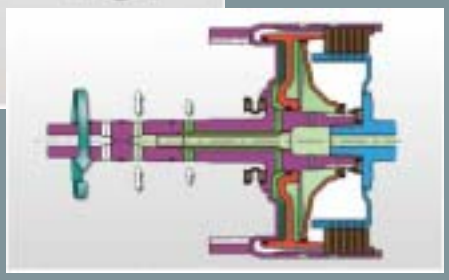
283

Service.



6-speed automatic gearbox 09E in the Audi A8 '03 - Part 1

Self Study Programme 283

Speed-change gearboxes are of prime importance with regard to fuel consumption, emission levels, dynamics and comfort in the vehicle.

New concepts such as automatic gearshift systems or continuously variable automatic transmission represent alternatives to the conventional multi-step automatic gearbox.

For a combination of high torque transmission levels with corresponding ride comfort, the multi-step automatic gearbox remains the uncompromising option in terms of torque conversion.

The new 6-speed automatic gearbox 09E represents the logical next stage in the development of the multi-step automatic gearbox concept. It sets new standards in its class as regards economy, dynamics and comfort.

The 09E was developed and is manufactured by the renowned system supplier ZF. Together with the gearbox development specialists at Audi, the unit was adapted to the quattro drive concept and vehicle-specific requirements.

The 09E is the first representative of a new 6-speed gearbox family which is to include further additions to both the top and bottom end of the torque transmission scale.

The new 6-speed generation is designed to replace the familiar 5-speed 01V and 01l automatic gearboxes.

Contents

Part 1 SSP 283

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The Self Study Programme contains information on design features and functions.

The Self Study Programme is not intended as a Workshop Manual.
Values given are only intended to help explain the subject matter and relate to the software version applicable when the SSP was compiled.

Use should always be made of the latest technical publications when performing maintenance and repair work.

New Note

Attention Note

Part 2 SSP 284

Page

Gearbox Control

Service

General

Technical data

Designation	**09E**
Audi factory designation	**AL 600-6Q**
ZF factory designation	6HP-26 A61
Code letters [2]	GNT (V8 3.7 l) GNU (V8 4.2 l) GKY (V8 4.0 l TDI)
Gearbox type	Electrohydraulically controlled 6-speed planetary gearbox (multi-step automatic gearbox) with hydrodynamic torque converter and slip-controlled torque converter lock-up clutch Four-wheel drive with integrated Torsen centre differential and front-axle differential in front of torque converter
Control	Mechatronik (hydraulic control unit and electronic control integrated into one unit) Dynamic shift program DSP with separate sports program in "Position S" and tiptronic shift program for manual gear change
Max. torque/power transmission [2]	Up to 650 Nm 320 kW/5800 rpm
Torque converter (2WK stands for two-lining torque converter clutch) [1]	Hydrodynamic torque converter with controlled torque converter clutch W 280 S - 2WK (650 Nm version) W 260 S - 2WK (440 Nm version)
Torque converter multiplication [1] (torque increase)	1.66 (GNT) 1.70 (GNU)

[1] These values depend on the version concerned.
[2] Two versions are currently available:
Up to 440 Nm for the V8 5V 4.2 l/3.7 l
Up to 650 Nm for the V8 TDI 4.0 l and W12 6.0 l
[3] The differences in weight result from the different torque converters, clutches and planetary gear train design.

Transmission ratios Planetary gearbox	1st gear 4.171 2nd gear 2.340 3rd gear 1.521 4th gear 1.143 5th gear 0.867 6th gear 0.691 R gear 3.403
Primary drive Front-axle spur gear unit Front-axle bevel gear unit Rear-axle bevel gear unit i constant (front/rear axle)	32Z/30Z 1.067 31Z/29Z 1.069 32Z/11Z 2.909 31Z/10Z 3.100 3.317 / 3.307 (data apply to GNU only)
Spread	6.04
Front/rear axle torque distribution	Torsen centre differential type A 50/50
Gear oils	Lifetime fill
ATF specification	G 055 005 A2 Shell ATF M-1375.4
Front-axle differential and transfer case specification	G 052 145 A1/S2 (Burmah SAF-AG4 1016)
Gear oil quantities	
ATF	approx. 10.4 l (fresh fill)
Front-axle differential	approx. 1.1 l (fresh fill)
Transfer case	approx. 1.1 l (fresh fill)
Total weight (incl. oil and ATF cooler) [3)]	approx. 138 kg (440 Nm version) approx. 142 kg (650 Nm version)
Length (from engine flange to rear-axle flange shaft)	approx. 98 cm (95 cm with 01L gearbox)

General

Brief description

The development aims....

- Improved performance
- Reduced consumption and emissions
- Greater efficiency
- Better weight distribution of drive system components
- Less weight
- High degree of gearshift spontaneity with outstanding shift comfort
- Minimisation of manufacturing costs with increased reliability and durability

....were implemented as outlined in the following.

One of the main factors in achieving the development goals in the fields of consumption, emissions and performance was the increase in gear ratio steps to include 6 forward gears in conjunction with a greater overall spread.

With a spread of 6.04, the 09E attains levels which were previously the sole domain of continuously variable transmission systems.

The 6-speed planetary gearbox is based on the Lepelletier principle. This concept is characterised by harmonic gear ratio steps and the implementation of six forward gears and one reverse gear with only five selector elements.

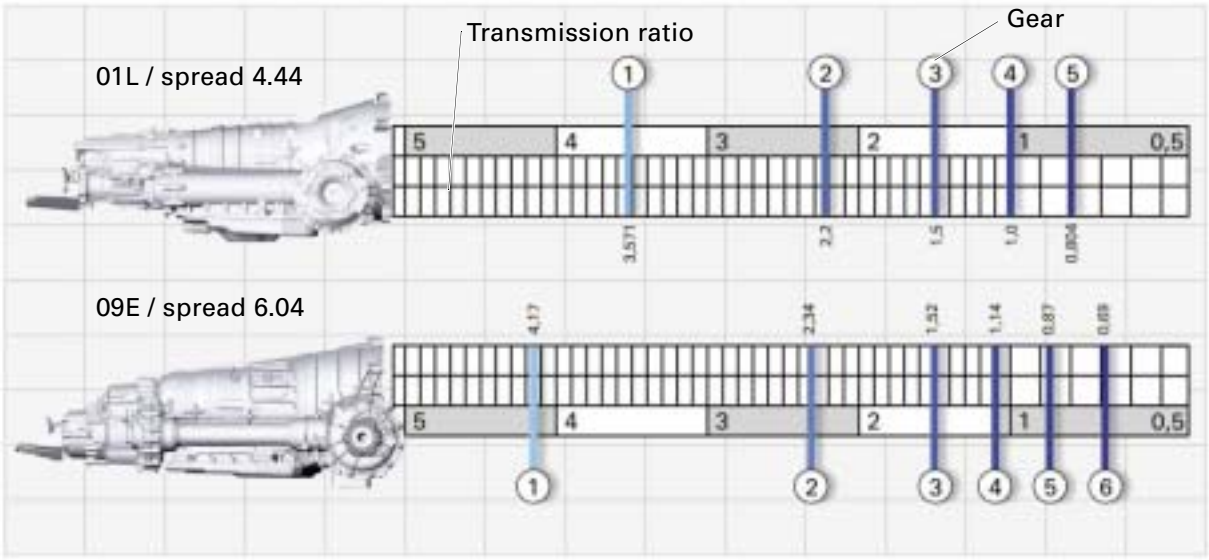
Explanatory note:

The gear train configuration used here was designed some 10 years ago by the now 75-year old engineer M. Lepelletier, the owner of the patent for this design which now bears his name.

01L / 09E transmission ratio comparison

283_092

Transmission ratio comparison / spread



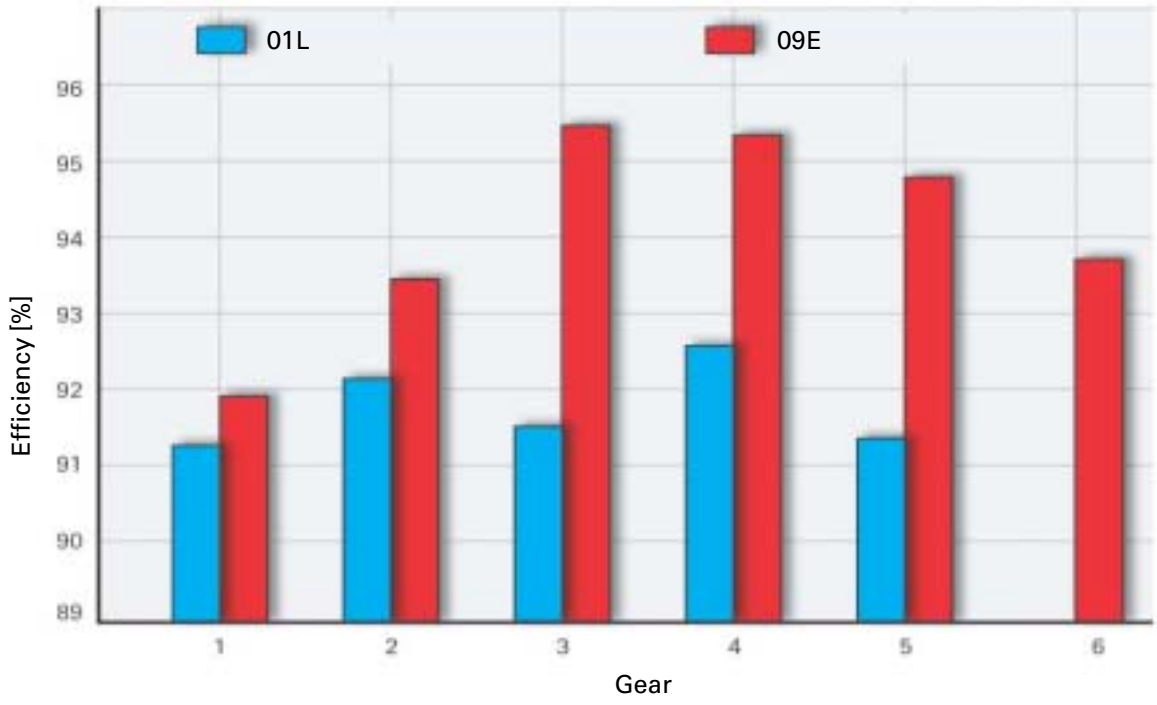
283_086

Petrol and diesel engines attain maximum speed in 5th and 6th gear respectively.

General

Optimisation of a wide range of details and technical concepts resulted in enhanced gearbox efficiency:

- The fact that there are only five selector elements reduces the friction torque in the clutches with no power transmission.
- A new, optimised gear oil with lower viscosity particularly at low gearbox temperatures reduces the friction loss.
- Improved internally geared oil pump with smaller delivery volume and reduced leakage.
- Optimisation of oil supply with reduced leakage in hydraulic control system.
- Increase in gearing efficiency to greater than 99% through optimisation of gear trains.
- Increase in permissible friction power of controlled torque converter clutch, thus extending the operating range (for more details, refer to Page 34 onwards).
- The "stationary vehicle decoupling" function reduces engine output when the vehicle is stopped with a gear engaged by interrupting power transmission. In addition to reducing consumption, ride comfort is enhanced due to the fact that less braking force is required (for more details refer to Part 2 SSP 284, Page 30 onwards).



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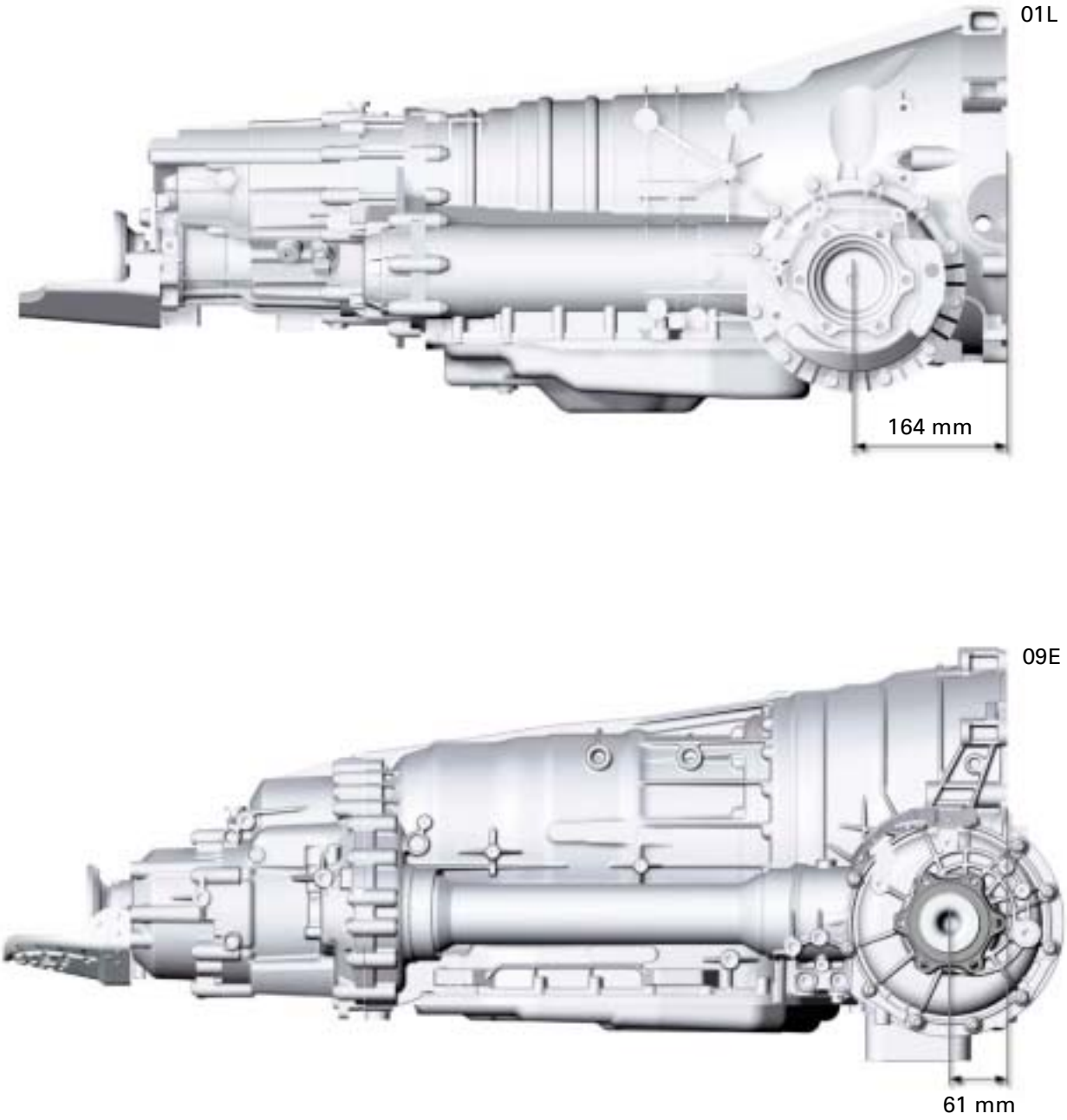
A special feature of particular note with regard to the 09E automatic gearbox is the location of the front axle differential (flange shaft) in front of the torque converter.

The distance between flange shaft and engine flange is now only 61 mm (01L = 164 mm).



283_004

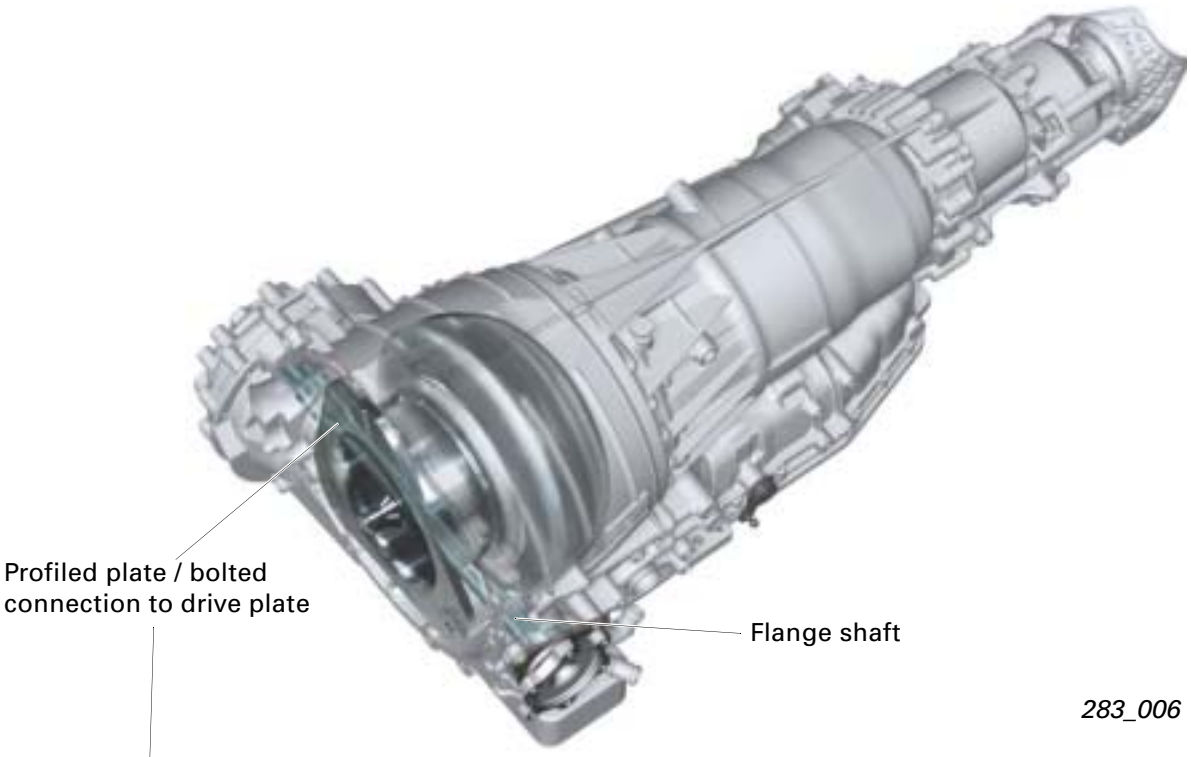
General

The method of bolting the torque converter to the drive plate by means of a profiled plate meant that it was possible to move the torque converter to the rear and create space for the flange shaft.

Thanks to this sophisticated concept, the entire drive unit is now closer to the centre of the vehicle.

The resultant more even weight distribution between front and rear axle is of significant benefit to vehicle handling.

To make optimum use of this advantage for all engine versions, various spacers are fitted between engine and gearbox to adapt each engine type to the given installation situation.



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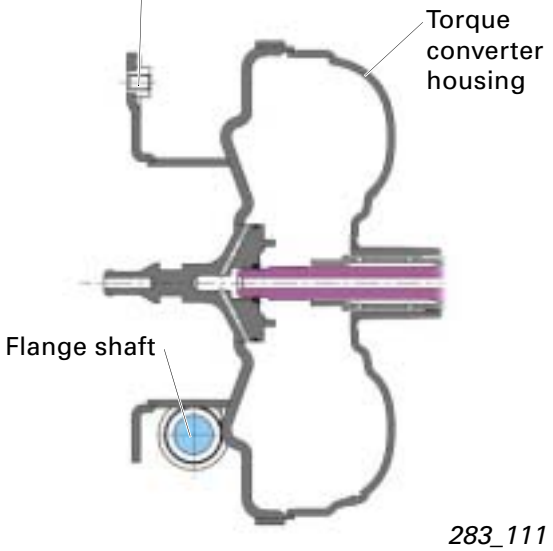


283_111

283_157

Spacers:

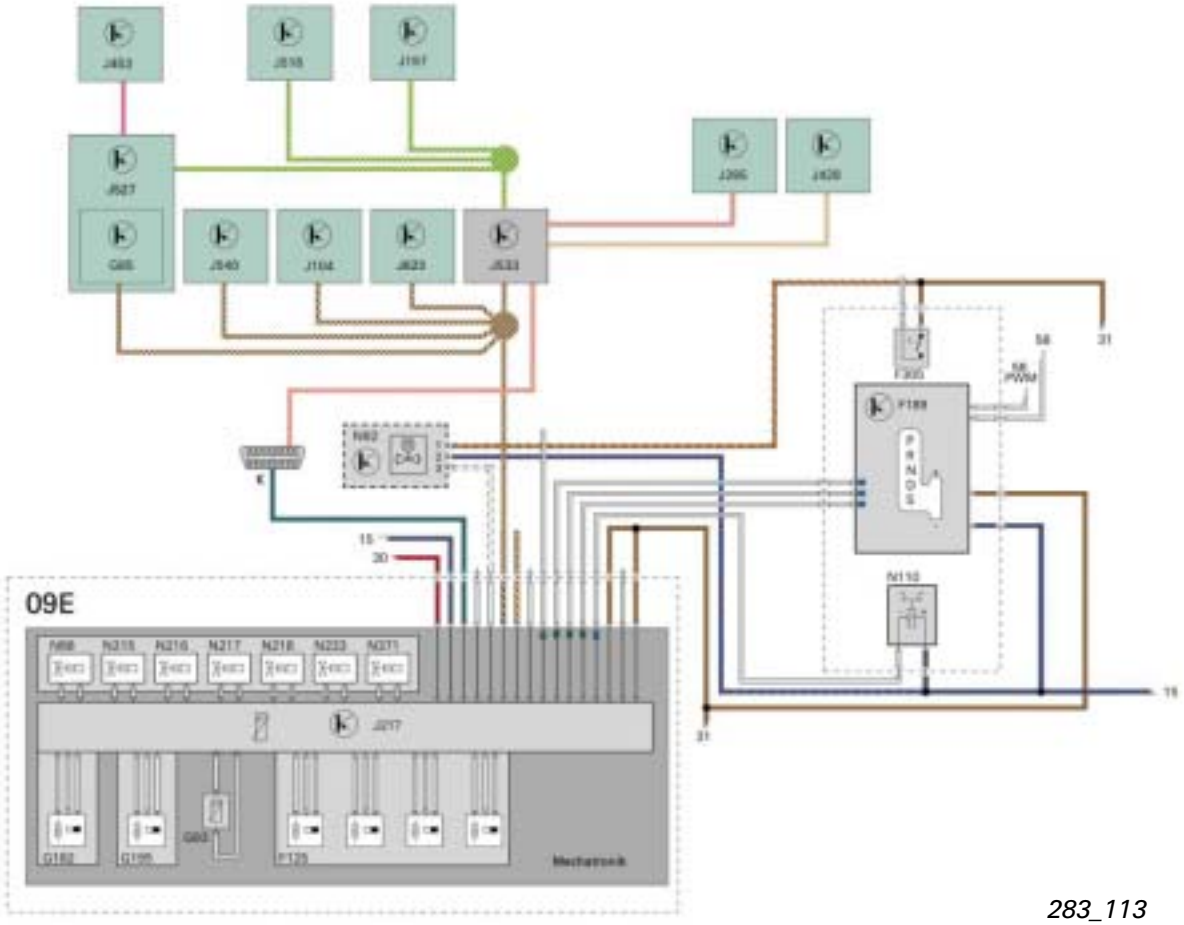
W12 6.0 l	13 mm
4.2 l / 3.7 l with toothed belt drive	23 mm
V8 TDI 4.0 l	None

The Mechatronik integrated into the gearbox housing is a new development. It combines the hydraulic control unit, sensors/actuators and electronic gearbox control unit in a coordinated assembly (for more details refer to Part 2 SSP 284, Page 4 onwards).

283_007

283_112

All data exchange with the vehicle periphery takes place via the drive system CAN, thus reducing the number of vehicle periphery interfaces to a minimum (13 pins) and at the same time enhancing operational reliability (for more details refer to Part 2 SSP 284, Page 25 onwards).



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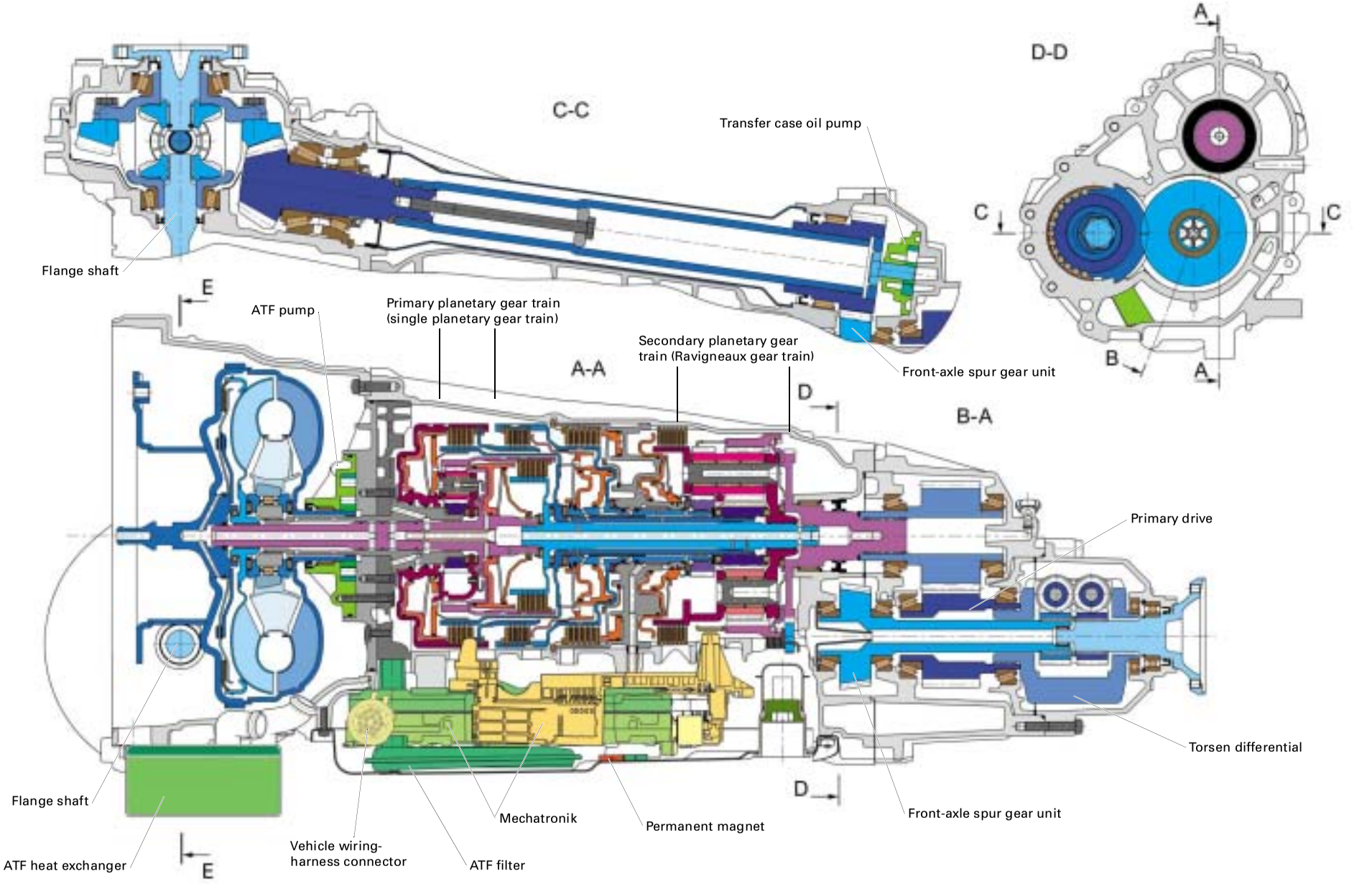
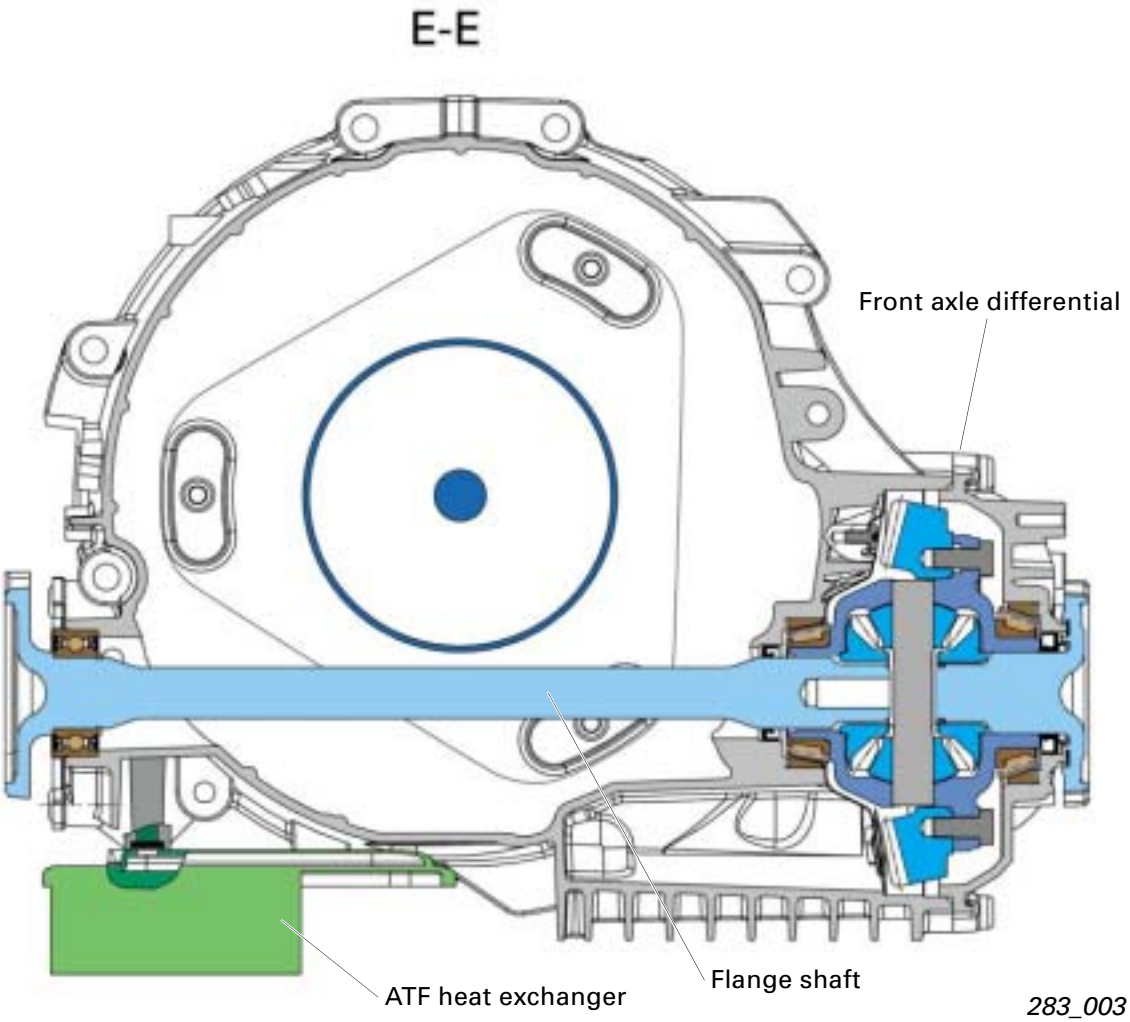

C-C
Transfer case oil pump
Flange shaft
D-D
A
C
C
B
A
E
ATF pump
Primary planetary gear train
(single planetary gear train)
A-A
Secondary planetary gear
train (Ravigneaux gear train)
D
B-A
Front-axle spur gear unit
Primary drive
Torsen differential
Flange shaft
ATF heat exchanger
E
Vehicle wiring-
harness connector
ATF filter
Mechatronik
Permanent magnet
D
Front-axle spur gear unit

283_002

Sectional view of gearbox



283_003

Colour coding

- Hydraulic components / control
- Planetary gear train components
- Shafts / gears
- Electronic components / control unit
- Multi-plate clutches, bearings, washers, circlips
- Plastic, gaskets, rubber, washers
- Selector element components, cylinders / pistons / baffle plates
- Housings, bolts, pins

Gearbox Periphery

Selector mechanism

The selector lever forms the mechanical link between the driver and the selector slide of the hydraulic control system.

The selector lever permits "mechanical" selection of the following positions:

*P = Park position for actuation of parking lock and interruption of power flow (neutral)
The ignition key can only be removed in this position (for more details refer to Ignition key removal lock, Page 26 onwards).
It is only possible to move out of P position with ignition switched on (for more details refer to Selector lever lock emergency release, Page 22 onwards).

R = Reverse gear
Reverse gear can still be engaged in gearbox emergency operation
(for more details refer to Control of reversing lights in Part 2 SSP 284, Page 32 onwards).

*N = Neutral position
Interruption of power flow (neutral)

D = Drive position
Automatic gearbox drive position, automatic selection of gears 1-6 with dynamic shift program DSP (for more details refer to Part 2 SSP 284, Page 36 onwards).

S = Sports program
Selector lever position "S" provides drivers with a power-oriented shift program. On receiving the information "Selector lever position S", the electronic control unit moves the characteristic shift curves to higher engine speeds, thus providing a higher level of vehicle dynamics. The DSP also ensures adaption to driver inputs (driving style factor) and driving situations in position "S".

Special features of "S" program:

– Moving the selector lever to "S" whilst driving with the accelerator pedal held constantly in the same position results in change-down within defined limits.

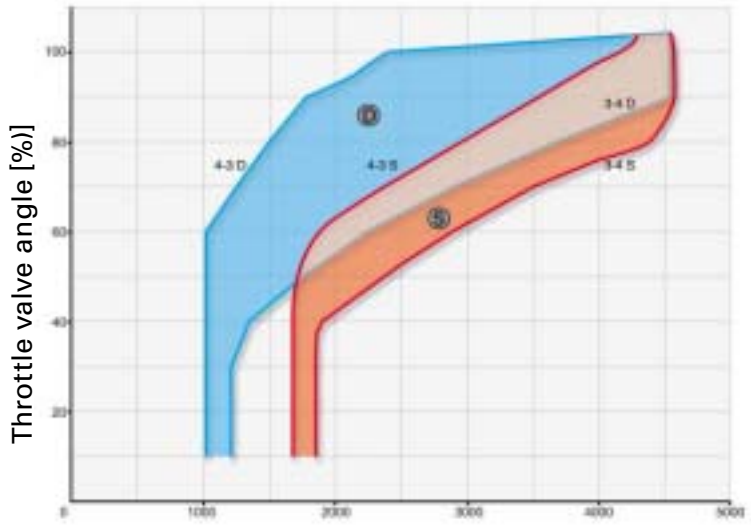
– To achieve more direct vehicle reaction to accelerator pedal movement, the torque converter clutch is kept closed wherever possible whilst driving.

– If 6th gear is designed for overdrive in the overall transmission ratio, only gears 1-5 are selected.

Note on ***N** and ***P** for vehicles with entry and start authorisation button E408 (with advanced key system)

For safety reasons, the engine can only be switched off using button E408 (stop button) in selector lever position N or P.

Comparison of D/S characteristic shift curves



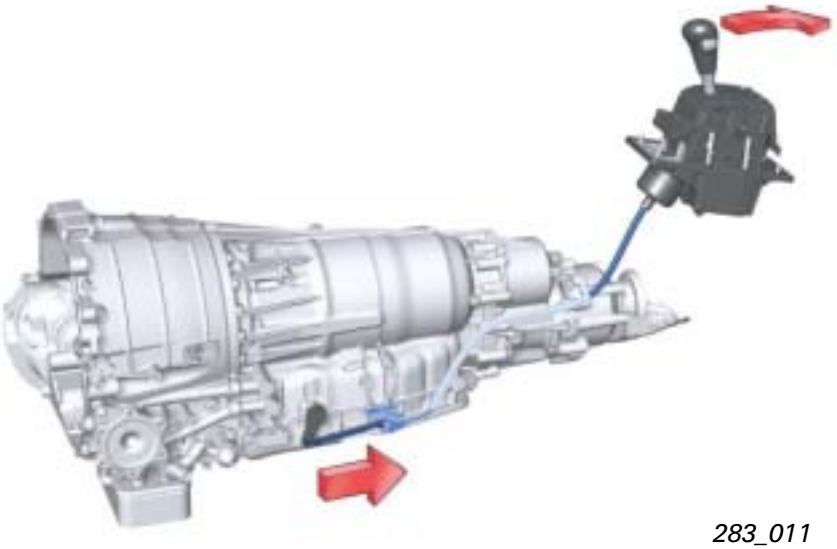
Gearbox output speed [rpm]

283_152

The sports program significantly extends the effective shift range between economical and sporty (for more details refer to Part 2 SSP 284, Page 39 onwards).

In terms of the following functions, there are interesting new aspects to the selector mechanism in the new Audi A8:

- Selector mechanism kinematics
- Selector lever lock
- Selector lever lock emergency release
- Selector lever/lock button kinematics
- Ignition key removal lock



283_011

283_115

Gearbox Periphery

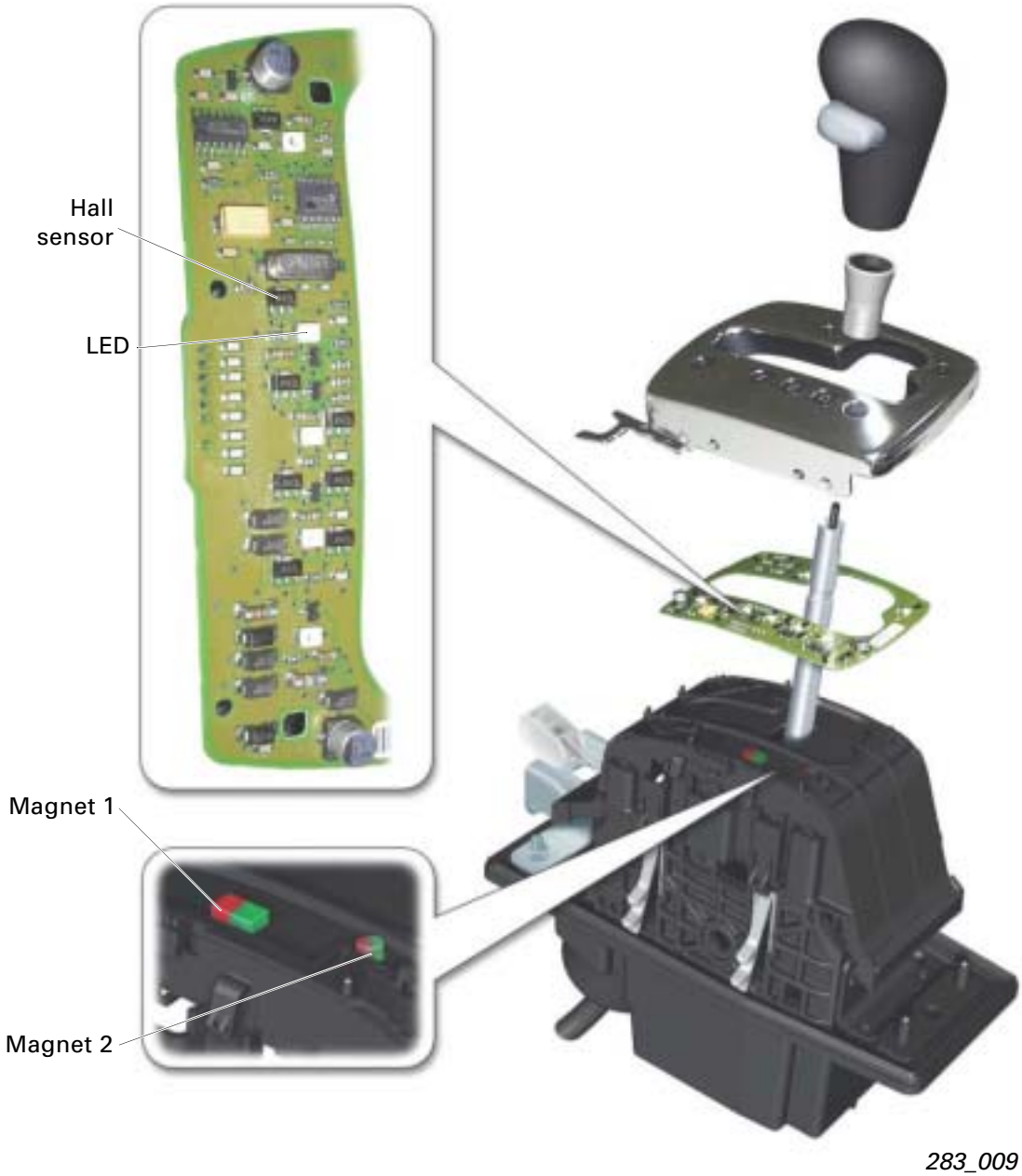
Selector lever gate

The selector lever gate is illuminated by means of correspondingly controlled LEDs.

The PC board of the selector lever gate is provided with 7 LEDs, one for each selector lever position as well as for the + and - symbols of the tiptronic gate.

One separate Hall sensor each controls the corresponding selector lever position LED.

The appropriate Hall sensors are switched by way of the permanent magnet 1 positioned on the masking panel (for more details refer to tiptronic switch F189 in Part 2 SSP 284, Page 18 onwards).



283_009

Selector mechanism kinematics

The installation situation in the new Audi A8 makes it possible to achieve selector mechanism kinematics involving pulling rather than pushing of the selector lever cable on "Shifting out of position P". This permits a highly flexible selector lever cable design, thus reducing the transmission of vibration to the passenger compartment and at the same time improving noise levels.

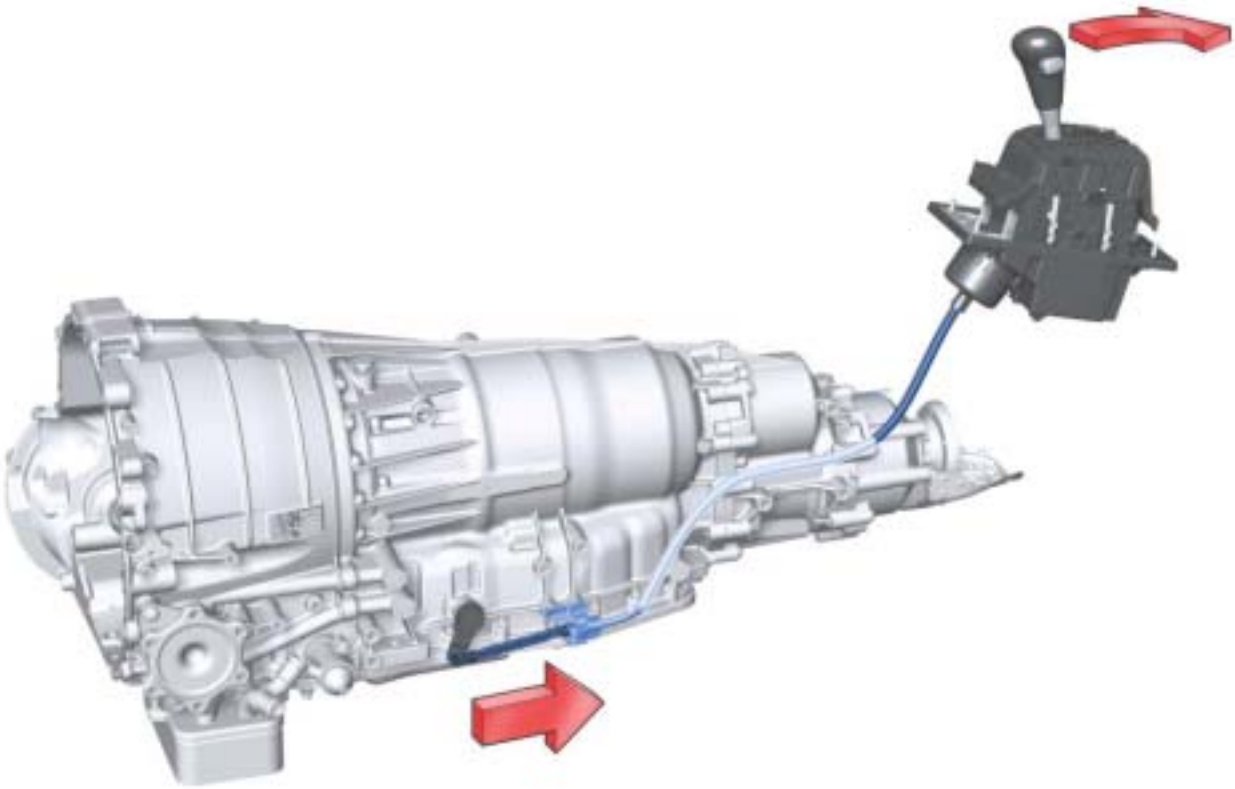
Cables are capable of withstanding high tensile force. In the opposite direction however (thrust) they are highly susceptible to kinking for physical reasons.

To be able to transmit the required level of thrust, selector lever cables therefore had to be sufficiently thick and thus rigid in design.

A rigid selector lever cable transmits vibrations to a far greater extent than a flexible one.

If the selector lever cable is subject to tension in its installation position, vibration from the drive system is transmitted to the passenger compartment and often leads to a noise nuisance.

Tension-free routing of the cable is of great importance in terms of passenger compartment noise levels.



283_011

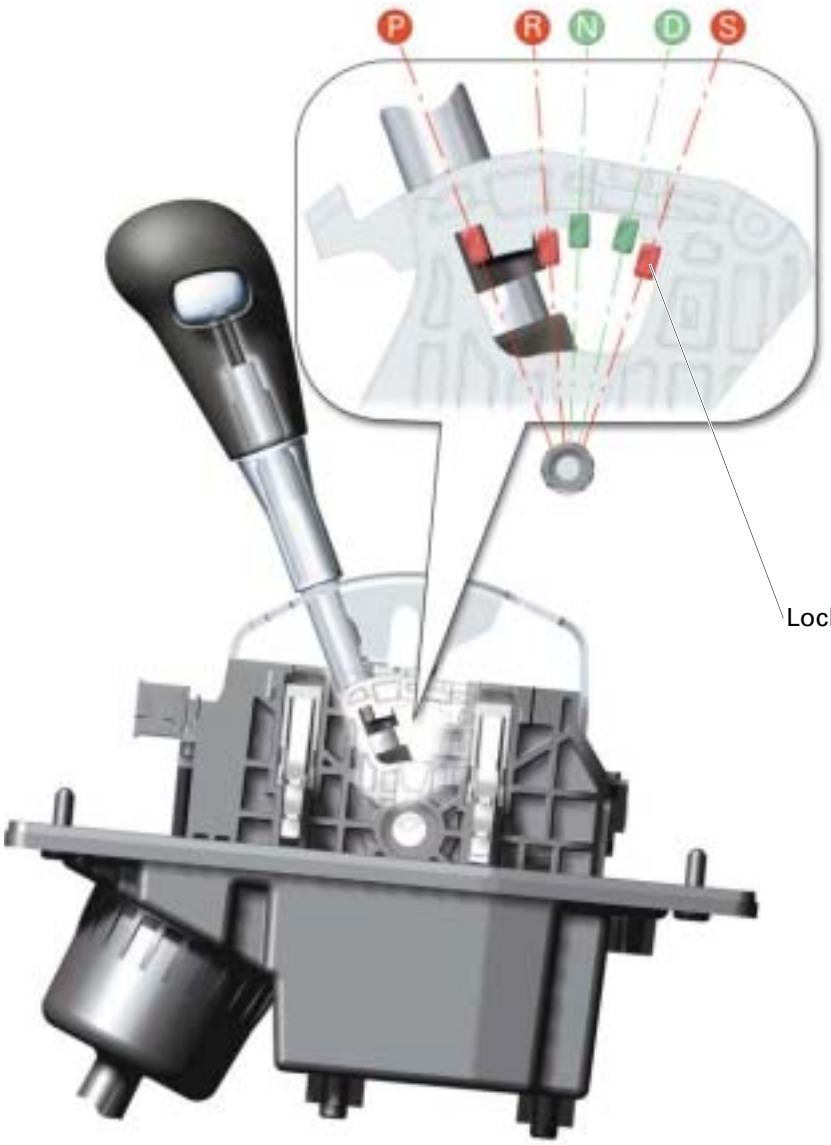
Gearbox Periphery

Selector lever/button kinematics

To prevent inadvertent shifting into selector lever position "S", a change has been made to the selector lever kinematics such that switching to "S" involves pressing the button in the gearstick knob.

A small gear mechanism is provided in the gearstick knob to reduce the required button operating force.

The locking rod is actuated by the application of pressure, which means changes have also been made to kinematics and gearstick knob assembly (refer to Workshop Manual).



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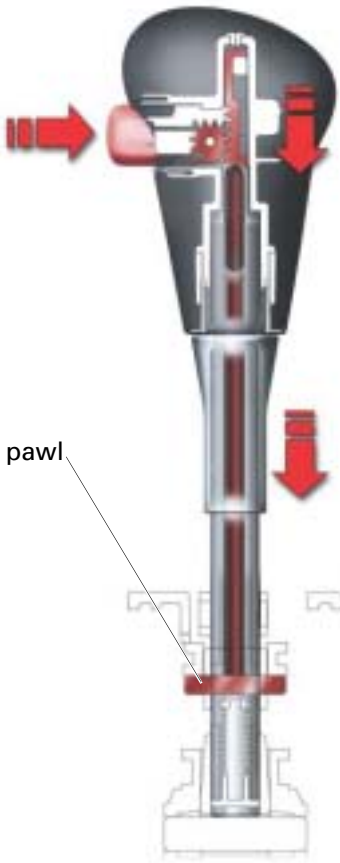


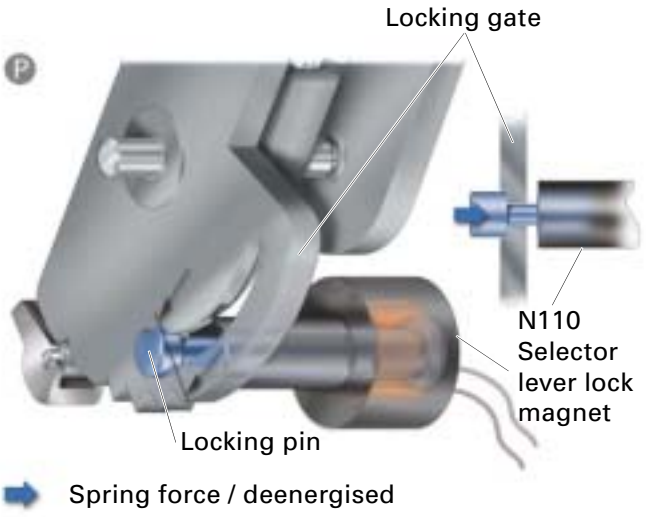
283_018

Selector lever locks (P lock + P/N lock)

A basic distinction is made between the P/N lock whilst driving/with ignition switched on and locking of the selector lever in position P with the ignition key removed (P lock).

In the past, the P lock function was implemented by the steering column lock by means of a cable to the selector mechanism. On account of the new "electronic ignition/ starter switch" (entry and start authorisation switch E415) and the electrical steering column lock control element N360, there is now no cable and thus also no mechanical link.

On the A8'03, the P lock function is assumed by the locking pin of N110. To achieve this, the locking gate of the selector lever and the locking pin of N110 are designed such that locking is possible both with N110 deenergised (P) and energised (N).



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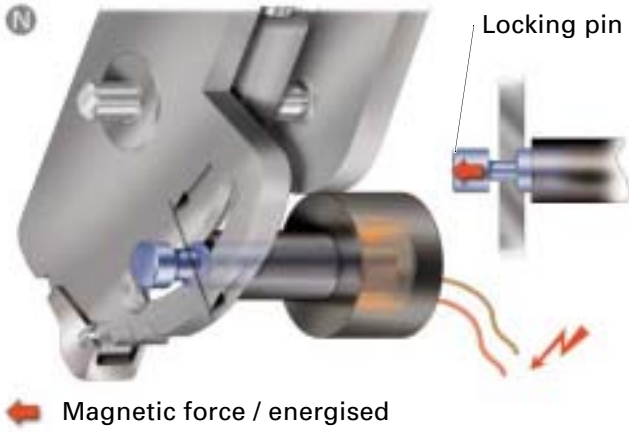

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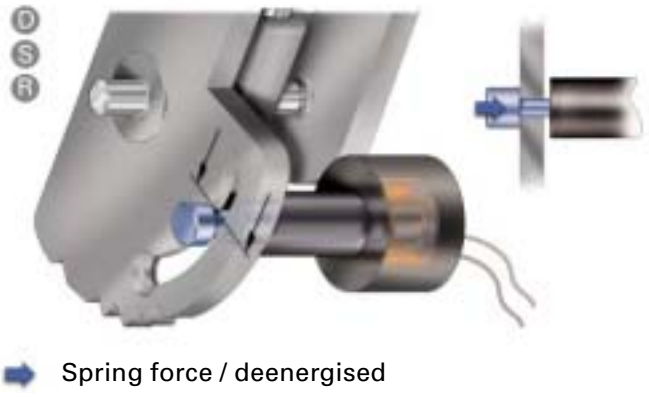


283_053

Gearbox Periphery

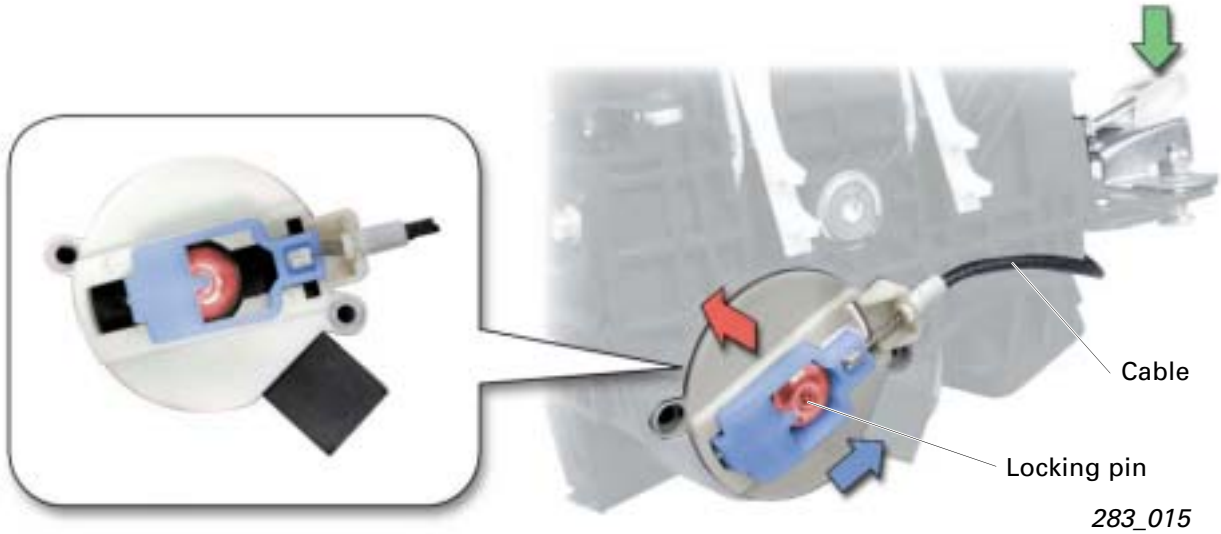
Selector lever lock emergency release

As a result of this modified function, the selector lever remains locked in position "P" in the event of problems with or failure of the power supply (e.g. battery flat). An emergency release mechanism is provided for the selector lever lock to enable the vehicle to be moved in such circumstances (e.g. towing).

Access to the emergency release mechanism is provided by removing the ashtray insert.

Actuation of the rocker causes a small cable mechanism to pull the locking pin of N110 out of the P lock, overcoming the spring force.

283_016



283_015

tiptronic steering wheel

The tiptronic steering wheel controls have been re-designed. One paddle each for change-up (+ right) and change-down (- left) is provided on the back of the steering wheel on either side.

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 actuating one of the two one-touch paddles on the steering wheel (selector lever in position "D" or "S"). The system then switches to the tiptronic function for roughly 8 seconds. Any gear can be selected in the permissible engine speed ranges.

Gears can be skipped by tapping several times, e.g. to change down from 6th to 3rd gear.

Return to normal automatic gearbox operation takes place approx. 8 seconds after the last one-touch shift request.

Special feature:

The approx. 8 second countdown before returning to normal automatic gearbox operation is interrupted while ever cornering is detected or if the vehicle is in overrun mode.

The period is extended as a function of vehicle dynamics. Switching from one-touch function to automatic mode is however implemented after 40 seconds at the latest.

The steering wheel tiptronic function in selector lever position D or S is not authorised for the USA.

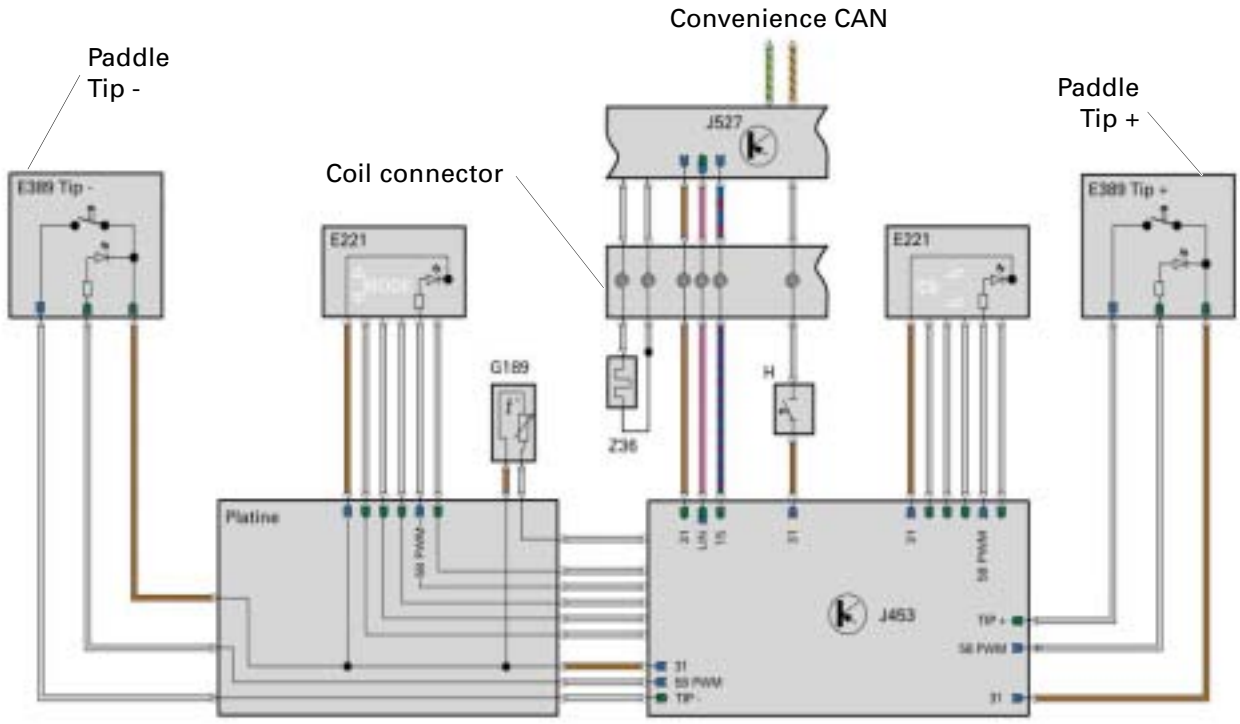
283_020

Gearbox Periphery

tiptronic function with multi-function steering wheel

The shift pulse of the paddles (earth signal) is evaluated in the multi-function steering wheel control unit J453 and transmitted via the LIN data bus to the steering column electronics control unit J527.

J527 transmits the information via the convenience CAN to the data bus diagnostic interface J533, from where the data are transmitted to the drive system CAN and thus relayed to J217.



283_021

E221	Operating unit in steering wheel
E389	tiptronic switch in steering wheel (left- = change-down, right+ = change-up)
G189	Overheating sensor
H	Horn plate
J453	Multi-function steering wheel control unit
J527	Steering column electronics control unit
Z36	Heated steering wheel
58PWM	Pulse-width modulated dimming of switch illumination
LIN	LIN one-wire bus system

The Audi A8'03 is fitted as standard with a multi-function steering wheel.