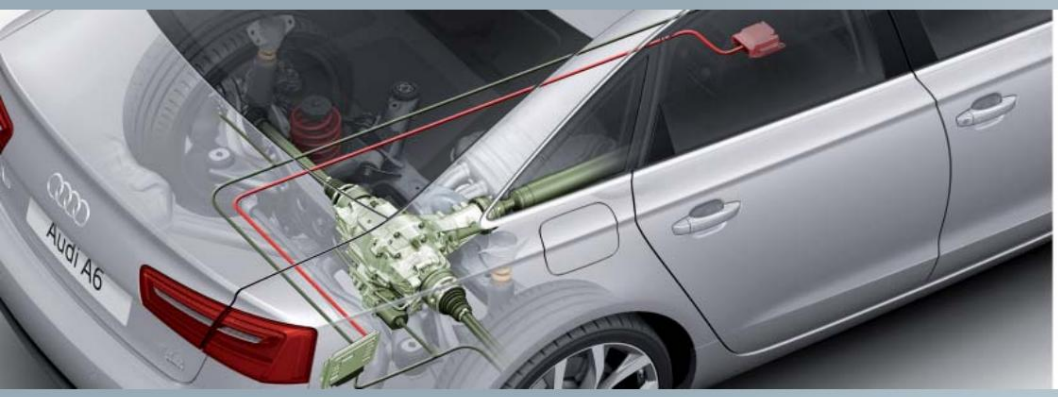
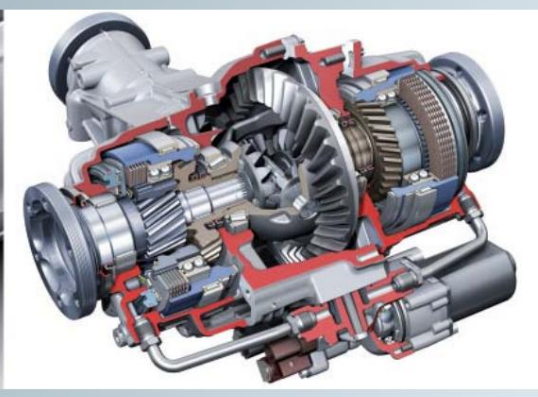
Self-study program 476





Rear axle drive 0BF/0BE

– Sport differential

quattro with sport differential

The quattro drive is still the best-known all-wheel drive concept and is directly associated with Audi.

quattro stands for:
- outstanding traction
- superior driving characteristics
- increased driving safety
- Emotion and fascination

The quattro drive is therefore one of the most important unique selling points1) of the Audi brand and requires continuous innovation.
to ensure that customers always receive the best all-wheel drive for the road.

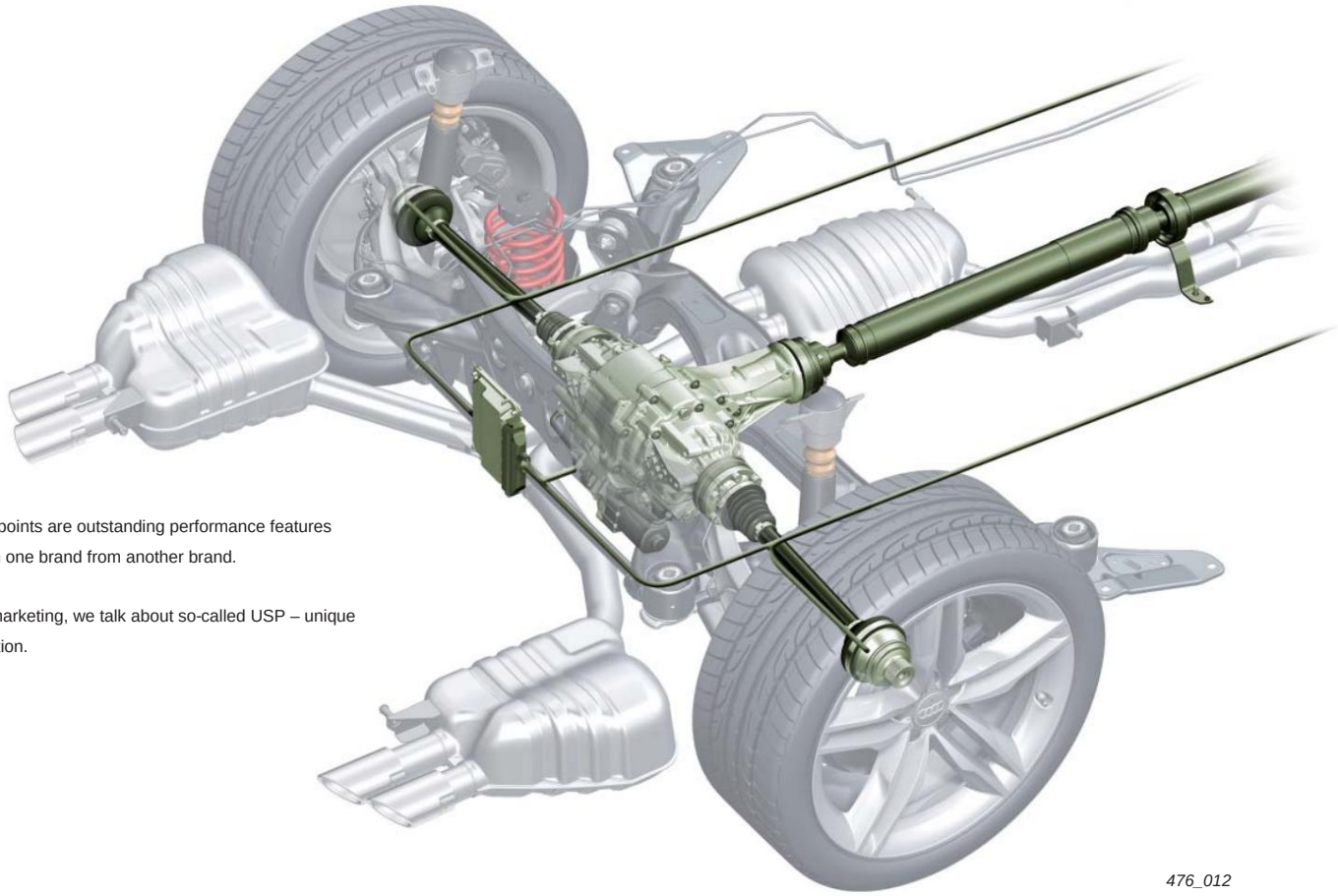
With its superior traction and driving dynamics, quattro technology is already at the highest level.

By distributing the propulsion forces across all four wheels, each drive wheel has more potential for lateral guidance. The vehicle remains stable for longer.

Electronic control systems such as the electronic differential lock EDS, the Audi-typical tuning of the ESP stabilization system and the wheel-selective torque control enable a further improvement in traction properties and contribute to the great driving pleasure and high stability of quattro.

The sports differential offers a new dimension in driving dynamics through targeted control of the power flow to the wheels on the rear axle. This allows the vehicle to steer into corners more spontaneously and directly and maintains directional stability for significantly longer. Understeering becomes a foreign word.

The sports differential is aimed at customers who have very high demands on the driving dynamics of their vehicle and are looking for a special driving experience.



476_012

1) Unique selling points are outstanding performance features that distinguish one brand from another brand.

In the field of marketing, we talk about so-called USP – unique selling proposition.

The sports differential was first introduced in the Audi S4 in 2009. Since then, customers with sporting ambitions have been able to order the sports differential as an option in all S models and particularly powerful models in the B8, C7 and D42 series .

The sports differential is an attractive option for the sporty, ambitious driver, and is not available anywhere else in this combination with the quattro drive.

2) The Audi A8 with 4.2l TDI engine comes with the sports differential as standard.

Customer benefits of the sports differential

- improved, direct steering behavior with low steering effort – more agile handling
- outstanding acceleration in curves
- Stabilization of the vehicle during load change reactions
- Increased driving stability without loss of dynamics (reverse function of ESP)
- Reduction of understeer when accelerating in Especially with high friction values
- fast system response times
- maintenance-free

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Audi iTV training

Get more additional information about the sports differential
You from the following four Audi iTV programs: • **Audi quattro with sports differential 0BF Part 1**
Content: Mode of operation, driving dynamics with sports differential
Operation, mode of operation and function

• **Audi quattro with sports differential 0BF Part 2**
Contents: Construction and function
Oil management and electro-hydraulic control
• **Audi quattro with sports differential 0BF Part 3**
Contents: Repairs to the sport differential • **Audi quattro with sport differential 0BF Part 4**
Contents: Working and testing with the vehicle diagnostic tester

The self-study program provides the basics of the design and function of new vehicle models, new vehicle components or new technologies.

The self-study program is not a repair manual! The values given are only intended to facilitate understanding and refer to the data status valid at the time the SSP was created.

For maintenance and repair work, please be sure to use the latest technical literature.

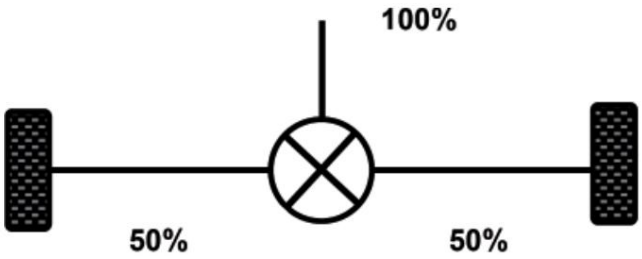
Notice

reference

Physical basics

Basics of moment transverse distribution

The classic, **open differential** always distributes drive torques equally, the left and right wheels always transmit the same forces (50:50), which means that the transmission is almost free of yaw moments.



476_003

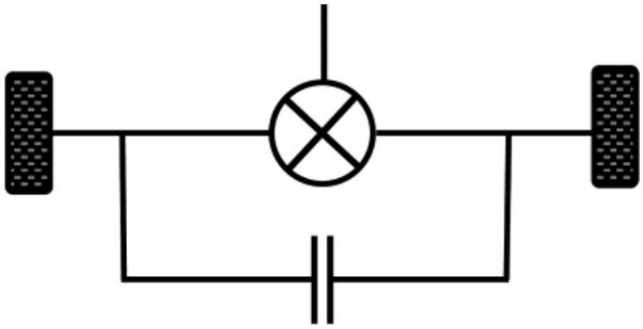
When cornering, the dynamic wheel load distribution means that the wheel on the inside of the curve determines how much torque the wheels can transfer, as it is the first to start spinning (the torque is lost). In this case, the inner wheel cannot transfer any torque, and therefore neither can the side on the outside of the curve. The same applies if a wheel comes onto ice, for example, this side cannot transfer any torque. Accordingly, the opposite side cannot transfer any torque either.

However, a differential always has a certain amount of internal friction. This friction leads to a small “locking torque” and this locking torque can always take effect. This physical property is used in the self-locking center differentials in the quattro drive.

With a **limited-slip differential,** depending on the locking value, a certain torque is shifted from the faster-rotating wheel to the slower-rotating wheel (inside of the curve). During normal cornering, this creates steering effects that counteract the steering direction. The vehicle tends to understeer.

When cornering quickly, the behavior changes.

The load on the other wheel is reduced and tends to spin. The limited-slip differential transfers the torque to the outside wheel and the
Axle can continue to transfer torque.



476_004

With **the superposition differential** we have an additional path of action1). Using a superposition gear and a clutch for each side, drive torque can be directed from the differential housing to the left or right flange shaft (inner or outer side of the curve).

This path of action can be used in both pulling and pushing operation.

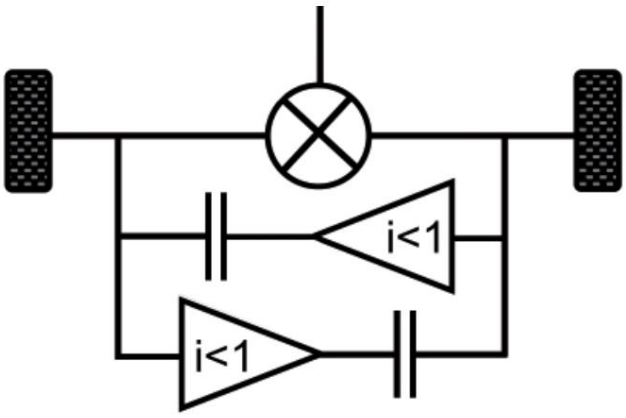
The sport differential belongs to the category of superposition differentials.

In contrast to a limited-slip differential, with a superposition differential not only is a torque transmitted via a clutch, but additional torque is added with a clutch by means of a gear ratio.

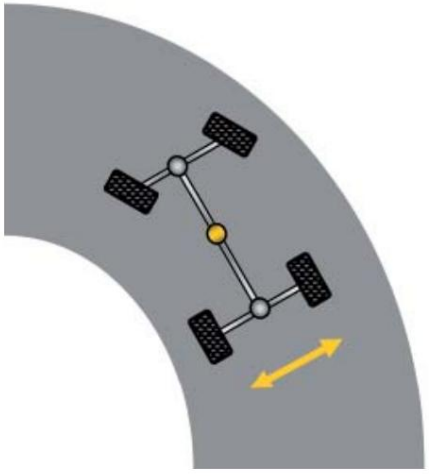
The clutch together with the gear ratio is called a superposition gear or superposition unit because an additional torque (and speed) is “superimposed” on the existing power flow by means of a gear ratio.

The superposition gear has a gear ratio of high speed (i<1). The additional drive torque results from or acts as a result of the increase in speed.

1) Path of action = a path that the flow of force can follow.



476_005



476_006

Possibilities of the superposition differential (sports differential)

If a wheel on an axle is accelerated with the help of the superposition gear, a yaw moment is generated on the vehicle, which has a steering effect on the vehicle.

A similar effect is known from electronic stabilization
ESP control program, which also generates a yaw moment through braking intervention, which stabilizes the vehicle and keeps it on course.

The physical operating principle of the sports differential is the opposite of that of the ESP. Instead of braking a wheel, it is accelerated. This increases driving dynamics and shifts the vehicle-specific limit range closer to the physically possible limit. ESP intervention is required less often.

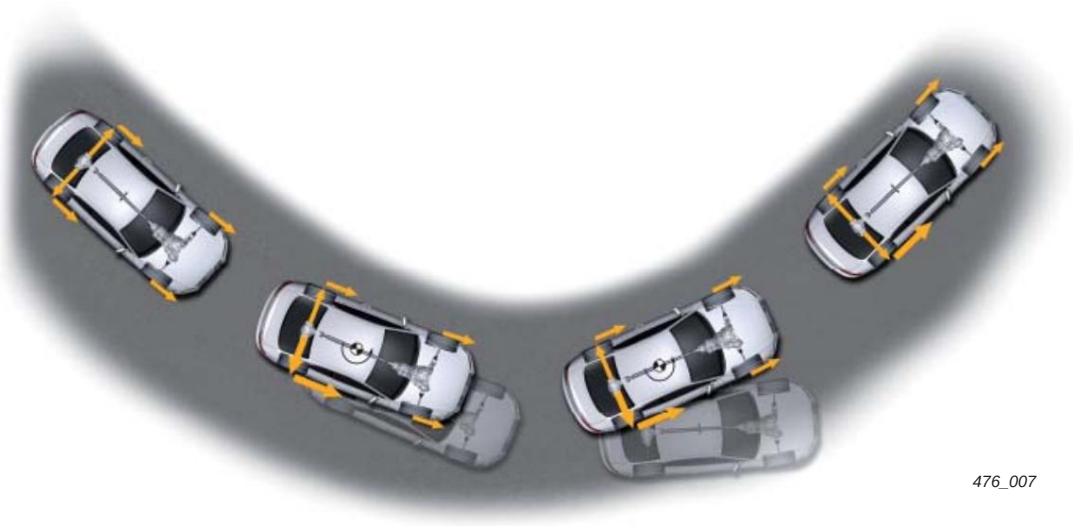
The sport differential controls the power flow continuously and at lightning speed, giving the vehicle neutral and precise handling both under load and when coasting. Even disruptive load change reactions when the accelerator is released in a curve are significantly reduced. Thanks to its delay-free and continuous operation, the sport differential also works much more smoothly than the ESP.

The sport differential and the ESP work closely together. The ESP is specially tailored to the sport differential. However, as soon as the ESP detects a critical driving situation, it takes control and deactivates the sport differential.

If the sports differential is not activated, it acts like a conventional rear axle transmission.

Intervention in understeer

When understeering, the front of the car slides out of the curve. By deliberately shifting the power flow to the outside of the curve, a yaw moment is generated, which steers the vehicle into the curve. Understeering is thus counteracted right from the start.

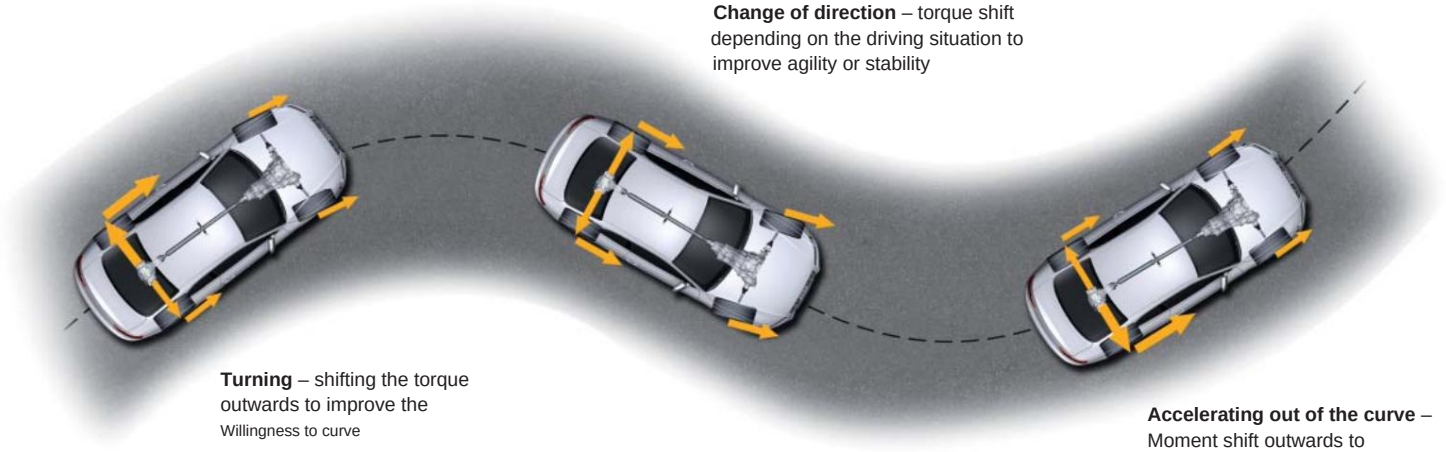


476_007

Driving situations

When driving dynamically through curve combinations, higher lateral accelerations and cornering speeds are achieved despite less steering effort from the driver.

Change of direction – torque shift depending on the driving situation to improve agility or stability



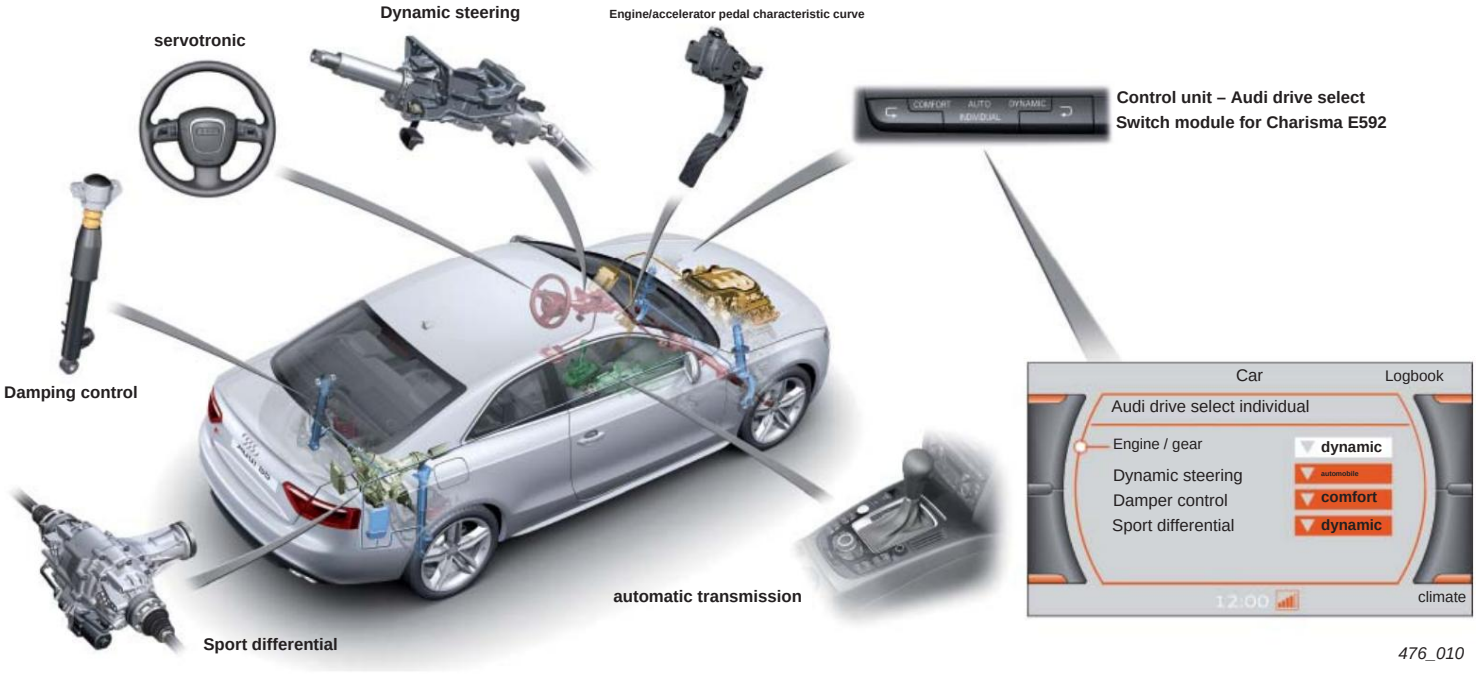
Turning – shifting the torque outwards to improve the
Willingness to curve

Accelerating out of the curve – Moment shift outwards to avoid
Acceleration understeer

476_009

Operation – Functions

Audi drive select



476_010

The sport differential is an optional1) component of the innovative Audi drive select driving dynamics system. The driver can choose between three different levels of performance using the three operating modes comfort, auto and dynamic on the Audi drive select control panel.

In **comfort mode,** the activation of the sports differential is limited to a minimum. It is mainly used to react to load changes.

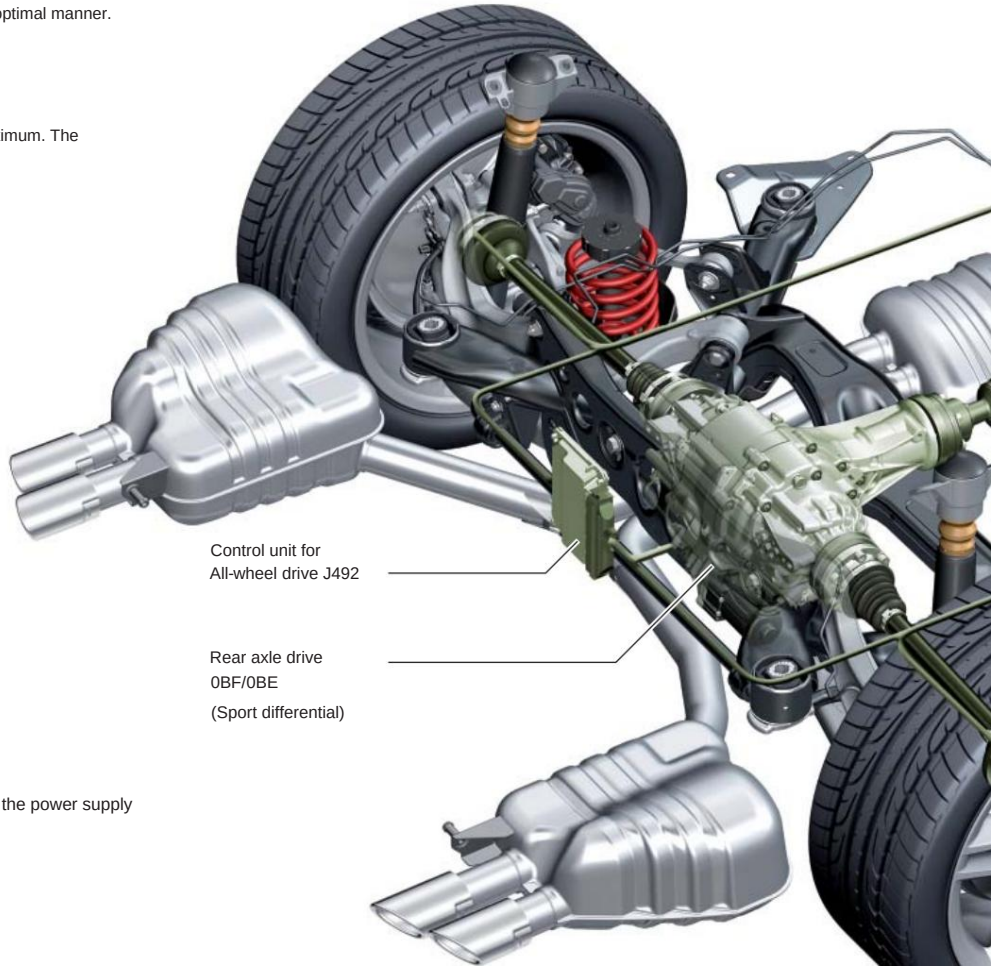
optimally dampened, which gives the vehicle a very balanced behavior.

In **auto mode,** the sports differential supports driving dynamics in an optimal manner. The vehicle steers very agilely through bends.

In **dynamic mode,** the effect of the sports differential is felt to the maximum. The driving dynamics are tuned to be particularly sporty.

The sports differential is always active when driving and cannot be switched off completely2). The operating range extends over a speed range between 15 km/h and 150 km/h.

The sports differential does not act as a differential lock if a rear wheel spins when setting off. However, newer vehicle models in the D4 series and the C7 series have a so-called "traction function", see page 46.



Further information on Audi drive select can be found in the following SSPs:

- SSP 409 (B8 series Audi A4 '08)
- SSP 478 (series C7 Audi A7 Sportback)
- SSP 486 (series C7 Audi A6 '11)
- SSP 456 (D4 series Audi A8 '10)

1) The Audi A8 with 4.2l TDI engine has a sport differential installed as standard.

2) The sports differential can only be switched off by disconnecting the power supply to the corresponding components.

System overview

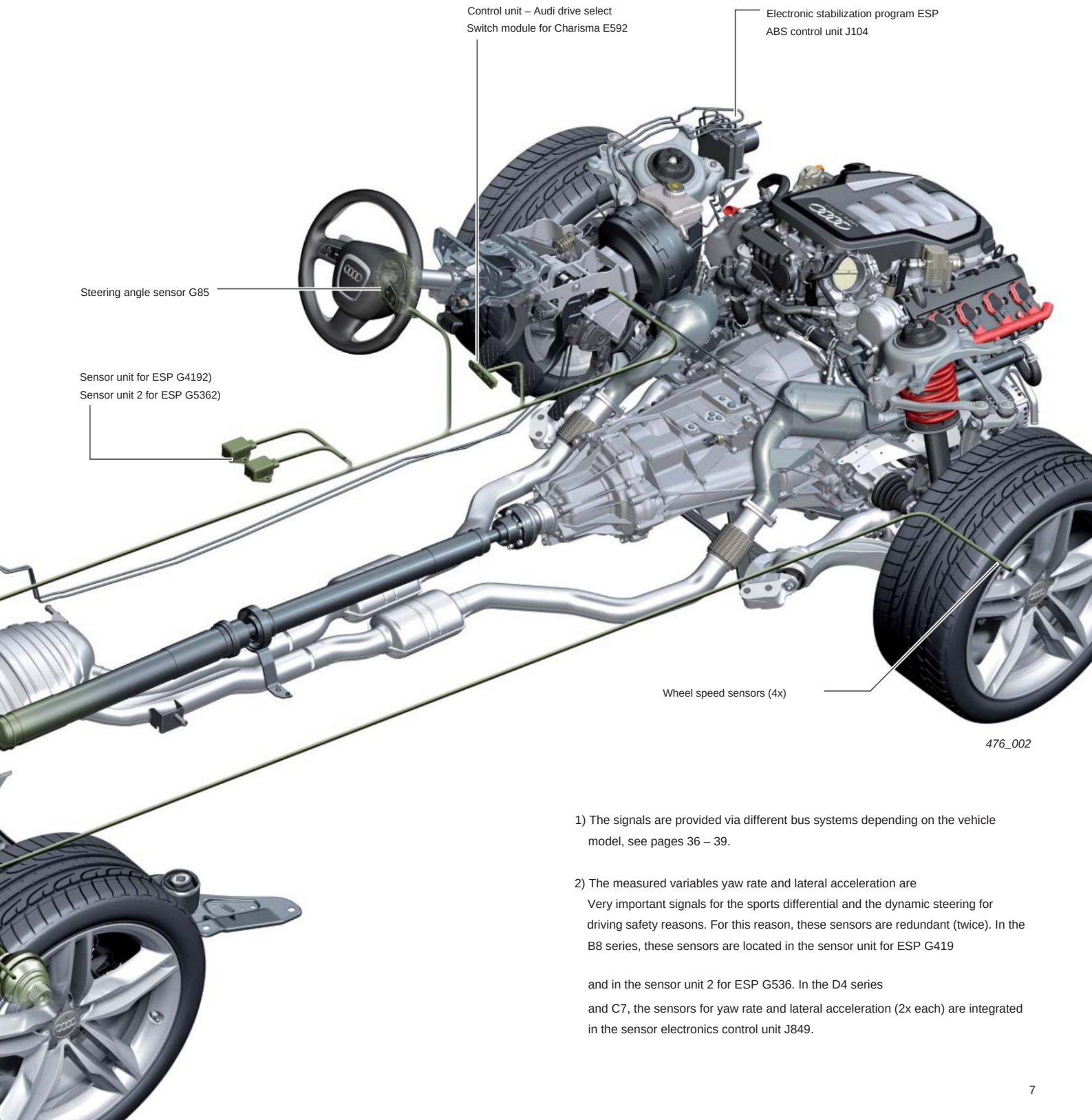
The sports differential consists of the following components:

- Rear axle drive 0BF/0BE
- All-wheel drive pump V415
- two clutch valves N445/N446
- two oil pressure and oil temperature sensors G437/G640
- All-wheel drive control unit J4921)

The sports differential works very closely with the ESP.
The ESP control unit is specially designed to coexist with the sports differential.

To control the drive torque, the sports differential essentially uses the following signals1):

- Steering angle
- Wheel speed of the four wheels
- Yaw rate2)
- Lateral acceleration2)



476_002

1) The signals are provided via different bus systems depending on the vehicle model, see pages 36 – 39.

2) The measured variables yaw rate and lateral acceleration are
Very important signals for the sports differential and the dynamic steering for driving safety reasons. For this reason, these sensors are redundant (twice). In the B8 series, these sensors are located in the sensor unit for ESP G419

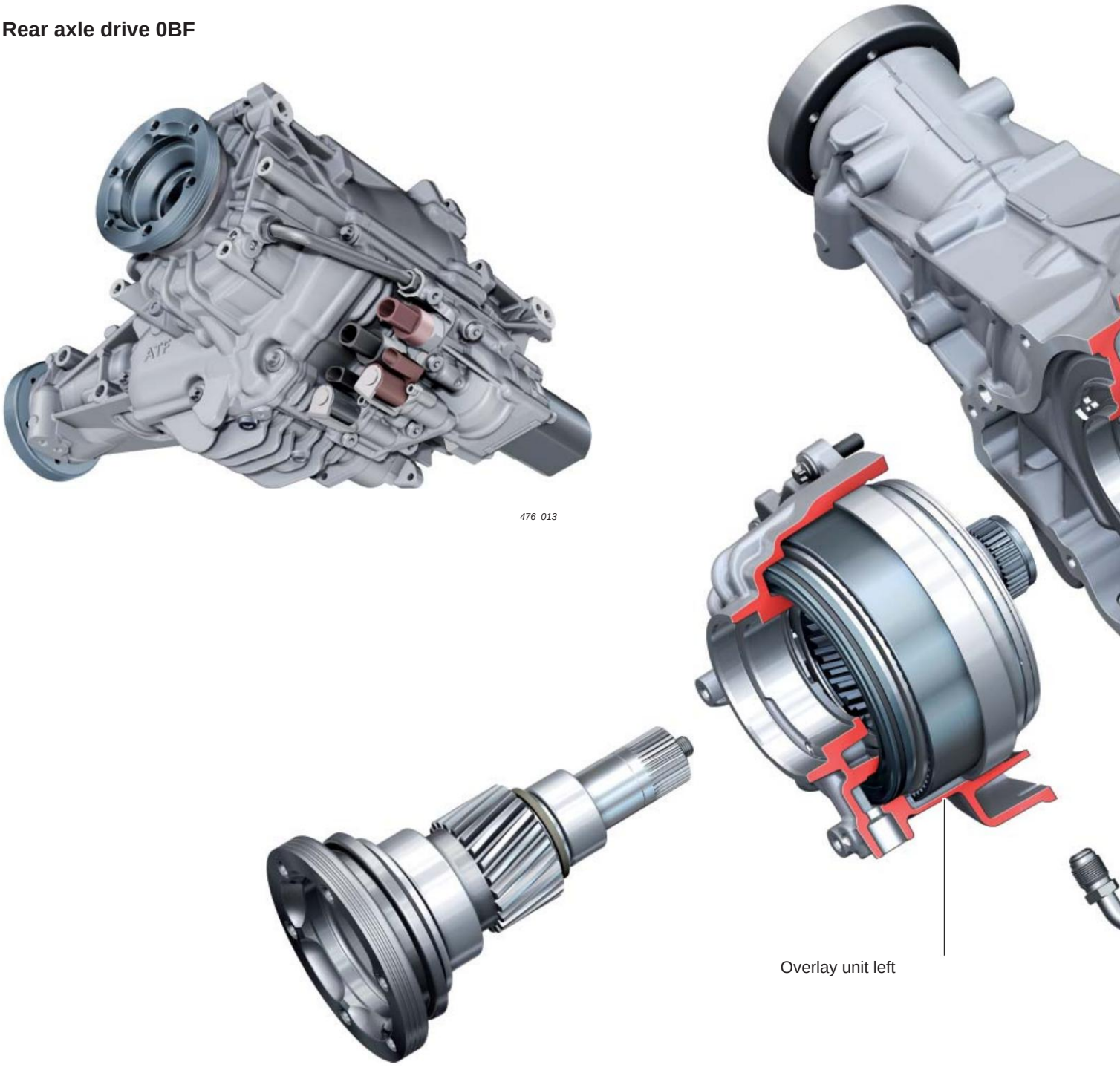
and in the sensor unit 2 for ESP G536. In the D4 series
and C7, the sensors for yaw rate and lateral acceleration (2x each) are integrated in the sensor electronics control unit J849.

Technical data

Terms in the service	Rear axle drive 0BF1)	Rear axle drive 0BE1)
Internal	HL601	HL951
In sales department	Sport differential	Sport differential
Development	Magna Powertrain (Graz, Austria) – Audi AG	Magna Powertrain (Graz, Austria) – Audi AG
Manufacturer	Magna Powertrain	Magna Powertrain
Torque capacity	up to approx. 700 Nm (engine torque)	up to approx. 1000 Nm (engine torque)
Translation overlay unit	i_{total} = 0.913	iges = 0.913
Weight	approx. 43.5 kg (incl. oils)	approx. 55 kg (incl. oils)
Oil budgets	Axle oil in the axle drive – bevel gear/differential (one oil supply) ATF in the two overlay units (one oil supply)	

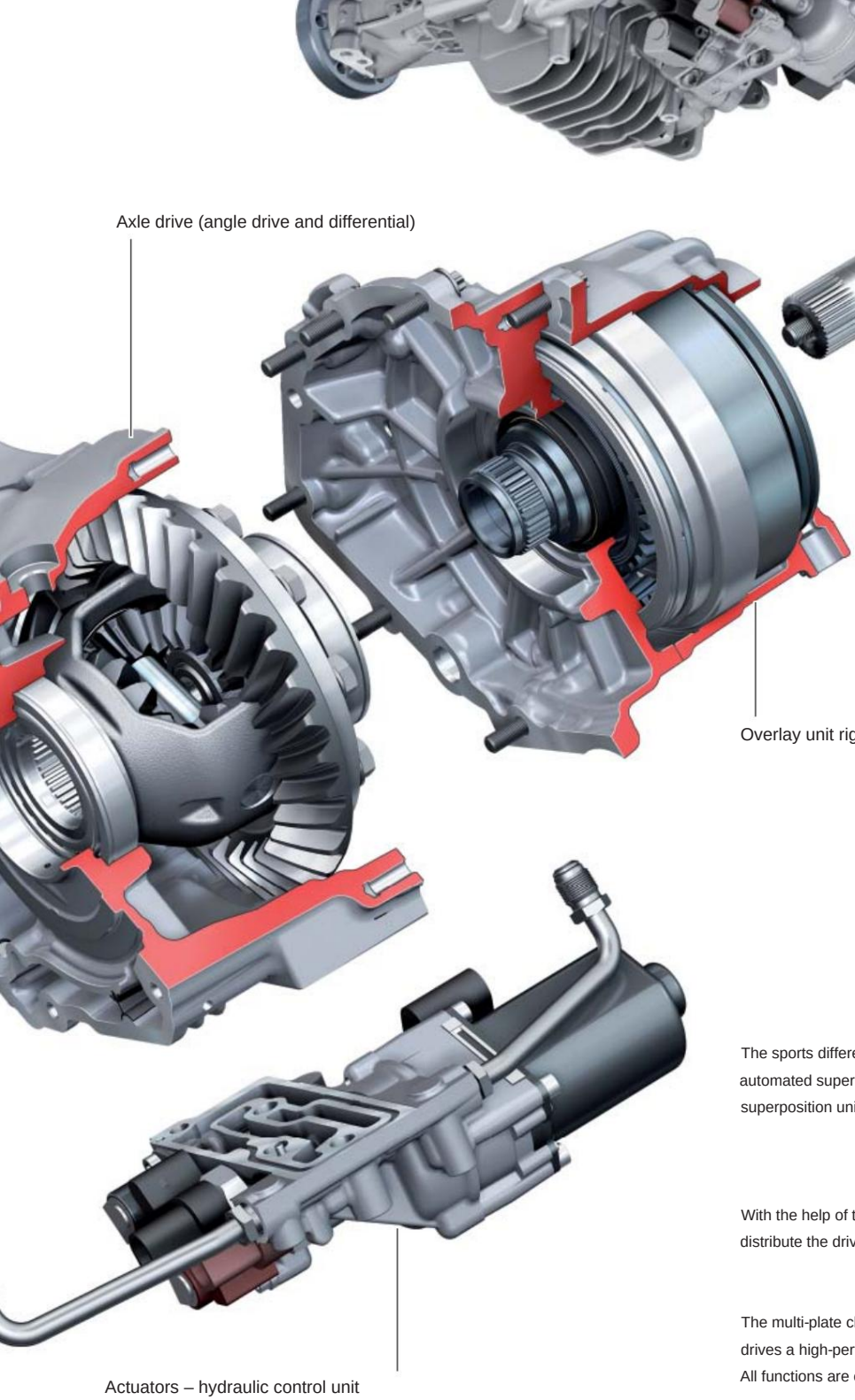
1) PR number (special equipment number) = GH2

Rear axle drive 0BF



Rear axle drive 0BE

476_015



476_014

Axle drive (angle drive and differential)

Overlay unit right

Actuators – hydraulic control unit

The sports differential consists of a conventional axle gear and two newly developed, automated superposition units, which are arranged on the left and right. One superposition unit consists of the superposition gear and a multi-plate clutch.

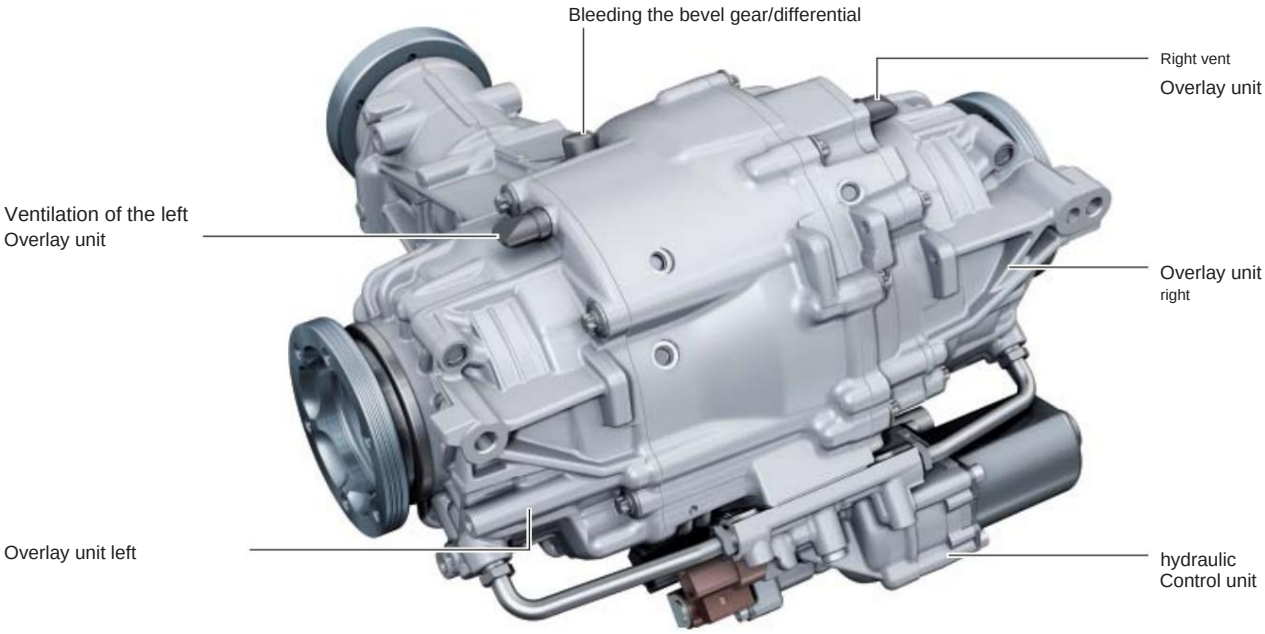
With the help of the integrated multi-plate clutches, the superposition gears can distribute the drive power variably between the wheels of the rear axle.

The multi-plate clutches are operated by the hydraulic control unit. An electric motor drives a high-performance oil pump, which provides the necessary hydraulic pressure. All functions are controlled and monitored by a separate control unit.

Gearbox cut

Rear axle drive 0BF (sport differential)

The 0BF sports differential can be combined with all engines up to approx.
700 Nm. It is currently used in the model series
B8, C7 and D4 installed.



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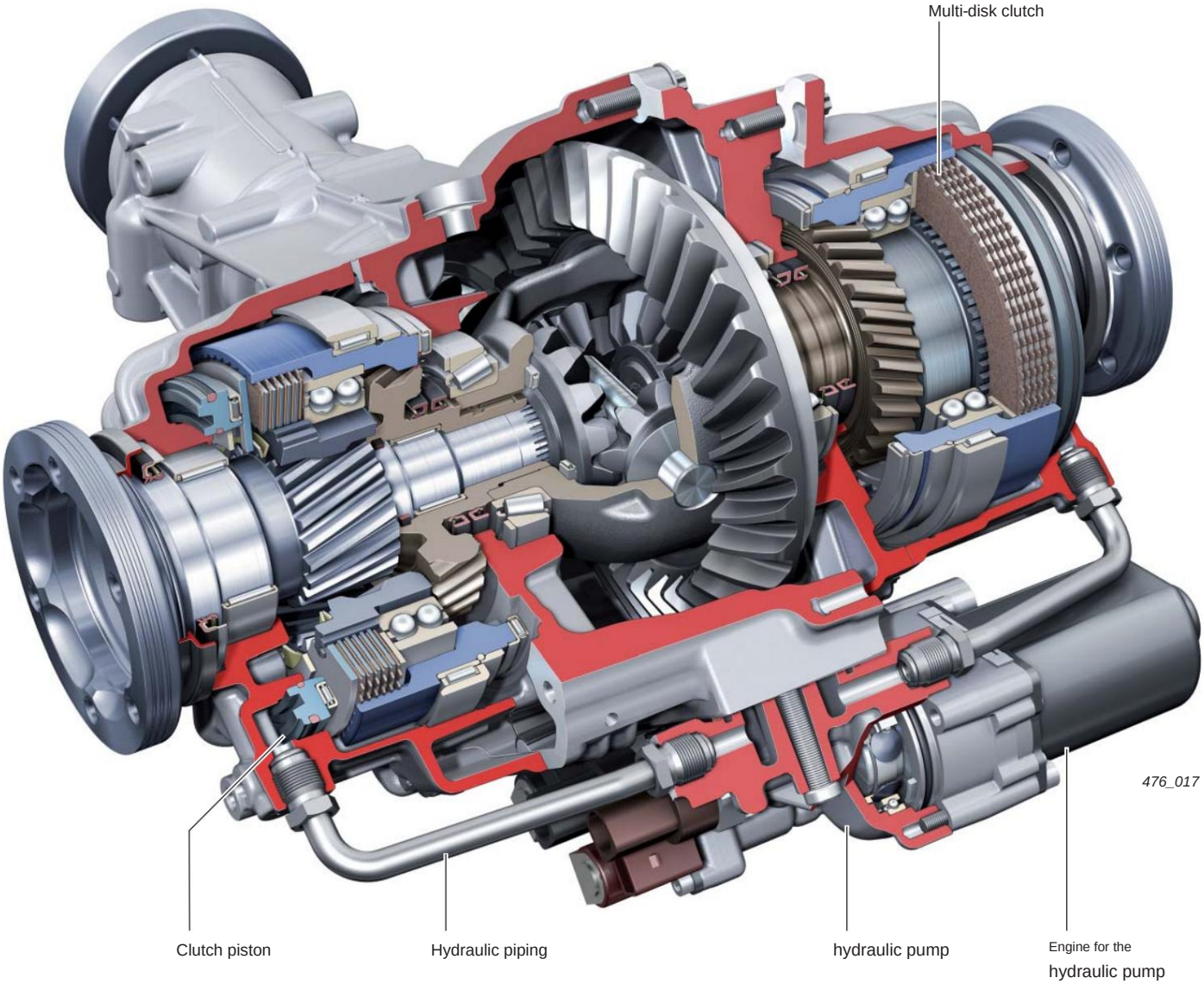
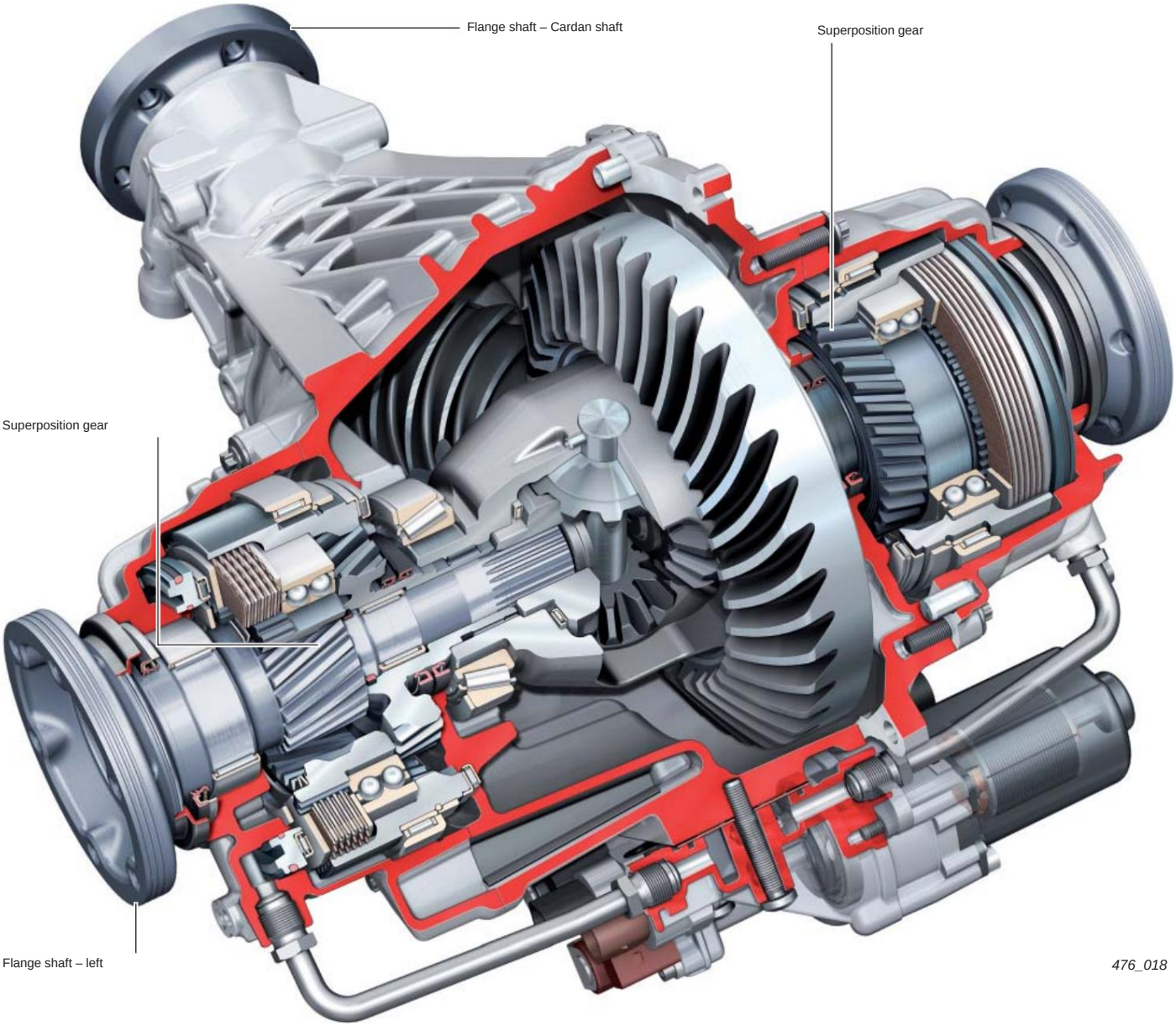


476_017

Rear axle drive 0BE (sport differential)

The sport differential 0BE is currently only intended for the Audi A8 '10 with a 4.2l TDI engine. The sport differential 0BE corresponds in function and structure to the sport differential 0BF.
The overlay units on the left and right as well as the electro-hydraulic control have also been adopted from the 0BF.

In order to cope with the high torque of the 4.2l TDI engine (800 Nm), the drive train components, crown gear, pinion, differential, bearings and all housing parts are dimensioned accordingly larger. This makes the 0BE gearbox around 45 mm wider and around 11.5 kg heavier than the 0BF gearbox.



476_018

Note on replacing the rear axle drive 0BF/0BE

The rear axle drive 0BF/0BE must always be assigned to the all-wheel drive control unit J492 and taught in.
Without this learning process, the sports differential will not work. The axle drive and the control unit are paired with each other.

When teaching a new axle drive, the axle drive is assigned (identified) to the control unit. The friction values of the multi-plate clutches (classification) are taught to the control unit, see pages 14 and 41.

Each axle drive is given an identity. The classification of the multi-disk clutches is engraved on the housing, see page 14.

The identity is determined by the two oil pressure and oil temperature sensors G437/G640. They have a chip with an individual identifier. Each sensor is therefore unique and has its own serial number, see page 31.

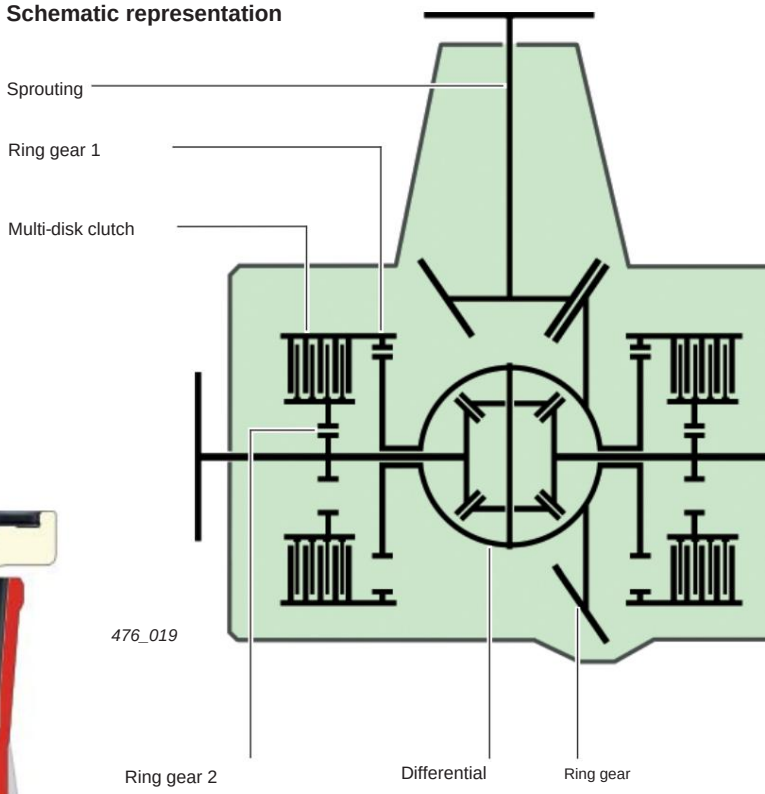
To replace the axle drive, the vehicle diagnostic tester has a function called “Replace rear axle drive”. This includes all the steps and processes required to teach the

Sport differential to the control unit. Further information on replacing the sport differential can be found on page 41.

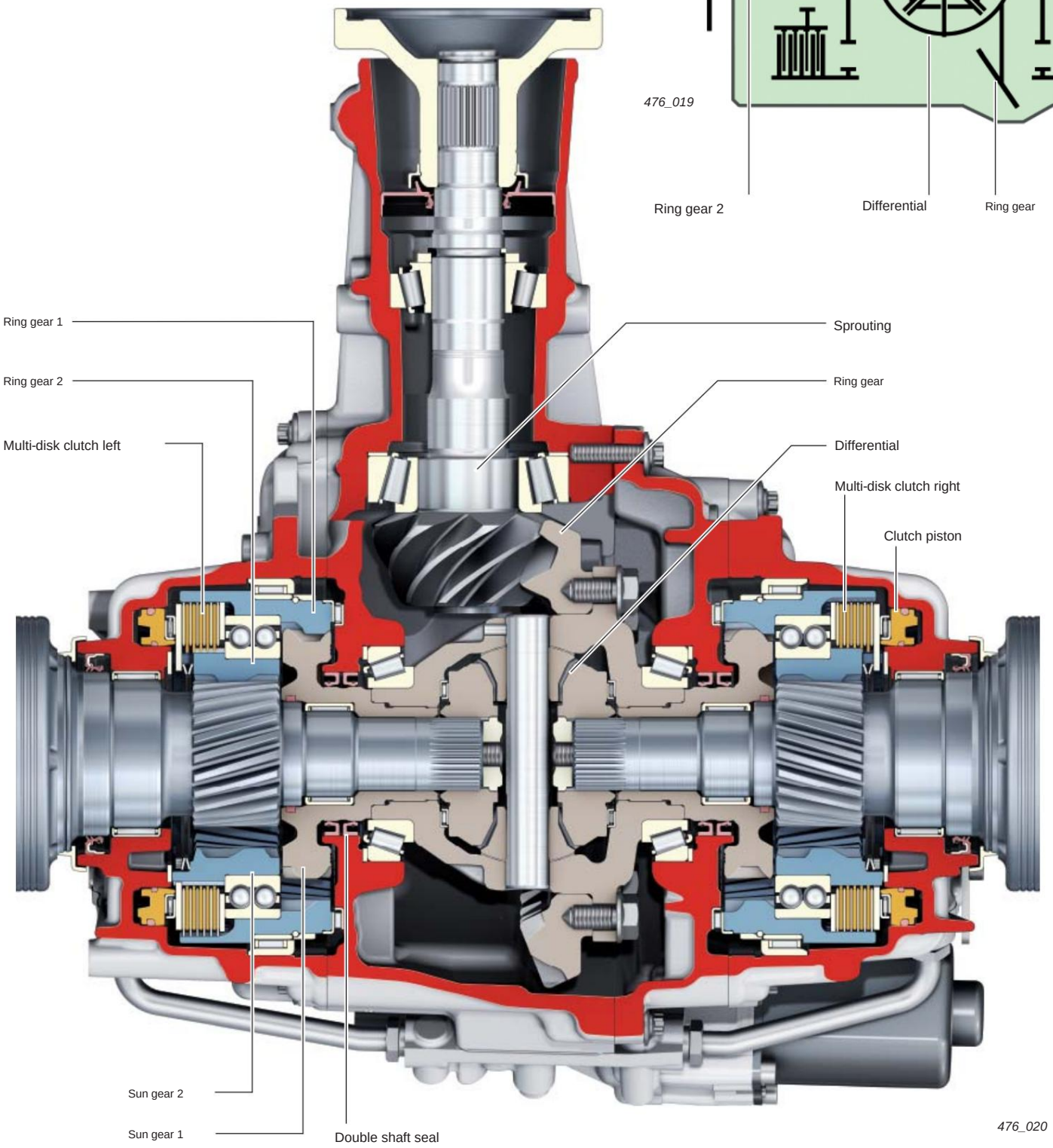
Superposition gear (ring gear)

The superposition gear consists of two coaxially arranged ring gears with a reduction stage (i1>1) and a transmission stage (i2<1). The transmission ratios i1 and i2 together result in a transmission ratio of approx. 10% to the fast stage (i<1), see calculation on page 13.

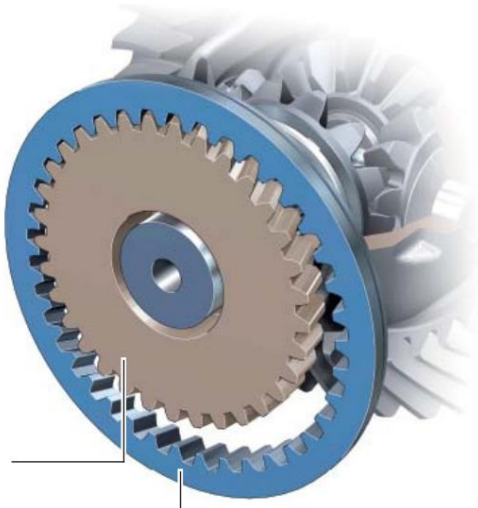
Schematic representation



Gearbox cut



Ring gear 1
Section A – A



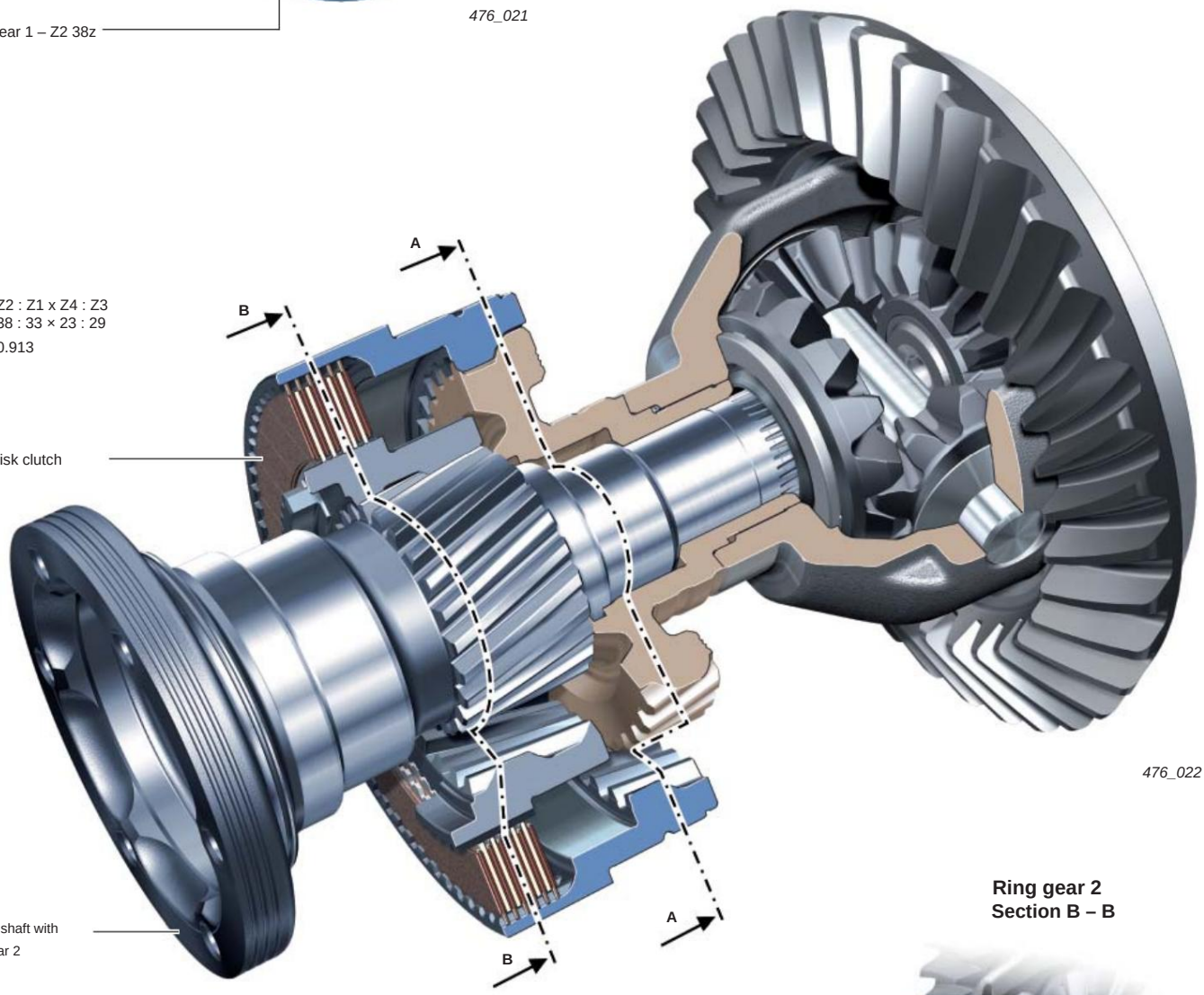
Sun gear 1 – Z1 33z

Ring gear 1 – Z2 38z

476_021

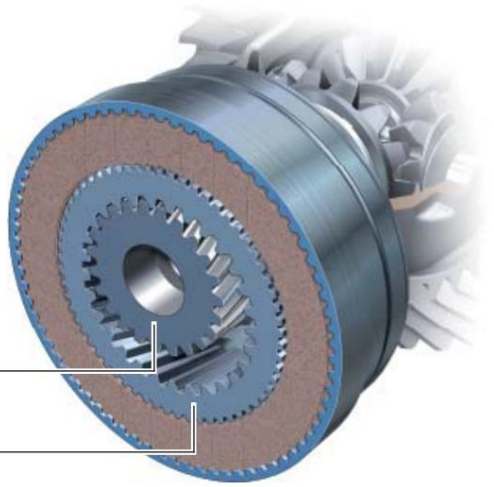
The sun gear 1 (Z1) is positively connected to the differential housing or to the ring gear and drives the ring gear 1 (Z2). The ring gear 1 transmits the torque to the ring gear 2 (Z3) in the case of a friction-locking multi-disk clutch . The ring gear 2 in turn engages the sun gear 2 (Z4), which is an integral part of the flange shaft and ultimately transmits the torque to the gear. The flange shaft is also positively connected and thus continuously connected to the bevel gear of the differential. With the help of the superposition gear, additional torque can be applied, depending on the frictional connection of the multi-plate clutch, combined with an increase in speed. This increases the transmitted power.

i_{total} = Z2 : Z1 x Z4 : Z3
= 38 : 33 × 23 : 29
= 0.913



476_022

Ring gear 2
Section B – B



Sun gear 2 – Z4 23z

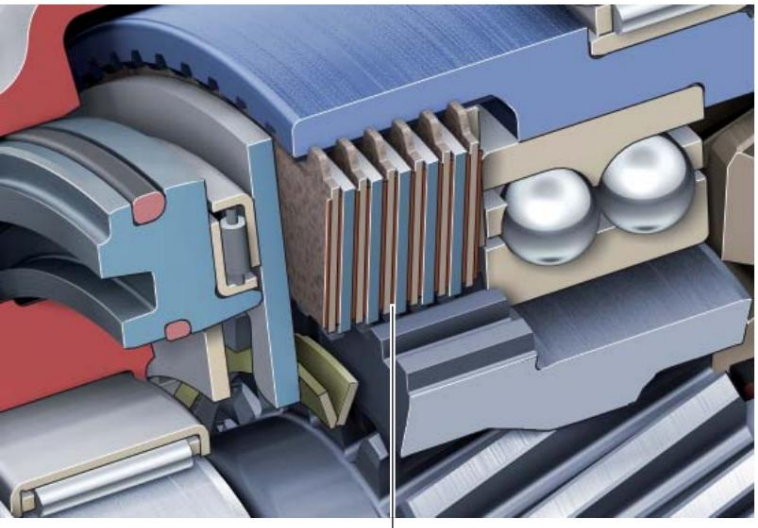
Ring gear 2 – Z3 29z

476_023

Speed increase on the flange shaft Speed of
the ring gear = nInput 1000 1/min
Flange shaft speed = nOutput ?

nOutput = nInput : iges
= 1000 rpm : 0.913
= 1095 rpm (speed increase of approx. 10%)

Multi-disk clutch



476_024

Multi-disk clutch

The multi-disk clutches are integrated in the ring gear and are operated electro-hydraulically. They transfer a desired clutch torque from the ring gear of the first ring gear ratio to the second ring gear ratio, i.e. from the ring gear to the flange shaft. The ratio results in a corresponding superposition torque.

The superposition torque is calculated by the transmission control unit and realized via a defined clutch pressure.

The multi-disk clutches are operated exclusively with slip. This means that they are not completely force-locked during operation. The superimposed torque is limited to a maximum of 1200 Nm, see page 35.

Due to the design of the hydraulic control, only one multi-plate clutch can be controlled at a time (left or right side), not both sides at the same time.

The multi-plate clutches and the ring gears operate in an ATF oil bath. The ring gear stages generate a certain oil flow that directs the ATF to the clutch plates for lubrication and cooling.

Note: There are a number of functions available in the vehicle diagnostic tester for checking the clutches and the control system, see page 42 onwards.

Clutch control – friction coefficient, classification

The friction values of the two clutches must be communicated to the control unit so that the clutch control can control the clutch torque as precisely as possible.
Only when the friction coefficient is known to the control unit can a corresponding clutch torque be generated via a defined clutch pressure.

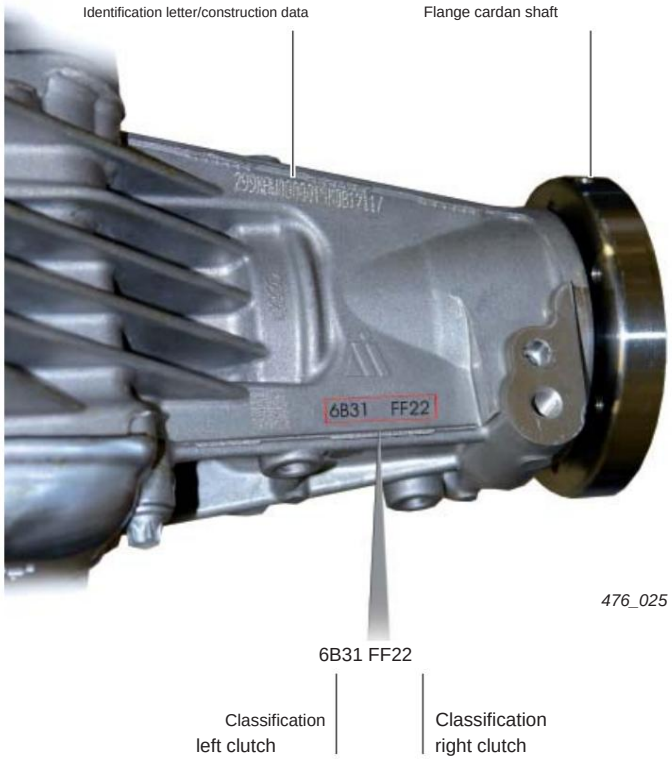
For this reason, the friction values of the clutches are determined on the manufacturer's test bench. These friction values are grouped (classified) and assigned the corresponding classification numbers. This process is called classification.
The classification is engraved on the sports differential and is also shown on the

Barcode stickers.

The classification is given in hexadecimal numbers.
It must be entered into the control unit using the vehicle diagnostic tester. By entering the classification, the control unit knows the friction value of the respective clutch and can control it accordingly.

Please note the instructions and effects when entering the classification on pages 40 and 41.

Without entering the classification, the function of the sports differential is blocked (with corresponding event memory entry).



reference

Further information on the principles of power transmission of “wet” multi-plate clutches and on adaptation can be found in Self-Study Programme 385 from page 54.

Clutch adaptation

Like any other component, the friction coefficient of a multi-plate clutch operated in an oil bath is subject to certain changes due to ageing and wear of the oil and the affected components (e.g. clutch plates, parts used for control).

The control unit must take this change in the friction coefficient into account so that it can control a desired clutch torque.
For this purpose, the control unit of the sports differential carries out a continuous clutch adaptation.

The clutch adaptation is a function in the control unit of the sports differential.
The clutch adaptation works as follows:

The control unit calculates the power (P) and work (W) (W = P xt) performed by each clutch for each clutch activation. These values for the individual clutch activations are saved and added up over the running time.

In other words, the energy input is calculated for each clutch and stored over the running time.

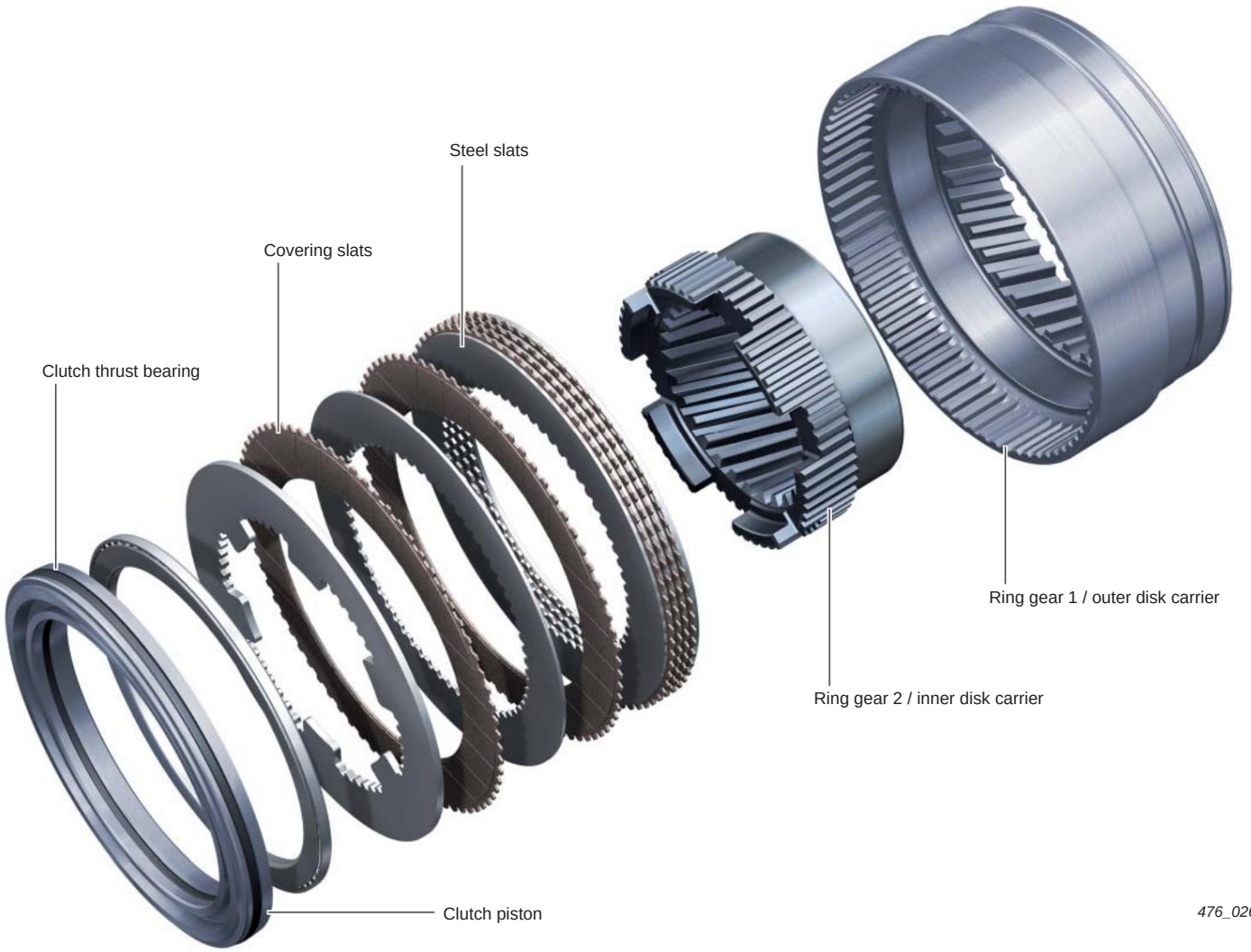
Through tests on the test bench, the friction coefficient changes with corresponding energy inputs of the clutches. The friction coefficient changes determined in this way are stored as a correction factor in the control unit. The clutch control takes this correction factor into account when calculating the clutch pressure.

Due to this type of clutch adaptation, special procedures must be observed when replacing the following system components:

- All-wheel drive control unit J492, see page 40
- Rear axle drive 0BF/0BE, see page 41
- Oil pressure and oil temperature sensor G437/G640, see page 31
- Multi-disk clutches or overlay units (if the repair depth allows for this)

Clutch temperature monitoring

The clutch temperature is calculated by the control unit taking the ATF temperature into account. Once a defined temperature limit is reached, the system is temporarily switched off. A corresponding error message is then displayed in the instrument cluster, see pages 30 and 41.



476_026

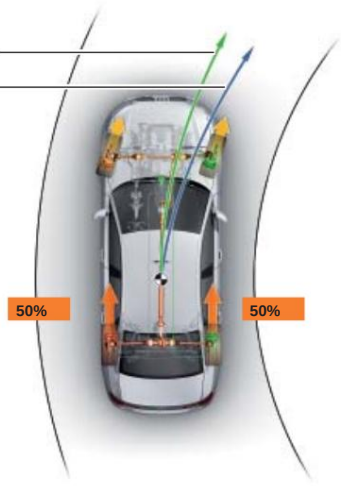
Power flow and driving dynamics

As already described, with the sports differential a defined drive torque is transmitted by means of a clutch and the associated superposition gear.

Not only is a torque shifted, but the speed is also increased at the same time via a gear ratio. Only the increase in speed plus the torque shift, e.g. to the outside of the curve, produces the desired effect, generating a yaw moment on the vehicle, which steers the vehicle into the curve.

The product of torque and speed is the power. The drive power therefore results from the drive torque and speed.

Therefore, to better explain the force distribution, the power (P) is considered in the further course.



without sports differential –
larger steering angle required,
Yaw moment free

476_027

n = speed
M = moment
P = Performance

n higher
M lower

X Nm = locking torque due to friction in the differential.
This moment is not taken into account in the calculation examples here.

476_028

Power distribution without control

When driving straight ahead, the sports differential is not activated.
The drive power is distributed equally to the rear wheels by the differential.

The example shown above shows driving through a right-hand bend without activating the sports differential. The power distribution is the same as with a normal axle drive with an open differential.

Due to the speed compensation when cornering and a certain amount of friction in the differential, the drive torque (X Nm) is shifted towards the inside of the curve.

In terms of driving dynamics, this situation has an understeering effect because the driving forces and other driving dynamics influences work against cornering. The vehicle must be steered through the curve with the appropriate steering angle so that it follows the desired curve radius. This means that the steering angle must be greater than is theoretically required for the curve radius.

If the traction capacity on the inside of the curve is exceeded, the wheel spins and the drive torque suddenly drops to a very low value. This behavior has a negative effect on driving dynamics because it greatly reduces the vehicle's propulsion.

Notice

The values shown in these examples are intended to provide a better understanding of the situation. They do not take into account all losses and factors that occur in practice.

Power distribution with control

Depending on the driving situation, the drive power can be sensitively redirected via the superposition gears with the help of the clutches.

In a right-hand bend, for example, additional drive power is shifted to the left wheel.

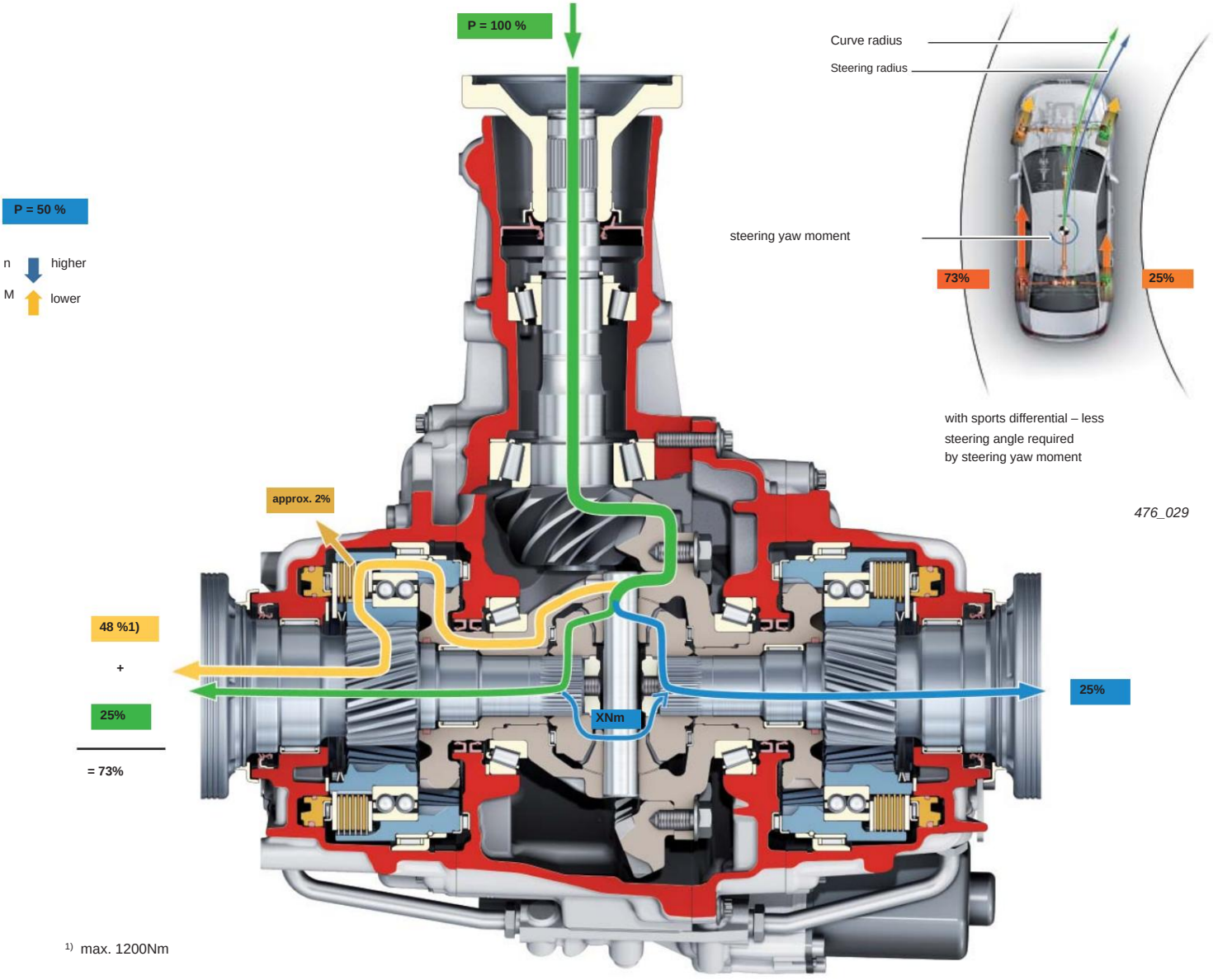
Of the 100% input power, 50% is directed to the left flange shaft by defined control of the left clutch.
The clutch works with slip, which produces heat and results in a loss of about 2%.

Therefore, only 48% of the diverted power of the 50% reaches the flange shaft.

The other 50% are distributed over the differential as on the
described on the previous page to the left (25%) and to the right (25%).

This results in a drive power of 73% on the outside of the curve and a drive power of 25% on the inside of the curve. This results in a power difference of 48% in favor of the outside of the curve. Traction no longer depends on the inside wheel, as the greater drive power is shifted to the outside wheel.

This distribution of drive power causes a yaw moment on the vehicle, which steers into the curve. A smaller steering angle is required than when cornering without power shift.
tion.
Understeering is prevented and the drive power is available where the greatest traction is available, namely on the outside of the curve. The dynamic driving limit is extended and the ESP intervenes significantly later.



476_029

476_030

1) max. 1200Nm

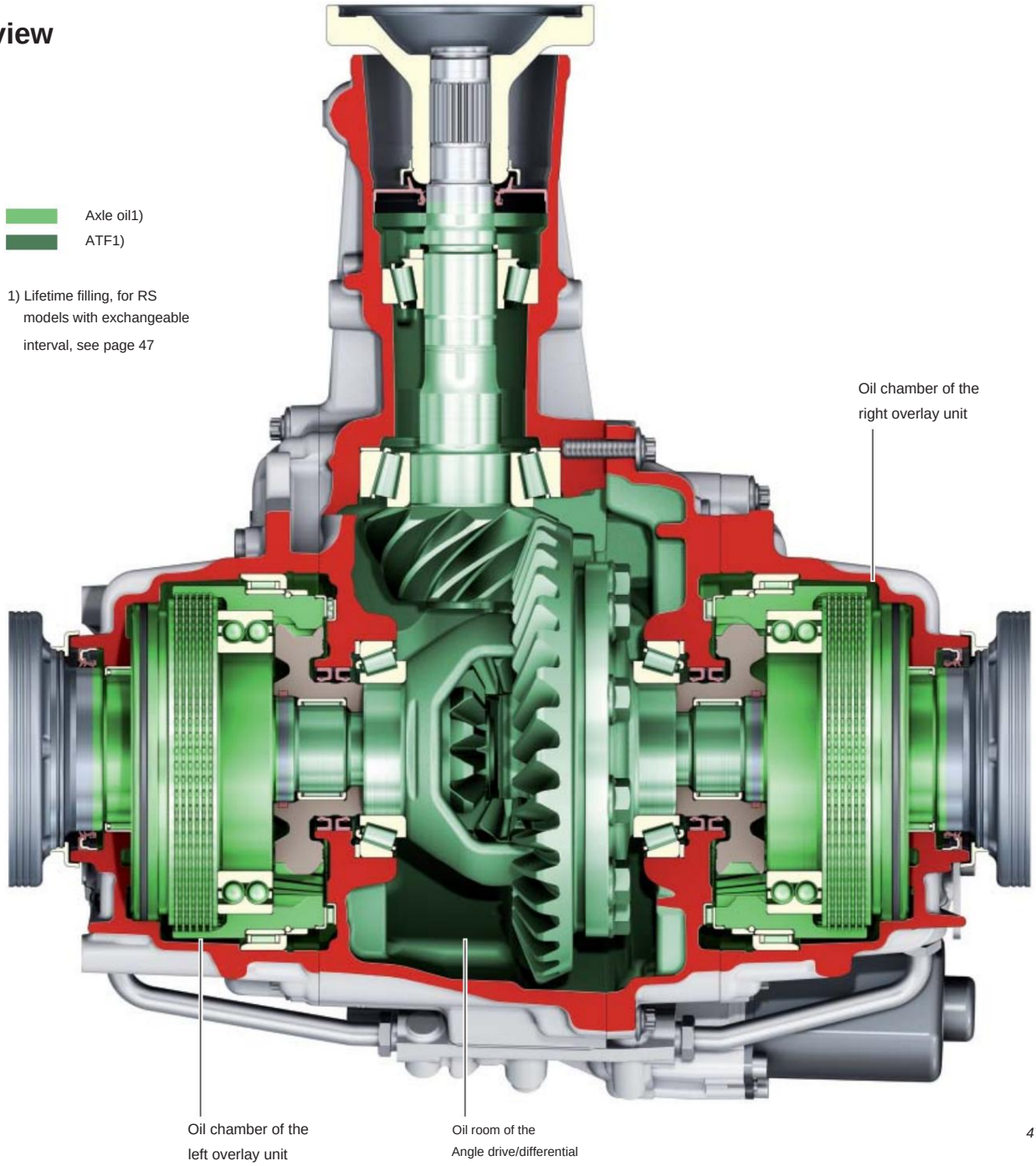
The sum of the output power (+ clutch torque loss) corresponds to the input power (other losses are not taken into account) 48% + 25% = 73% + 25% = 98% + 2% = 100%

Oil budgets

Overview

Axle oil1)
ATF1)

1) Lifetime filling, for RS models with exchangeable interval, see page 47



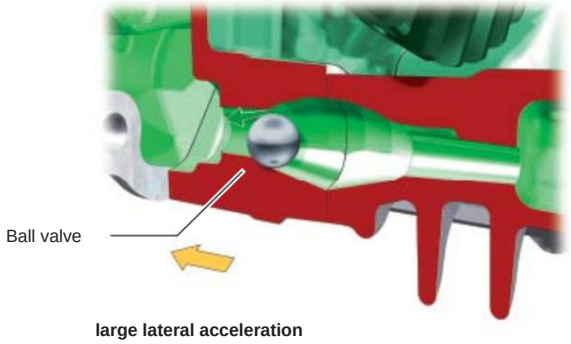
476_031

The sports differential has **two oil reservoirs** and three oil chambers.

The angle drive and the differential have their own oil chamber which is filled with **axle oil (hypoid oil) .**

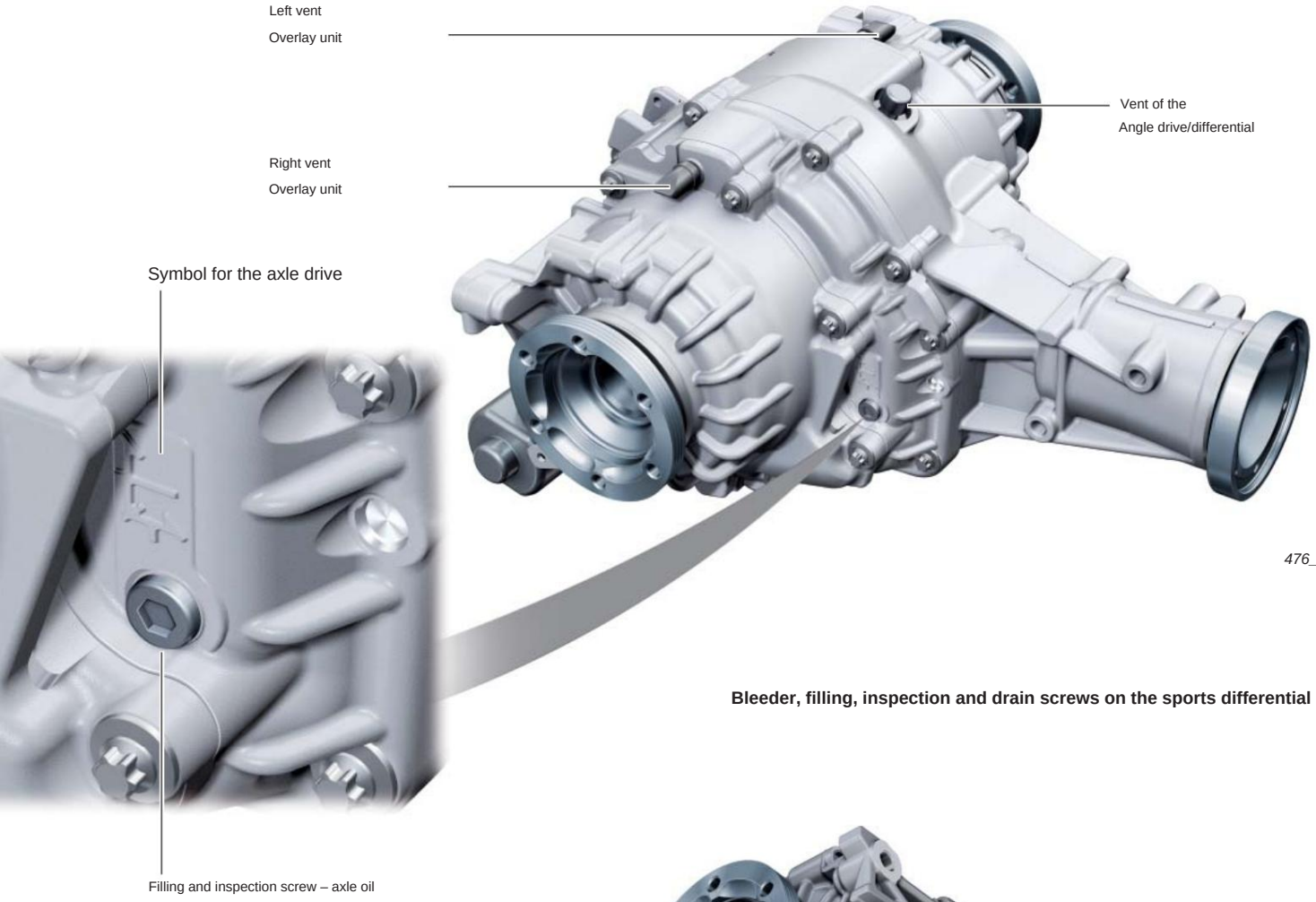
Separately, the two superposition gears each have their own oil chamber. The two oil chambers are connected to each other via an oil channel. They thus form a common oil reservoir that is filled with a special **ATF .** In addition to lubricating and cooling the superposition gears and the multi-disk clutches, this oil reservoir supplies the hydraulic control system with the necessary oil.

An **oil channel** connects the oil chambers of the two superposition gears. A **ball valve** is integrated in the oil channel. It ensures that the oil level on both sides is balanced and prevents overflow to one side when a defined lateral acceleration occurs.



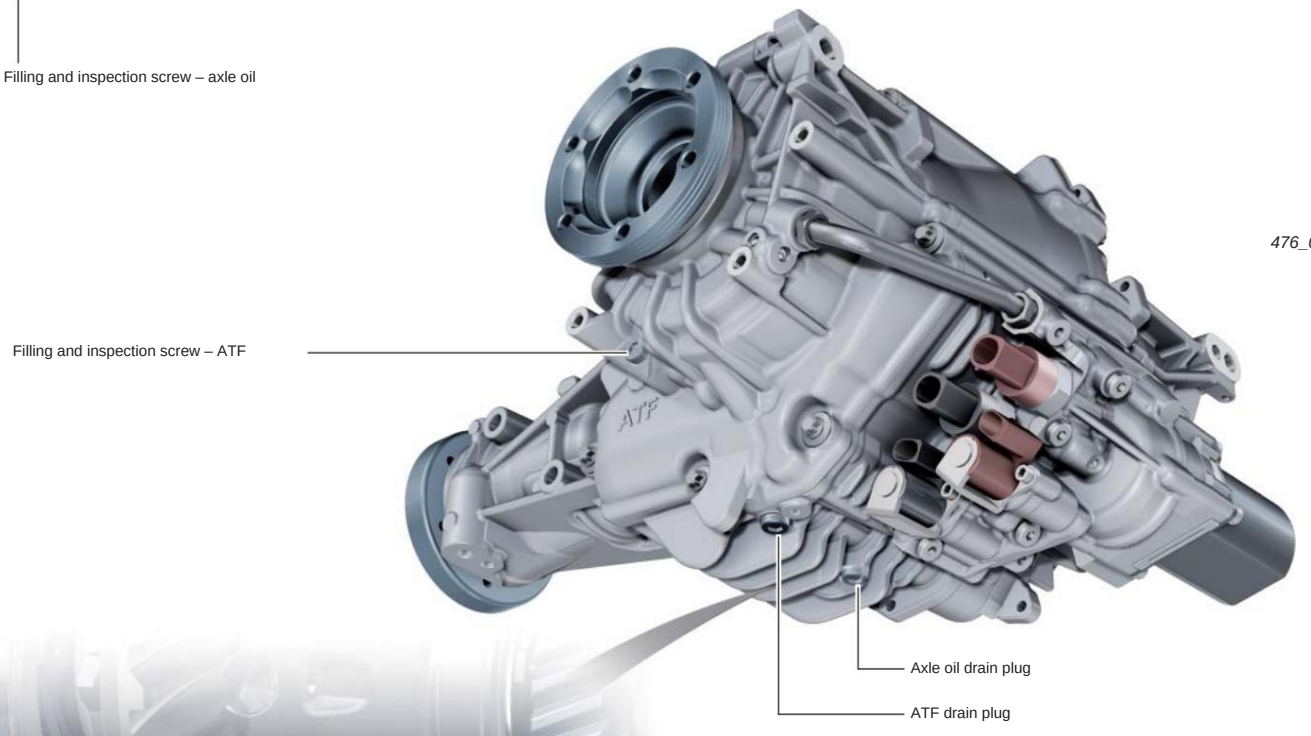
large lateral acceleration

476_032



476_033

Bleeder, filling, inspection and drain screws on the sports differential 0BF



476_034

no or little lateral acceleration

Both the ATF1) and the axle oil1) are for Lifetime1)
and are not changed during normal service.
If the ATF is refilled when changing1) or after a repair, the hydraulic system must be bled.
For this purpose, a corresponding function is available in the vehicle diagnostic tester, which ensures a defined process and the venting of the system, see page 43.

1) ATF and axle oil change interval only for RS models, see page 47.

Separation points sport differential 0BF

A double shaft seal and a special sealing ring (rectangular ring) on both sides ensure a safe separation of the oil supplies between the overlay units and the axle drive.

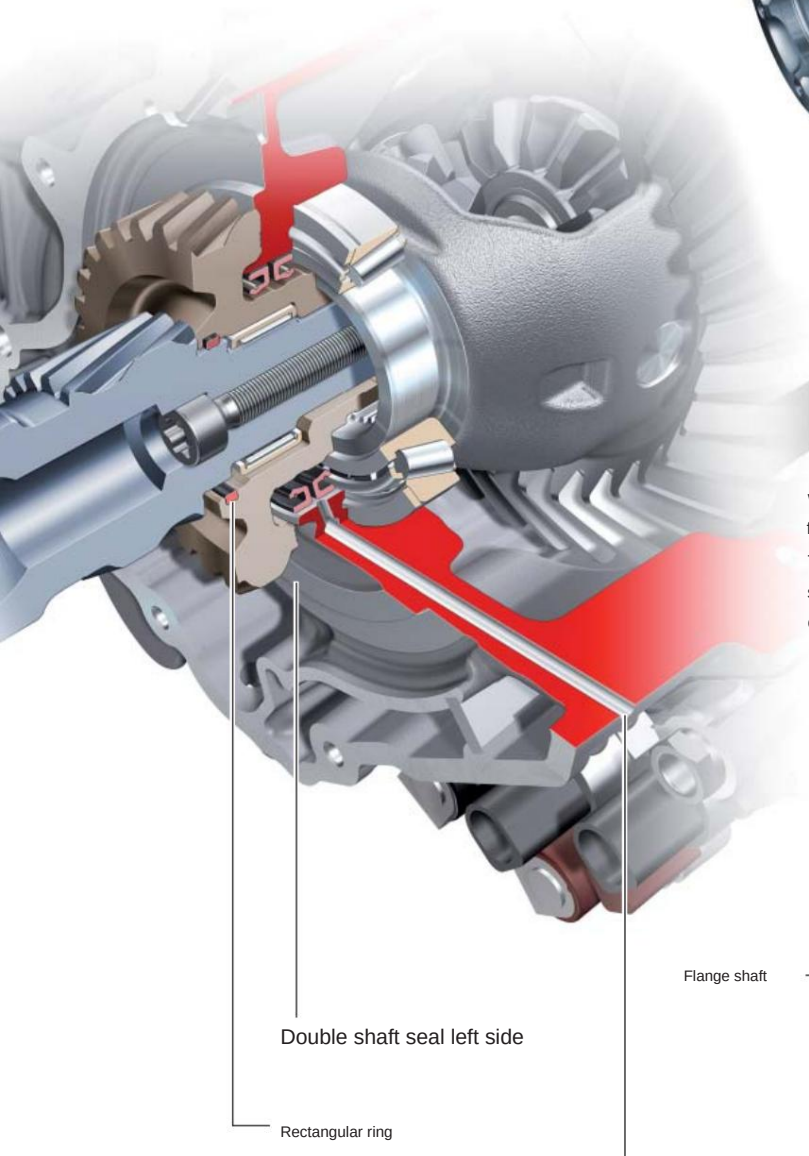
Due to different requirements, the oils from two neighboring oil systems are often very different. Mixing the oils can therefore have serious consequences. For this reason, double shaft seals with oil leak holes are used at these separation points.

The double shaft seal consists of two simple shaft seals arranged next to each other. There is a small annular gap between the two shaft seals, which is ventilated to the outside (into the open air) via a hole (leakage oil hole).

If one of the two shaft seals becomes leaky, the oil from the affected oil system escapes to the outside via the leak oil hole. This prevents the oils from the different oil systems from mixing in the event of leaks.

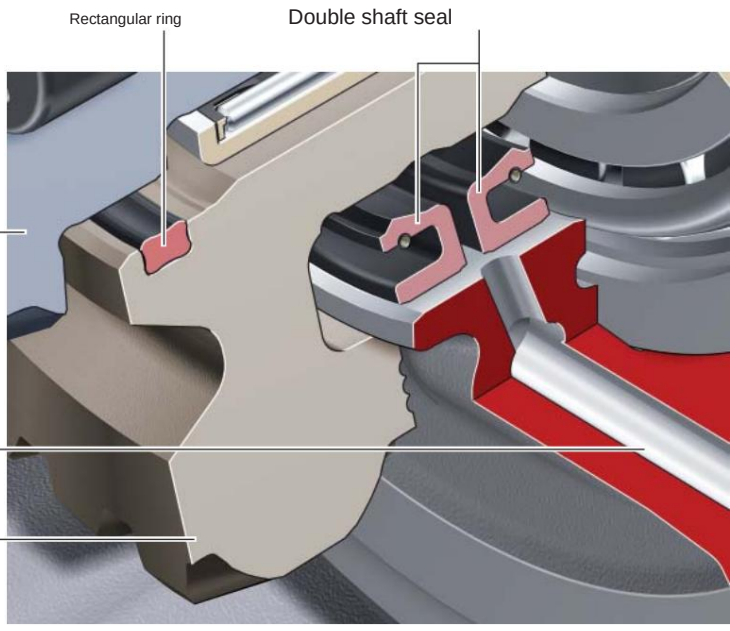
476_035

Leak oil hole left

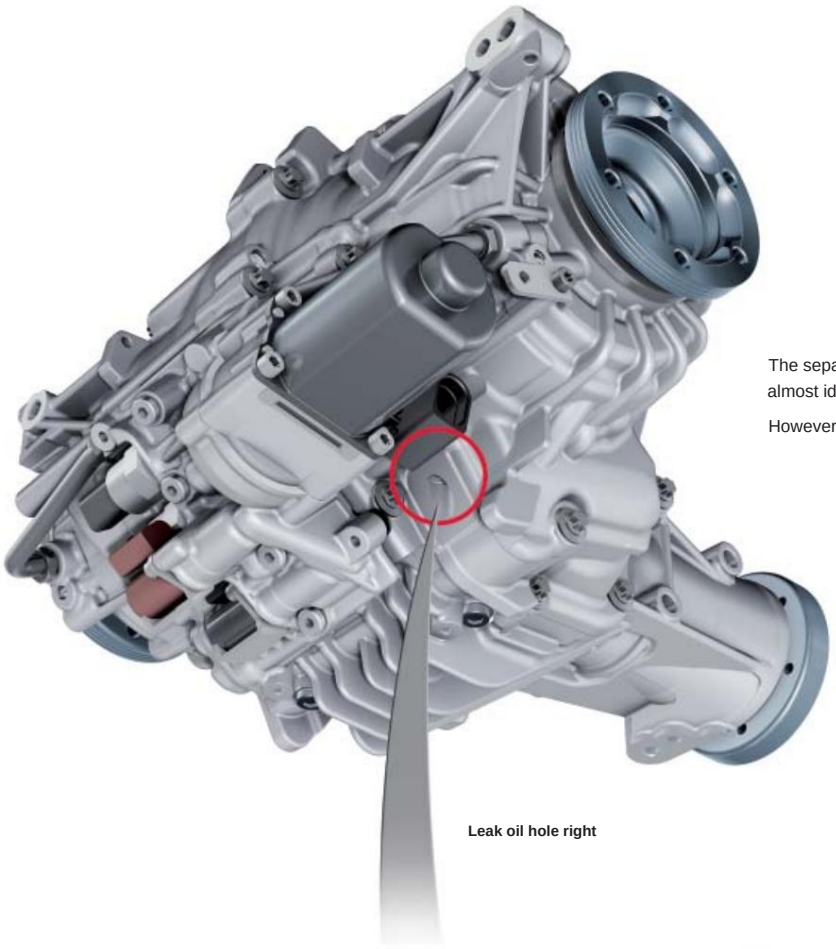


When cornering, there is a radial relative movement between sun gear 1 and the flange shaft (sun gear 2).

The **rectangular ring** is a specially shaped sealing ring that withstands this radial sealing task and reliably seals both oil systems against each other without a leakage oil hole.



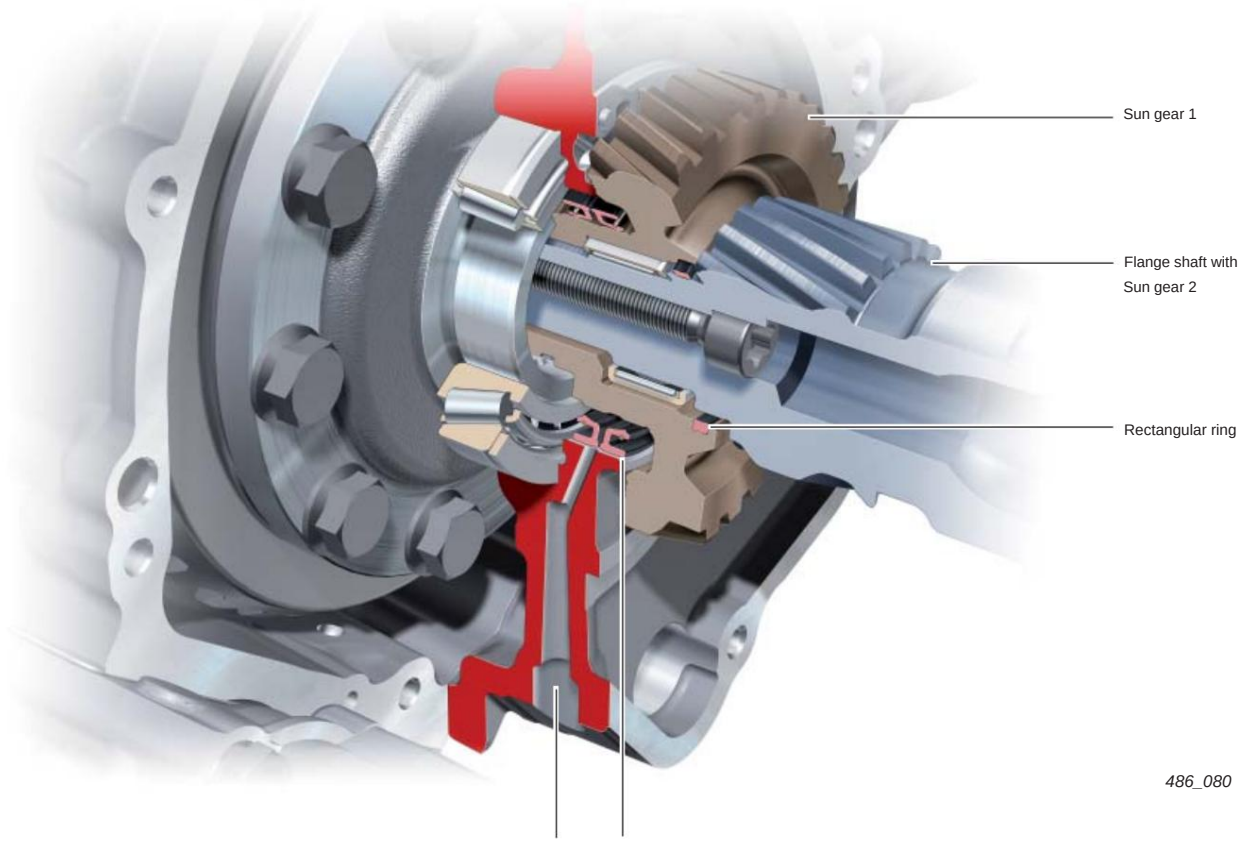
476_036



Leak oil hole right

The separation points of the oil systems of the sports differential 0BF and 0BE are almost identical.

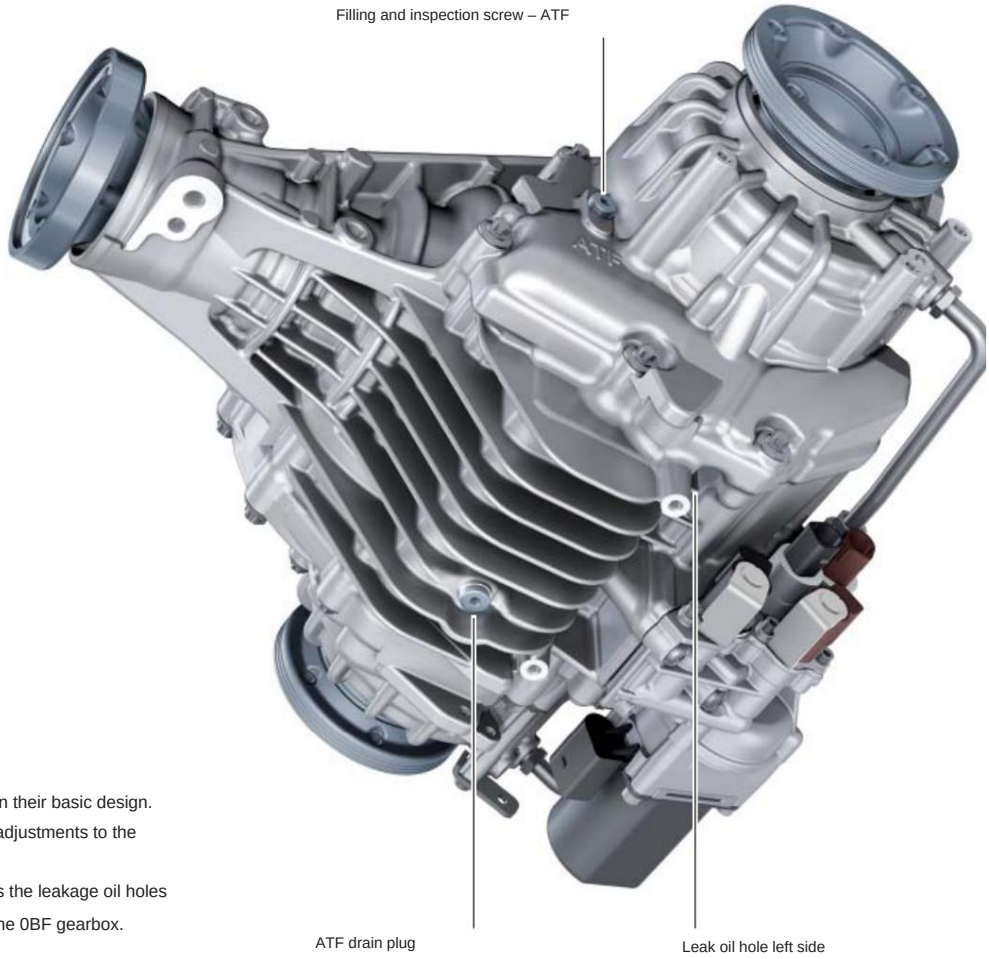
However, the position of the leak oil holes is different, see next page.



Notice

When replacing a double shaft seal, it is particularly important to ensure that the ventilation (leakage oil hole) is freely accessible. The correct offset must be observed precisely, otherwise the sealing ring may cover the leakage oil hole and thus become blocked.

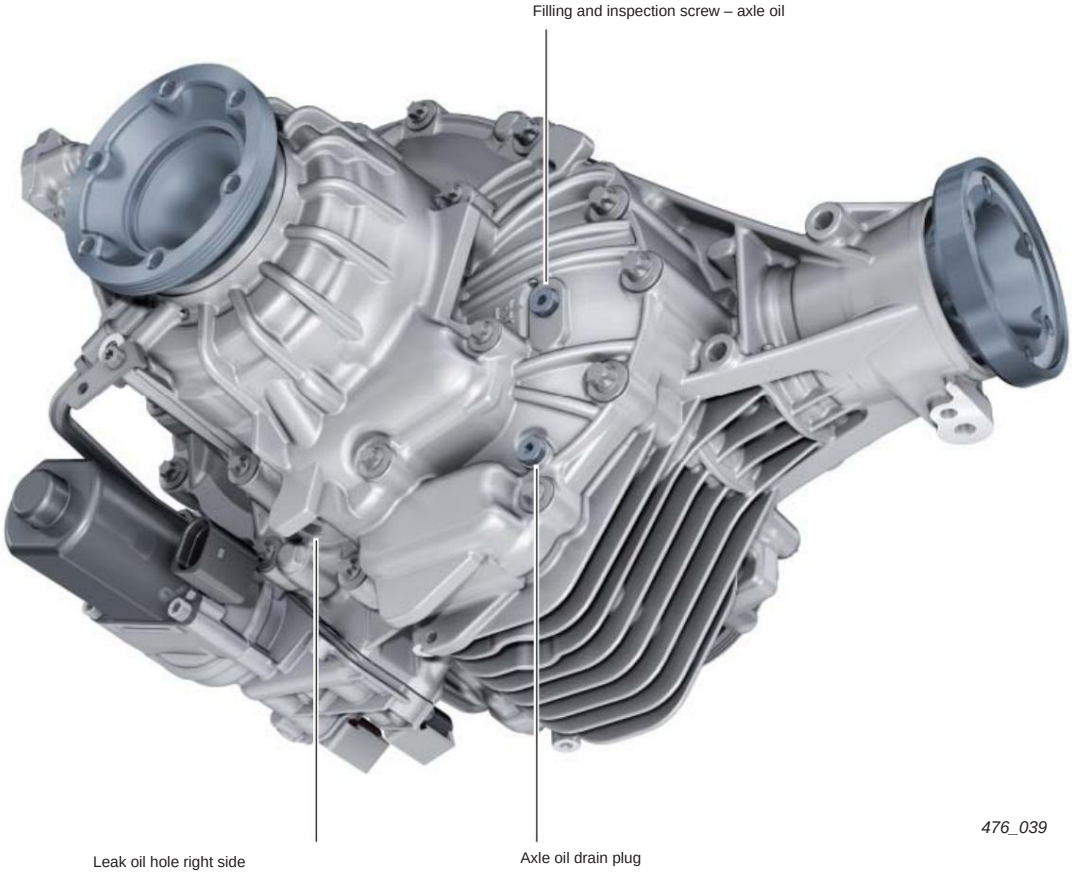
Separation points sports differential 0BE



476_038

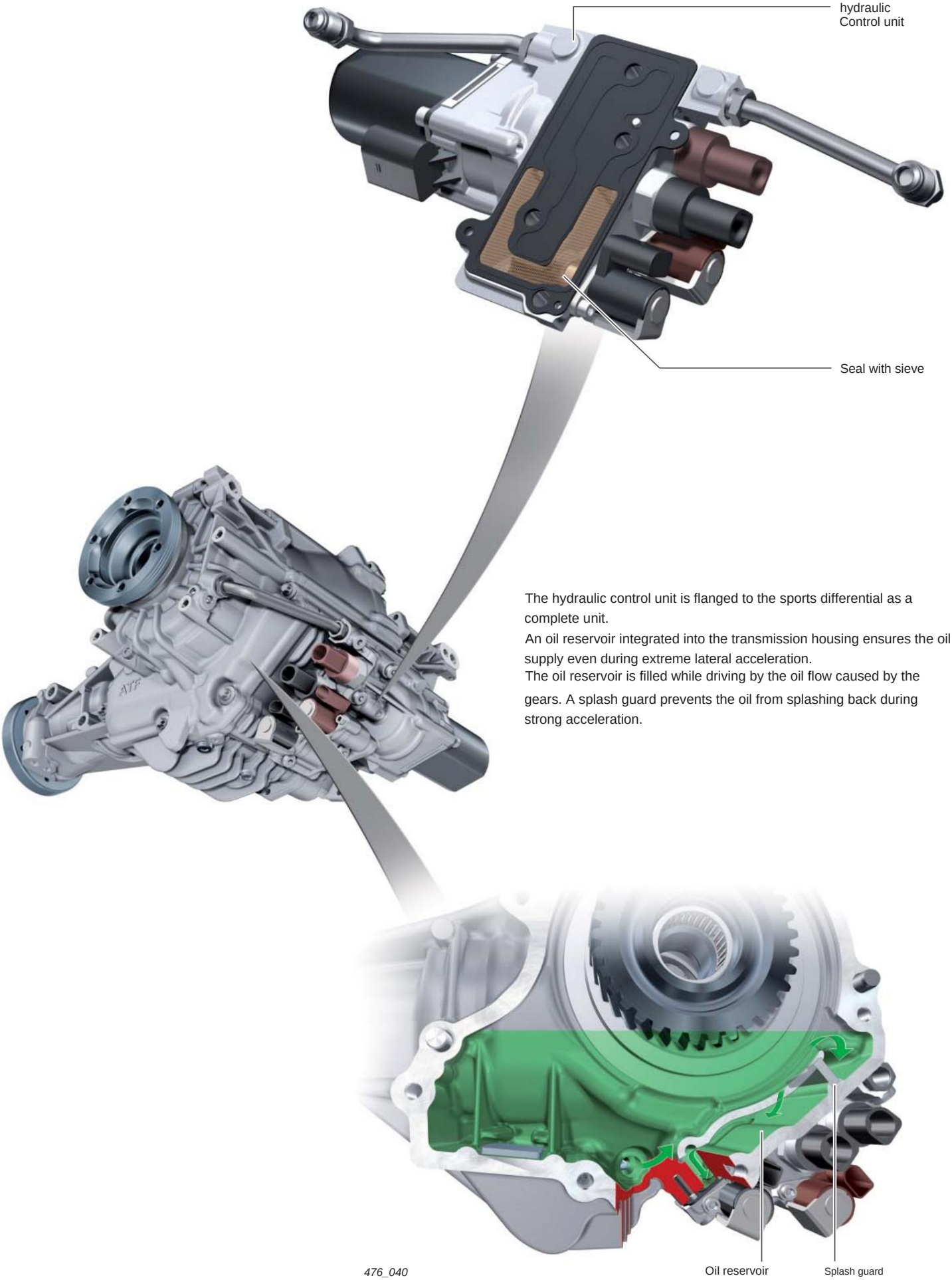
The sports differentials 0BF and 0BE are largely identical in their basic design. However, the changes in the axle drive require significant adjustments to the housing parts.

As a result, the filling, inspection and drain plugs as well as the leakage oil holes on the 0BE gearbox are partly in different places than on the 0BF gearbox.



476_039

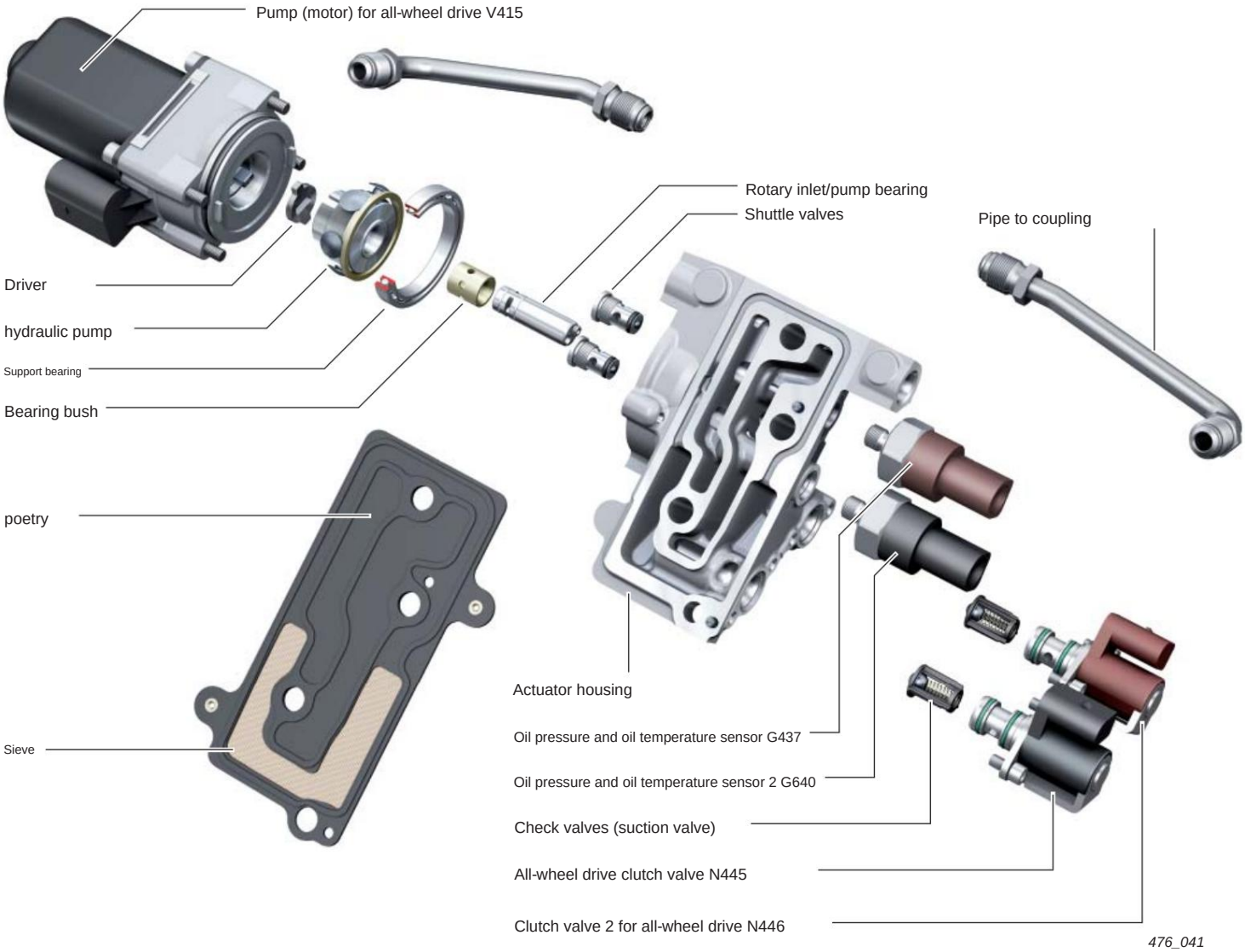
Hydraulic control unit



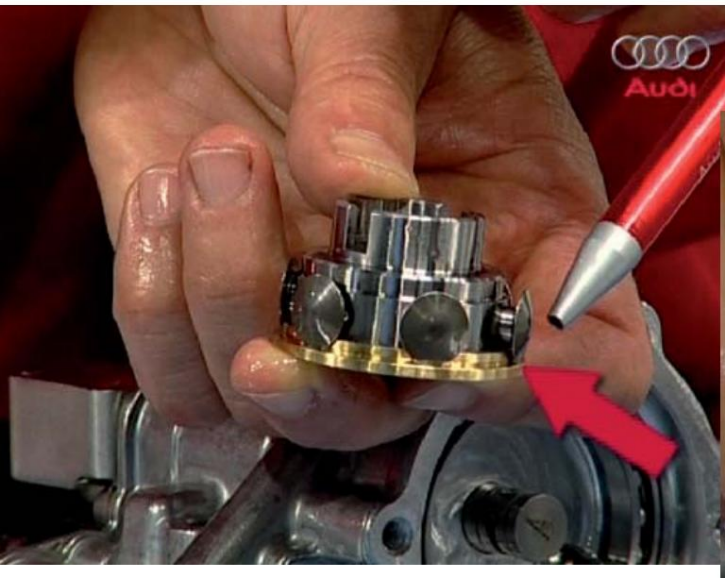
The hydraulic control unit is flanged to the sports differential as a complete unit.
An oil reservoir integrated into the transmission housing ensures the oil supply even during extreme lateral acceleration.
The oil reservoir is filled while driving by the oil flow caused by the gears. A splash guard prevents the oil from splashing back during strong acceleration.

476_040

Component overview



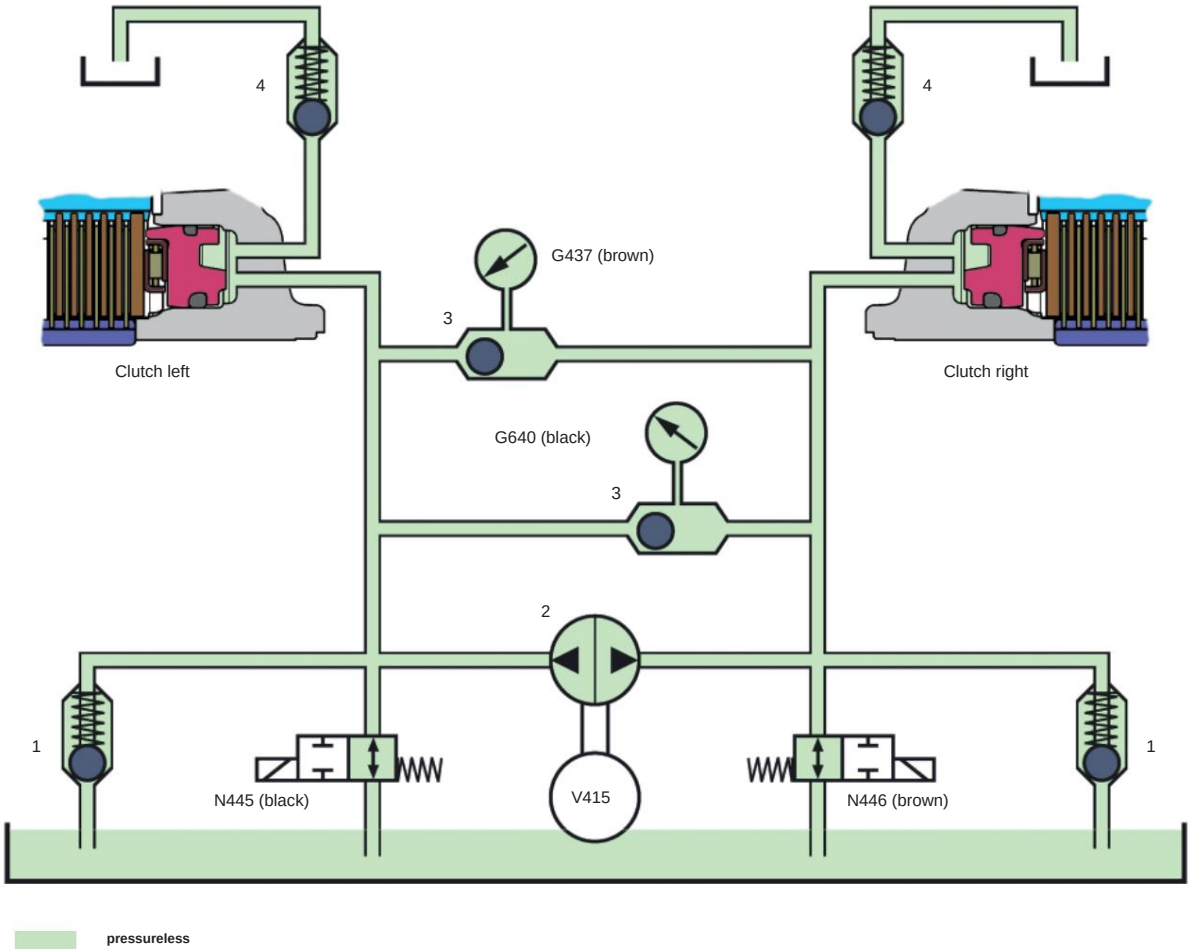
476_041



476_042

476_043

Hydraulic plan



Legend:

1	Check valve (suction valve)
2	hydraulic pump
3	Shuttle valve
4	Pressure relief valve

G437 Oil pressure and oil temperature sensor (brown)
G640 Oil pressure and oil temperature sensor 2 (black)
N445 All-wheel drive clutch valve (black)
N446 Clutch valve 2 for all-wheel drive (brown)
V415 pump for all-wheel drive

Structure of the hydraulic system

The hydraulic system is designed in such a way that by changing the direction of rotation of the pump and in conjunction with the corresponding coupling and check valve, the pressure builds up on the respective side (coupling).

Only one side (one clutch) can be controlled at a time.

The advantage of this design is that it requires fewer components and that pressure can be increased and reduced very quickly. Because the suction and pressure sides alternate, both the oil volume flow and the leakages remain very low.

If the coupling valves are de-energized, the system is depressurized.

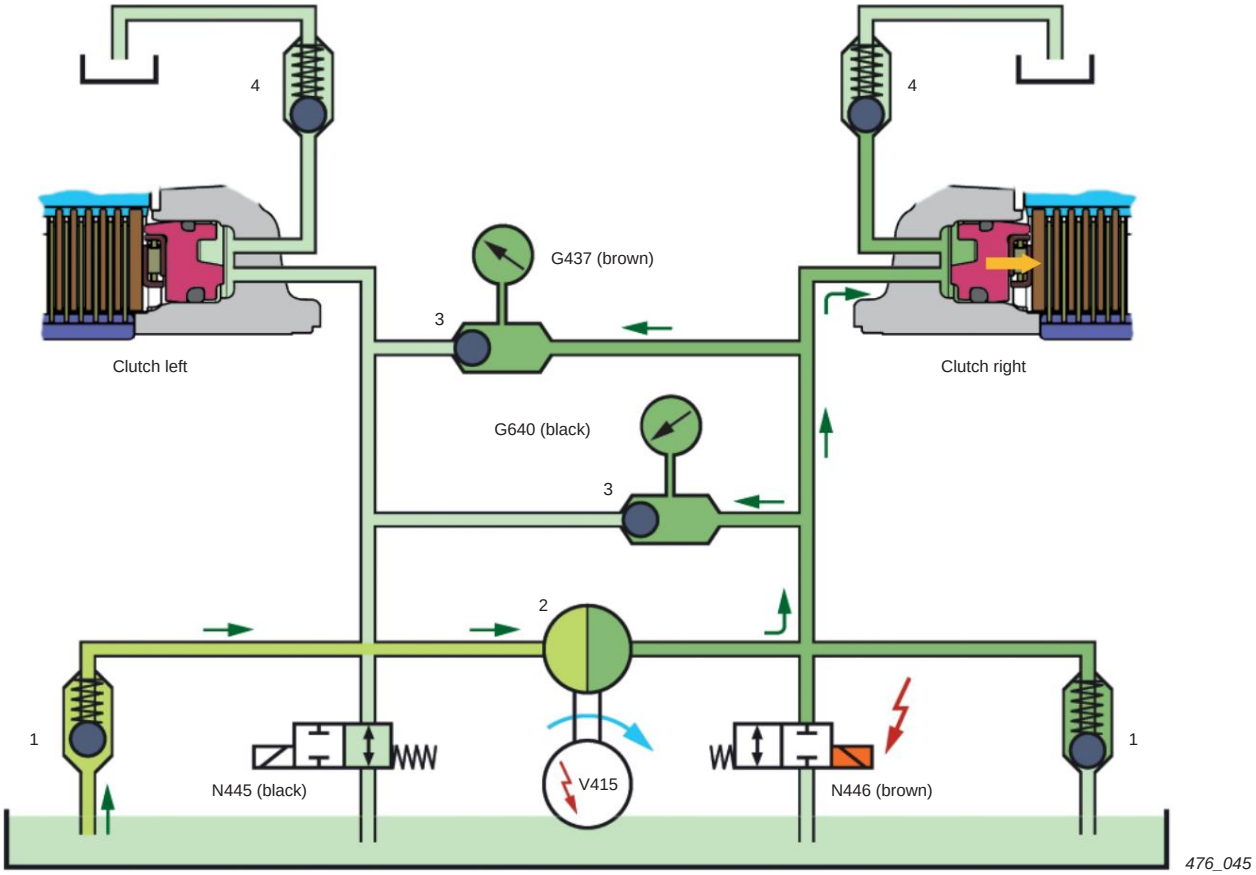
With the help of the shuttle valves, the clutch pressure on both sides can be measured with one sensor.
For safety reasons, two sensors are installed.

reference

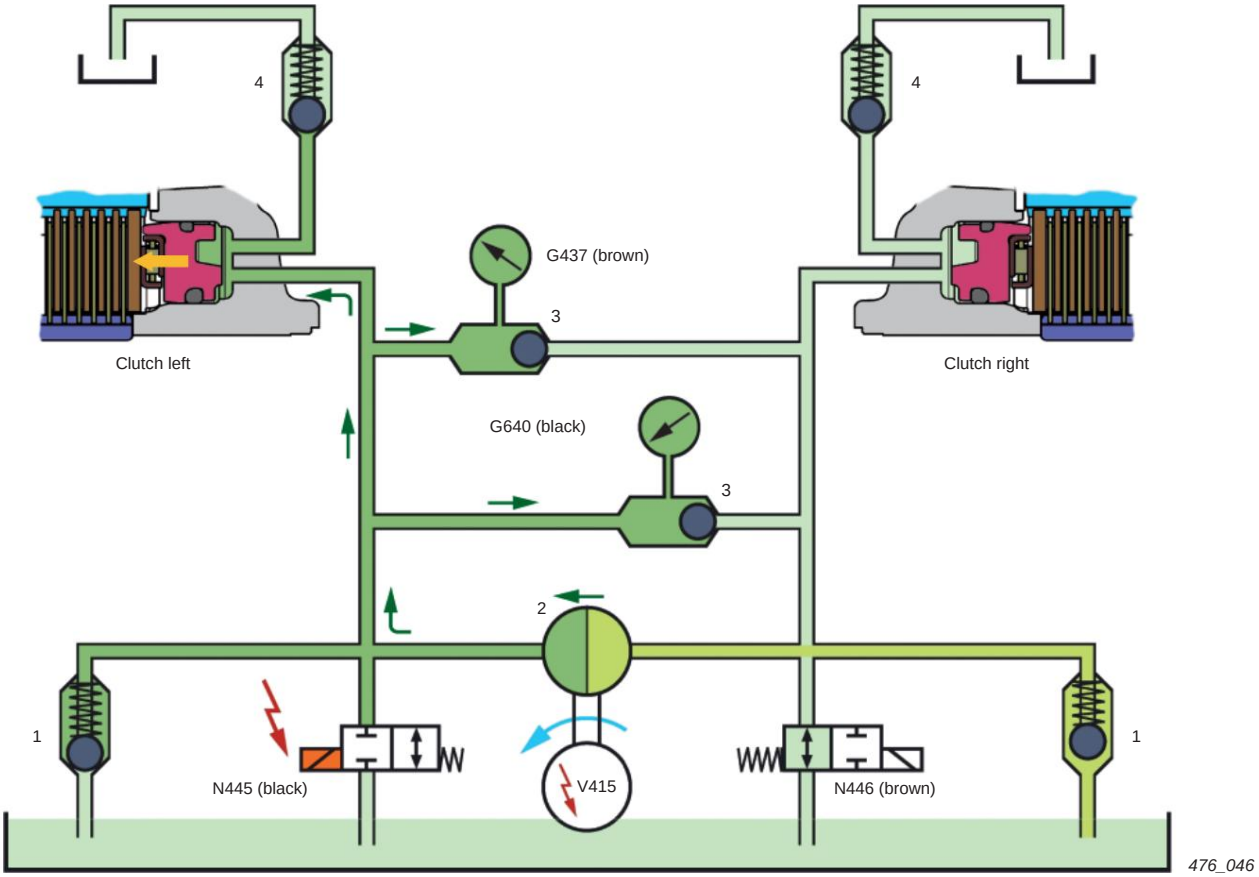
Further information and tips on removing and installing various parts of the hydraulic control system can be found in the iTV program “Audi quattro with sports differential 0BF Part 3, repairs to the sports differential”.

Hydraulic function switch positions

Activation of the right clutch



Activation of the left clutch



Activating the clutch

Starting from a pressureless system, the activation of a clutch is carried out as described below using the example of the left
Coupling:

The clutch valve N445 is energized and thus closed.
At the same time, the all-wheel drive pump V415 is energized in a defined manner and polarized so that pressure builds up to the left clutch. The pump speed defines the pressure in the clutch cylinder and thus the clutch torque. The oil is sucked in via the right check valve and through the open clutch valve N446.

The shuttle valves 3 close the connections to the clutch on the right. The two oil pressure and oil temperature sensors G437 and G640 measure the pressure in the left clutch cylinder. The pressure limiting valves 4 prevent the oil from flowing out.

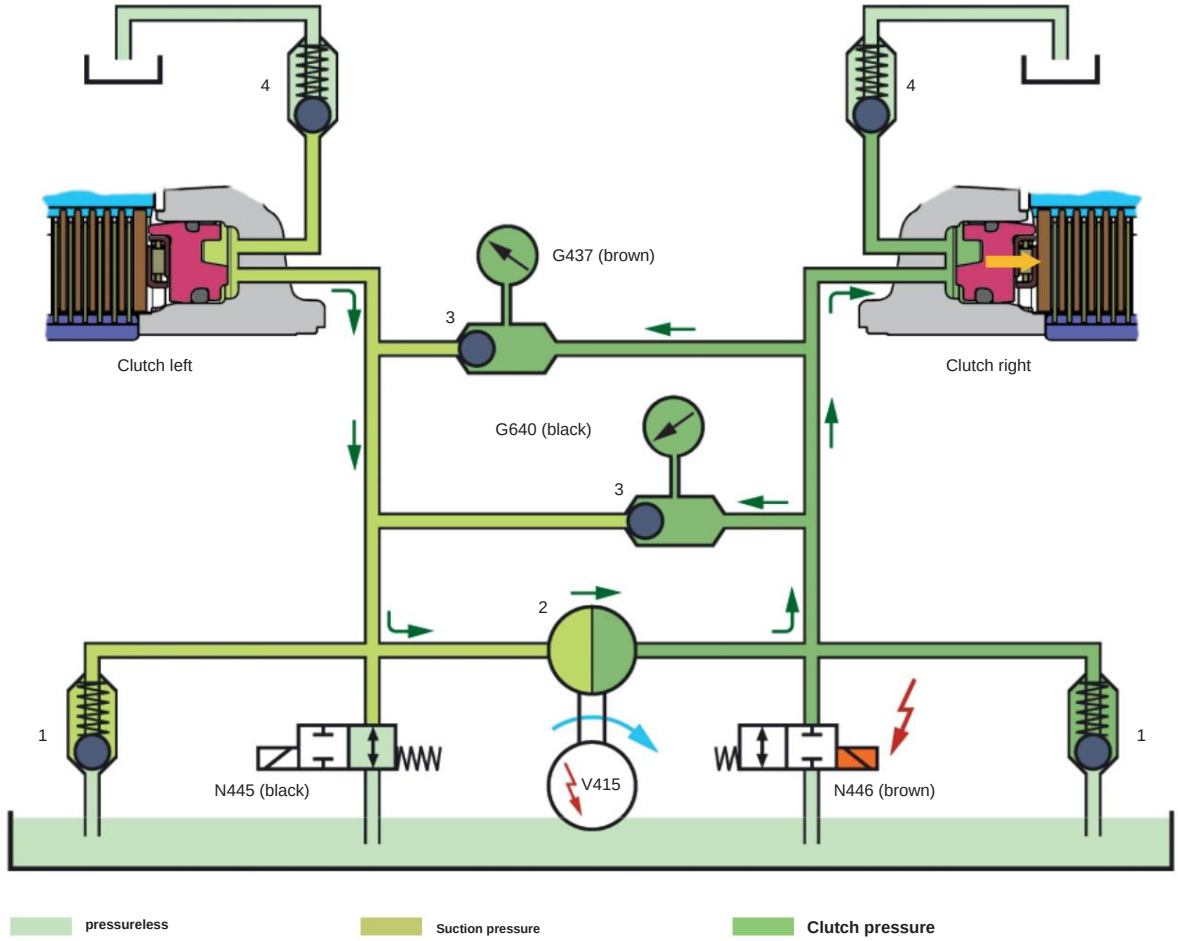
The right clutch is controlled analogously.

Actuation change (page change)

The actuation change describes the situation when the vehicle makes a seamless change of direction (e.g. from a right turn to a left turn).

In this situation, the hydraulic pump's polarity is reversed accordingly and the clutch valves are controlled.
Because the suction and pressure sides change, the pressure oil from the opening clutch is sucked out and directed to the closing clutch. During this process, hardly any additional oil needs to be sucked in from the oil sump. This makes it possible to change the actuation very quickly.

Actuation change (page change)



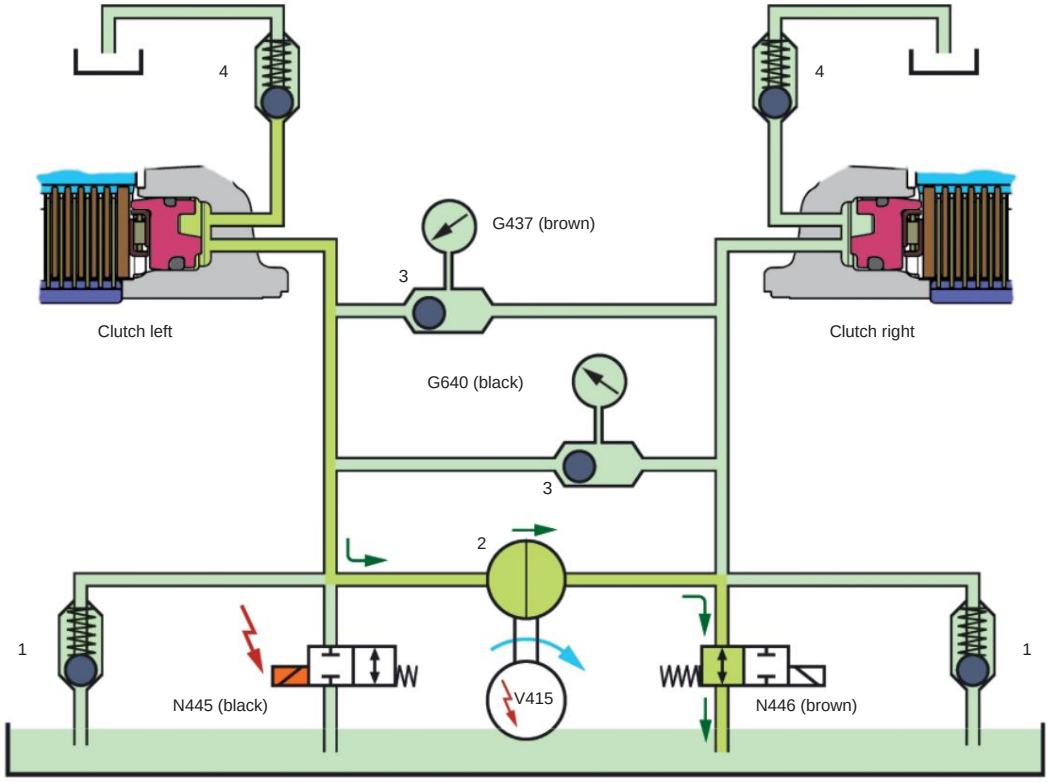
476_047

Legend:

1	Check valve (suction valve)
2	hydraulic pump
3	Shuttle valve
4	Pressure relief valve

G437 Oil pressure and oil temperature sensor (brown)
G640 Oil pressure and oil temperature sensor 2 (black)
N445 All-wheel drive clutch valve (black)
N446 Clutch valve 2 for all-wheel drive (brown)
V415 pump for all-wheel drive

Pressure reduction 1



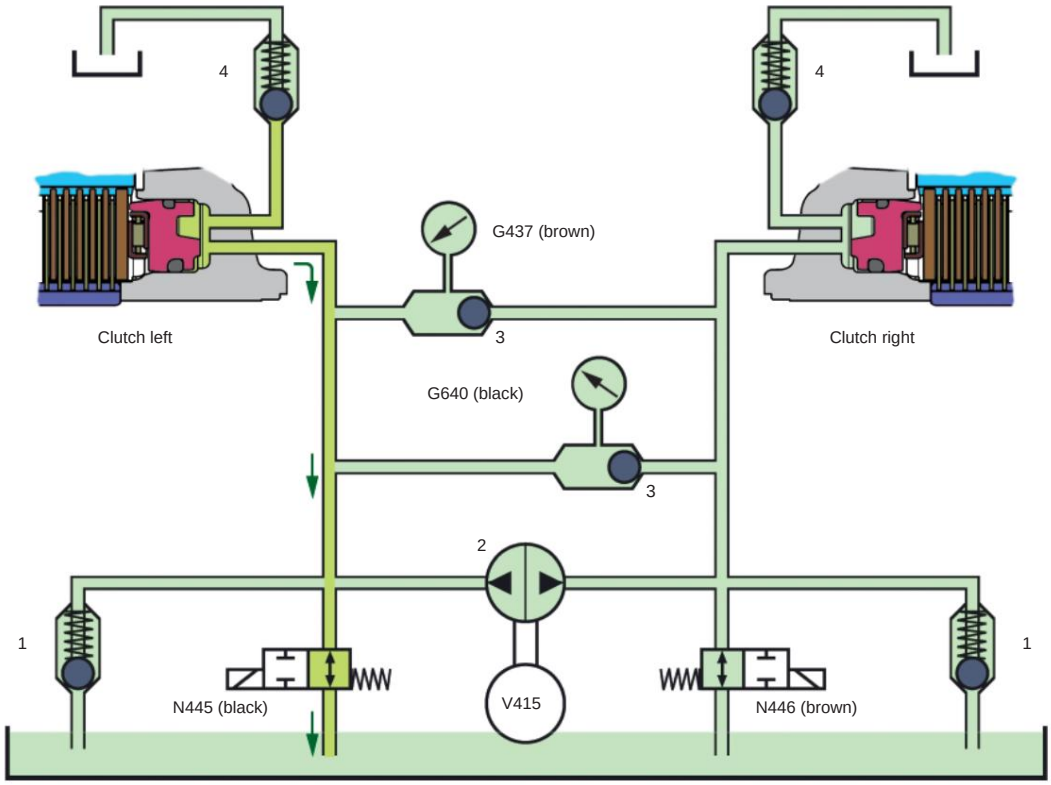
476_048

The pressure can be reduced in two ways:

Pressure reduction 1: Here the pressure is actively reduced using the hydraulic pump. The pressure reduction occurs very quickly.

Pressure reduction 2: The actuators are switched off and the pressure is automatically reduced via the open coupling valves. This variant of pressure reduction is used, for example, if there is a corresponding system error and the system must be deactivated.

Pressure reduction 2



476_049

Legend:

1	Check valve (suction valve)
2	hydraulic pump
3	Shuttle valve
4	Pressure relief valve

G437 Oil pressure and oil temperature sensor (brown)
G640 Oil pressure and oil temperature sensor 2 (black)
N445 All-wheel drive clutch valve (black)
N446 Clutch valve 2 for all-wheel drive (brown)
V415 pump for all-wheel drive

System venting

To ensure that air in the system does not affect the reaction and function, the hydraulic system is vented at regular intervals. The prerequisites for activating the venting function are:

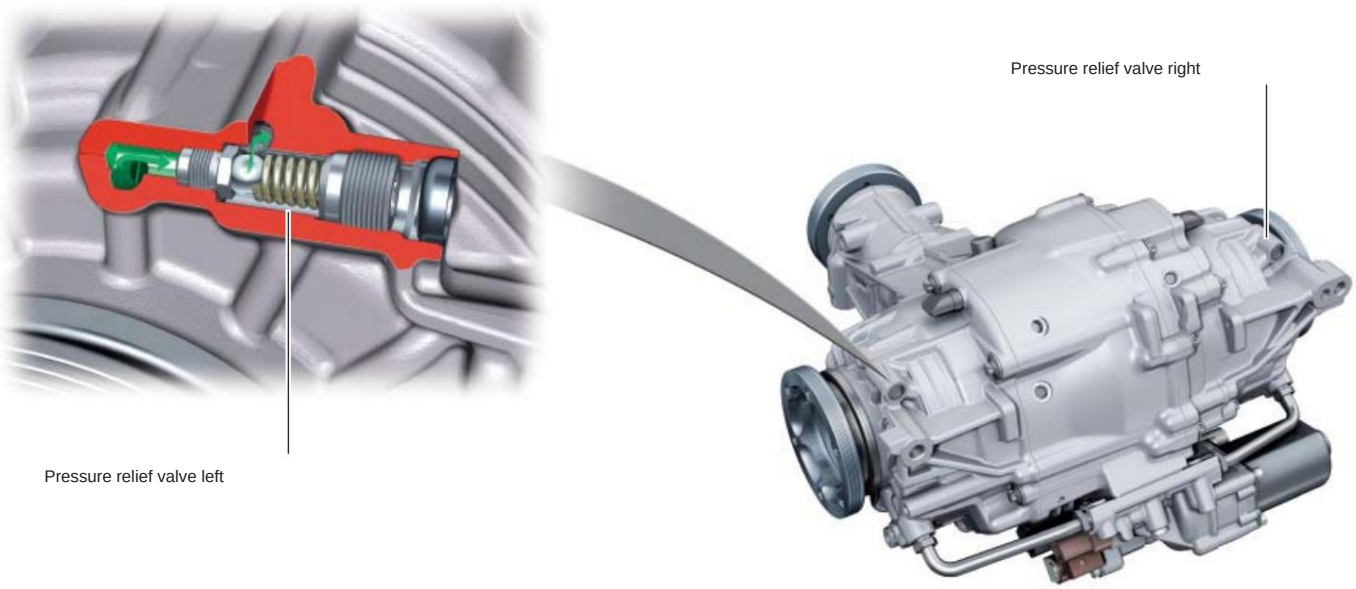
- Engine idling,
- Wheel speed = 0,
- Time factor.

If the requirements are met, the pump on each side is controlled at full power for a period of approx. 100 – 200 ms until the pressure relief valves open (= maximum pressure).

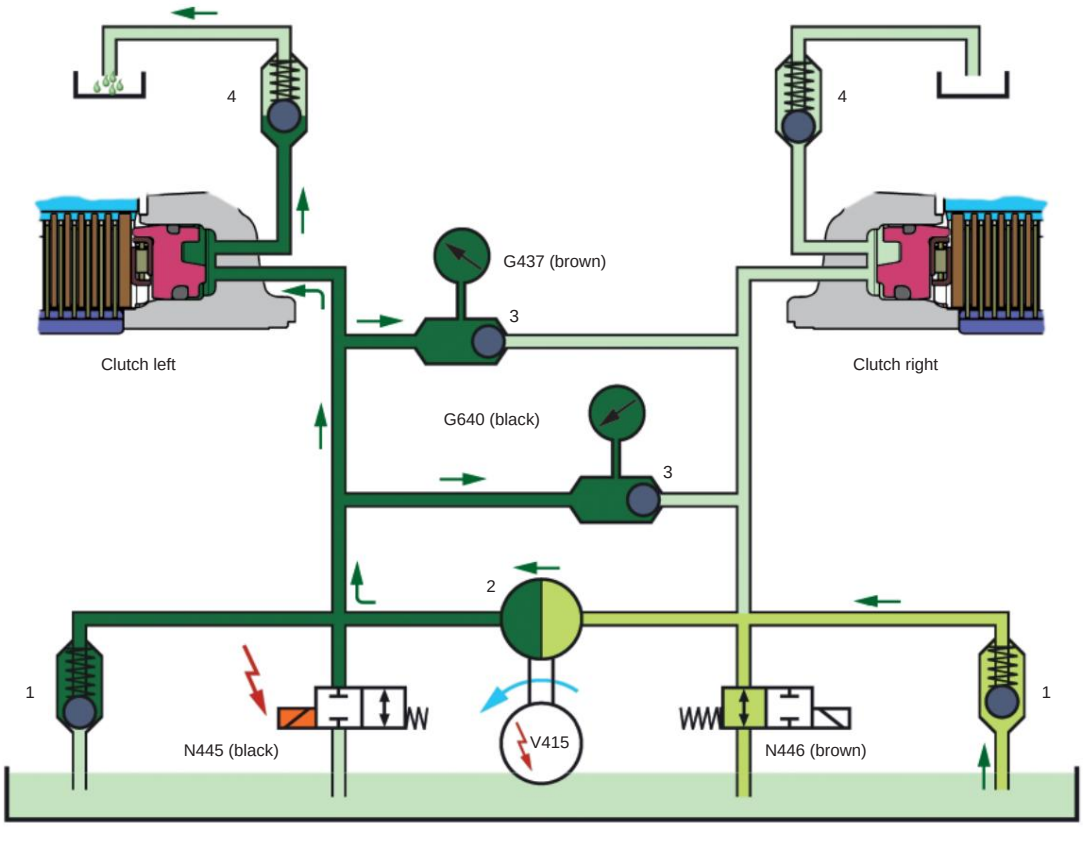
The system is flushed and any trapped air escapes. The oil is returned to the respective oil chamber.
tet.

Note: After working on the hydraulics of the sports differential, the hydraulic system must be bled. A function is available for this in the vehicle diagnostic tester, see page 43.

For further information, see the section “Start-Stop operation” on page 46.



476_051



476_050

pressureless

Suction pressure or low pressure

maximum clutch pressure

Sensors and actuators

Oil pressure and oil temperature sensor G437/G640

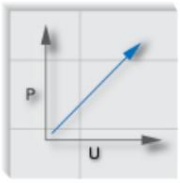
Oil pressure sensors

When controlling the clutches, monitoring the clutch pressure is an important and safety-relevant task.
For this reason, two pressure sensors measure the clutch pressure of the clutch that is currently being actuated. Two shuttle valves close the pressure-free oil channel of the clutch that is not being actuated (see Figures 476_056 and 476_057).
The pressure sensors deliver a pressure-dependent voltage signal to the all-wheel drive control unit J492.
To improve the electrical self-diagnosis, the two pressure sensors have an opposing pressure/voltage characteristic curve.
This means that the G437 (brown) has a rising characteristic curve (approx. 0.6 V – 4.4 V) and the G640 (black) has a falling characteristic curve (inverse).

Color coding makes it easier to correctly assign and connect.

476_052

G437 (Sensor 1)
Oil pressure and oil temperature sensor



476_053

rising characteristic curve

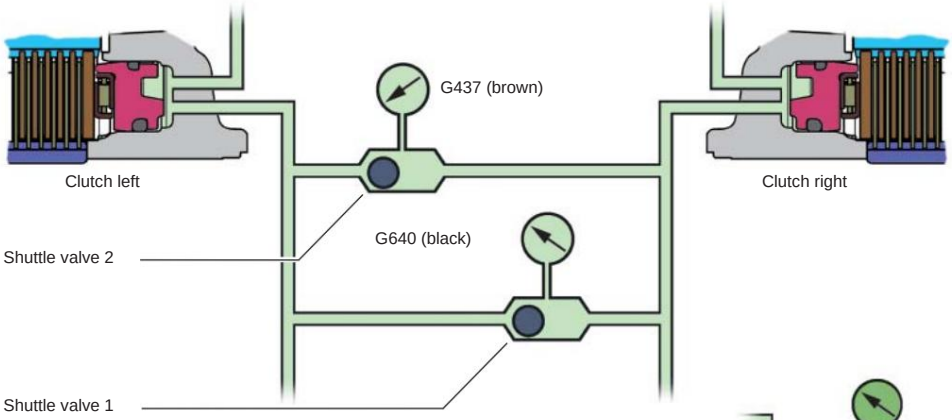
476_054

G640 (Sensor 2)
Oil pressure and oil temperature sensor 2

476_055

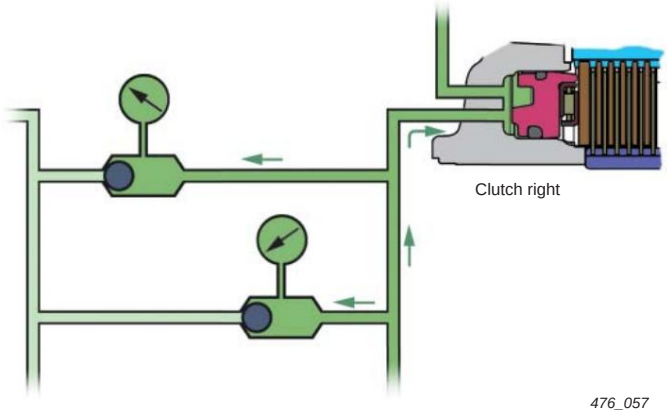
falling characteristic curve

P Pressure
U Tension



476_056

Control of the right clutch.
The two shuttle valves close the channel to the left clutch.

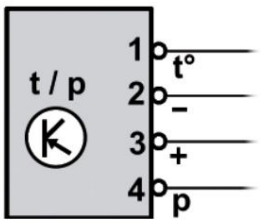


476_057

Oil temperature sensors

As the name suggests, a temperature sensor is integrated into each of the two oil pressure sensors. The temperature of the ATF is an important parameter for controlling the clutches and for calculating the clutch temperature. The control unit monitors the ATF temperature using the two temperature sensors and, if necessary, initiates protective measures to protect the components and the ATF from excessively high temperatures.

When the ATF temperature reaches approximately 150 °C or when the calculated clutch temperature reaches a defined value, the system is temporarily switched off. A message appears in the instrument cluster, see page 41. The clutches and the ATF are thus protected from overload.



476_072

Connection diagram G437/G640

Pin 1 temperature signal (NTC sensor)
Pin 2 Power supply –
Pin 3 Power supply +
Pin 4 pressure signal (analog signal) and identification (digital signal)

Identity of the sports differential

The rear axle drive 0BF/0BE (sports differential) must be paired with the control unit J492. The control unit and sports differential form a unit that can only be replaced individually if precise specifications are taken into account. After a certain mileage, only the trained control unit knows the operating history and thus the adaptation values of the clutches. See the information on replacing the control unit on page 40.

It is therefore extremely important for functional safety that the control unit can identify the sports differential and that uncontrolled installation of these parts is immediately detected.

If the control unit recognizes that it is working with the correct sports differential, each sports differential receives an identity.

This identity is contained in the two oil pressure and oil temperature sensors G437/ G640. Both sensors are so-called active sensors. They have integrated evaluation electronics (IC chip) that output the sensor signal and an individual code (identifier). Each sensor is therefore unique and has its own consecutive serial number.

The identification of the two sensors is taught to the control unit when the sport differential is taught, and the sport differential thus receives its identity. The identity is queried by the control unit with each new ignition cycle. To do this, the two sensors G437 and G640 send their identification to the control unit via the pressure signal line. They then supply the signals for the oil pressure and oil temperature.

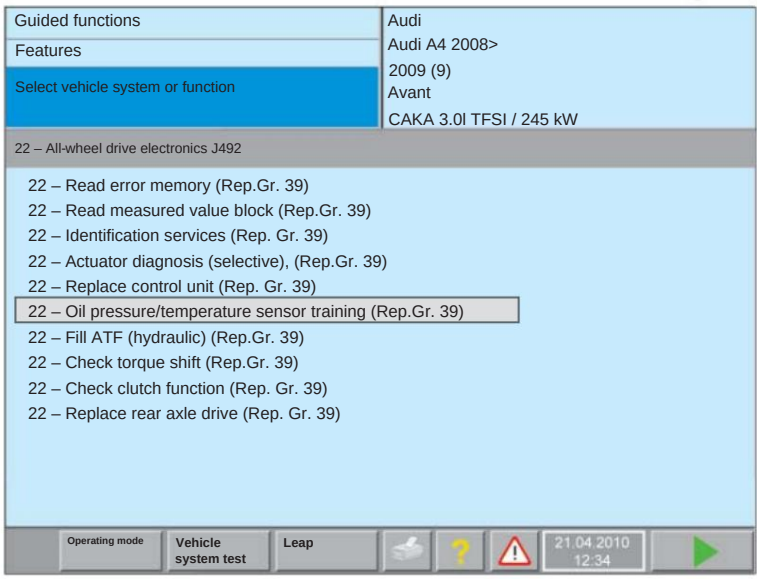
Notes on exchanging the donors

The control unit only works when the two identifiers of the sensors G437 and G640 match both of the learned identifiers. This means that if one or both sensors, the sport differential, or the control unit are replaced, the identity must be relearned.

To ensure that the adaptation values are not deleted when the sensors are taught, a corresponding function is available in the vehicle diagnostic tester. In addition, some special features and procedures must be observed. Different scenarios must be considered when replacing the sensors:

1. Only one of the two sensors needs to be replaced:

This case is not a problem because the control unit still recognizes the identity of the old sensor. The identity of the new sensor only needs to be taught to the control unit using the “teach oil pressure/temperature sensor” tester function.



476_060

2. Both sensors must be replaced:

For the control unit, this scenario is equivalent to replacing the sports differential, as it no longer recognizes any identity. In this case, the classification must be re-learned.
This process leads to the irreversible deletion of the adaptation values of the clutch adaptation. The control quality of the sports differential is thereby impaired. The new sensors are then automatically taught. In addition, the ATF

be replaced.

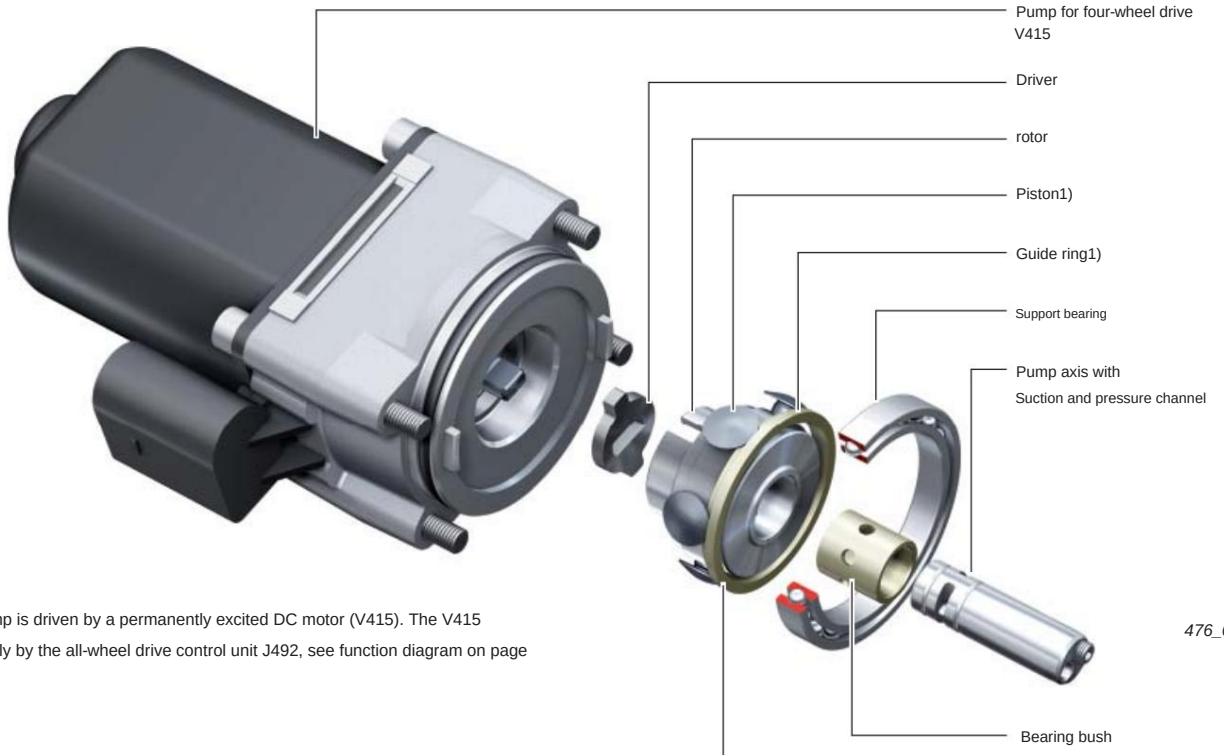
Notice

If both sensors need to be replaced (e.g. because they have been damaged in an accident), this should be done in two steps if possible, i.e. one after the other. Then the adaptation values of the clutches and the control quality of the sports differential are maintained. In addition, the ATF does not need to be replaced.

reference

In addition to the repair manual, you will find further information on replacing the oil pressure/oil temperature sensors in the iTV program “Audi quattro with sports differential part 3”.

Pump for all-wheel drive V415



476_059

The hydraulic pump is driven by a permanently excited DC motor (V415). The V415 is controlled directly by the all-wheel drive control unit J492, see function diagram on page 36.

Note: In addition to the repair manual, you will find further interesting information on installing the V415 engine and the hydraulic pump in the iTV program “Audi quattro with Sportdiff e-renzial Part 3”.

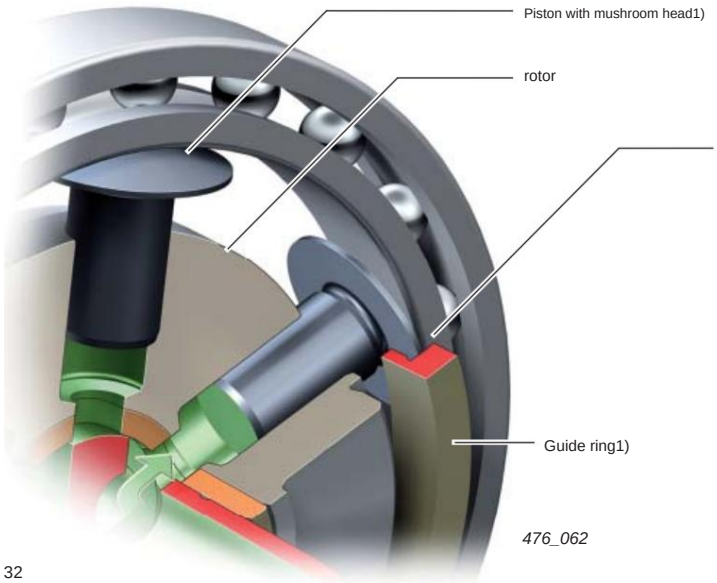
hydraulic pump

The hydraulic pump only runs when needed, i.e. when a clutch is activated. The pressure is controlled via the speed of the pump.

In order to achieve the extremely short reaction times of the sports differential, the electro-hydraulic control must react at lightning speed. A radial piston pump with six pistons, driven by a powerful DC motor, ensures the correspondingly rapid pressure build-up.

476_061

View from the back



476_062

1) When assembling the pump, make sure that the mushroom heads of all pistons are in the recess of the guide ring. Otherwise, pump damage is inevitable when the pump is first run. Check the piston strokes by turning the pump rotor several times by hand in both directions!

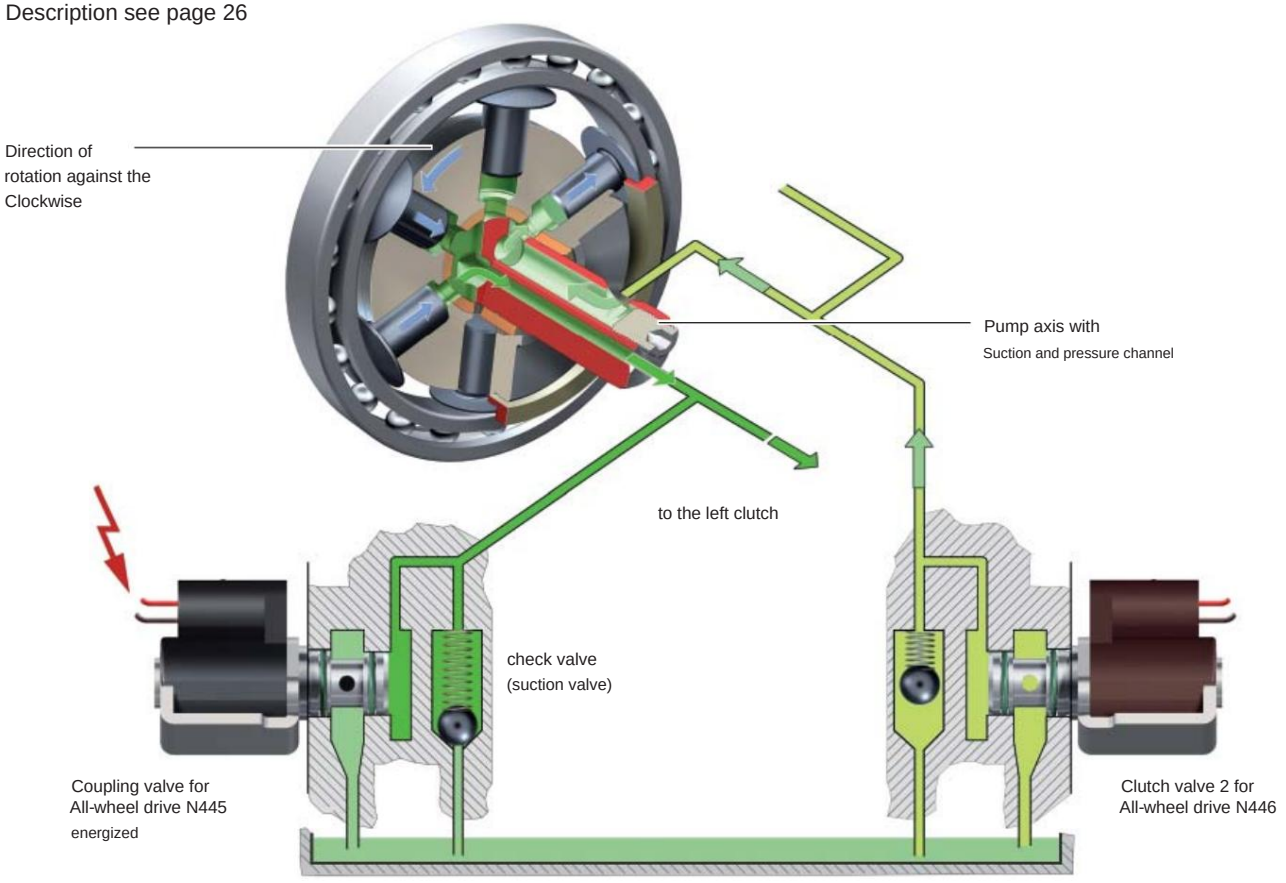
The hydraulic system is designed in such a way that pressure builds up on the respective side (clutch) by changing the direction of rotation of the pump and in conjunction with the corresponding coupling and check valve.

Only one side (one clutch) can be controlled at a time.

Function of the hydraulic pump

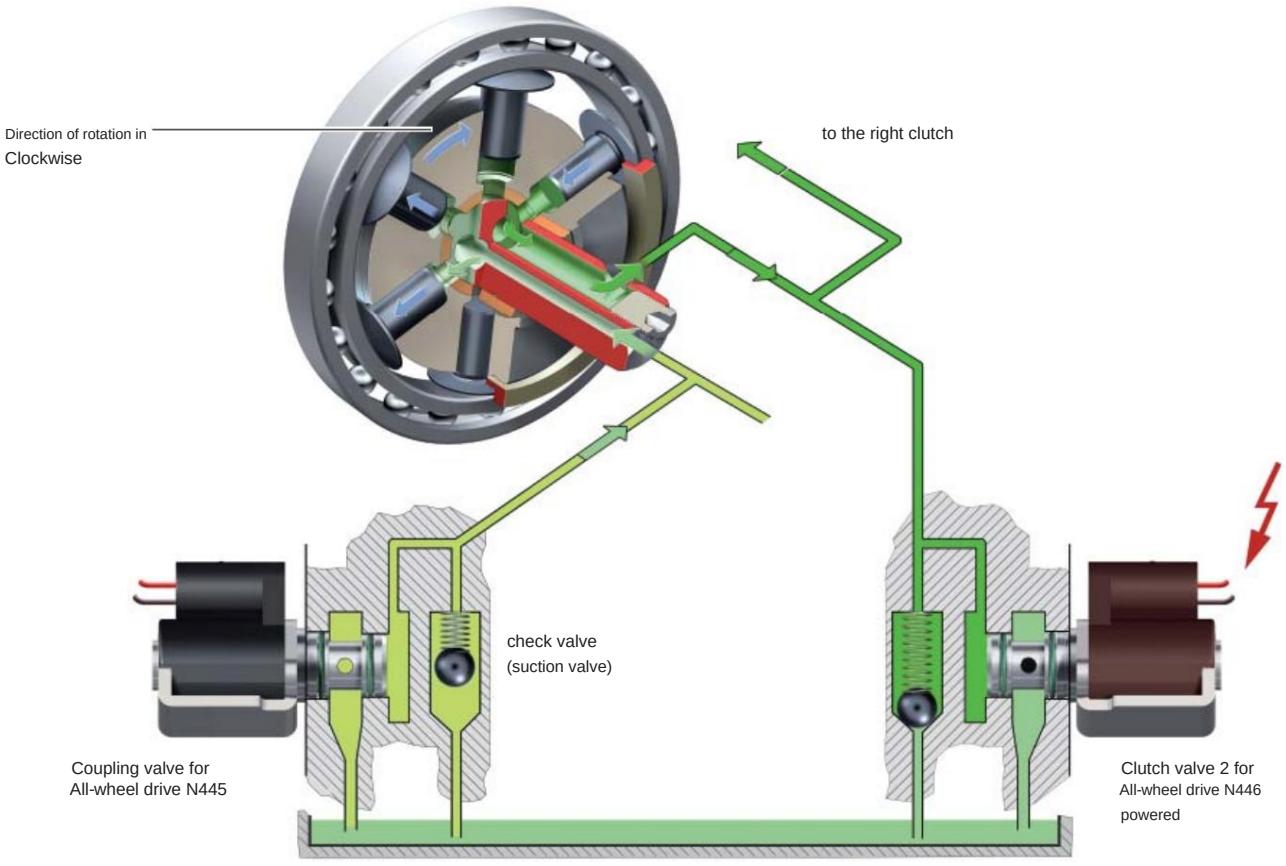
Activation of the left clutch

Description see page 26



476_063

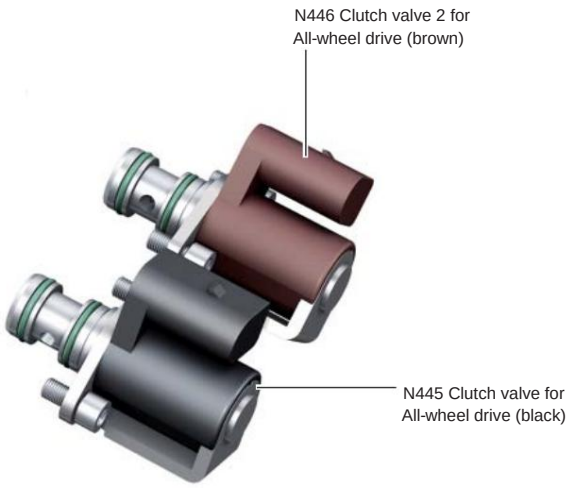
Activation of the right clutch



476_064

Suction pressure | pressureless | Clutch pressure

Clutch valve for all-wheel drive N445/N446



476_065

The two clutch valves are electromagnetic hydraulic valves. The clutch valves are operated with on-board voltage.
There are two operating positions: OPEN and CLOSED. When de-energized, the valves are open (OPEN).

The clutch valves are used for quick venting and as safety valves. In order for clutch pressure to build up, the respective valve must be energized. Since they are open when de-energized, pressure cannot build up accidentally.

The pressure is monitored by the two oil pressure and oil temperature sensors G437/G640. If an inadmissible pressure is detected, the valves are de-energized and the pressure breaks
together.

Instructions for replacing valves N445/446

The two coupling valves are functionally identical, but must not be interchanged. Therefore, they and the connection

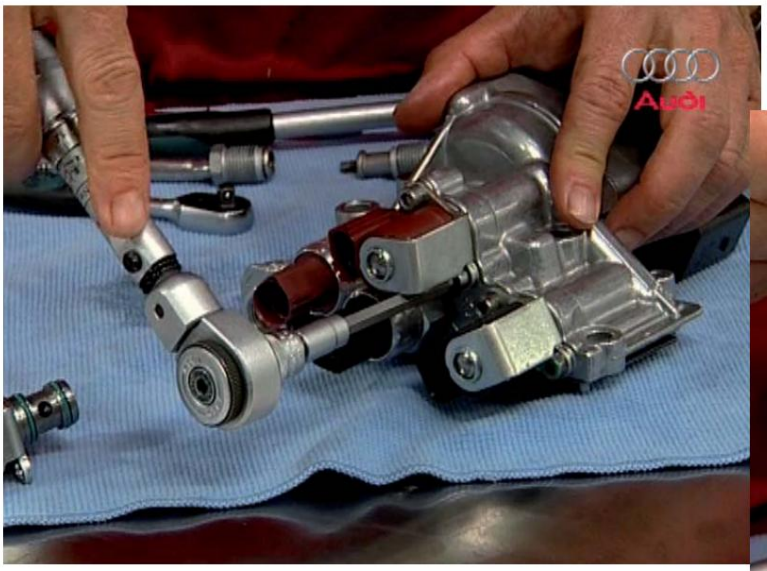
The plugs on the wiring harness are color-coded. The plug connections are also coded according to their design, so the connectors cannot be plugged in incorrectly. However, the valves can be installed incorrectly in the housing of the hydraulic control unit. For this reason, it is advisable to replace the valves one at a time.

After removing and installing the clutch valves, the ATF must be refilled. To do this, use the function available in the vehicle diagnostic tester, see page 43.

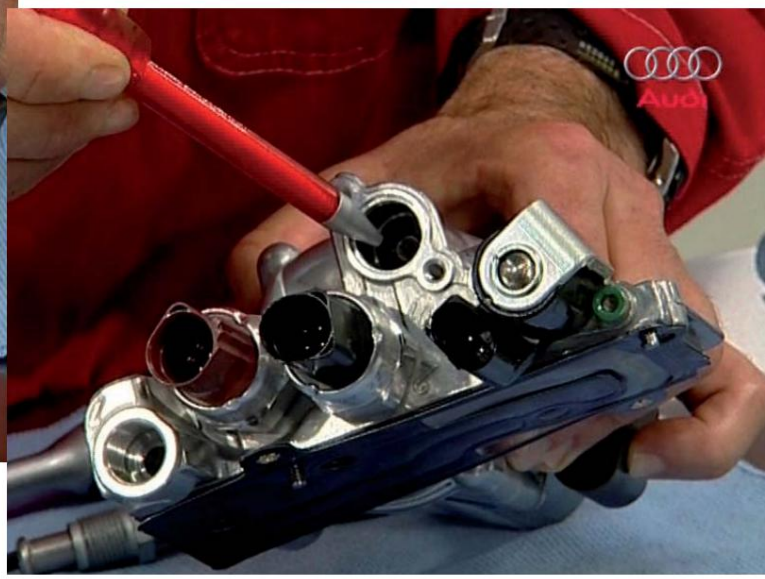
To check whether the valves are installed correctly, a system test must be carried out and the torque shift checked, see pages 42 and 44.

In addition to the repair manual, you will find further interesting information on replacing the valves in the iTV program “Audi quattro with sports differential part 3”. The removal and installation is shown there.

After working on the hydraulics of the sports differential, appropriate tests and processes must be carried out. Information on this can be found in the chapter “Guided functions” from page 42.



476_079

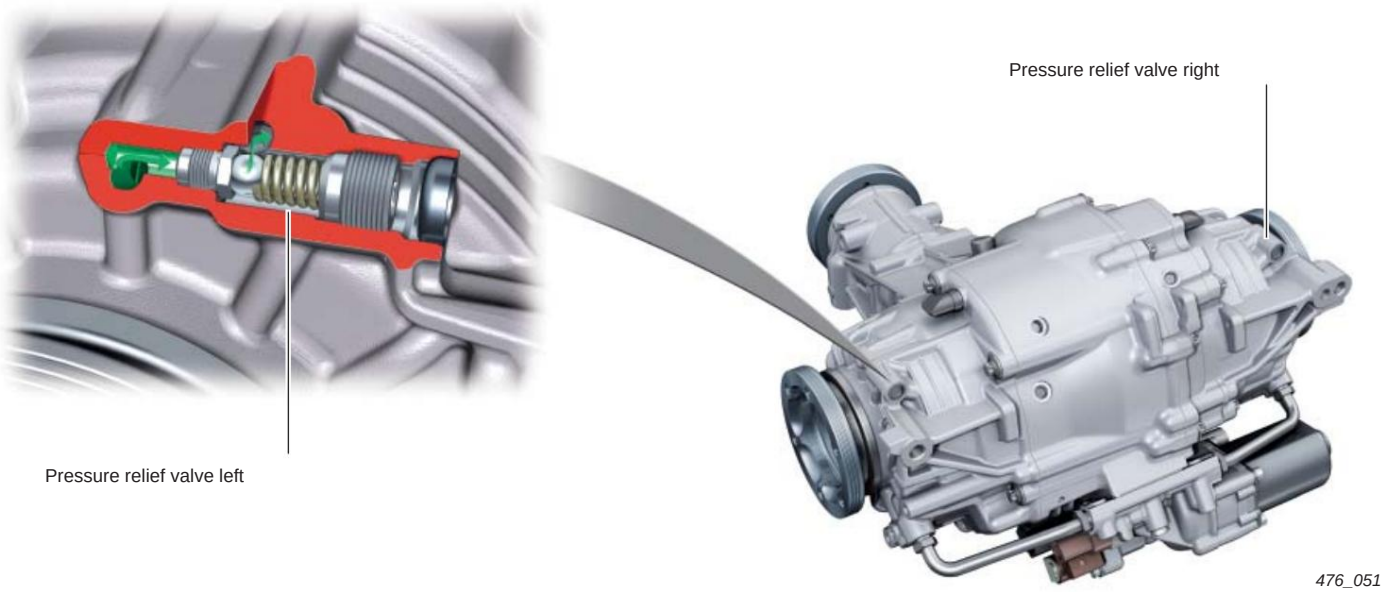


476_080

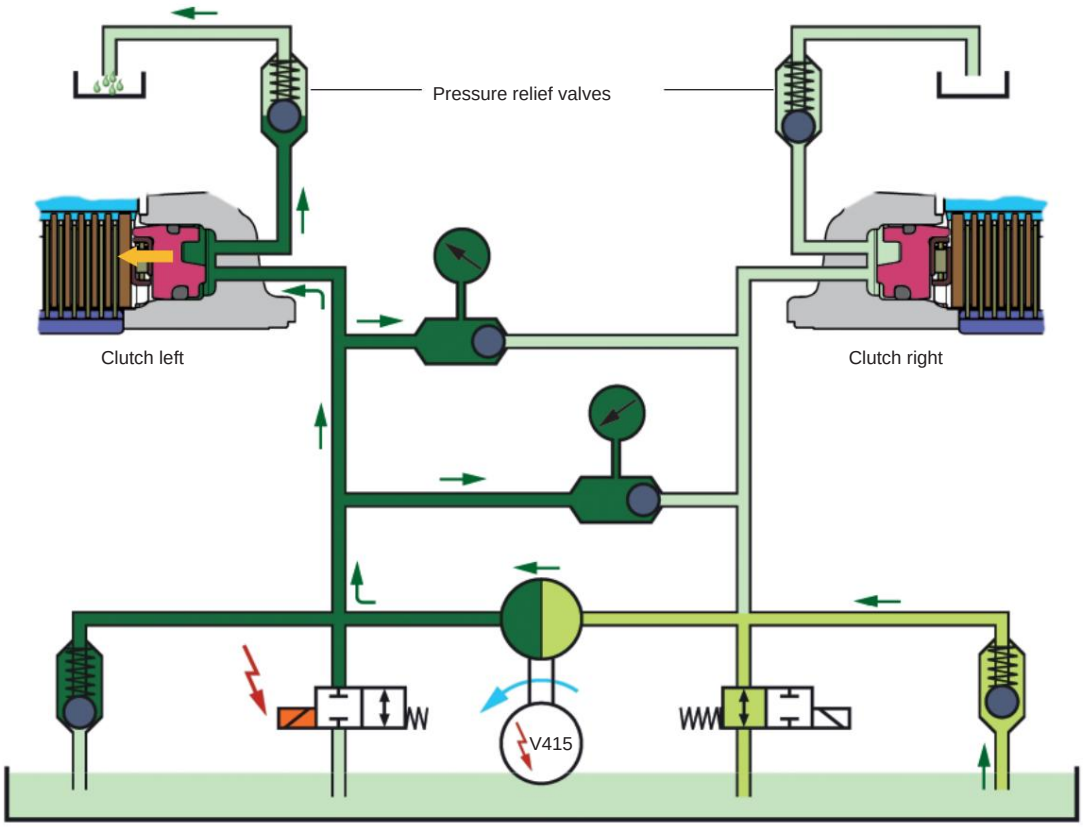
Pressure relief valves

The two pressure relief valves have two functions:

1. They are used to vent the hydraulic system, see
   Page 29.
2. They limit the maximum pressure in the system to a
   defined value. On the one hand, this protects the components from
   high pressure. On the other hand, the maximum clutch transmission torque
   is limited to approx. 1200 Nm.
   This limitation serves to ensure driving safety so that excessive yaw moments
   cannot occur on the vehicle, which would ultimately make the vehicle unstable.



476_051

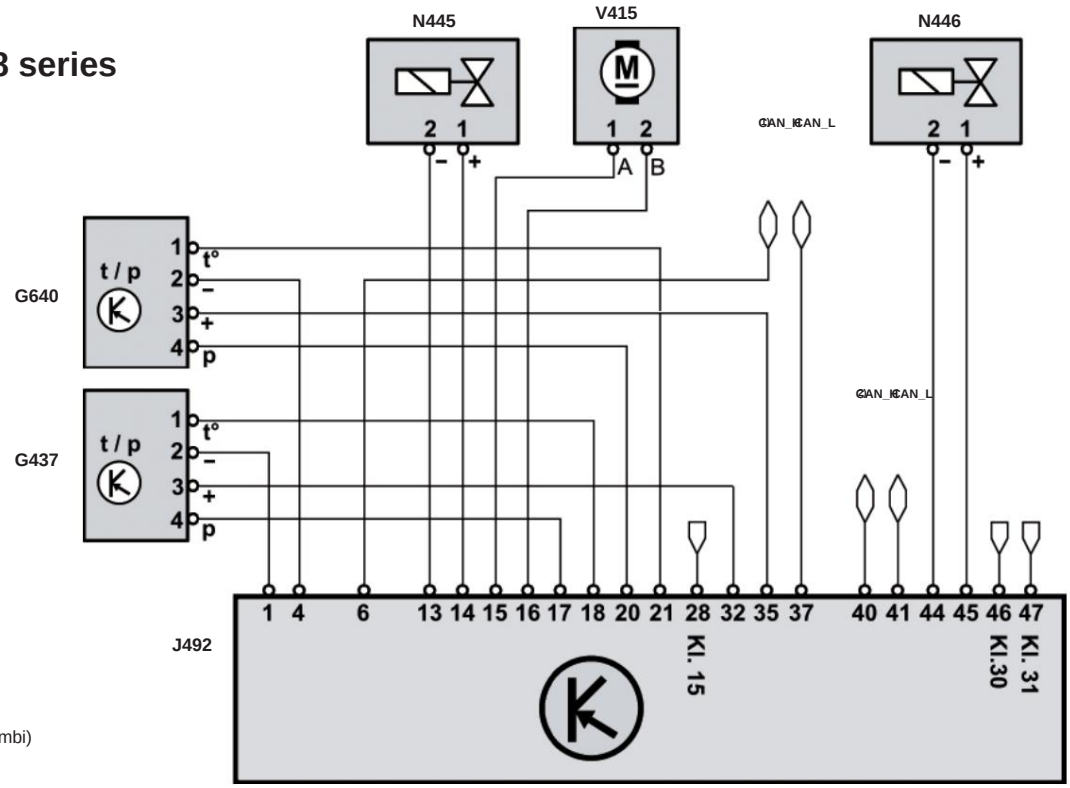


476_050

Electrical control

Functional plan – B8 series

(Status: 01/2011)



1) CAN-Bus chassis/dashboard insert (combi)
2) CAN-Bus chassis sensors

476_073

To calculate the clutch pressure, the control unit J492 essentially requires information that is also used by the ESP control unit. The yaw rate and the lateral acceleration are very important information. For this reason, the sensors for this are in combination with the sports differential and/or
or the dynamic steering is present twice (redundancy).
In the B8 series, this sensor technology is located in the two sensor units G419 and G536. The bus topology on this page shows the extensive data exchange with all control units involved.

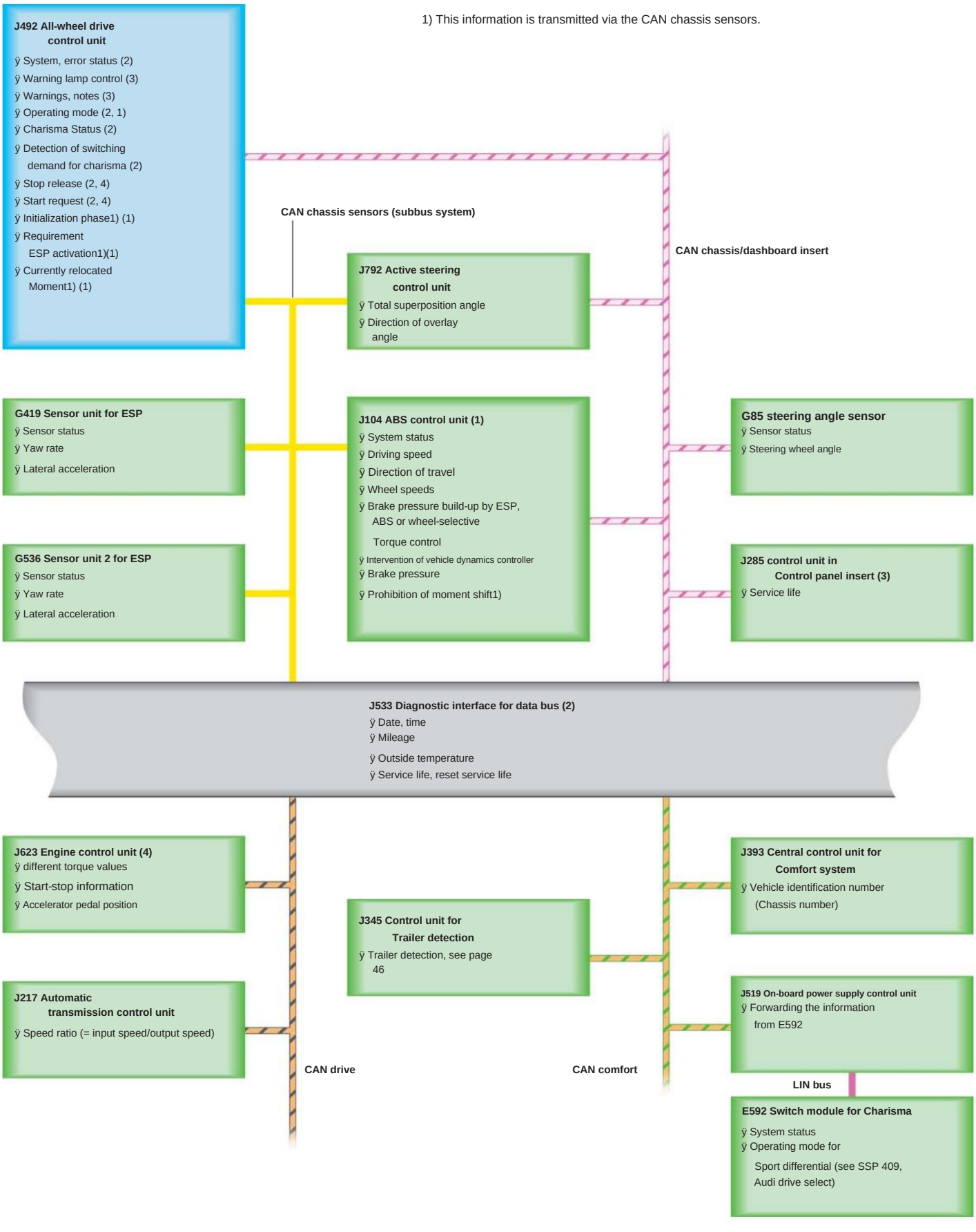
Legend:

G437 Oil pressure and oil temperature sensor
G640 Oil pressure and oil temperature sensor 2
J492 All-wheel drive control unit
N445 All-wheel drive clutch valve
N446 Clutch valve 2 for all-wheel drive
V415 pump for all-wheel drive

476_074

Networking bus topology – B8 series

(Status: 01/2011)



1) This information is transmitted via the CAN chassis sensors.

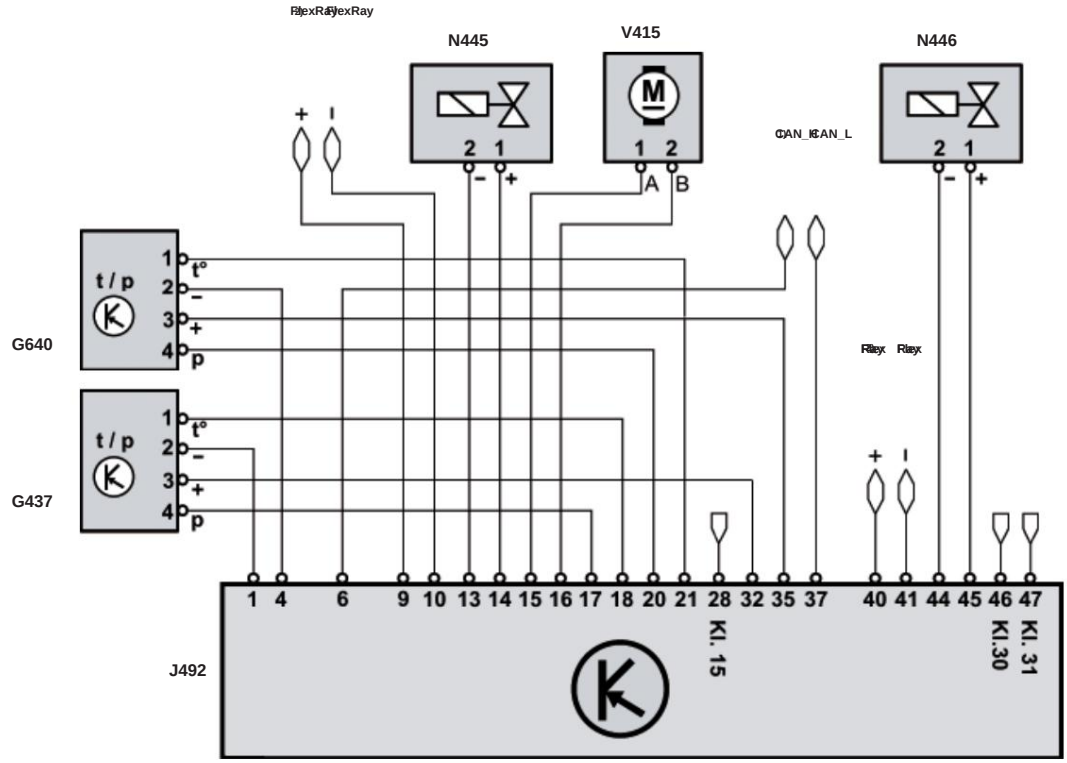
476_075

Information sent by control unit J492
The number in brackets indicates to which bus participant the respective information is sent.

Information that is received and evaluated by the control unit J492.

Functional plan – D4 and C7 series

(Status: 01/2011)



1) CAN bus drive

2) FlexRay bus

476_076

To calculate the clutch pressure, the control unit J492 essentially requires information that is also used by the ESP control unit.

The yaw rate and lateral acceleration are very important information. For this reason, the sensors are in combination

In combination with the sports differential and/or the dynamic steering, there are two sensors (redundancy). In the D4 and C7 series, there are two of these sensors in the sensor electronics control unit J849. Information on J849 can be found in SSPs 458 and 480.

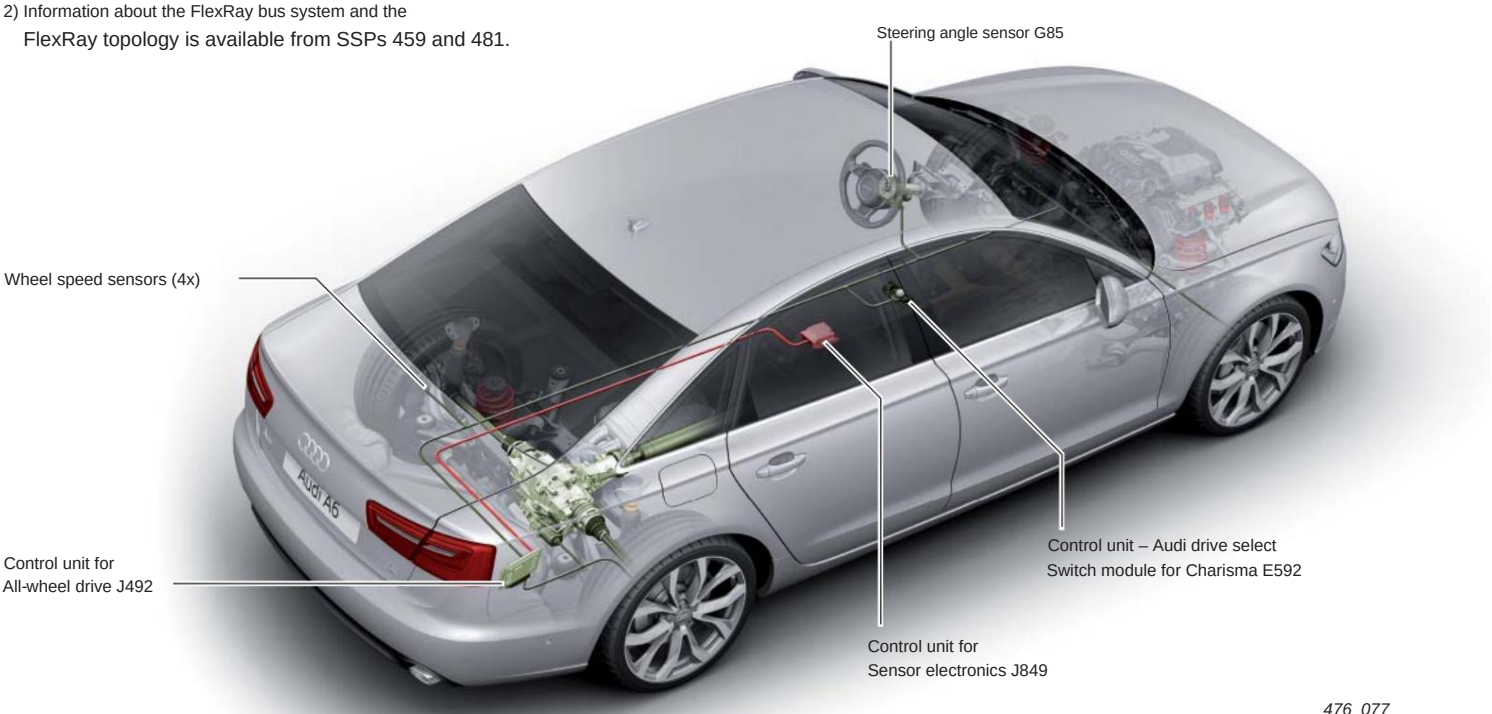
In the D4 and C7 series, the J492 communicates with the two bus systems, CAN drive and FlexRay.

Legend:

G437 Oil pressure and oil temperature sensor
G640 Oil pressure and oil temperature sensor 2
J492 All-wheel drive control unit
N445 All-wheel drive clutch valve
N446 Clutch valve 2 for all-wheel drive
V415 pump for all-wheel drive

The bus topology next door shows the extensive data exchange with all control units involved.

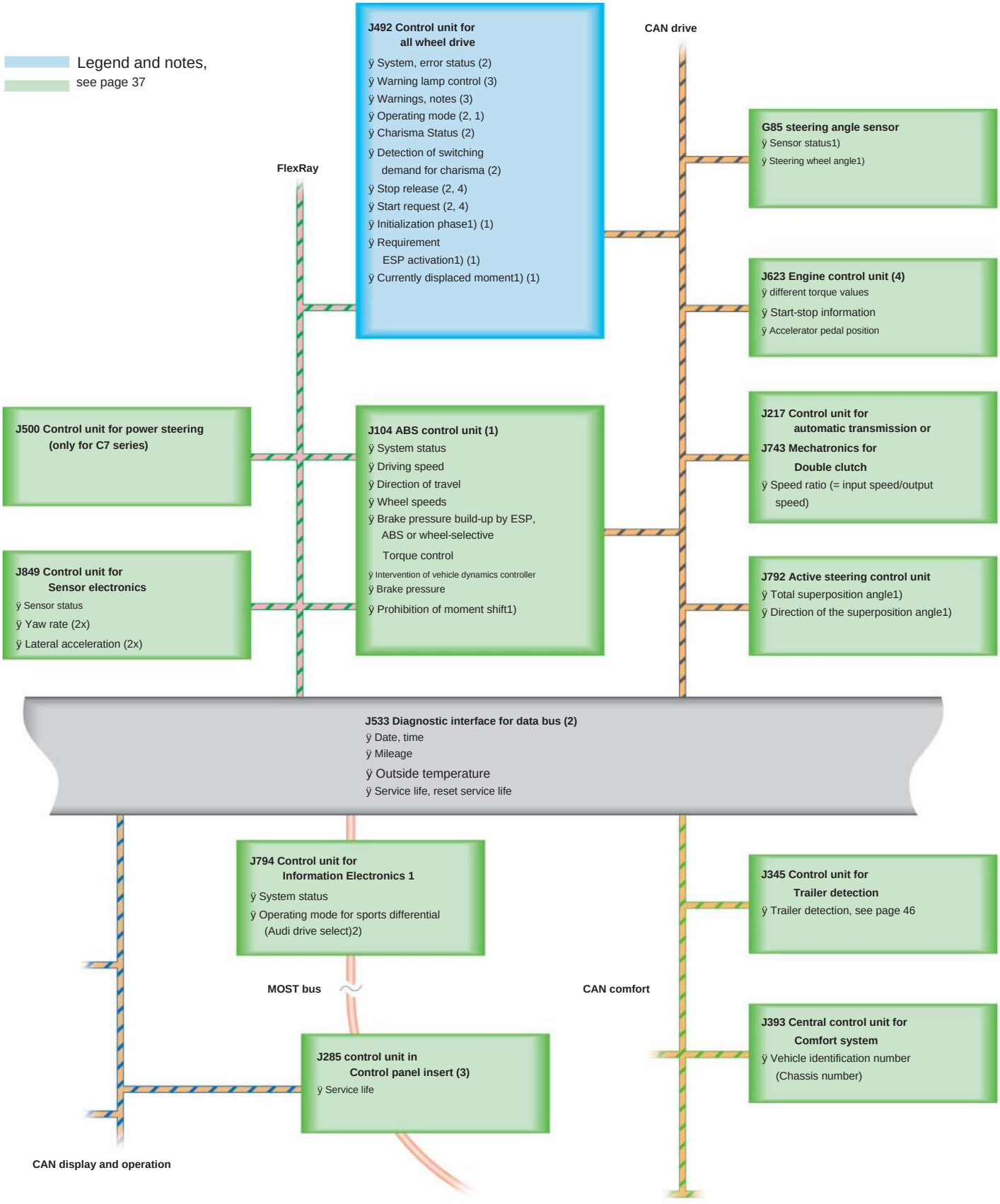
2) Information about the FlexRay bus system and the FlexRay topology is available from SSPs 459 and 481.



476_077

Networking bus topology – D4 and C7 series

(Status: 01/2011)



476_078

1) Except for the information from the G85 and the J792, all other information is received or transmitted via the FlexRay data bus. Posted.

2) In the D4 and C7 series, the operating mode for the sports differential (Audi drive select) is only available in the MMI menu “CAR” selected. The central information control of Audi drive select is assigned to the on-board power supply control unit, see SSPs 456, 478, 486.

All-wheel drive control unit J492

Depending on the vehicle model, the control unit is located at different locations in the trunk, see repair manual.

Essential information for calculating the clutch pressure are the following parameters:

- Steering angle
- Yaw rate
- Lateral acceleration
- Wheel speeds
- and the current data of the engine control (e.g. various Engine torque specifications).

The control unit J492 receives this information from the ABS control unit J104 and partly directly from the sensors via the data bus system. Depending on the vehicle model, the J492 communicates with different bus systems, see pages 37 and 39.

If there are system faults, a corresponding display appears in the instrument cluster. The sports differential is then switched off.

The control unit calculates a clutch temperature from the control data and the ATF temperature. If this exceeds a defined value or if the ATF temperature exceeds a temperature of 150 °C, the clutches are no longer controlled, see page 30. A corresponding display appears in the instrument cluster.

Instructions for replacing the control unit for All-wheel drive J492

Due to the way the clutch adaptation works, the control unit must know the associated axle transmission. This identification is done via the identification of the two oil pressure/
Temperature sensors. On the one hand, the sports differential cannot be controlled without this identification. On the other hand, when teaching a new classification, the adaptation values of the clutches are deleted, see page 15. Therefore, the following must be observed when replacing the control unit.

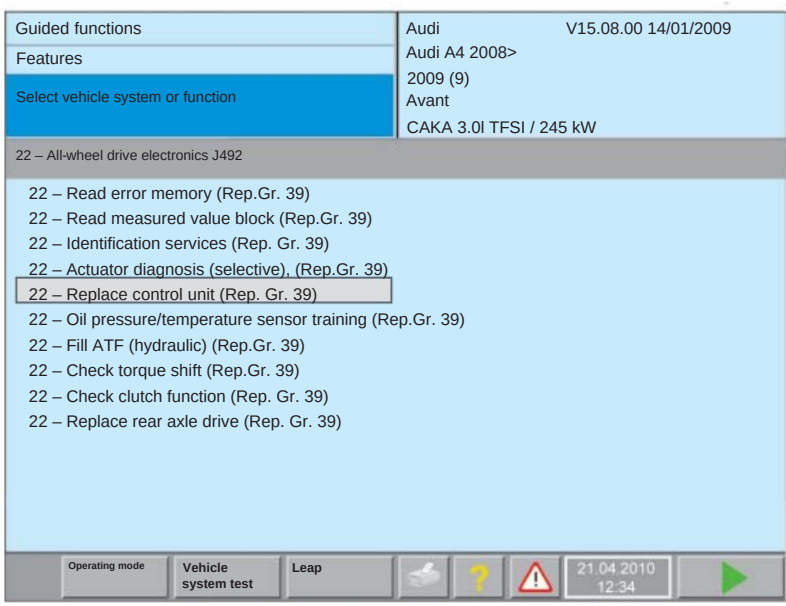
There are two different scenarios:

Scenario 1: The old control unit is responsive enough that the learned values can be read out.

For this purpose, a special function is available in the “Replace control unit” function. Process available:

First, all learning values1) of the old control unit must be read out and temporarily stored in the vehicle diagnostic tester.
After installing the new control unit, an online connection to the SVM must be established in order to parameterize the new control unit.

The previously cached learning values1) transferred to the new control unit.



476_060

Scenario 2: The old control unit can no longer be accessed or the learned values cannot be read out and transferred to the new control unit.

Here too, the new control unit must first be parameterized via the SVM. Next, the classifications of the clutches from the rear axle drive must be read and entered into the new control unit. The previous adaptation values are deleted in the process. The identifiers of the oil pressure and oil temperature sensors are automatically adopted to identify the axle drive. The ATF must then be renewed.

1) The learning values consist of three adjustments:

- The classifications of the couplings, see page 14.
- The adaptation values of the couplings, see page 15.
- The identification of the oil pressure and oil temperature sensors, see Page 31.

become.

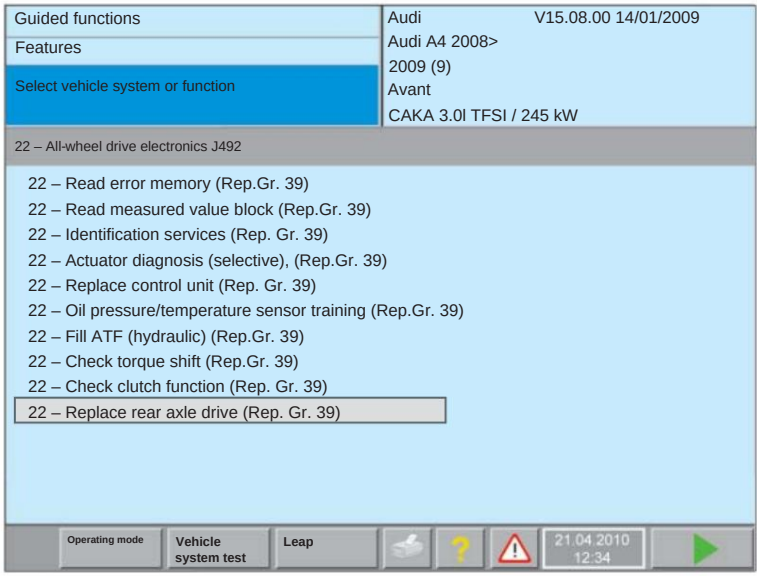
A notice:

The vehicle system tester will ask whether the rear axle drive has also been replaced or not.

Only if this query is answered correctly can the program continue to run according to the situation. In scenario 2, in the event of a warranty claim, the axle drive will also be replaced after consulting product support.

Notes on replacing the rear axle drive (Sport differential)

As already described for the oil pressure and temperature sensors and the control unit, the following must also be observed when replacing the sports differential. The sports differential must be adapted to the control unit so that it can control the clutches precisely. To do this, certain procedures must be initiated that are stored in the menu selection - Replace rear axle drive.



476_060

In the menu selection Replace rear axle drive two Scenarios taken into account:

1. Rear axle drive (sport differential) **new:** When this selection is made, the following procedures are carried out:
   - The classifications of the clutches must be taught, see page 14. The codes of the two oil pressure and oil temperature sensors for identifying the sports differential are automatically adopted, see page 31. **The adaptation values of the previous sports differential are irretrievably deleted.**

2. Rear axle drive (sport differential) **required:** With this selection, the procedures are as described under 1.
   - In addition, the ATF must be replaced.

A notice:

The vehicle diagnostic tester will ask whether the rear axle drive is new or used.

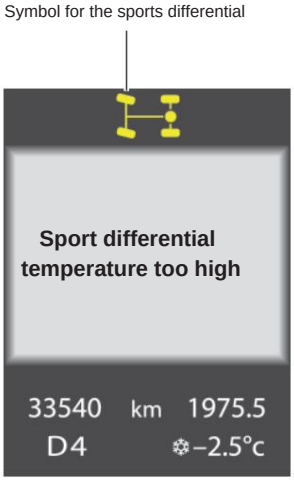
Only if this query is answered correctly can the further program flow be carried out appropriately.

Displays and system information

476_058

This display appears when the sport differential has been switched off due to system errors.

Symbol for the sports differential



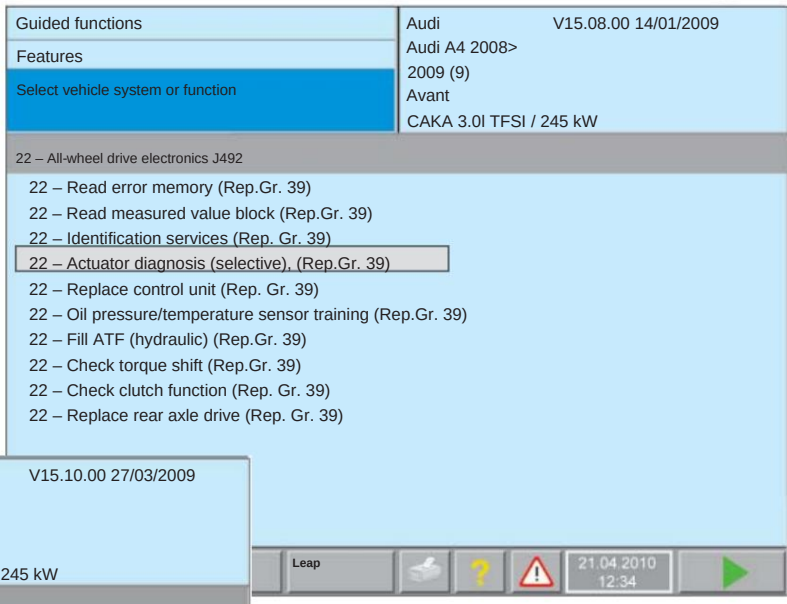
476_058

This display appears when the clutch or ATF has exceeded a defined temperature. The clutch control is temporarily deactivated until the corresponding temperature values are exceeded. The display goes out.

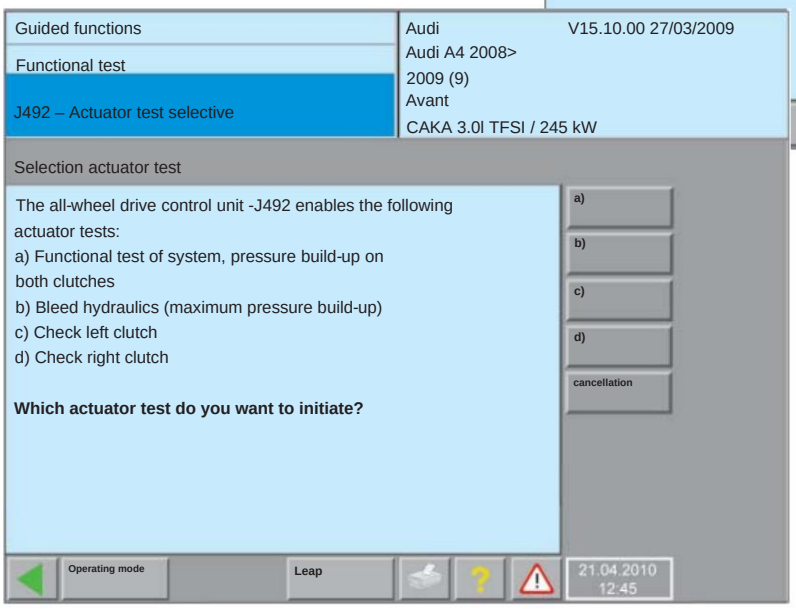
Guided functions

Actuator diagnostics

The “Actuator Diagnosis” menu selection contains a number of functions and tests for checking the sports differential. Some of these can also be found in the other functions.



476_060



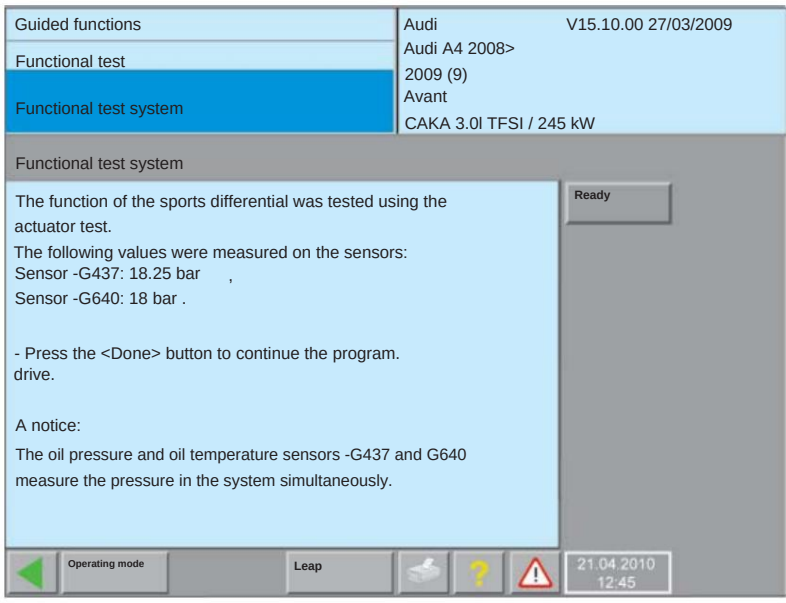
476_066

a) Functional test system …

… is a system function test in which a defined pressure build-up occurs on both clutches and the pressure sensors are checked.

The test is successful if the pressure on both sides reaches a defined value. The pressure value of both sensors must be approximately the same.

This system test should always be carried out after all work on the sports differential. It is integrated in some program sequences and is activated automatically. If the system test is aborted or not carried out, an event log entry "C102AF0 - System test not carried out" is made.



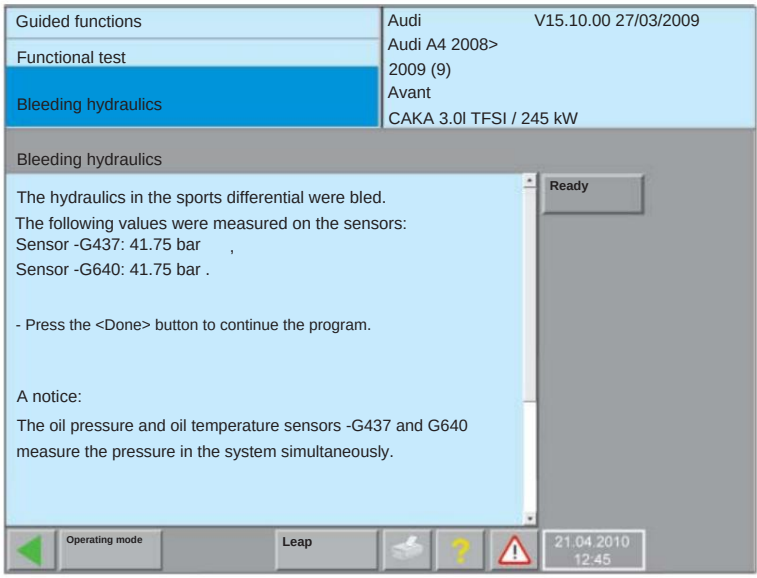
476_067

b) Bleed the hydraulics

This function can be used to check whether the maximum pressure is reached on the left and right. This shows whether the pump is building up sufficient pressure and at what pressure the pressure relief valves respond.
The pressure value must be approximately the same on both sensors and approximately 42 bar, see also page 29.
This function is also part of the program – filling ATF.

This function should be used to evaluate the function of the sports differential.

The displacement moment depends, among other things, on the pressure.
If pressure values significantly lower than 42 bar are reached, the maximum displacement torque cannot be achieved.



476_068

c/d) Check clutch left/right

These functions correspond to the same test sequence as the function "Check clutch function (Rep.Gr.39)" in the main menu.
These functions can be used to check the transmission capacity of the couplings, see page 45.

The functions and tests of the actuator diagnosis are shown in the iTV program …

… **Audi quattro with sports differential 0BF Part** 4, work and tests with the vehicle diagnostic tester …

… shown.

Fill ATF (hydraulic)

In order for the sport differential to function properly, the ATF level must be correctly adjusted and the system must be bled.
Therefore, when filling the ATF, the function "Fill ATF (hydraulic)" must be carried out.

The "Fill ATF (hydraulic)" function must be carried out during the following work:

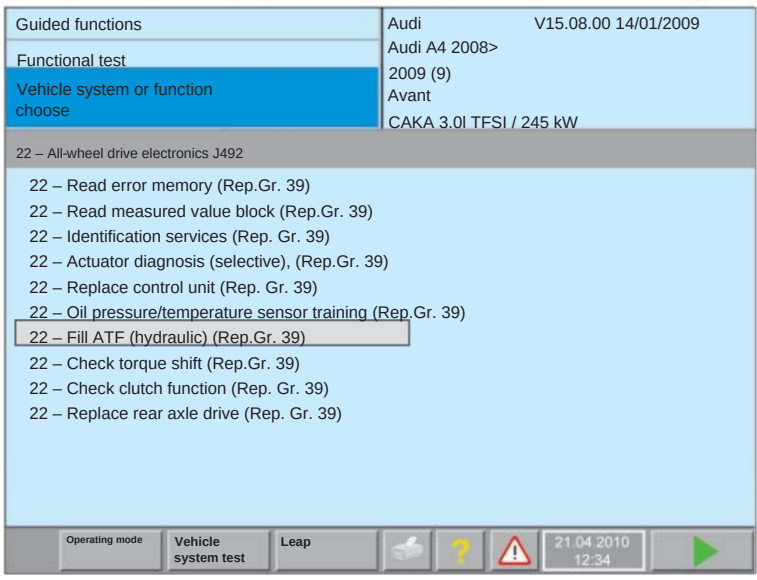
- Work on the hydraulic system (e.g. dismantling/replacing the hydraulic control unit, working on the valves and the oil pump)
- Work that requires the ATF to be drained and refilled, e.g. after replacing a double shaft seal.

The function is divided into three processes:

1. Pre-filling and flushing the system
   The pump is activated with the coupling valves open and part of the hydraulic system is filled.

2. Bleed the system
   To do this, the full pressure is built up on each side with the clutch valve closed until the pressure relief valves open. This fills the remaining lines, channels and the clutch cylinders and pushes the air out.

3. Functional test
   As the program continues, any event memory entries are deleted and a system function test is carried out. This corresponds to function test a) from the actuator diagnosis, see page 42.



476_060

The program sequence of the function "Fill ATF (hydraulic)" is shown in the iTV program …

… **Audi quattro with sports differential 0BF part 4,** Working and testing with the vehicle diagnostic tester …

… shown.

Check torque shift

The “Check torque shift” function is used to check whether the correct clutch (left side or right side) is being controlled.

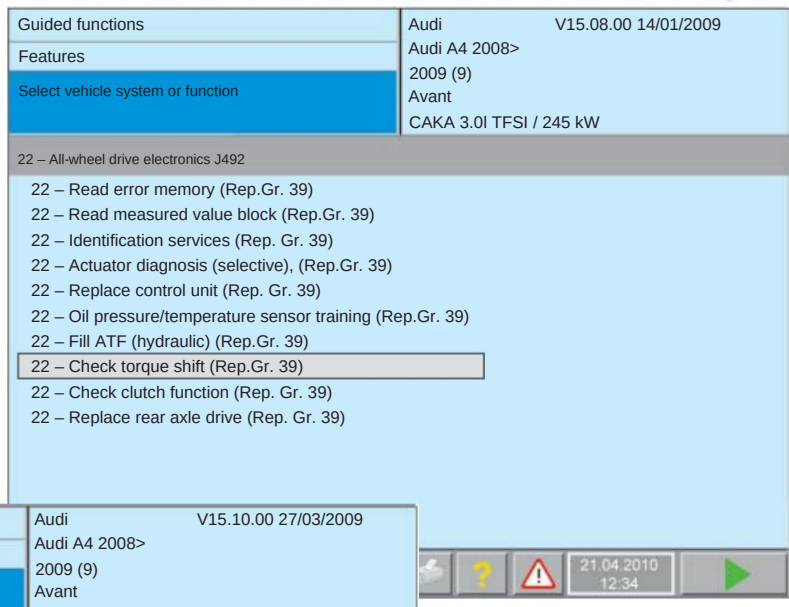
476_069

This test must always be carried out after the following work:

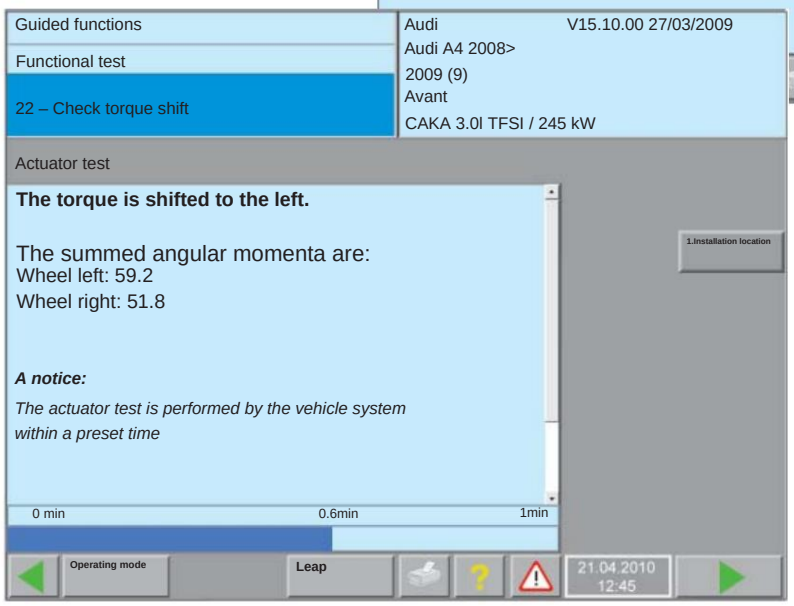
- Working on the wiring of the rear axle drive
- Working on the hydraulic control unit
- Working on the clutch valves

When testing the torque shift, the left clutch is activated. This changes the gear ratio between the left and right wheels. If you now turn either side, the left wheel must turn faster than the right wheel. The control unit records the speed signals (rotational pulses) from the wheel speed sensors and determines which wheel is turning faster. If the left wheel turns faster than the right

Wheel, the electro-hydraulic control works correctly.



476_060



476_070

The torque shift test is shown in the iTV show …

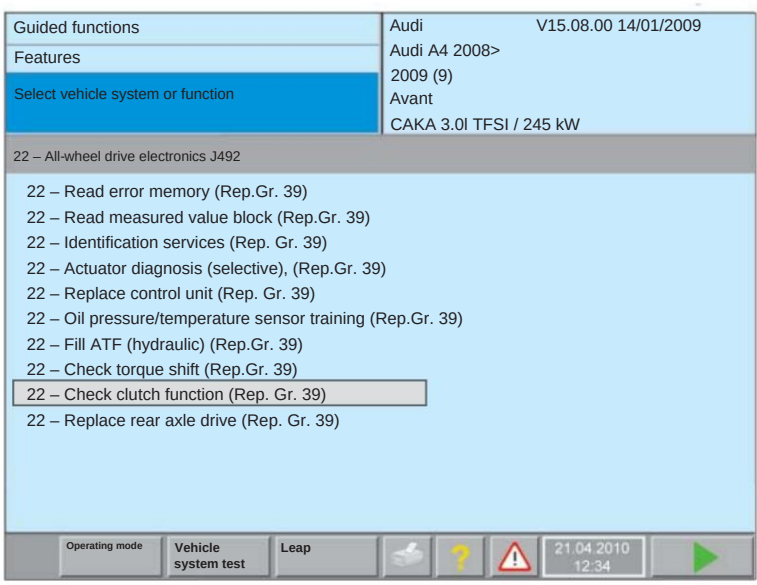
… **Audi quattro with sports differential 0BF part 4,**
Working and testing with the vehicle diagnostic tester …

… shown.

Check clutch function

Behind this menu selection there is a test program with which the transmission capacity of the two clutches can be checked.

The test program “Check clutch function” in the main menu is the same test program as the function tests c) and d) of the actuator diagnosis, see page 43.



476_060

This test program must be carried out …

... if there is a complaint about the function of the sports differential. This test is one option (of several) to analyze the function of the sports differential, e.g. if the customer complains that he does not feel any effect of the sports differential.

… before replacing the sports differential to ensure that the sports differential is not replaced without authorization.

How the clutch test works

The control unit has no direct feedback as to whether the calculated clutch torque is actually transmitted by the clutch. In other words, the control unit does not know whether the control leads to the desired clutch torque.

If the clutch function is intact (depending on the parameters: condition of the ATF, quality of the components, adaptation, etc.), a defined clutch pressure causes a corresponding clutch torque. If one or more of the previously mentioned parameters deviate, the actual clutch torque also deviates accordingly.

The clutch test can be used to determine whether the desired transmission capacity (clutch torque) is achieved at a defined pressure.

For this purpose, each clutch is controlled with two defined pressures in the test program. A torque wrench is used to check whether a specified torque is maintained.

476_071

The clutch test is shown in the iTV show …

… **Audi quattro with sports differential 0BF part 4,**
Working and testing with the vehicle diagnostic tester …

… shown.

Other notes and information

Traction function

Newer vehicles with sports differentials have a so-called “traction function”.

Additional drive torque is directed to the wheel with the higher traction capability. This means that if the left rear wheel spins, the drive torque of the right (stationary) wheel is increased by controlling the right overlay unit. The traction function is only activated at a driving speed of around 15 km/h and therefore does not provide a starting aid. The function improves driving dynamics when the road friction coefficients vary greatly because the power is shifted to where it can be effective. An EDL braking intervention, which results in power being lost, is not necessary in this situation.

The following vehicle models have a traction function:

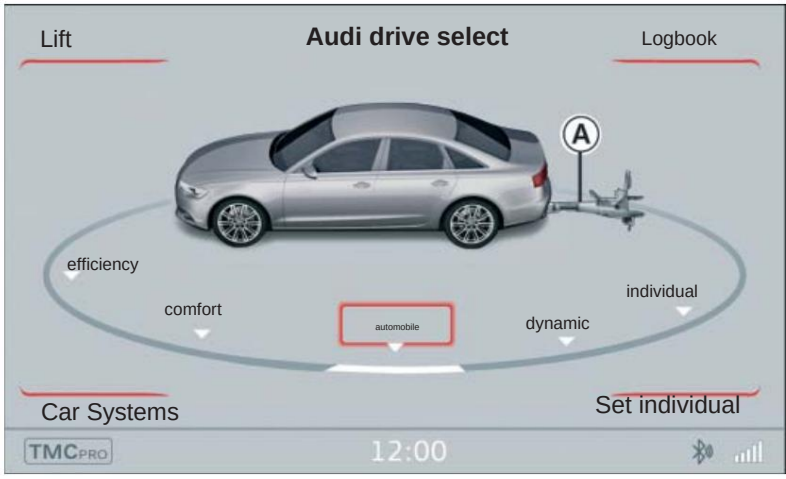
• Audi A8 '10 (D4) • Audi A7 Sportback • Audi A6 '11 (C7) • Audi A4 '08 (B8)	from construction date KW32/2010 from construction date KW41/2010 from SOP not provided

Trailer operation

If the sports differential is in “dynamic” operating mode, it is automatically switched to “auto” operating mode for the time when towing a trailer.

The trailer operation is detected by the trailer detection control unit J345 when the 13-pin trailer connector is plugged in, or when the customer has manually selected trailer mode in the MMI. A trailer coupling (A) appears in the menu - Audi drive select.

Information on the operating modes of the sports differential can be found on page 6.



476_081

Start-stop operation

The sports differential bleeds the system at defined intervals, see page 29.

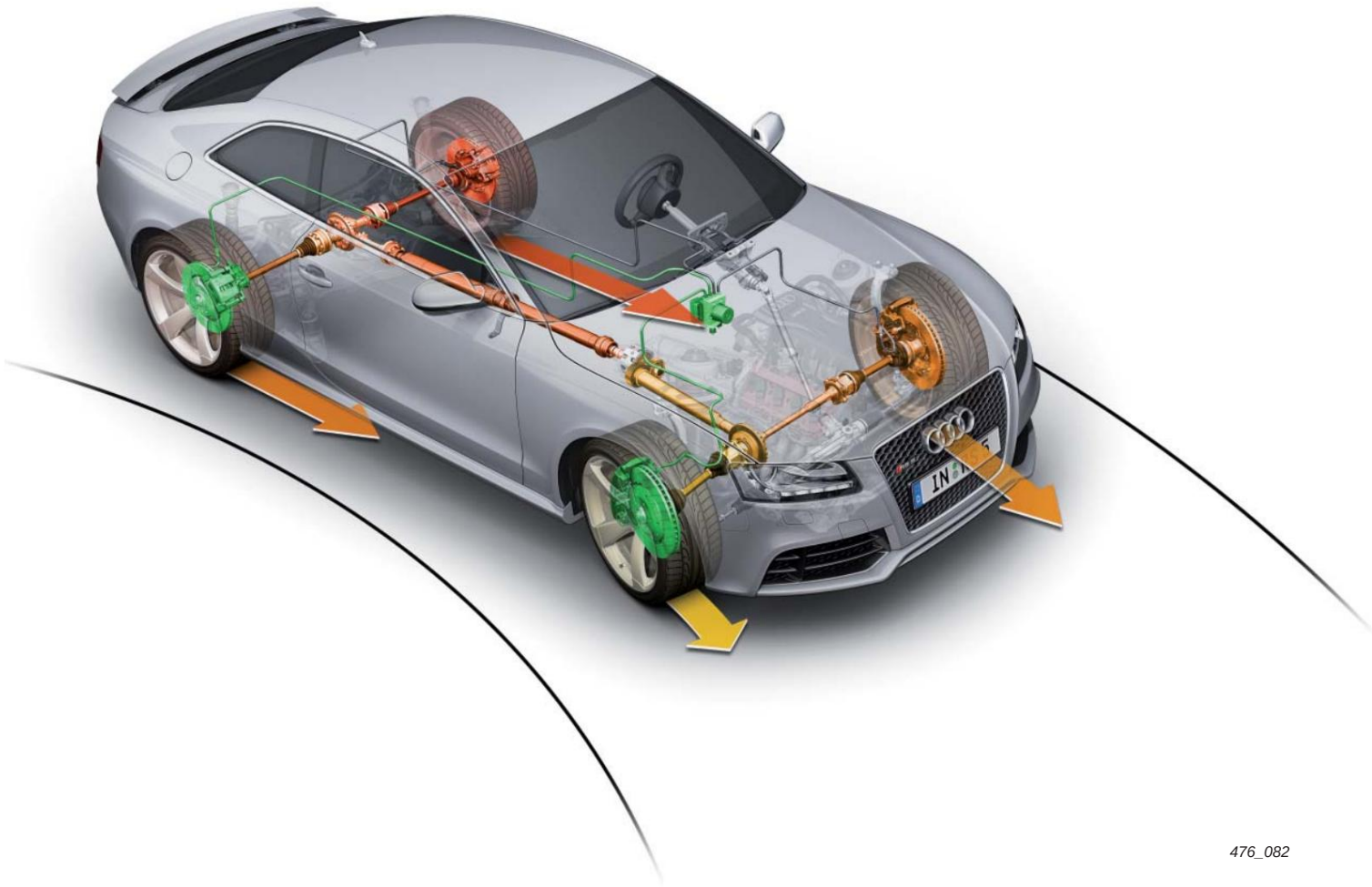
This system venting is only activated when the vehicle is at a standstill or when the engine is idling.

Therefore, the four-wheel drive control module J492 can prevent the engine from stopping if a system venting request is made.
After the system has been vented, a stop release is issued from J492.

Wheel-selective torque control

In vehicles with a sports differential and wheel-selective torque control, the wheel-selective torque control only affects the front axle; the torque distribution of the sports differential acts on the rear axle.

The wheel-selective torque control was first used in conjunction with the quattro drive in the Audi RS5 and the Audi A8 '10 (D4). It will gradually find its way into other quattro models. It is used under the name "electronic differential lock" in front-wheel drive vehicles.



476_082

reference

Information on wheel-selective torque control can be found in the self-study program 478 “Audi A7 Sportback” on page 33 and in the iTV program “Audi RS5 – Power transmission part 2”.

ATF and axle oil change on the RS models

RS models (e.g. the Audi RS5) are often also subjected to the tough
Motor racing conditions are a real challenge for both the components and the oils. For this reason, some RS models have special instructions regarding maintenance work and the intervals between them.

For the RS models, a change of the ATF and the
Axle oil in the sports differential is essential.

- Axle oil change interval every 60,000 km.
- Change interval for the ATF every 60,000 km or earlier if the temperature counter for the MTF (manual transmission fluid) in the 7-speed dual clutch transmission 0B5 (S tronic) is full.

For detailed information on replacement intervals, please refer to
Please refer to the current workshop literature.

reference

Information on the MTF replacement interval for the Audi RS5 with 0B5 transmission can be found in the iTV program “7-speed dual clutch transmission 0B5 - Innovations in the Audi RS5 and other models from model year 2011” from October 21, 2010.

Repair overview

Repair situation	Work to be performed	Function in Vehicle diagnostic tester
Replacing the axle drive rear 0BF/0BE (new part) **reference** SSP pages 11, 41	• Enter axle drive classifications • Automatic learning of the new oil pressure and oil temperature giver • Select program query for new rear axle drive • The previous learning values of the clutch adaptation are deleted, the control unit starts the clutch adaptation based on new clutches. **Notice** B8 series only: First, the respective tester function automatically checks whether the software version 0025 is present. If not, a software update to SW > = 0025 is carried out.	• Rear axle drive to exchange
Replacing **an** oil pressure and oil temperature sensor G437 or G640 **reference** SSP Page 31	• Teaching the new sensor • Check ATF, top up ATF if necessary • System testing **Notice** B8 series only: First, the respective tester function automatically checks whether the software version 0025 is present. If not, a software update to SW > = 0025 is carried out.	• Teach oil pressure/temperature sensor • Actuator diagnostics – System functionality test
Replacing **both** oil pressure and oil temperature sensors G437 or G640 (at least one donor is still capable of communication) **reference** SSP Page 31	• First replace and teach the defective sensor, then teach the second sensor (one after the other) • Continue as described above • The simultaneous exchange of both sensors should be avoid **Notice** B8 series only: First, the respective tester function automatically checks whether the software version 0025 is present. If not, a software update to SW > = 0025 is carried out.	• Teach oil pressure/temperature sensor
Replacing **both** oil pressure and oil temperature sensors G437 or G640 (neither of the two donors is capable of communication) **reference** SSP Page 31	• Enter axle drive classifications • Automatic learning of the new oil pressure and oil temperature giver • Select program query for used rear axle drive • The previous learning values of the clutch adaptation are deleted. • The control unit corrects the clutch pressure for the used Couplings. • Renew ATF **Notice** B8 series only: First, the respective tester function automatically checks whether the software version 0025 is present. If not, a software update to SW > = 0025 is carried out.	• Rear axle drive to exchange
Exchange or work on the Clutch valves N445/N446 **reference** SSP pages 34, 42, 43, 44	• Replace the valves one after the other to ensure that the installation position is not mixed up. Make sure that the check valves do not fall out and are installed correctly. • Check ATF, top up ATF if necessary • System testing • Check torque shift	• Fill ATF (hydraulic) • Actuator diagnostics – System functionality test • Check torque shift
Exchange or work on the Hydraulic pump V415 **reference** SSP pages 32, 42, 43, 44	• Top up ATF • System check • Check torque shift **Notice** Pay attention to the information in the repair manual, self-study program and in the Audi iTV program – “Audi quattro with sport differential e-renzial part 3”!	• Fill ATF (hydraulic) • Actuator diagnostics – System functionality test • Check torque shift

Repair situation	Work to be performed	Function in Vehicle diagnostic tester
Exchange or work on the hydraulic control unit (Actuator) **reference** SSP pages 42, 43, 44	• install the old oil pressure and oil temperature sensors • Check ATF, top up ATF if necessary • System testing • Check torque shift **Notice** The hydraulic control unit is delivered without the two oil pressure and oil temperature sensors. The “old” oil pressure and oil temperature sensors must be installed.	• Actuator diagnostics – System functionality test • Check torque shift
Replacing the control unit J492 Prerequisite: The control unit is capable of communication and has no event memory entry “Control unit defective” **reference** SSP Page 40	• The learning values (identification of the oil pressure-oil temperature sensors, Classification of the clutches and adaptation values) must be temporarily stored in the vehicle diagnostic tester and transferred to the new control unit. • Parameterization of the new control unit via the SVM • System testing	• Replace control unit
Replacing the control unit J492 Prerequisite: The control unit is no longer communicative capable or event memory entry "Control unit faulty" **reference** SSP pages 40, 43	• The new control unit must have the SVM (software version Management) can be parameterized. • Program query for used (like new or new) Select rear axle drive, see note • Teaching the classification and identification of the oil pressure and oil temperature sensors • Renew ATF • System testing **Hints** under 15,000 km: • only replace control unit • Clutch adaptation values are set to zero over 15,000 km (under warranty): • Replace control unit and additionally • Replace rear axle drive over 15,000 km (outside the GW): • Replace control unit • Control unit is adjusted to a used axle drive • Renew ATF	• Replace control unit • Fill ATF (hydraulic)
Software update	If necessary, the software update is carried out automatically via the corresponding tester functions. **Notice** Currently (as of March 2011) there is no software update for the control unit J492 using the “Audi Flashing” function.	
Work on the electrical Connections and cables (Cable harness) **reference** SSP pages 42, 44	• System check • Check torque shift	• Actuator diagnostics – System functionality test • Check torque shift
Customer complaint about inadequate effect of Sport differentials **reference** SSP Page 42, 45	• Use the vehicle system test to check whether the event log contains Relevant entry exists. If there are any, edit them first. • Check ATF and top up ATF if necessary. • Carry out a test drive, check the complaint • Carry out a complete actuator test, checking whether the pump reaches the maximum pressure. • The scope of the actuator test includes a clutch function test. hold.	• Actuator diagnostics – System functionality test • Check clutch function
Only for RS models: Maintenance every 60,000 km **reference** SSP Page 47	• Change axle oil • Change ATF1) 1) If the temperature counter for the MTF is full on the Audi RS X with 7-speed dual clutch transmission 0B5 (S tronic), the ATF in the sports differential must also be changed.	In the automatic transmission control unit J217 (mechatronic J743) • Temperature counter (G754) reset to default

Attachment

Test your knowledge

1. What type of differential is the Audi sports differential?

ÿ a) open differential b)
ÿ limited-slip differential
ÿ c) superposition differential

2. How does the Audi sports differential work?

ÿ a) The sport differential brakes the inside wheel when cornering to prevent oversteering. b) The sport
ÿ differential locks when cornering to ensure sporty driving behavior. c) The sport differential shifts drive power
ÿ to the outside wheel when cornering. This creates a yaw moment, which
steers the vehicle into the curve.

3. What should be taken into account when replacing the rear axle drive 0BE/0BF?

ÿ a) After the replacement, the axle drive must be assigned to the control unit for all-wheel drive. b) After the
ÿ replacement, an adaptation drive must be carried out in which the axle drive and the control unit for
"Adapt" all-wheel drive.
ÿ c) After replacement, the "Replace rear axle drive" function must be carried out using the vehicle diagnostic tester.

4. What is the purpose of the multi-plate clutches?

ÿ a) The multi-disk clutches brake the wheel that is spinning. This prevents the drive power from breaking off. b) The multi-disk clutches transfer a
ÿ defined drive power to the corresponding rear wheel. c) The multi-disk clutches interrupt the flow of power above a certain
ÿ brake pressure so that the ESP can regulate correctly.

5. Which statements about the oil balance are correct?

ÿ a) The angle drive and the two superposition gears have a common oil chamber. b) The angle drive and
ÿ the differential have their own oil chamber, which is filled with axle oil. c) The two superposition gears each
ÿ have their own oil chamber, which is filled with special ATF. d) The two oil chambers of the superposition units are combined
ÿ into one oil system.

6. Which statements about the oil supply of the superposition gears are correct?

ÿ a) The two oil chambers of the superposition gears are connected by an oil channel. b) A ball valve
ÿ in the oil channel prevents the ATF from overflowing to one side during high lateral acceleration. c) The two superposition gears
ÿ each have their own self-contained oil chamber.

7. What needs to be taken into account with regard to the ATF and axle oil in the sports differential?

ÿ a) The ATF is only changed on RS models, all other models have an ATF lifetime filling. b) If the ATF is filled after a
ÿ repair, the system must be bled. c) The system must be bled using the vehicle diagnostic tester with
ÿ the "Fill ATF (hydraulic)" function. d) The axle oil is only changed on RS models, all other models have an axle oil lifetime filling.
ÿ

8. Which statements apply to the oil pressure and oil temperature sensors G437/G640?

ÿ a) The identity of a rear axle drive is determined by the identifiers of the two oil pressure and oil temperature sensors.
The axle drive can thus be unmistakably assigned to the all-wheel drive control unit J492.
ÿ b) The two oil pressure and oil temperature sensors are located directly on the all-wheel drive control unit. c) The
ÿ two oil pressure and oil temperature sensors monitor the clutch pressure of the respective controlled clutch.

9. Which statements apply to the hydraulic pump?

ÿ a) The hydraulic pump is controlled as needed, e.g. when a clutch is activated. b) The hydraulic pump is driven by
ÿ a permanently excited DC motor (V415). c) The hydraulic pump feeds the oil pressure into a storage volume. d) The
ÿ clutch pressure is controlled via the speed of the hydraulic pump.
ÿ

10. What are the functions of the two clutch valves for all-wheel drive N445/N446?

ÿ a) They determine the level of clutch pressure. b) They
ÿ are used to reduce the clutch pressure. c) They act as safety
ÿ valves because they are open when there is no current, so no unintentional pressure can build up.

11. Which components are located on the hydraulic control unit?

ÿ a) The clutch valves for all-wheel drive. b) The
ÿ control unit for all-wheel drive. c) Both oil
ÿ pressure and oil temperature sensors.

12. When must or should the hydraulic system be bled?

ÿ a) If the ATF needs to be topped up after work on the sport differential (function “Fill ATF (hydraulics)”). b) The function “b) Bleed
ÿ hydraulics” should also be used to assess the function of the sport differential. c) At every inspection service or when the system message “Sport
ÿ differential system fault” is displayed in the instrument cluster.
becomes.

13. What is the function of the two pressure relief valves?

ÿ a) They are used to vent the hydraulic system. b) They limit the
ÿ maximum pressure in the system. c) They limit the
ÿ maximum clutch torque.

14. Which bus systems are involved in the information exchange for the sports differential in the B8 series?

ÿ a) CAN chassis, CAN comfort and CAN drive. b) CAN
ÿ infotainment, CAN chassis and CAN drive. c) CAN chassis
ÿ sensors and LIN bus.

15. In which cases must the function of the two multi-disk clutches be checked using a vehicle diagnostic tester become?

ÿ a) If a customer complains that the sports differential is not working. b) Before replacing the
ÿ sports differential, to ensure that the sports differential is not replaced without authorization. c) A functional test must be carried out within
ÿ certain service intervals.

16. How does the sports differential react when trailer towing is detected?

ÿ a) For the duration of trailer operation, the sports differential switches from “dynamic” mode to “auto” mode. b) The effect of the
ÿ sports differential is switched off when a trailer is detected. c) The sports differential functions
ÿ without restrictions.

away; 16 a 1 c; 2c; 3a, c; 4 b; 5 b, c, d; 6 a, b; 7 a, b, c, d; 8 a, c; 9 a, b, d; 10 b, c; 11 a, c; 12 a, b, c; 13 a, b, c; 14 a, c; 15

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