limp-home circuit. The parking lock valve is connected to the pressure duct leading to clutch C. Clutch pressure C is exerted upon the annular face of the valve piston.

The parking lock valve is pushed into its working position against the pressure of the spring, and system pressure is admitted to the cylinder chamber of the parking lock slide valve. The parking lock stays disengaged.

If the engine is turned off, the pressure in the system drops and the parking lock is engaged by the force of the spring exerted upon the parking lock lever. The limp-home circuit is designed such that clutch C, i.e. the parking lock system, stays depressurised when the engine is restarted. The parking lock stays disengaged

Parking lock sender G747

The position of the parking lock is monitored by the gearbox control unit using a sensor - the parking lock sender G747.

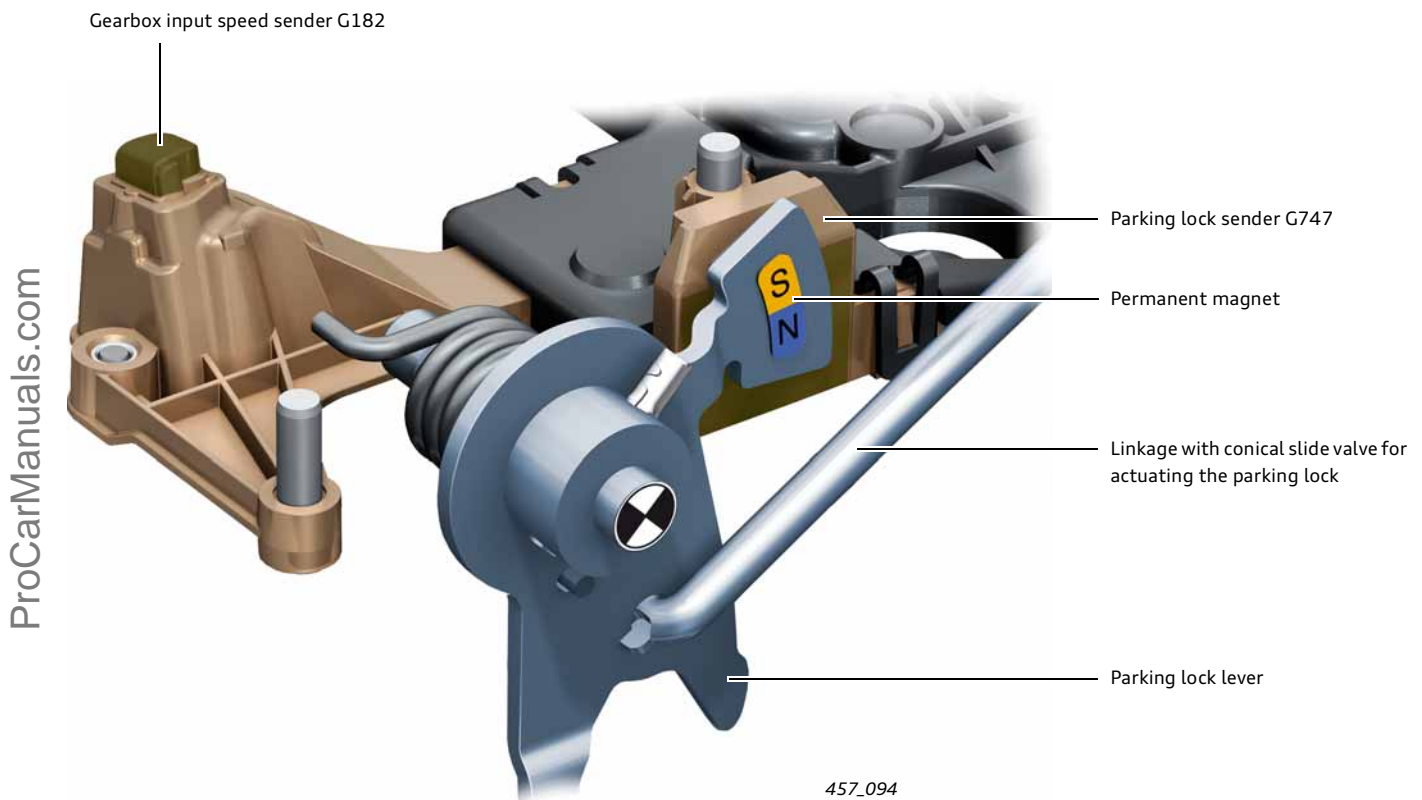
G747 is comprised of two Hall sensors. The Hall sensors are operated by a permanent magnet on the parking lock lever.

The P sensor determines/recognises the following positions:
P engaged → intermediate position → P **not** engaged.

The intermediate position does not normally exist during operation and is defined as a fault after a predetermined filtering time.

The parking lock sender G747 has the following tasks:

1. Monitoring the proper functioning of the parking lock
2. Start enabling in P (the sensor signal is directly converted to a P/N signal by the gearbox control unit)
3. Display in dash panel insert "Gearbox in position P"
4. Display in dash panel insert when parking lock emergency release is actuated



Information regarding point 3, page 50:

First of all, clutch C or clutch E has to be activated so that the limp-home circuit (described under point 3) is functional. This is the case with one of the eight forward gears (refer to "Shift matrix" on page 28).

If the power supply is interrupted while the selector is in position R or N, the parking lock is engaged unless either of the two clutches has previously been activated as described above.

If G747 fails or is faulty (e.g. intermediate position), this has following effects:

- ▶ Fault message in dash panel insert
- ▶ The system pressure is set to maximum (to ensure that the parking lock slide valve has maximum power)
- ▶ The engagement of the parking lock is not indicated in the dash panel insert (even if it is engaged).

Functions – neutral idle

The neutral idle control significantly improves fuel economy in city traffic. This is achieved by interrupting the transmission of converter loss torque when the engine is idling, when driving forwards, when the vehicle is stationary and when the foot brake is applied. Engine idling torque is reduced to a minimum, e.g. when waiting at traffic lights. In addition to the advantages in terms of fuel efficiency at engine idle, both acoustics and ride comfort are improved. As there is less load on the engine, it runs more smoothly and quietly. Reducing torque to a small residual amount keeps brake pedal force to a minimum.

The neutral idle control is implemented in the OBK and OBL gearboxes by opening brake B. Opening brake B interrupts the transmission of multiplying torque to ring gear 1. The torque is diverted to brake B.

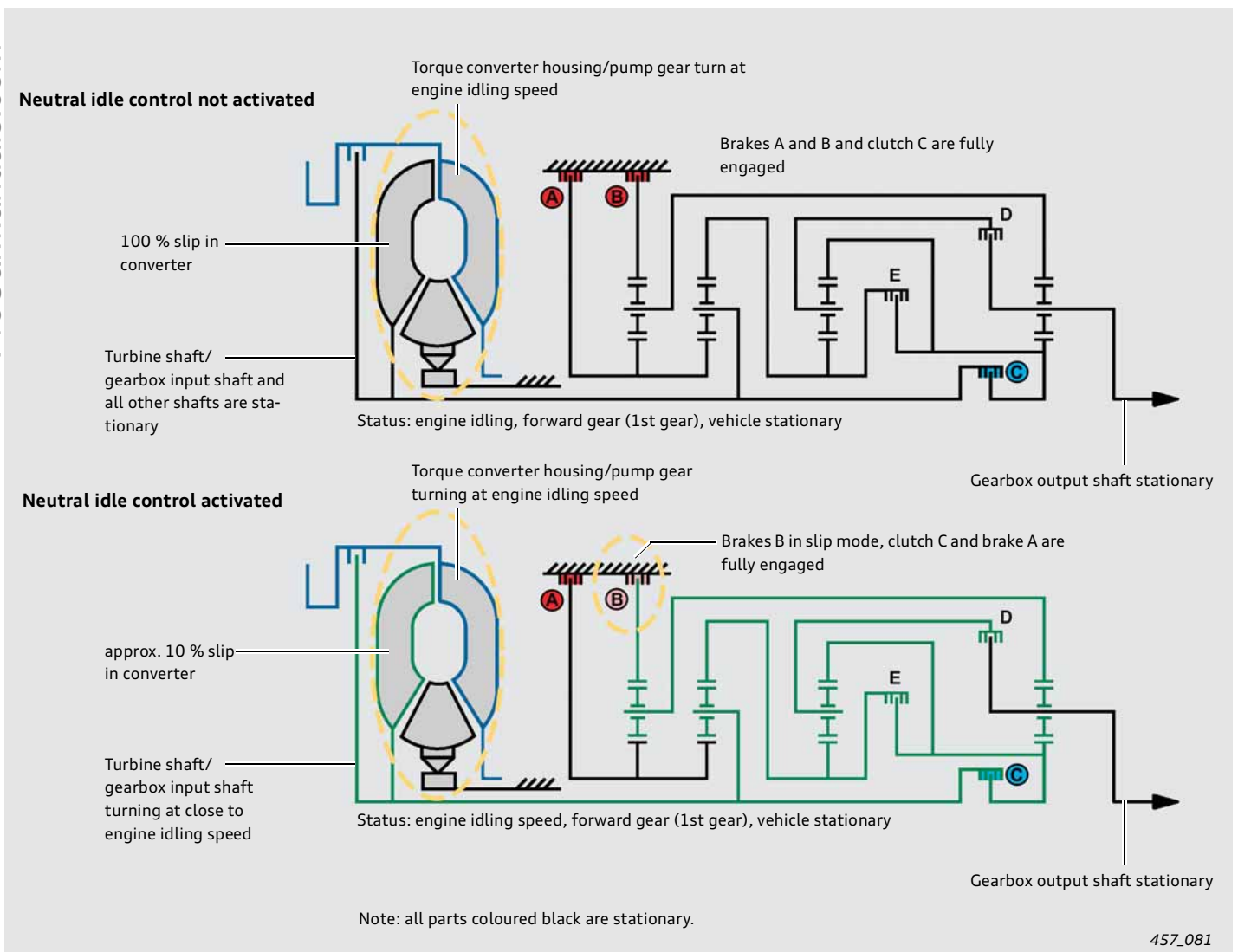
Brake B is operated with slip in neutral idle mode. Brake B is specially rated for continuous duty in neutral idle mode. It is also cooled in a controlled fashion when activated by the hydraulic unit.

The neutral idle control was introduced in an early version of the OB6 gearbox (refer to SSP 385). Thanks to systematic further development of the hardware and software, the second generation of the neutral idle control (in the OBK and OBL gearboxes) sets new standards in terms of comfort and fuel economy.

In addition to reducing the converter residual torque, response to positive engagement has been improved.

The neutral idle control can be activated and deactivated by means of encoding (refer to page 63).

The neutral idle control system is also referred to as NIC.



Reference

The neutral idle control function is described in SSP 385, page 36 ff. Apart from minor changes in the values given, this description also applies to the OBK and OBL gearboxes.

Functions – gearbox adaption

A detailed description of the gearbox adaption process can be found in SSP 385, page 54 ff. and also applies to the OBK and OBL gearboxes. The OBK and OBL gearboxes have the new data and diagnostic log previously used in the OB6 gearbox (refer to SSP 385, page 35 and SSP 392, page 90). For this reason, pages 61 and 64 concerning the reading and deleting of adaption values are relevant to the OBK and OBL gearboxes.

To ensure good shift quality, it is necessary that the 5 shift elements (brakes A and B and clutches C, D and E) be correctly adapted.

For example, the adaption values are deleted after a software update is performed. In this case, an adaption cycle must be carried out using the vehicle diagnostic tester. The exact procedure is explained in the Guided Functions and Guided Fault Finding and is self-explanatory.

Notwithstanding the content of SSP 385, the adaption procedures and adaption conditions are listed below in summary form for the OBK and OBL gearboxes.

Quick adaption – shift adaption

(from an ATF temperature of 40 °C)²⁾

Brake	A	6 → 7 shift ¹⁾
Brake	B	6 → 5 rolling gearshift
Clutch	C	2 → 3 shift ¹⁾
Clutch	D	3 → 4 shift ¹⁾
Clutch	E	1 → 2 and 5 → 6 shift ¹⁾

Pulse adaption

(ATF temperature 50 °C – 110 °C)²⁾

Brake A	6th gear selector cable, load: 80 – 180 Nm, turbine speed 1200 – 2100 rpm (charging pressure/quick charge time)
Brake B	7th gear selector cable, load: 80 – 180 Nm, turbine speed 1200 – 2100 1/min (quick charge time only, the charging pressure of brake B is adapted for rolling gearshift 6 → 5)
Clutch C	4th gear selector cable, load: 30 – 100 Nm, turbine speed 1200 – 1700 rpm (charging pressure/quick charge time)
Clutch D	3rd gear selector cable, load: 30 – 100 Nm, turbine speed 1200 – 1700 rpm (charging pressure/quick charge time)
Clutch E	7th gear selector cable, load: 80 – 180 Nm, turbine speed 1200 – 2100 rpm (charging pressure/quick charge time)

The following adaption procedures are used:

- ▶ Shift adaption (during an upshift or downshift)
Shift adaption is mainly used for quick adaption (start adaption).
- ▶ Slip adaption
- ▶ Pulse adaption (continuous adaption of the shift elements)

Quick adaption – slip adaption

(from an ATF temperature of 40 °C)²⁾

In neutral idle mode, brake B is additionally adapted by means of slip adaption.

This adaption takes approx. 7 seconds.

The quick adaption and pulse adaption run concurrently.

This means that the corresponding adaption is carried out depending on which conditions are met first. As mentioned, this is the quick adaption (limited to 4).

Result of adaption

The evaluation of shift quality is mandatory. The number of adaptations can be checked by referring to the corresponding measured value (e.g. analysis 3 for the charging pressure adaption of brake A). Each count should have a value of at least 3. The individual shift elements can be adapted separately, if need be.

As a rule, no vehicle should be handed over to the customer if one or more shift elements are not adapted.

¹⁾ With regard to upshifts, the shift elements can be adapted up to four times by means of shift adaption at loads of up to 150 Nm.

²⁾ The "general boundary conditions" must be observed. For further information, refer to the description of the adaption procedure in SSP 385.

Functions – start-stop system

For the first time in the V6 3.0 TDI, the start-stop function is used in combination with an automatic gearbox.

The start-stop function represents a major challenge for the automatic gearbox. In start-stop mode, the system has to be ready to start up within an extremely short period of time. To ensure there is no noticeable delay, the engine and automatic gearbox must be ready for start-up after approx. 350 ms.

An automatic gearbox cannot meet this requirement unless it is specially configured and the oil supply is modified accordingly.

The problem with start-stop operation:

When the engine is turned off, the oil supply in the gearbox shuts down. The shift elements of each gear open and power transmission is interrupted. When the engine is started, the gearbox must be positively engaged and thus ready for start up. In the case of the eight-speed automatic gearbox, means that three shift elements have to be closed (refer to shift matrix).

The volume of oil delivered by the ATF pump at engine start-up is not enough to pressurise the shift elements within the required time and provide sufficient positive engagement.

In principle, the ATF pump could be configured so as to meet this requirement. However, such a pump would incur totally unacceptable losses at low engine speeds.

Hydraulic Impulse Storage – HIS



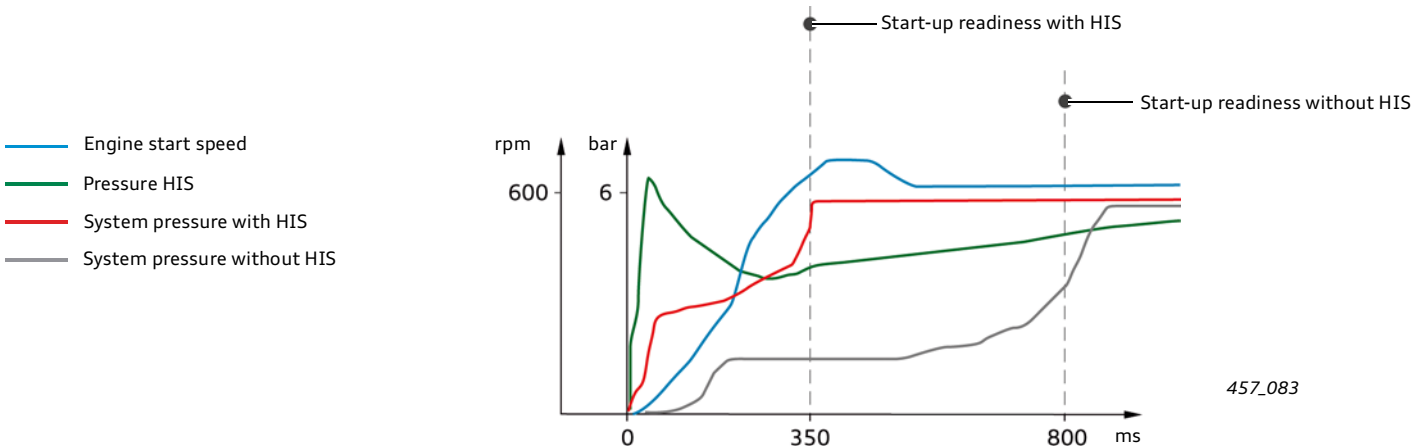
The Hydraulic Impulse Storage system has an effective capacity of approx. 100 cm³.

The solution – Hydraulic Impulse Storage (HIS)

A highly efficient solution to this problem is the so-called "Hydraulic Impulse Storage" system (HIS).

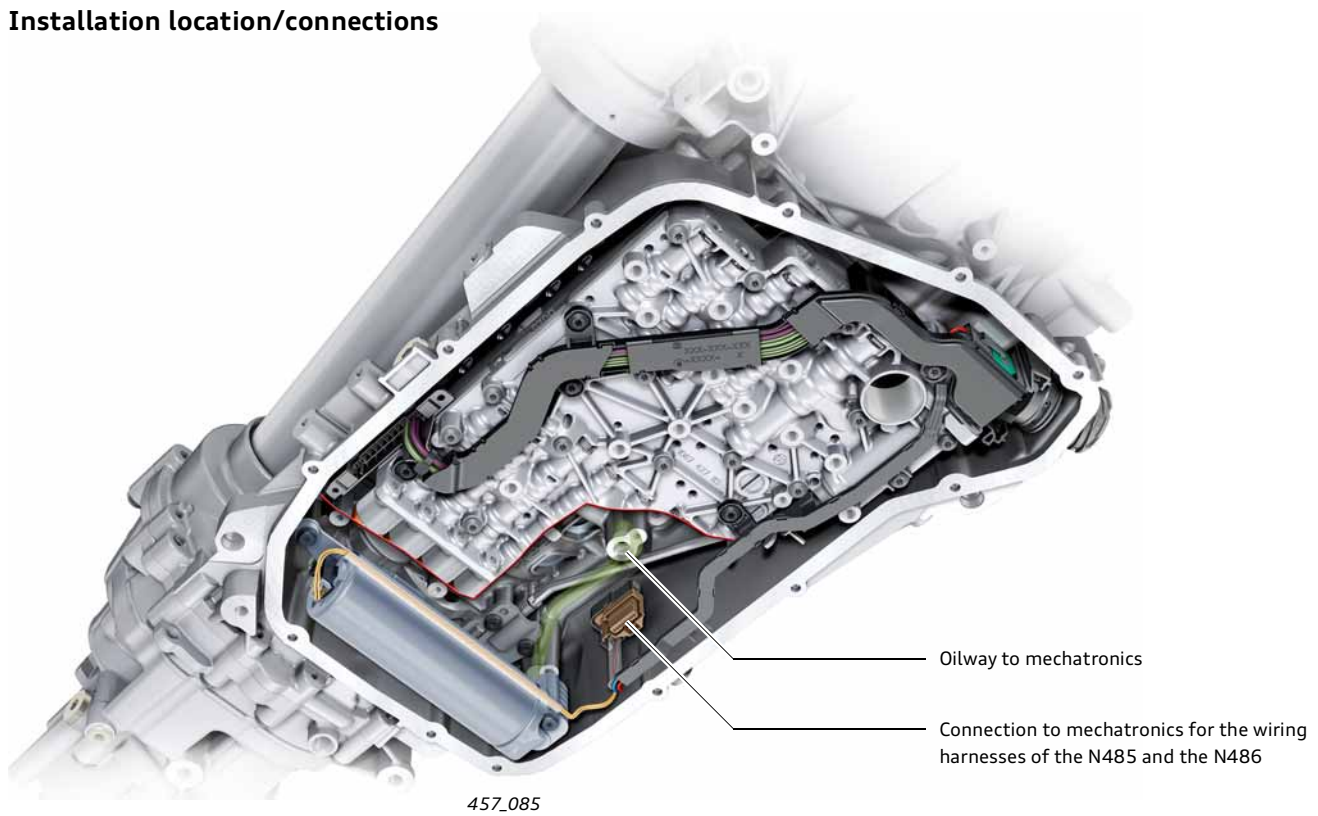
The HIS is a special oil reservoir with an electromechanical locking unit.

It provides torque-transmissible pressure to the shift elements with a fraction of a second. The HIS ingeniously ensures the start-up readiness of the gearbox within about 350 ms.



Comparison of start-up readiness with and without Hydraulic Impulse Storage – HIS

Installation location/connections



The HIS is installed below oil level. The piston spring reservoir therefore cannot run empty and always stays full when charged.

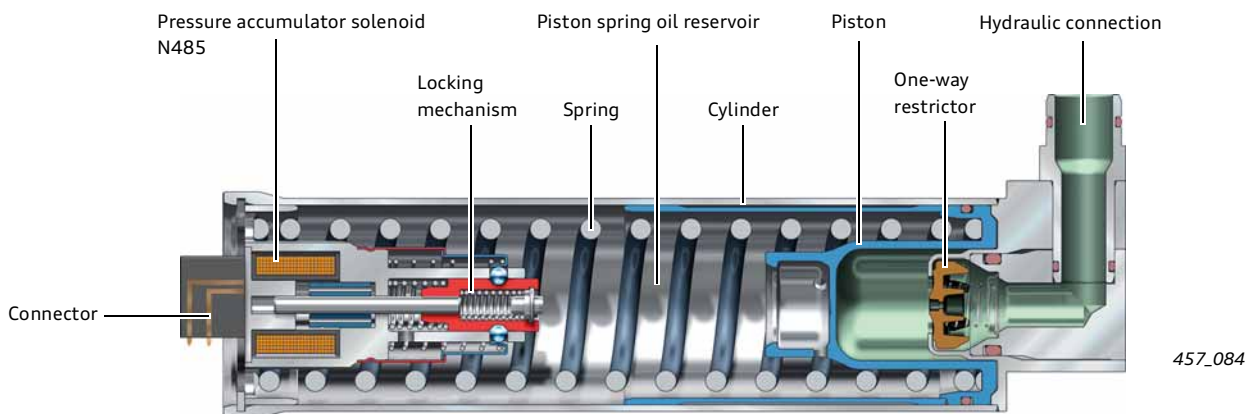
Design and function

The HIS comprises the piston spring oil reservoir system, an electromechanical locking unit (pressure accumulator solenoid N485) and a one-way restrictor. The piston spring oil reservoir consists of a piston, cylinder and steel spring. The task of solenoid N485 is to keep the piston preloaded (N485 energised).

The piston spring oil reservoir is "charged" when the engine is running. When the engine is started, solenoid N485 is deenergised and the oil stored in the reservoir is forced into the hydraulic control (discharged) by the force of the spring.

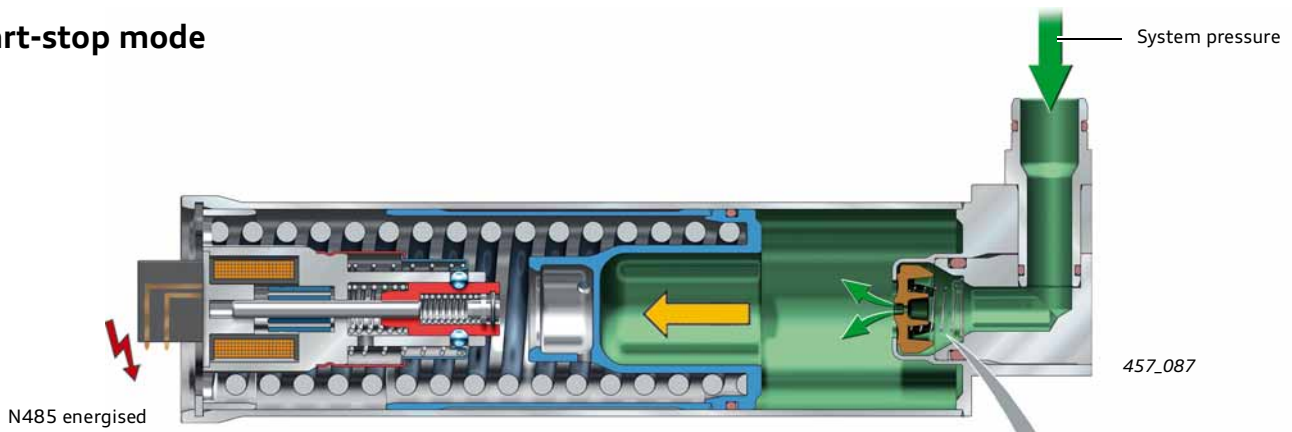
This means that the shift elements are subjected to oil pressure as soon as the ATF pump begins to operate. The HIS thus assists the ATF pump and enables the pressure to build up extremely quickly.

The pressures built up by the HIS system and by the ATF pump overlap when the pump begins to deliver sufficient pressure. The charging cycle of the piston oil reservoir begins at this moment. To ensure that the charging cycle does not interfere with further pressure build-up, the inlet to the piston spring oil reservoir is restricted. This task is performed by the one-way restrictor. Nevertheless, the charging time of approx. 5 seconds (at 20 °C) is very short and does not interfere with start-stop operation.



An empty Hydraulic Impulse Storage system

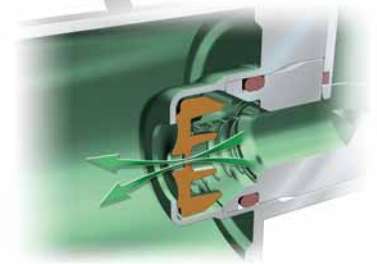
Start-stop mode



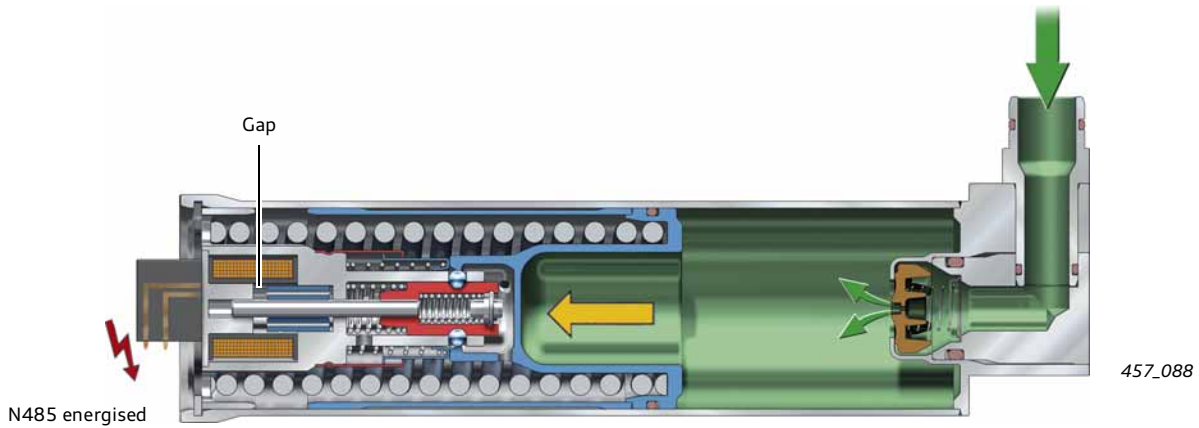
The piston is pushed against the pressure of the spring.

Start of charging (engine operation)

When the engine is running, the piston spring oil reservoir is charged through the restrictor orifice (charged). Charging time is approx. 5 seconds.



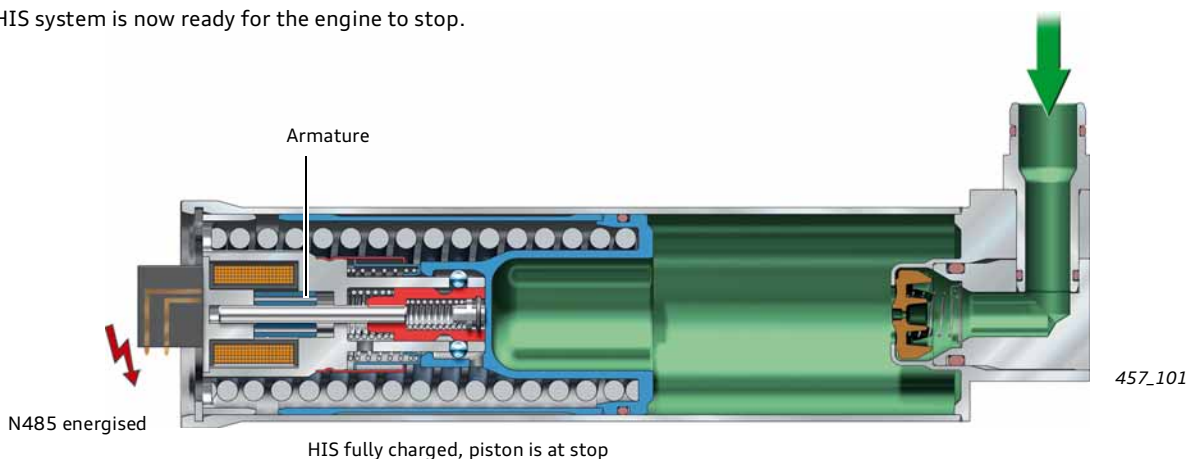
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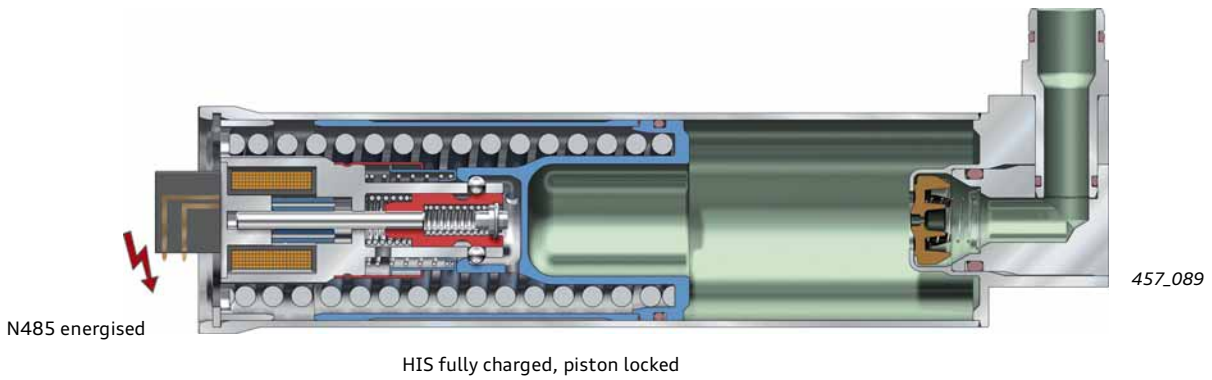
The piston moves over the ball locking mechanism.

The piston is moved all the way to the left during the charging cycle. The armature of the holding magnet is moved into the end position necessary for locking and the gap is overcome¹⁾. The balls are pushed outwards to lock the piston and the solenoid N485 can now hold the armature so that the piston remains locked in place.

The HIS system is now ready for the engine to stop.

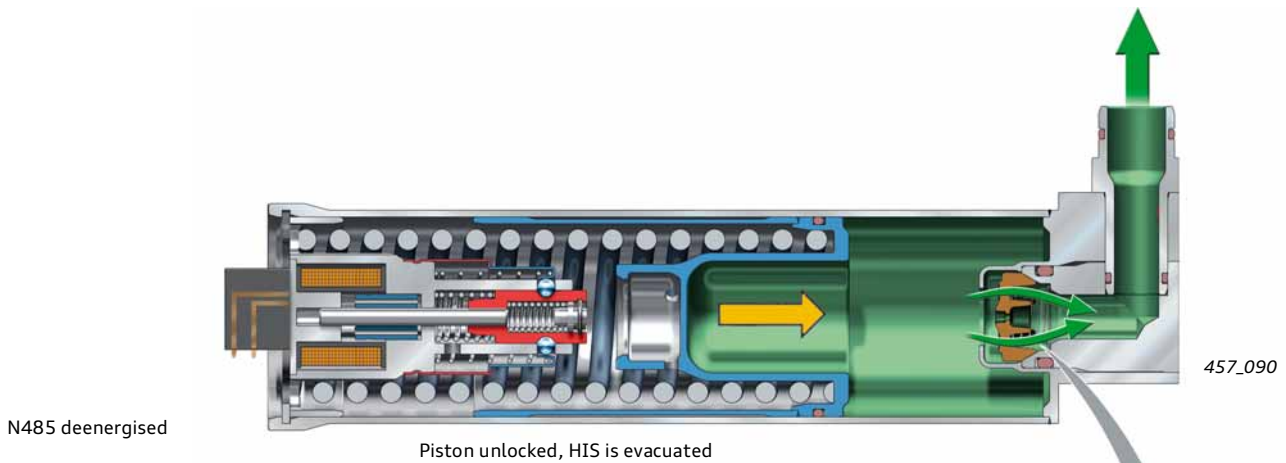


HIS fully charged, piston is at stop



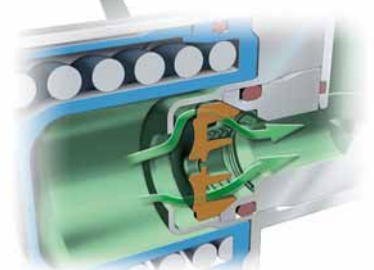
HIS is charged (engine at standstill)

When the engine is turned off, both the system pressure and the pressure within the HIS decrease. The oil in the HIS system is depressurised. The piston is now held in place by the ball locking mechanism.



HIS is discharged (engine start phase)

When the engine is started, the piston is unlocked by switching off the holding current. The piston forces the oil into the hydraulic shift element control unit. The one-way restrictor opens, providing a large cross-section.



1) The magnetic field produced by solenoid N485 is not strong enough to attract the armature against the pressure of the spring. When the piston pushes the armature to the far left (Fig. 457_101), the magnetic force is strong enough to hold the armature by itself.

Functions – navigation-based gear selection

An innovation contributing to improved gear selection strategy is the inclusion of route data from the navigation system.

In the Audi A8 '10 the navigation system provides detailed information on the road immediately ahead of the vehicle. The gearbox control unit utilises the information on the geometry of corners ahead of the vehicle (curvature, curve length etc.) and whether the vehicle is driving within or outside of built-up areas.

This preview of the road ahead of the vehicle allows a significant reduction in shift frequency, e.g. when cornering. Another aim is to calculate the "ideal gear" when cornering or when accelerating out of a corner.

The following functions are executed by the gearbox control unit:

Anticipatory upshift prevention ahead of a corner

When the driver takes his foot off the accelerator ahead of the corner, the DSP shift program usually performs an upshift. An anticipatory assessment of the corner curvature and a knowledge of the distance to the relevant corner allows unwanted upshifts to be suppressed. Depending on the driving situation and the route further ahead, the gear is maintained or a corresponding gear is selected (refer to page 60).

Active downshifting before/in the corner

When braking ahead of the corner, an anticipatory calculation of the maximum cornering speed and the "ideal" gear allows the gearbox to actively downshift into a suitable gear before the corner (and not in the corner) (refer to page 60).

In addition to enhancing ride comfort by reducing the number of gearshifts, driving dynamics are also better because the "ideal gear" is already pre-selected when accelerating out of the corner.

This innovation is a logical and useful enhancement of the previous dynamic shift program (DSP). Shift frequency is significantly reduced, particularly when driving economically, because it prevents unnecessary upshifts before corners.

The navigation-based gear selection is one of a series of "navigation-based vehicle assistance" functions. For further information on this subject, refer to SSP 456.

In the technical jargon, this system is referred to as "PSD" (predictive route data).

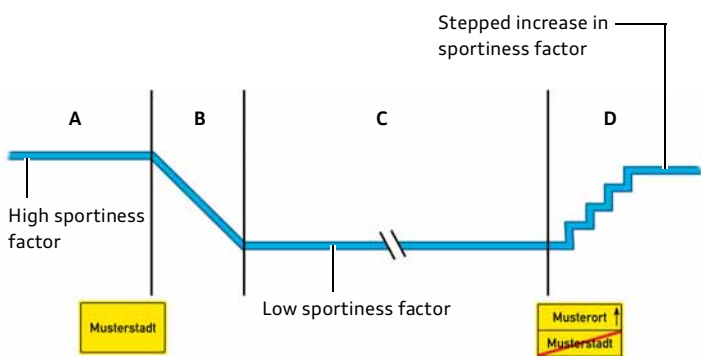
Stepped upshifting when exiting the corner

The purpose of this function is to avoid multiple upshifts after cornering. Depending on the sportiness factor, the gears are held for longer in order to avoid unwanted upshifts in quick succession (refer to page 60).

Limitation/reduction of driver type assessment in built-up areas

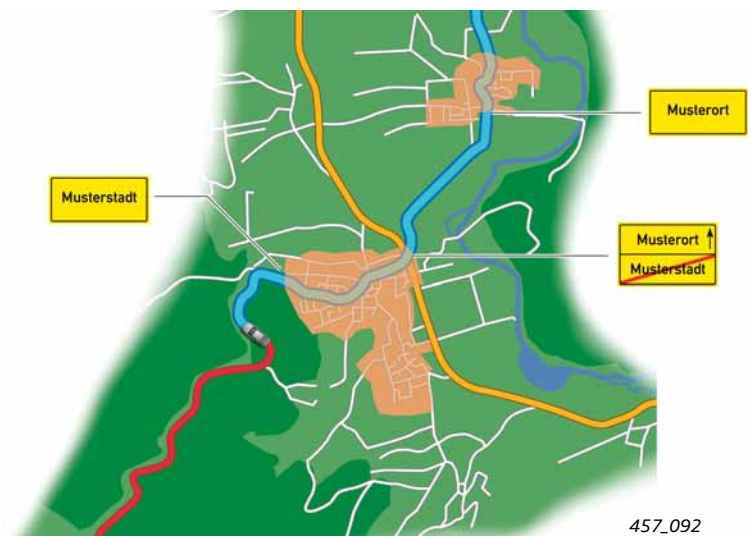
If the vehicle is driven in a very sporty style outside of built-up areas, DSP reacts accordingly and the driver assessment program computes a high sportiness factor. This, in turn, results in unwanted high shift speeds when entering a built-up area, since it usually takes a certain amount of time until the sportiness factor decreases again. If the system knows that the vehicle is entering a built-up area, the sportiness factor can be reduced quickly. This avoids unnecessarily high engine speeds within built-up areas.

Limitation/reduction of driver type assessment in built-up areas



457_093

- A Driving outside built-up area with high sportiness factor
- B Entering built-up area and quick reduction in sportiness factor (approx. 7 s)



457_092

- C Driving in built-up area with a reduced sportiness factor
- D Leaving built-up area. Cancellation of limitation on sportiness and increase in sportiness factor depending on driving style

Possibilities of navigation-based gear selection

There are certain prerequisites for the accuracy of gear selection. Firstly, the quality of the route data is decisive. Secondly, it is important to factor in how well the road ahead of the vehicle or the predetermined route matches the actual route travelled (reliably detected route, probable route).

Quality of route data

The route data is not 100% reliable. This is because the data is not 100% accurate. For example, the curvature of corners (curve radius, apex, distances) is not always specified accurately enough. Another factor is the up-to-dateness of data. This means that the route has changed in the course of time and no longer corresponds to the route data.

Reliably detected route – probable route

The navigation-based gear selection program evaluates how reliably the actual route is predictable. A distinction is made between a "reliably detected route" and a "probable route".

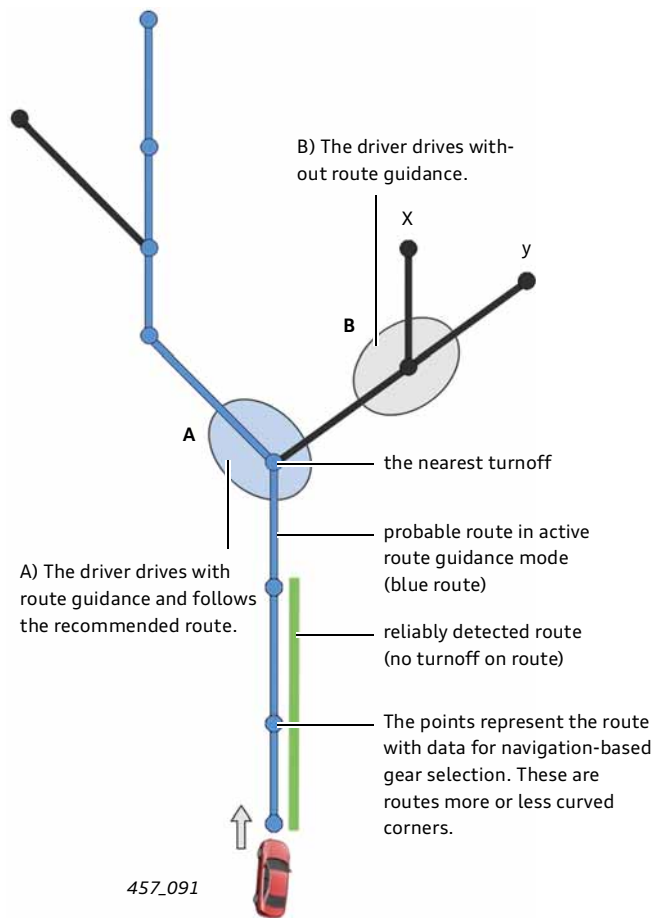
Navigation-based gear selection is available even if the route guidance function has not been activated. An active route guidance system does not, however, enhance the performance of navigation-based gear selection.

A **reliably detected route** is characterised in that the section of the route does not have a turnoff option. The route is therefore distinct and the calculated gear selections correspond to the curvatures ahead of the vehicle.

A **probable route** is characterised in that other routing options (e.g. a turnoff) are available within the anticipated range.

If the route guidance system is active, a route which the driver will very probably take is mapped out. The recommended route comprises sections of reliably detected route and sections of probable route.

Schematic diagram of the predictable route in active route guidance mode ("predictive route tree")



re A) in Fig. 457_091

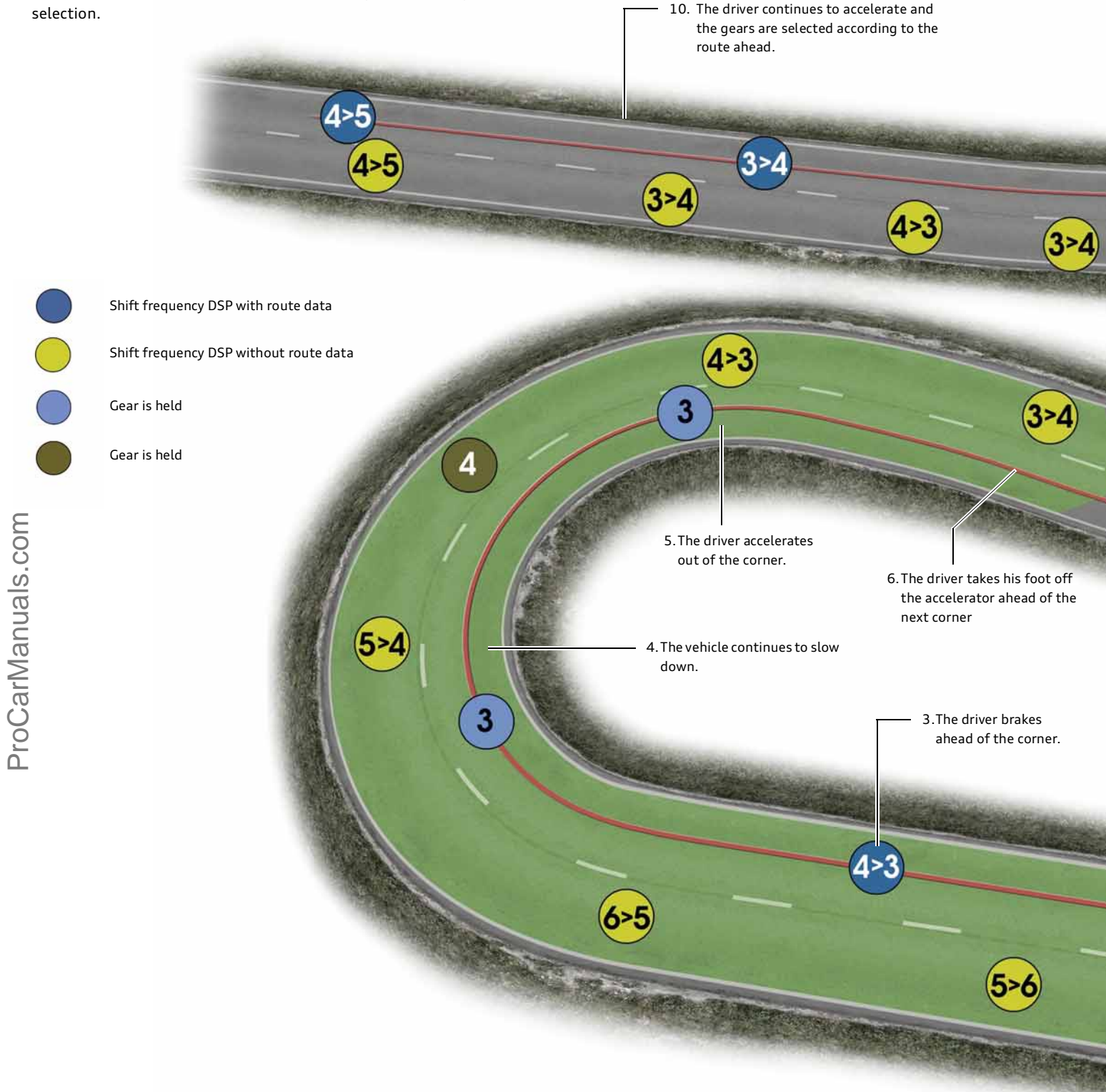
If the **route guidance system is active**, the route recommended by the navigation system becomes a "probable route". In this case, gear selections are based on the route data for the recommended route. When the route guidance system is active, it is not absolutely certain that the driver will stick to the recommended route. For this reason, active downshifts are only performed under heavy braking.

re B) in Fig. 457_091

If the **route guidance system is not active**, the turnoffs along the route are taken into account. In this case, gear selection is based on the route with the greatest curvature (or a straight). This means that if the driver turns off in direction x, gear selection would be the same as if the driver were to go in direction y.

Navigation-based gear selection – functional example

The functions and driving situations are illustrated on the basis of an exemplary route. Gear selection and shift frequency are compared with a vehicle with and without navigation-based gear selection.



- Shift frequency DSP with route data
- Shift frequency DSP without route data
- Gear is held
- Gear is held

re 1. (upshift prevention ahead of a corner)

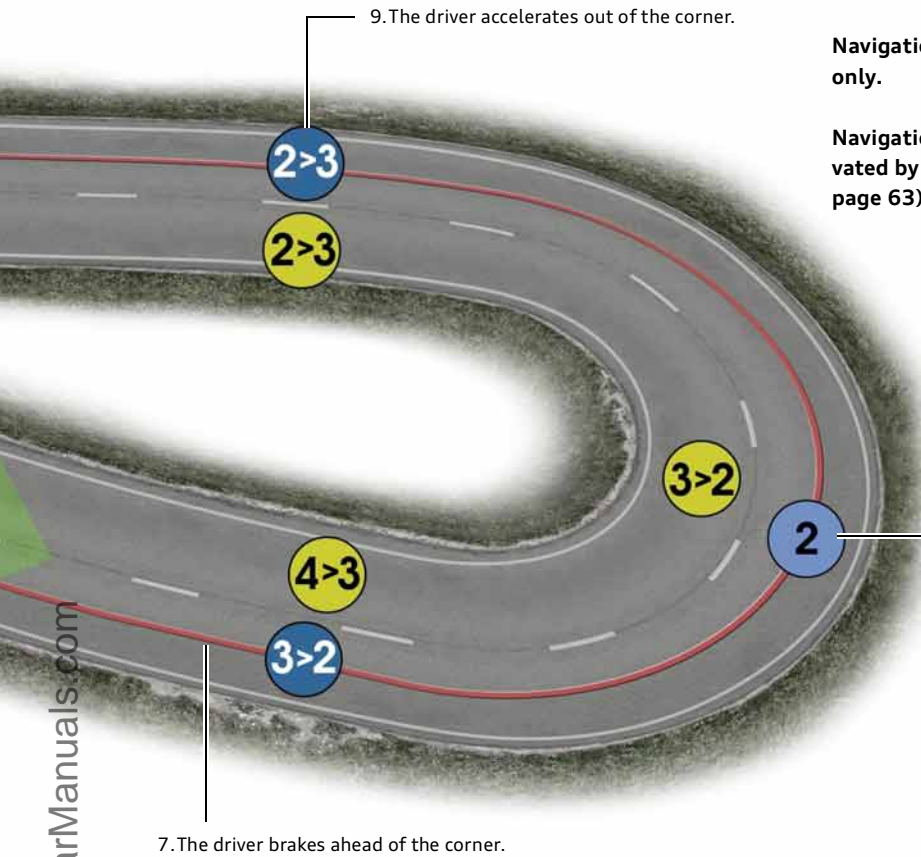
The gearbox control unit has detected a corner ahead and its geometry and can compute from this information the "ideal gear selection". In this way, unnecessary gearshifts are suppressed.

re 2. (holding gear)

The gearbox control unit holds the gear since the geometry of the next curve is already known and an upshift would not make sense (upshift prevention).

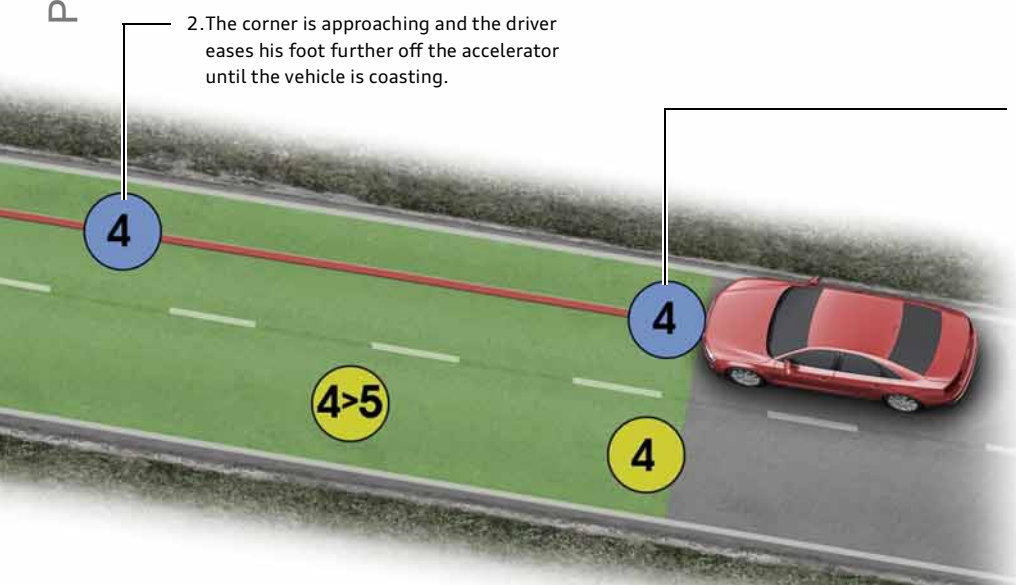
re 3 - 5. (active downshifting, holding gear)

The maximum cornering speed and the "ideal gear" (third gear in this case) have already been computed. If the brake is applied accordingly, the gearbox shifts down into third gear ahead of the corner. This gear can be held while cornering and is available as an ideal gear for accelerating out of the corner.



7. The driver brakes ahead of the corner.

9. The driver accelerates out of the corner.



2. The corner is approaching and the driver eases his foot further off the accelerator until the vehicle is coasting.

1. The initial situation is a winding route: after a corner, the driver accelerates into fourth gear before the next corner. The driver sees that a right-hand corner is next and eases his foot off the accelerator.

457_103

re 5 - 9. (active downshifting, holding gear)

The knowledge that another tight corner is coming up prevents the gearbox from shifting up on the straight. The next corner is much tighter, so the vehicle has to negotiate the corner more slowly.

re 10. (stepped upshifting)

The gearbox control unit recognises that the vehicle has been driving in a straight line for a time. The gearbox is now prevented from shifting up too quickly. This prevents unwanted downshifts when the driver presses the accelerator.

Navigation-based gear selection is currently available in Europe only.

Navigation-based gear selection can be activated and deactivated by means of the control unit encoding function (refer to page 63).

The gearbox control unit now computes that second gear is the ideal gear and shifts down into this gear ahead of the corner. An unwanted downshift directly in the corner is prevented. This gear can be held while cornering and is already available as an ideal gear for accelerating out of the corner.

Functions – displays/warnings

System malfunctioning or protective functions of the gearbox are indicated in the dash panel insert by means of a warning lamp (gearbox fault icon) and as textual driver information. The following warnings and information can be displayed.

Display 1

Icon



Text

**Gearbox malfunction:
You may continue driving**

This message appears in the event of faults which the driver might not even notice because the gearbox control unit is able to use a substitute signal (substitute program). The fault has little or no effect on performance. The purpose of the warning is to prompt the driver to take the vehicle to an authorised workshop at the next opportunity.

Display 2

Icon



Text

**Gearbox malfunction:
you can continue driving in D only**

When this message is displayed, the gearbox has activated an emergency limp-home program, which holds the gear until either neutral is selected or the engine is turned off. There is no drive when the gear is reselected or when the engine is restarted.

Display 3

Icon



Text

**Gearbox malfunction:
you can continue driving (limited
functionality)**

This message indicates a system fault in which the gearbox can only select certain gears or cannot select any gears at all (a defined gear is held). Vehicle operation can be very limited (e.g. no drive-away on gradients, limited acceleration and speed).

Display 4

Icon



Text

**Gearbox malfunction:
no reverse gear (you can continue
driving)**

This message indicates a system fault in which the gearbox can only select certain gears or cannot select any gears at all (a defined gear is held). Vehicle operation can be very limited (e.g. no drive-away on gradients). Reversing is not possible because the gearbox cannot select reverse.

Display 5

Icon



Text

**Vehicle may roll! Cannot shift to P.
Please apply parking brake.**

This driver information appears when the parking lock emergency release is actuated. Neutral position "N" is also indicated.

Display 6

Icon

without icon (**with warning tone**)

Text

**Vehicle may roll.
Selector lever not in P.**

This driver information appears together with a warning tone if P is not selected after turning off the ignition.

Functions – special feature of adaptive cruise control (ACC) mode

To maximise drive-away comfort in ACC mode, the gearbox only shifts down into second gear when the vehicle stops. The vehicle then drives away in second gear. This provides a softer start without any need for shifting gear.

As of a defined gradient, the gearbox shifts down into first gear. The vehicle then drives away in first gear, so full traction is available.

Functions – encoding the automatic gearbox control unit J217

In the gearbox control unit, the following functions can be activated and deactivated by encoding:

1st digit	Country/variant code	1 = RoW, 2 = USA
2nd digit	Neutral idle control	1 = active, 0 = not active
3rd digit	Automatic upshift before engine cut-out RPM	1 = active, 0 = not active
4th digit	tiptronic function in D/S	1 = active, 0 = not active
5th digit	unassigned	
6th digit	Navigation-based gear selection	1 = active, 0 = not active

6-digit code: X X X X X X
 6. 5. 4. 3. 2. 1.

Note: The control unit must be encoded using the Software Version Management system.

Functions – adapting the gear indicator

In the gearbox control unit, the adaption function can be used to select whether the actual gear is to be indicated additionally to gears D and S in the dash panel insert. The gear indicator is always active in tiptronic mode.

The gear indicator can be activated and deactivated separately for gears D and S. The gear indicator is active in RoW-spec vehicles and inactive in US-spec vehicles. After replacing the mechatronics or after a software update, a check must be made for correct adaption of the gear indicator.

Functions – limp-home programs and substitute programs

Gearboxes 0BK and 0BL do not have a hydro-mechanical limp-home function. This means that no drive is available if no voltage is present (refer to page 43). The limp-home programs and substitute programs have been updated to state of the art and ensure a high degree of availability in case of fault.

Towing

If a vehicle with an 0BK or 0BL gearbox has to be towed, Audi's usual restrictions for automatic gearboxes must be observed:

- ▶ Actuate the parking lock emergency release device.
- ▶ Do not exceed the maximum towing speed of 50 kph.
- ▶ Do not exceed the maximum towing distance of 50 km.
- ▶ The vehicle must not be towed with the front or rear axle raised off the ground.

Reasons:

When the engine is at standstill, the oil pump is not driven and there is no flow of lubricant to certain parts of the gearbox. If the towing conditions are not adhered to, severe gearbox damage can result.

Note: note the other descriptions and information on tow-starting and towing in the Owner's Manual.



Important

To permanently unlock the parking lock for towing the vehicle, the parking lock emergency release device must be actuated. Failure to do so will result in engagement of the parking lock while travelling. The parking lock cannot engage at speeds over 7 kph (for mechanical reasons), but will suffer mechanical damage (refer to page 50).

Rear axle drive OBC/OBF/OBE

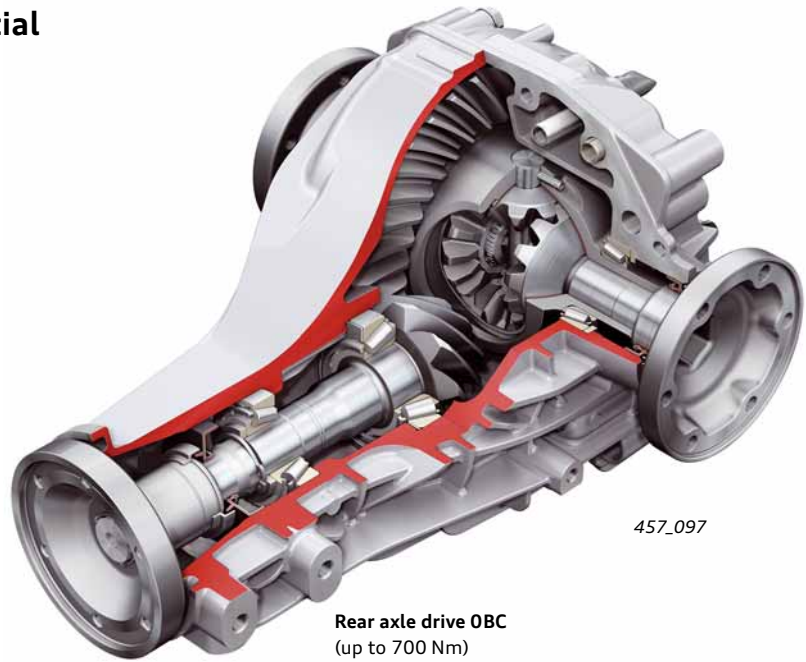
Conventional rear axle drive/sport differential

All engine versions except the 4.2l TDI engine and S models are equipped as standard with the conventional rear axle differential OBC. The OBF sport differential, first used in the Audi S4 in early 2009, is optional.

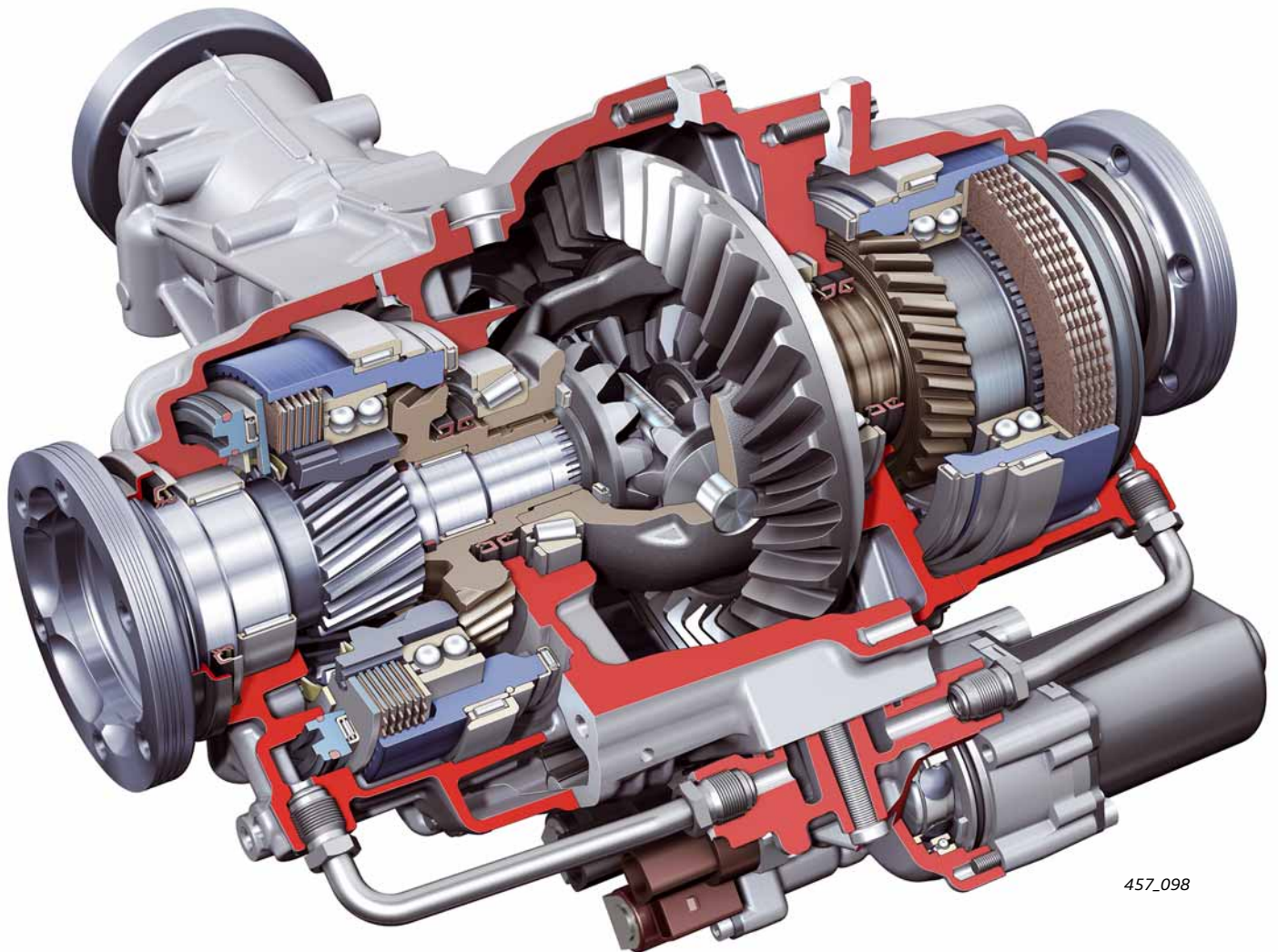
Vehicles with the 4.2l TDI engine come as standard with sport differential OBE. A major new feature of the sport differential is that the four-wheel drive control unit J492 interfaces with the FlexRay data bus. This gives much better performance in every respect. The J492 obtains all the relevant current information on vehicle dynamics from the sensor electronics control unit J849 via the FlexRay data bus (refer to SSP 458 and SSP 459).

Sport differential with start-up function

The sport differential in the Audi A8 '10 will be enhanced with a special start-up function from week 32/2010 onwards (date of manufacture). Additional drive torque will be directed to the wheel able to transmit the highest drive torque. If the rear left wheel starts to spin at drive-away, drive torque to the right (stationary) wheel is increased by activating the right speed modulation unit.



Rear axle drive OBC
(up to 700 Nm)



Rear axle drive OBF/sport differential
(up to 700 Nm)

Rear axle drive OBE/sport differential

The 4.2l TDI engine features the new OBE sport differential. It is identical to sport differential OBF in terms of its function and design. The OBF has also adopted the left and right speed modulation units, as well as the electro-hydraulic control unit.

To handle the high torque produced by the 4.2l TDI engine (800 Nm), the components of the drive pinion set, crown wheel, drive pinion, differential, bearing and all housing parts have been updated. As a result, the OBE gearbox is about 45 mm wider than the OBF gearbox.

You can learn more about the sport differential from the following four Audi iTV programmes:

Audi quattro with sport differential OBF Part 1

Contents: How it works, driving dynamics and the sport differential, Operation, working principle and function

Audi quattro with sport differential OBF Part 2

Contents: Design and function
Oil systems and electro-hydraulic control unit

Audi quattro with sport differential OBF Part 3

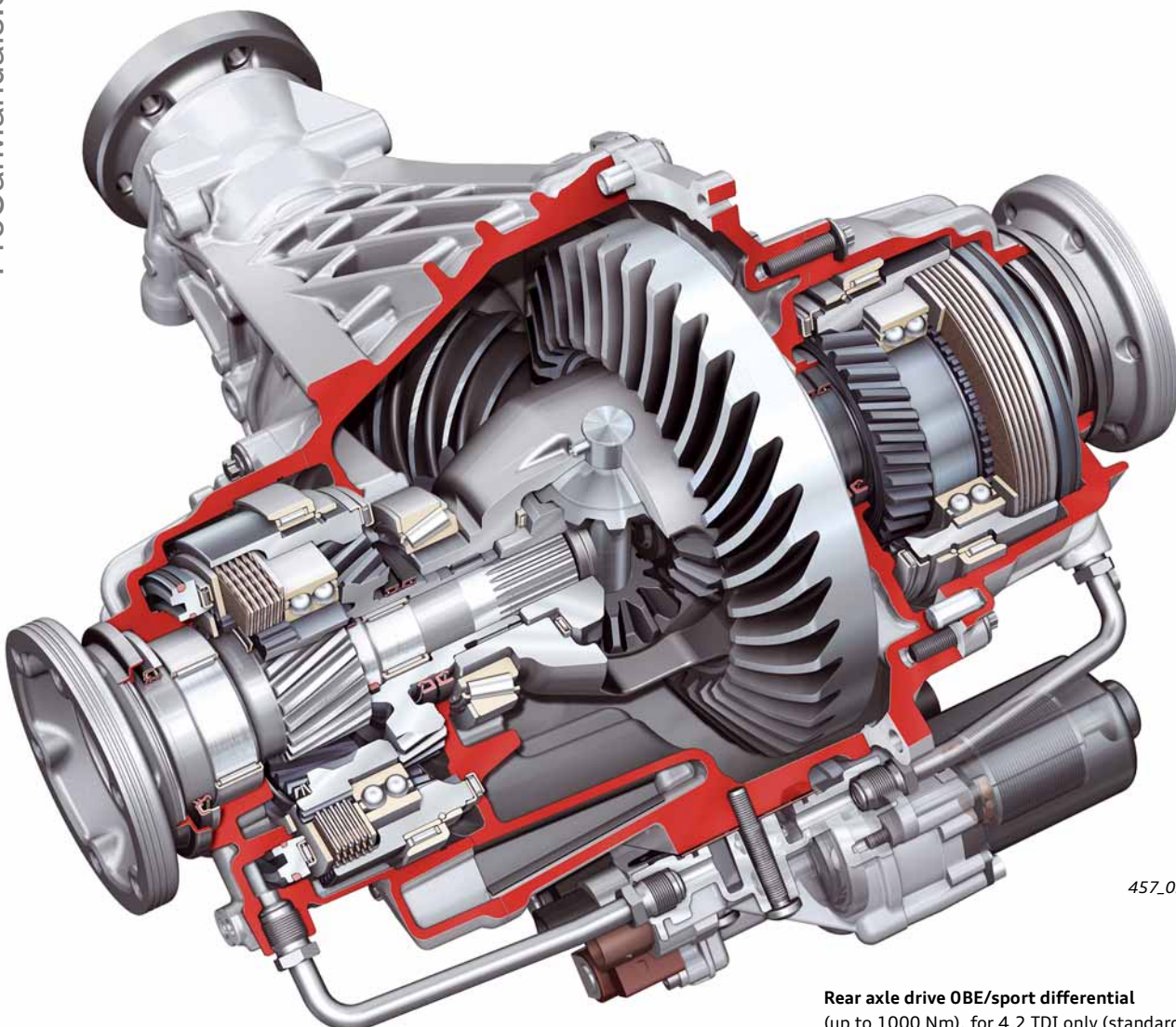
Contents: Repairing the sport differential

Audi quattro with sport differential OBF Part 4

Contents: Working and testing with the vehicle diagnostic tester

In addition to these four programmes, you will find further information in the answers to the Frequently Asked Questions of each programme.

Other programmes will be made if the current scope of repair work is extended.



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Rear axle drive OBE/sport differential
(up to 1000 Nm), for 4.2 TDI only (standard)

Intelligent torque distribution

The Audi A8 '10 will come equipped with the new "intelligent torque distribution" system from Q3 2010 onwards.

Intelligent torque distribution is an enhanced version of the current EPC function (electronic differential lock). Unlike the EPC system, the electronic transverse lock is active when cornering and intervenes before critical slip occurs at the wheels.

For this purpose, the control unit computes the load taken off the wheels on the inside of the corner and the load on the wheels on the outside of the corner when cornering. This calculation is essentially based on the measurement data acquired by the steering angle sensors and the transverse acceleration sensors. The ESP control unit uses this information to determine the ideal brake pressure for the wheels on the inside of the corner.

Intelligent torque distribution - how it works/function

A multiplying torque is produced when cornering by controlled braking of the wheels on the inside of the corner. As a result, additional drive torque is directed to the wheels on the outside of the corner. Cornering traction is significantly better. The vehicle is capable for higher cornering speeds and handles with greater precision. Likewise, this greatly improves agility when steering into corners and during steering manoeuvres.

As mentioned, the system reacts to the change in wheel load and not to wheel slip. The necessary brake pressure of 5 - 15 bar is relatively low, minimising brake load and material stress.

The intelligent torque distribution system offers driving dynamics of the highest order with a minimum of system complexity and high ride comfort.

Vehicles with the OBC standard rear axle drive have **intelligent torque distribution** on the front and rear axles. In vehicles with a sport differential, intelligent torque distribution is effective only on the front axle.

Basic principles

Basically, driving physics dictate that the maximum transmissible drive torque becomes greater with increasing transverse acceleration at the wheels on the outside of the corner, while decreasing to the same extent at the inner wheels.

That is due to the effect of centrifugal force acting on the vehicle's centre of gravity and its line of action towards the outside of the corner. This results in what is known as "roll torque", which is exerted on the wheels. This roll torque reduces the load on the wheels on the inside of the corner and increases the load on the wheels on the outside of the corner. Consequently, the wheels on the inside of the corner are not able to transmit as much torque as the wheels on the outside of the corner.

The open axle differentials distribute drive torque at a ratio of 1:1 to both wheels on an axle. If the maximum transmissible torque at the driven wheel on the inside of the corner decreases, therefore, the wheel on the outside of the corner will only be able to transmit the same amount of torque – even though the greater effective wheel load would theoretically allow it to transmit considerably more drive torque.

If the wheel on the inside of the corner loses drive torque, the entire powertrain will lose drive torque.

Self-Study Programmes relevant to the Audi A8 '10

This Self-Study Programme summarises all the information you need to know about power transmission in the Audi A8 '10. For further information about the Audi A8 '10, refer to the following Self-Study Programmes.

SSP 456 Audi A8 '10

- Body
- Passive/active safety
- Engine
- Suspension system
- Electrical system/air conditioning/infotainment

Order number: A10.5500.60.20

SSP 458 Audi A8 '10 Suspension system

- Front axle/rear axle
- adaptive air suspension
- Dynamic steering
- Brake system

Order number: A10.5500.62.20

SSP 459 Audi A8 '10 Onboard power supply and networking

- Topology
- FlexRay
- Light system
- LED headlight

Order number: A10.5500.63.20

SSP 460 Audi A8 '10 Convenience electronics and Audi tracking assist

- Control unit with display in dash panel insert J285
- Convenience system control unit J393
- Background lighting
- Audi tracking assist

Order number: A10.5500.64.20

SSP 461 Audi A8 '10 Driver assistance systems

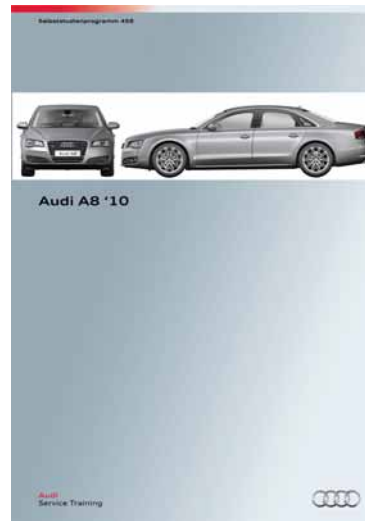
- New image processing system
- Camera control unit J852
- Intelligent light system with navigation assistance
- Image processing control unit J851
- Functions of the ACC Stop & Go image processing system

Order number: A10.5500.65.20

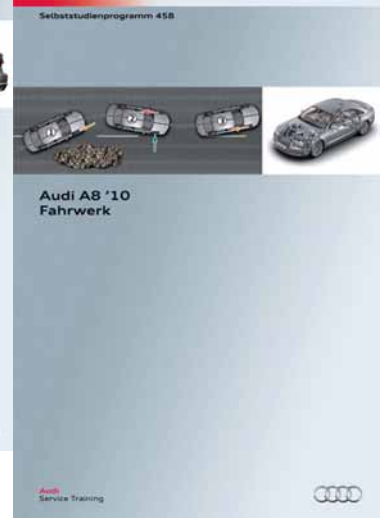
SSP 462 Audi A8 '10 Night vision assist

- Functions of the night vision assist system
- System operation and displays
- System components
- System overview
- Diagnostic functions and system calibration

Order number: A10.5500.66.20



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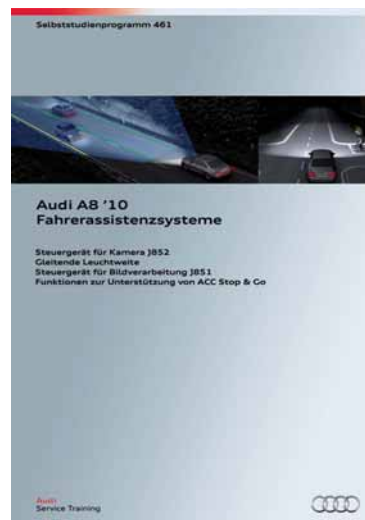
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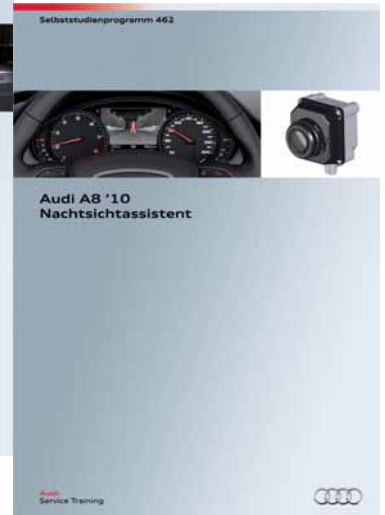
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