285

Service.

Running Gear in the Audi A8

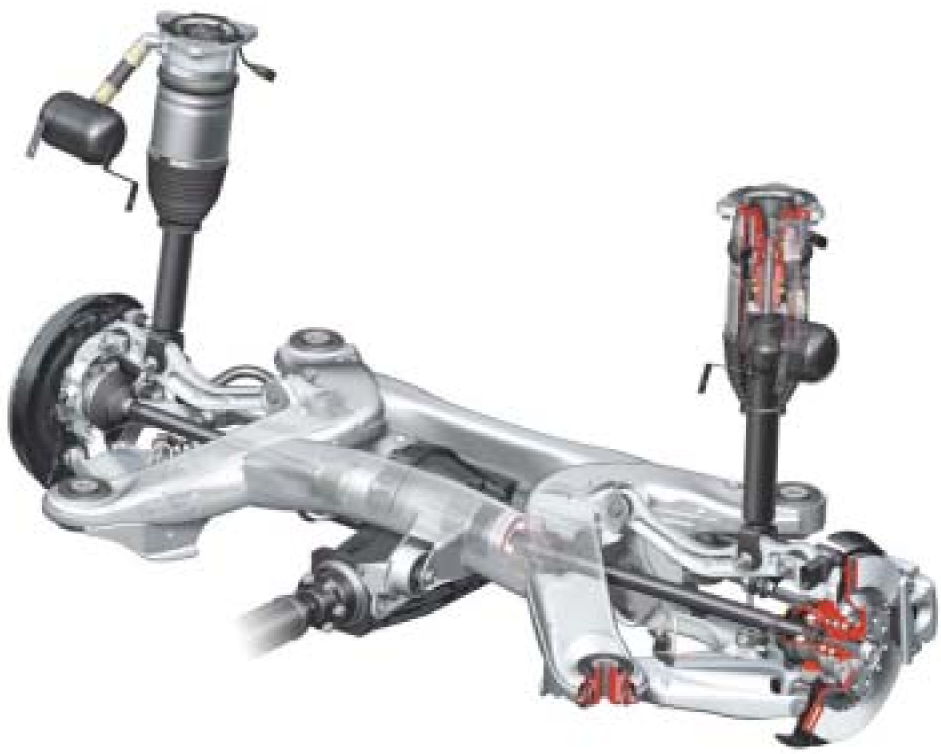
Self Study Programme 285

For internal use only

The requirements to be met by the new A8 running gear were highly diverse and thus led to a whole series of conflicting technical aims.

The remedy to these complex problems was found in the introduction of new concepts alongside progressive improvements to existing ideas and the close coordination of all sub-systems.

This approach meant that it was possible to raise the high level of active road safety of the predecessor model still further and thus to again set new standards in the luxury segment.



Contents

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!

Attention!
Note!

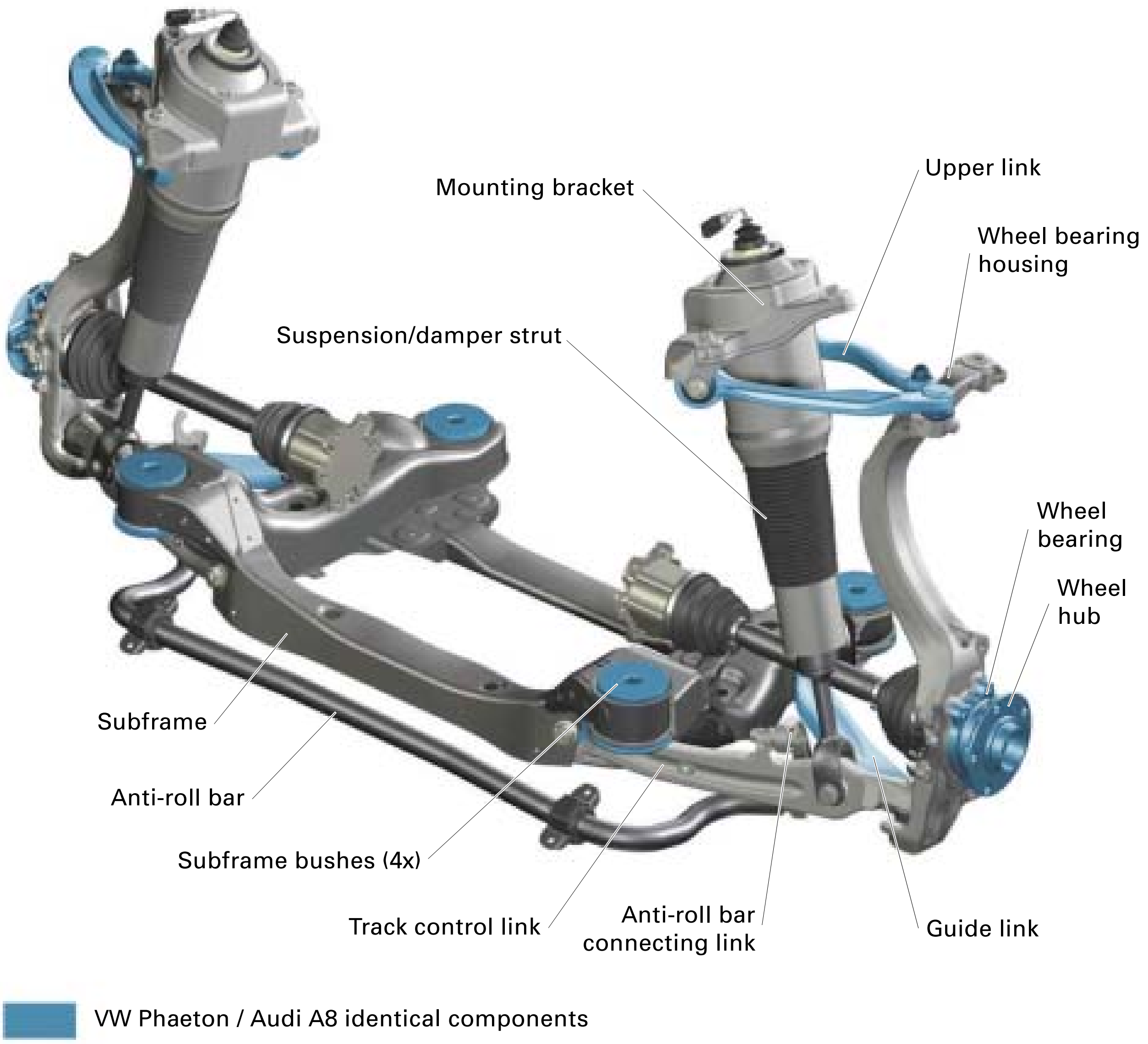
Front Axle

Summary

The new A8 is fitted with the familiar four-link front axle (refer to SSP 161).

A significant new feature is the air suspension in combination with electronically controlled dampers (refer to SSP 292).

All axle components are new on account of the geometric and kinematic modifications as compared to the predecessor model, as well as the air suspension and the weight reductions achieved.
Wherever technically feasible, use is made of identical components for the VW Phaeton and Audi A8.

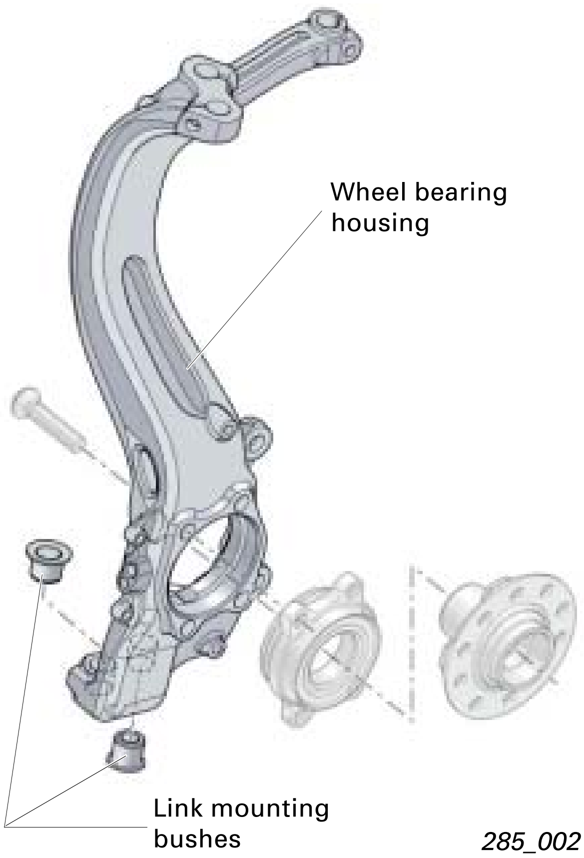


285_001

System components

Wheel bearing housing

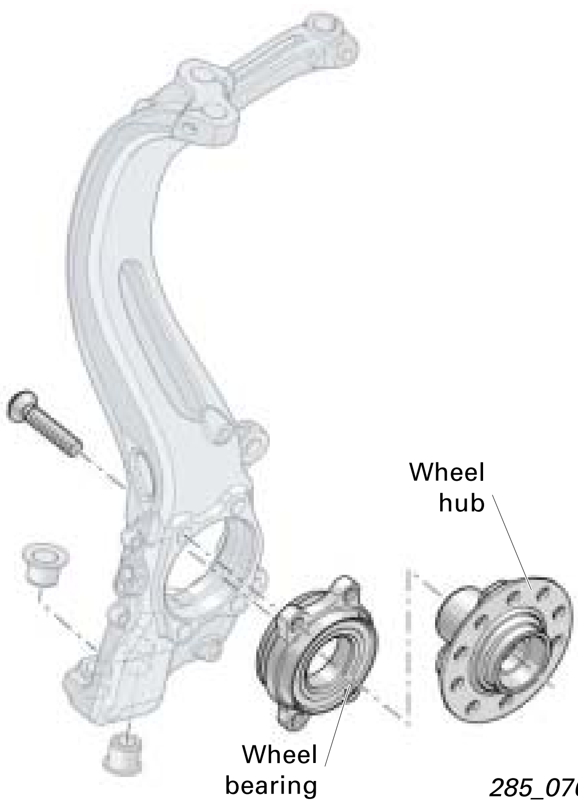
The wheel bearing housing is a forged aluminium component. The guide and track control link mounts take the form of press-fit zinc-iron coated bushes.



285_002

Wheel bearing

Use is made of a 2nd generation wheel bearing (flange bearing). A Ø 92 mm bearing is employed for all engines. The wheel speed sensor ring forms part of the wheel bearing (refer to ESP).



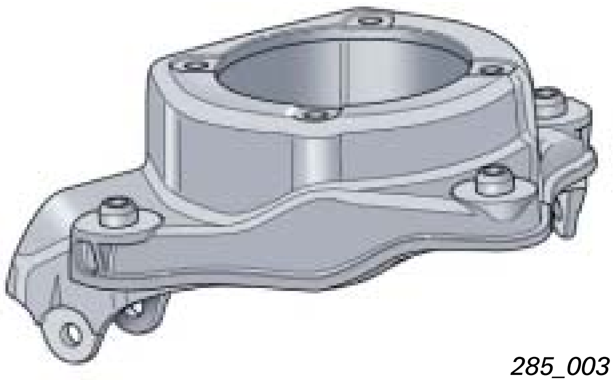
285_076

Front Axle

Mounting bracket

The mounting bracket is made of Poral cast aluminium. It is bolted to the body and designed to support the upper transverse links and the spring/damper unit.

Pay attention to body bolted joint tightening sequence!
(refer to current Workshop Manual).



285_003

Links

The upper and lower links are made of forged aluminium. To minimise road noise and tyre vibration, the guide link is connected to the subframe by means of a large hydraulically cushioned bush.

Heed installation positioning!
(refer to current Workshop Manual).

285_004

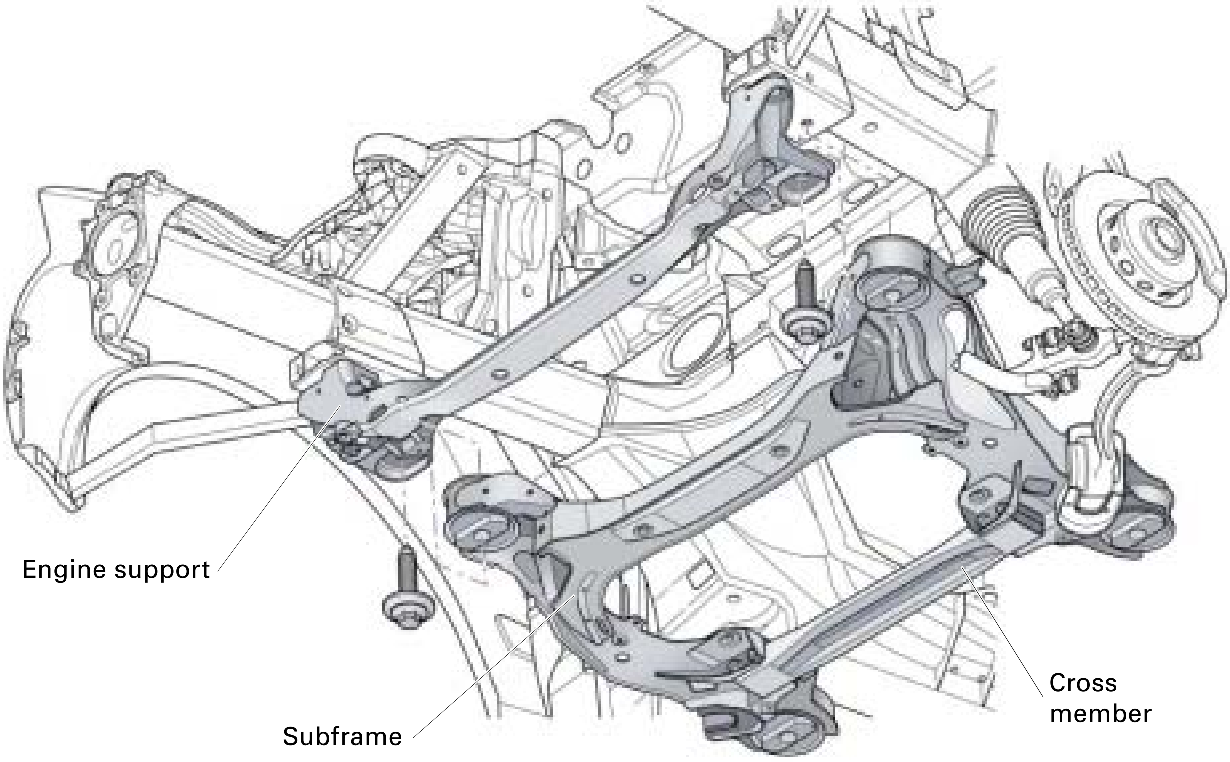
Spring/damper unit

Details of the design and operation of the air suspension system components can be found in SSP 292.

285_077

Subframe

The subframe takes the form of a welded stainless steel shell. To increase rigidity, the U-shape is completed by a bolted cross member at the rear.



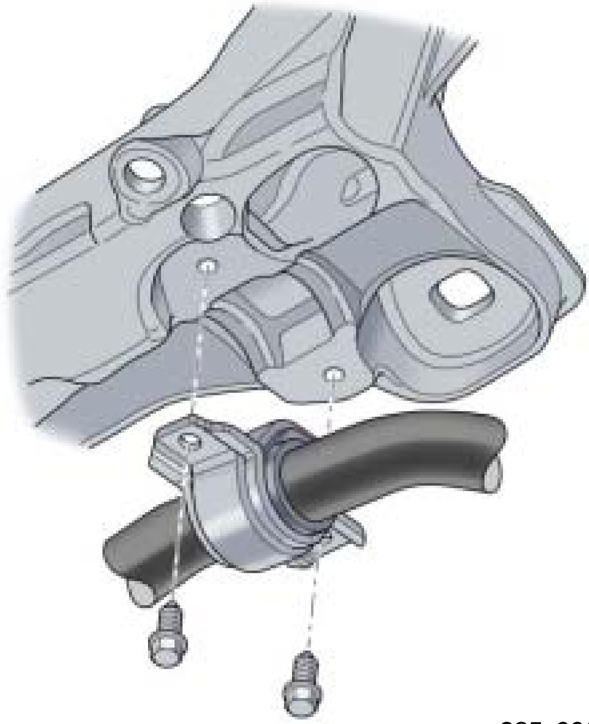
285_005

Engine support

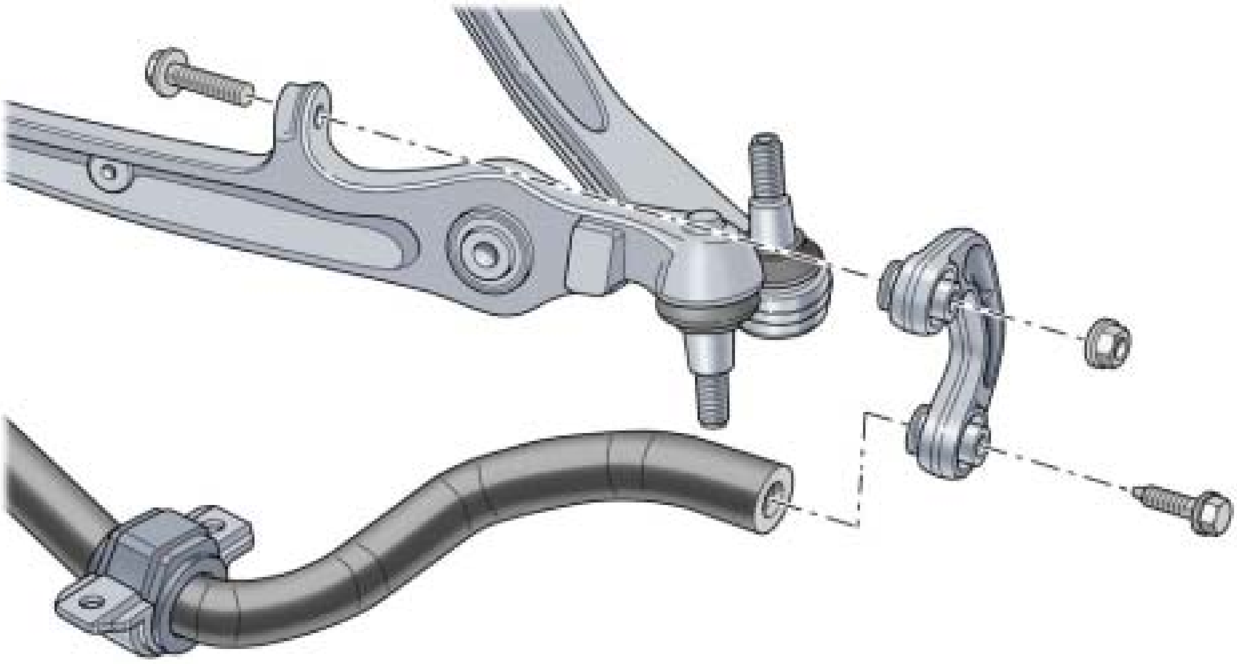
A new feature is an engine support bolted to the front attachment points of the subframe.

Anti-roll bar

For weight-saving reasons, the vehicle is fitted with a tubular anti-roll bar. The anti-roll bar joins the two track control links by way of connecting links. A new development is the method of mounting the anti-roll bar at the engine support.
The bushes are vulcanised onto the tubular bar and can no longer be replaced separately when performing service work.



285_006



285_007

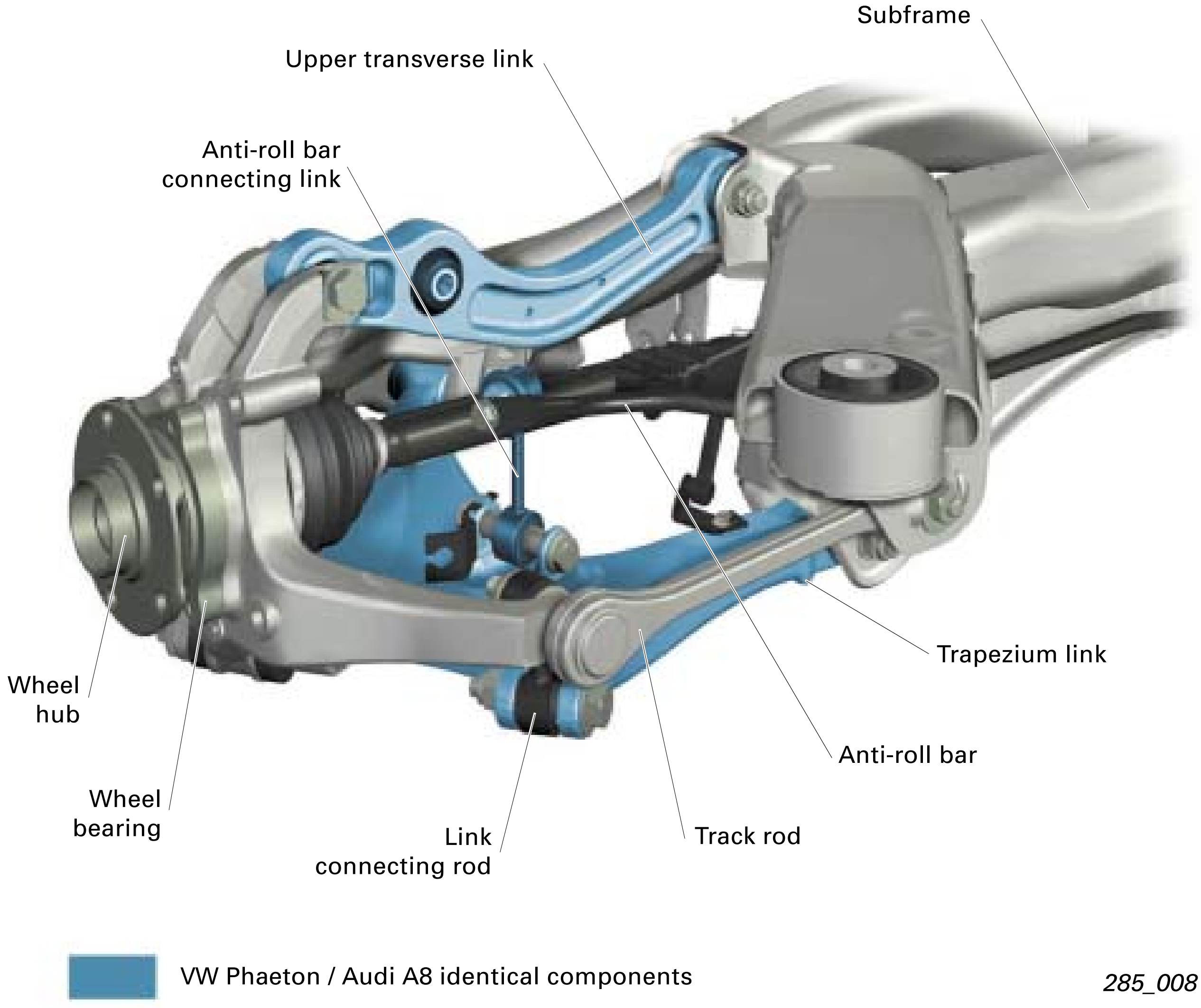
All mounting elements are to be attached in basic level setting ("Automatic" mode, refer to SSP 292).

Rear Axle

Summary

The rear axle is a more advanced version of the familiar A8' 02 trapezium-link axle.
All axle components are new on account of the geometric and kinematic modifications as compared to the predecessor model, as well as the air suspension and the weight reductions achieved.

Wherever technically feasible, use is made of identical components for the VW Phaeton and Audi A8.



285_008

Principal new features compared to A8 `02

– Use of air suspension in conjunction with electronically controlled damping

– Aluminium subframe to help reduce weight

– Joint arrangement of spring and damper at upper transverse link

– Connection of anti-roll bar to trapezium link

– Use of modified track rod to reduce change in toe on compression and extension of suspension

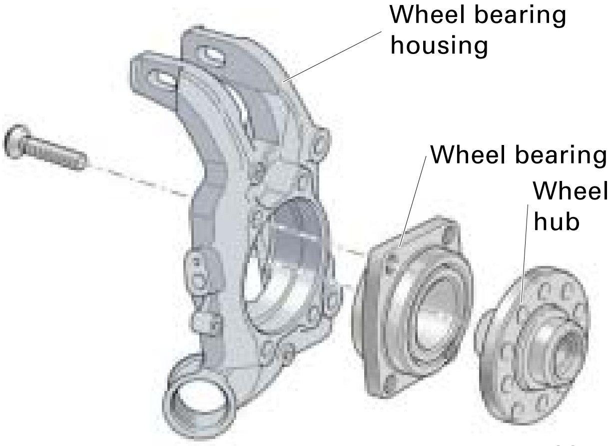
– Use of ball studs to connect wheel bearing housing and track rod, thus reducing secondary spring rate

– Use of slotted bonded rubber bushes in upper transverse link and connection between trapezium link and subframe

System components

Wheel bearing housing

The wheel bearing housing is made of gravity die cast aluminium.



285_009

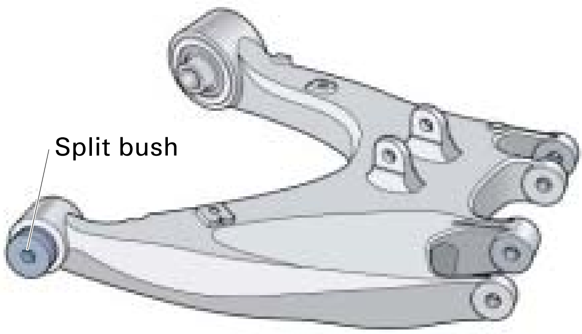
Wheel bearing and wheel hub

Use is made of a Ø 85 mm 2nd generation wheel bearing (flange bearing). The wheel speed sensor ring forms part of the wheel bearing (refer to ESP).

Trapezium link

The trapezium link is made of sand cast aluminium. It acts as lower connecting element between wheel bearing housing and subframe.
The anti-roll bar connecting link is now attached to the trapezium link.

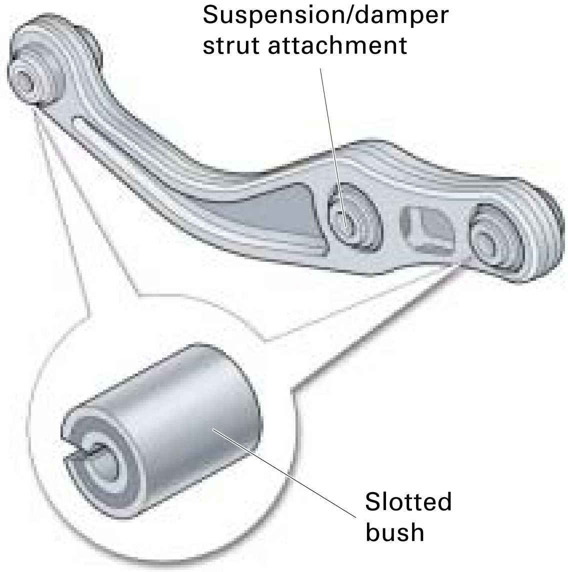
The subframe mount takes the form of an asymmetrically split bush. This helps to enhance self-steering action in the event of load changes (e.g. braking and cornering).



285_010

Upper transverse link

The transverse link is a forged aluminium component. It forms the upper connection between wheel bearing housing and subframe.
Body support at the transverse link is provided by the suspension strut.
This is the first time new mounting elements have been used by Audi. The bonded rubber bushes are axially slotted to enable them to absorb great axial forces with minimum deformation. They nevertheless retain their torsional flexibility and the link can thus turn without any great resistance.



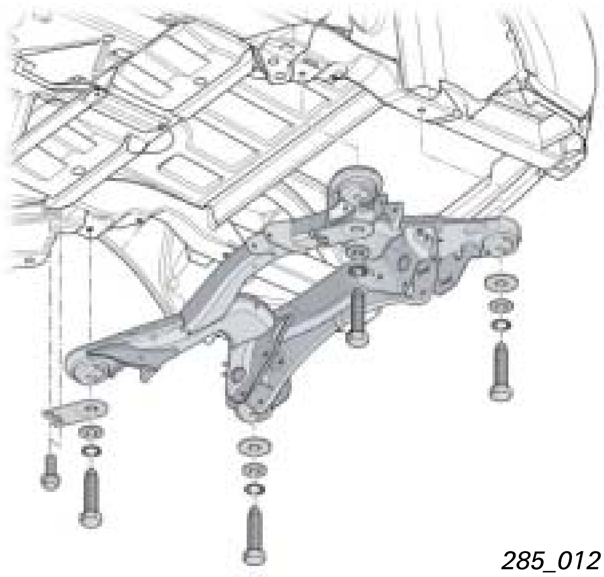
285_011

Refer to current Workshop Manual for information on Disassembly/Assembly.

Subframe

For the first time use is made of an aluminium subframe, thus achieving a weight reduction of approx. 9 kg as opposed to a steel construction.
Mounting at the body is provided by four identical hydro-bushes.

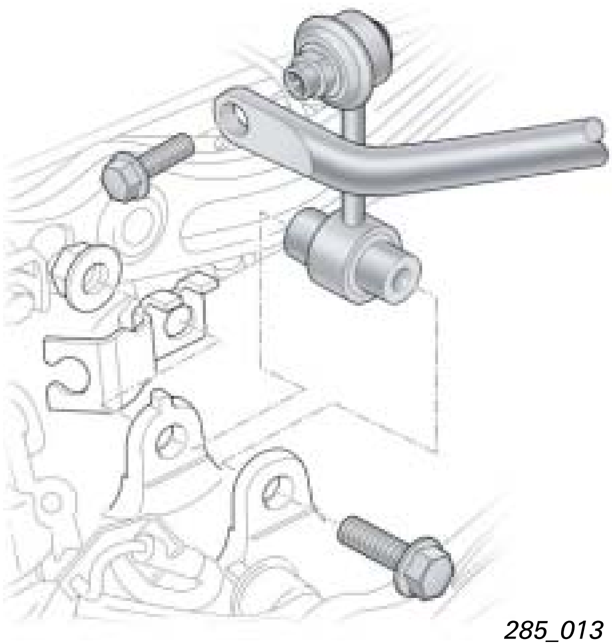
The bushes have a specified installation position in the subframe (refer to current Workshop Manual)!



285_012

Anti-roll bar

The anti-roll bar is mounted at the subframe and attached to the trapezium links by means of connecting rods.



285_013

285_014

Wheel Alignment

General procedure

The basic principles of wheel alignment and adjustment have been retained.

Main changes over A8 `02

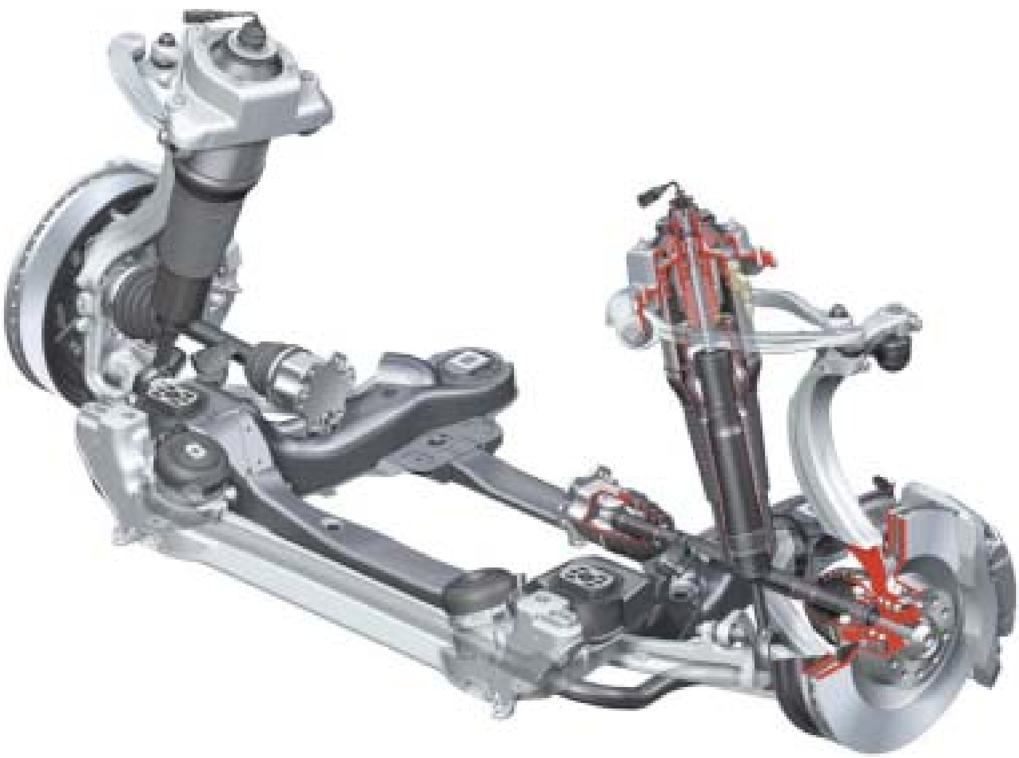
- The toe constant is now set in vehicle basic position (B=1).
- Balancing out of front axle toe values involves adjusting subframe together with engine support.
- On vehicles with adaptive cruise control, the distance sensor has to be checked/ adjusted after changing rear axle toe values.

"Automatic" mode must be set shortly prior to wheel alignment.
Vehicle must be at a settled level at the start of wheel alignment.
For details, refer to wheel alignment computer user prompting.

Front axle settings

As in the past, individual toe values and the toe change profile on suspension compression/extension (= "toe-in curve") can be set for the four-link front axle.
The camber values can be balanced out between the right and left side of the axle.

This is achieved by moving the subframe sideways together with the engine support (for detailed information, refer to current Workshop Manual).



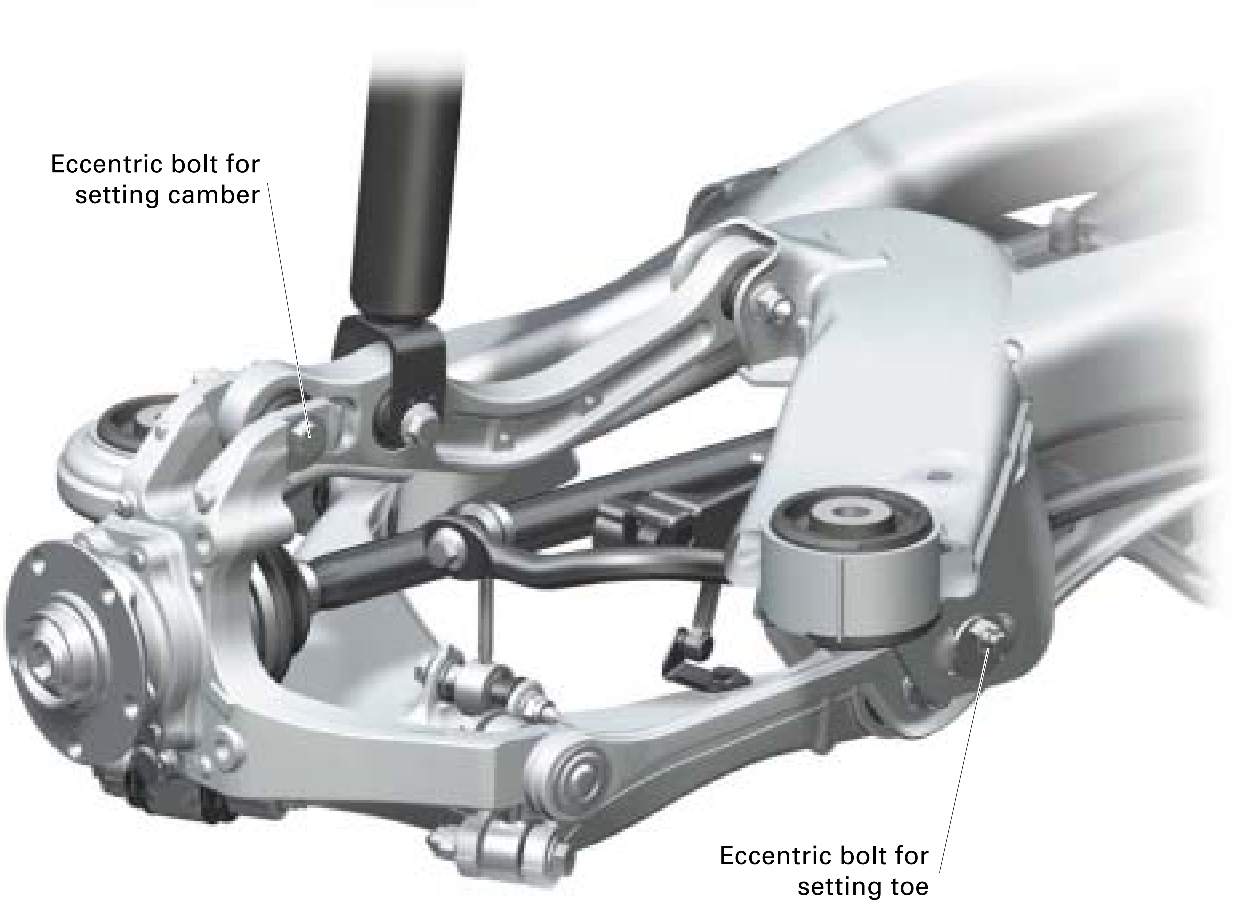
285_078

Rear axle settings

The camber is set by means of an eccentric at the transverse link/wheel bearing housing bolted joint.

The toe is set at the track rod/subframe bolted joint.

(For detailed information, refer to current Workshop Manual).



285_079

Steering System

Summary

Customers can choose between mechanical and electrical steering column adjustment, as well as between power steering and Servotronic.

Principal new features compared to A8 `02

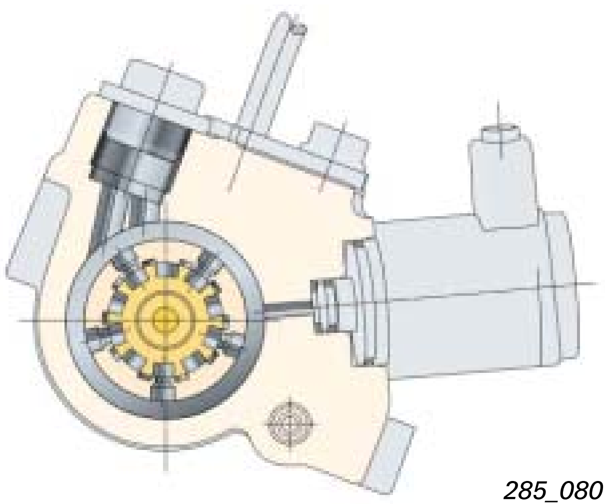
- Electrical steering lock
- Spindle-driven electrical steering column tilt adjustment
- Rigid track rods
- Variable steering ratio
- Servotronic II
- Larger steering mechanism piston diameter
- More detent positions at steering column splines

System components

Steering pump

Use is made for all petrol engines of the FP6 vane pump with a delivery volume of 15 cm^3 per revolution. The maximum system pressure is limited to 125 bar.

For all diesel engines, use is made of the FP4 vane pump
with a delivery volume of 11 cm^3 per revolution. The maximum system pressure is again limited to 125 bar.



285_080

Steering mechanism

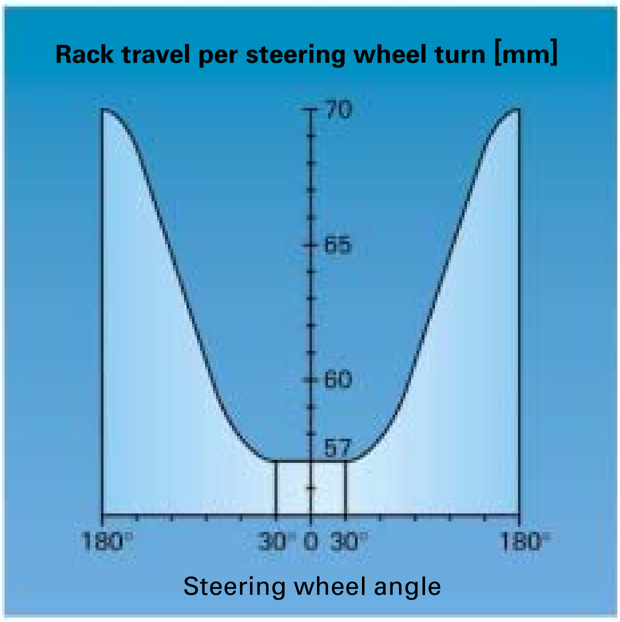
Design:

The rack and pinion steering mechanism essentially consists of a rack and pinion with mounting elements, piston and rotary slide valve.

285_017

Principal differences compared to A8 `02

- Manufacturing the rack splines with different modules and meshing angles permits variable translation of steering wheel movements into rack travel. This variable ratio achieves a more direct response with larger steering angles.
- The piston diameter was increased from 43 mm to 45 mm on account of the higher axle load on vehicles fitted with the full range of equipment.
- The rotary slide now has 10 grooves instead of 6, thus increasing the number of helices at the rotary slide. This produces a larger cross-section for the flow of fluid and lowers the sound level by reducing flow noise.



285_018

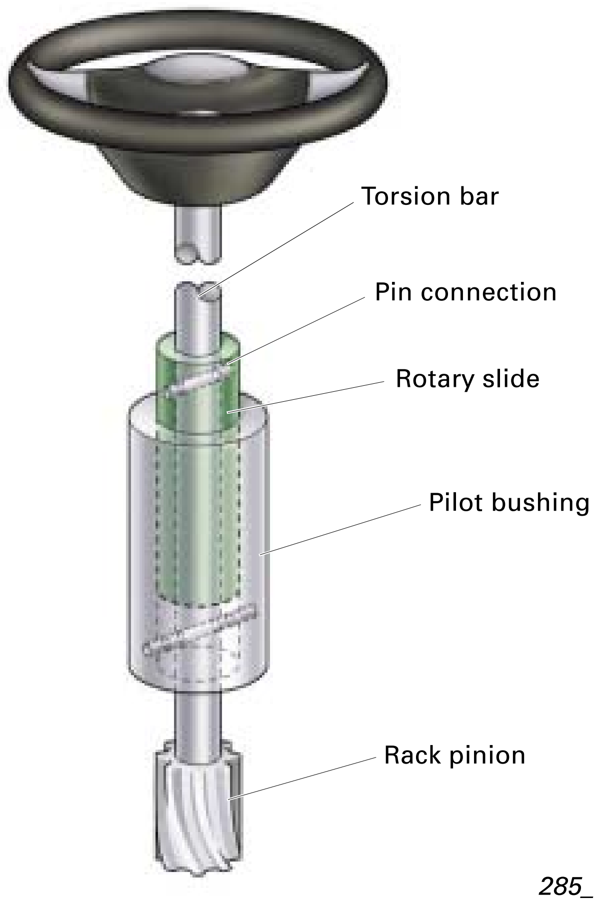
Steering System

A torsion bar in the rotary slide valve is directly connected to the steering column shaft by way of a universal joint. The upper end of the torsion bar is rigidly linked to the rotary slide by means of a pin connection. The lower end is pinned to the rack pinion and pilot bushing.

Driver-induced steering motion causes a force to act on the torsion bar. The torsion bar is turned (= twisted) in a manner comparable to anti-roll bar torsion at an axle subjected to one-sided suspension compression.

The rotary slide is turned together with the torsion bar relative to the pilot bushing.

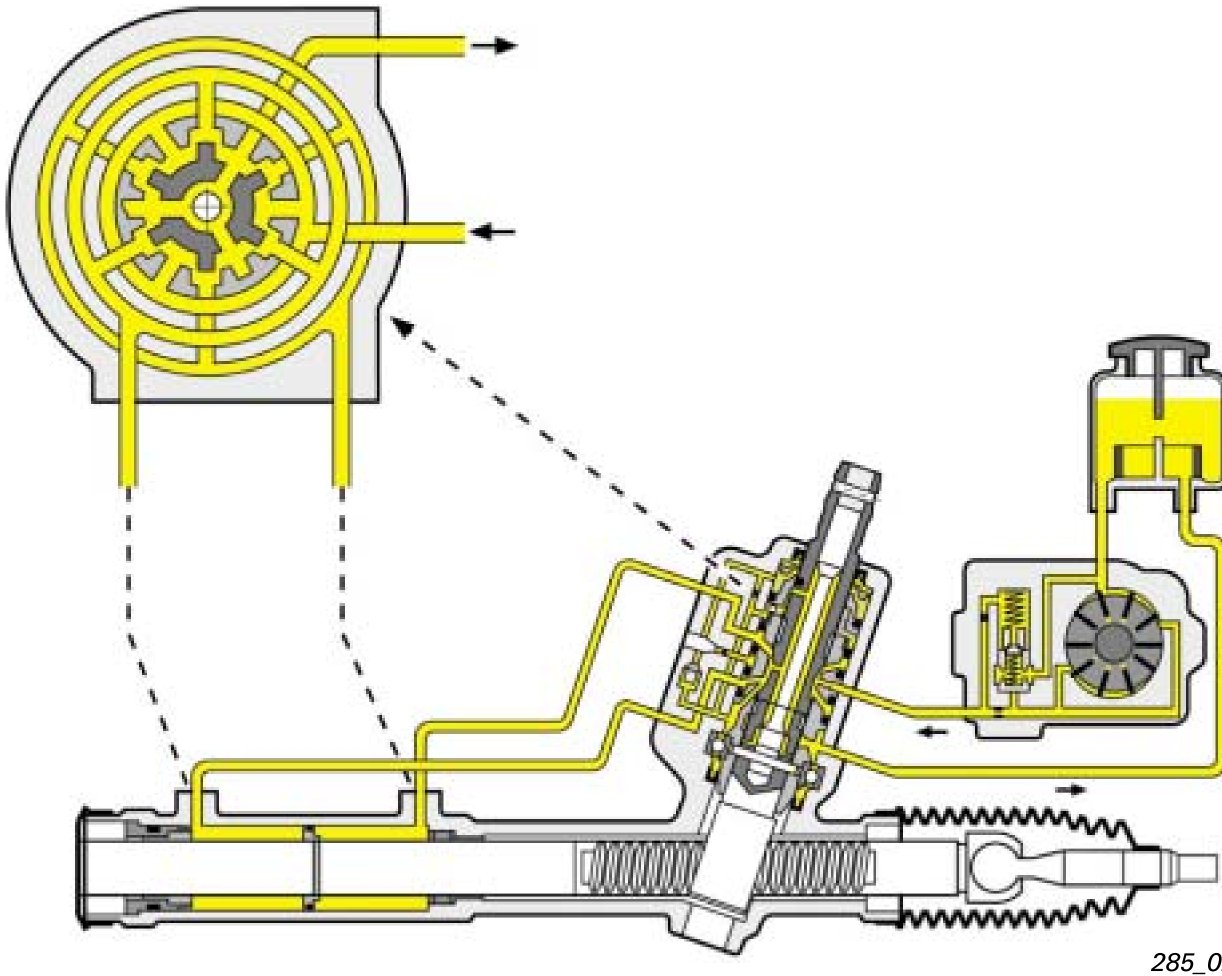
This results in a change in the relative positions of the grooves and bores in the rotary slide and pilot bushing.
Specific fluid ducts can thus be opened and others closed depending on the angular offset between rotary slide and pilot bushing.



285_019

Neutral position

If force is not being applied to the steering wheel, the operating cylinder and pressure pipe are connected to the fluid reservoir and no pressure is built up in the system.



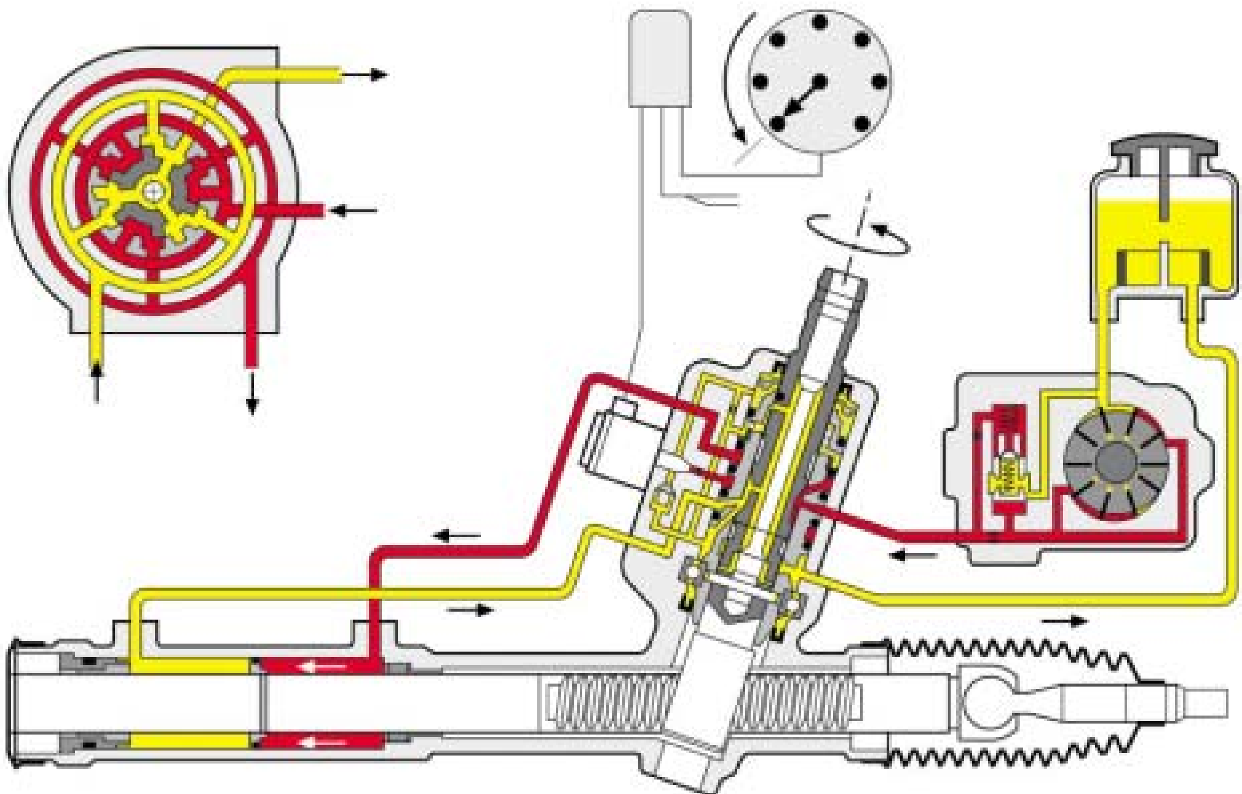
285_021

In the interests of clarity, the rotary slide is illustrated with 6 instead of 10 grooves.

Left wheel lock

Turning the steering wheel to the left causes the torsion bar and rotary slide to be turned on account of the resistance exercised by the tyres and road surface to turning.
This action opens up a fluid duct from the pressure pipe to the right operating cylinder. The left operating cylinder is connected to the return pipe to the fluid reservoir. The piston is subjected to a force acting in the direction of left wheel lock. The rotary slide continues to turn until the total piston and steering force is sufficient to move the wheels to left lock.

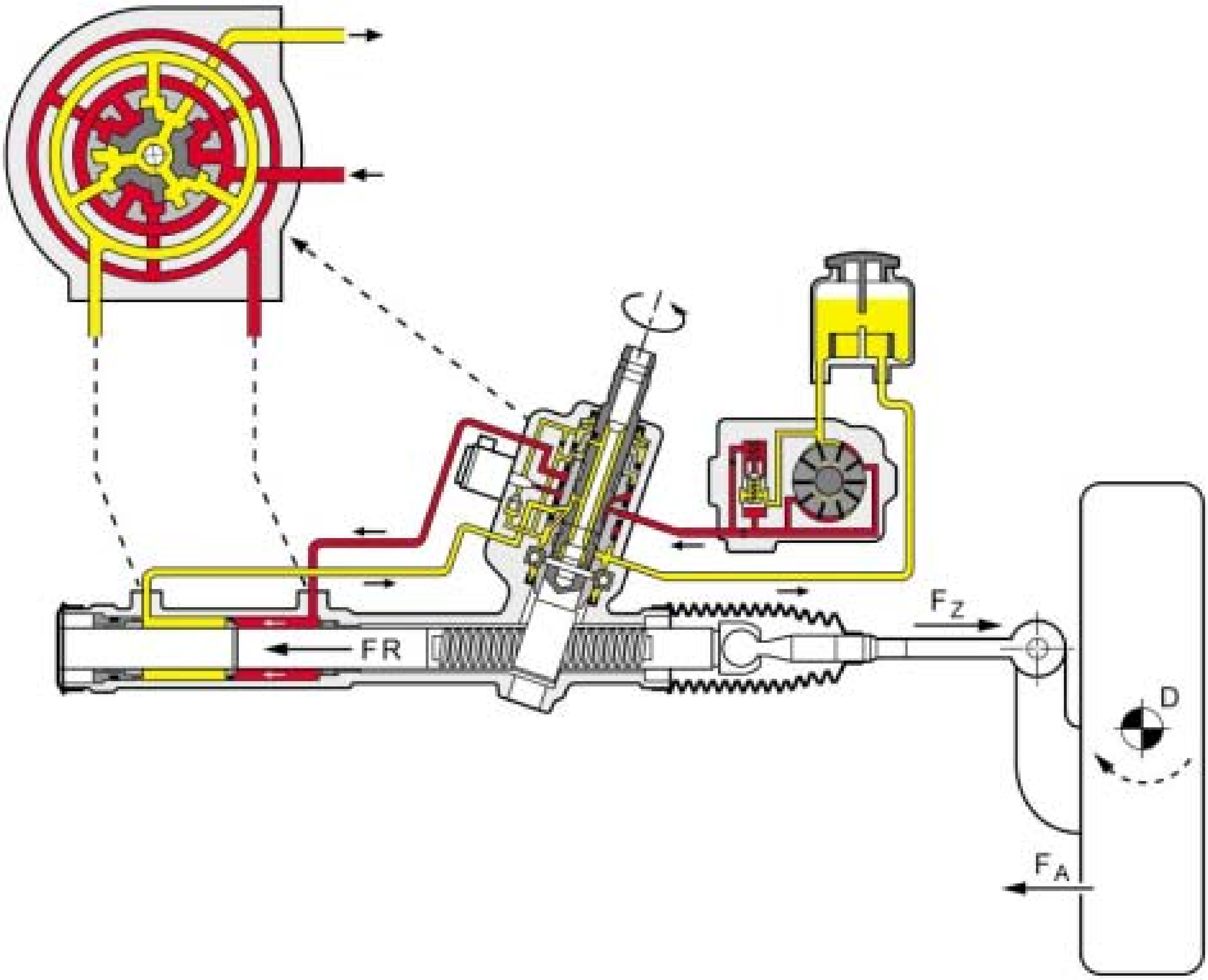
The associated movement of the rack pinion also causes the lower part of the torsion bar to be turned with the pilot bushing. This movement is maintained until there is no longer any turning of the torsion bar and thus no angular offset between the rotary slide and the pilot bushing (= neutral position). The return pipe to the fluid reservoir is re-connected to the operating cylinders and pressure pipe and the system is virtually depressurised again. Each time force is applied to the steering wheel, the torsion bar is turned and the above-mentioned sequence is implemented again.



285_081

In the event of forces acting in the opposite direction, e.g. as a result of an uneven road surface, the power steering has a cushioning effect. This results in turning of the torsion bar due to the force of the rack acting on the pinion and torsion bar.

The rotary slide and pilot bushing are turned towards one another out of the neutral position. Fluid under pressure is then conveyed to the operating cylinder chamber, where it counteracts the rack movement.



285_022

Example:
A bump in the road exerts force F_A on the front wheels, causing the wheel to turn about point D (to the right).
The resultant force at the rack (F_Z) causes the pinion and torsion bar to turn. The fluid supply to the right cylinder side is then opened up and the left side is connected to the return. The reaction force F_R at the piston and rack equalises the action of force F_Z and thus prevents turning of the wheel.

Servotronic solenoid valve N119

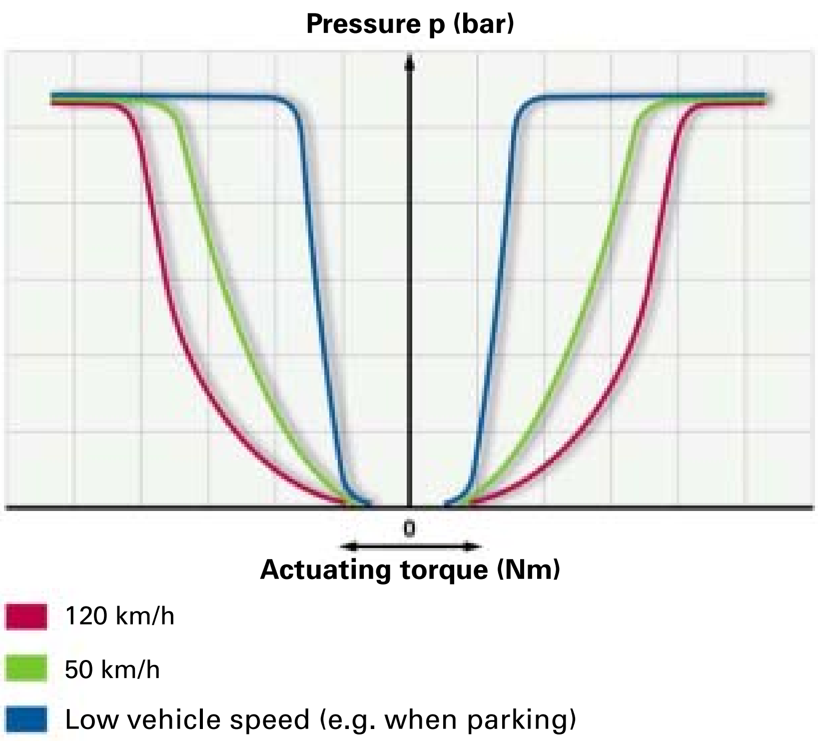
The solenoid valve acts as electrohydraulic converter for implementing the Servotronic function. It is of the proportional type and open when deenergised. The higher the current level actuating the valve, the smaller the opening cross-section.

285_023

Servotronic operation

The higher the vehicle speed, the lower the force which has to be exerted by the driver on the steering wheel when changing direction. This basically applies to all steering systems (with and without servo action).
Certain compromises therefore have to be made when designing the steering.
It is important to avoid an impression of over-light steering at high vehicle speeds.

This is remedied by Servotronic.
The Servotronic regulates the actuating torque at the steering wheel as a function of vehicle speed.
The maximum servo action is provided when the vehicle is stationary or moving very slowly (e.g. when parking).



285_025

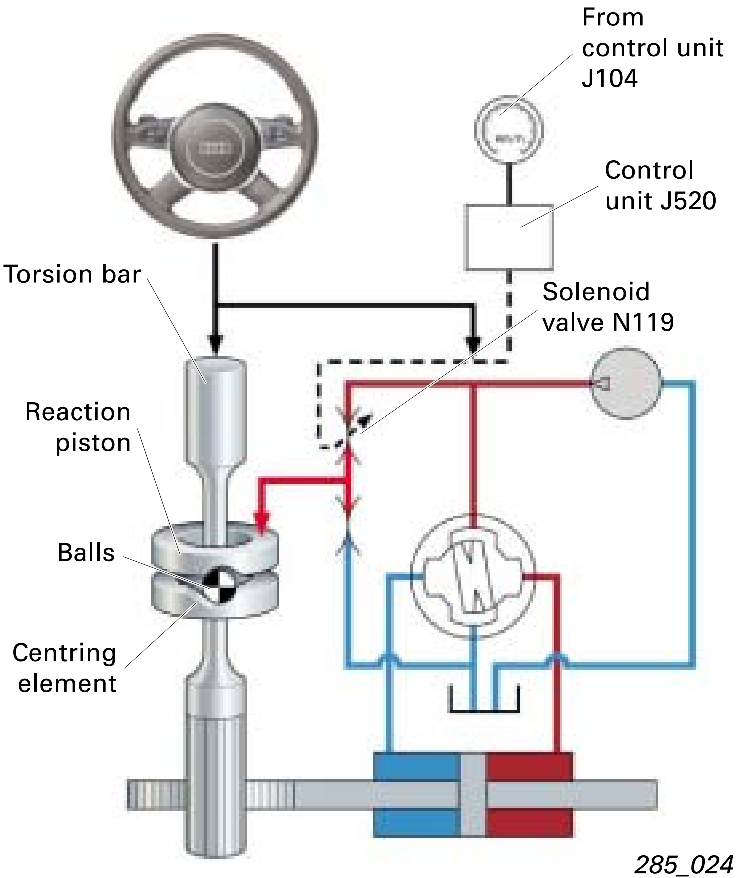
The Audi A8 `03 is fitted with the newly developed Servotronic II.
This again operates on the active hydraulic reaction principle.
The reaction piston is located above the pilot bushing. The piston is connected to the rotary slide and thus also to the torsion bar and is supported by way of balls on the centring element linked to the pilot bushing.
When the steering wheel and thus also the torsion bar are not being turned, the balls are located in a guide collar. Fluid is applied to the chamber above the reaction piston.
The force exerted by the reaction piston on the balls and thus on the pilot bushing varies in line with fluid pressure.

The higher the fluid pressure, the greater the force applied and thus the higher the actuating torque to be exerted by the driver on the steering wheel. The pressure control element is the Servotronic solenoid valve N119.
The valve is actuated by the onboard power supply control unit -2- J520. The input signal for the control unit is the vehicle speed signal from the ESP control unit J104. The larger the opening cross-section of the valve, the smaller the drop in pressure at the valve and thus the higher the pressure in the chamber above the reaction piston.
Different characteristic curves for steering wheel actuating torque and steering system pressure are thus obtained depending on vehicle speed.

In addition to its actual function, the method of operation of the Servotronic II offers two further advantages:

– The guide collar for the balls provides additional steering centring. Straight ahead stability is enhanced particularly at high speeds.

– Fluid pressure and volumetric flow rate are not reduced. This ensures that there is always a safety margin for dealing with emergency situations (e.g. in the event of abrupt, unforeseeable steering correction).



285_024

Steering System

Steering column

As regards basic design, there is no difference between the principal components of steering columns with mechanical and electrical adjustment. Both are equipped with the electrical steering lock.

The steering wheel mounting splines now have 72 detent positions instead of 6.

285_026

Steering column with mechanical adjustment

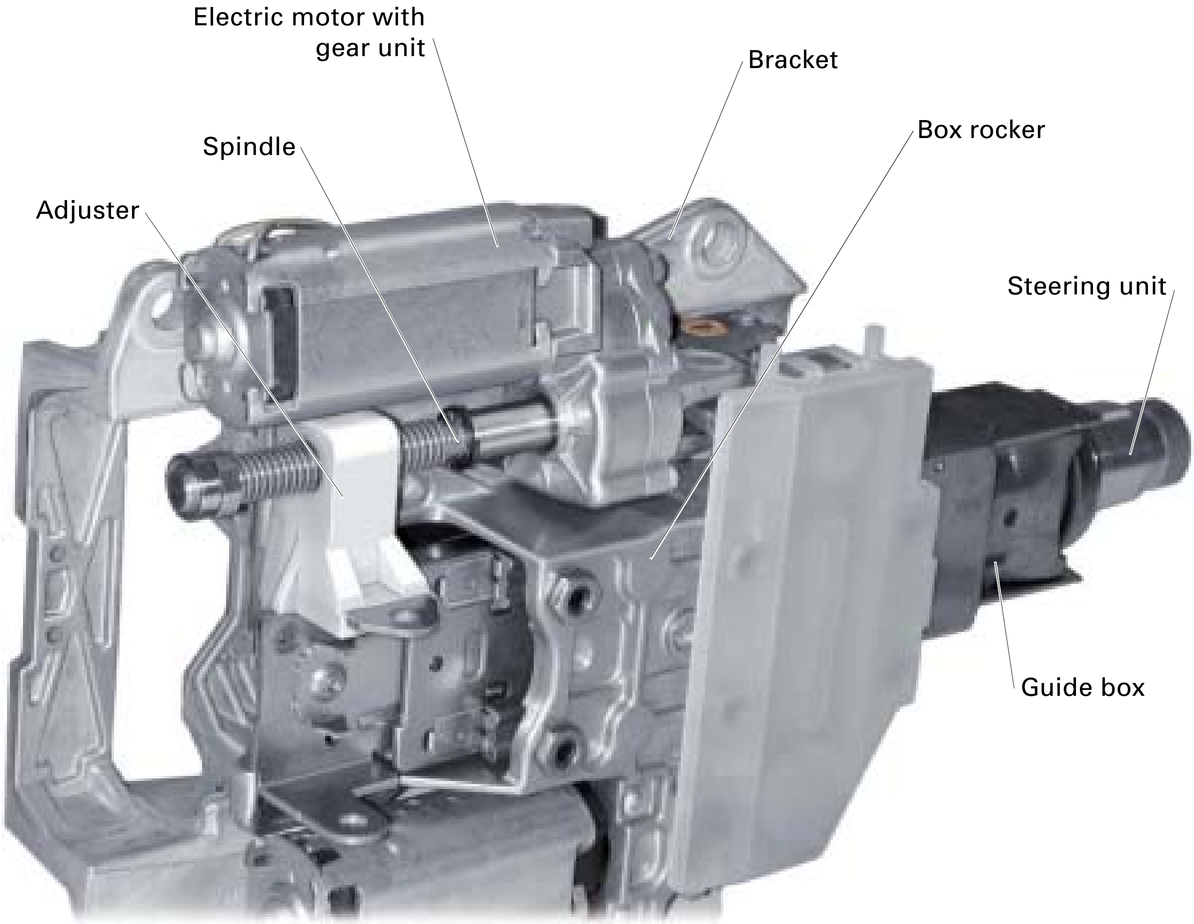
The steering column is fixed in position by means of two sets of plates with eight steel plates each. Four plates each permit axial adjustment. The recesses in the plates for adjustment are arranged axially.
The other four plates on each side are arranged vertically and permit vertical adjustment.
Clamping is achieved by two rollers which run up a ramp on a cam plate during the locking process.
The lever is fixed in position by an over-centre spring.

285_027

Steering column with electrical adjustment
Axial adjustment

The electric motor with gear unit and spindle is permanently connected to the box rocker. The guide box with steering unit is permanently connected to the adjuster. The spindle is screwed into the internal thread of the adjuster.

The rotation of the spindle is converted into axial movement of the adjuster with guide box and steering unit. A Hall sensor in the electric motor measures the number of revolutions. The control unit uses this information to determine the current position in the steering column adjustment range.

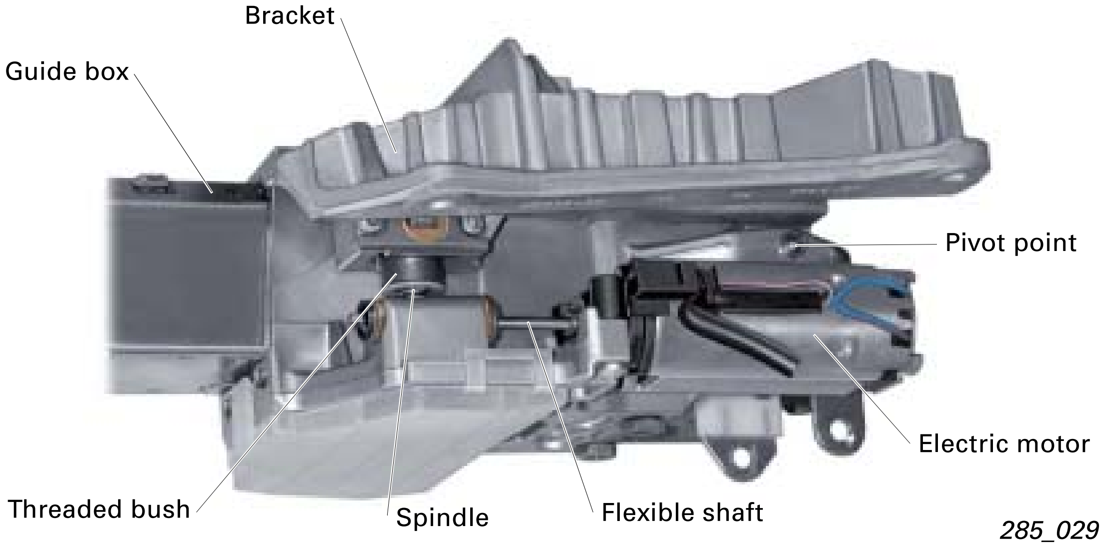


285_028

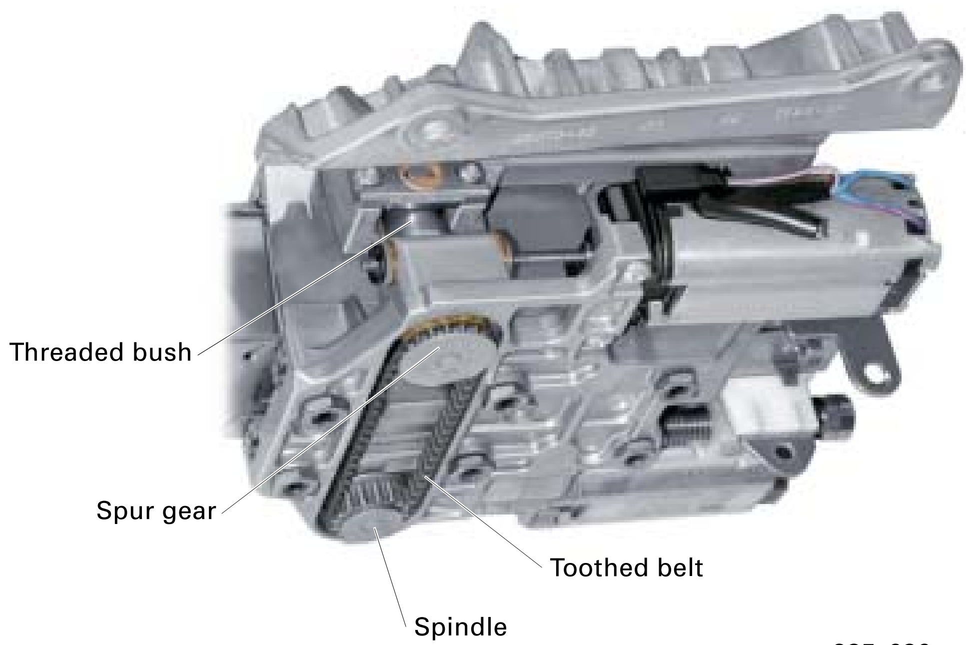
Vertical adjustment

The box rocker with guide box and steering unit is swivel-mounted in the bracket.
The electric motor with flexible shaft, spindle and gear unit is permanently connected to the box rocker.
A threaded bush into which the spindle engages is mounted in the bracket.
Rotation of the spindle produces vertical movement of the threaded bush. The rocker with guide box and steering unit is turned about the joint pivot point.

The other end of the spindle is permanently connected to a spur gear. A toothed belt transmits the rotation to a spindle on the other side of the steering column, where adjustment takes place with identical components. The two-sided mounting system provides far more rigid attachment of the steering column.
A Hall sensor in the electric motor measures the number of revolutions. The control unit uses this information to determine the current position in the steering column adjustment range.



285_029

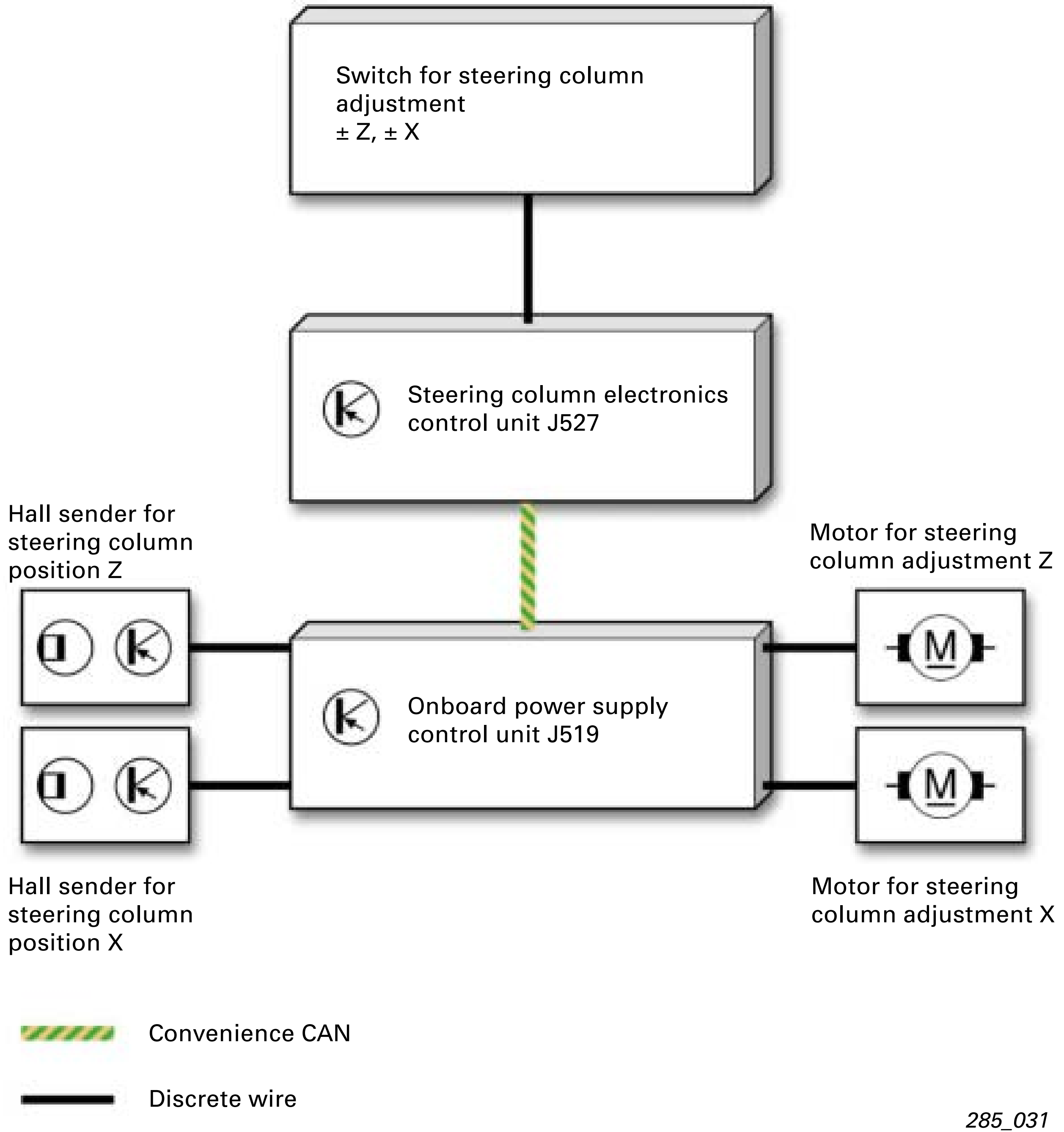


285_030

Steering column adjustment: Block diagram

Following initial assembly, the end positions are approached in Z (vertical adjustment) and X (axial adjustment) directions. These values are stored in the onboard power supply control unit J519.

Each time any further adjustment is made, the Hall senders record the number of revolutions of the corresponding adjustment motor. The control unit J519 uses these values and the stored end positions to determine the current position of the steering column in the adjustment range.



285_031

Electrical steering column lock (ESCL)

Summary

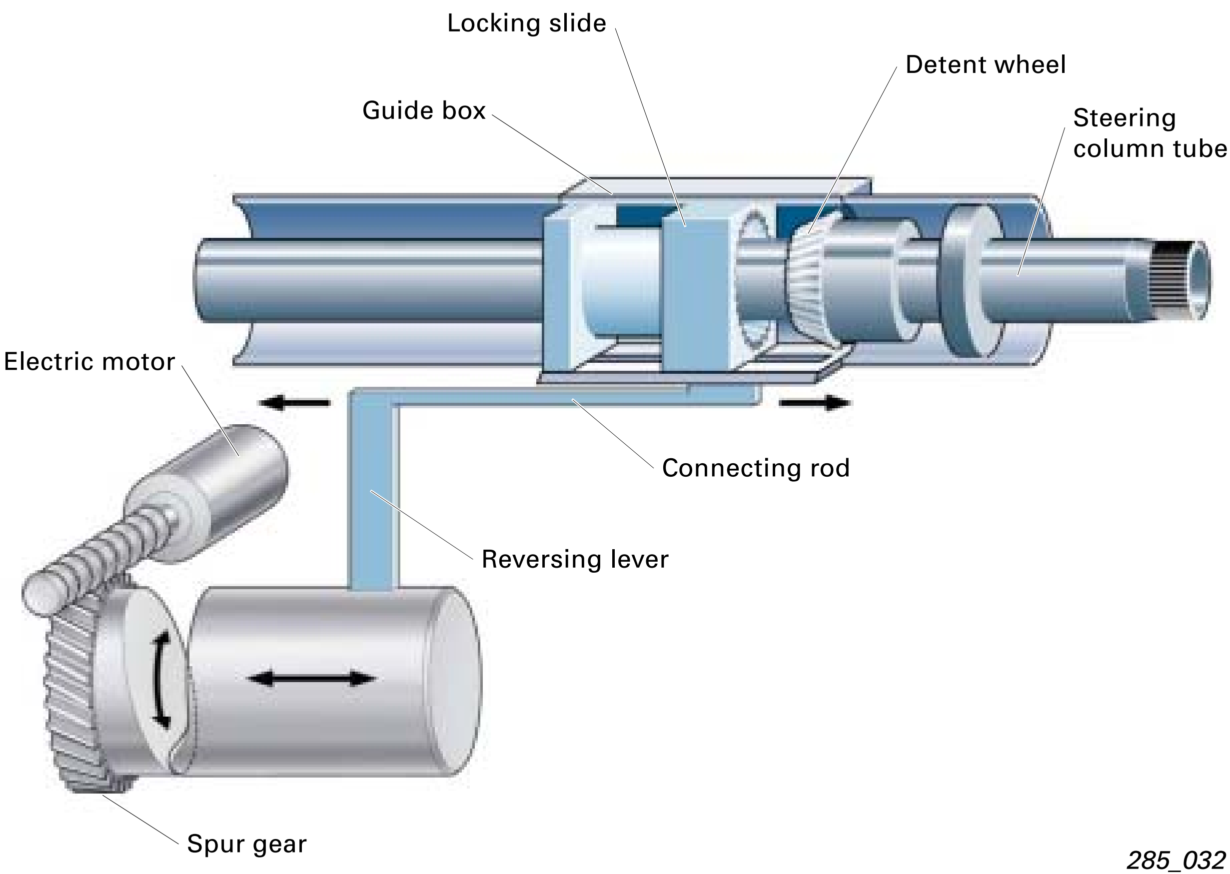
The A8 `03 is the first Audi vehicle to be fitted with an electrical steering column lock. Significant advantages have been achieved by installing the ESCL unit and the locking mechanism at different locations:

- Passive vehicle safety: Space for additional knee guards
- Anti-theft protection: Components less accessible
- Costs: Arrangement of control unit, motor and gear unit in one assembly

Design:

The detent wheel with bevelled outer splines is connected by means of a friction clutch to the steering column tube. The axially adjustable locking slide with bevelled inner splines is mounted in the guide box.

The electric motor drives the spur gear by means of worm gearing. The axially adjustable reversing lever is mounted in the ESCL unit and linked by way of the connecting rod to the locking slide.



285_032

Operation:

Actuation of the motor turns the spur gear. The side face of the spur gear takes the form of a ramp. The reversing lever runs on this ramp and is axially adjusted in line with the position of the spur gear and ramp position.

The movement of the reversing lever is transmitted directly to the locking slide. Meshing of the locking slide and detent wheel mechanically locks the steering column.

The ESCL unit is connected to the steering column by way of shear bolts and can only be replaced together with the steering column.
For information on operation and electrical function refer to SSP 287 Control Units.

Service:

The ESCL function can be checked with VAS 5051 using the control element test.
Matching is performed with the adaption function.

For details, refer to current Workshop Manual and assisted fault-finding.

Brake System

Summary

Use is made of two new brake systems:
A 16-inch system for 6-cylinder engines and a 17-inch system for all larger engines.

The principal new feature is the electrically actuated parking brake.

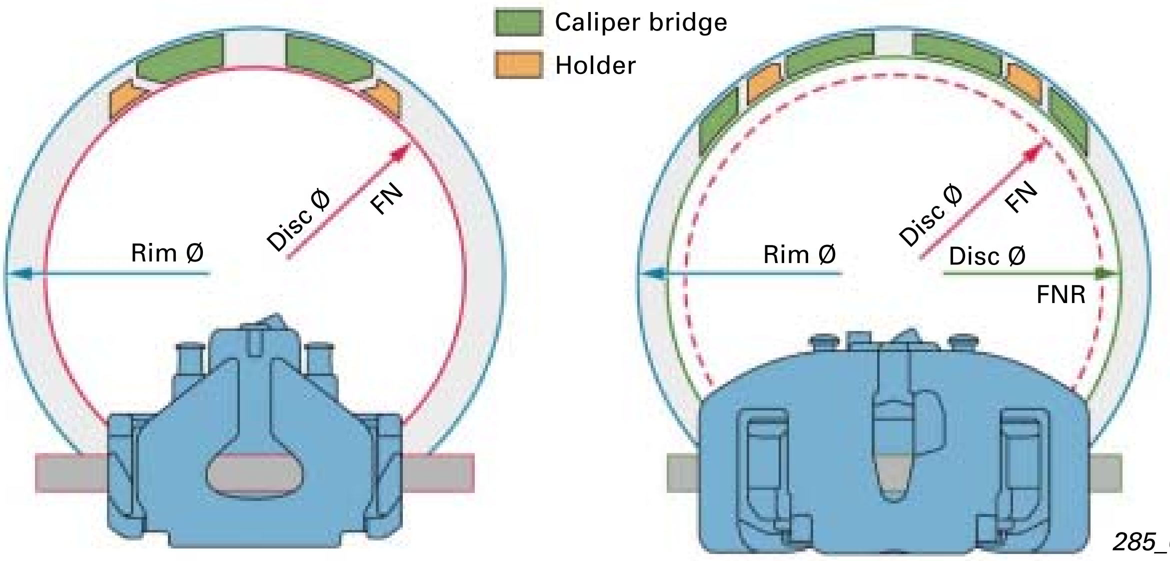
	Front axle		Rear axle	
Engine	V6 engines	V8 engines	V6 engines	V8 engines
Min. wheel size	16"	17"	16"	17"
Type of brake	16" FNRG 60 Aluminium floating frame-type caliper	17" 2FNR 42 AL Two pistons Aluminium floating frame-type caliper	16" C II 43 EPB Aluminium floating caliper	17" C II 43 EPB Aluminium floating caliper
Number of pistons	1	2	1	1
Piston diameter (mm)	60	2 x 42	43	43
Brake disc diameter (mm)	323	360	280	310

System components

Front axle brake caliper

A new design principle has been employed (floating frame type FNR).
In this case the floating caliper is designed as a frame, thus permitting a considerable reduction in material thickness at the caliper bridge.
For the first time it was possible to integrate a brake disc of 360 mm diameter into 17" wheels. In the past, 18" wheels were required for this brake disc dimension.

285_034



285_035

Comparison of technologies: FN and FNR disc brake in the same wheel

Rear axle brake caliper

Use is made of an advanced aluminium floating-caliper brake.
Brake disc diameter and pad area were enlarged to adapt them to the front brake dimension. This resulted in greater braking power and a longer pad service life.

Corrosion resistance was improved by the introduction of stainless steel pad springs and greater pad clearance in the pad guides.
Further details were modified to optimise noise level, braking comfort and environmental compatibility.
The caliper concept was designed for use with the electromechanical parking brake.