Service Training

6-speed Automatic Gearbox 09G

Self-Study Programme 291

Dynamics and economy

The 6-speed automatic gearbox 09G sets new standards in the segment of transversely mounted multi-step automatic gearboxes

- Low weight
- Wide *ratio spread**
- Compact gearbox dimensions
- High shifting speed
- High level of shift comfort

Brief technical description

6-speed automatic gearbox using the Lepelletier planetary gear set concept.

The wide *ratio spread** of 6.05 provides flexibility in use (sport or economy mode).

Only five gear shifting components are required.

Highly compact, lightweight and powerful.

There are three gearshift modes to choose from: sport program and manual gear selection by tiptronic.

In triponic mode, it is possible to start in second gear.

* you will find an explanation of the terms/ paragraphs marked with an asterisk as of page 72

This Self-Study program gives general descriptions of the 09G gearbox and shows the special features in combination with the Audi A3 '04 and Audi TT.

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The basics for this Self-Study Programme are covered in the multimedia training course "Power Transmission 2" and in the previously published self-study programmes on multi-step automatic gearboxes.

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

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General

Gearbox periphery

Gearbox subassemblies

Gearbox control

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Introduction

The 6-speed automatic gearbox 09G is used in the Audi A3 '04 and Audi TT.

The gearbox is a conventional multi-step automatic with hydrodynamic torque converter and electrohydraulically operated planetary gear.

The 09G gearbox is developed and manufactured by the Japanese transmissions specialist AISIN AW CO., LTD.

In association with Audi's development engineers, the gearbox has been adapted to suit the characteristics specific to each vehicle and engine*.

Compared to the predecessor gearbox (model 09A), the weight of gearbox 09G has been reduced by 19.5 kg from 102 kg to 82.5 kg, even though a sixth gear has been added.
This was achieved by using the Lepelletier gear set concept and through selective optimisation of component parts.

With the additional gear, the *spread** has been increased to 6.05. This figure surpasses that of all front/transversely mounted multi-step automatic gearboxes currently on the market and matches the ratio spread of variable automatic gearboxes.

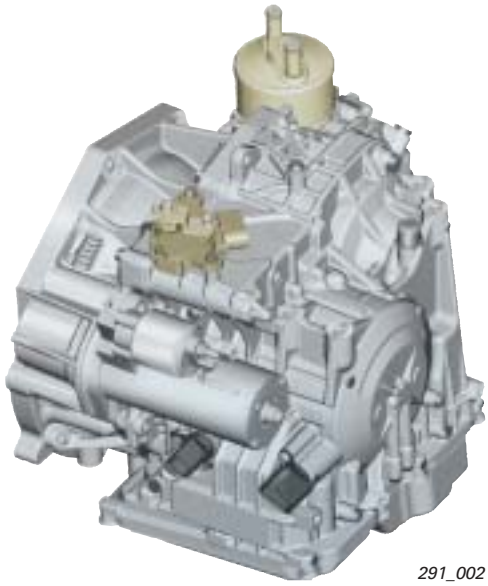
The Lepelletier gear set concept, as found previously in the Audi A8 gearbox 09E, is used in gearbox 09G.

The advantage of the Lepelletier gear set concept is its simple, space-saving and low-weight design. It combines a simple planetary gear train with a Ravigneaux gear seat further down. This allows a harmonious 6-speed transmission to be achieved using only five gear shifting components.

The six forward gears and reverse gear are engaged by three multi-plate clutches and two plate brakes.

Reference

For further information on the Lepelletier gear set concept, refer to SSP 283.



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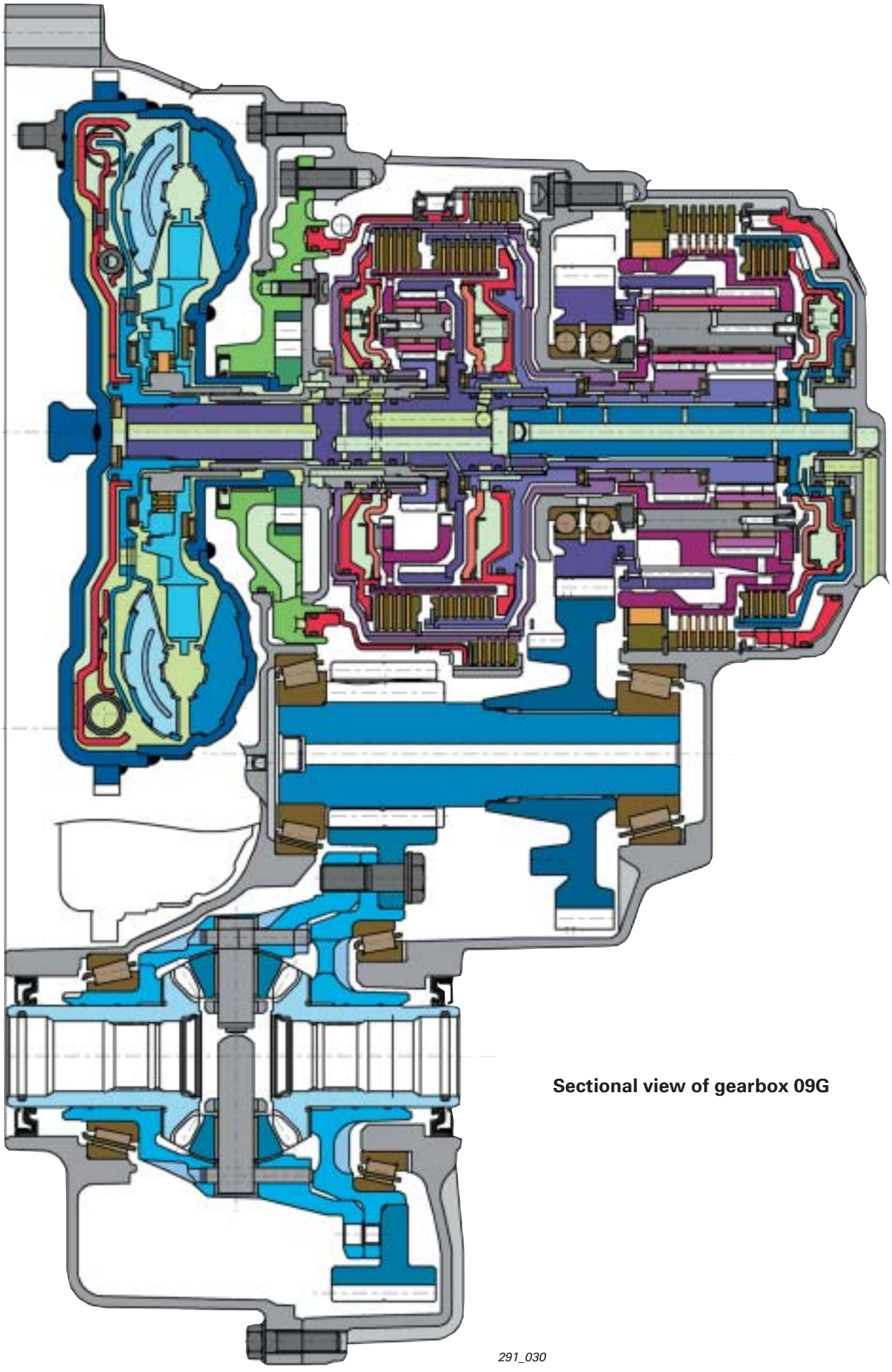
Specifications	
Developer/manufacturer	AISIN AW CO, LTD Japan
Designations	Manufacturer: TF-60SN Audi AG: AQ250-6F Service: 09G
Gearbox type	electrohydraulically controlled 6-speed planetary gear (multi-step automatic gearbox) with hydrodynamic torque converter and slip-controlled converter lock-up clutch for front-wheel drive and transverse installations
Control	hydraulic control unit integrated in the oil sump with external electronic control unit Dynamic Shift Program DSP with separate sport program in "Position S" and the tiptronic shift program for manual gearshifts (optionally available with tiptronic steering wheel)
Torque in Nm	up to over 300 Nm depending on type
Ratios: **Planetary gear** **(for engine codes** **GSY 1.6 l and** **GJZ 2.0 l FSI)**	First gear 4.148 Second gear 2.370 Third gear 1.556 Fourth gear 1.155 Fifth gear 0.859 Sixth gear 0.686 Reverse gear 3.394
Idler	Z52/49 1.061 (GSY and GJZ)
Final drive	Z61/15 4.067 (GSY) or Z58/15 3.867 (GJZ)
i constant*	4.316 (GSY) or 4.102 (GJZ)
Spread* **(GSY/GJZ)**	6.05
ATF specification	G 052 025 A2, Esso JWS 3309
Capacity	7.0 litre (refilling) lifetime filling
Weight in kg	approx. 82,5
Overall length in mm	approx. 350

The gearbox in the Audi A3 '04 (with 1.6 l FSI and 2.0 l FSI engines) is configured as a so-called 5+E gearbox. Max. speed is reached in fifth gear. Sixth gear is an overdrive gear which reduces engine revs, improves driving comfort and increases fuel economy.

The gearbox in the Audi TT is configured as a so-called sport gearbox.
Max. speed is attained in sixth gear.
Sixth gear provides closer ratios and enhanced driving dynamics.

Reference

* You can find an explanation of the marked terms/paragraphs as of page 72.



Sectional view of gearbox 09G

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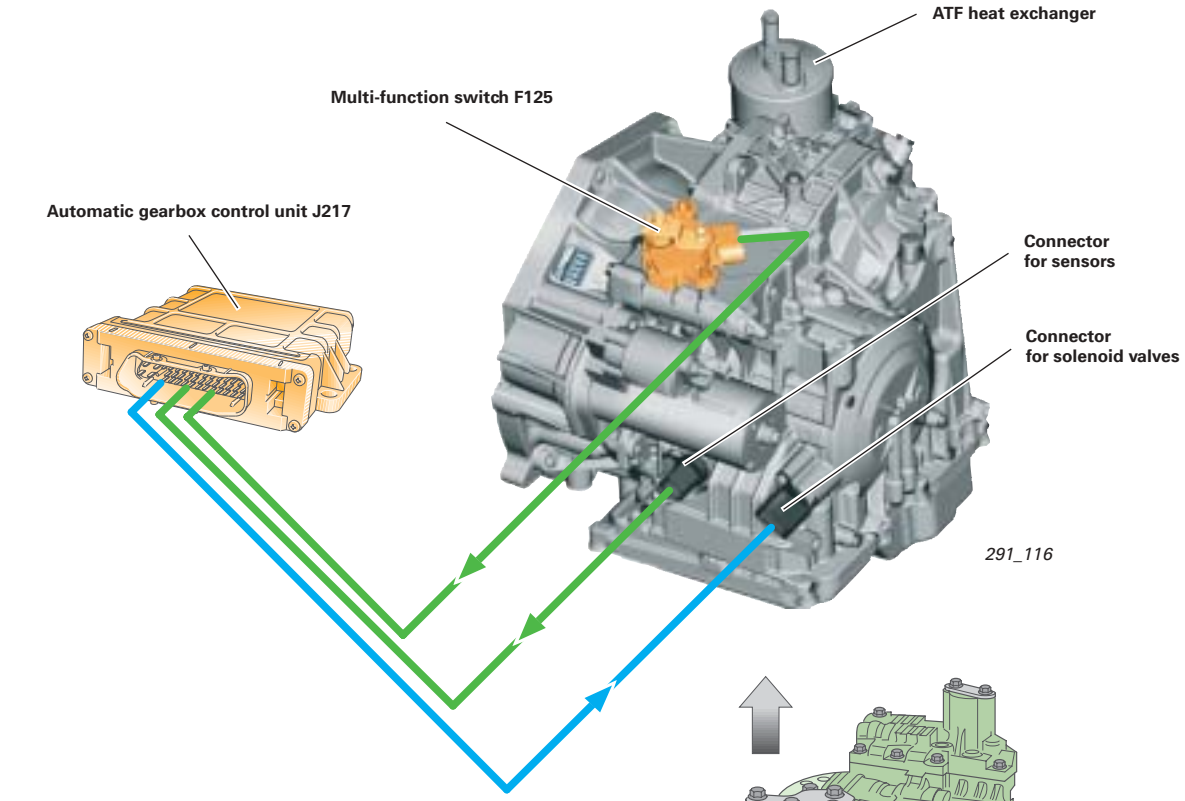
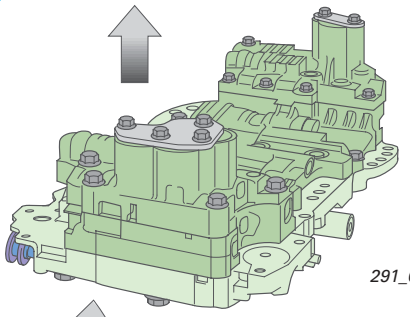
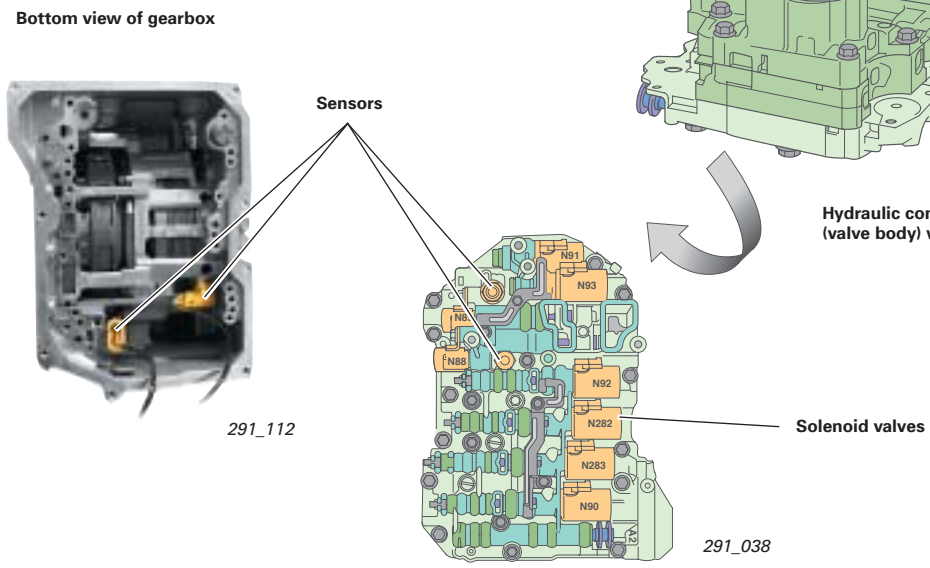
Components overview:







Legend to sectional view of gearbox

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

Gear selector of the Audi A3 ‘04

Selector gate cover/selector lever gate

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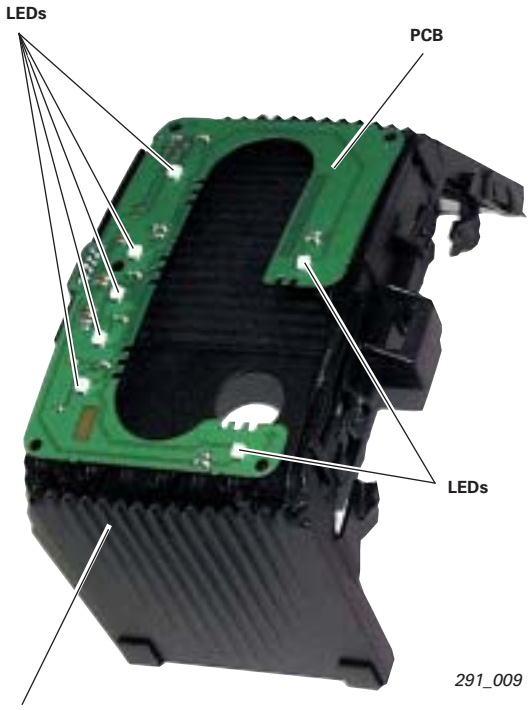
Selector gate cover



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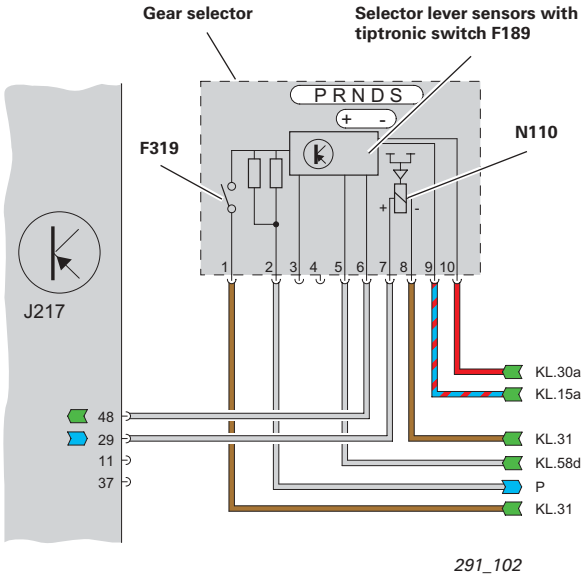
Selector lever gate

The "D–S" gear selector, as found in higher vehicle classes, is used in combination with the new automatic gearbox variants.

On the selector lever gate PCB, there are LEDs for illuminating the various selector lever and tiptronic positions on the selector gate cover. These LEDs are activated by the selector lever sensors integrated in the gear selector.



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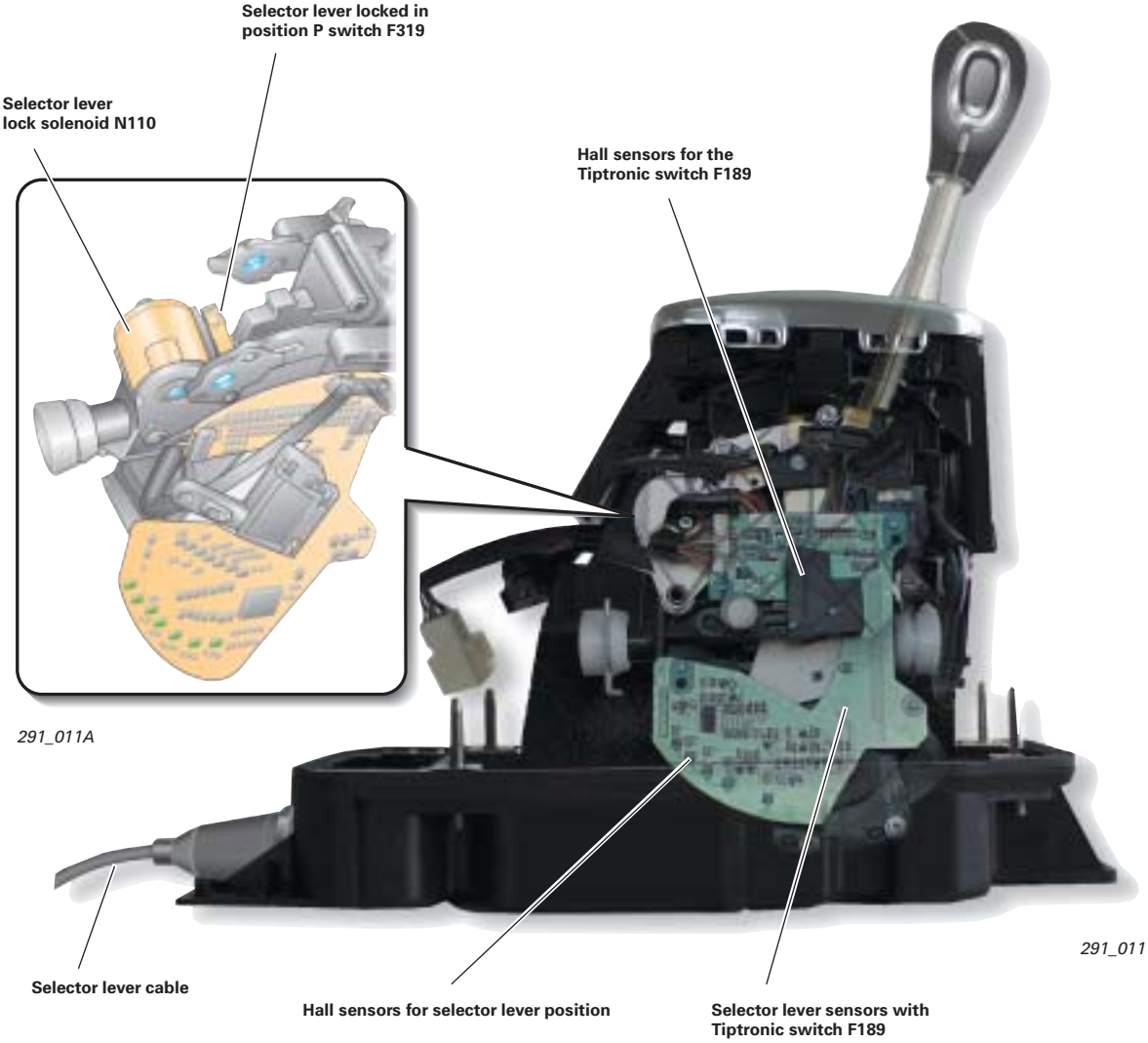
Legend

F319	Selector lever locked in position P switch
J217	Automatic gearbox control unit
N110	Selector lever lock solenoid
P	signal to steering column electronics control unit J527

Output

Input

Gear selector/design



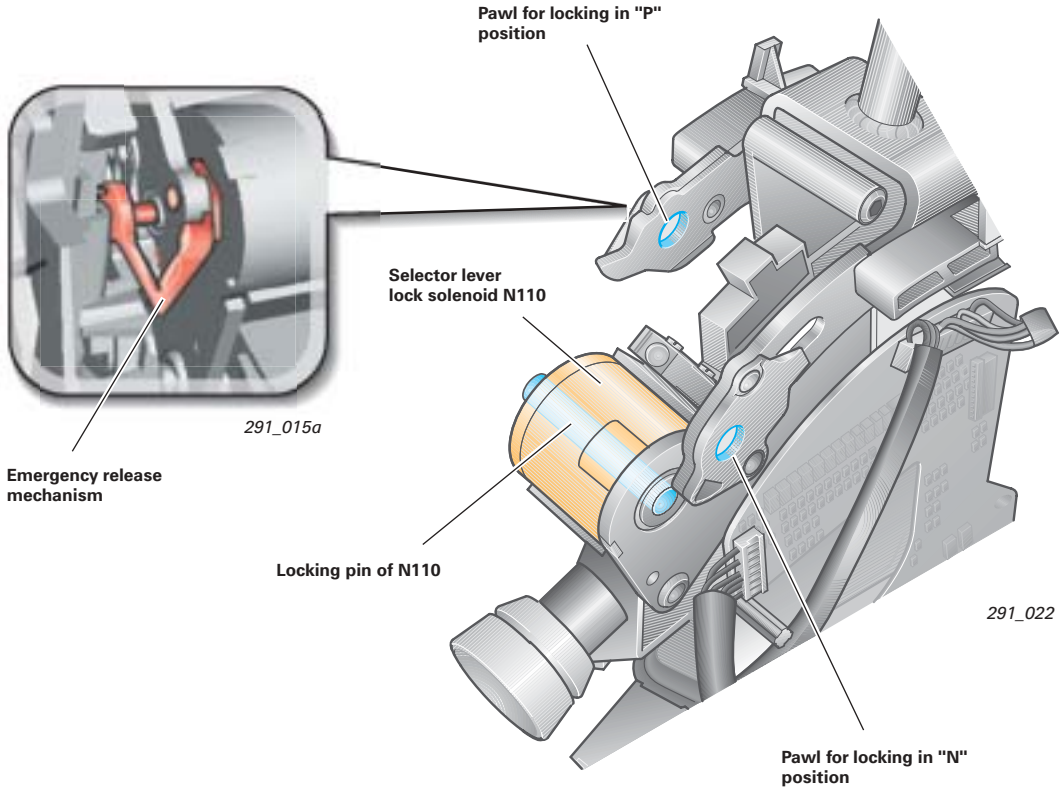
Integrated in the gear selector of the Audi A3 '04 are the sensors for the selector lever positions and the tiptronic function (F189).
The various selector lever positions are determined by Hall sensors which are operated by permanent magnets and processed by the evaluation electronics.
The evaluation electronics activate the LEDs on the selector gate cover according to the selector lever position.

The signals from the tiptronic switch F189 are also evaluated by the selector lever sensors and transferred to the gearbox control unit through a separate interface in the form of a frequency-modulated square-wave signal (FMR signal).

Reference

You can find further information about this subject on page 50 of this Self-Study Programme.

Selector lever locks on the Audi A3 '04



The selector lever lock function is new:

Basically, there is a distinction to make between, first, P/N lock application when driving or with the ignition ON and, second, locking of the selector lever in the "P" position with the ignition key removed (P-lock).

The P-lock function was previously performed by the steering lock by means of a gear selector cable. The electromechanical ignition key removal lock has eliminated the need for a cable pull and a mechanical connection between the steering lock and gear selector.

The P-lock function is carried out by the locking pin of the selector lever lock solenoid N110.
The selector lever pawls and the locking pin kinematics of N110 are such that the P-lock can be applied regardless of whether solenoid N110 is energised (position "N") or deenergised (position "P").

Emergency release

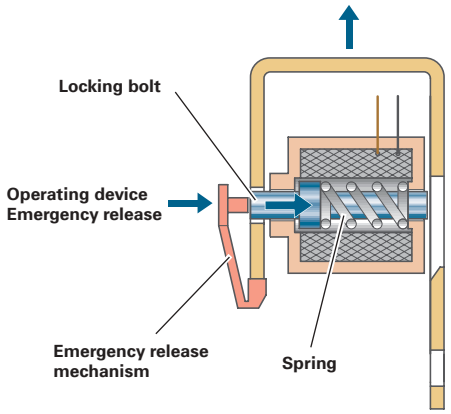
Based on the functional principle, the selector lever remains locked in position "P" if malfuncting occurs or the voltage supply fails (e.g. flat battery), see Fig. 088.
The selector lever lock has an emergency release mechanism which enables the vehicle to be moved (e.g. towed).

Selector lever position "P" locked:

Solenoid N110 is deenergised; the locking bolt is engaged by spring pressure in the park (P) pawl. The selector lever is locked.

Emergency release

The emergency release mechanism can be accessed after removing the gearshift console cover (see Operating instructions).
When the emergency release is operated, the locking bolt of the N110 is forced out of the "P" (park) pawl against the pressure of the spring.
The selector lever can now be moved out of the park ("P") position.



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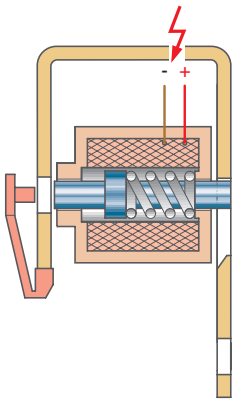
Selector lever position "P" unlocked:

Solenoid N110 is energised by J217; the locking bolt is pulled out of the park ("P") pawl against the pressure of the spring.
The selector lever lock is released.



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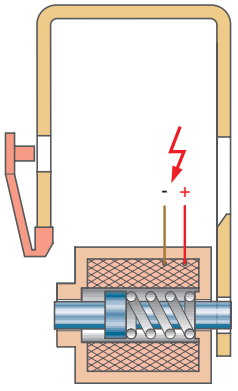
Selector lever position "N" locked:

If the selector lever is in the "N" position for longer than 2 sec. with the ignition on, then solenoid N110 will be energised by J217. The locking bolt is pressed into the "N" (neutral) position against the pressure of the spring.
The N lock is not activated at road speeds of higher than approx. 5 kph.



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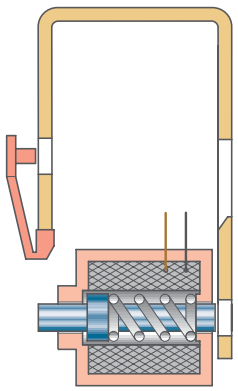
Selector lever position "N" unlocked:

The N110 is deenergised when the brake is applied and when the ignition is OFF. The locking bolt is pulled out of the neutral ("N") pawl by the pressure of the spring.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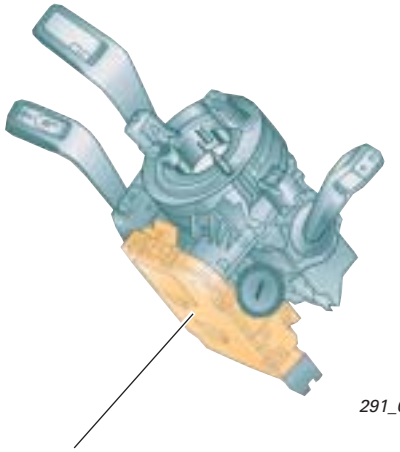
Ignition key removal lock Audi A3 ‘04



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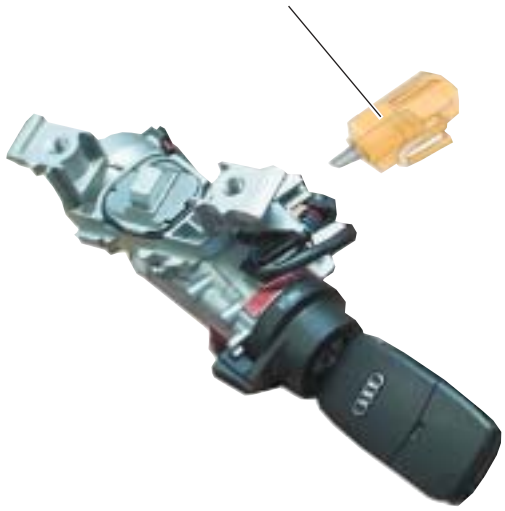
Steering column electronics control unit J527

Ignition key with drawal lock solenoid N376



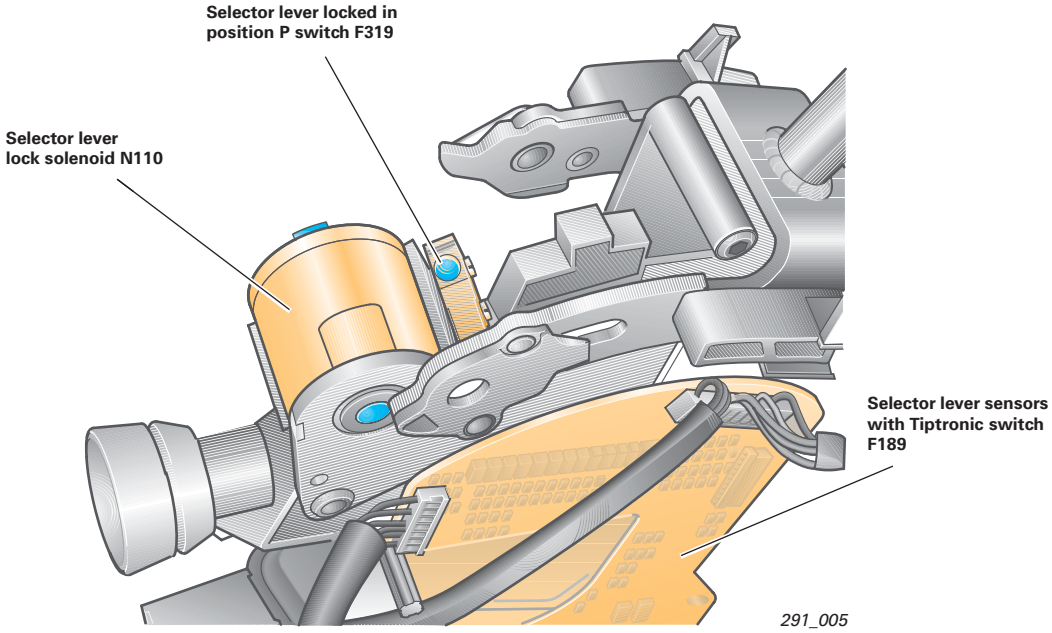
291_003

The ignition key withdrawal lock is implemented in such a way that the ignition key cannot be fully turned anticlockwise to the end position (withdrawal position) when the selector lever is not in the "P" position.

On the Audi TT, this function is performed mechanically by the steering lock by means of a cable pull (locking cable).
The ignition key withdrawal lock function in the Audi A3 ’04 is carried out electromechanically by means of the ignition key withdrawal lock solenoid N376.
Solenoid N376 is activated by the steering column electronics control unit J527. For this purpose, J527 requires the information "selector lever position P locked".

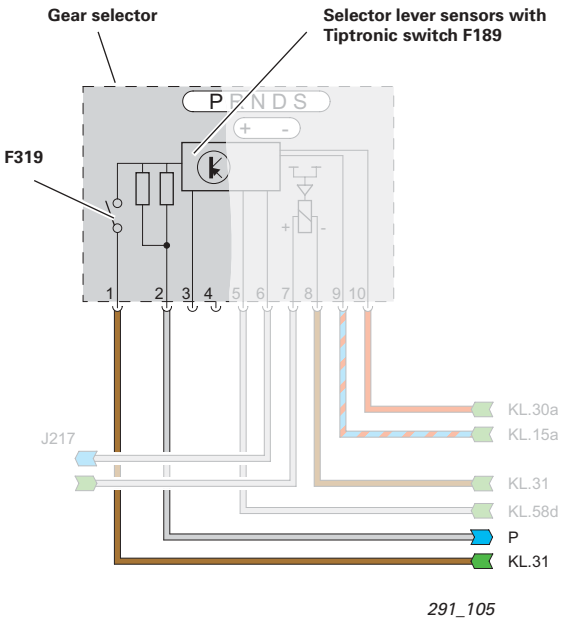
This information is acquired by multi-function switch F125 and sent to via CAN bus to control unit J527 by gearbox control unit J217.

At the same time, the microswitch F319 selector lever locked in position P switch is active in the gear selector. The signal from this switch is also evaluated by control unit J527 and checked for plausibility against the CAN information from J217.



The F319 is designed as an NC contact.
Switch F319 is operated if the lock button on the gear shift knob is released in selector lever position "P" (circuit state "open").

The switch is closed in selector lever positions "R", "N", "D", "S" and tiptronic (and in "P" **with** lock button pressed).



Legend

F319	Selector lever locked in position P switch
J217	Automatic gearbox control unit
P	signal for ignition key withdrawal lock (to J527 steering column electronics control unit)

Output

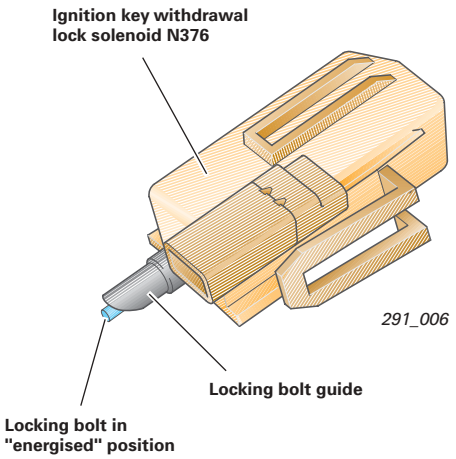
Input

Note

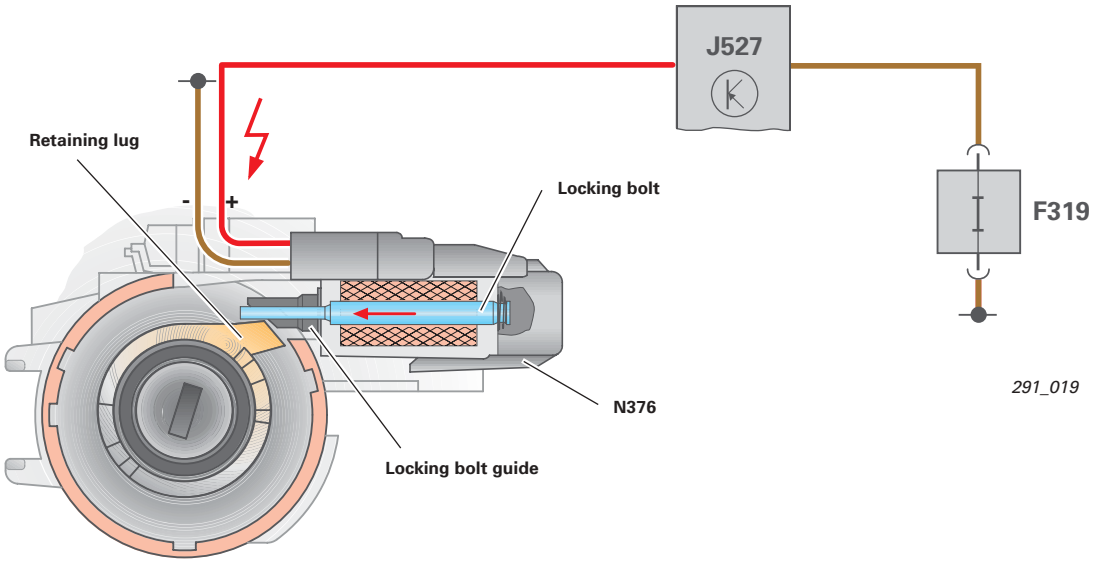
To improve diagnosis of the F319, two resistors are connected in series to switch F319.

The ignition key withdrawal lock function

If the selector lever is not in the "P" (park) position, the ignition key withdrawal lock solenoid N376 will be energised by J527.
The locking bolt of the N376 is forced into the steering lock against the pressure of the spring. As long as the N376 is energised (locking bolt retracted), the ignition lock cannot be turned to the withdrawal position. The ignition key cannot be removed.



N376 "energised"



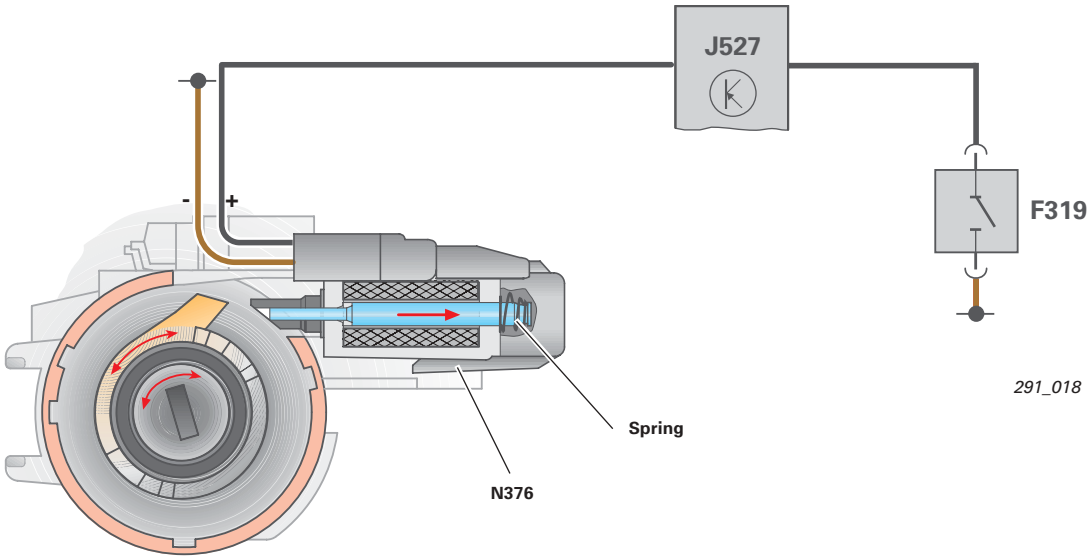
Key position: "ignition OFF"
Ignition key withdrawal lock applied

Legend

F319	Selector lever locked in position P switch
J527	Steering column electronics control unit
N376	Ignition key withdrawal lock solenoid

With the ignition OFF and in the "P" position of the selector lever (button on selector lever is not pressed), the J527 switches off the solenoid N376. As a result, the locking bolt is pulled back by the spring in the N376. The ignition key can now be turned to the withdrawal position and removed.

N376 "not energised"



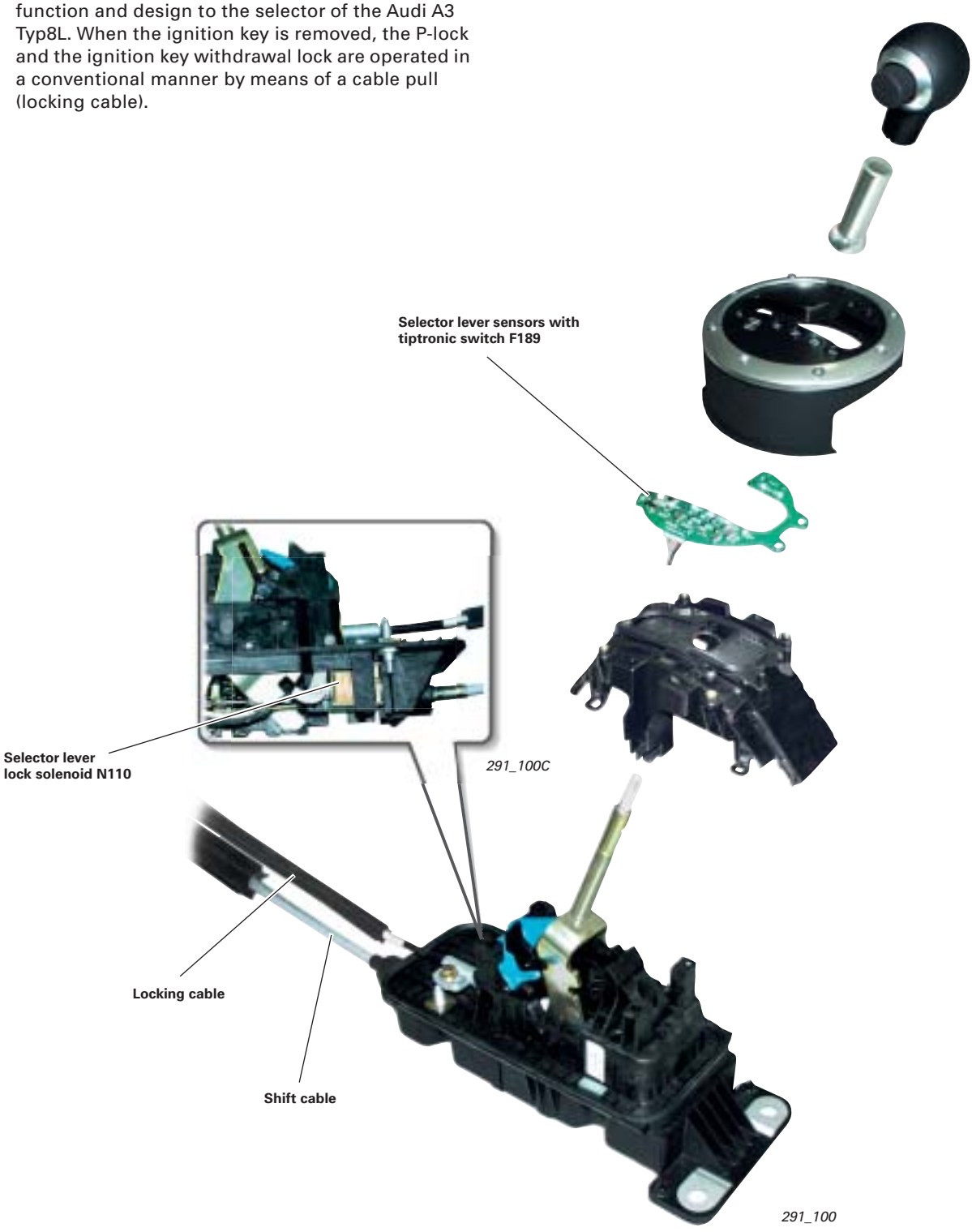
Key position: "withdrawal position"
Ignition key withdrawal lock released

Note

As long as the selector lever out of the "Park" position after ignition off, the J527 energises solenoid N376.
If the vehicle is parked for an extended period of time with the selector lever out of the "P" position, this will cause battery to become discharged in the long term.

Gear selector of the Audi TT

The gear selector of the Audi TT is identical in function and design to the selector of the Audi A3 Typ8L. When the ignition key is removed, the P-lock and the ignition key withdrawal lock are operated in a conventional manner by means of a cable pull (locking cable).



Reference

For information on the function of tiptronic switch F189, please refer to page 52 of this Self-Study Programme.

tiptronic steering wheel

In combination with the tiptronic steering wheel, the "Tiptronic" function is also available in selector lever position "D" or "S".

The tiptronic function is selected by pressing one of the two tip-shift paddles on the steering wheel (selector lever in position "D" or "S").

The system then switches to tiptronic mode for approx. 8 sec.
All gears can be selected within the permissible engine speed range.
It is possible to skip gears, e.g. to shift down from sixth to third, by pressing the shift paddle several times.

The system returns to normal automatic operation approximately 8 sec. after the last tip shift request.

Special feature: the countdown of approx. 8 sec. until return to normal automatic operation is discontinued while the vehicle is cornering or in overrun.
The countdown time is extended depending on the vehicle's driving dynamics. However, the system will switch from tiptronic mode to automatic mode within 40 seconds at the latest.

In the Audi A3 '04 the shift pulses are transferred from the tiptronic buttons or multi-function buttons to the steering column electronics control unit J527 via LIN data bus.

4-spoke multifunction steering wheel with tiptronic (Audi A3)

291_013

3-spoke sport steering wheel with tiptronic (Audi A3)

291_012

3-spoke sport steering wheel with tiptronic (Audi TT)

291_124

Note

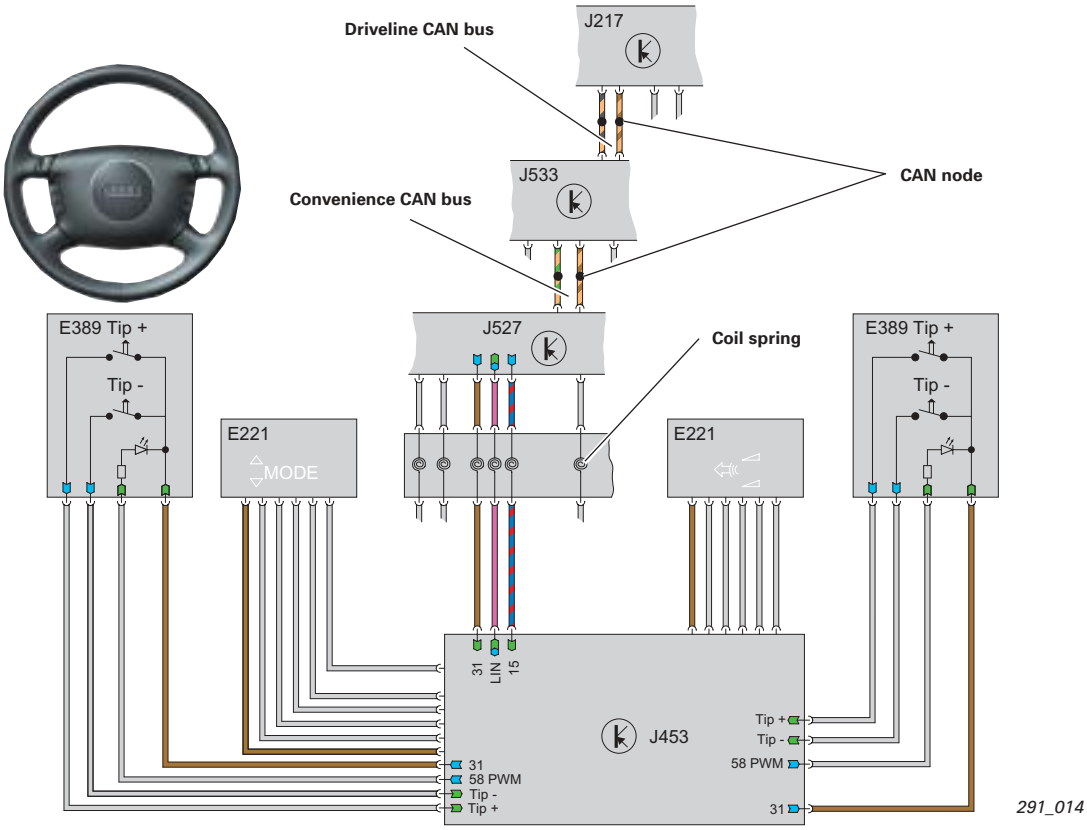
In export vehicles for the USA, the tiptronic steering wheel function is disabled in selector lever position "D" or "S".

Function in the Audi A3 ‘04

The shift pulse from the tiptronic switches E389 (earth signal) is evaluated by multifunction steering wheel control unit J453 and sent via LIN data bus to the steering column electronics control unit J527.

The J527 sends the information by convenience CAN bus to data bus diagnostic interface J533 (gateway). The data is sent from J533 to the driveline CAN bus, and thereby to the automatic gearbox control unit J217.

Multifunction tiptronic steering wheel with multifunctional capability in the Audi A3 ‘04



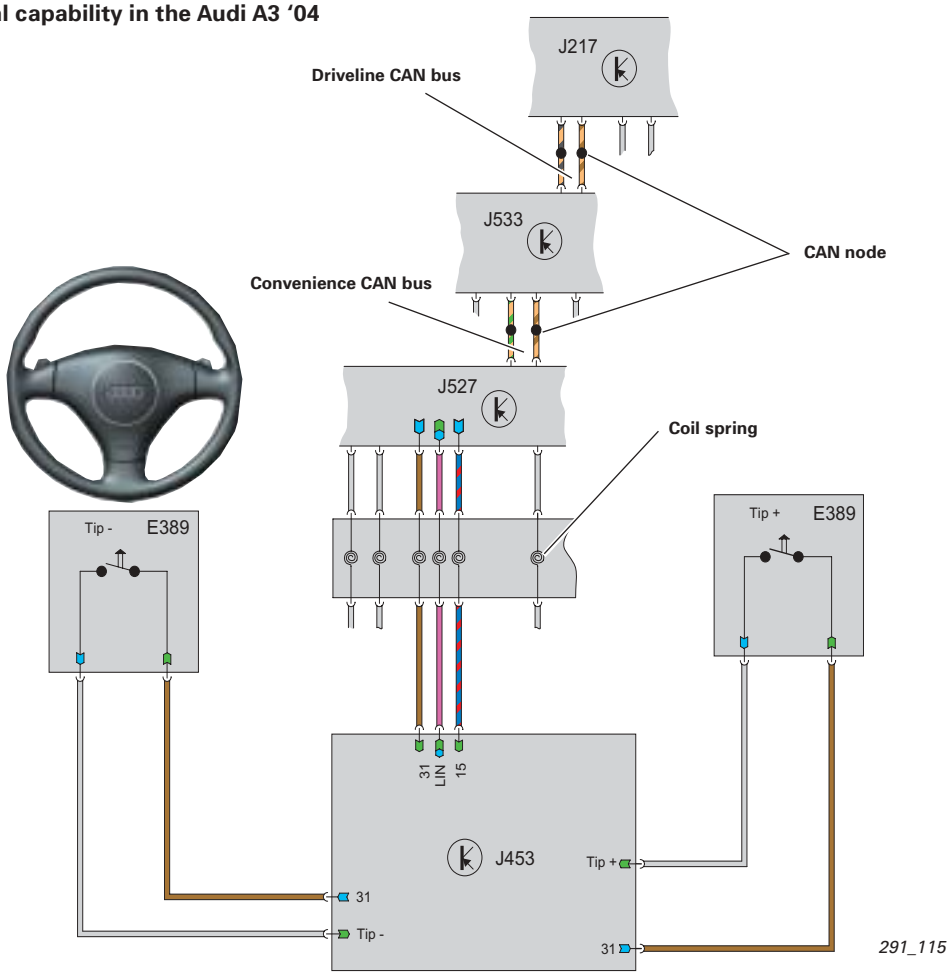
Legend

E221	Operating unit in steering wheel
E389	Tiptronic switch in steering wheel
J217	Automatic gearbox control unit
J453	Multi-function steering wheel control unit
J527	Steering column electronics control unit
J533	Data bus diagnostic interface (gateway)
LIN	LIN single-wire bus system
58 PWM	Pulse-width modulated dimming of the switch light

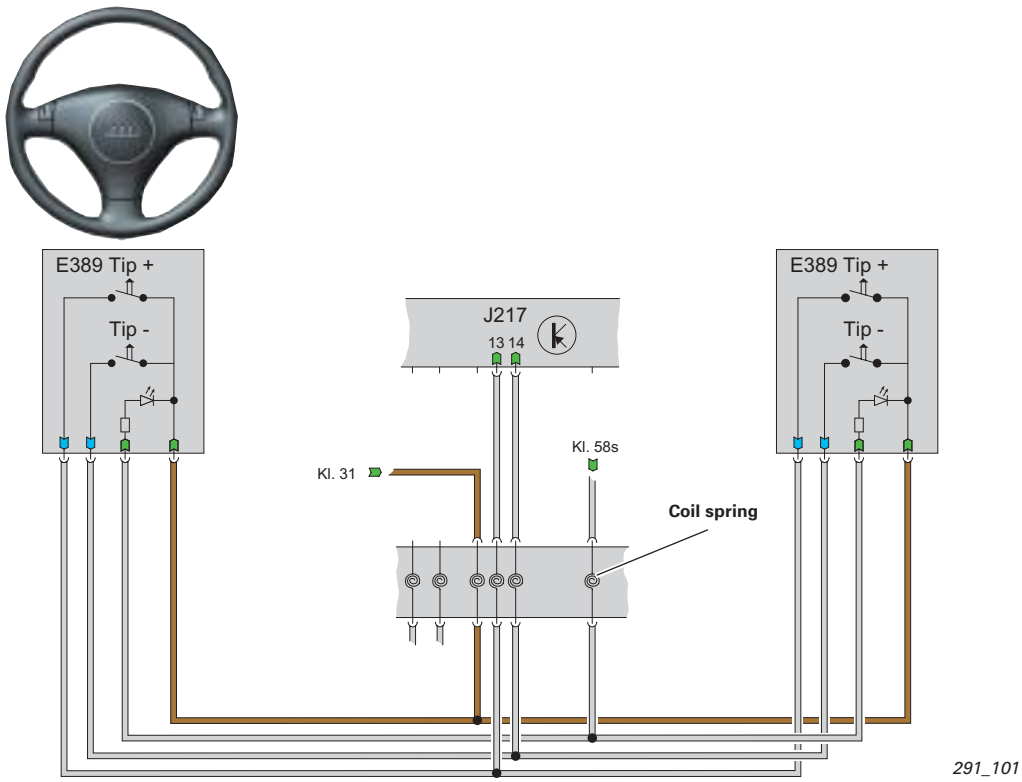
Output

Input

Multifunction tiptronic steering wheel without multifunctional capability in the Audi A3 '04



Tiptronic steering wheel in the Audi TT



Torque converter

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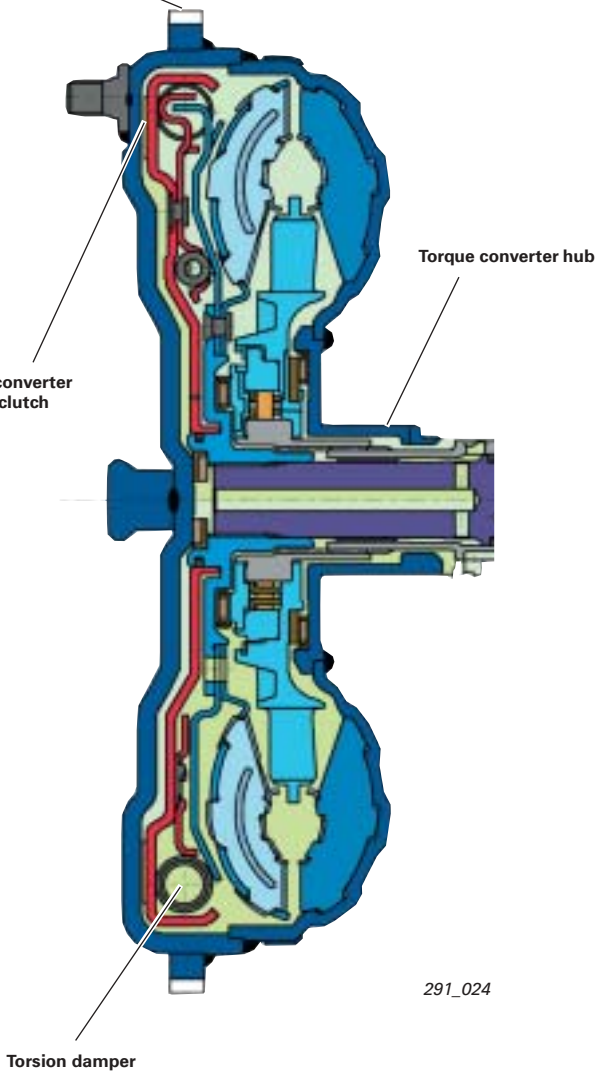

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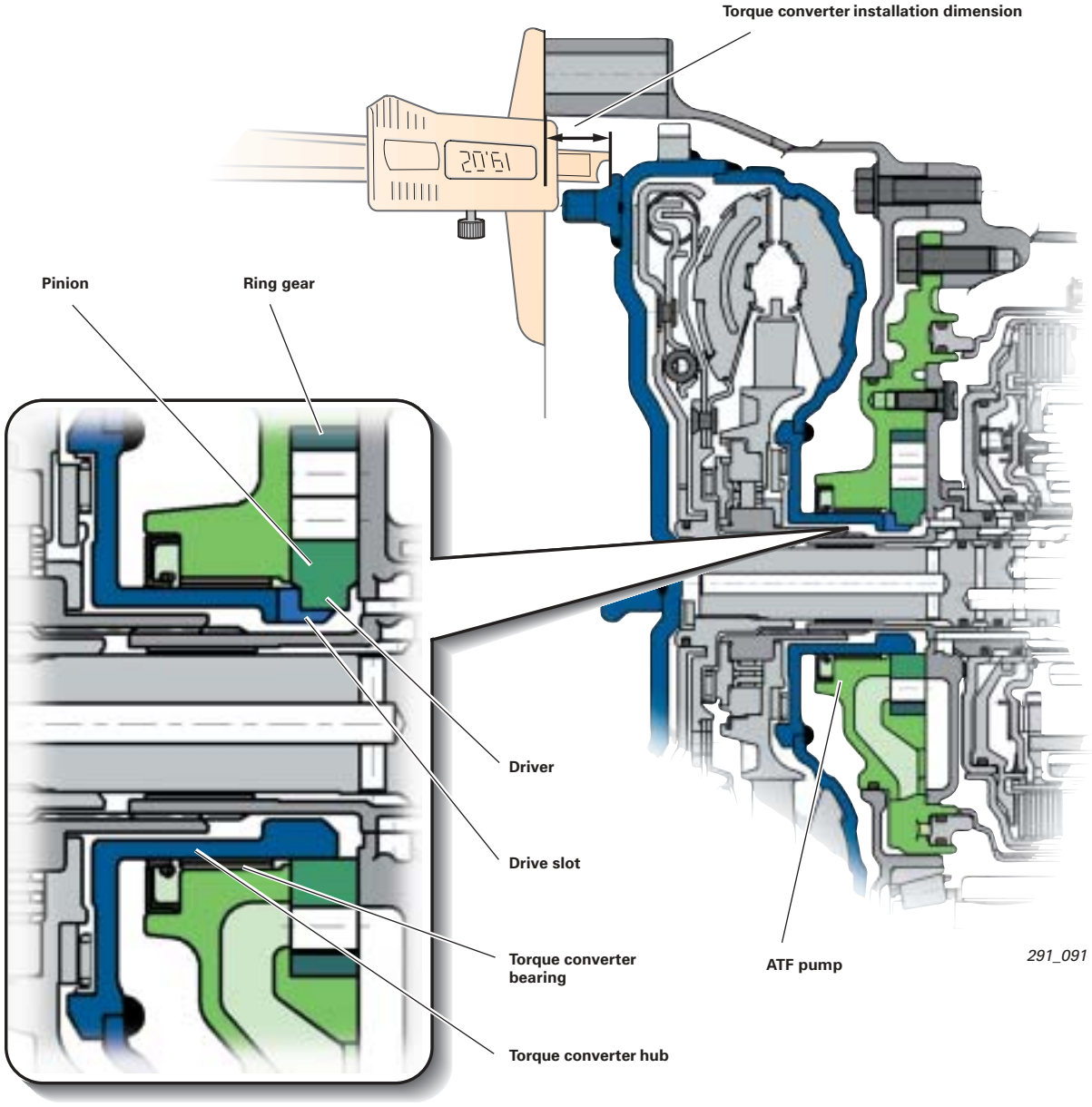
The starter sprocket is welded onto the torque converter housing, and therefore is a component part of the torque converter.
This construction detail contributes to the compact design of the gearbox.

The torque converter hub is mounted on the ATF pump by means of a low-friction bearing (torque converter bearing).
The ATF pump is driven via the drive slots in the torque converter hub.

This can be adapted to the characteristics of various engines by using different torque converter types, whereby the torque conversion characteristic (torque multiplication) is adapted.
For example: factor 1.95 for gearbox GJZ or factor 2.20 for gearbox GSY.

Mounting instructions



Note

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

Note

Care must always be taken to ensure that the bushing press fits are correctly installed between the engine and gearbox. Failure to fit bushing press fits will cause irreparable damage to the low-friction bearing and the torque converter hub due to the offset between the engine and the gearbox.

Torque converter lock-up clutch

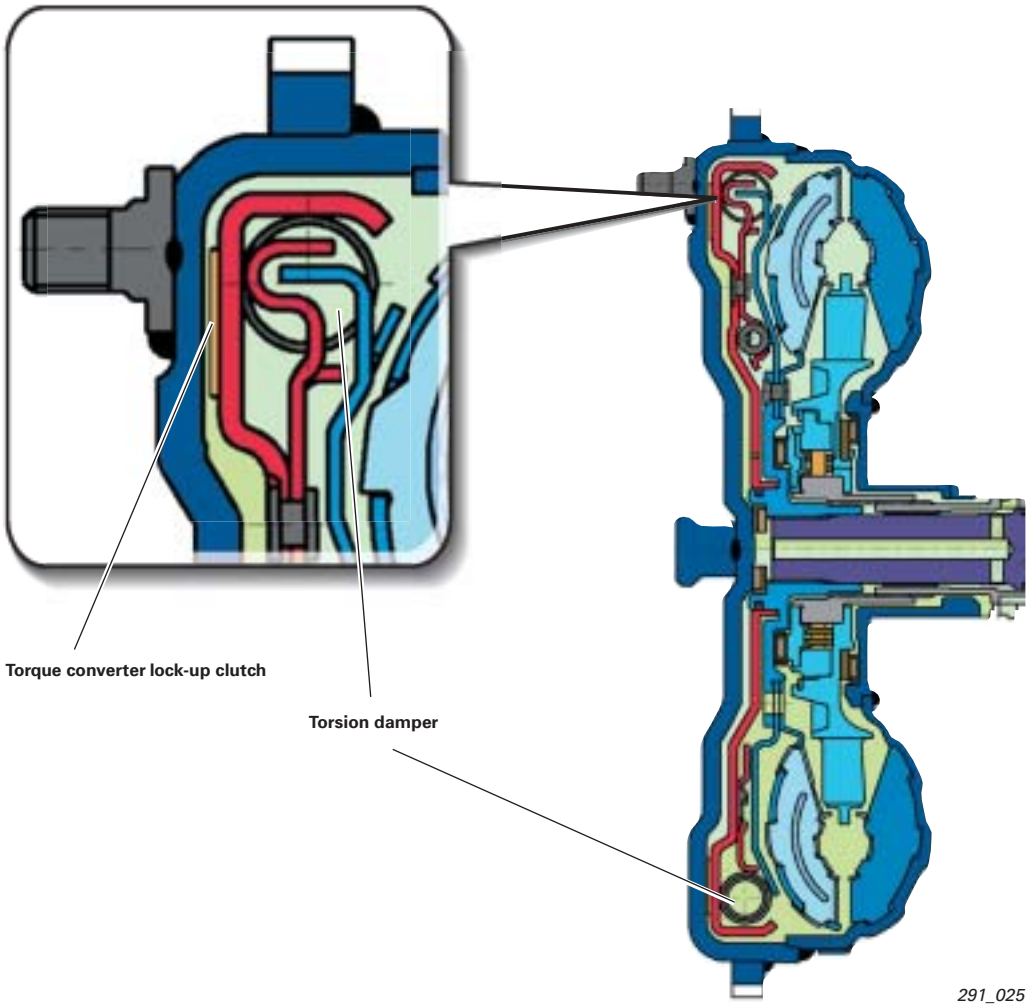
Design

The torque converter has a torque converter lock-up clutch with built-in torsion dampers.
The torsion dampers reduce torsional vibration when the torque converter lock-up clutch is closed. This allows the operating range "torque converter lock-up clutch closed" to be extended.

Basically, a distinction is made between a distinction is made between the following functional states:

- converter lock-up clutch - open
- converter lock-up clutch - controlled operation
- converter lock-up clutch - closed

During normal vehicle operation, the torque converter lock-up clutch is operated from third gear.



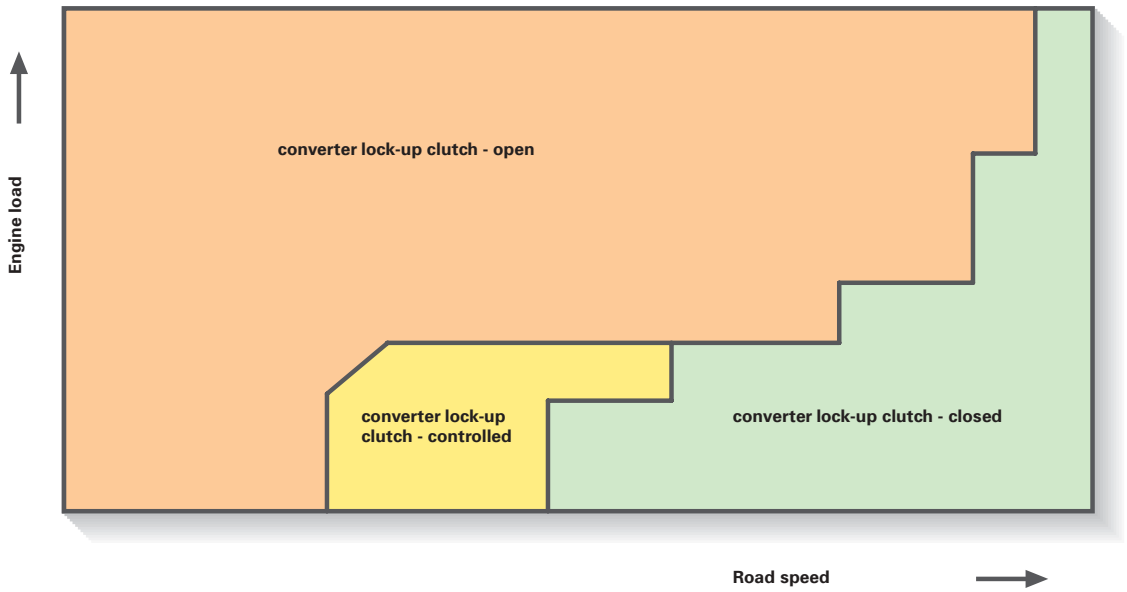
Reference

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

Controlled operation

The torque converter lock-up clutch is operated with a minimum of slip at defined operating points (controlled operation).
Controlled operation offers, first, better fuel economy than operation with the torque converter lock-up clutch open and, second, better ride comfort than operation with the torque converter lock-up clutch closed.

Torque converter lock-up clutch operating ranges in "D"



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In tiptronic mode and in the "S" programme, the converter lock-up clutch is closed at the earliest possible moment. The positive, direct connection between the engine and gearbox emphasises the sporty driving feel.

In the hill-climbing program, the torque converter lock-up clutch is closed in second gear.

In the Hotmode programme, the converter lock-up clutch is operated in a controlled manner, but is closed early. This reduces the heat transfer caused by converter lock-up clutch friction or hydrodynamic power transmission.

Hotmode programme: see page 60

Oil supply/lubrication

ATF (Automatic Transmission Fluid)

The stringent requirements with regard to shift quality, functional reliability and ease of maintenance place extremely high demands on the ATF, too.
The ATF is a key factor in determining the friction coefficient of the clutches/brakes.

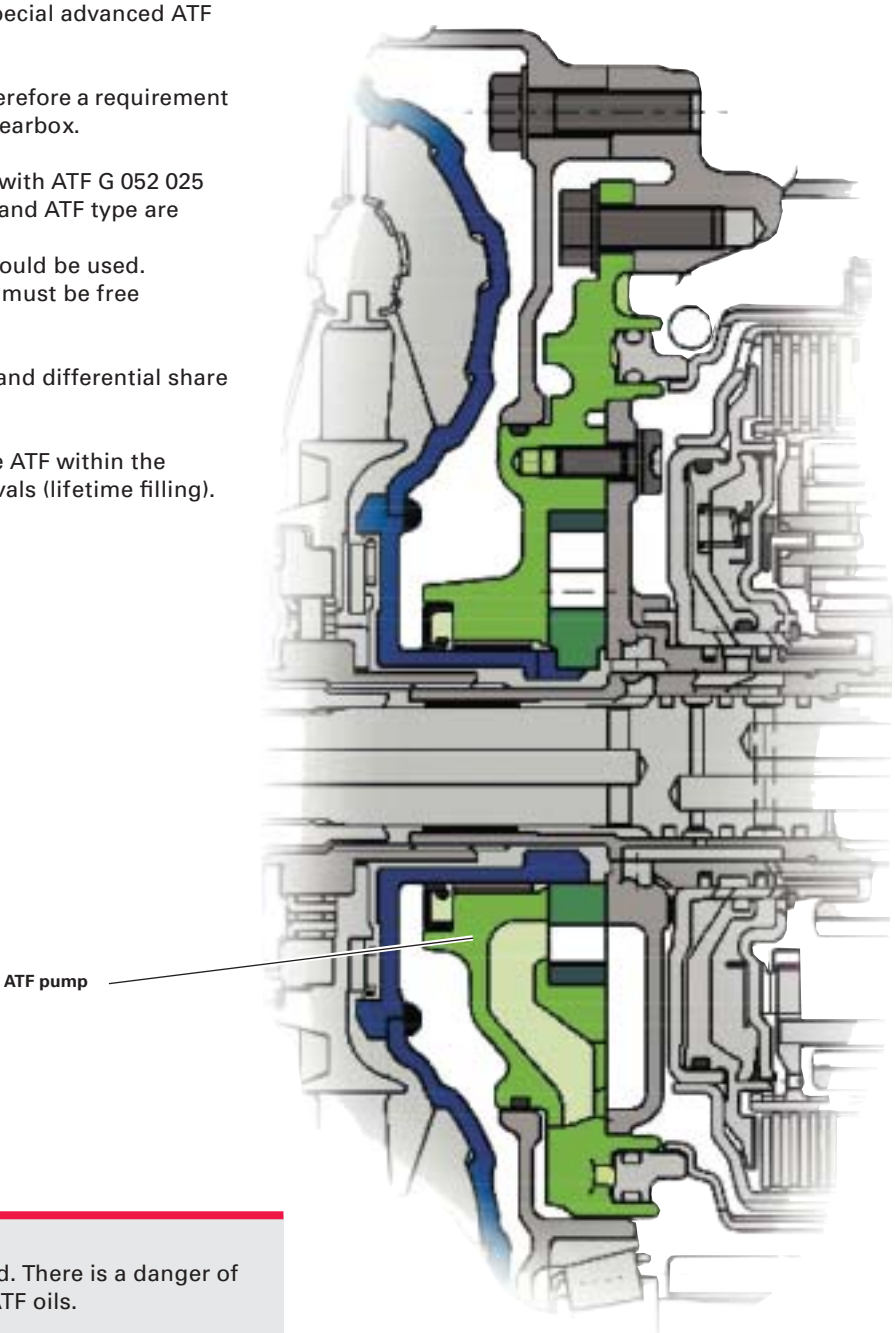
For this reason, the ATF is developed parallel to design and testing. It therefore stands to reason that the 09G gearbox uses a special advanced ATF type.

Use of the prescribed ATF is therefore a requirement for proper functioning of the gearbox.

The 09G gearbox is lubricated with ATF G 052 025 (Esso JWS 3309). The gearbox and ATF type are adapted to match each other.
Only the approved ATF type should be used.
The filling system (V.A.G 1924) must be free of foreign ATF residues.

The planetary gear, final drive and differential share the same oil supply.

There is no need to change the ATF within the designated maintenance intervals (lifetime filling).



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Note

The ATF is red-coloured. There is a danger of mixing up with other ATF oils.

A separate filling system should therefore be used for each ATF.

ATF pump

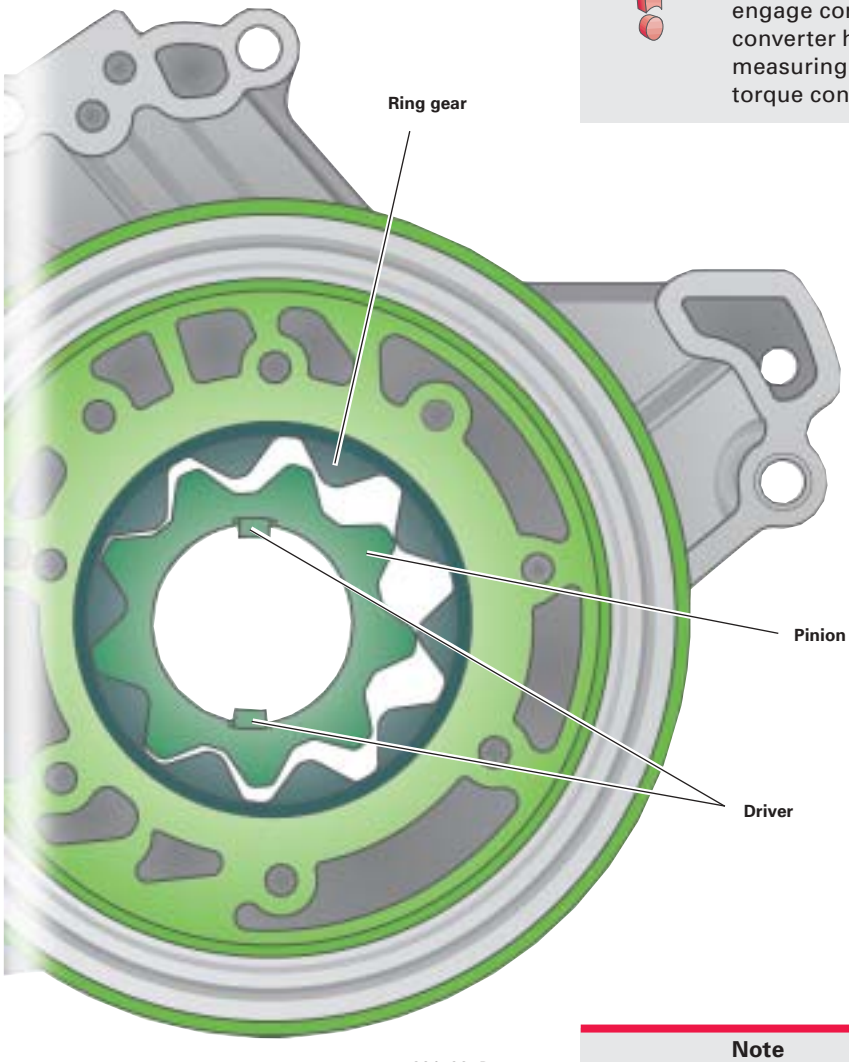
One of the key components of an automatic gearbox is the ATF pump.
The gearbox does not function correctly without an ample supply of oil.

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

It is driven directly by the engine (engine speed) via the torque converter housing and the torque converter hub. Two drive slots in the torque converter hub engage the pinion drivers. The torque converter hub is mounted on the pump housing using a low-friction bearing.

Note

During installation of the torque converter and before installing the gearbox, special care must be taken to ensure that the ATF pump drivers engage correctly in the slots in the torque converter hub. This can be checked by measuring the installation position of the torque converter (refer to Workshop Manual).



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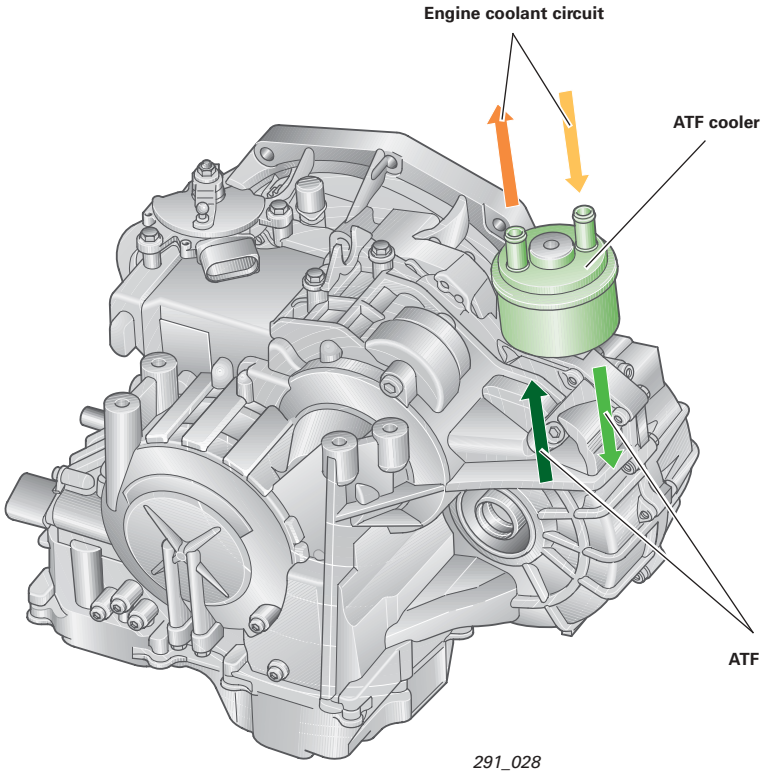
Note

Also, care must always be taken to ensure that the bushing press fits are correctly fitted between the engine and gearbox.
Failure to fit bushing press fits will cause irreparable damage to the low-friction bearing and the torque converter hub due to the offset between the engine and the gearbox.

ATF cooling

The ATF is cooled by an ATF cooler (coolant-oil heat exchanger) which is directly flanged onto the gearbox and integrated into the engine's cooling circuit.

The direct connection between the ATF cooler and the gearbox allows cooling capacity to be adapted more easily. The elimination of ATF lines greatly reduces the number of potential fault sources with regard to leak-tightness.



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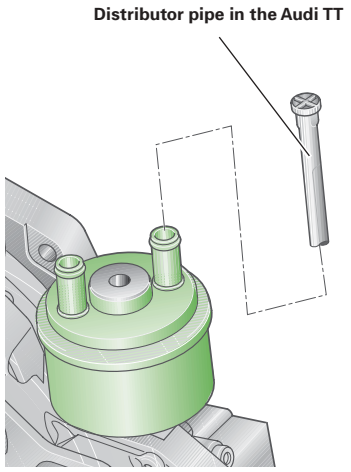

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The "closed-circuit oil supply" makes it easier to fill the gearbox with ATF and check the oil level. There is no need to disconnect ATF lines when removing and installing the gearbox.

In this way, ingress of dirt into the gearbox is minimised. The ATF cooler is included in the scope of supply of the gearbox.
It is no longer necessary to clean the cooler and the oil lines when replacing a damaged gearbox.

For flow reasons, a distributor pipe is installed in the supply line to the ATF heat exchanger in the Audi TT.

Note

Do not install the distributor pipe in the return line of the ATF heat exchanger.