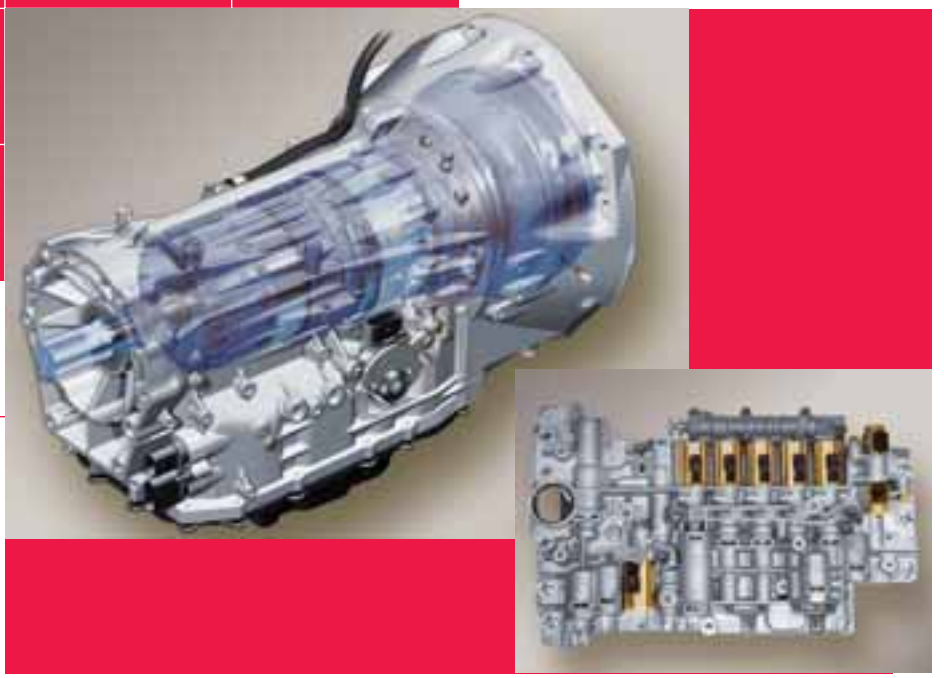
Service Training



The six-speed automatic gearbox 09D in the Audi Q7

Self-Study Programme 367

Contents

General

Gearbox subassemblies

Reference

For information about the basics of power transmission and the basic functions of automatic gearboxes, refer to the multimedia training CDs
"Power Transmission 1 - Basic Principles",
"Power Transmission 2 - Automatic Step Gearbox Mechanism" and
"Power Transmission 3 - Hydraulics Principles".

Use the training courses available under the "Power Transmission" Qualification Roadmap for your advanced training. For information on the "Power Transmission" qualification roadmap, refer to Audi ServiceNet.

Gearbox control unit

Gearbox periphery

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

The Self-Study Programme is not a Repair Manual!
The values given are intended as a guideline only and refer to the software version valid at the time of publication of the SSP.

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

Reference

Note

The six-speed automatic gearbox 09D in the Audi Q7

Unlike the usual Audi longitudinal AWD gearboxes, where the front axle differential and the transfer case are integrated in an automatic or manual gearbox, six-speed automatic gearbox 09D is designed as an independent component.

The power train of the Audi Q7 has a modular configuration. This means that the various sub-assemblies - the manual or automatic gearbox, the front axle differential and the transfer case - are separate units.

Note

In addition to the general descriptions of the 09D gearbox, this Self-Study Programme shows the special features of the gearbox in the context of the Audi Q7.

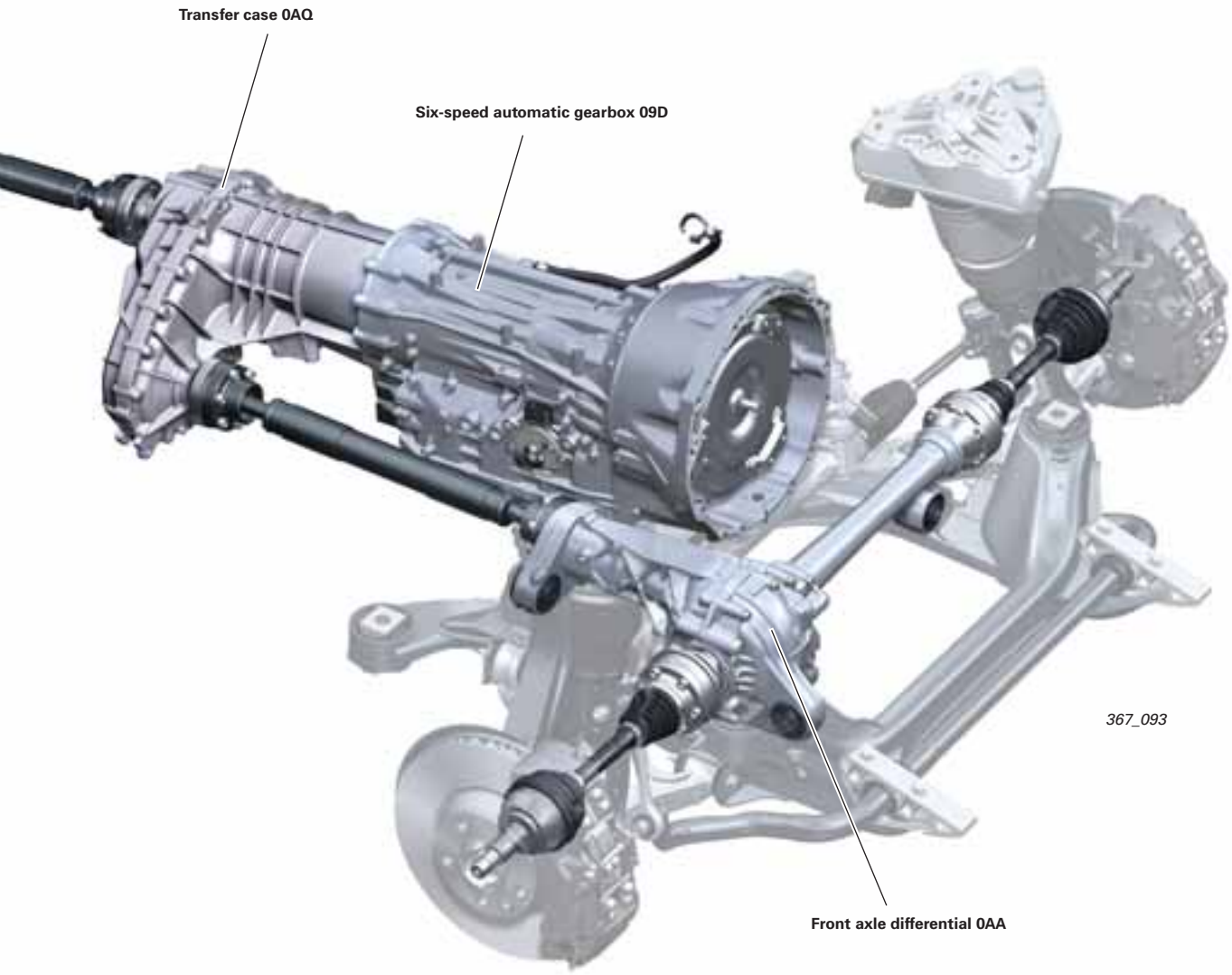
For information about power transmission in the Audi Q7 and transfer case 0AQ, refer to SSP 363.

The 09D gearbox is related to six-speed automatic gearbox 09G (refer to SSP 291).

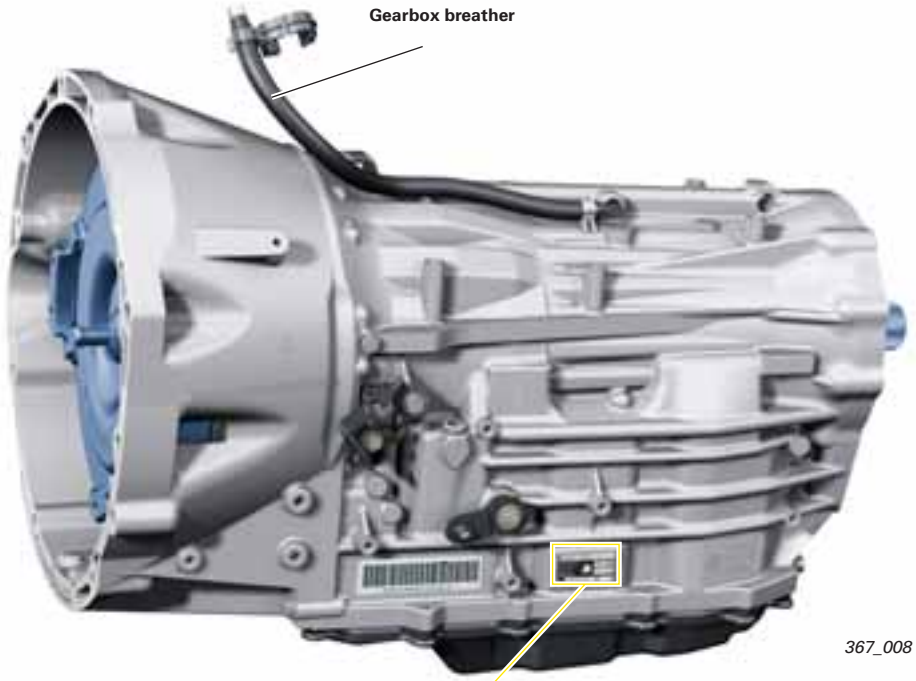
The 09D gearbox is a modern six-speed automatic gearbox of the conventional type.
It derives from the VW Touareg, in which it has been very successful, and is notable in particular for its compact build and robustness. The 09D gearbox can transmit up to 750 Nm of engine torque, and is currently used in combination with the most powerful engines in the Audi Q7.

Special features designed for off-road use

- A special low ATF intake point and a high ATF capacity ensure reliable oil intake in rough terrain.
- A large ATF cooler maintains the ATF temperature at a safe level.
- The elevated gearbox breather hose prevents ingress of water into the gearbox, even under adverse conditions.
- A large torque converter with lockup clutch reduces heat build-up in the ATF and allows power to be transmitted directly.



Specifications



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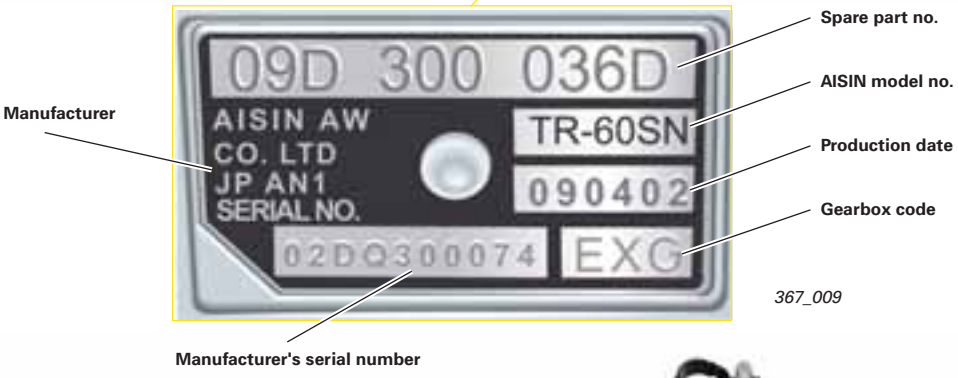
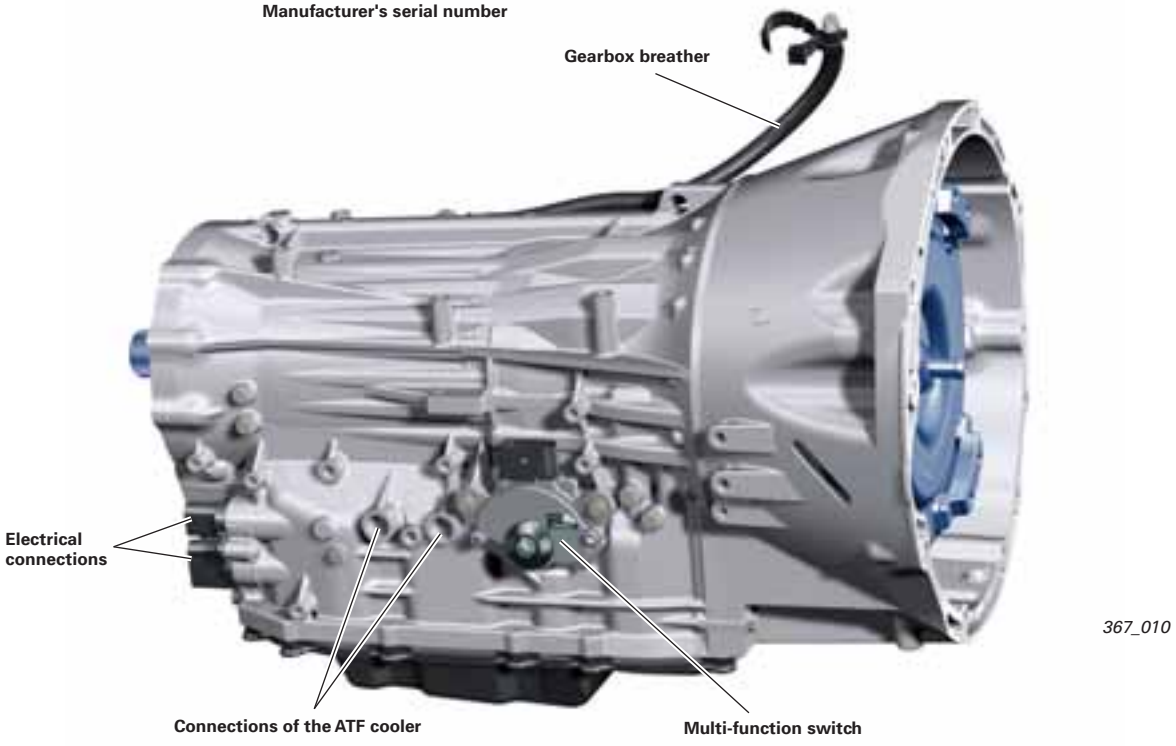


367_009



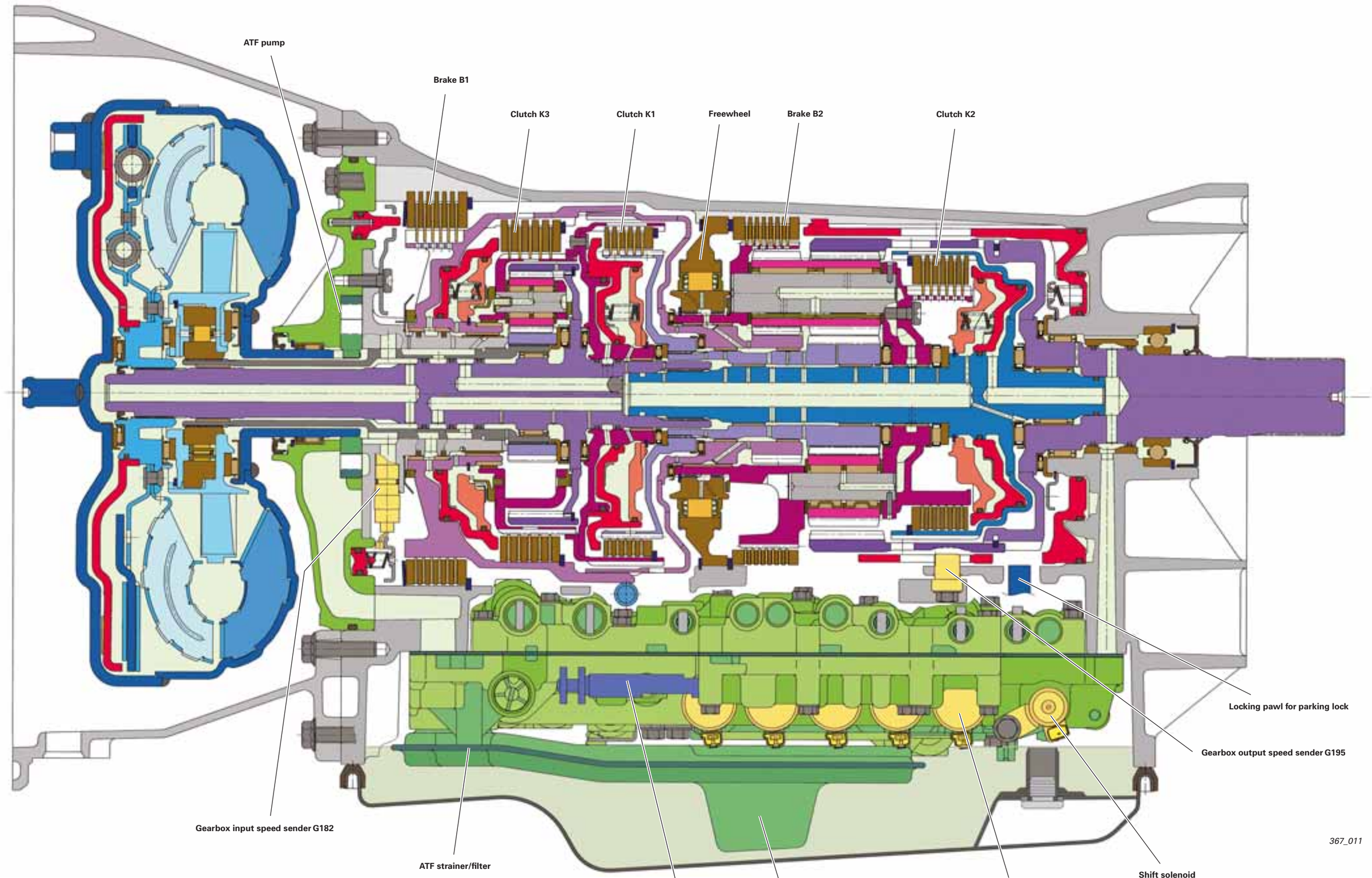
367_010

Specifications	
Developer/manufacturer	AISIN AW CO. LTD Japan
Designations	Manufacturer: TR-60SN Audi AG: AL750-6Q Service: 09D
Gearbox type	– Electro-hydraulically controlled six-speed planetary gear (step automatic gearbox) with a planetary gear set concept based on the Lepelletier principle – Hydrodynamic torque converter with slip-controlled lockup clutch – Designed for longitudinal installation in combination with a transfer case
Control	Hydraulic control unit (valve assembly) in the oil sump with external electronic control unit Dynamic Shift Program (DSP) with separate sport program in "position S" and tiptronic shift program for manual gear shifting (optionally available with tiptronic steering wheel) Special feature: in tiptronic mode, it is possible to start insecond gear.
Max. torque in Nm	up to 750 Nm depending on type
Ratios: **Planetary gearbox**	1st gear 4.148 2nd gear 2.370 3rd gear 1.556 4th gear 1.155 5th gear 0.859 6th gear 0.686 R gear 3.394
Spread*	6.05
ATF specification	refer to Electronic Parts Catalogue
ATF service	approx. 9.0 litres (new filling) lifetime filling
Weight in kg	between 97 kg and 110 kg, depending on engine power*
Run flat capability	3rd gear and R gear

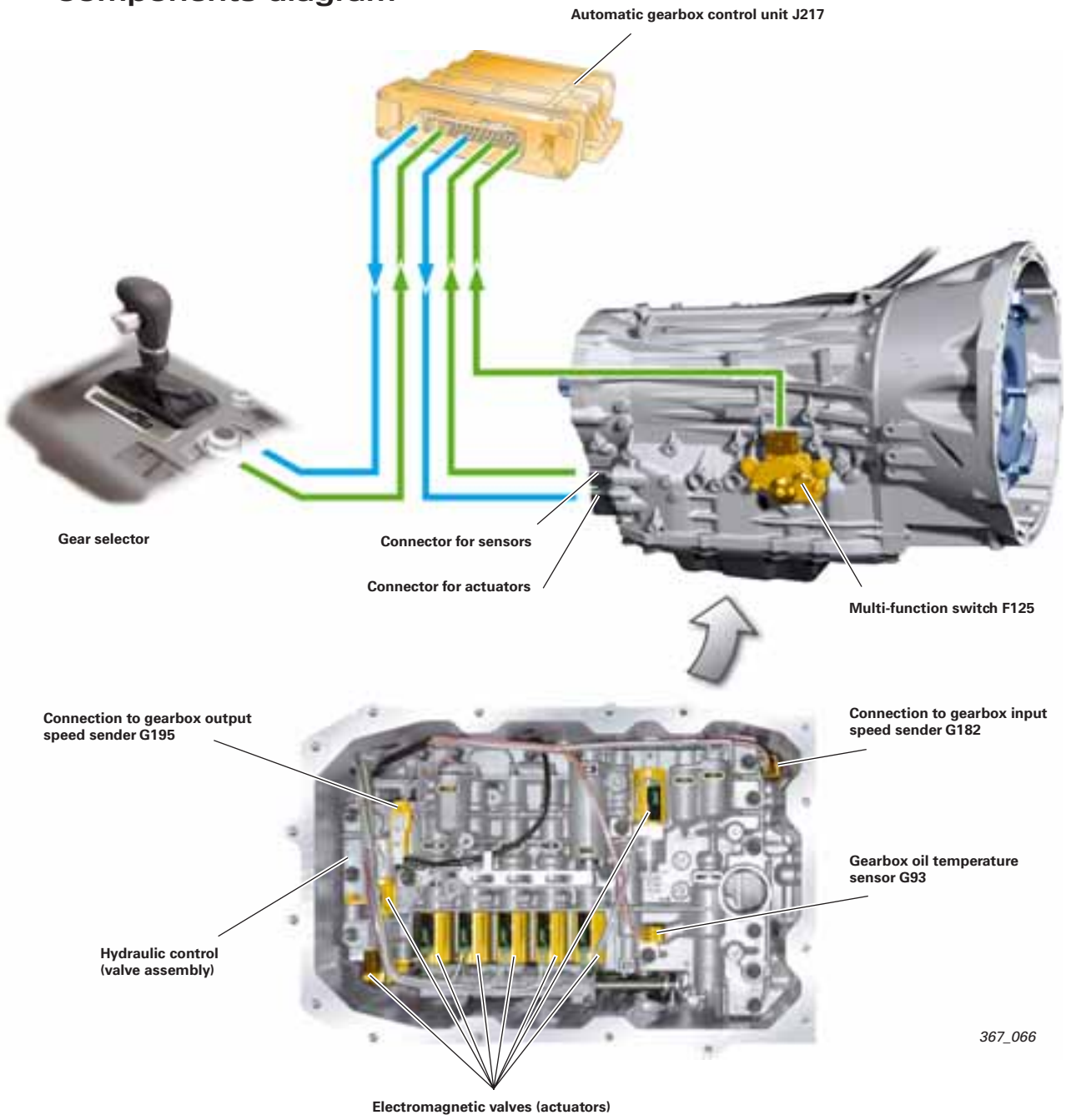
Reference

* you will find explanations of the marked terminology / paragraphs on page 69.

Cutaway view of gearbox 09D



Components diagram



Bottom view of the gearbox - looking at the hydraulic control (valve assembly)

Legend to sectional view of gearbox

- Hydraulic parts, hydraulic control, ATF
- Components of the planetary gear sets
- Shafts and gears
- Multi-plate clutches, bearings, washers and circlips
- Plastics, seals, rubber and washers
- Components of the shift elements Cylinders, pistons and air sensor plates
- Housings, screws and bolts
- Electrical components

Torque converter

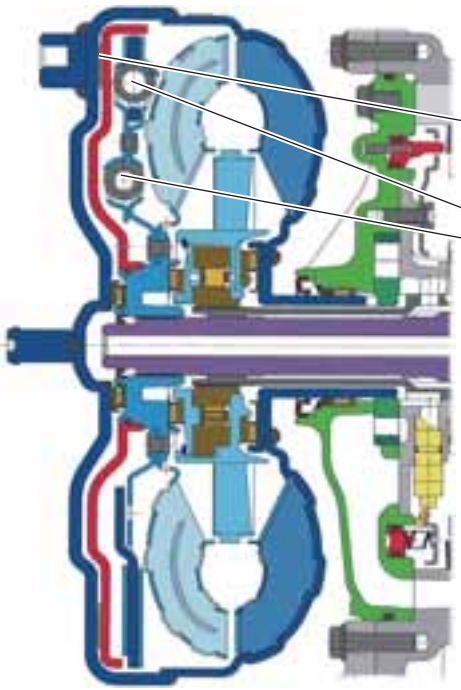
In an 09D gearbox, torque is transmitted from the engine to the gearbox by a hydrodynamic torque converter with slip-controlled lockup clutch.

Different types of torque converter are used depending on engine power output and characteristics.

They differ in respect of their...

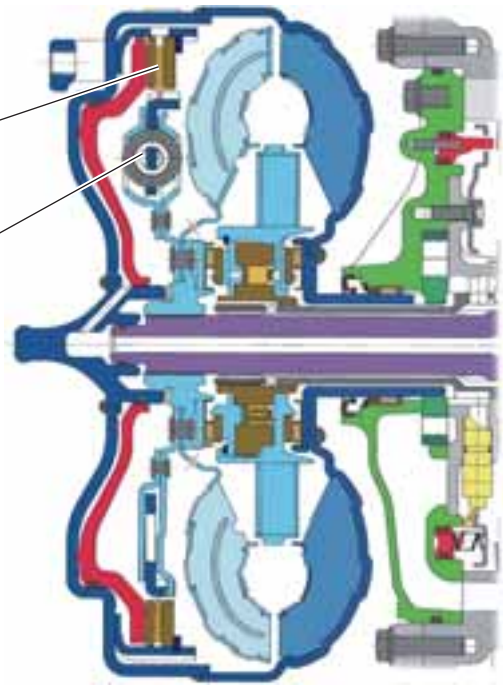
... size (capacity),
... torque conversion factor,
... torque converter characteristic,
... torsion damper and
... lockup clutch configuration.

Configuration: V8FSI engine



367_075

Configuration: V6TDI engine



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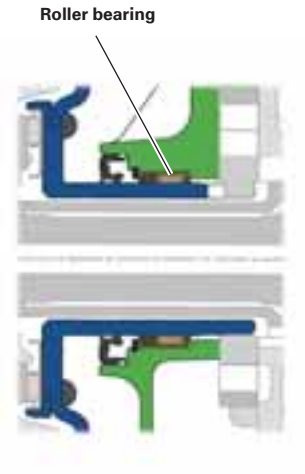
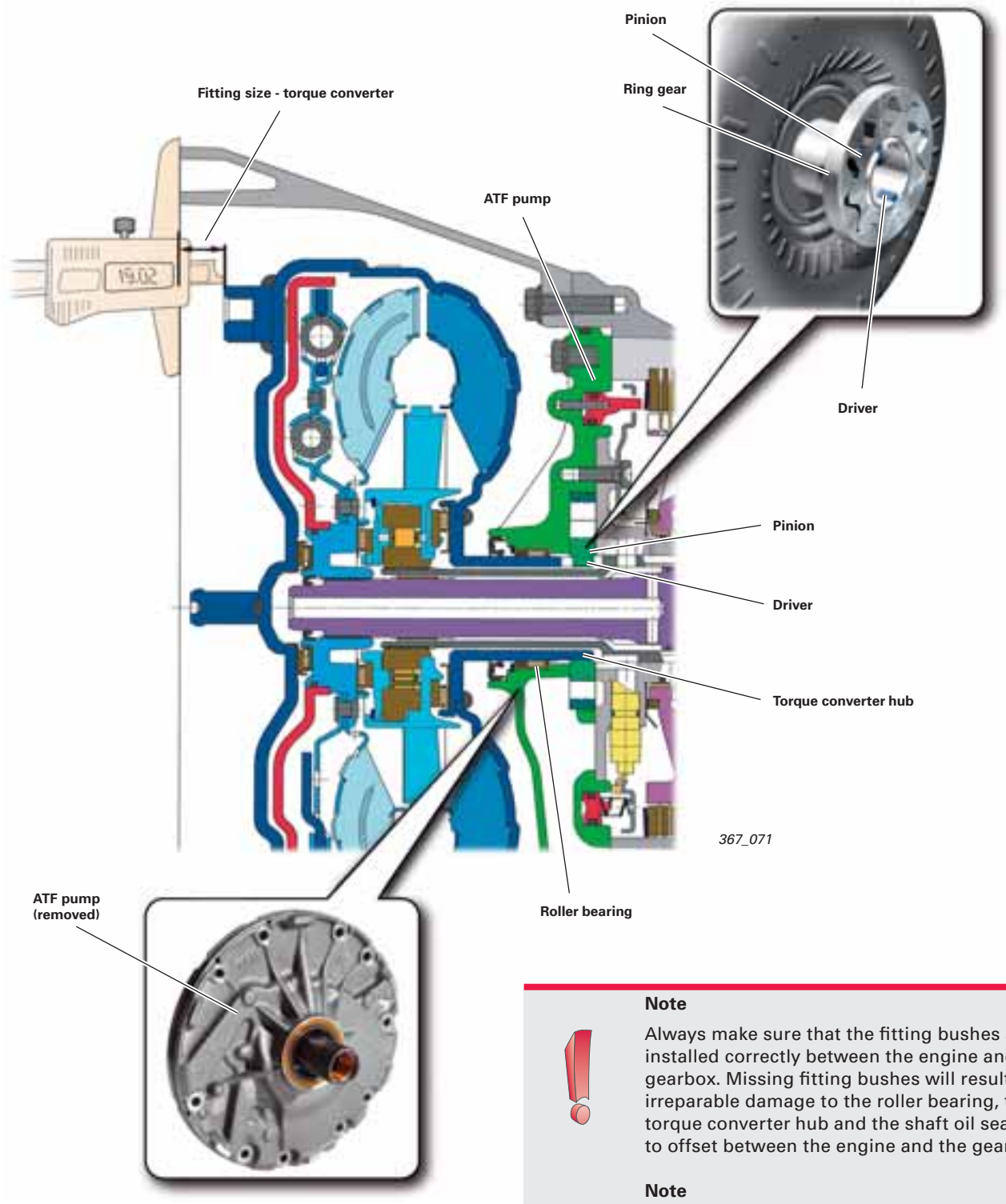
Mounting

The torque converter runs in a wear resistant roller bearing . This design provides a durable mounting particularly in operating states with slow oil feed (e.g. during cold starting).



367_077

Mounting instructions



Reference

You will find information about the basic functions of the torque converter in multimedia training course "Power Transmission 2".

Note

Always make sure that the fitting bushes are installed correctly between the engine and the gearbox. Missing fitting bushes will result in irreparable damage to the roller bearing, the torque converter hub and the shaft oil seal due to offset between the engine and the gearbox.

Note

When installing the torque converter and before installing the gearbox, special care must be taken to ensure that the ATF pump drivers engage properly into the driver grooves on the torque converter hub.
This can be checked by measuring the installed position of the torque converter (refer to the Workshop Manual).

Torque converter lockup clutch

Design

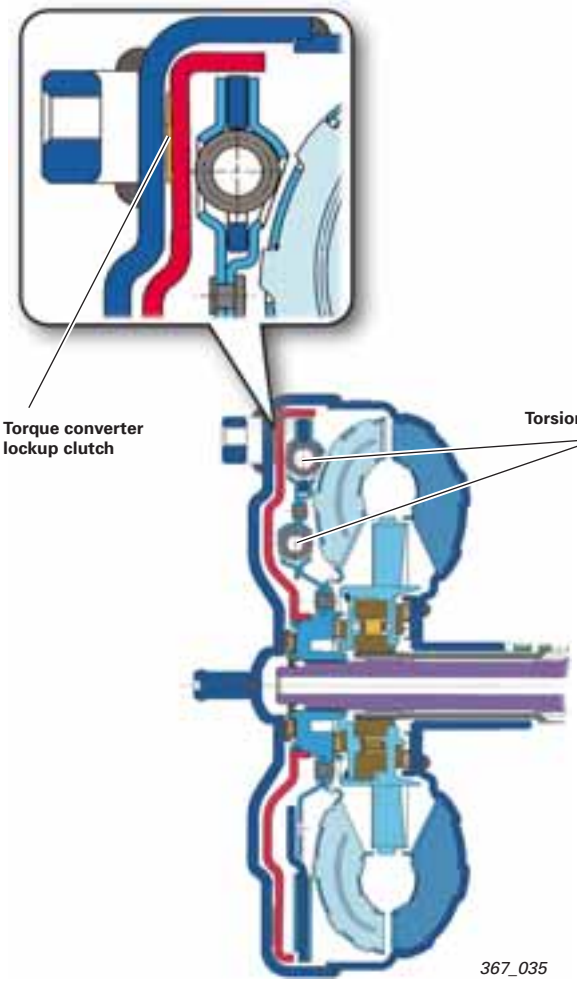
The torque converter has a lockup clutch with integrated torsion dampers.
The torsion dampers reduce torsional vibration when the torque converter lockup clutch is closed. This allows the operating range "converter lockup clutch closed" to be extended.

Basically, distinctions are made between the following functional states:

- converter lockup clutch - open
- converter lockup clutch - controlled operation
- converter lockup clutch - closed

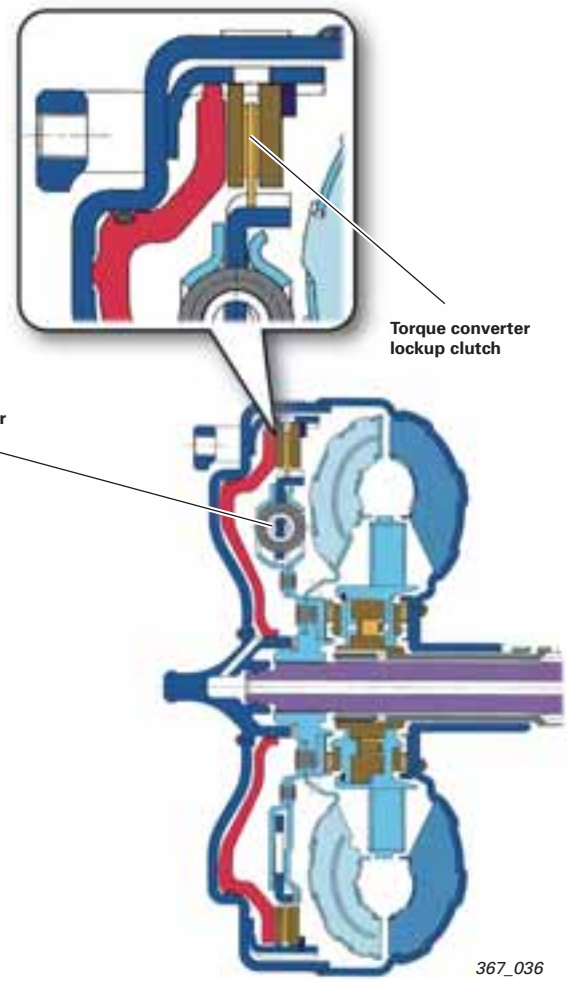
During normal vehicle operation, the lockup clutch is engaged in 4th gear and higher (upwards of speeds of approx. 40 kph).

Configuration: V8FSI engine



367_035

Configuration: V6TDI engine



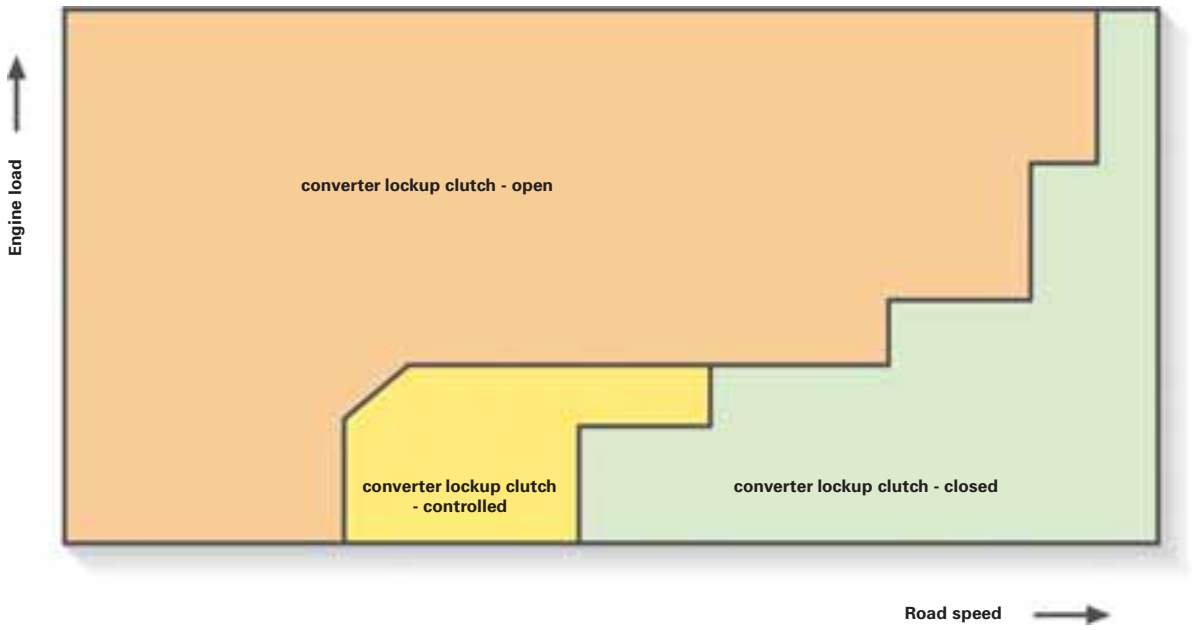
367_036

Reference

For more detailed information about the basic design and function of the torque converter lockup clutch, refer to SSP 283.

Controlled operation

At defined operating points, the lockup clutch is operated with a low slip (controlled operation). Controlled operation provides better fuel economy than with the converter lockup clutch open, and better ride comfort than with the converter lockup clutch closed.



367_039

In tiptronic mode and in the "S" program, the converter lockup clutch is closed at the earliest possible moment. The direct frictional engagement between the engine and the gearbox accentuates the sporty driving feel.

In the hill-climbing program, the converter lockup clutch is closed in 3rd gear.

In the Hotmode program, the lockup clutch is no longer operated in a controlled manner, but is closed early to reduce heat transfer due to friction in the lockup clutch and hydrodynamic power transmission.

Hotmode program: refer to page 48

Oil supply/lubrication

ATF (Automatic Transmission Fluid)

As mentioned previously, taking the drive concept of the Audi Q7 as a basis, the 09D gearbox is designed as an independent component, without the usual integrated transfer case and front axle differential.
This is why the 09D gearbox only has a single ATF oil supply.

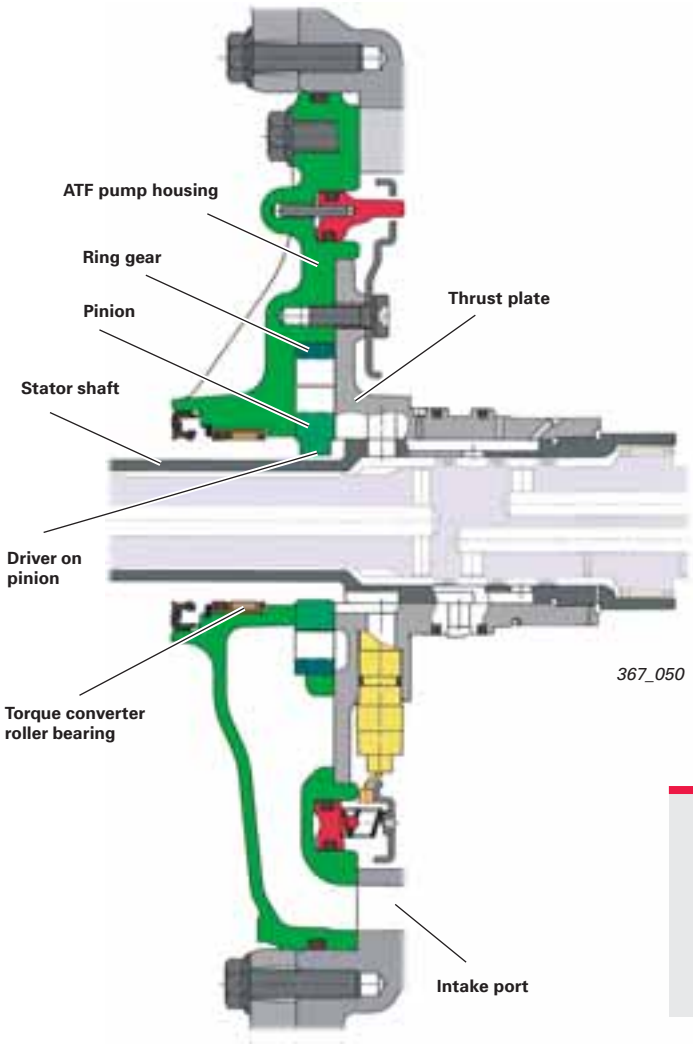
The exacting requirements with regard to shift quality, functional reliability and ease of maintenance put extreme demands on the ATF.

The ATF is a key factor influencing the coefficient of friction of the clutches and brakes.
For this reason, ATF development is carried out in parallel with the design and testing phases.
It is logical, therefore, that the 09G gearbox should use a special, advanced ATF.

No ATF change is normally needed within the maintenance intervals (lifetime filling).
If the ATF has to be changed after repairs or for some other reason, the adaption values must be cleared and an adaption drive performed. Refer to the chapter "Gearbox adaption" on page 56.

A requirement for proper functioning of the gearbox is use of the prescribed ATF (refer to the Electronic Parts Catalogue).
The filling system (V.A.G 1924) must be free of contaminant ATF residues.

ATF pump



367_050

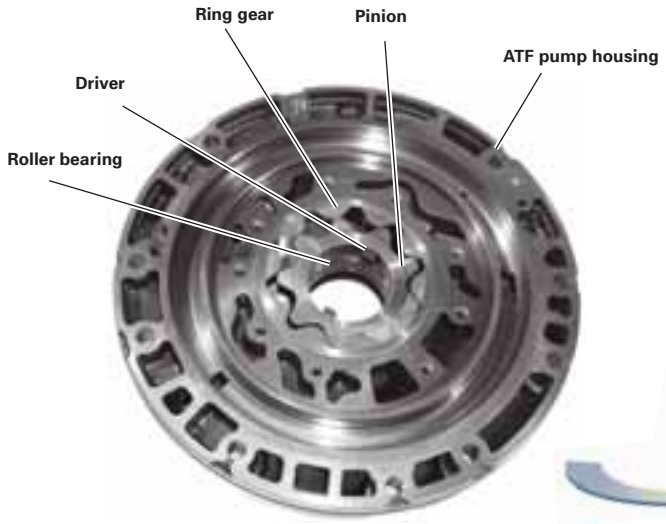
ATF pump (fully assembled)

367_052

Note

The ATF is red-coloured. There is a danger of confusing it with other ATF fluids.

For this reason, use a separate filling system for each type of ATF.



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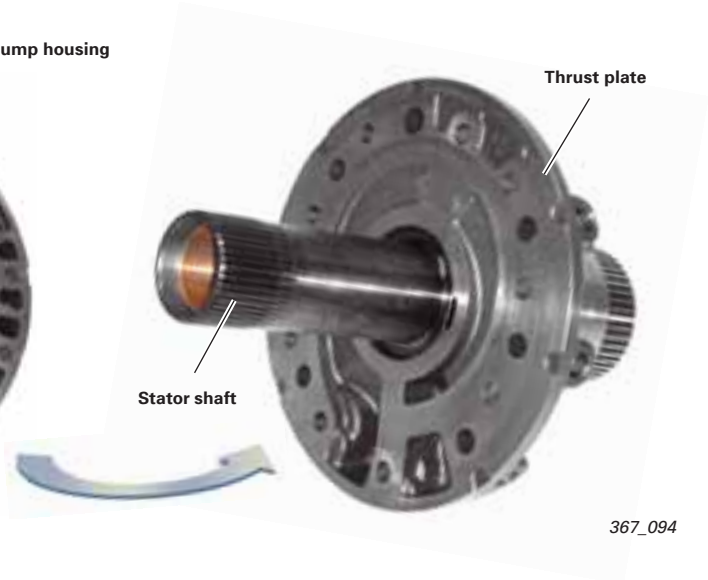


367_094

One of the key components of an automatic gearbox is the ATF pump.
The gearbox cannot function properly without a sufficient supply of oil.

The ATF pump is designed as an internal gear pump (duocentric pump).

It is directly driven by the engine (at engine speed) via the converter housing and the converter hub. Two driver grooves on the torque converter hub engage the pinion drivers. The torque converter hub runs on low-friction bearings in the pump housing.

367_074

Note

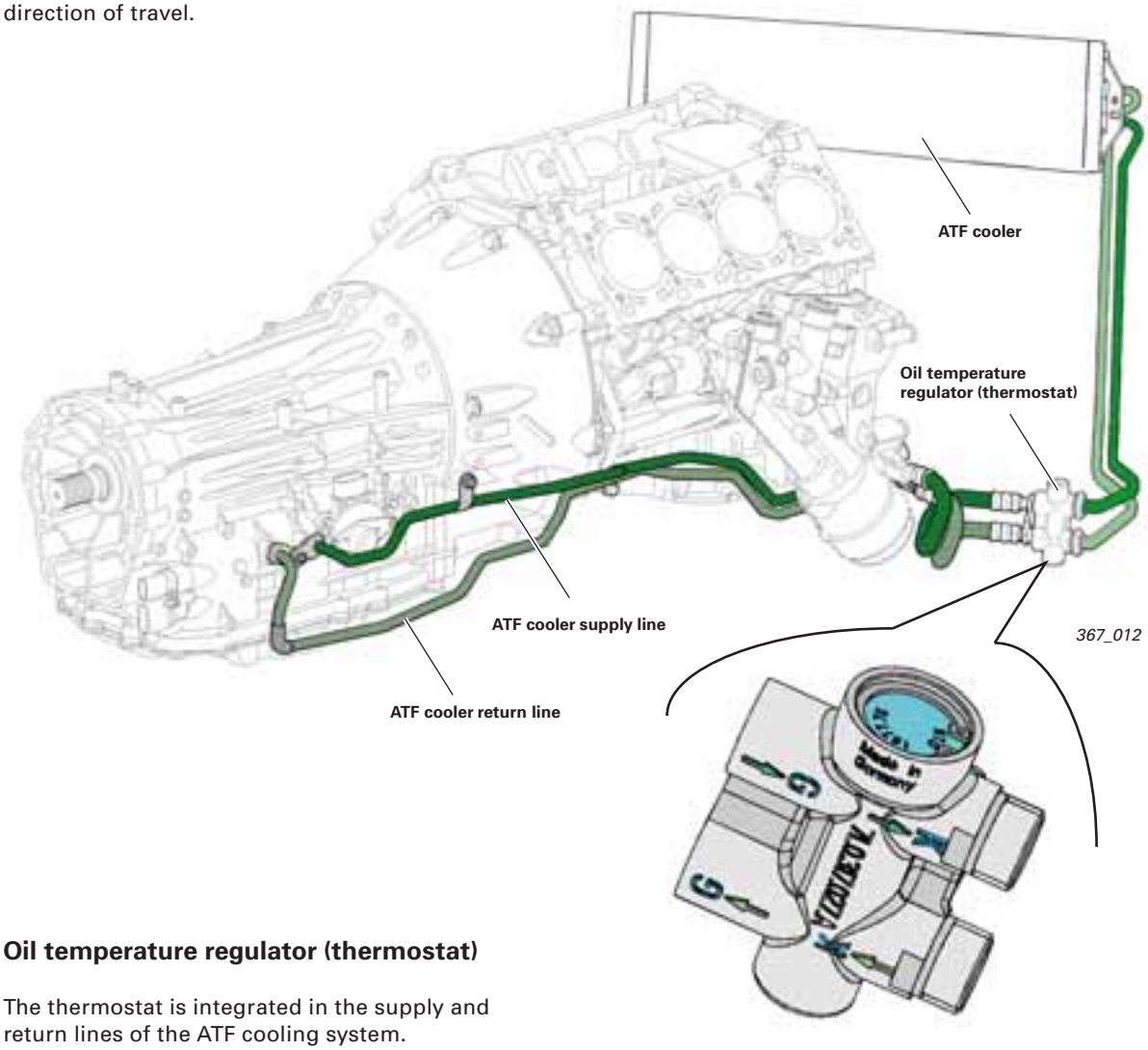
When installing the torque converter and before installing the gearbox, special care must be taken to ensure that the ATF pump drivers engage correctly into the grooves on the torque converter hub. This can be checked by measuring the installed position of the torque converter (refer to the Workshop Manual).

Note

Always make sure that the fitting bushes are installed correctly between the engine and the gearbox. Missing fitting bushes will result in irreparable damage to the roller bearing, the torque converter hub and the shaft oil seal due to offset between the engine and the gearbox.

ATF cooling

ATF cooling is thermostat-controlled by means of an oil-to-air heat exchanger (ATF cooler).
The ATF cooler located in front of the engine cooler and the air conditioning compressor, as seen in the direction of travel.

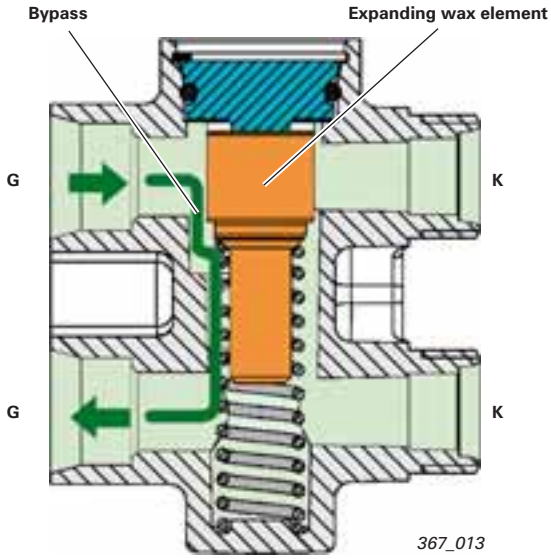


Oil temperature regulator (thermostat)

The thermostat is integrated in the supply and return lines of the ATF cooling system.
An expanding wax thermostat with integrated bypass (bypass thermostat) is used.

Note

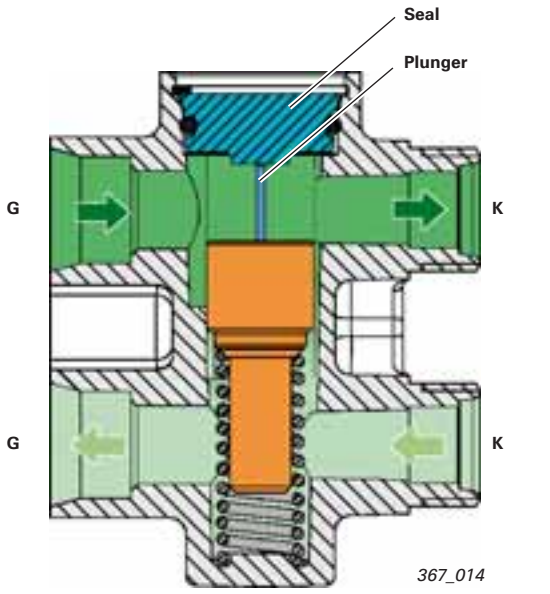
Please note that impurities in the ATF (e.g. abrasion, chips, emulsions) are distributed throughout the ATF cooling system and deposit here. The cooling system must, therefore, be flushed thoroughly before repair or replacement.
For this purpose, the lines must be disconnected from the thermostat and the cooler in order to rinse the individual components.
Make sure that all contaminants are removed.
If in doubt, components such as the ATF cooler or thermostat must be replaced.
Residual contaminants will lead to further complaints and damage the gearbox.



G = from or to gearbox
K = from or to cooler

Thermostat closed

The expanding wax element also acts as the thermostat slide valve and regulates the ATF feed to the cooler. In the closed state, a small fraction of the ATF flows through the bypass, thereby heating the expanding wax element.
At a temperature of approx. 75 °C, the plunger of the expanding wax element begins to press downwards against the force of the spring, thereby opening the inlet to the cooler (see next figure).



Thermostat open

At a temperature of approx. 90 °C, the thermostat is fully open.

Note

Contaminants can clog the thermostat bypass, thereby impairing the function or disabling the thermostat.
This can cause the gearbox to overheat!
At an ambient temperature of 25 °C and during normal vehicle operation, the ATF temperature barely exceeds 110 °C.

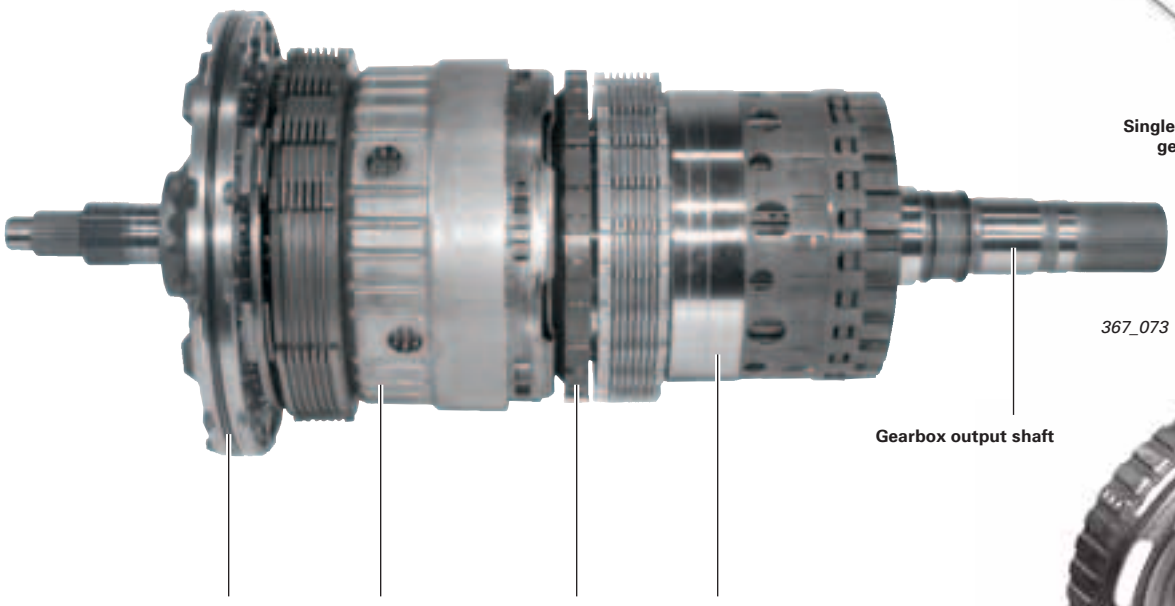
Note

If the cooling system has been opened to carry out repairs (thereby draining the ATF cooler), the ATF temperature must be raised to at least 90 °C by carrying out a test drive in order to set the ATF level correctly.
This ensures that the ATF cooler is filled. The ATF level must be set after the ATF has cooled down to normal test temperature (refer to Workshop Manual).

Planetary gearbox

The 09D gearbox is based on the Lepelletier planetary gear set concept (6 forward gears and R gear).

The Lepelletier planetary gear set is based on a single planetary gear set (primary planetary gear set) and a Ravigneaux planetary gear set further down the drive train (secondary planetary gear set).



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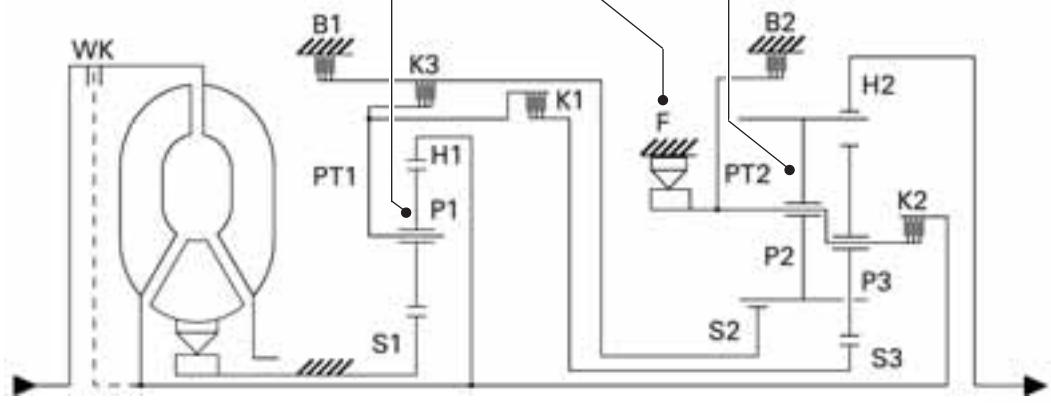


367_022

Reference

You will find explanatory notes on the schematic diagram of the planetary gearbox on page 22 and in SSP 283 on page 55.

367_016

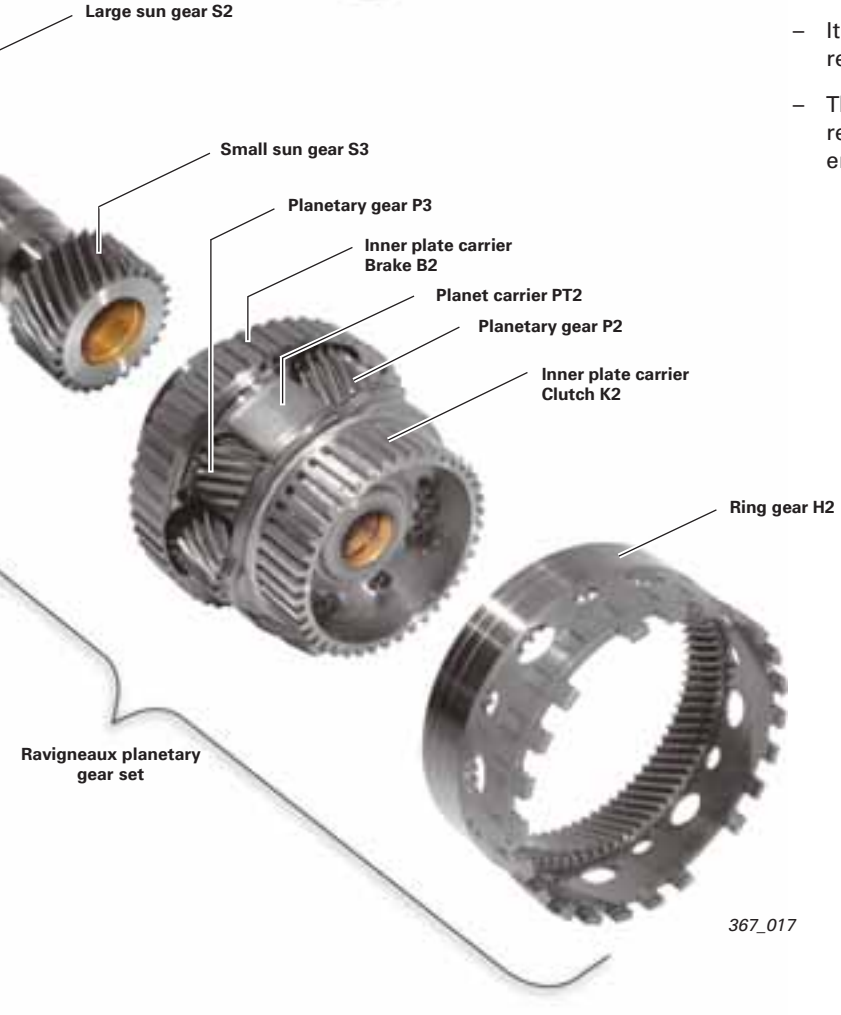
The special feature of the Lepelletier planetary gear set is that the sun gears and the planet carrier of the Ravigneaux gear set are driven at different speeds. This allows a large number of ratios to be realised.

The sun gears of the Ravigneaux gear seat are driven at the reduced output speed of the single planetary gear set.
The planet carrier of the Ravigneaux gear seat is driven at gearbox input speed.

A further special feature of the Lepelletier planetary gear set is that only 5 shift elements are required for engaging all six forward gears and reverse.

Advantages of the Lepelletier planetary gear set concept

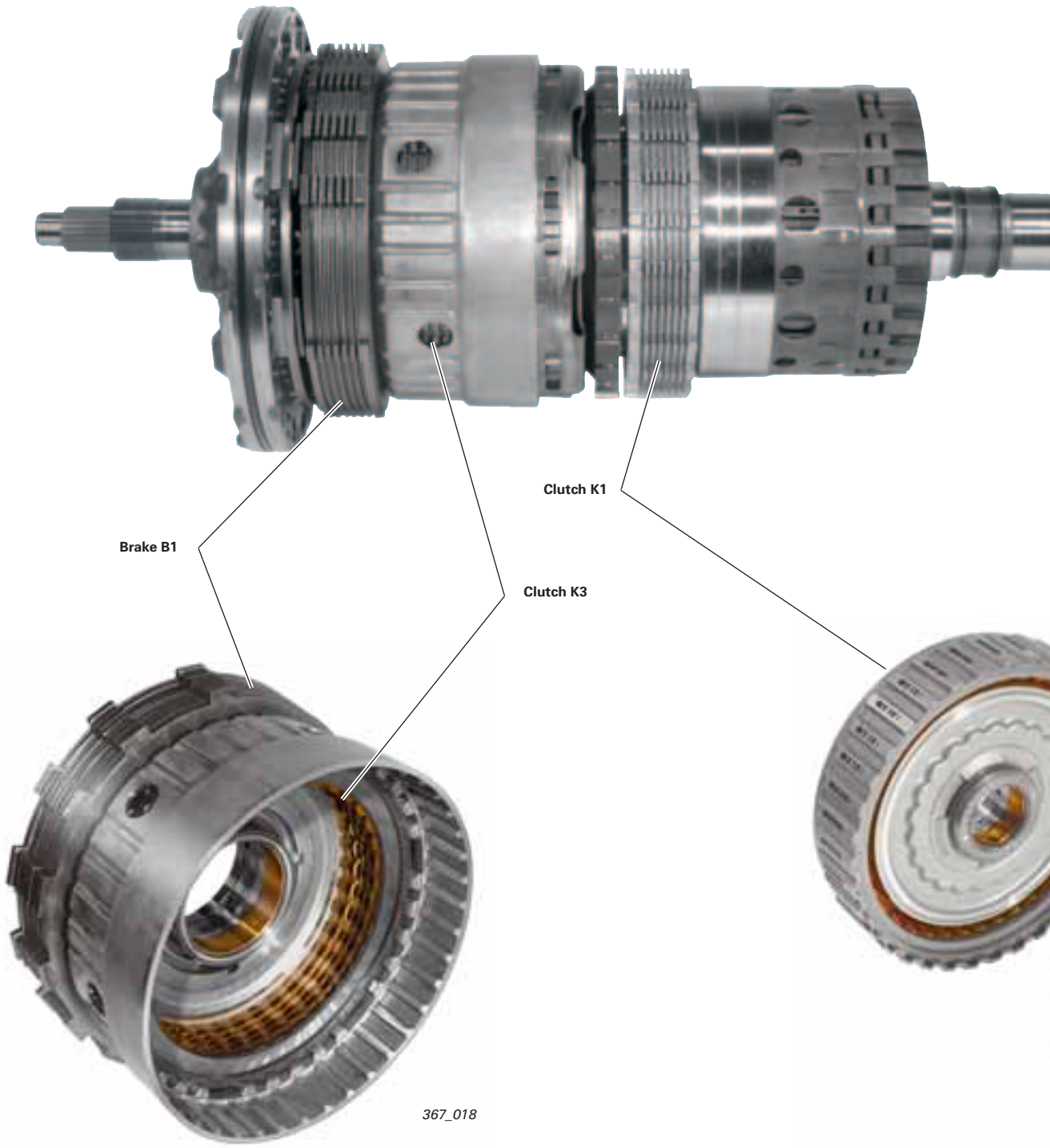
- It allows a very compact design, despite a wider ratio spread and more gear steps.
- It has much fewer components, significantly reducing weight and cost of manufacture.
- The wide ratio spread, the closer ratios and the reduced number of gear shifting components ensure a high level of efficiency.



367_017

Shift elements

A continuous flow of power and different ratios can be obtained in a planetary gear set by introducing torque into a corresponding component (e.g. on the planet carrier) and holding a different component stationary (e.g. the sun gear) or interconnecting two components of a planetary gear set (e.g. connecting the planet carrier to the sun gear).



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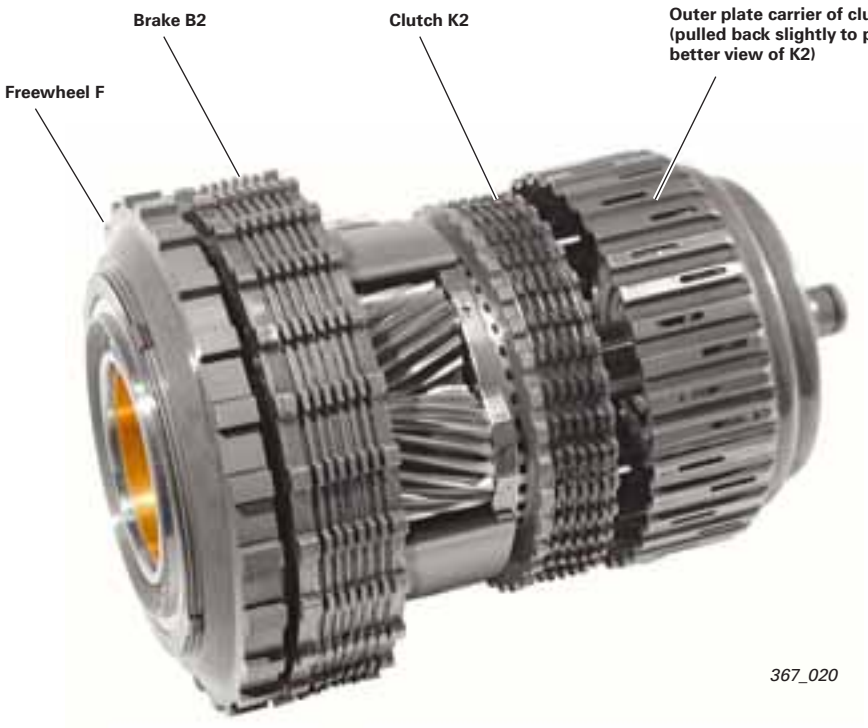
367_073



367_020

367_019

Inner plate carrier, clutch K1

These tasks are performed by the so-called shift elements (clutches/brakes). The shift elements, in combination with the planetary gear sets, establish a flow of power and execute gear shifts under load, without any interruption in tractive power.

The following shift elements are fitted:

- three planetary multi-plate clutches (K1, K2 and K3)
- two fixed plate brakes (B1 and B2)
- one freewheel (F)

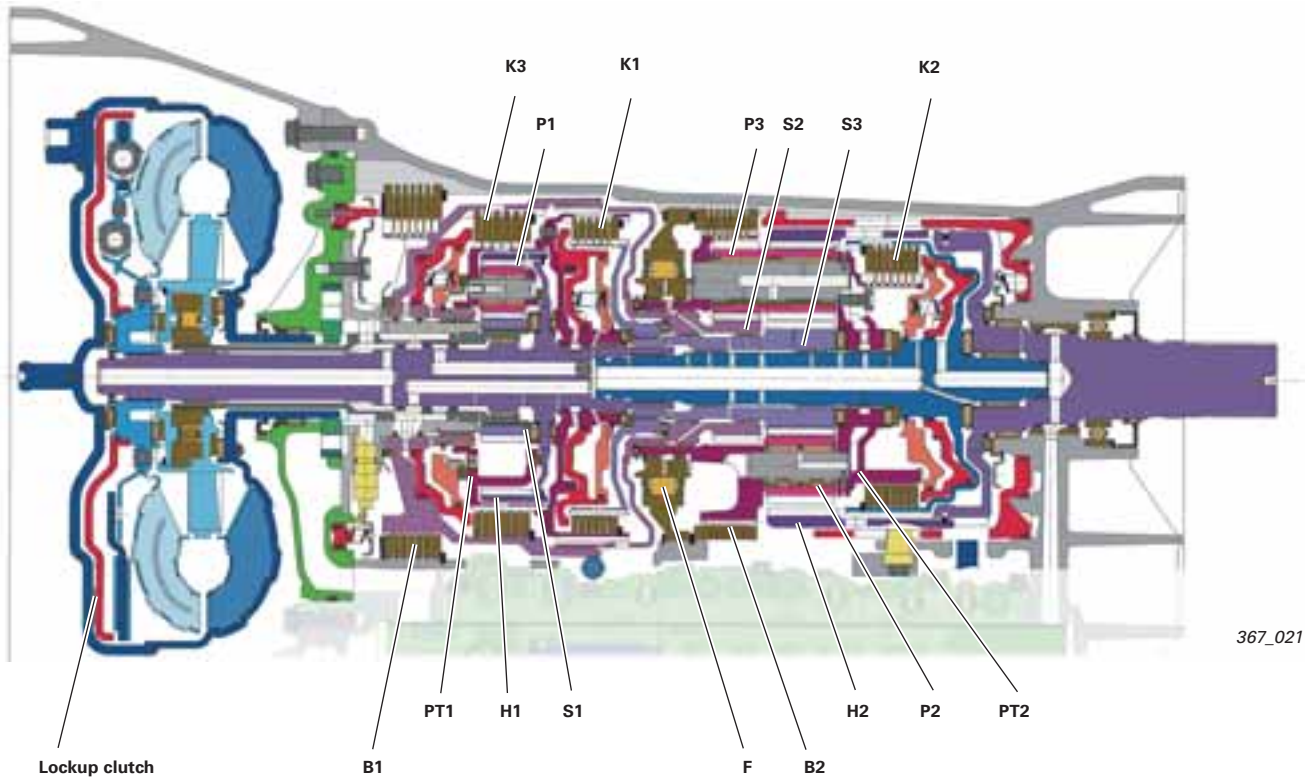
Clutches K1, K2 and K3 introduce engine torque into the planetary gearbox.
All clutches have a dynamic pressure compensation function, which the result that clutch response is independent of engine speed (refer to page 26).

Brakes B1 and B2 or freewheel F maintain a torque balance at the gearbox housing.

All clutches and brakes are activated indirectly by the electronic pressure control valves.

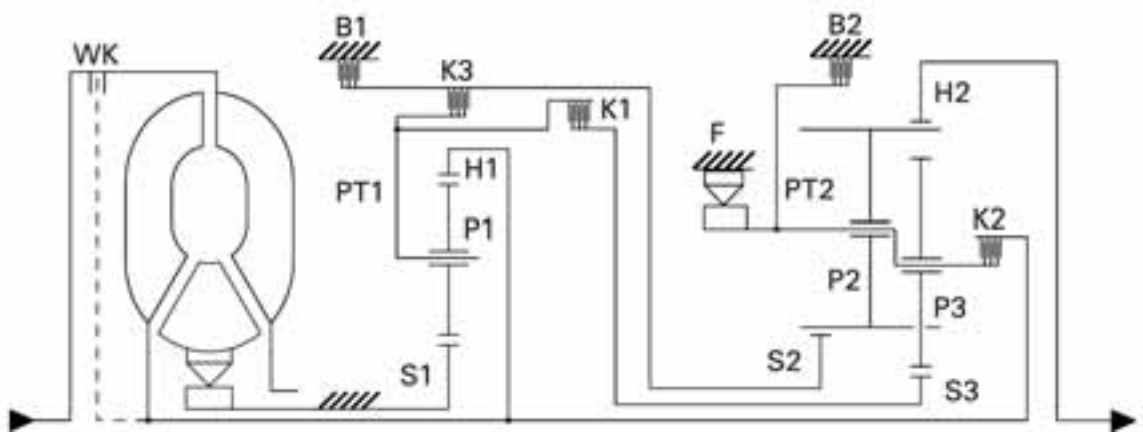
Freewheel F, which is also a shift element, is arranged in parallel with brake B2.
During automatic operation, it takes over the function of brake B2. The freewheel simplifies electro-hydraulic shift control when selecting gears and when shifting up and down between 1st and 2nd gear (refer to pages 27, 30 and 31).

Overview of planetary gearbox/shift elements



367_021

Schematic power flow diagram



367_022

Primary planetary gear set

Component:			connected to:
H1	–	Ring gear 1	Turbine shaft (drive)/clutch K2
P1	–	Planetary gears 1	Power transmission in planetary gear set
S1	–	Sun gear 1	Stationary
PT1	–	Planet carrier 1	Clutches K1 and K3

Secondary planetary gear set

Component:			connected to:
H2	–	Ring gear 2	Output
P2	–	Planetary gears 2, long	Power transmission in planetary gear set
P3	–	Planetary gears 3, short	Power transmission in planetary gear set
S2	–	Sun gear 2, large	Clutch K3/brake B1
S3	–	Sun gear 3, small	Clutch K1
PT2	–	Planet carrier 2	Clutch K2/brake B2/freewheel F

Clutches, brakes, freewheel

Component:			connects or task:
K1	–	Clutch 1	Planet carrier PT1 (primary gear set) connected to small sun gear S3 (secondary gear set)
K2	–	Clutch 2	Turbine shaft (input) connected to planet carrier PT2 of the secondary planetary gear set
K3	–	Clutch 3	Planet carrier PT1 (primary gear set) connected to small sun gear S2 (secondary gear set)
B1	–	Brake 1	Holds the large sun gear S2 (secondary gear set) stationary
B2	–	Brake 2	Holds planet carrier PT2 (secondary gear set) stationary
F	–	Freewheel	holds the planet carrier PT2 (secondary gear set) stationary counter to the direction of rotation of the drive Used when driving under throttle in 1st gear (no engine brake).

Converter lockup clutch

367_031

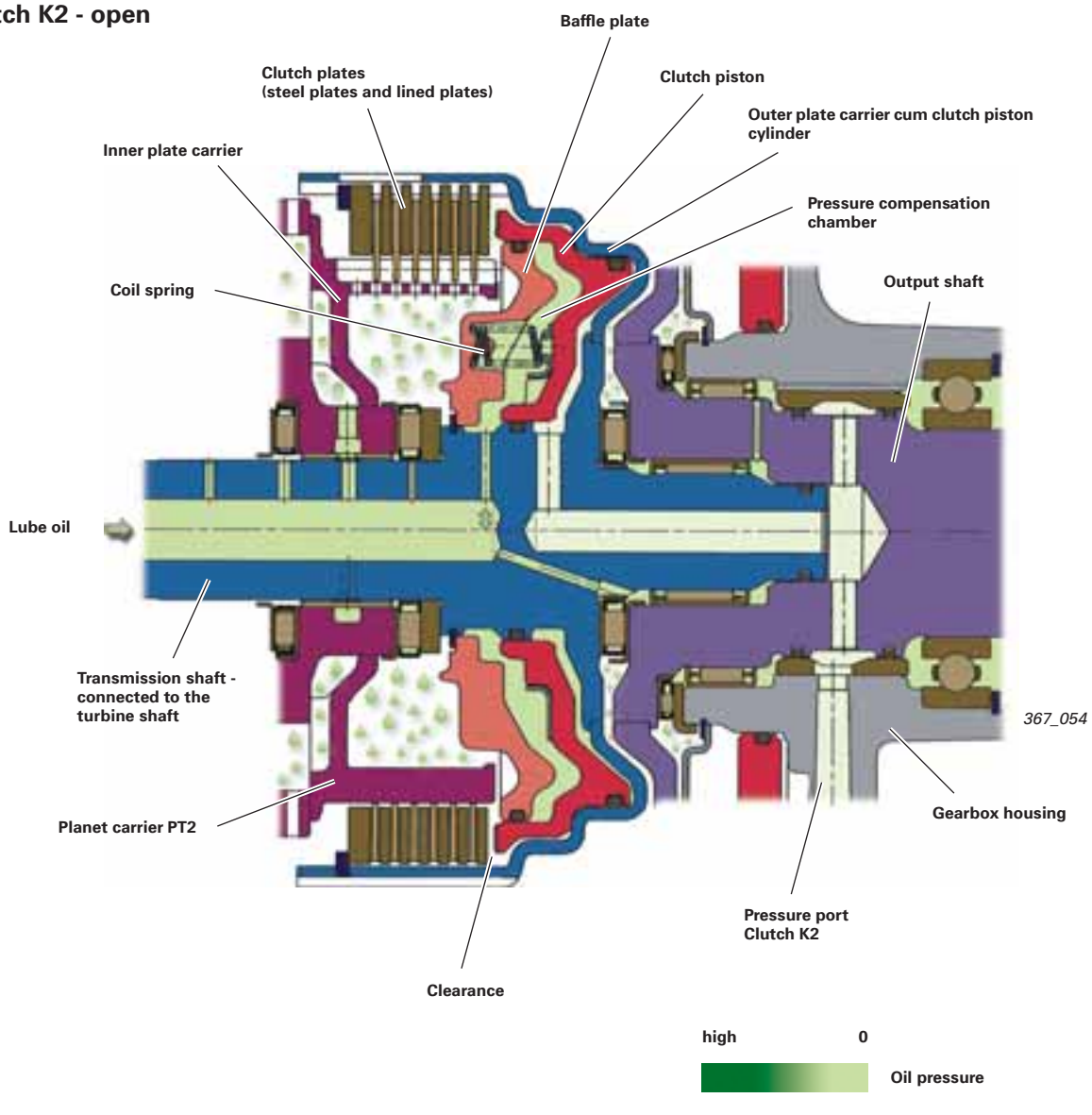
Function of the shift elements

Clutches and brakes

The function of the shift elements is explained here using clutch K2, which is exemplary of clutches K1 and K3, as well as brakes B1 and B2.
Unlike the clutches, the brakes require no dynamic pressure compensation, because their clutch pistons and cylinders are non-rotating, and therefore are not subject to a dynamic increase in pressure (refer to page 26).
The shift elements are actuated hydraulically. Pressure oil is supplied to the shift elements by the valve assembly through stationary and rotating ports in the gearbox housing, on the shafts and other components.
Lube oil is supplied to the bearings and the shift elements in the same way.

The clutch plate carriers are perforated, allowing the oil (ATF) to flow through each clutch from the inside outwards (normally when the clutch is open). The design of the lined plates and the centrifugal force are both conducive to oil flow through the clutches.

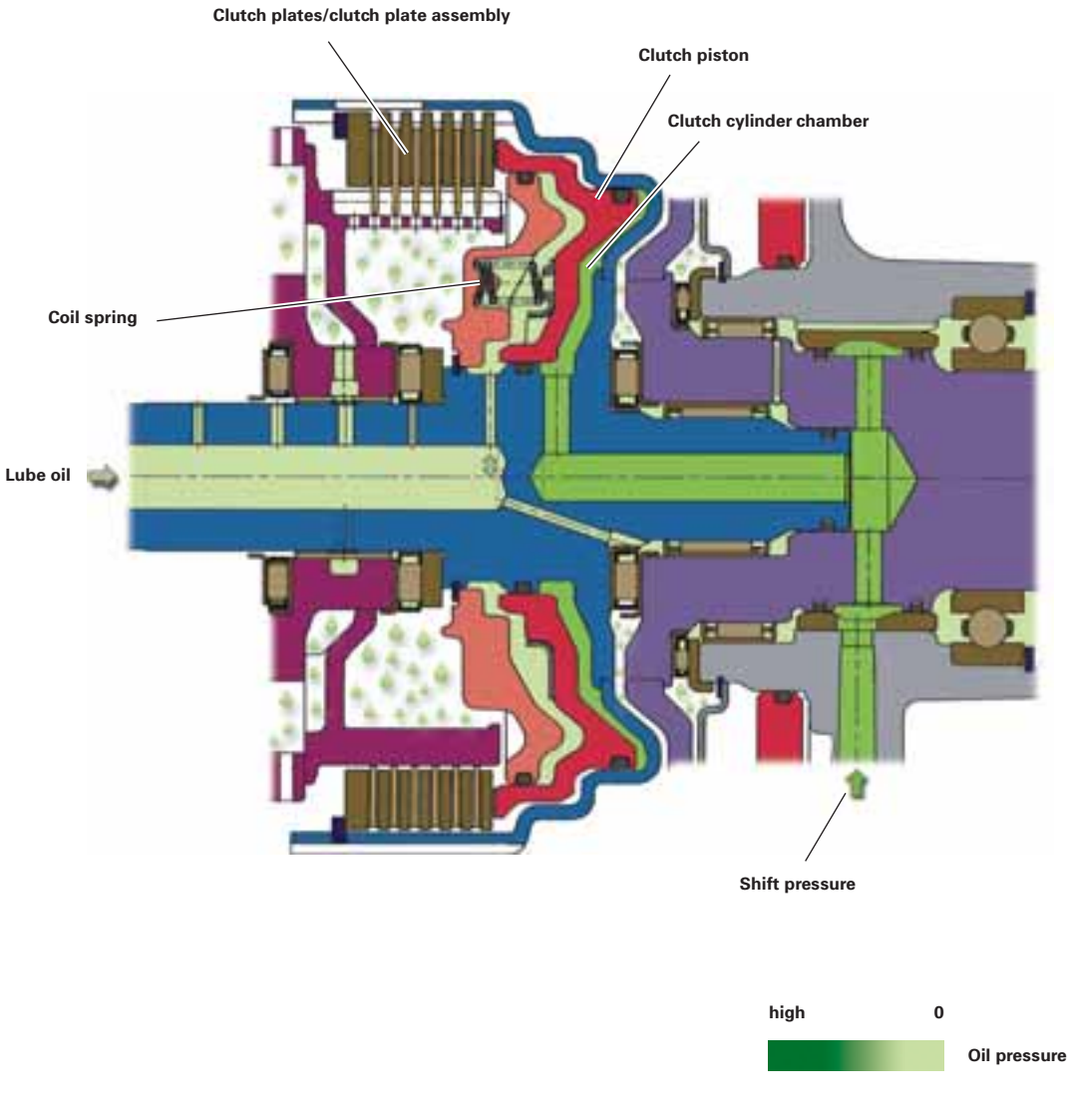
Clutch K2 - open



In order to close the clutch, oil pressure is admitted into the clutch cylinder chamber. The clutch piston compresses the clutch plate assembly, and the clutch engages when the required oil pressure is reached. If the clutch cylinder chamber is pressure-less, the clutch piston is forced back into its initial position by spring pressure (in this case, by multiple coil springs). A clearance is maintained between the clutch piston and the clutch plate assembly in order to minimise friction when the clutch is open.

In order to match transmission efficiency to the engine as best possible, the number of clutch plates is adapted to the engine power output. Drag losses of open clutches are thus kept to a minimum.

Clutch K2 - closed

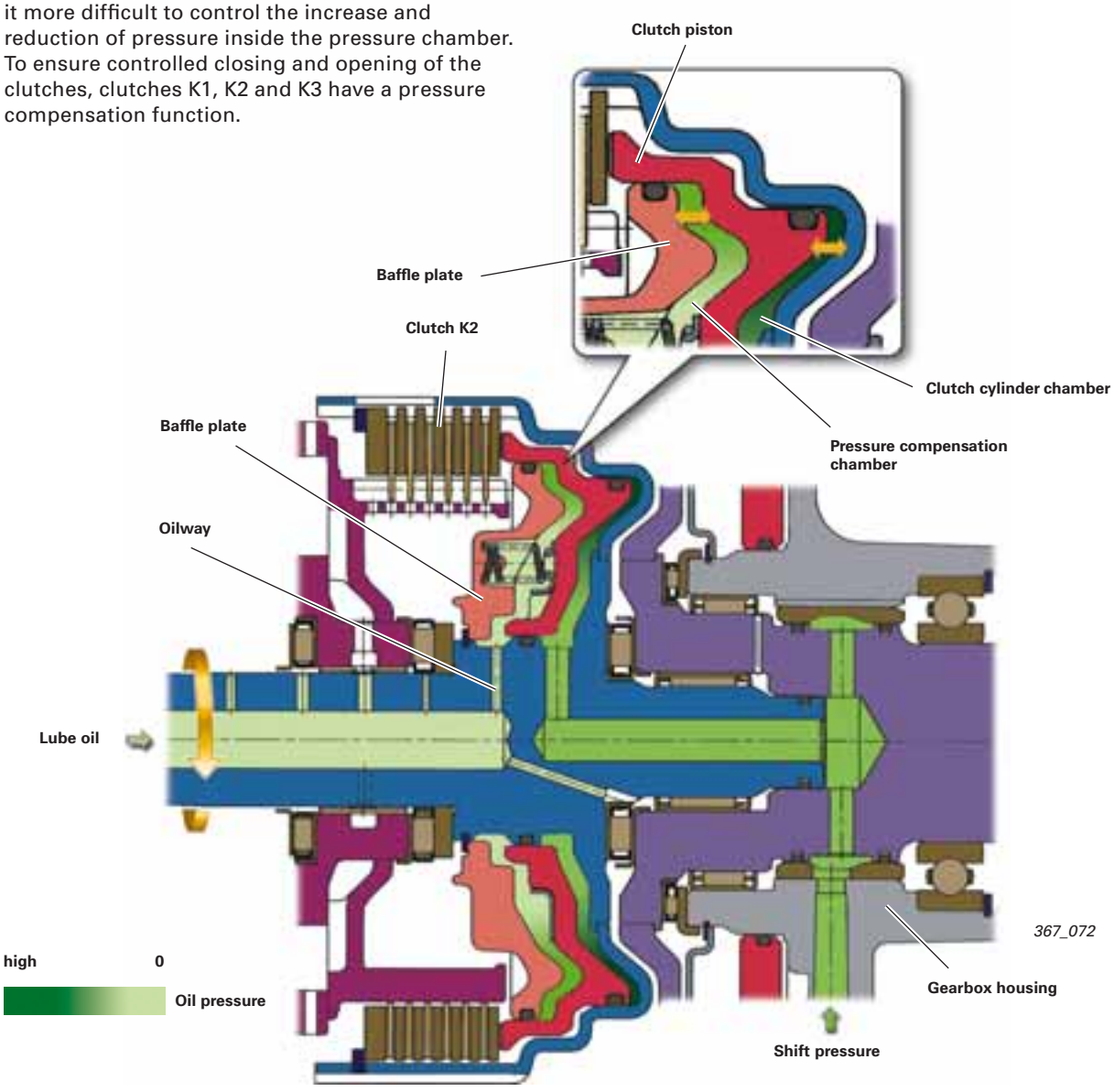


367_084

Dynamic pressure compensation in the clutches

At high engine speeds, due to rotation, the oil is subject to high centrifugal forces inside the clutch cylinder chamber.
This causes the pressure inside the clutch cylinder chamber to increase towards the largest radius. This process is referred to as "dynamic pressure increase".
Dynamic pressure increase is best avoided, because it unduly increases the surface pressure and makes it more difficult to control the increase and reduction of pressure inside the pressure chamber.
To ensure controlled closing and opening of the clutches, clutches K1, K2 and K3 have a pressure compensation function.

It allows gearshifts to be controlled precisely, and this, in turn, greatly enhances shift comfort. Leaks in the pressure equalisation chamber can, at high engine speeds, lead to uncontrolled frictional engagement of the clutch and damage it.



Principle/mode of operation explained using clutch K2 as an example

The clutch pistons are swept by ATF on both sides. This is implemented by means of the baffle plate. The baffle plate creates a sealed space leading to the clutch piston. This space is referred to as the pressure compensation chamber. The pressure compensation chamber is filled with low pressure via an oilway branching off the lube oil line.

The ATF in the pressure compensation chamber is subjected to the same centrifugal forces (dynamic pressure increase) as the ATF in the clutch cylinder chamber. This compensates for the increase in force acting upon the clutch piston (due to dynamic pressure increase).

Freewheel

The freewheel transmits torque in one direction of rotation only. No torque is transmitted in the opposite direction.
In the 09D gearbox, the freewheel is used for driving away in 1st gear. The freewheel holds planet carrier PT2 stationary and thus allows power to flow (refer to page 31).

Principle/mode of operation

The freewheel in the 09D gearbox is a so-called sprag type freewheel. It consists of an outer ring (positively connected to the gearbox housing), an inner ring (positively connected to planet carrier PT2) and sprags located between the inner and outer rings. The sprags are asymmetrically shaped and accommodated in the space between the inner and outer rings.

Direction of rotation

In the direction of rotation of the planet carrier (inner ring), the sprags change their orientation without creating any resistance, on account of their shape.

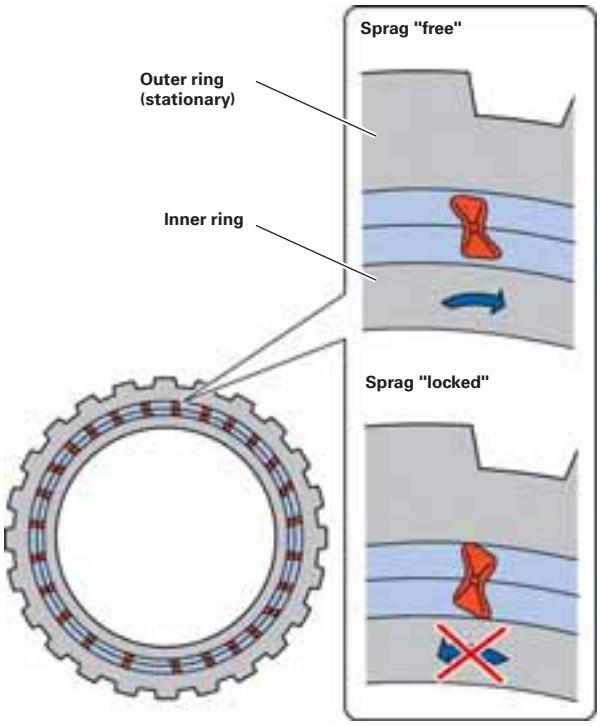
Locking direction

In the locking direction of the planet carrier (inner ring), the sprags erect themselves on account of their shape, and fill the annular space between the inner and outer rings in such a way that the inner and outer rings are positively engaged. In this instance, the planet carrier is held stationary, since the outer ring is, in turn, positively connected to the gearbox housing.

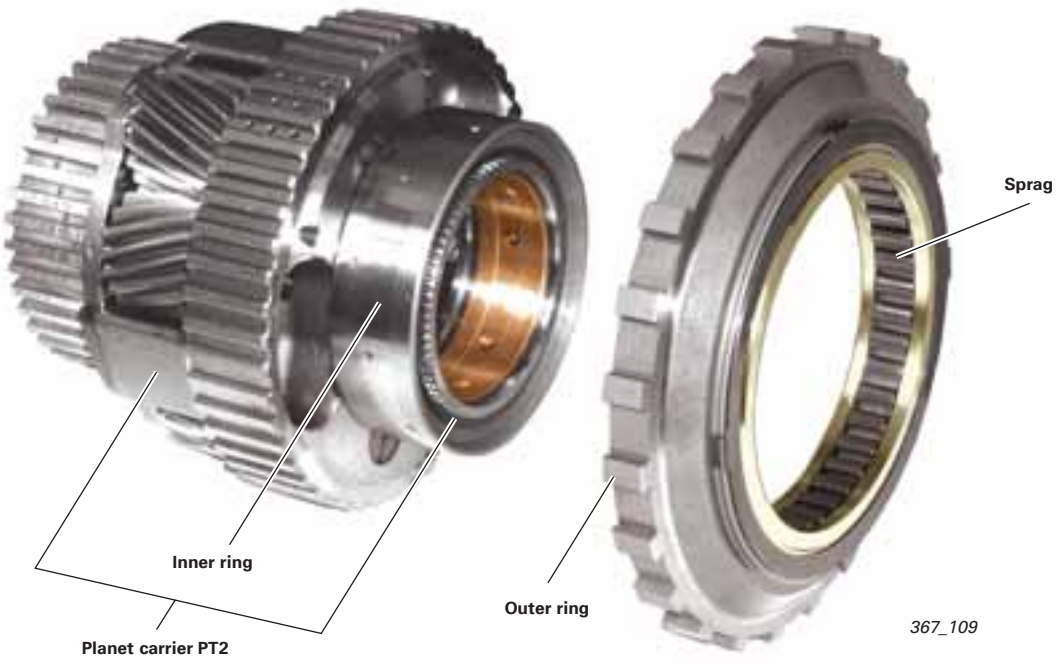
Note

Due to the freewheel, no engine braking effect is available in 1st gear during normal automatic operation.

If the freewheel is faulty, no power flow will be possible in 1st gear during normal automatic operation. In this case, a flow of power can be achieved by selecting 1st gear using the tiptronic function (refer to page 32).



367_110



367_109

Hydraulic control

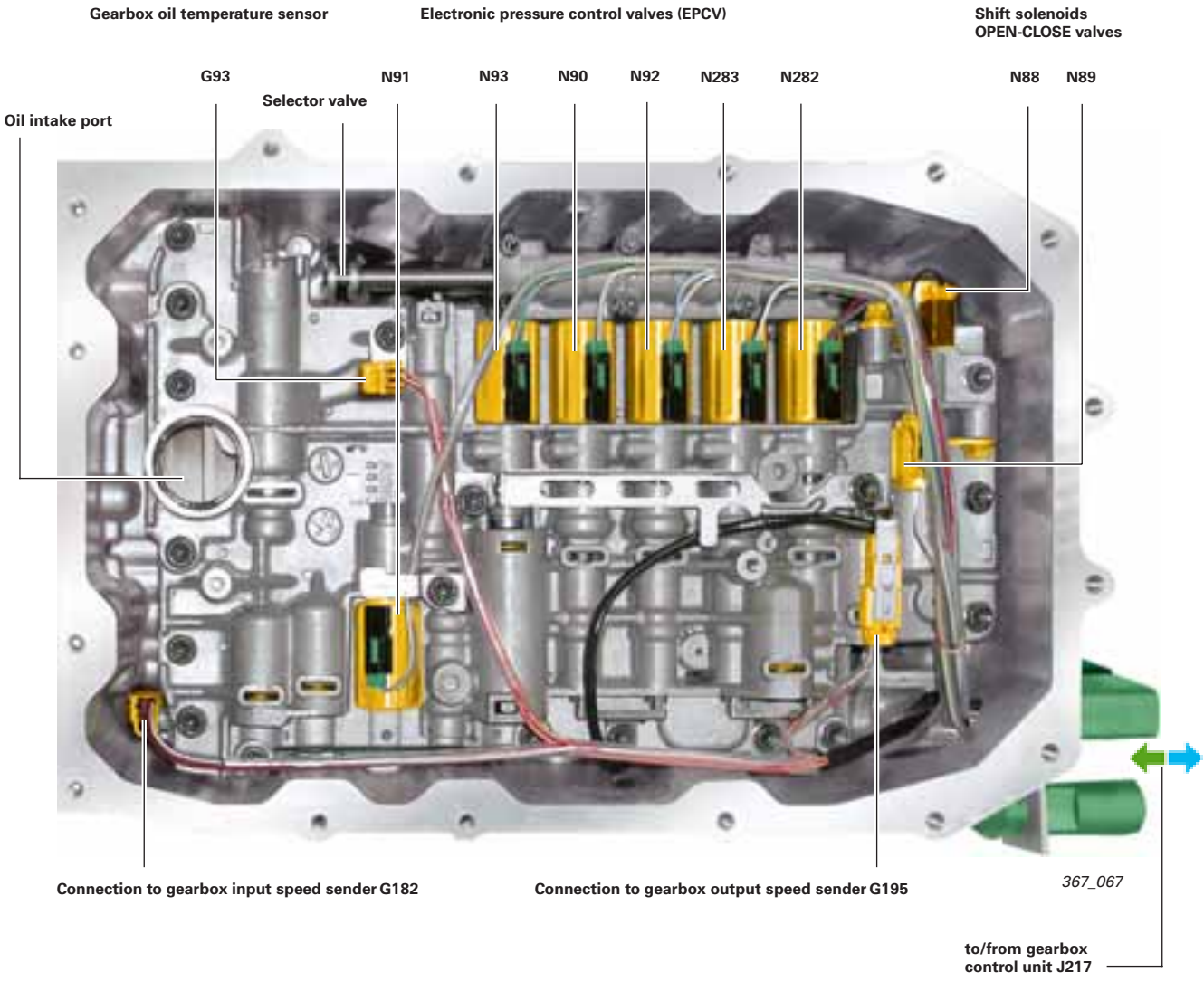
Valve assembly

The clutches and brakes (shift elements) are controlled by the valve assembly by means of hydraulic shift control valves (so-called gate valves). The gate valves are controlled by electromagnetic valves, which, in turn, are activated by the automatic gearbox control unit J217.

In addition to the shift elements, the valve assembly controls the lockup clutch and the various pressures throughout the gearbox (e.g. main pressure, control pressure, torque converter pressure, lubricating pressure etc.). The valve assembly is largely responsible for oil supply and therefore for proper functioning of the gearbox.

The valve assembly comprises the following components:

- the mechanically actuated selector valve
- the hydraulic shift control valves
- two electrically controlled shift solenoids (3/2-way valves)
- six electronic pressure control valves (modulating valves) and
- the gearbox oil temperature sensor



Bottom view of valve assembly

Electromagnetic valves

In the case of the electromagnetic valves, a distinction is made between shift solenoids with two switching positions (OPEN - CLOSE) and electronic pressure control valves (known as EPCVs or modulating valves).

The shift solenoids (N88/N89) are so-called 3/2 way valves or OPEN-CLOSE valves.
3/2 valve means the valves has 3 connections and 2 switching positions (open/closed or OPEN–CLOSE). These valves are used for switching hydraulic shift control valves.

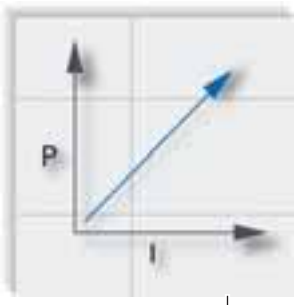
The electronic pressure control valves (EPCV) convert an electrical current to a proportional, hydraulic control pressure. This control pressure, in turn, activates hydraulic shift control valves, which control the "working pressure" of the shift elements, the lockup clutch and the master pressure.

Two types of EPCV are used.

EPCVs with a rising characteristic increase pilot pressure (P) as a function of rising control current (I) - no current - zero pilot pressure (0 mA = 0 bar).

EPCVs with a falling characteristic reduce pilot pressure as a function of rising control current - no current - max. pilot pressure.

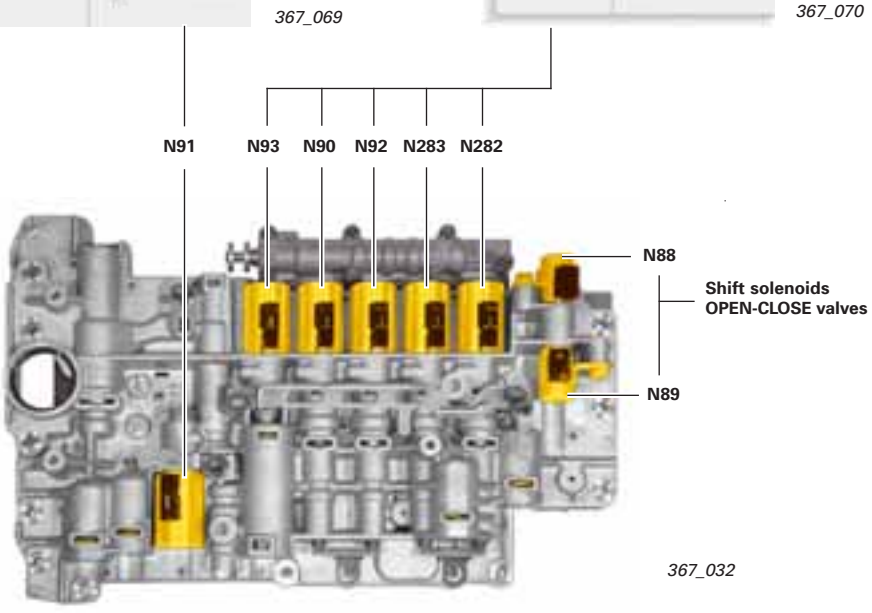
EPCV with rising characteristic



367_069

367_070

EPCV with falling characteristic



367_032

Effects of malfunctioning:

If the self-diagnostics detect a faulty electromagnetic valve, the limp-home mode is normally activated. You will find more information about the limp-home mode on page 55. Electrical and mechanical malfunctions have very different effects due to the complexity of the electro-hydraulic control system. The effects may be confined to the actual malfunctioning system (e.g. in the case of N91, the lockup clutch), but they can also cause the vehicle to enter limp-home mode if safe operation is no longer assured.

Examples:

N93 controls the master pressure.
If EPCV N93 fails, the gearbox will operate at maximum system pressure. The effects are "clunky" shifting from "P" or "N" to "D/S" or "R" and during gearshifting in general.

EPCV N91 controls the lockup clutch.
If EPCV N91 fails, the lockup clutch cannot be activated and therefore remains open.

Shift logic

	Solenoid logic								Gear shifting component logic					
	3/2 valves		Electronic pressure control valves (EDS)						Clutches, brakes, freewheel					
	N89	N88	N92	N282	N90	N283	N93	N91	K1	K2	K3	B1	B2	F
P			■	■	■	■	■							
N			■	■	■	■	■							
Reverse (R) gear			■	■		■	■				■		■	
First gear	T	T		■	■	■	■		■				T	■
Second gear				■	■		■	■	■			■		
Third gear	T/Z	z		■		■	■	■	■		■			
Fourth gear	T/Z	z			■	■	■	■	■	■				
Fifth gear	T/Z	z	■			■	■	■		■	■			
Sixth gear		z	■		■		■	■		■		■		

367_033

Function assignments of the electromagnetic valves

N90 controls clutch K3,
N91 controls the torque converter lockup clutch,
N92 controls clutch K1,
N93 controls the master pressure/system pressure,
N282 controls clutch K2 and
N283 controls brake B1.

Solenoid valves N88 and N89 are used for controlling gearshifts from 4th to 6th gear and are activated (energised) temporarily or alternately during gearshift operations.

Solenoid valves N88 and N89 also control brake B2 in 1st gear - tiptronic mode (for the engine brake).

Note

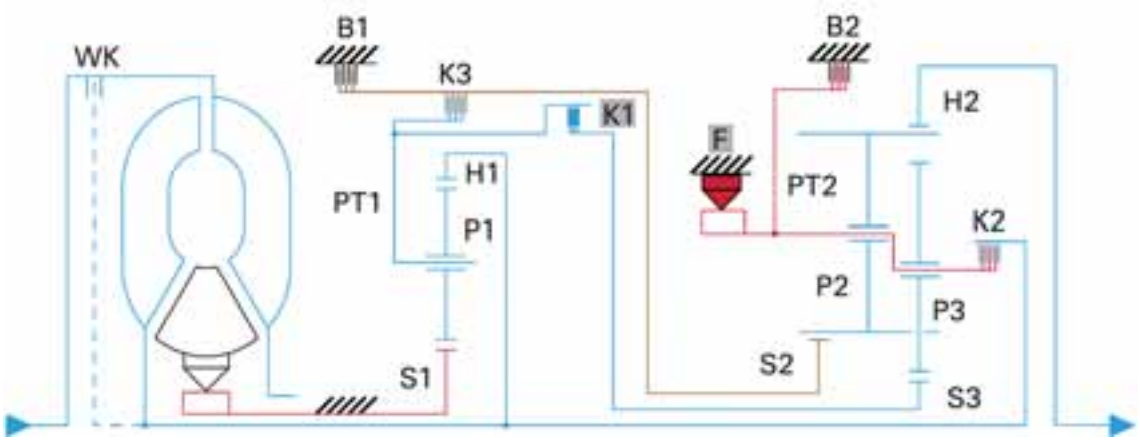
Function is inverse to electrical current applied, since EPCVs N92, N93, N282 and N283 have a falling characteristic. This means that a shift element is operated if the corresponding EPCV is not activated.

Legend of solenoid valve logic:

- Solenoid valve is not activated (el. current approx. 100 mA) or shift element open
- Solenoid valve is activated (solenoid valve open)
- Solenoid valve is activated (el. current approx. 1.0 A)
- Corresponding clutch closed
- Corresponding brake closed
- Freewheel locked
- The el. current applied to the solenoid valve differs depending on its operating state
- T - in tiptronic mode (1st gear with engine brake)
- Z - solenoid valves are activated only temporarily during gearshifts

Description of gear/torque curve

1st gear i = 4.148



367_023

Shift elements: clutch K1 - freewheel F

The turbine shaft drives ring gear H1 of the primary planetary gear set. Ring gear H1 drives the planetary gears P1, which revolve around the stationary sun gear S1.
Planet carrier PT1 is driven in this way.
Clutch K1 connects PT1 to sun gear S3 and thus introduces torque into the secondary planetary gear set.
Freewheel F locks planet carrier PT2.
Torque is transmitted from sun gear S3 to the short planetary gears P3 and , in turn, to the long planetary gears P2.

The torque multiplied by PT2 is transmitted to ring gear H2, which is connected to the gearbox output shaft.

Since 1st gear is implemented via freewheel F, no power is transmitted when coasting in 1st gear. When coasting, the wheels drive the engine. Freewheel F rotates counter to its locking direction (in the freewheeling direction), with the result that the engine braking effect cannot be used.

To be able to utilise the engine braking effect in 1st gear, tiptronic mode must be selected.
See description of 1st gear in tiptronic mode overleaf.

Reference

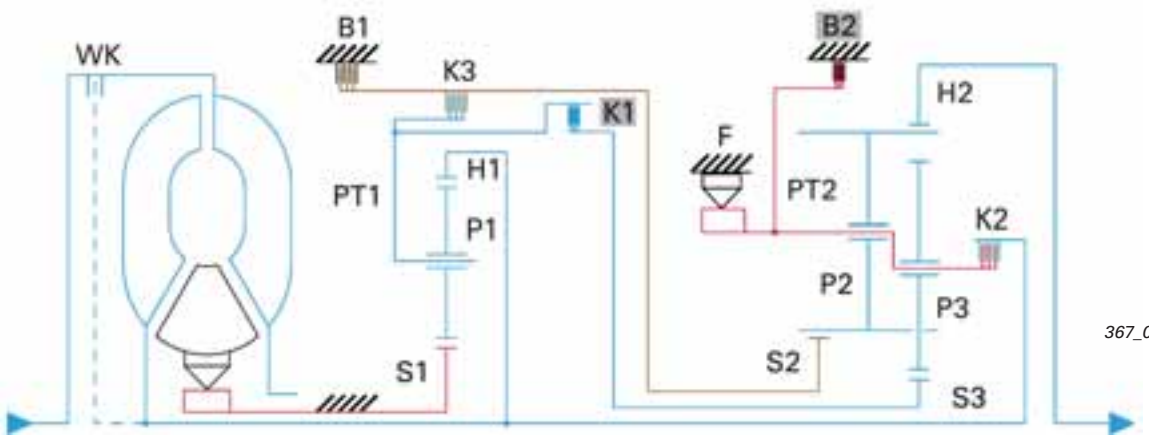
You will find notes on the schematic diagram on page 18, 22 and in SSP 283 on page 55.

Torque curve/power flow

Parts are stationary or are held stationary

Parts rotate without being involved in the flow of power

1st gear in tiptronic mode (with engine braking effect)



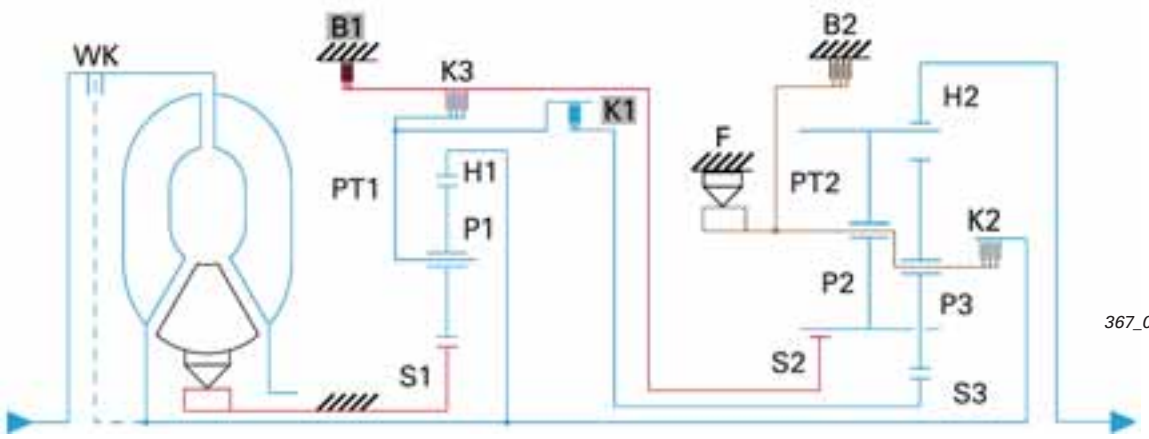
367_024

Shift elements: clutch K1 - brake B2

The engine braking effect can be utilised in 1st in special driving situations - e.g. on steep downhill gradients - by selecting 1st gear in tiptronic mode (B2 closed). The torque curve is as described for 1st gear (on previous page).

The engine braking effect can only be utilised in 1st gear by closing brake B2. Brake B2 locks the planet carrier PT2 like freewheel F. Unlike F, however, B2 holds PT2 stationary in both directions of rotation. This is necessary in order to engage reverse and utilise the engine braking effect in 1st gear.

2nd gear i = 2.370



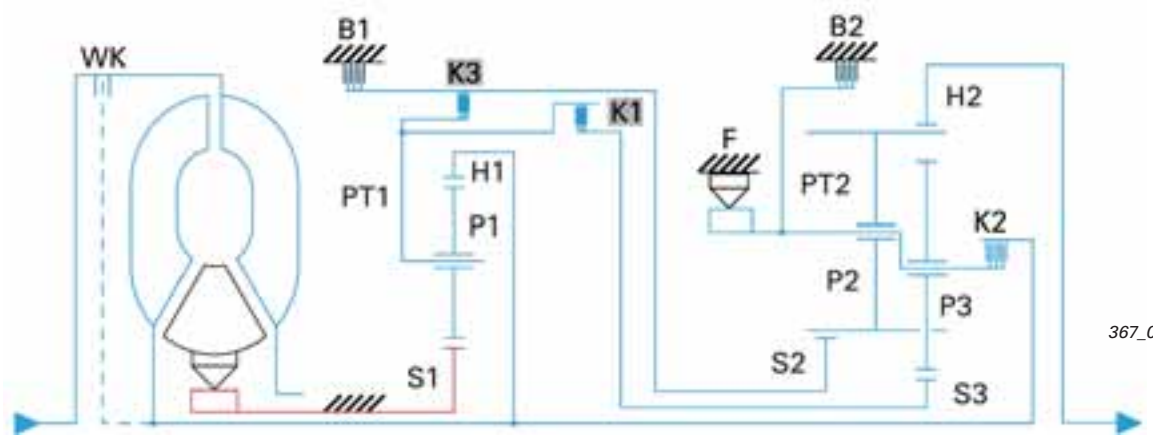
367_025

shift elements: clutch K1 - brake B1

The turbine shaft drives ring gear H1 of the primary planetary gear set. Ring gear H1 drives the planetary gears P1, which revolve around the stationary sun gear S1.
Planet carrier PT1 is driven in this way.
Clutch K1 connects PT1 to sun gear S3, and thus introduces torque into the secondary planetary gear set.

Brake B1 locks the large sun gear S2 in place.
Torque is transmitted from sun gear S3 to the short planetary gears P3 and, in turn, to the long planetary gears P2.
The long planetary gears P2 roll around the stationary sun gear S2 and drive ring gear H2, which is connected to the gearbox output shaft.

3rd gear i = 1.556



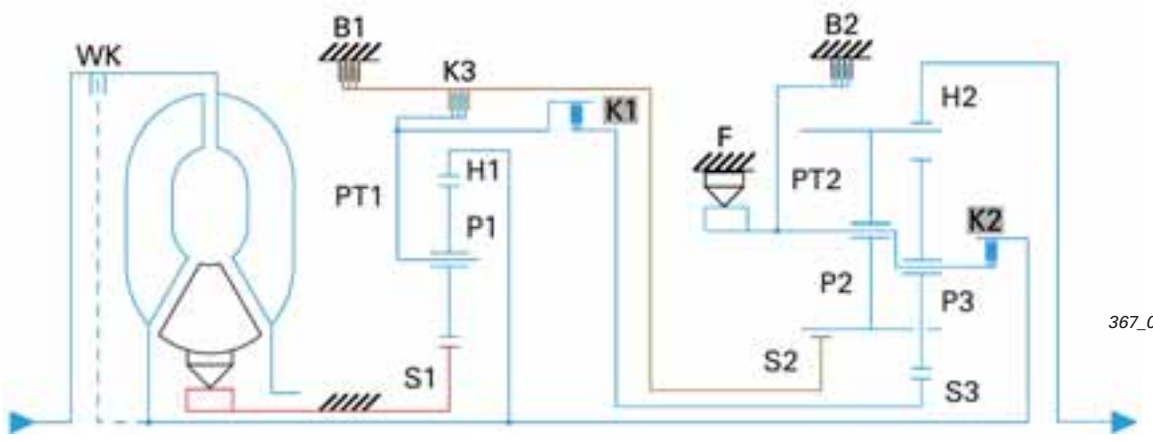
367_026

shift elements: clutch K1 - clutch K3

The turbine shaft drives ring gear H1 of the primary planetary gear set. Ring gear H1 drives the planetary gears P1, which revolve around the stationary sun gear S1.
Planet carrier PT1 is driven in this way.
Clutch K1 connects PT1 to sun gear S3 and thus introduces torque into the secondary planetary gear set.

Clutch K3 likewise introduces torque into the secondary planetary gear set driving sun gear S2.
The secondary planetary gear set is locked when clutches K1 and K3 close.
Torque is now transmitted directly from the primary planetary gear set to the gearbox output shaft.

4th gear i = 1.155



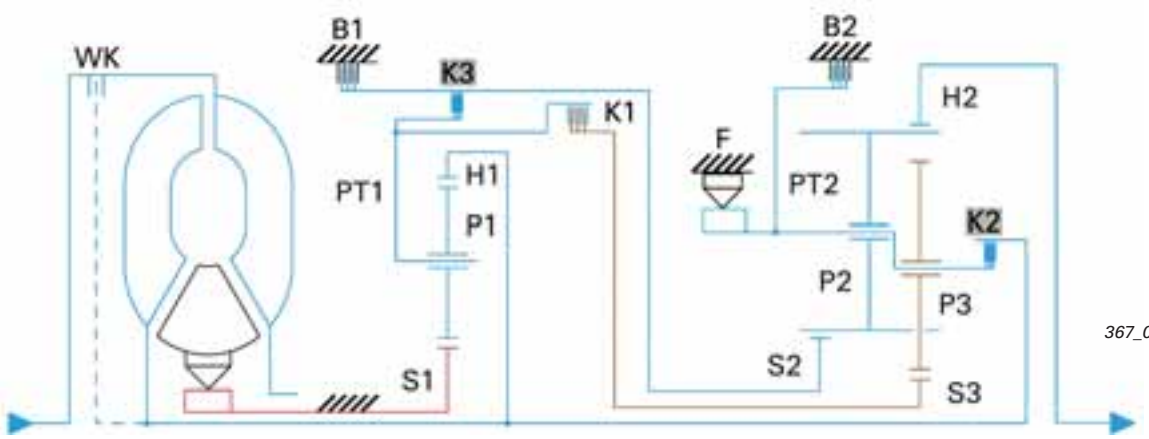
367_027

Shift elements: clutch K1 – clutch K2

The turbine shaft drives the ring gear H1 of the primary planetary gear set and the outer plate carrier of clutch K2.
Ring gear H1 drives the planetary gears P1, which revolve around the stationary sun gear S1. Planet carrier PT1 is driven in this way.

Clutch K1 connects PT1 to sun gear S3, and thus introduces torque into the secondary planetary gear set.
Clutch K2 connects the turbine shaft to planet carrier PT2, and likewise introduces torque into the secondary
planetary gear set.
The long planetary gears P2, which mesh with the short planetary gears P3, together with planet carrier PT2, drive ring gear H2, which is connected to the gearbox output shaft.

5th gear i = 0.859



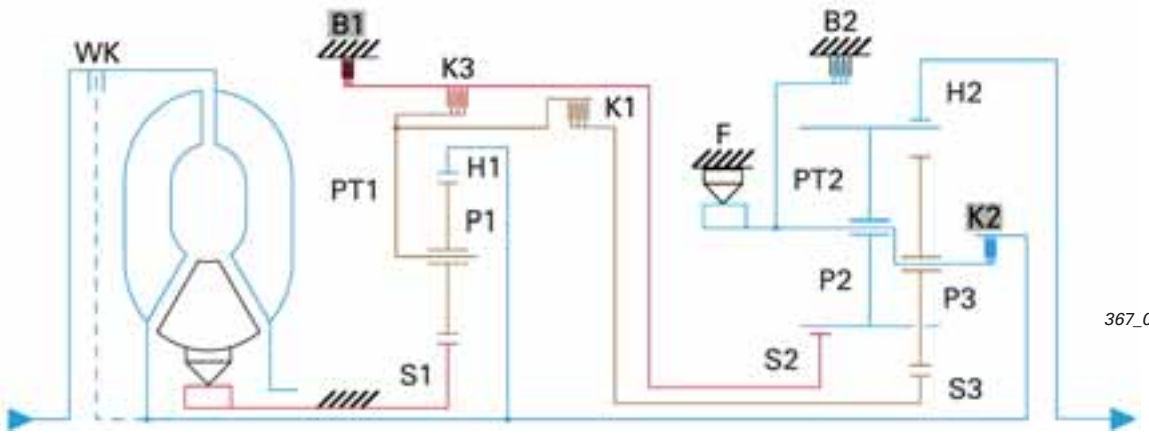
367_028

shift elements: clutch K2 - clutch K3

The turbine shaft drives the ring gear H1 of the primary planetary gear set and the outer plate carrier of clutch K2.
Ring gear H1 drives the planetary gears P1, which revolve around the stationary sun gear S1. Planet carrier PT1 is driven in this way.

Clutch K3 connects PT1 to sun gear S2, and thus introduces torque into the secondary planetary gear set.
Clutch K2 connects the turbine shaft to the planet carrier of secondary planetary gear set PT2, and likewise introduces torque into the secondary planetary gear set.
The long planetary gears P2, together with planet carrier PT2 and sun gear S2, drive ring gear H2, which is connected to the gearbox output shaft.

6th gear i = 0.686



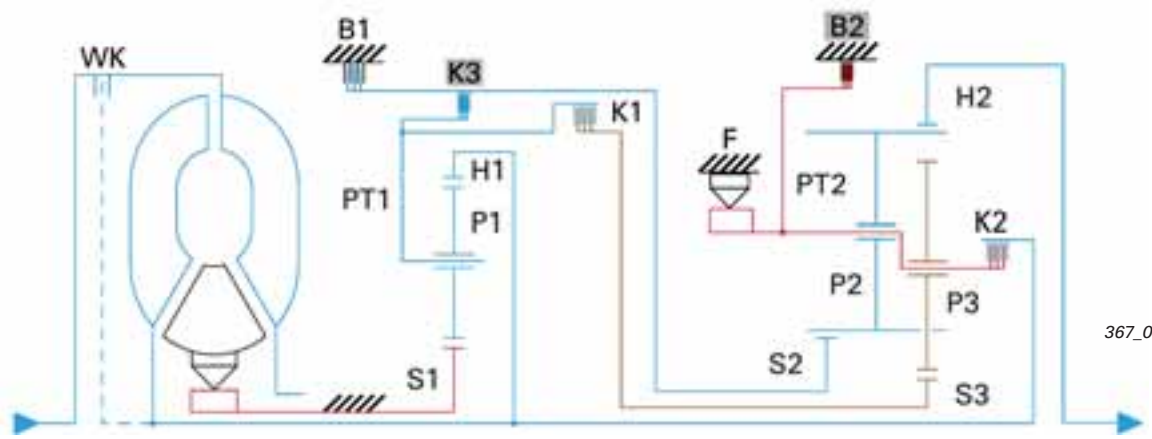
367_029

Shift elements: clutch K2 – brake B1

Brake B1 locks in place sun gear S2.
Clutch K2 connects the turbine shaft to the planet carrier of secondary planetary gear set PT2, and thus introduces torque into the secondary planetary gear set.

The long planetary gears P2 roll around the stationary sun gear S2 and drive ring gear H2, which is connected to the gearbox output shaft.
Clutches K1 and K3 are open.
The primary planetary gear set is not involved in the power transmission process.

R gear i = 3.394



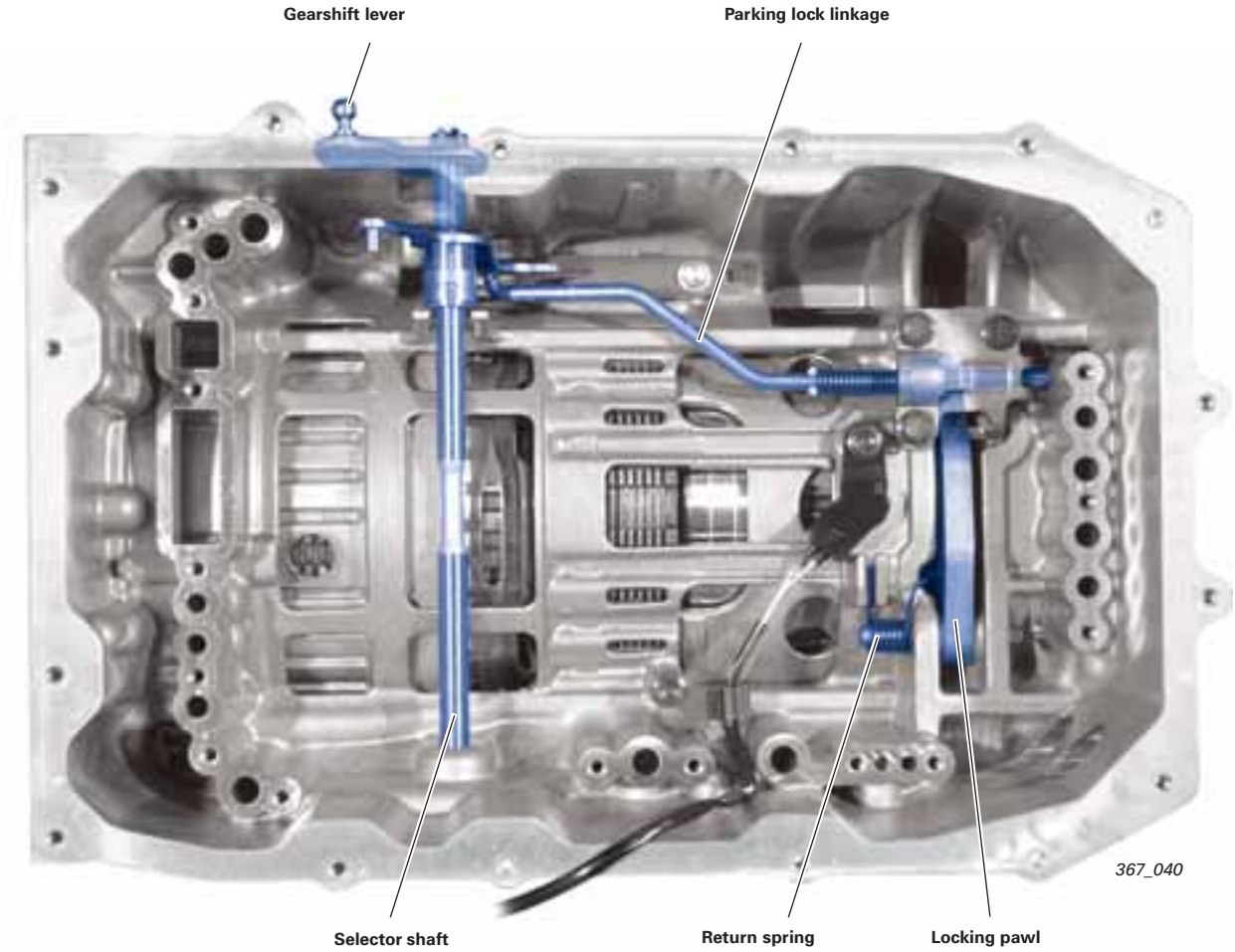
shift elements: clutch K3 - brake B2

The turbine shaft drives ring gear H1 of the primary planetary gear set. Ring gear H1 drives the planetary gears P1, which revolve around the stationary sun gear S1.
Planet carrier PT1 is driven in this way.
Clutch K3 connects PT1 to sun gear S2, and thus introduces torque into the secondary planetary gear set.

The brake B2 locks the planet carrier PT2 in place.
Torque is transmitted from the sun wheel S2 to the long planetary gears P2.
The torque multiplied by PT2 is transmitted to ring gear H2, which is connected to the gearbox output shaft.
At the same time, the ring gear H2 (output) is driven counter to the direction of rotation of the engine.

Parking lock

The parking lock is a device which prevents the vehicle from rolling away.
It has a conventional (all-mechanical) design, i.e. it is actuated by the selector lever via a Bowden cable.

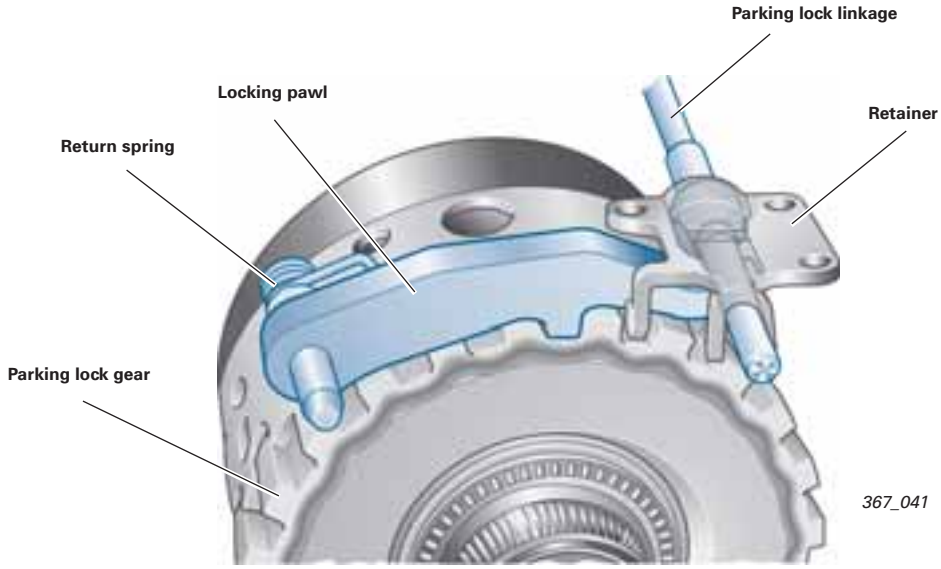


The parking lock gear is rigidly connected to the gearbox output shaft.
This enables the locking pawl, which engages the teeth of the parking lock gear, to lock the transfer case. A constant wheel height is maintained when the axle is raised on one side only.
For this reason, it is not possible to secure the vehicle to prevent it from rolling away when the front axle is raised on one side (e.g. when changing a wheel using the car jack). It is necessary to apply the handbrake.

To preserve the selector lever cable and enable the selector lever to be engaged more easily, the handbrake should always be applied on steep gradients before shifting the selector lever into the "P" position..
This prevents build-up of tension in tension in the pawl and parking lock gear. Before driving away, shift the selector lever out of "P" before releasing the handbrake.

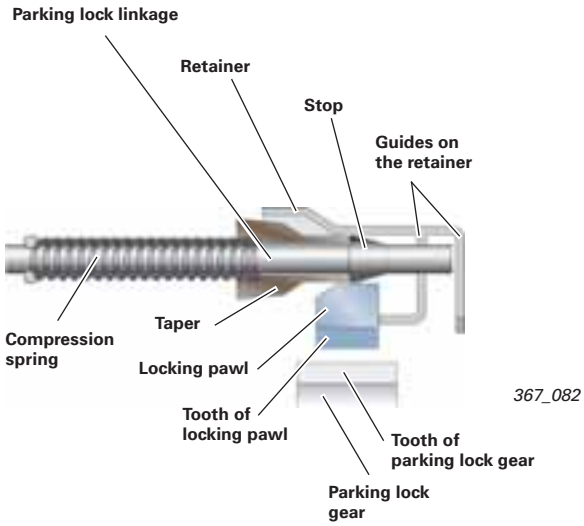
Note

For safety reasons, the shape and flank angle of the locking pawl, the parking lock gear teeth and the compression force of the locking pawl are configured in such a way that the locking pawl does not engage when the speed at which the vehicle is travelling exceeds approx. 7 kph.
If the parking lock is inadvertently actuated at a higher speed than 7 kph, the locking pawl will ride loudly over the teeth of the parking lock gear.



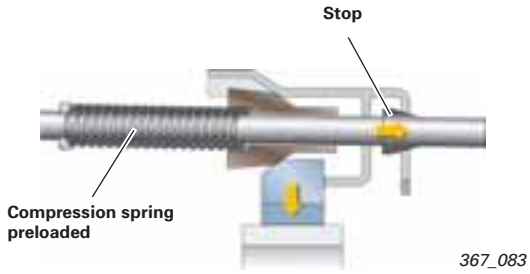
Selector lever positions R/N/D/S

In selector lever positions R/N/D/S, the parking lock linkage is in a position in which the taper is not engaging the locking pawl.
The locking pawl is held in an initial position with sufficient clearance to the teeth of the parking lock gear by the return spring.



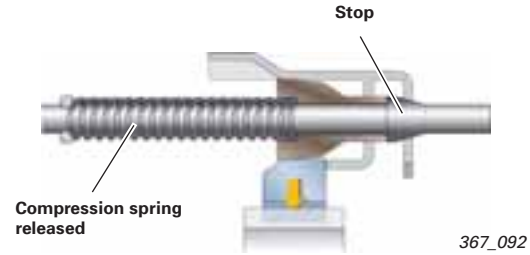
Selector lever position "P "
(the tooth of the parking lock gear is opposed to the tooth of the locking pawl)

In selector lever position "P" the taper is thrust between the retainer and the locking pawl. The locking pawl is pushed towards parking lock gear. If the tooth of the locking pawl is opposed to a tooth of the parking lock gear, the taper is preloaded by the compression spring.
This preload acts across the diagonal of the taper and in turn exerts a preloading force on the locking pawl.

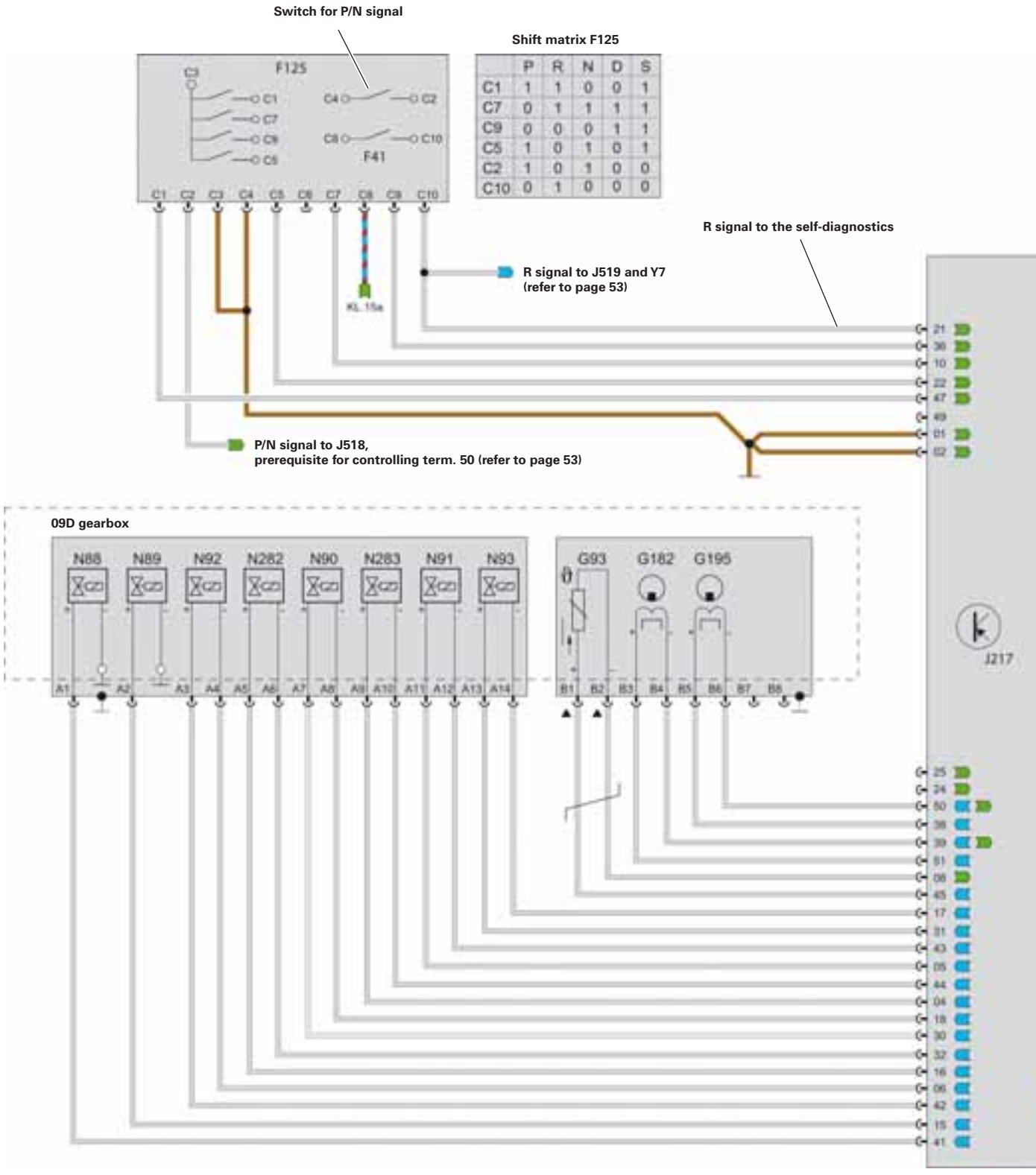


Selector lever position "P "
(locking pawl engages)

When the vehicle moves (the parking lock gear rotates further), the locking pawl is automatically pressed by the preloaded taper into the next tooth space on the parking lock gear.



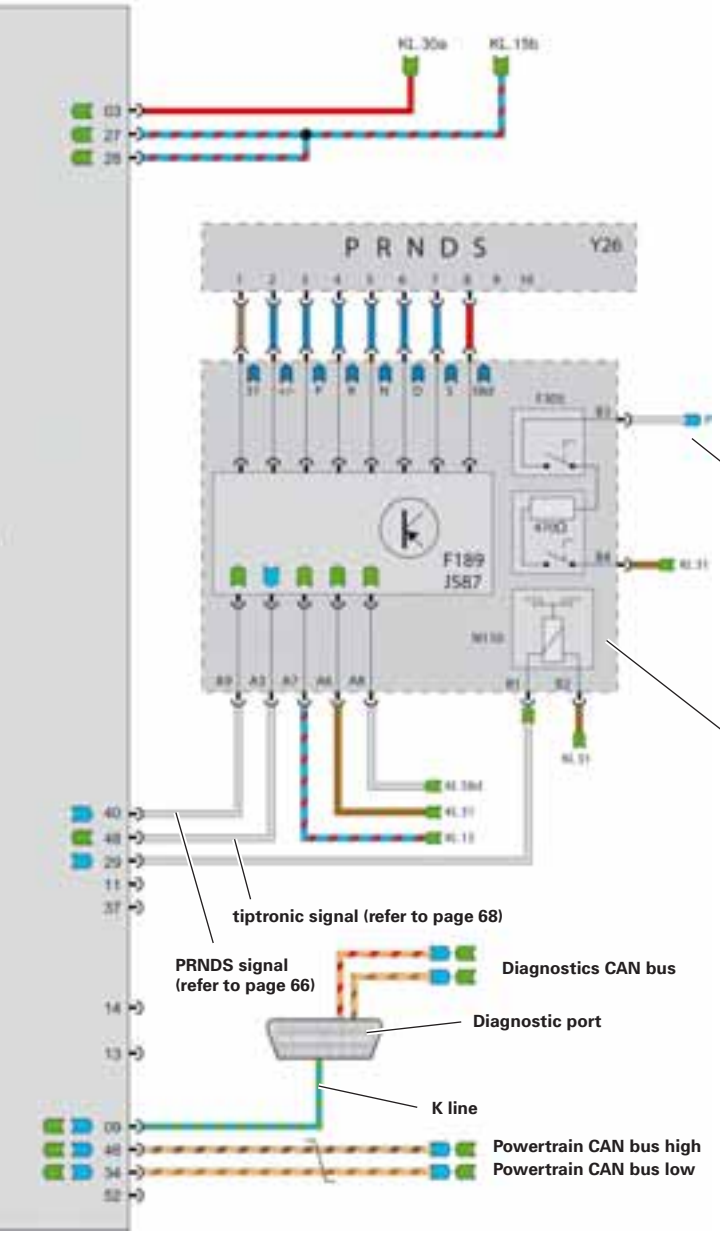
Function diagram of the 09D gearbox on the Audi Q7
(as at May 2007)



Note

Always use the current version of the current flow diagram to troubleshoot the vehicle.

E313	Selector lever
E415	Entry and start authorisation switch
F41	Reversing switch
F125	Multi-function switch
F189	tiptronic switch
F305	Gear selector position P switch
G93	Gearbox oil temperature sensor
G182	Gearbox input speed sender
G195	Gearbox output speed sender
J217	Automatic gearbox control unit
J518	Entry and start authorisation control unit
J519	Onboard power supply control unit
J587	Selector lever sensor system control unit
N88	Solenoid valve 1
N89	Solenoid valve 2
N90	Solenoid valve 3
N91	Solenoid valve 4
N92	Solenoid valve 5
N93	Solenoid valve 6
N110	Selector lever lock solenoid
N282	Solenoid valve 9
N283	Solenoid valve 10
Y7	Automatic anti-dazzle interior mirror
Y26	Selector lever position indicator unit



Output
Input
Gold-plated contact
Twisted wire

367_034

Automatic gearbox control unit J217

The gearbox control unit on the Audi Q7 is located under the front right seat below onboard power supply control unit 2 J520.

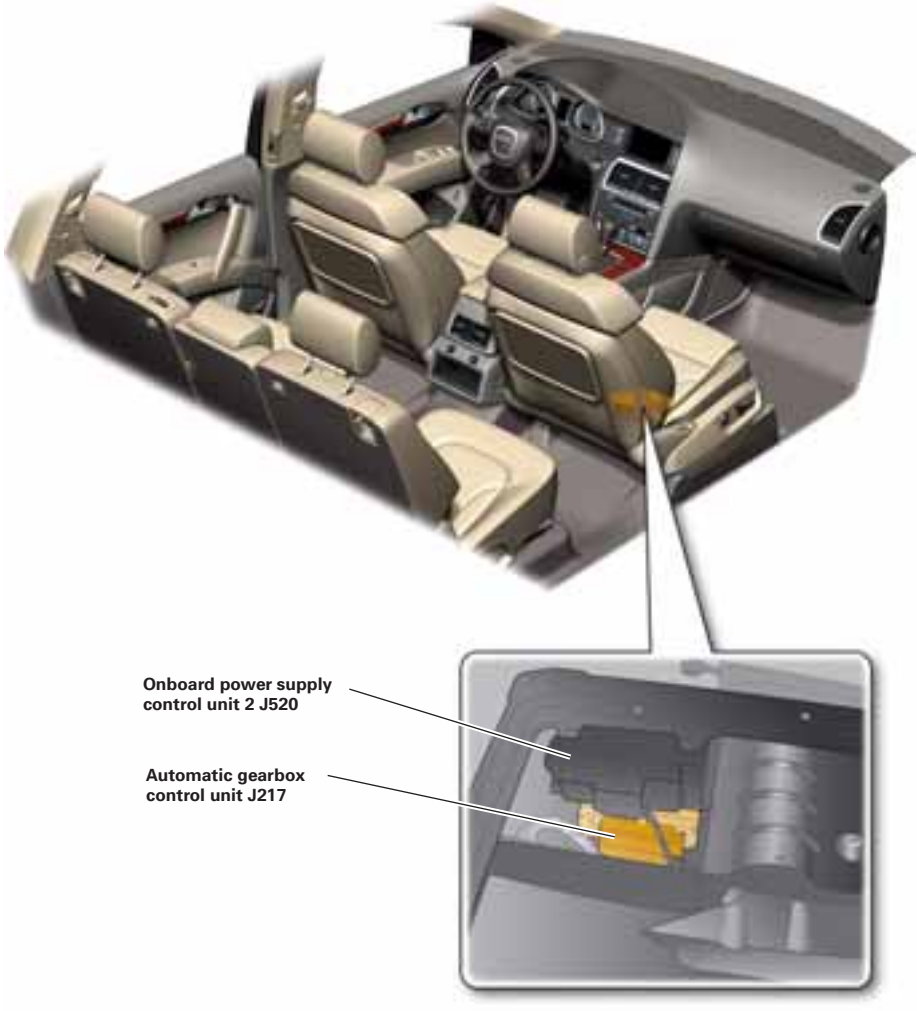
The control unit is manufactured by Japanese gearbox specialist AISIN AW Co., Ltd.

Update programming is possible with the VAS 5051.

Note

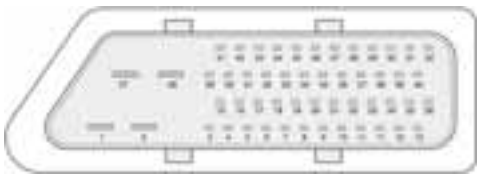
After replacing the gearbox control unit, the basic setting procedure must be performed using the diagnostic tester (under "Guided Fault Finding").

The adaption values have to be cleared after specific repair work on gearbox (e.g. change of ATF, etc.), or after replacing the gearbox. (refer to page 59).



367_055

The control unit is connected by means of a 52-pin plug. VAS adapter cable 1598/48 is available for static and dynamic measurements on the system.



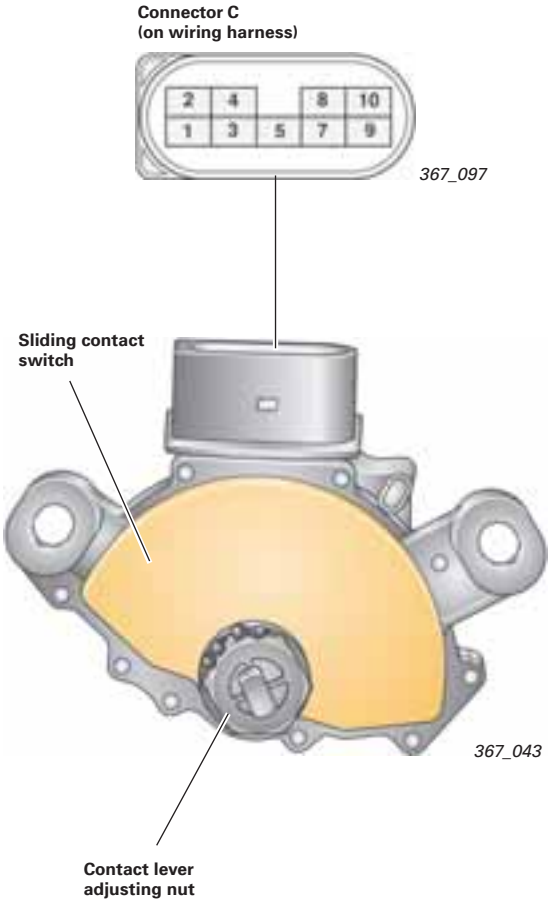
367_096

Multi-function switch F125

367_042

Multi-function switch F125 has the following tasks and controls the following functions:

- Starter inhibitor control (see function diagram)
- P/N lock control (activation of shift lock solenoid N110)
- It identifies the vehicle operating states forward/ reverse/neutral/sport program, and this information is used by the gearbox control unit J217 for controlling the gearbox
- It identifies reversing or the intention to reverse for use in controlling all functions relevant to reversing, e.g. reversing lights, anti-dazzle rear-view mirror, acoustic parking system, trailer towing mode, mirror fold-back etc.



Effects of signal failure

Faults in the F125 manifest themselves in very different ways. The effects vary depending on which switch contacts or interfaces are affected. The following effects can occur:

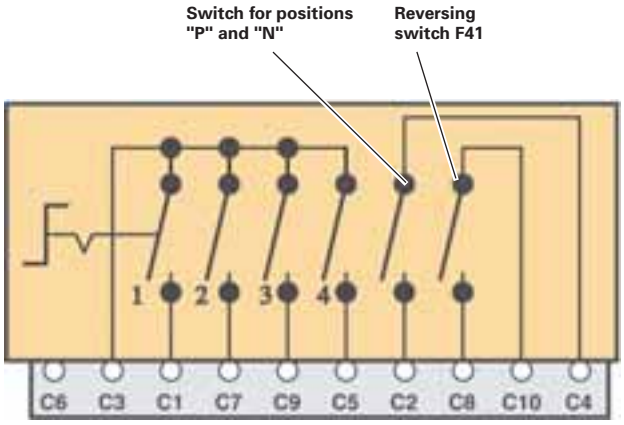
- Engine does not start (starter does not turn)
- No power flow
- Gearbox enters electrical or mechanical limp-home mode
- Fault indicator lamp comes on (inverted LEDs on shift indicator)
- P/N lock does not function properly
- Fault memory entry

Contact assignments of the multi-function switch

The multi-function switch is a mechanical multi-position switch with 6 sliding contacts:

- 4 switches for identification of the selector valve position and selector lever position
- 1 switch for activating the functions relevant to reversing (F41)
- 1 switch for starter control in selector lever positions "P" and "N"

Since the switch contact is fully mechanical, F125 can be checked using the ohmmeter.



367_078

Shift logic F125

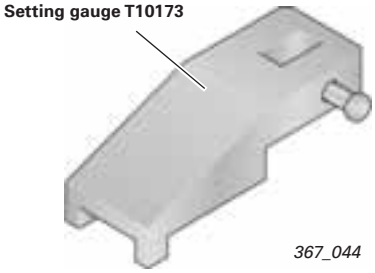
Coding of connector C (on the wiring harness)

	P/N signal		R signal		Position signal					Data block 9/4. Value	
	C2	C4	C10	C8	C3	C1	C7	C9	C5	Switch position	Intermediate position
P	○	○			○	●			●	1001	1101
R			○	○	○	●	●			1100	1101
N	○	○			○		●		●	0101	0111
D					○		●	●		0110	0111
S					○	●	●	●	●	1111	

367_099

Setting multi-function switch F125

Use setting gauge T1073 to set the multi-function switch. Please follow the instructions given in the Workshop Manual.



Note

Special care must be taken to ensure that the correct torque is applied to the contact lever adjusting nut.
If the nut is over-torqued, the multi-function switch will move stiffly and the rubber seals will be damaged.
If the nut is not tightened sufficiently, this can lead to leaking of the multi-function switch.

Note

The multi-function switch must be set after installing or if the wrong gear is indicated in the dash panel insert (refer to Workshop Manual).

Gearbox input speed sender G182

G182 is integrated in the ATF pump housing and measures the direct gearbox input speed (turbine speed) by means of a ring gear on the gearbox input shaft.

The electronic gearbox control requires the exact turbine speed for the following functions:

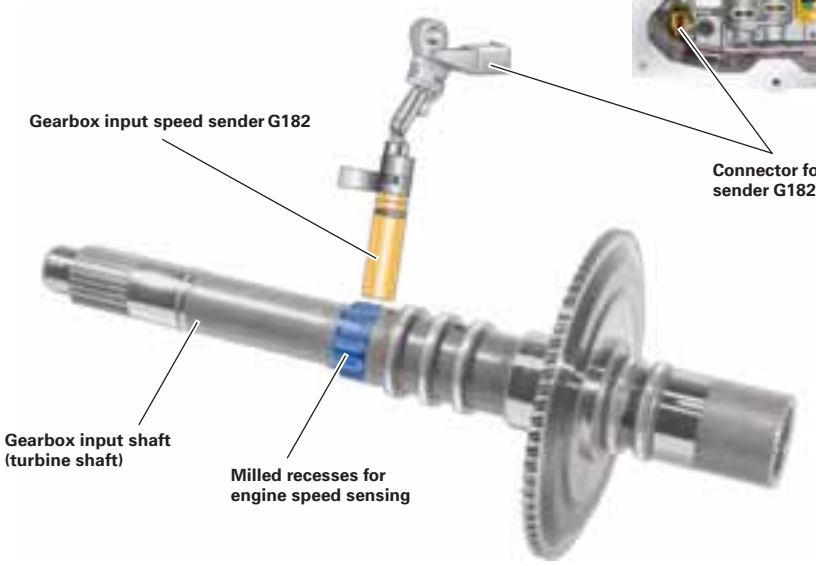
- Control, adaption and monitoring of gearshifts and gear selection
- Regulation and monitoring of the converter lockup clutch
- Diagnosis of the shift elements and plausibility checking of engine RPM and gearbox output speed

Note

Due to torque converter slip, the gearbox input speed (turbine speed) is not equivalent to the engine speed (except when the torque converter lockup clutch is fully closed).

Bottom view of gearbox

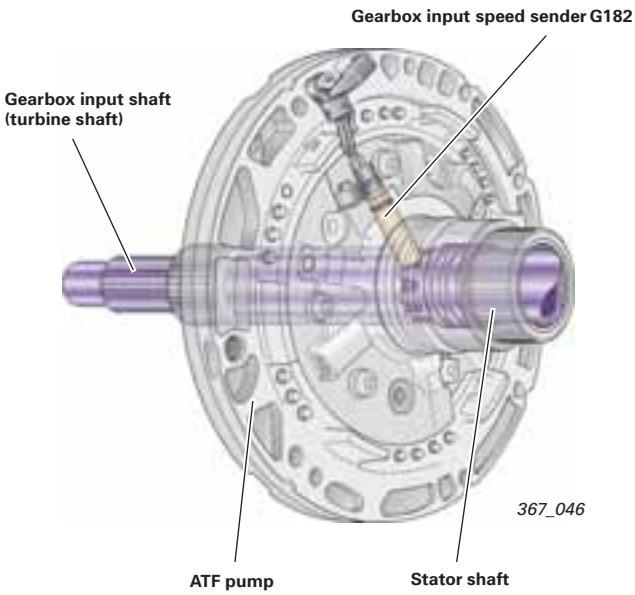
367_059



367_116

Protective/substitute function in case of failure:

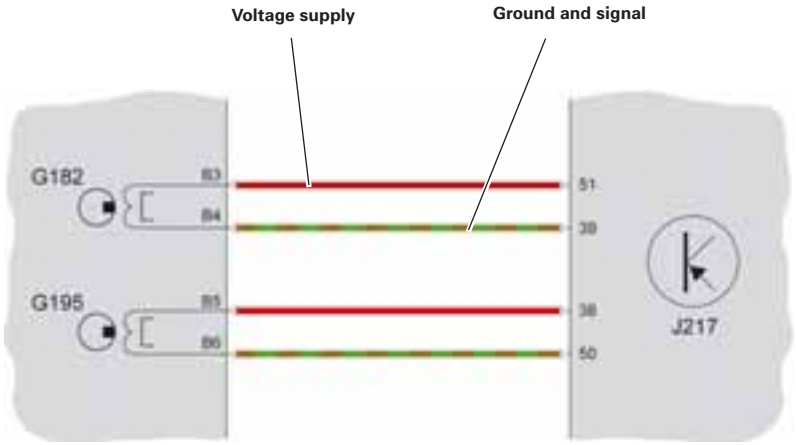
- Engine RPM is used as a substitute value
- No adaption of gearshifts
- No controlled operation of converter lockup clutch (open or closed only)
- No pressure regulation when selecting gear (e.g. N-D or N-R), -clunky- shift action



367_046

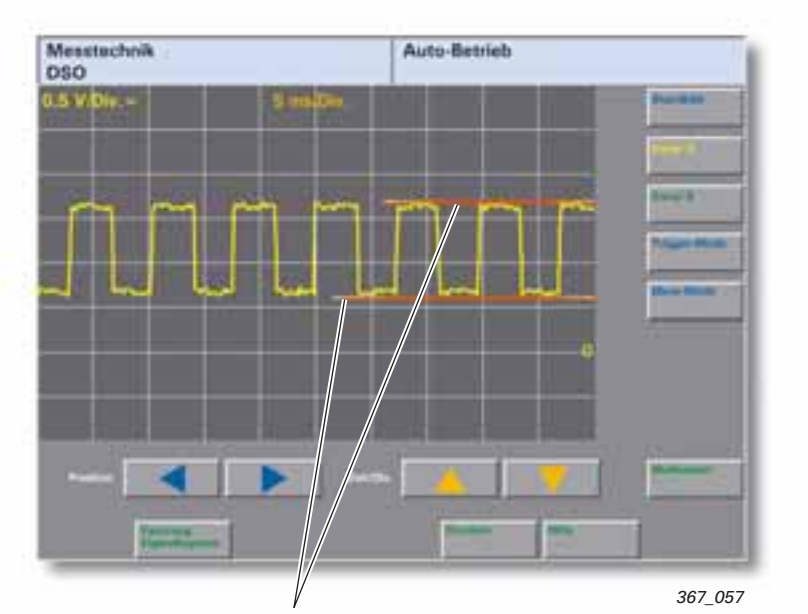
Function - sender G182

Sender G182 is based on the Hall principle.
The output signal is a square-wave signal whose frequency is proportional to turbine speed.



367_037

DSO image - signal from G182



367_057

Voltage level when the turbine shaft is stationary, i.e gear selected, driving speed 0 kph (depending on whether a tooth space or a tooth is located in front of the sensor)

DSO connection for G182

- black probe tip pin 1
- red probe tip pin 39

Test conditions:

- Engine idling
- Selector lever position "N" or "P"

Auxiliaries:

- VAS 5051
- V.A.G 1598/48 with
- V.A.G 1598/42

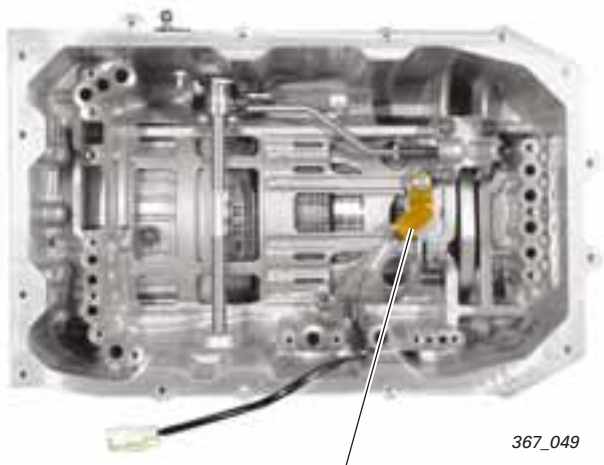
Gearbox output speed sender G195

G195 is located behind the valve assembly. It is bolted to the gearbox housing and measures the gearbox output speed at the ring gear of the Ravigneaux planetary gear set. The ring gear has special milled recesses for this purpose, and serves as an encoder disc.

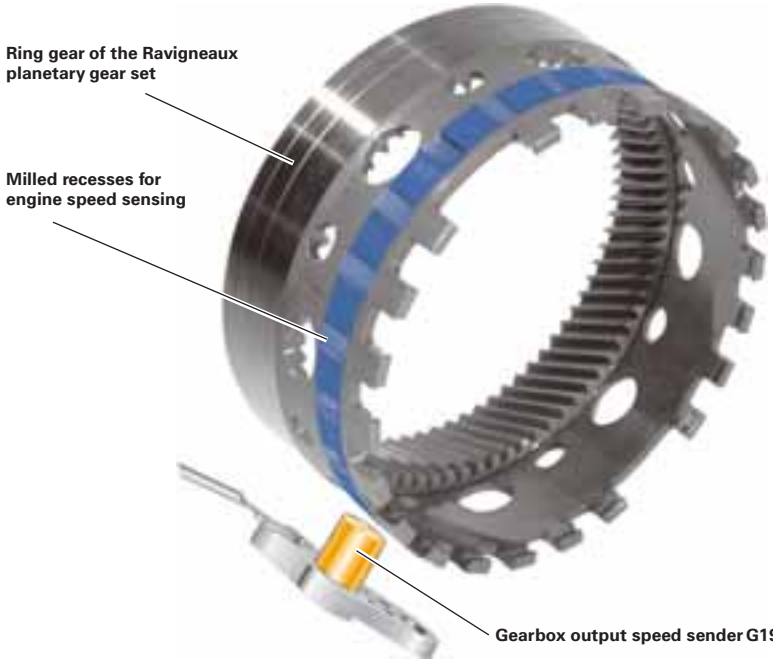
One of the principal signals of the electronic gearbox control system is the gearbox output speed. There is a direct correlation between gearbox output speed and driving speed.

The gearbox output speed is required to realise the following functions:

- Shift point selection
- Functions of the Dynamic Shift Program (DSP), e.g. driving status evaluation
- Diagnosis of shifting components and plausibility checking of engine and turbine speed (gear monitoring)



Gearbox output speed sender G195

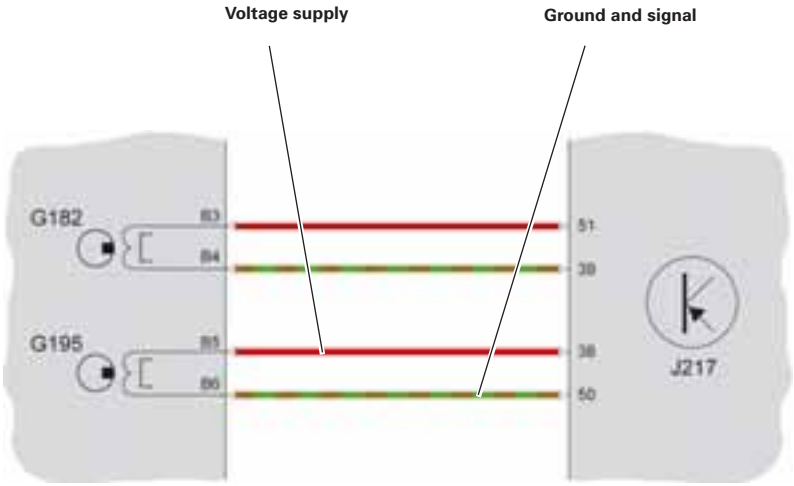


Protective/substitute function in case of failure:

- The wheel speed value generated by the ESP control unit is used as a substitute value (via CAN bus)
- Limited DSP capability

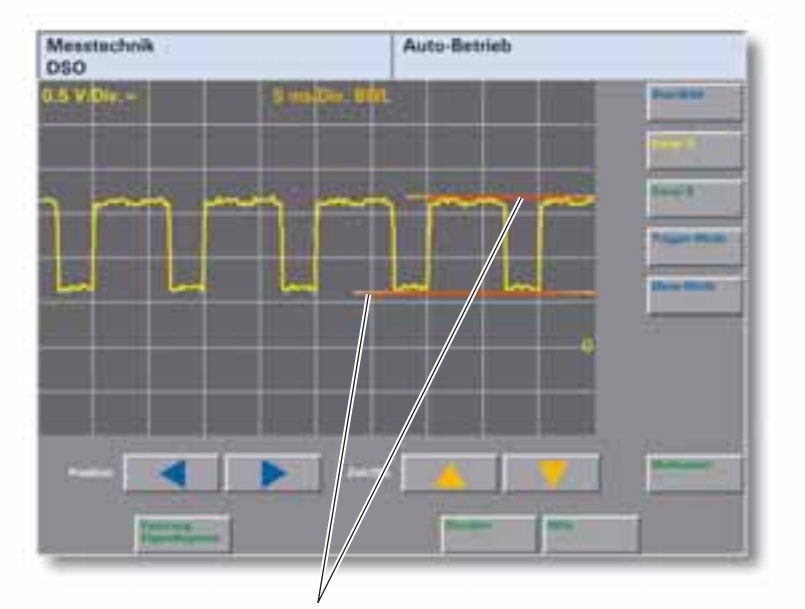
Function - sender G195

Sender G182 is based on the Hall principle. The output signal is a square-wave signal, the frequency of which is a function of gearbox output speed (driving speed).



367_037

DSO image - signal from G195



367_113

Voltage level at a road speed of 0 kph (depending on whether a tooth space or a tooth is located in front of the sensor)

DSO connection for G195

- black probe tip Pin 1
- red probe tip Pin 50

Test conditions:

- Road speed approx. 10 kph
- Selector lever in position "D", engine idling (vehicle raised on lift)

Auxiliaries:

- VAS 5051
- V.A.G 1598/48 with
- V.A.G 1598/42

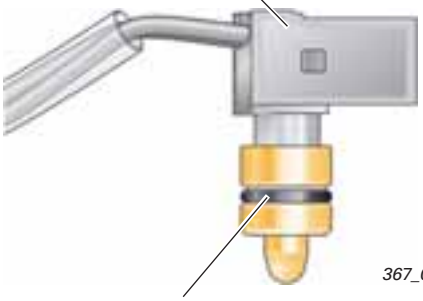
Gearbox oil temperature sensor G93

G93 is integrated inside the valve assembly and is swept by ATF. It generates an ATF temperature signal for the automatic gearbox control unit J217.

G93 is an NTC resistor and an integral part of the wiring harness.
(NTC - Negative Temperature Coefficient)

367_059

Gearbox oil temperature sensor G93



367_058

O-ring

The ATF temperature is required for the following functions:

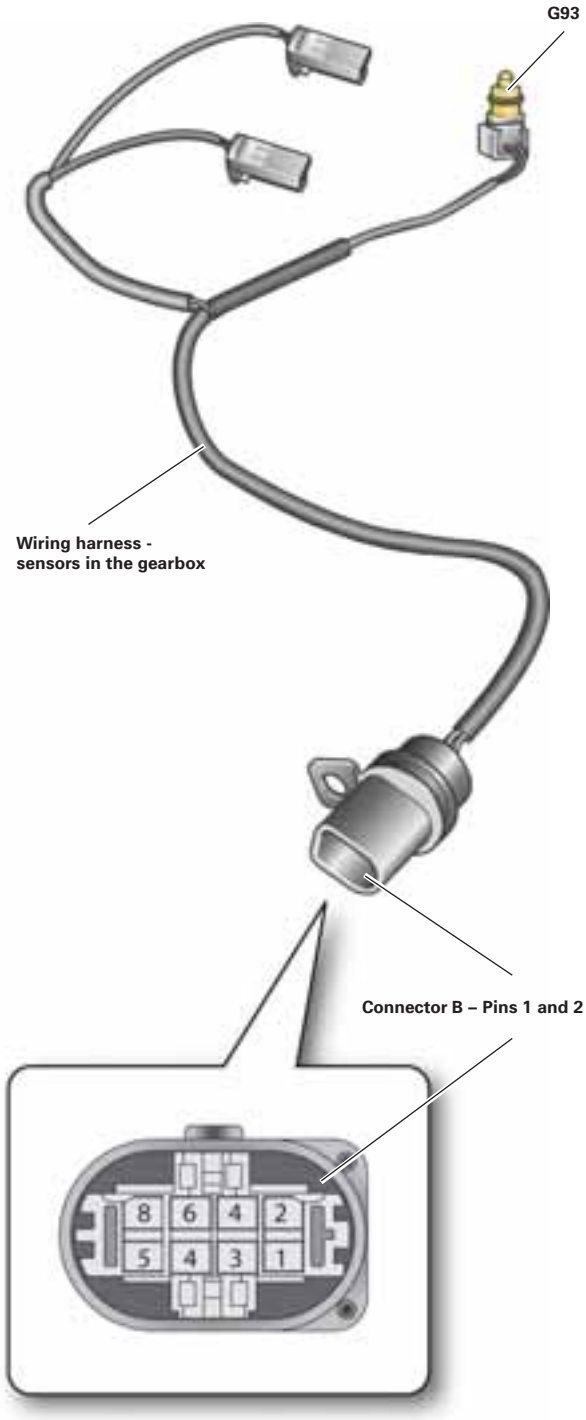
- To adapt the shift pressures (system pressure) and to increase and reduce pressure during gearshifts.
- To activate and deactivate temperature-dependent functions (warm-up program, converter lockup clutch, etc.).
- To activate gearbox protection measures if the ATF temperature is too high (Hotmode).
- To activate the gearbox adaption functions (EPCV control current).

As protection against overheating, counter-measures (Hotmode) are taken when defined temperature threshold values are exceeded:

Hotmode stage 1 (approx. 150 °C): The shift characteristics are adjusted towards higher engine speeds using the DSP function.
The operating range within which the torque converter lockup clutch is closed is extended.

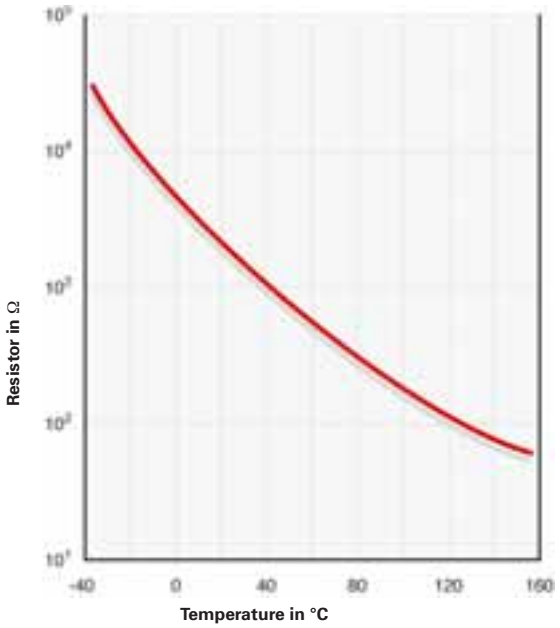
Hotmode stage 2 (approx. 170 °C): Engine torque is reduced.

Wiring harness incl. G93



367_061

NTC resistor characteristic of the G93



367_060

Protective/substitute function in case of failure:

- A substitute value is generated from the engine temperature and operating time.
- No controlled operation of converter lockup clutch (open or closed only)
- No shift pressure adaption (which usually results in clunkier gearshifts)

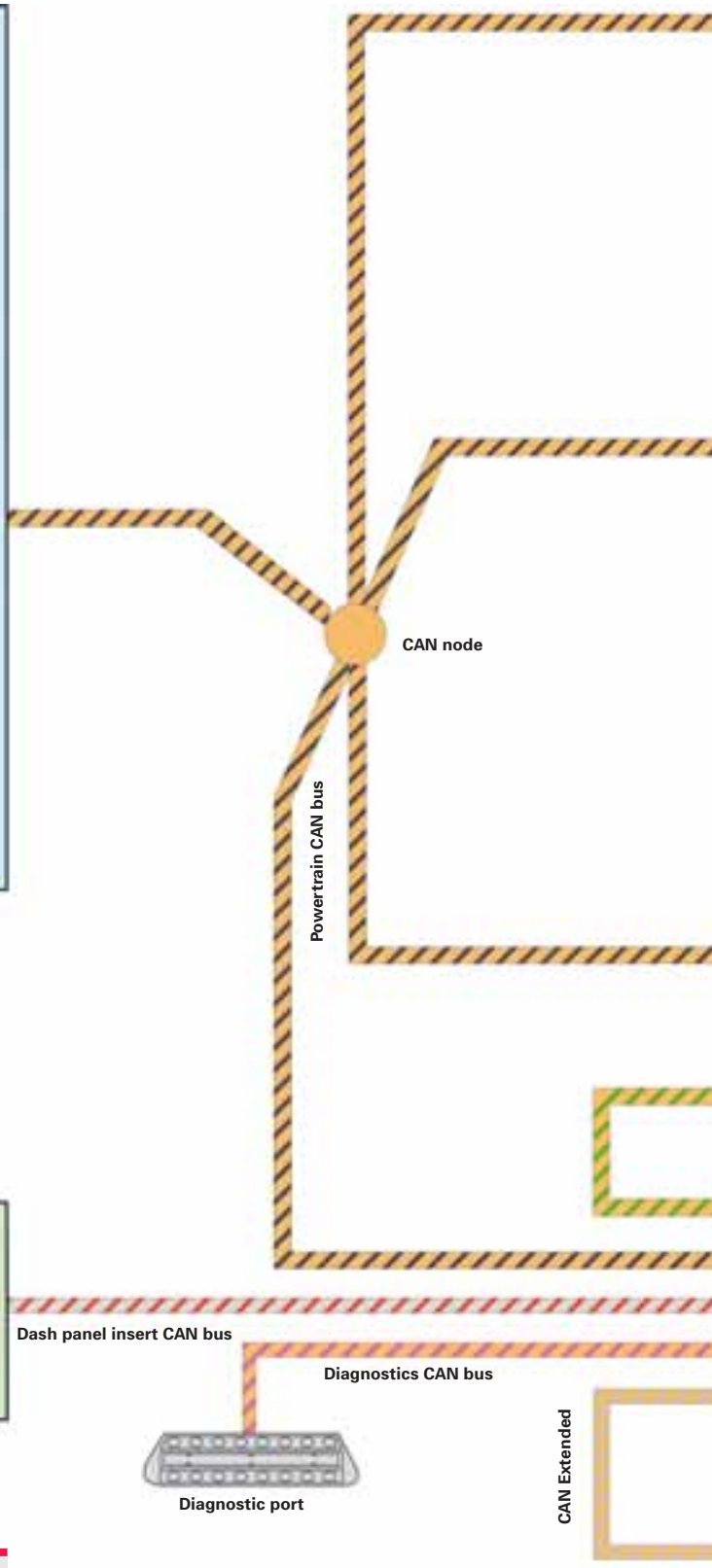
CAN information exchange with the 09D gearbox on the Audi Q7

J217 – Automatic gearbox control unit

- System status
- Fault memory entry/status
- Selector mechanism active
- Coding in engine control unit
- Momentary gear or target gear
- Selector lever position
- Motion resistance index
- Information on emergency running mode and self-diagnosis
- OBD status
- Nominal idling speed
- Torque gradient limitation (converter/gearbox protection)
- Converter/gearbox protection status
- Selector lever position display
- Nominal engine torque (gearbox intervention)
- CAN sleep indication
- Torque converter lockup clutch status
- Self-diagnosis/measured data
- Compressor "off"
- Cooling demand
- Turbine speed

J285 – Control unit with display in dash panel insert

- Ambient temperature
- Mileage (km)

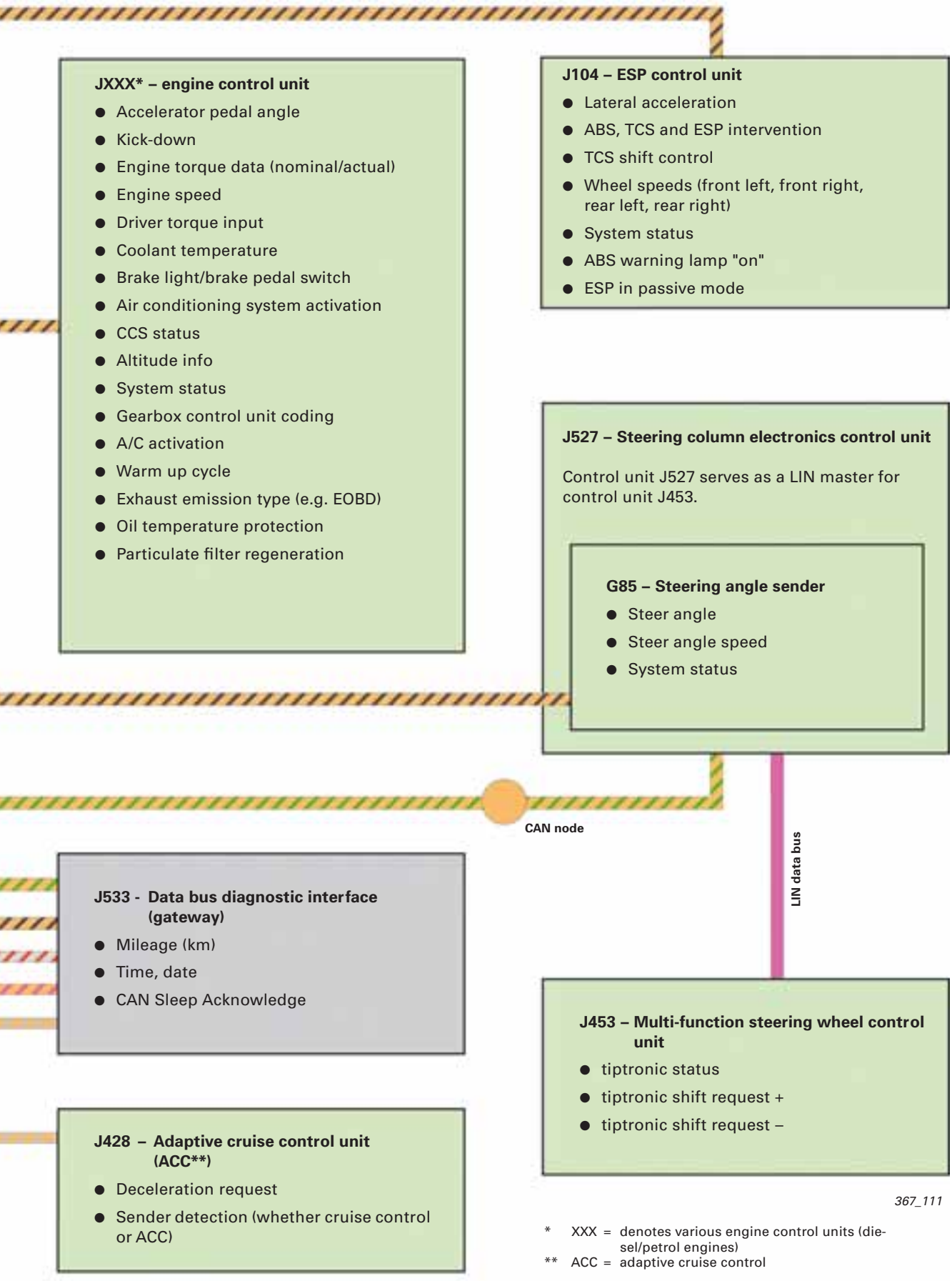


Note

The CAN information exchange processes shown here refer only to information relevant to the gearbox.

= information sent by the gearbox control unit

= information received by the gearbox control unit



367_111

* XXX = denotes various engine control units (diesel/petrol engines)
** ACC = adaptive cruise control

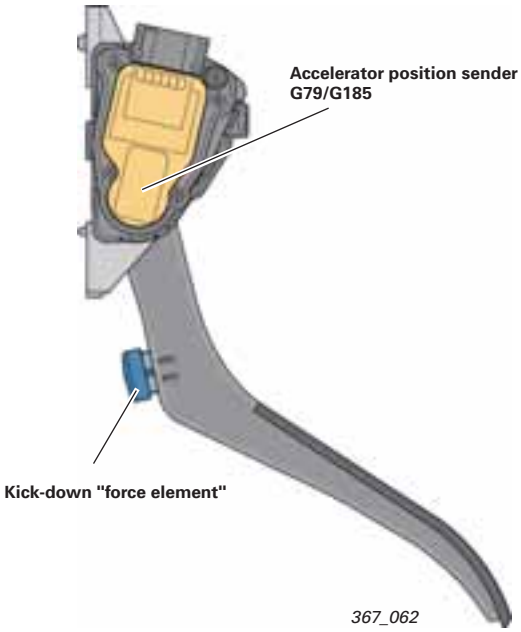
Interfaces/auxiliary signals

Kick-down information

There is no separate switch for kick-down information. A "force element" is integrated in the accelerator position sender in place of a stop buffer (for manual gearboxes). The force element produces a "mechanical pressure point" which conveys an authentic "kickdown feel" to the driver. When the driver engages the kickdown, the full-load voltage of the accelerator position senders G79 and G185 is exceeded.

If a defined voltage threshold in the engine control unit is reached, this is interpreted as a kickdown request by the driver and the automatic gearbox is informed (via the powertrain CAN bus).
The kick-down point can only be checked using the diagnostic tester.

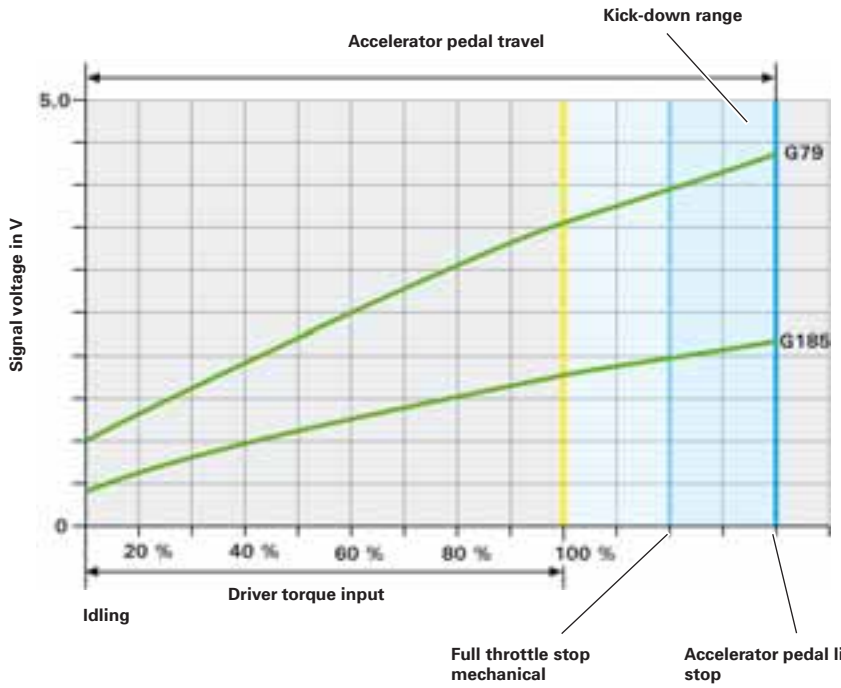
Accelerator pedal in Audi Q7



367_062

Note

If the accelerator pedal module or the engine control unit is replaced, the kick-down point must be re-adapted.



367_063

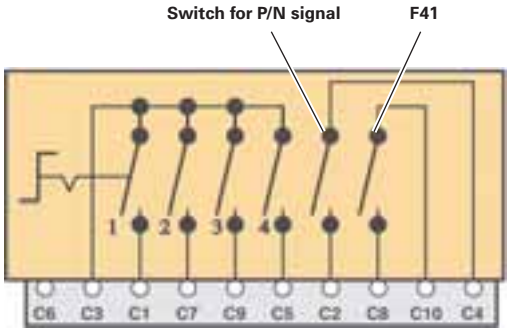
Distributed functions in the Audi Q7

Starter inhibitor/starter control

The starter control/starter inhibitor function is implemented via entry and start authorisation control unit J518.

The P/N signal (ground), a requirement for start enabling, is generated by a separate switch in the multi-function switch F125.
The P/N signal is transmitted to J518 via a discrete line.

J518 only enables the engine control unit J623 to activate terminal 50 in selector lever position "P" or "N".
For self-diagnostic purposes, the selector lever position is also indicated to J518 via the databus.



Multi-function switch F125 *367_078*

Reversing switch F41

The reversing switch F41 is integrated in the multi-function switch F125. F41 supplies a voltage signal (R signal) to the onboard power supply control unit J519 and other control units which utilise the R signal.

The R signal is required for the following functions and systems:

- Reversing light
- Anti-dazzle rear-view mirror
- Self-diagnosis of gearbox control unit J217

The reversing light is activated by the convenience system central control unit 2 J773.
The information path is as follows:
reversing switch F41 > discrete line to onboard power supply control unit J519 > to convenience system central control unit 2 J773 via convenience CAN > discrete line to reversing light.

The R signal is also sent to the gearbox control unit J217 via a discrete line.
The self-diagnostics in J217 utilise the R signal to check the plausibility of the multi-function switch F125.

If the R signal is faulty, the gearbox enters limp-home mode.

Dynamic Shift Program DSP

As a modern automatic gearbox, the 09G also features the latest generation of the Dynamic Shift Program (DSP).

DSP evaluates vehicle operating parameters such as motion resistance (e.g. uphill gradient), route profile (e.g. corner) and driver type (driving style).

The main parameters used to compute the gear selection have not changed fundamentally compared to previous automatic gearboxes.
Due to the increasing networking of the gearbox control unit and other vehicle systems, such as engine, ESP and steering angle sensor, today a larger volume of information is available, providing an even better description of momentary driving status and driving style for the gearbox control unit.

Reference

For a detailed description of the basic functions of the DSP, refer to SSP 284 (page 36 onwards).

tiptronic shift strategy

- Automatic upshift upon reaching maximum engine speed
- Automatic downshift when engine speed drops below the minimum threshold
- Kick-down
- Drive-away in second gear by selecting second before setting off[1)]
- Upshift prevention and downshift prevention[2)]

[1)] The vehicle is normally driven away in first gear. It can also be driven away **in second gear** by shifting up into second before setting off (with steering wheel tiptronic or selector lever). This makes driving away easier on low friction road surfaces, e.g. on icy or snow-covered roads.

[2)] In addition to manual gearshifting, the tiptronic function is, for example, necessary for making use of the engine braking effect.
The selector lever gate (with positions "D" and "S") does not allow intervention in order to prevent upshifts or downshifts. The tiptronic function (selector lever in tiptronic gate) can be used to maintain the actual gear position or to select a different gear within the shift limits. In this way, as mentioned, it is possible to use the engine braking effect and prevent repeated shifting back and forth between gears (e.g. in trailer towing mode).

Sport program "S"

In selector lever position "S", a performance-oriented shift program is available to the driver.

When the gearbox control unit is informed that the selector lever is in the "S" position, it alters the gearbox shift characteristic so it is biased toward higher engine speeds. This enhances driving dynamics.

When the selector lever is n position "S", DSP also adapts to driver inputs (driver type analysis) and driving situations.

The "S" program also has the following special features:

- If the selector lever is moved into the "S" position under constant acceleration, the gearbox kicks down within defined limits.
- To ensure a more direct driving response to movement of the accelerator, the vehicle is, where possible, operated with the converter lockup clutch closed.
- If sixth gear is configured as an overdrive gear, only gears 1 to 5 are selected.

Limp-home mode

In the event of faults/malfunctions which activate the mechanical limp-home mode, 3rd gear is always selected during vehicle operation in any gear up to third.

If the gearbox is already in fourth, fifth or sixth gear, the momentary gear is maintained until the selector lever is moved into neutral or the ignition turned off.

When driving away again or restarting the engine in selector lever position "D" or "S", third gear is always selected.

Reverse gear is available (R gear lock is disabled).

The maximum system pressure is set and, as a result, maximum shift pressure is applied to the shift elements. This results in clunky gear engagements.

The converter lockup clutch stays open.

367_064

Reference

For further information, refer to SSP 284 (page 34 onwards).

Towing

When the vehicle is towed, the ATF pump is not driven, as a result of which the rotating parts are not lubricated.

To avoid serious gearbox damage, the following conditions must be met:

- The selector lever must be in position "N".
- A max. towing speed of 50 kph must not be exceeded.
- A max. towing distance of 50 km must not be exceeded.

The engine cannot be jump-started by towing (e.g. if the battery is flat).

If the battery is disconnected or flat, the selector lever's emergency release device must be operated in order to move the selector lever from "P" to "N" (see page 64).

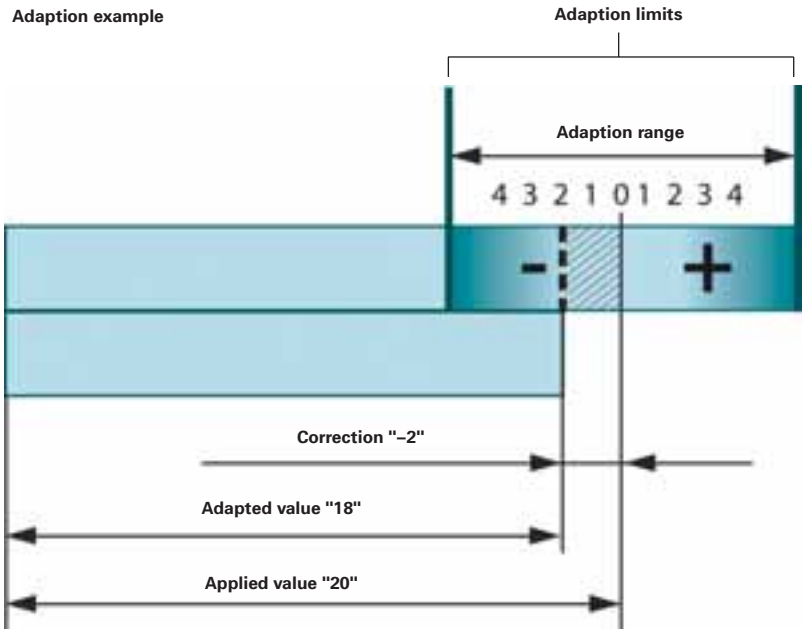
Gearbox adaption (09D gearbox)

Introduction

A prerequisite for good and consistent shift quality, in additon to the design, is precision control of the shift elements. This is the purpose of the gearbox adaption feature. In order to maintain constant shift quality during the entire service life of the gearbox, it is necessary to continuously adapt the various open and closed-loop control parameters and save acquired adaption data. These adjustments and the teach-in process are collectively defined as "adaption".

The task of the adaption function is to compensate for production tolerances in gearbox components and changes which occur during their service life.

The adaption values serve as corrective values, or so-called offsets, which are either added to or subtracted from the default values (applied values) stored in the gearbox control unit.



367_115

Note

Gearbox adaption is a very complex subject. Only basic principles and general topics are discussed in the content of this Self-Study Programme. You will find further information in the relevant expert training course.

Mechanical and hydraulic influencing factors

The shift elements are actuated hydraulically. For this purpose, allowance must be made for the characteristics of the electrical and mechanical control valves. The resistances produced by mechanical friction in components, as well as the pressure of the piston resetting springs, have to be overcome. In addition, attention must be paid to the filling of all ports, lines and cylinder chambers, as well as the clutch clearance. All of these are factors which affect the overall gearshifting sequence, not to mention the parameters which apply to the shift elements themselves.

Parameters of the shift elements

Clutch torque is dependent on the following parameters:

- Type of engine
- Contact pressure (clutch pressure)
- Coefficient of friction

Note:
These parameters must always be in correct correlation with each other so that a specific amount of torque can be transmitted.

The **type** is defined in design terms and therefore constant. **Contact pressure** is regulated by the clutch pressure. **Clutch pressure** is the parameter which is used to control clutch torque and which is most easily influenced. The **coefficient of friction** is a parameter which changes continuously during vehicle operation and throughout the service life of the vehicle.

Now, therefore, let us look the variable parameters, clutch pressure and coefficient of friction.

The coefficient of friction is dependent on the following influencing factors:

- the materials of the friction partners (specification, quality, ageing and wear)
- ATF (specification, quality, ageing and wear)
- ATF temperature
- clutch temperature
- clutch slip

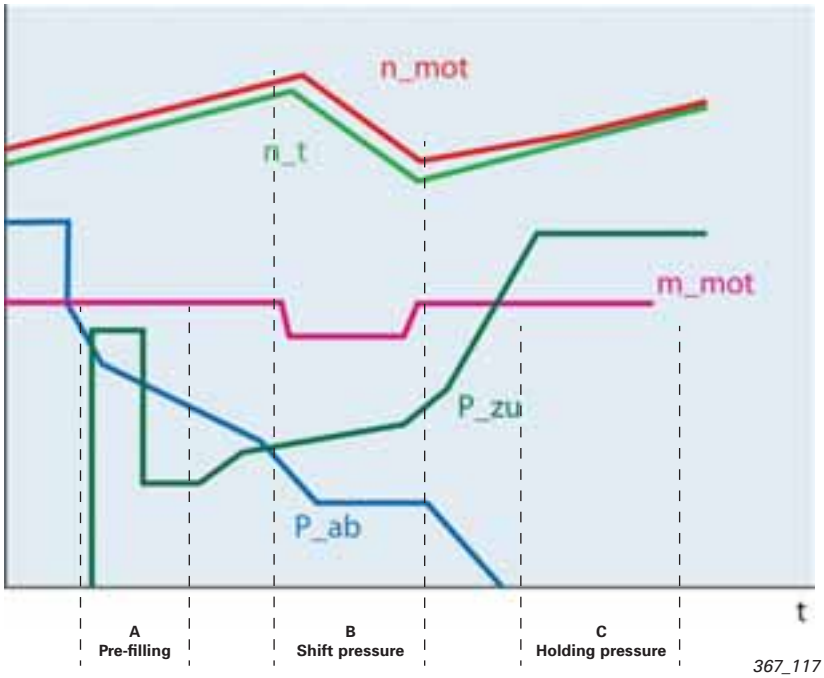
In addition to the previously mentioned mechanical and hydraulic influencing factors, the above influencing factors have to be compensated by adaption.

Fig. 367_117 shows, in a simplified manner, the sequence of a so-called overlap gearshift (upshift under acceleration) and the adaption ranges within which adaption processes take place.
In an overlap gearshift, the power-transmitting clutch maintains the torque at a reduced pressure level until the engaging clutch has taken up the torque.
To make the gearshift sequence as comfortable as possible and to conserve the clutches as best possible, engine torque is reduced while the overlap gearshift is being performed.

Upshift under acceleration sequence

Legend

n_mot	=	engine speed
n_t	=	turbine speed
m_mot	=	engine torque
P_zu	=	engaging clutch
P_ab	=	disengaging clutch
t	=	time
A, B, C	=	adaption range

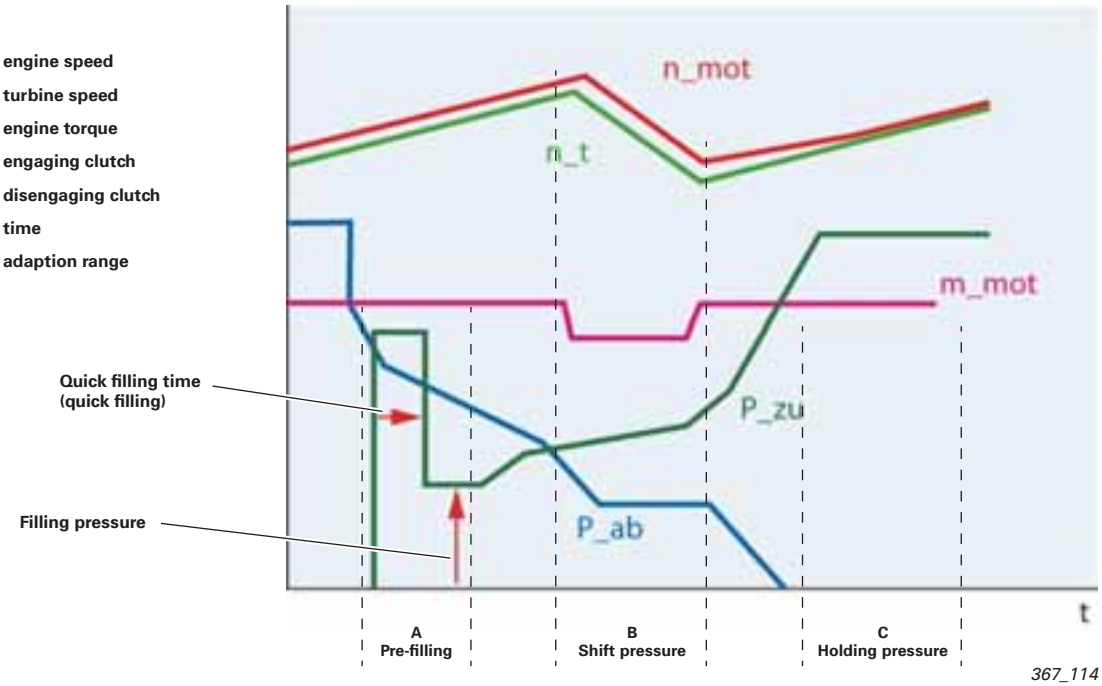


367_117

Upshift under acceleration sequence

Legend

n_mot	=	engine speed
n_t	=	turbine speed
m_mot	=	engine torque
P_zu	=	engaging clutch
P_ab	=	disengaging clutch
t	=	time
A, B, C	=	adaption range



367_114

The following aspects of the gearshift sequence are adapted:

- Quick filling time (pre-filling)
- Filling pressure (pre-filling)
- Shift pressure (engaging and disengaging clutch)
- Holding pressure

Explanation / definition of the individual adaption ranges:

Quick filling time = period during which increased pressure is applied to the clutch in order to engage the clutch assembly and fill the clutch cylinder chamber.

Filling pressure = pressure which is required to compress the clutch plate assembly to the point where the clutch just comes into engagement but a significant amount of this torque is still not transmitted.

Shift pressure = pressure which acts during the slip phase.

Holding pressure = pressure required to keep the clutch securely closed.

Adaptions are made during gearshift cycles and when the vehicle is stationary with the engine running at idling speed.

Certain **adaption conditions** have to be met so that adaptions can be performed:

- The ATF temperature must be between 66 °C and 110 °C.
- Engine load must be within a defined range (very low engine load or low accelerator pedal angle).
- No faults registered in the fault memory of the gearbox control unit
- A defined driving state (e.g. certain adaptions are only performed when the vehicle is stationary and when the engine is running at idling speed)
- Good road conditions (no uphill gradient or downhill gradient, straight road)

The gearbox adaption status is established over a prolonged period of time in service. A further feature of the gearbox control unit is that the adaption frequency is reduced with increasing mileage. This means that the adaption frequency of a gearbox with low mileage or with cancelled adaption values is very high. On the other hand, gearboxes with high mileage has longer adaption intervals.

Deleting adaption values

The adaption values of the 09D gearbox are preserved even if the power supply to the gearbox control unit is cut off (e.g. battery is disconnected, etc.). However, they can be deleted using the "Basic setting 04" function on the diagnostic tester.

The function Basic setting 04 can be used not only to delete adaption value, but also to teach in the kick-down point and activate the steering wheel tiptronic function (if available).

When does the basic setting procedure have to be performed?

- after replacing the gearbox
- after replacing the gearbox control unit J217
- after changing the ATF
- after repair work on the gearbox (e.g. replacing the valve assembly, clutch repairs)
- after replacing or after removing and installing the accelerator position sender G79/G185
- after complaints about shift comfort
- possibly after engine repairs (e.g. after replacing engine, engine control unit, etc.)
- possibly after a software update

It is recommended to perform an adaption drive after deleting adaption values or carrying out the basic setting procedure.

An adaption drive must always be performed after deleting adaption values due to complaints about shift comfort.

Adaption drive

Step 1:
Firstly, the aforementioned adaption conditions must be fulfilled.

Step 2:
When the engine is running at idling speed, the vehicle is stationary and the brake is applied, move the selector lever from "N" to "D" and keep it in position "D" for at least 3 sec.
Repeat this procedure 5 times. Then carry out the same procedure for the gearshift from "N" to "R".

Step 3:
Accelerate the vehicle in selector lever position "D" from a standing start until 6th gear is engaged and the vehicle is travelling at a speed of approx. 80 kph, or more. **The main thing is that an accelerator pedal angle between 25 % and 30 % is maintained (check this using the diagnostic tester).** After this, allow the vehicle to coast and bring the vehicle to a standstill within 60 seconds by applying minimal brake pressure. Repeat this procedure 10 times.

Step 4:
Shift quality assessment.

Gear selector

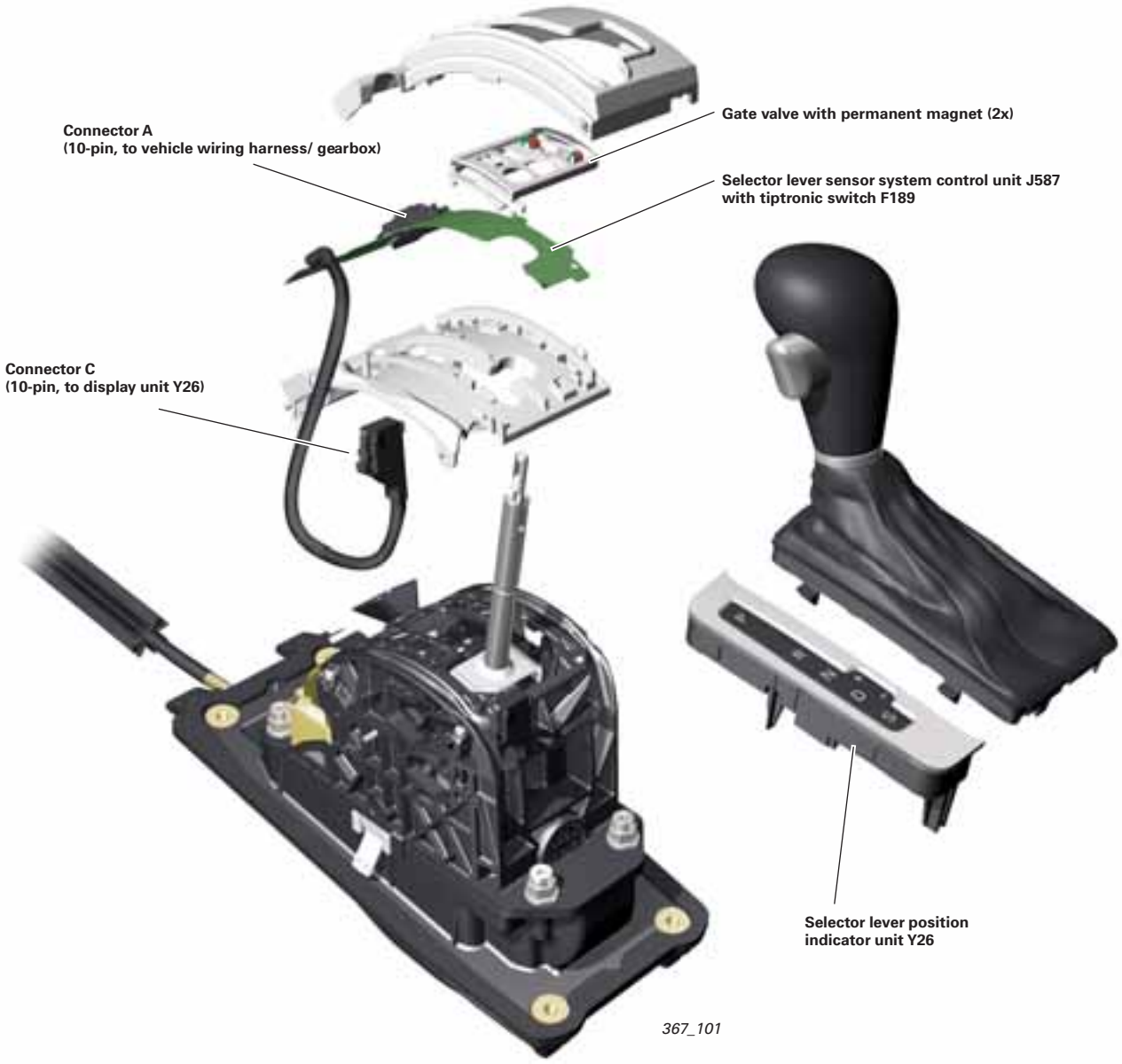
The gearshift mechanism is connected mechanically to the automatic gearbox via the selector lever cable. It also performs several tasks and functions, for which an electrical connection exists to the gearbox control unit and the vehicle periphery.

Mechanical functions:

- Actuation of the parking lock
- Actuation of the selector valve of the hydraulic control unit
- Actuation of the multi-function switch on the gearbox
- P/N lock (shift lock)

Electrical functions:

- P/N lock control
- Ignition key withdrawal lock
- Activation of the selector lever position indicator unit
- tiptronic function



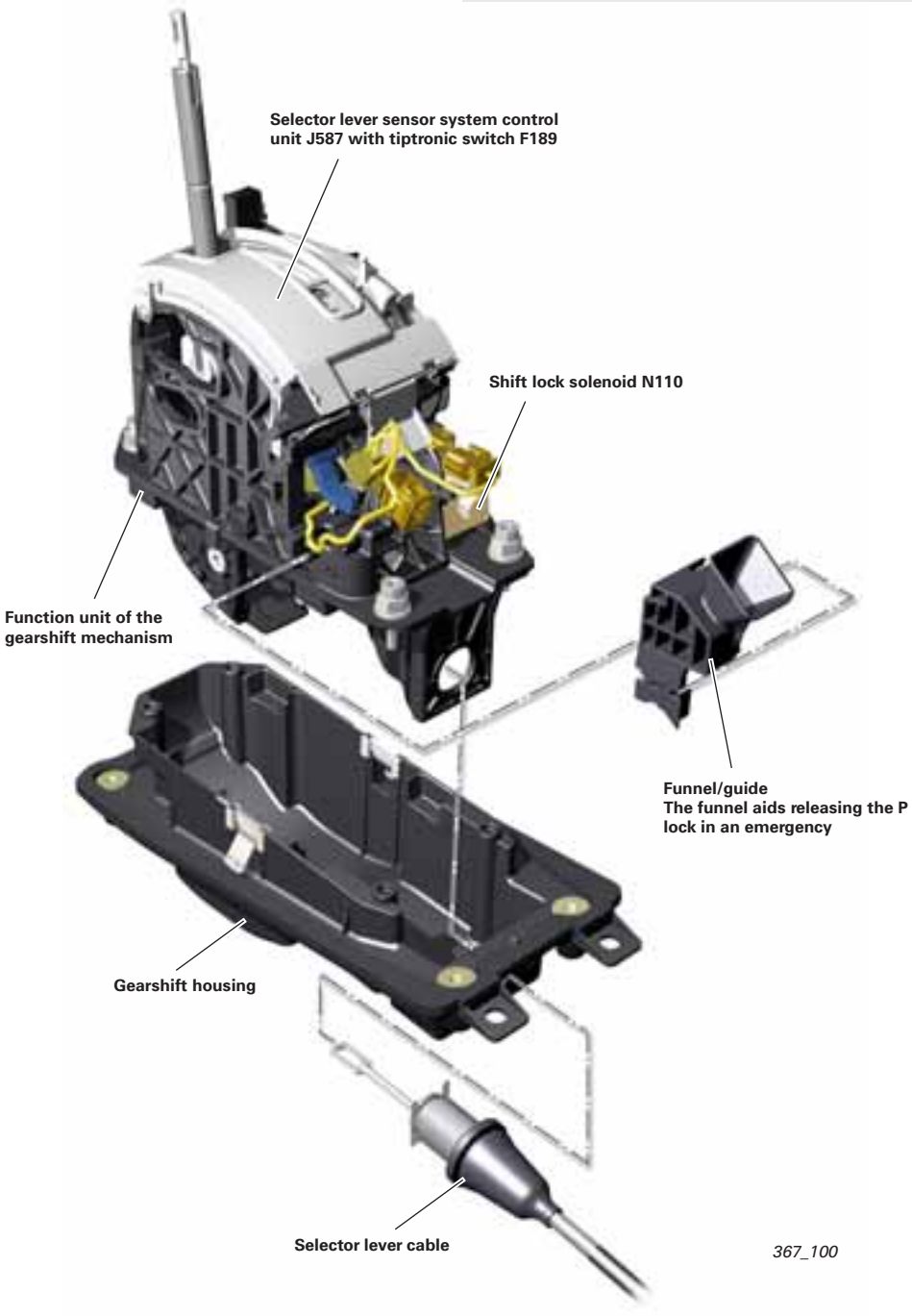
The design and functioning of the gearshift mechanism on the Audi Q7 are largely identical to the gearshift mechanism on the Audi A6 ´05 (up to approx. mid-2006).
Here are the main differences:

The gearshift mechanism can be removed from the interior of the vehicle in order to make repairs (e.g. to replace microswitch F305).

When replacing the gearshift mechanism, the selector housing (fitted from the outside) remains in the vehicle. Only the function unit of the gearshift mechanism needs to be replaced.

Reference

See also Audi iTV broadcast of 28.03.2007 "Gearshift Mechanisms of the Automatic Gearbox".

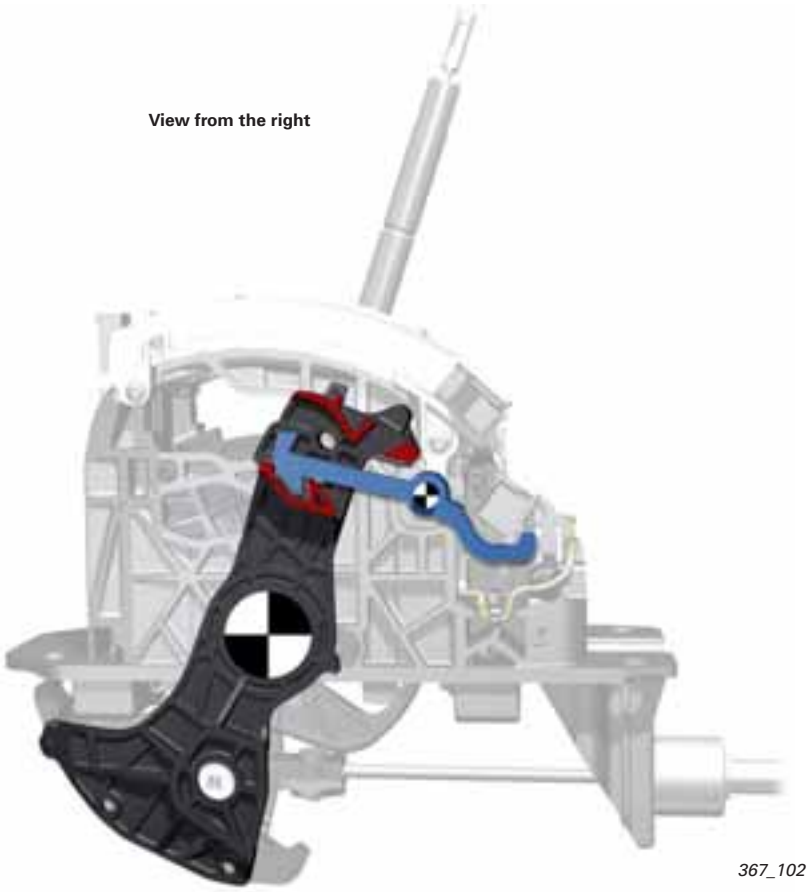


Shift locks (P lock and P/N lock)

Basically, a distinction is made between the P/N lock while driving and the P/N lock with the ignition "on" and locking of the selector lever in the "P" position with the ignition key removed (P lock).

The kinematics of the locking mechanism are designed in such a way that locking is possible both in the deenergised state of the N110 (position "P") and in the energised state (position "N").

View from the right



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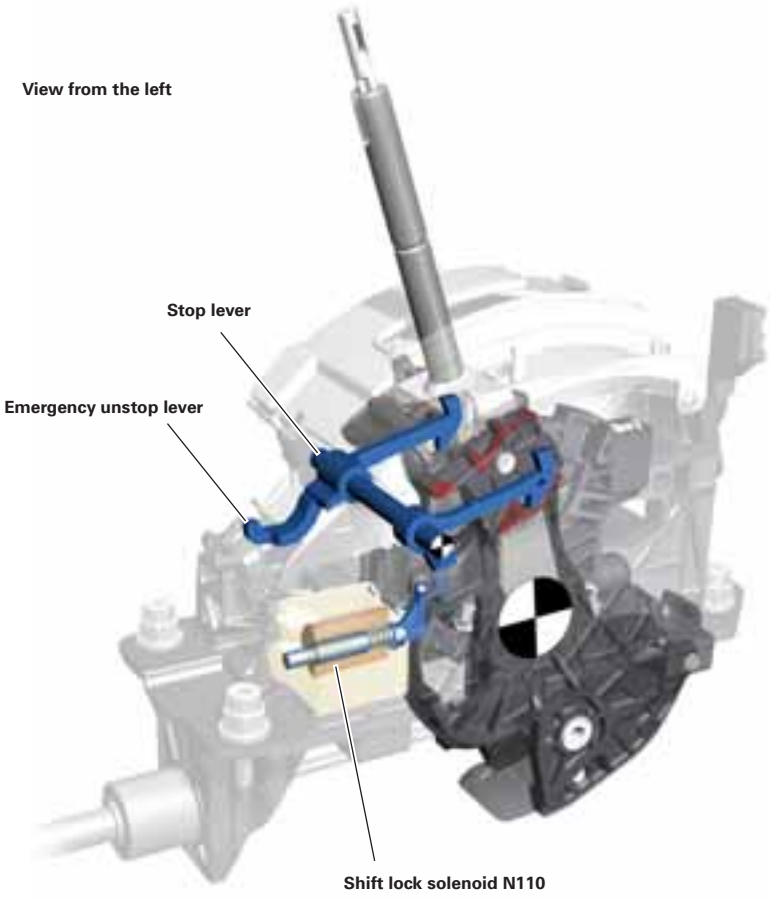
View from the left



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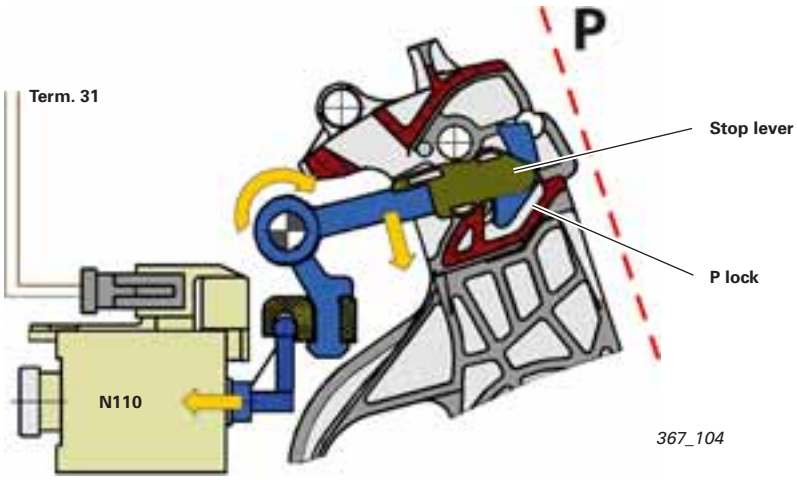
Shift lock in selector lever position "P"

Locking of the selector lever in lever position "P" is ensured by the automatic locking of the stop lever in this position.

If solenoid N110 is deenergised, the stop lever, assisted by a spring in solenoid N110, drops automatically under gravity into the P lock as soon as the selector lever is moved into position "P".

To release the shift lock, solenoid N110 is energised, with the result that the solenoid pushes the stop lever back out of the P lock.

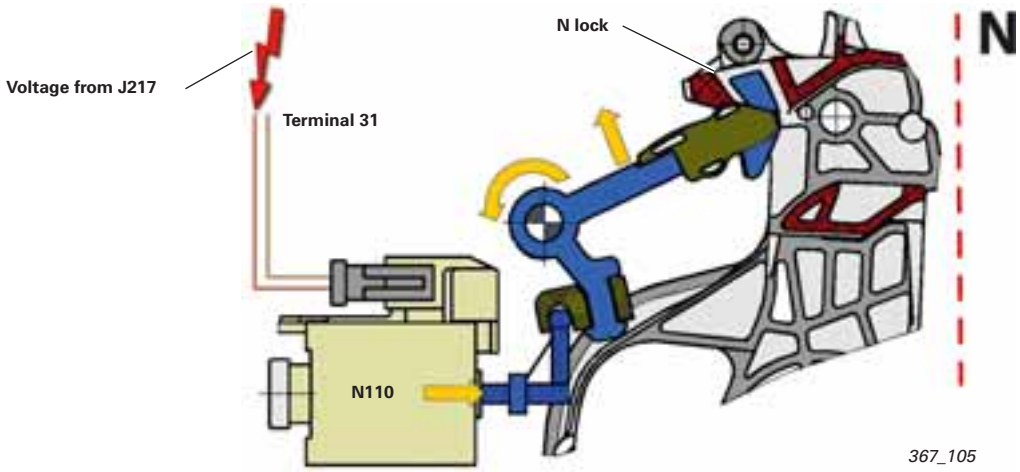
In the event of a fault or power failure, the selector lever remains locked in position.
There is an emergency release mechanism for such cases (refer to "Emergency release").



Shift lock in selector lever position "N"

If the selector lever is in position "N", solenoid N110 is activated, whereupon it pushes the upper hook of the stop lever into the N lock and locks the selector lever.

To release the shift lock, solenoid N110 is deenergised, and the stop lever drops down (as described under "Shift lock in selector lever position "P").



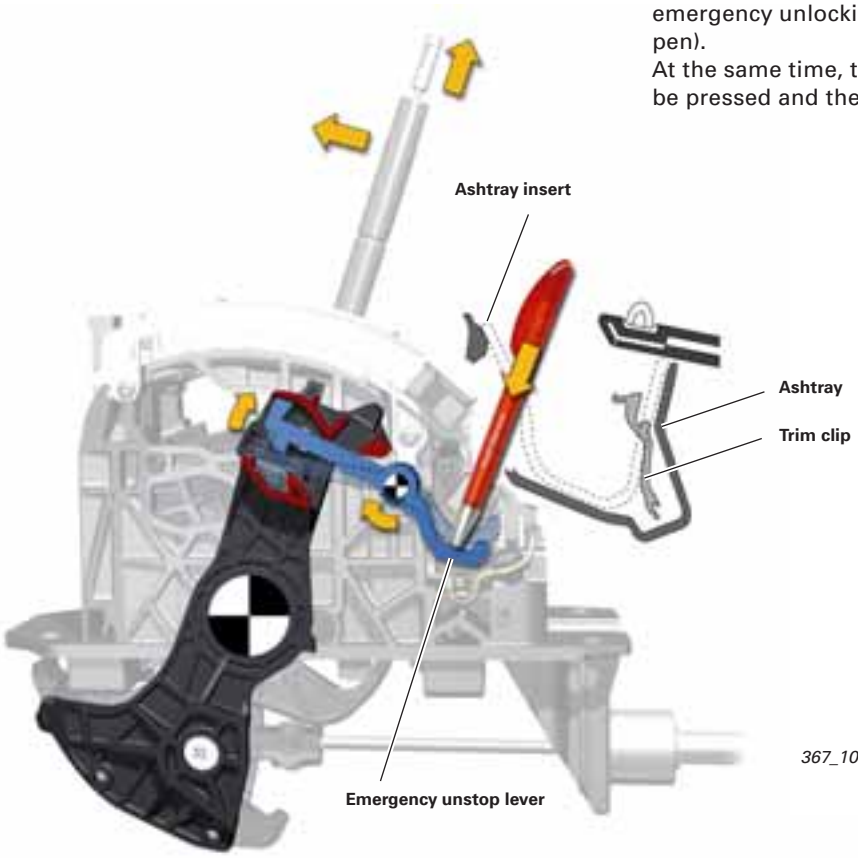
Emergency release of the P lock

Due to the fact that the P lock is only unlocked when solenoid N110 is activated, the selector lever remains locked in position "P" in the event of a malfunction (e.g. flat battery, failure of solenoid N110, etc.).

To enable the vehicle to be moved in such a situation, there is an emergency release lever on the left-hand side of the stop lever.

The emergency release mechanism can be accessed by removing the ashtray insert and the trim clip behind it.

The stop lever is unlocked by pushing down the emergency unlocking lever (e.g. using a ball point pen).
At the same time, the button on selector lever must be pressed and the selector lever pulled back.



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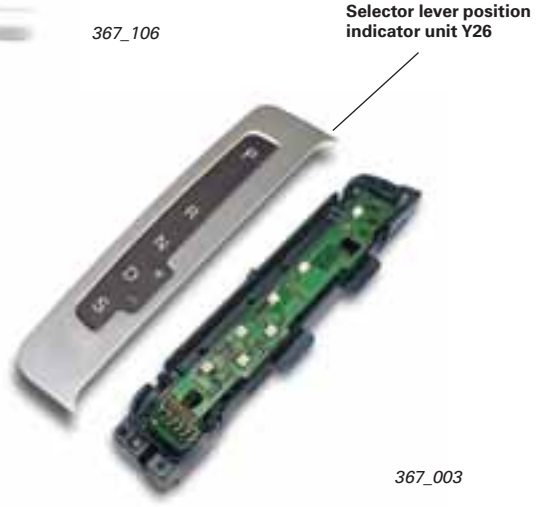
Selector lever position indicator unit Y26

The LEDs on the display unit are powered by the selector lever sensor system J587 and activated according to the selector lever position.

The brightness of the LEDs is controlled via term. 58d (PWM signal, dimming) and varies with voltage level (generated by J587).
This means that the LED which indicates the current selector lever position is activated by a "pulsed voltage" of approx. 12 V, while approx. 4 V is applied to all other LEDs.



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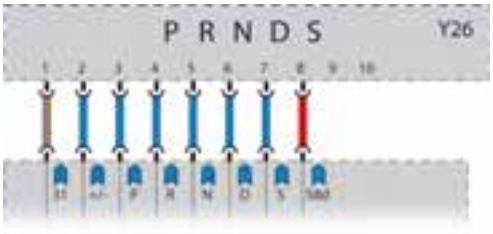

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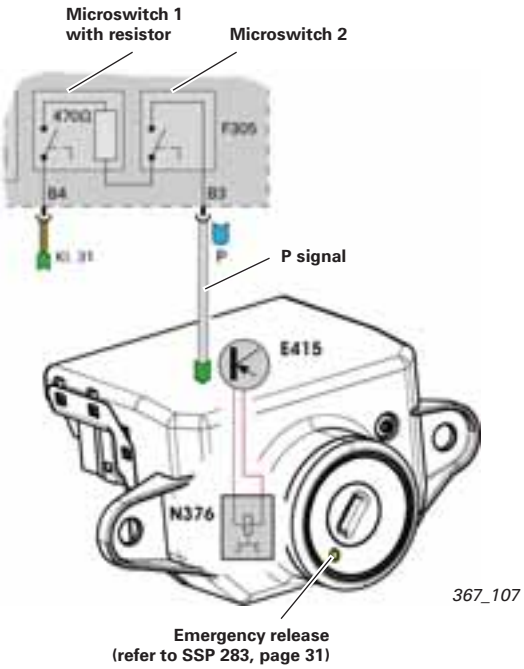
Ignition key withdrawal lock

The ignition key withdrawal lock is realised automatically by a mechanical locking mechanism integrated in the entry and start authorisation switch E415.

The ignition key withdrawal lock is released electro-mechanically by brief activation of the ignition key withdrawal lock solenoid N376. For this purpose, switch E415 requires information on selector lever position "P".

The information on selector lever position "P" is supplied by the two mechanical microswitches F305. They are connected in series and form a unit.

In selector lever position "P", the two switches are closed and deliver a ground signal directly to E415. If the ignition is turned off, solenoid N376 is energised by E415 for a short time, whereupon an unlocking mechanism cancels the ignition key lock.



For safety reasons, two microswitches are fitted:

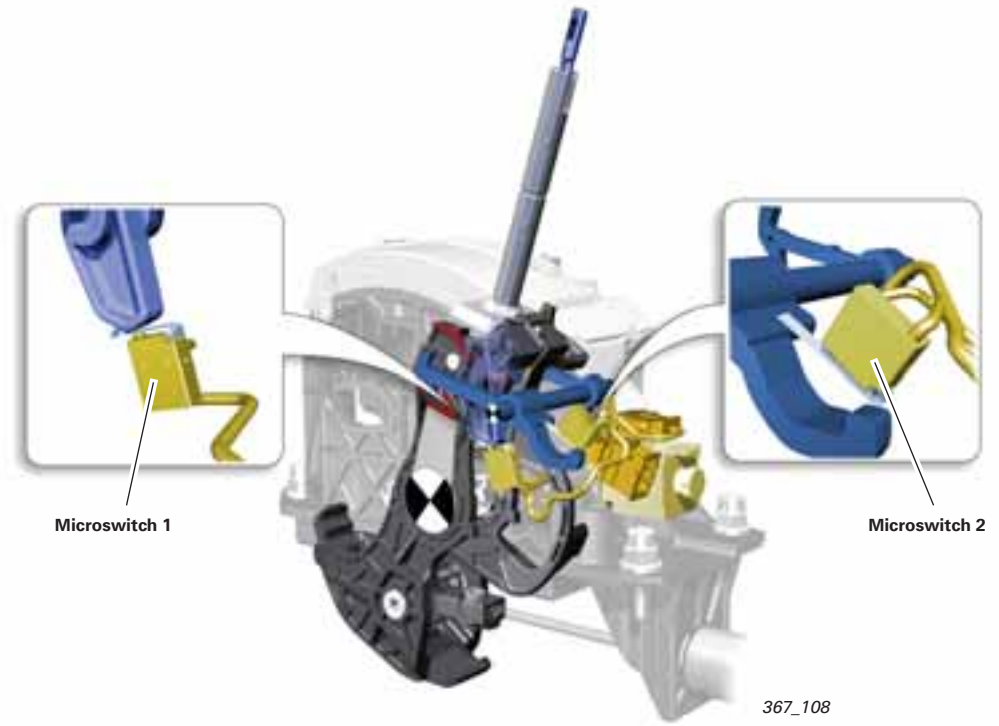
Microswitch 1 is closed the selector lever button is released in selector lever position "P" (the button is not pressed).

The series-connected resistor enables the signal line to be diagnosed.

Microswitch 2 is closed when the stop lever for the P/N lock is in its home position (refer to "Shift locks").
It signals when the selector lever is actually locked in position "P".

Reference

The basic functions of the ignition key withdrawal lock are described in Self-Study Programme 283 (page 28 onwards).



Selector lever sensor system J587

The functions of the selector lever sensor system J587 are limited to generating the tiptronic signal for the tiptronic function (from F189) and the P/R/N/D/S signal for activating the selector lever position indicator unit Y26.

P/R/N/D/S signal

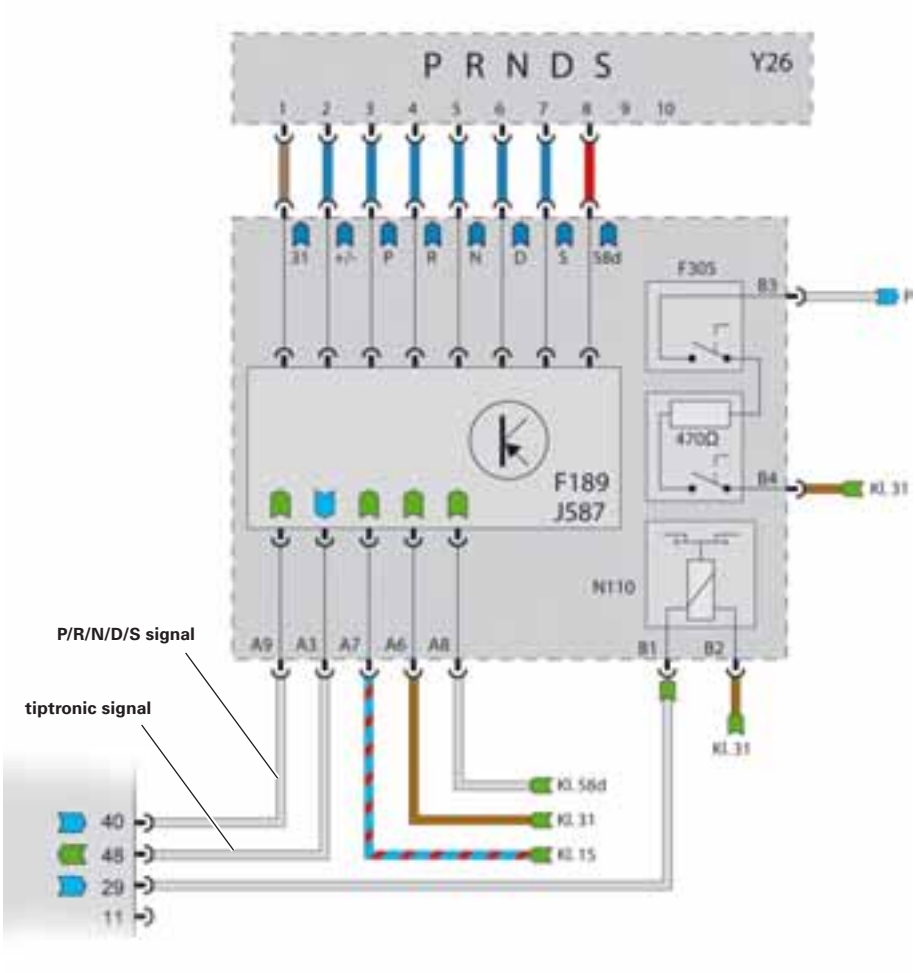
The information on the selector lever position (P/R/N/D/S signal) is sent from the gearbox control unit to the selector lever sensor system in the form of a frequency-modulated square-wave signal (FMR signal). The relevant LEDs on display unit Y26 are then activated.

A defined signal frequency is assigned to each selector lever position (see DSO images).
The selector lever sensor system evaluates the signal and activates the relevant LED on display unit Y26 (ground activation), see also page 64.

The advantages of this new feature are:

- Synchronous indication of the selector lever position in the dash panel insert and on the selector lever.
- Cost savings through simplification of the selector lever sensor system control unit J587 (elimination of additional Hall sensors).

Functional diagram of the gear selector mechanism with 09D gearbox



F189	tiptronic switch
F305	Gear selector position P switch
J587	Selector lever sensor system control unit
N110	Selector lever lock solenoid
Y26	Selector lever position indicator unit

DSO images of the P/R/N/D/S signals

DSO connection:

– black probe tip Pin 6*
– red probe tip Pin 9*

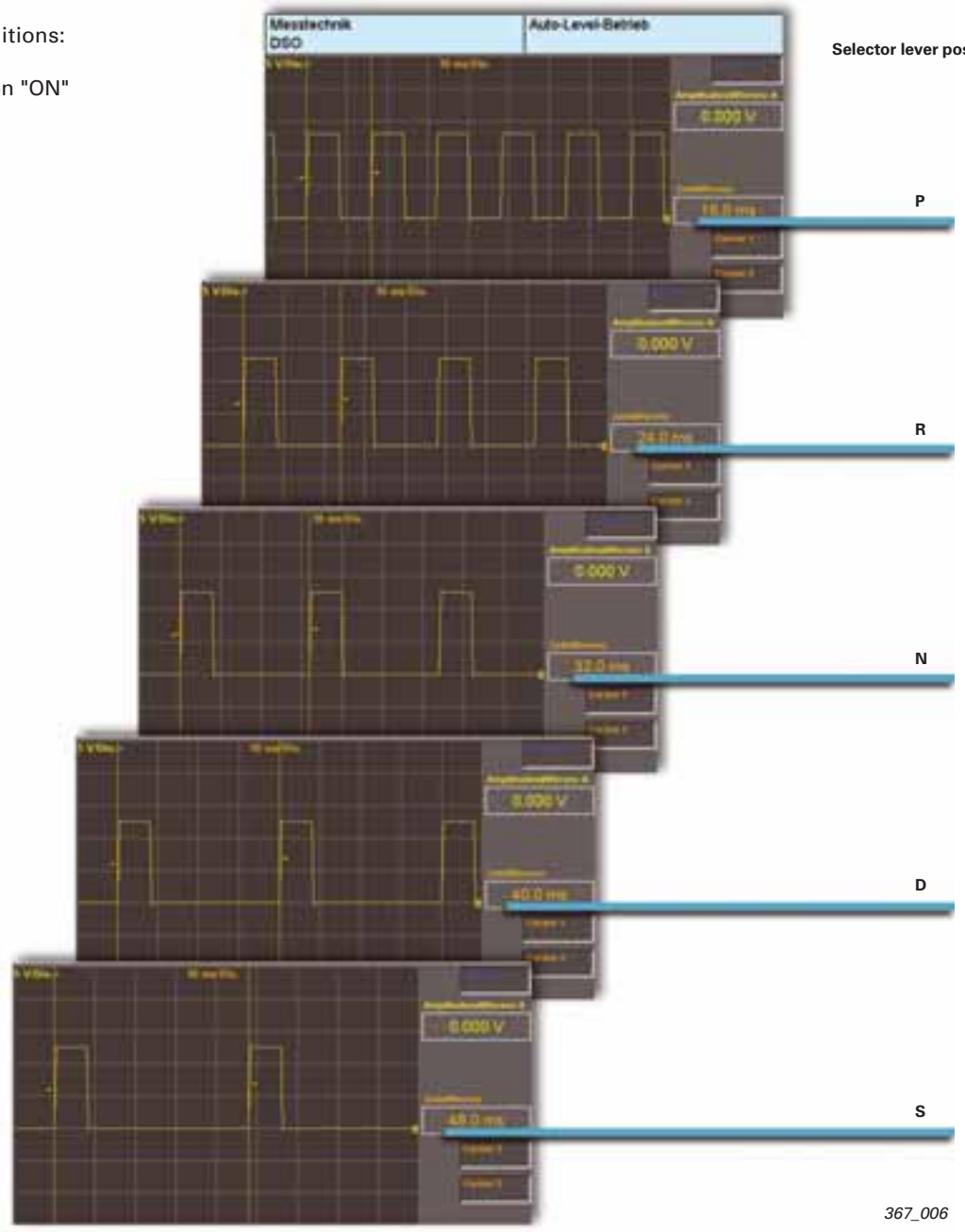
* Pin on connector A or test adapter V.A.G. 1598/42

Test equipment:

– V.A.G 1598/54 with
– V.A.G 1598/42
– VAS 5051

Test conditions:

– Ignition "ON"



tiptronic signal

The information selector lever in tiptronic gate, selector lever in Tip+ position or selector lever in Tip– position is transferred via a discrete line (see DSO images) to the gearbox control unit in the form of a frequency-modulated square-wave signal (FMR signal).

Advantages of this new feature:

– Higher operational reliability - only one line to the control unit is required (instead of three), thereby reducing the number of potential sources of fault.

– Improved self-diagnosis

DSO images of the tiptronic signal

DSO port:

– black probe tip Pin 6*
– red probe tip Pin 3*

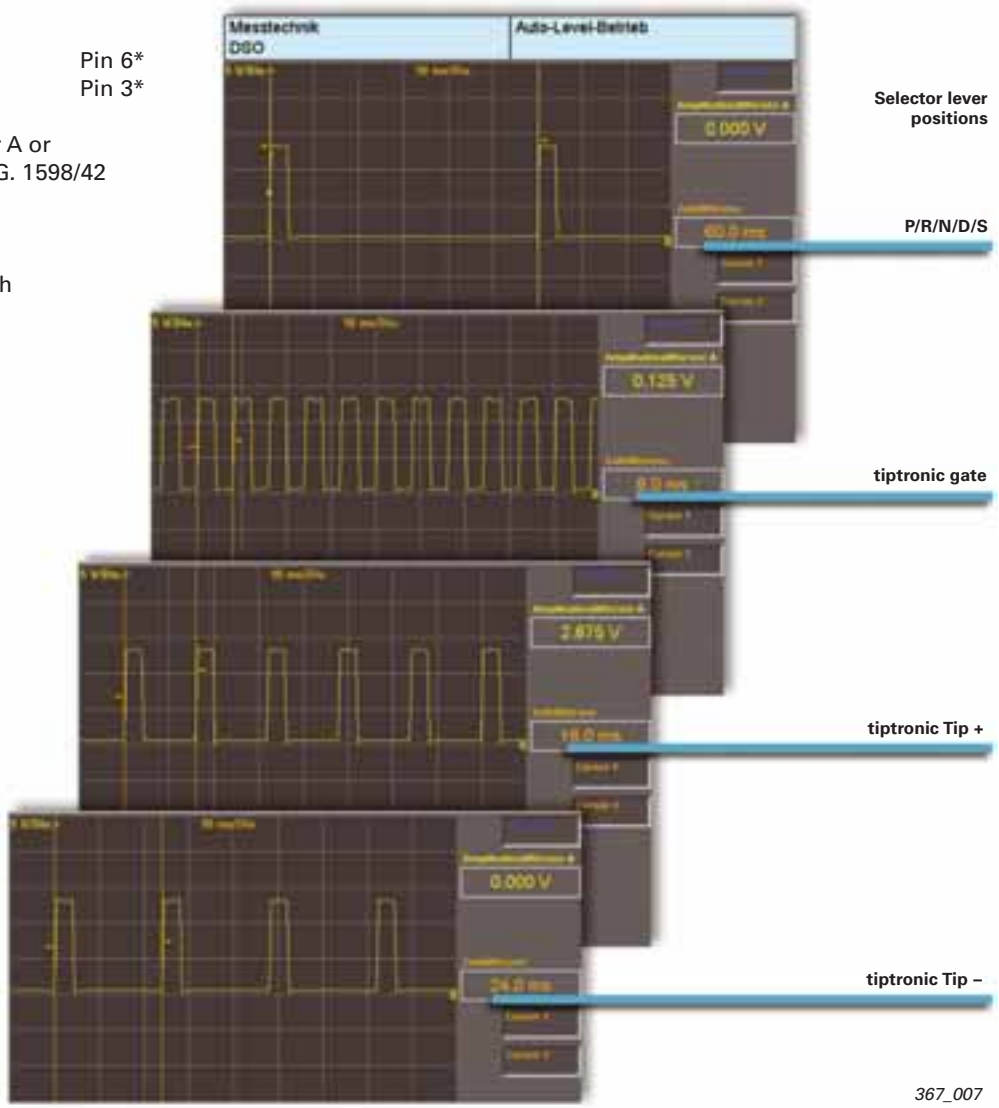
* Pin on connector A or test adapter V.A.G. 1598/42

Test equipment:

– V.A.G 1598/54 with
– V.A.G 1598/42
– VAS 5051

Test conditions:

– Ignition "ON"



Test adaptor V.A.G 1598/54 is available in combination with test box V.A.G 1598/42 for testing the signals to and from the **gearshift mechanism**.

Test adaptor V.A.G 1598/48 is available in combination with test box V.A.G 1598/42 for testing the signals to and from the **09D gearbox**.

Reference

For further information about the tiptronic signal and tiptronic switch F189, please refer to SSP 291 (page 50 onwards).
The selector mechanism has the same basic functions as that on the Audi A3'04, having only a different signal waveform.

Glossary

Ratio spread

In the context of gearboxes, the "spread" of a gearbox is its "range of ratios". The ratio spread is the ratio of the lowest (first) and highest (sixth) gear ratios. The ratio spread value is obtained by dividing the first gear ratio by the highest gear ratio (in this case, 6th gear).

Example (using the 09G gearbox):

i First gear 4.148
i Sixth gear 0.686 4.148 : 0.686 = 6.05 (value rounded up)

The advantages of a wide ratio spread are:
In addition to a high starting torque ratio (for high tractive power), a low end torque multiplication ratio is achieved. The latter provides a reduction in engine speed, which, in turn, curbs noise levels and improves fuel economy.

A wide ratio spread requires a certain number of gears in order to avoid overly large speed differentials during gearshifts (ratio steps).
When changing gear, engine speed must not be allowed to enter low-torque RPM ranges which will adversely affect or prevent acceleration.

The best solutions are multiple gears or, better still, a continuously variable transmission ratio, as used in the multitronic gearbox.

Gearbox adaption

A gearbox type is, depending on torque and engine type, adapted to different engine variants through:

- the number of plate pairs used for the clutches and brakes
- the adaptation of the ATF pressure to the clutches and brakes
- the configuration of the gear pairs, planetary gear sets (e.g. 4 planetary gears instead of 3), shafts and mountings
- gearbox housing reinforcement
- the transmission ratios of the final drive and idlers
- the size of the torque converter
- the torque converter characteristic (torque conversion factor or torque converter multiplication).

The ratios of the individual gears are generally constant.

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