eSelf Study Program 960163

The 2017 Audi Q7 Running Gear and Suspension System

Audi Academy

Audi of America, LLC
Service Training
Created in the U.S.A.
Created 9/2015
Course Number 960163

Always check Technical Bulletins and the latest electronic service repair literature for information that may supersede any information included in this booklet.

Revision 1:10/2015

This eSelf Study Program teaches a basic knowledge of the design and functions of new models, new automotive components or technologies.
It is not a Repair Manual! All values given are intended as a guideline only.
For maintenance and repair work, always refer to the current technical literature.

! Note

Reference

The running gear and suspension of the 2017 Audi Q7 feature numerous changes. Both the front and rear axles are five-link designs replacing the double wishbone axles of the previous model.

New elastomer bearings and separate springs and dampers at the rear axle allow the suspension to respond sensitively to driving conditions. The electromechanical power steering with Servotronic provides direct steering response as well as enabling the use of new driver assistance systems.

Compared to the previous model the suspension of the Q7 is approximately 220 lb (100 kg) lighter. The links of the wheel suspension for example, are now made of aluminum and high-strength steel. The front and rear propeller shafts are hollow and the pivot bearings are aluminum forgings. The center of mass of the SUV has been lowered by about 2.0 inches (50 mm) in part by installing the engine lower.

A revised adaptive air suspension (optional) is managed by a newly designed central vehicle control module that directs all body control systems. New actuators for the air suspension and active damping vary the body height and body comfort as required by the driving situation.

The new Audi Q7 comes as standard with 19-inch wheels with 255/55 R19 111H XL all-season tires. Audi offers a number of optional wheels in sizes up to 21 inches. Large, vented brake discs bring the SUV safely to a stop. The discs are stopped up front by aluminum six-piston calipers. The electromechanical parking brake, updated with convenient hill hold and startup functions, acts on the rear wheels. Audi also offers another ground breaking innovation as an option: all wheel steering.

An electronic hill descent assist complements the wealth of equipment. New ESC and ACC generations provide the basis for a number of driver assistance systems.

633_001

The Audi Q7 will be offered with two suspension versions at model introduction.

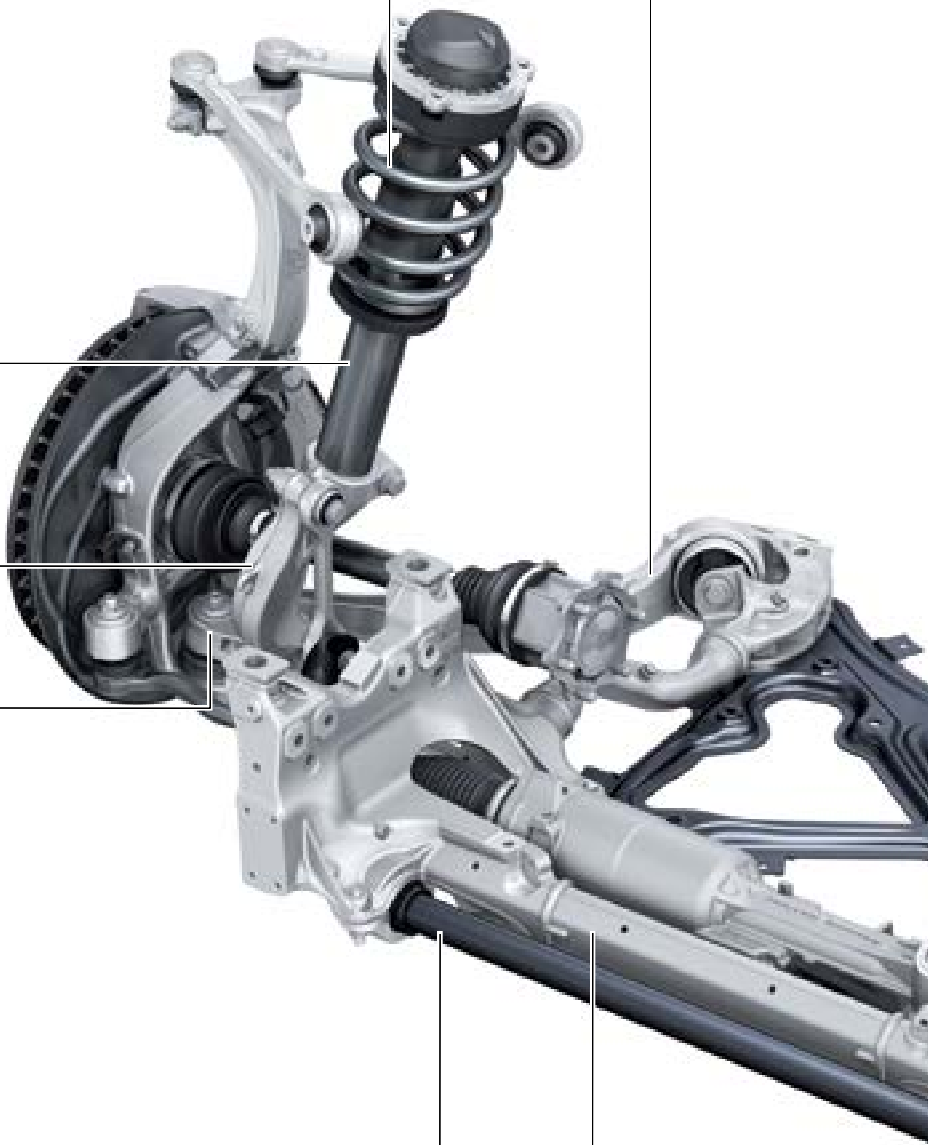
Standard chassis (1BA)
The standard suspension as basic equipment features steel springs and unregulated damping.

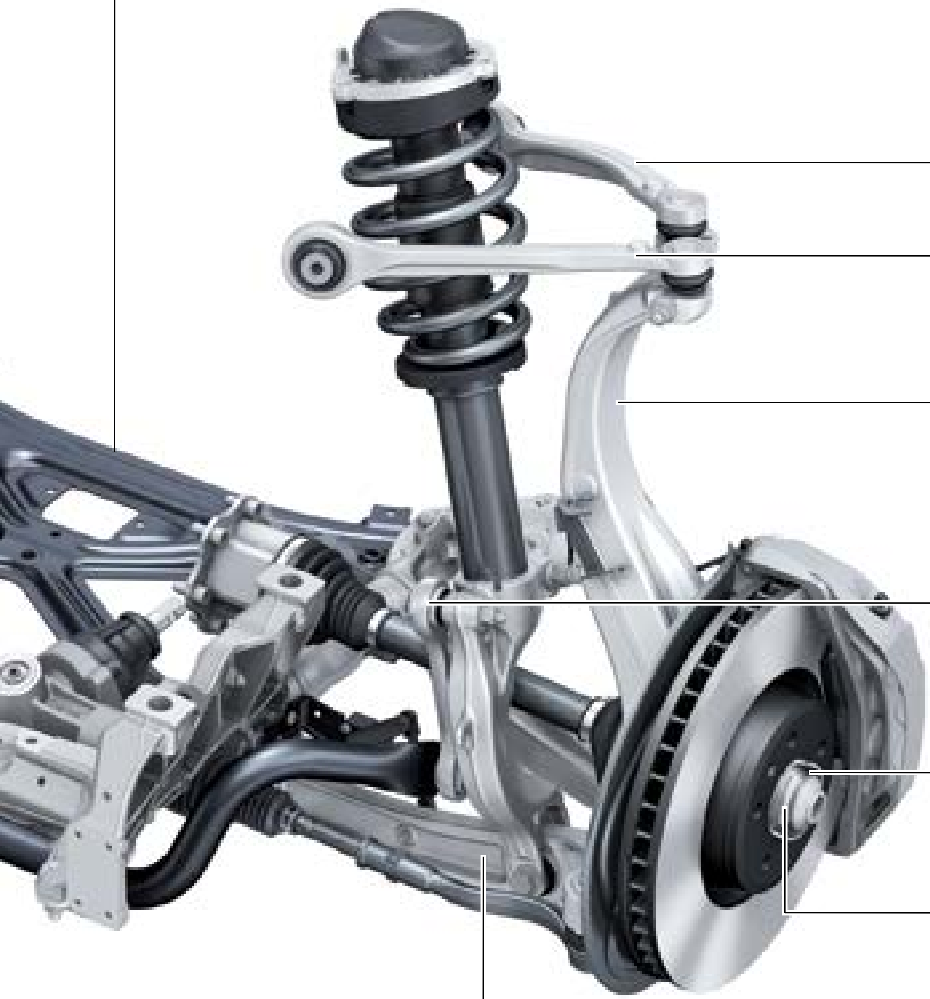
Chassis with air suspension and electronic damper (1BK)
This suspension version is optional.

Axles and suspension alignment

Front axle

The front axle is based on the modular longitudinal platform (MLB). The Audi Q7 adopts the tried and tested five-link axle concept already used on other Audi models.





Cross strut
- Steel construction
- Bolted to sub-frame to increase stiffness

Upper link
- Forged aluminum design
- Mounted directly to body without a separate bearing pedestal

Pivot bearing
- Forged aluminum design
- 2 axle load dependent versions (wheel bearing widths are different)

Tie rod
- Aluminum housing with rubber-metal bearings

Wheel bearing
- 2nd generation wheel bearing
- 2 versions with different wheel bearing widths (40.5 mm and 42 mm)

Wheel hub
- Steel construction

Support link
- Forged aluminum design

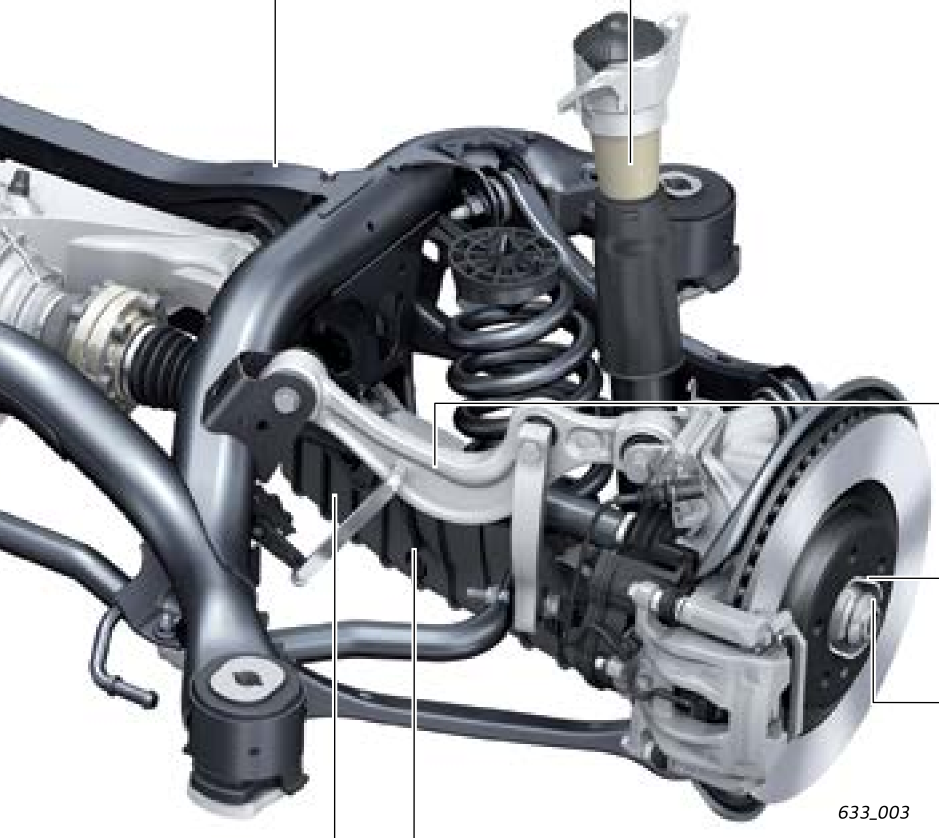
633_002

Rear axle

The rear axle is also based on the modular longitudinal platform (MLB). The Audi Q7 features a newly developed five-link axle. By following lightweight design parameters, the weight of the rear suspension has been reduced by 88.1 lb (40.0 kg) compared with the previous model.

Engine/transmission mount
- Steel construction
- Flexible body attachment, achieved using rubber-metal bearings at rear and hydraulic bearings at front

Damper
- Twin-tube shock absorber with additional polyurethane spring



Upper wishbone
- Forged aluminum design
- Attachment of the anti-roll bar coupling rod and the linkage of the level control system sensor

Wheel carrier
- Aluminum casting
- 2 versions based on different wheel bearings

Wheel bearing
- 2nd generation wheel bearing
- 2 axle load based versions (various outer diameters)

633_003

Spring link
- Shaped aluminum extrusion profile
- Attachment of spring and damper concealed by aero trim

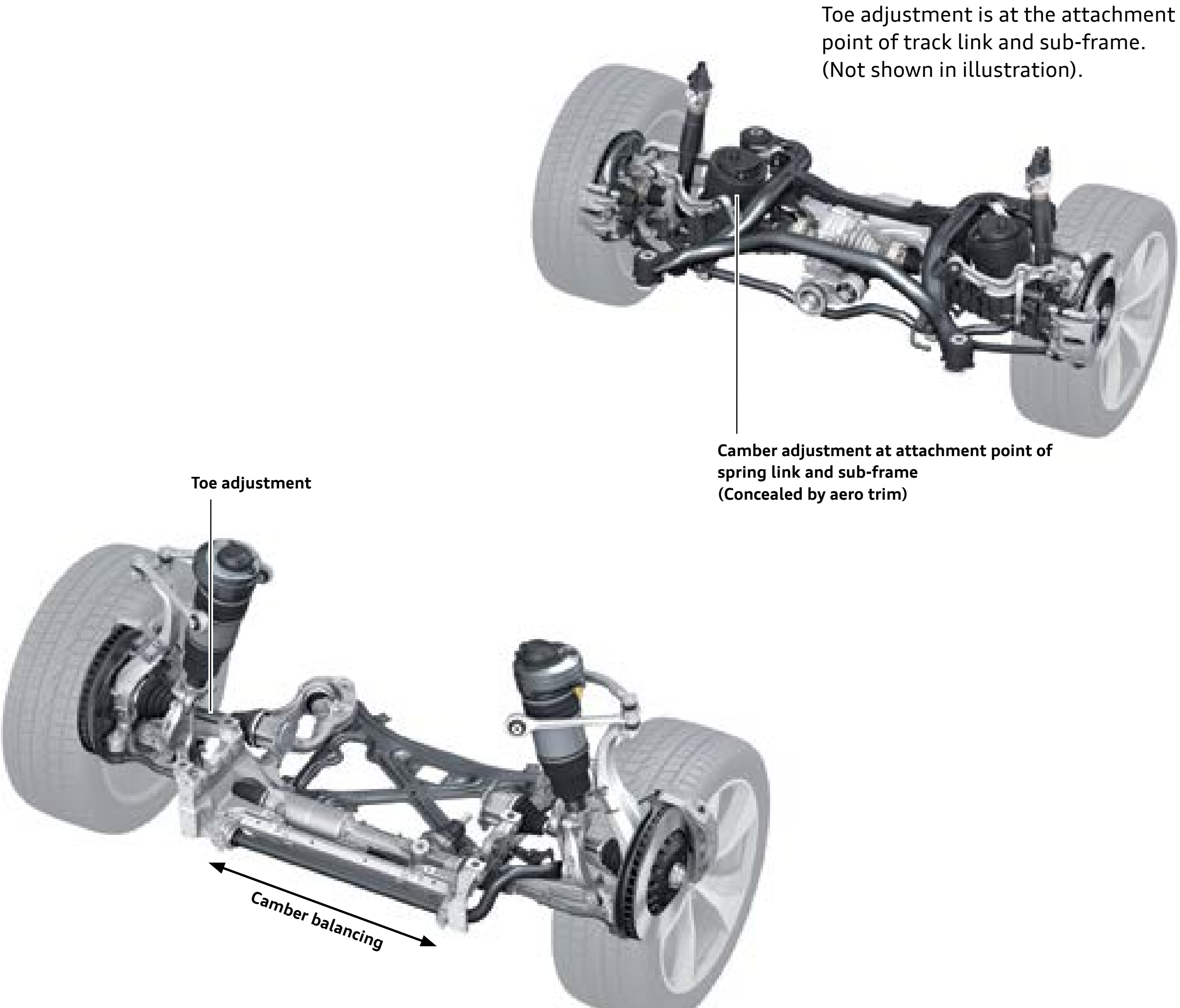
Aero trim
- Attached by clips to the spring link at the bottom
- Reduces lift

Balancer weight
- Bolted to sub-frame (not visible in illustration)

Suspension alignment / setup

The left and right toe values of the front axle can be set individually. The camber can be centered within narrow limits by shifting the sub-frame transversely.

Individual toe values and camber values can be adjusted on the rear suspension.



633_004

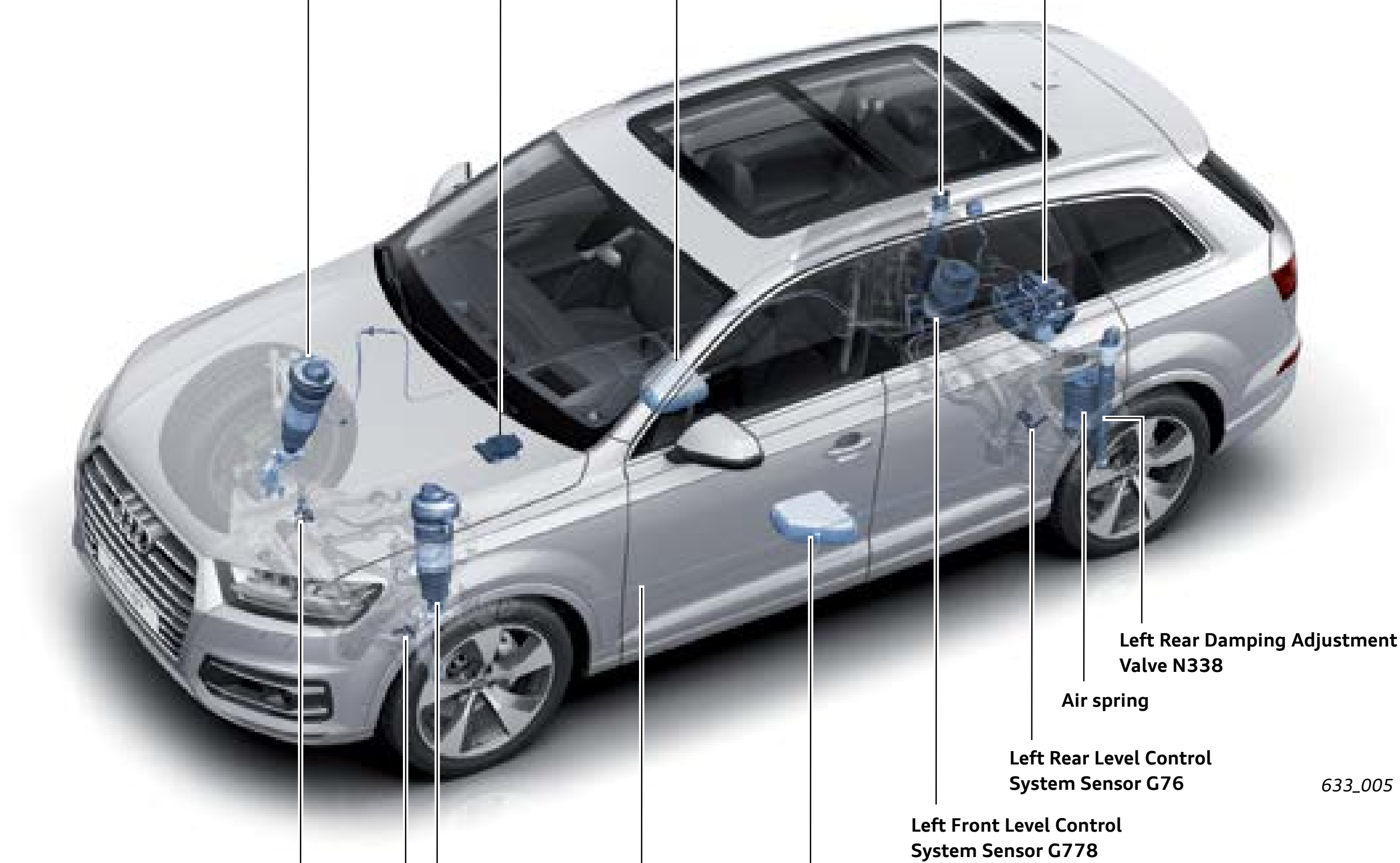
Note
Always adjust the rear axle camber first, then the toe values. This is important because the toe values will change slightly when the camber is adjusted.

Air suspension and electronic damper control

(adaptive air suspension)

Overview

The adaptive air suspension system of the 2017 Q7 is based on systems already in use by Audi. A key new feature is the addition of Drivetrain Control Module J775. It provides software for the air suspension and damping system and will in the future have control algorithms for other suspension control systems.



633_005

Design and function

Drivetrain Control Module J775

J775 provides the software for the suspension and damping control developed by Audi. In addition, the sensors to measure vertical acceleration (z) as well as yaw rates around the longitudinal axis (x direction, squat and roll) and the transverse axis (y direction and pitch) are now housed in the module.

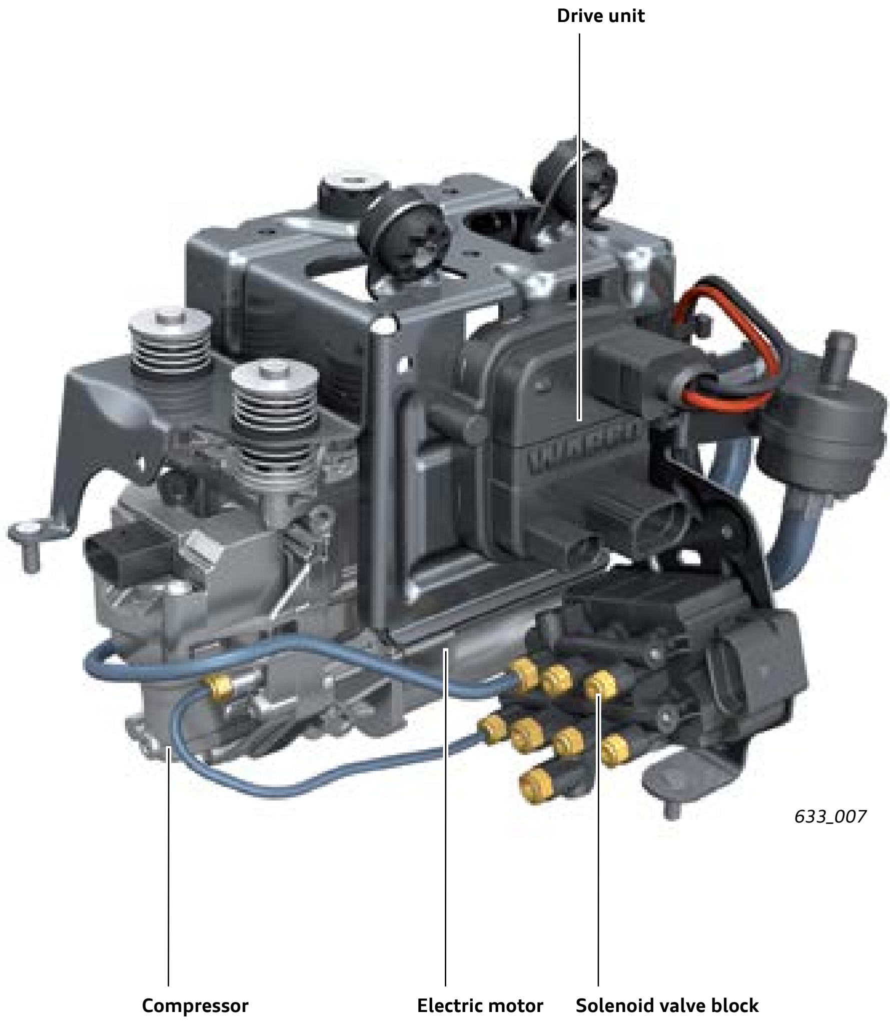
It communicates over the FlexRay data bus.

633_006

Air supply unit

The compressor, electric drive motor and solenoid valve block form a compact unit installed on a common bracket at the right rear of the vehicle.

The components are mounted to the bracket by spring elements. The bracket is vibration-isolated from the body at the mounting points by rubber mounts. The complete unit is protected against stone chip damage and other damage by a special cladding.



633_007

Electric motor driven compressor

A newly developed two-stage "twin" compressor is used to produce the required air pressure. The compressor is driven by an electric motor. A few feature is the mode of activation of the electric motor. Instead of using a mechanical relay, the motor is now activated by a pulse width modulated (PWM) signal.

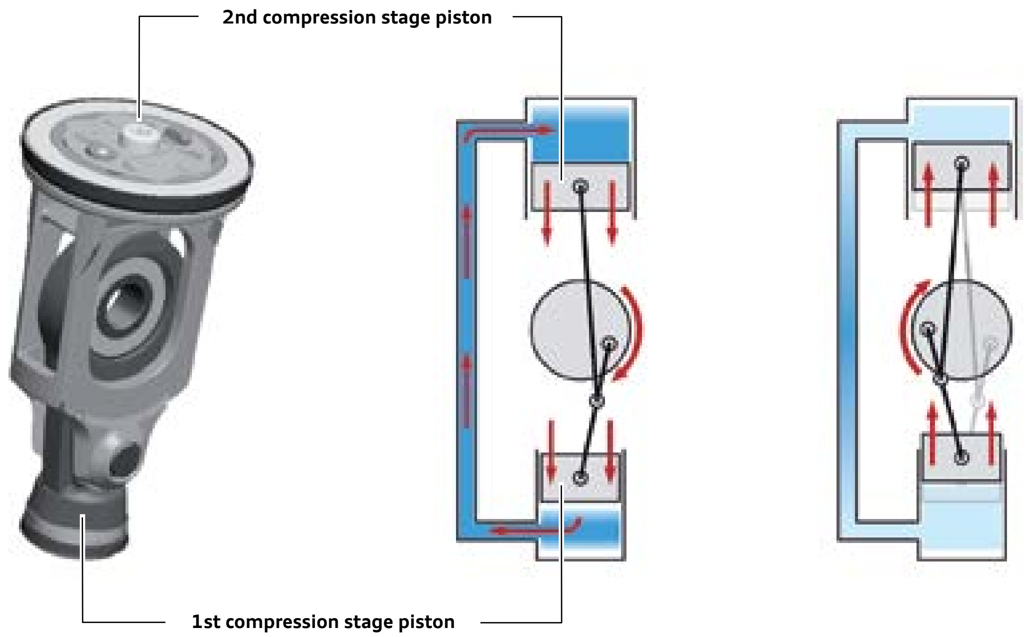
This mode of activation allows for soft starting and stopping of the motor and reduces the peak load of the vehicle power supply. The activation signal is processed by a special drive unit, which is also attached to the common bracket by clips.

A separate bus (CAN bus) is used for data transfer between the suspension control module and the drive unit.

Air is compressed by means of 2 pistons. The piston of the first compression stage (smaller diameter) is connected directly to the eccentric plate of the drive shaft by its connecting rod. The piston of the second compression stage (larger diameter) is mounted on the connecting rod of the first compression stage. As a result, both pistons move jointly in the same direction. While the first compression stage piston is compressing the air, the second compression stage piston draws in air.

The first compression stage produces approximately 58.0 - 87.0 (4 - 6 bar) while the second compression stage piston delivers a system pressure of approximately 261.0 psi (18 bar).

The temperature and running time of the compressor are monitored on the basis of a temperature model. The maximum "on" time is about four minutes. The activation electronics also have a safety function which, in the worst case scenario, switches off the compressor after a maximum of six minutes.



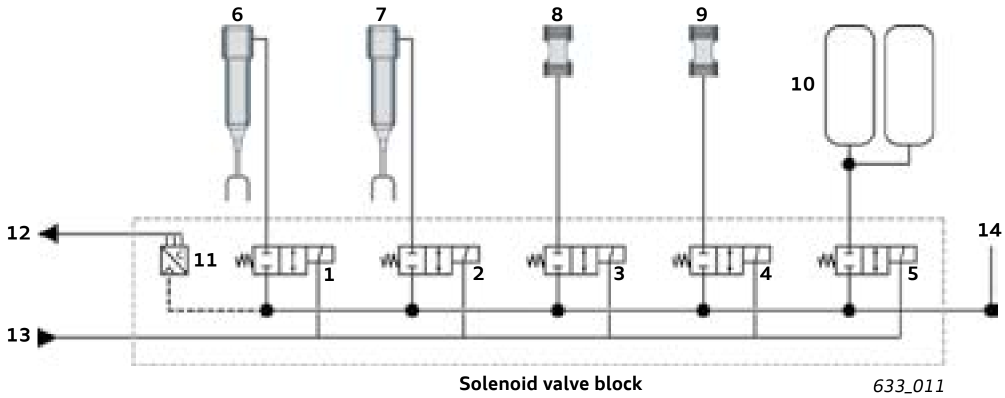
633_008

Solenoid valve block

The solenoid valve block has five valves which connect the air supply unit to the air suspension components.

A pressure sensor is integrated in the solenoid valve block.

633_010



633_011

1-5	=	solenoid valves
6,7	=	air suspension, front axle
8,9	=	air suspension, rear axle
10	=	pressure accumulator
11	=	pressure sensor
12	=	pressure reading
13	=	electrical activation of solenoid valves
14	=	compressor connection

The 2/2 way valves (1-5) in the solenoid valve block open or close the pathway to the pressure accumulators and the air suspension. The graphic shows the valves in a neutral state, that is, not electrically activated. The valves are closed when de-energized.

When required, the corresponding solenoid valve is activated in order to fill or exhaust the assigned air spring.

The pressure sensor is configured in such a way that it measures either the pressure in the accumulator or the pressure in the air suspension components depending on the position of the solenoid valves.

Pressure accumulator

The Audi Q7 has two 5.2 gal (5.0l) aluminum accumulators. They are installed in the rear foot wells on the right and left hand side of the vehicle and are interconnected by an air line.

The accumulators are primarily used for making corrective adjustments while the vehicle is stationary or moving at low speeds. This eliminates any noise the passengers would hear if the compressor pump was running. When the vehicle speed exceeds approximately 18.6 mph (30 km/h), the pressure accumulators are filled and control operations of the suspension system are done by pressure developed from the air compressor.

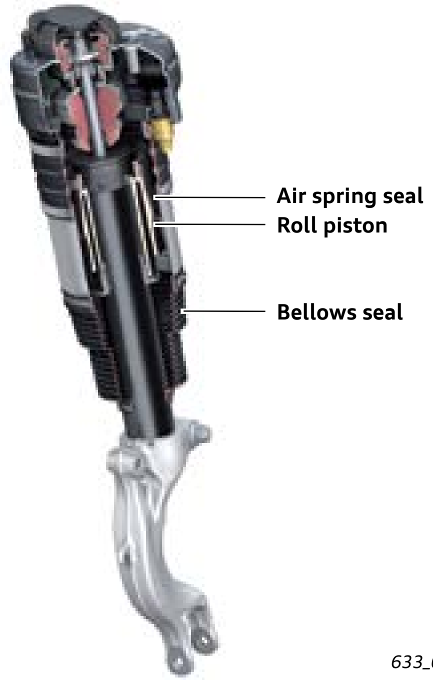
Control operations can be implemented using the pressure accumulator only if the pressure in the accumulator is at least 43.5 psi (3.0 bar) higher than the pressure of the suspension component being controlled.

633_012

Front axle air spring strut

The air spring seal is made of natural rubber with polyamide strength members. Its is attached to the damper tube at the bottom and to the damper bearing at the top by clips. The resultant enclosed space forms the air chamber. The air spring seal "rolls" over the roll piston when the springs compress and rebound. The geometric shape of the roll piston determines the spring characteristic.

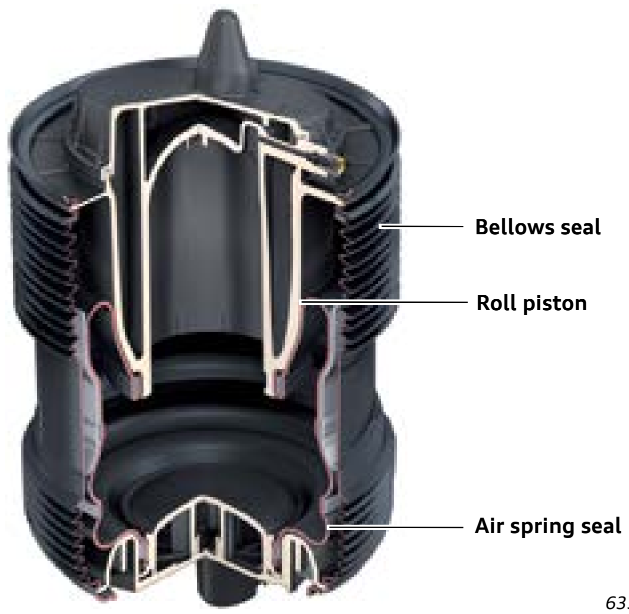
The minimal air pressure inside the chamber is limited to about 43.5 psi (3.0 bar) by a special valve (residual pressure retention valve) at the air connection. This protects the air spring seal against mechanical damage which can occur when the chamber is evacuated, particularly in the area of the rolling fold.



633_013

Rear axle air spring

The air spring seal is made of natural rubber with polyamide strength members. It is attached to the roll piston and the baseplate of the air spring by clips. The geometric shape of the baseplate and the upper part of the air spring define the installation position in the vehicle and provide protection against twisting.



633_014

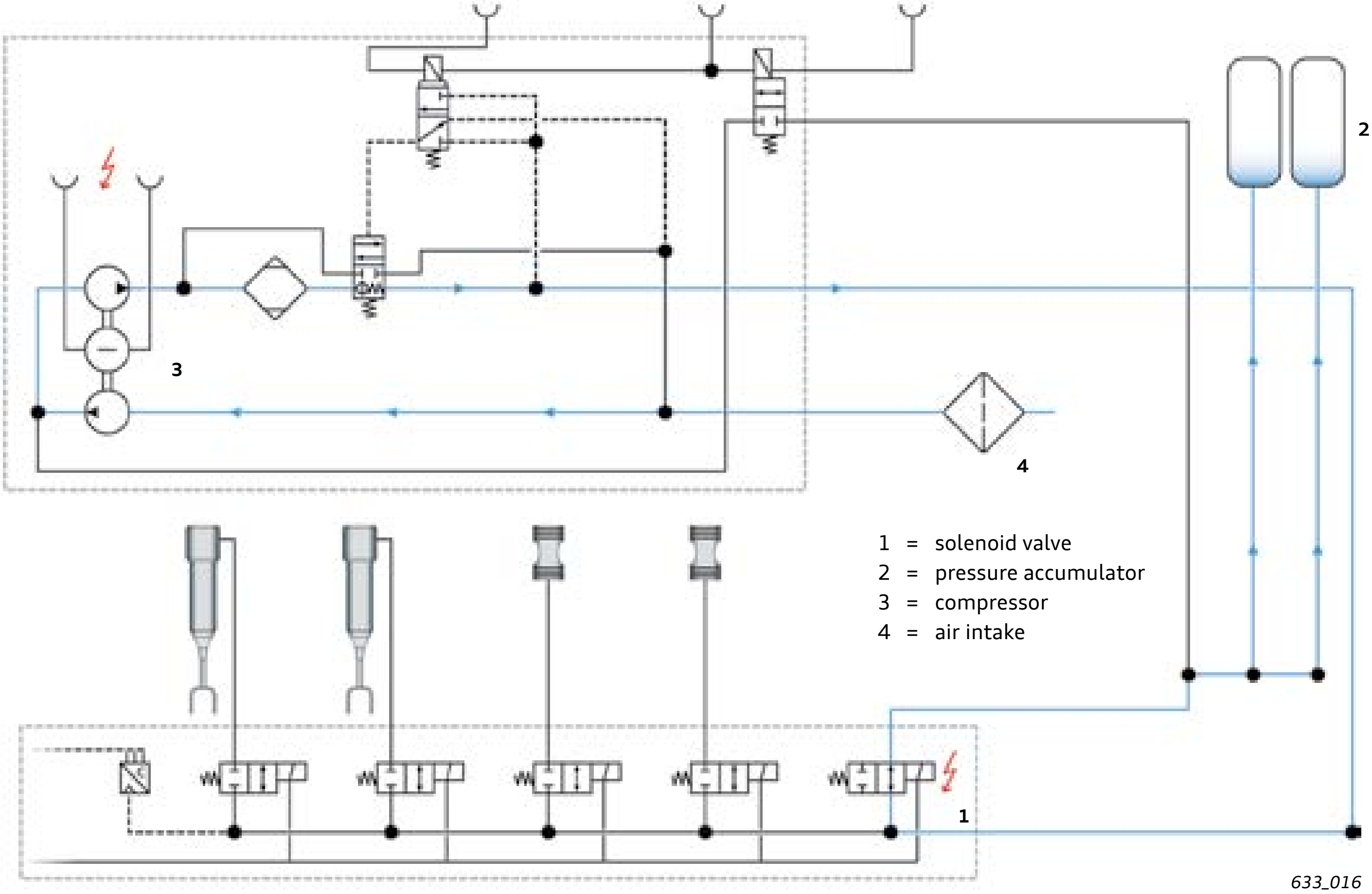
Air intake/ventilation

To meet the acoustic requirements, a noise damper is used for air intake and air discharge from the system. The damper is installed in the right rear of the vehicle, where it is protected inside the vehicle in front of the right-hand wheel arch.

633_015

System function

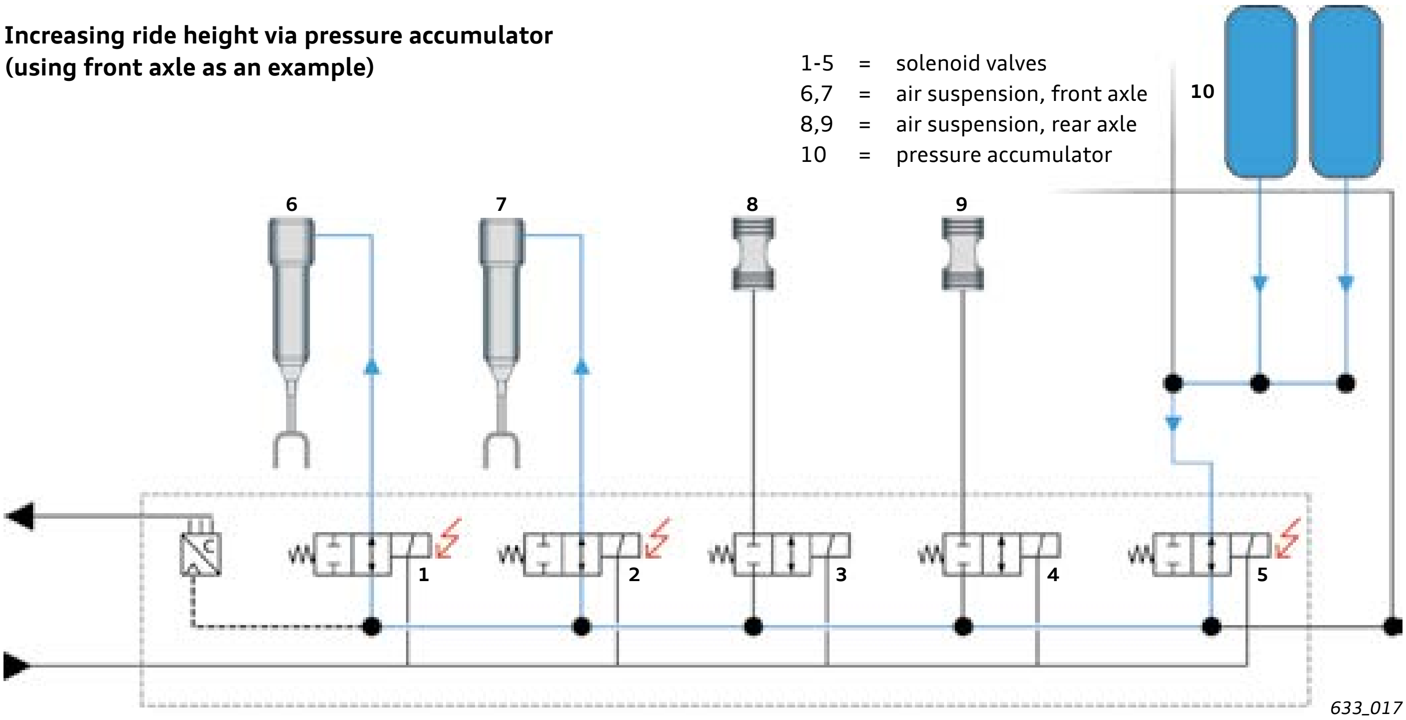
Filling the pressure accumulator



633_016

When the vehicle exceeds a speed of approximately 18.6 mph (30.0 km/h) the pressure accumulators are filled. The solenoid valve 1 is activated and a connection is established between the compressor and accumulators.

Increasing ride height via pressure accumulator (using front axle as an example)

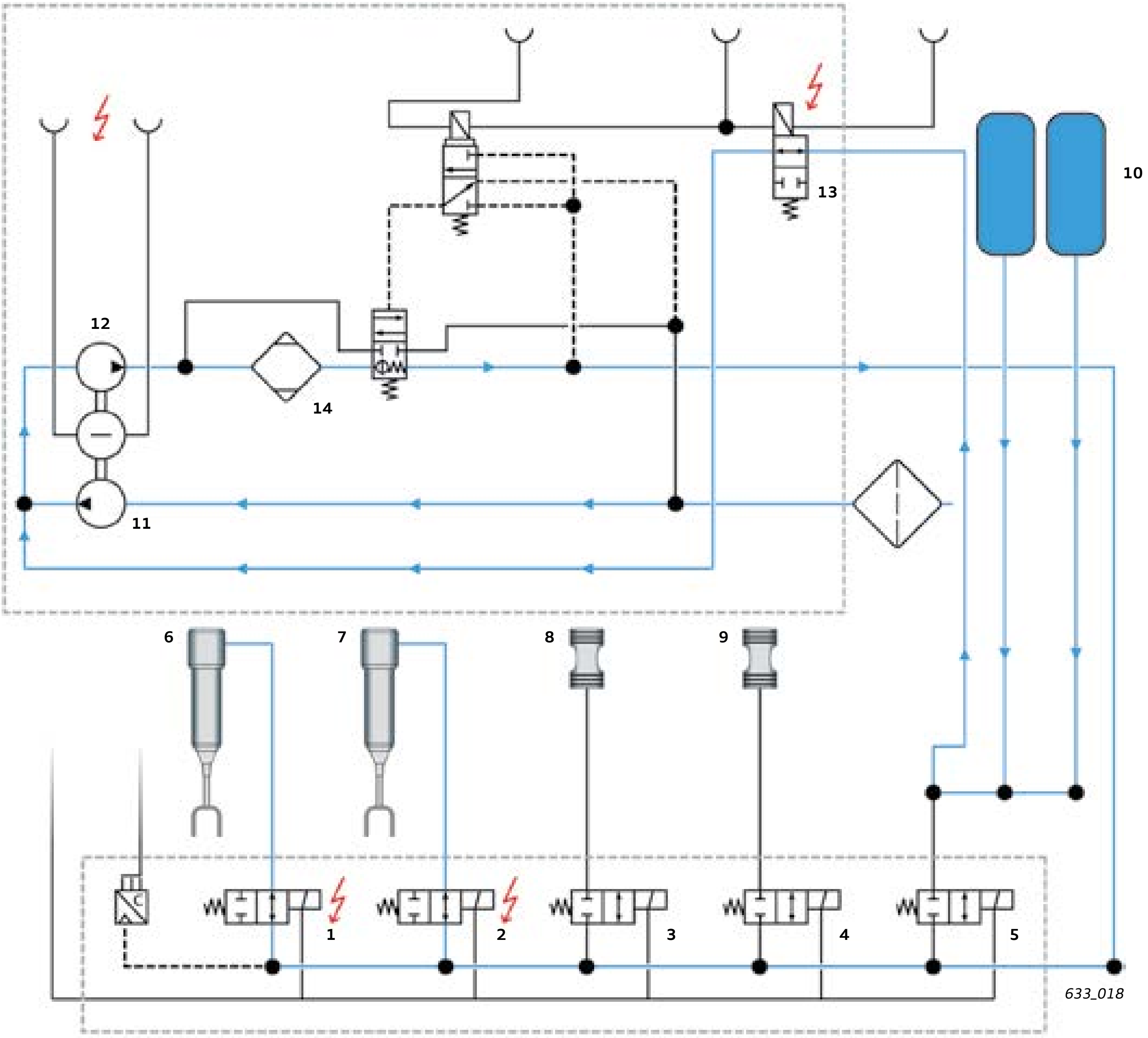


633_017

The pneumatic diagram above shows the valve configuration using an increase in ride height at the front axle as an example. Solenoid valves 1 and 2 in the solenoid valve block are activated and the compressor is not running.

The air flows from the pressure accumulators 10 into air springs 6 and 7 via open solenoid valves 1 and 2.

Increasing ride height via compressor (using front axle as an example)



633_018

1-5	=	solenoid valves	11	=	1. compression stage
6,7	=	air suspension, front axle	12	=	2. compression stage
8,9	=	air suspension, rear axle	13	=	solenoid valve for boost function
10	=	pressure accumulator	14	=	air drier

When the vehicle exceeds a speed of 18.6 mph (30.0 km/h), control operations are preferably implemented by pressure from the compressor. For this purpose, the corresponding solenoid valves in the solenoid valve block are activated and the lines interconnecting the compressor and air suspension are opened.

In the example given here, pressure is produced by the compressor with boost function in order to increase ride height at the front axle.

The boost function is an innovation which provides a rapid increase in pressure when required.

The function uses the pressure accumulator pressure. The compressed air from the pressure accumulators flows into the intake tract of the 2nd compression stage on the compressor. This serves to increase the pressure of the first compression stage 11.

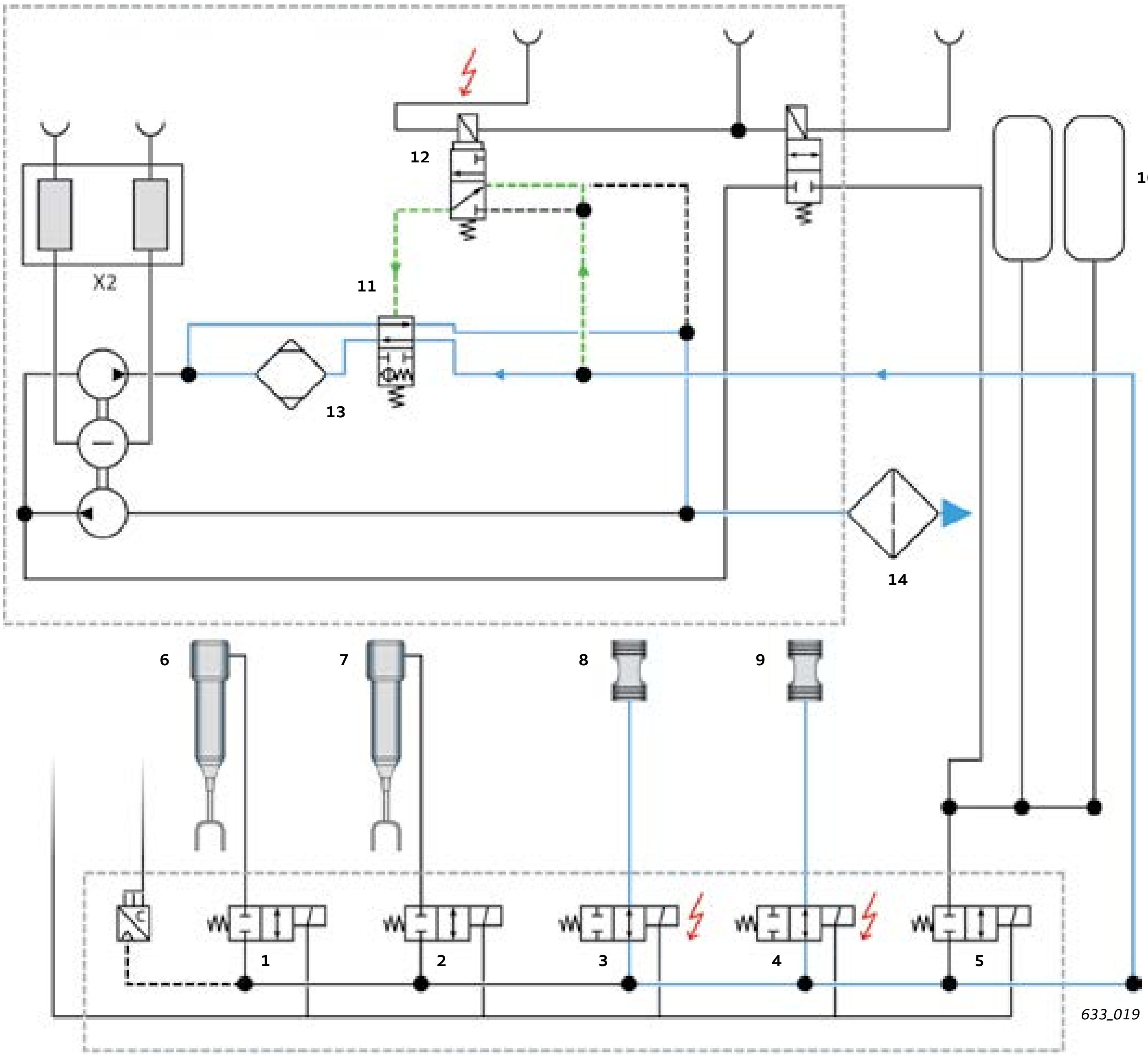
The boost function is active whenever the pressure in the pressure accumulators is insufficient for control purposes, but is greater than 72.5 psi (5.0 bar). If the pressure in the pressure accumulators drops below this during an active control phase, the control operation is not cancelled, but rather is completed.

The boost function increases the capacity of the compressor. Without this function, the compressor would have to be much larger (and therefore also heavier).

The solenoid valve 13 is activated in such a way that the compressed air from the pressure accumulators can flow into the intake tract of the 2nd compression stage on the compressor.

Before leaving the compressor, the compressed air flows through the air drier 14, which extracts any moisture.

Lowering the ride height (using the rear axle as an example)



1-5	=	solenoid valves	11	=	pneumatic switching valve
6,7	=	air suspension, front axle	12	=	solenoid valve
8,9	=	air suspension, rear axle	13	=	air drier
10	=	pressure accumulator	14	=	intake and ventilation connection

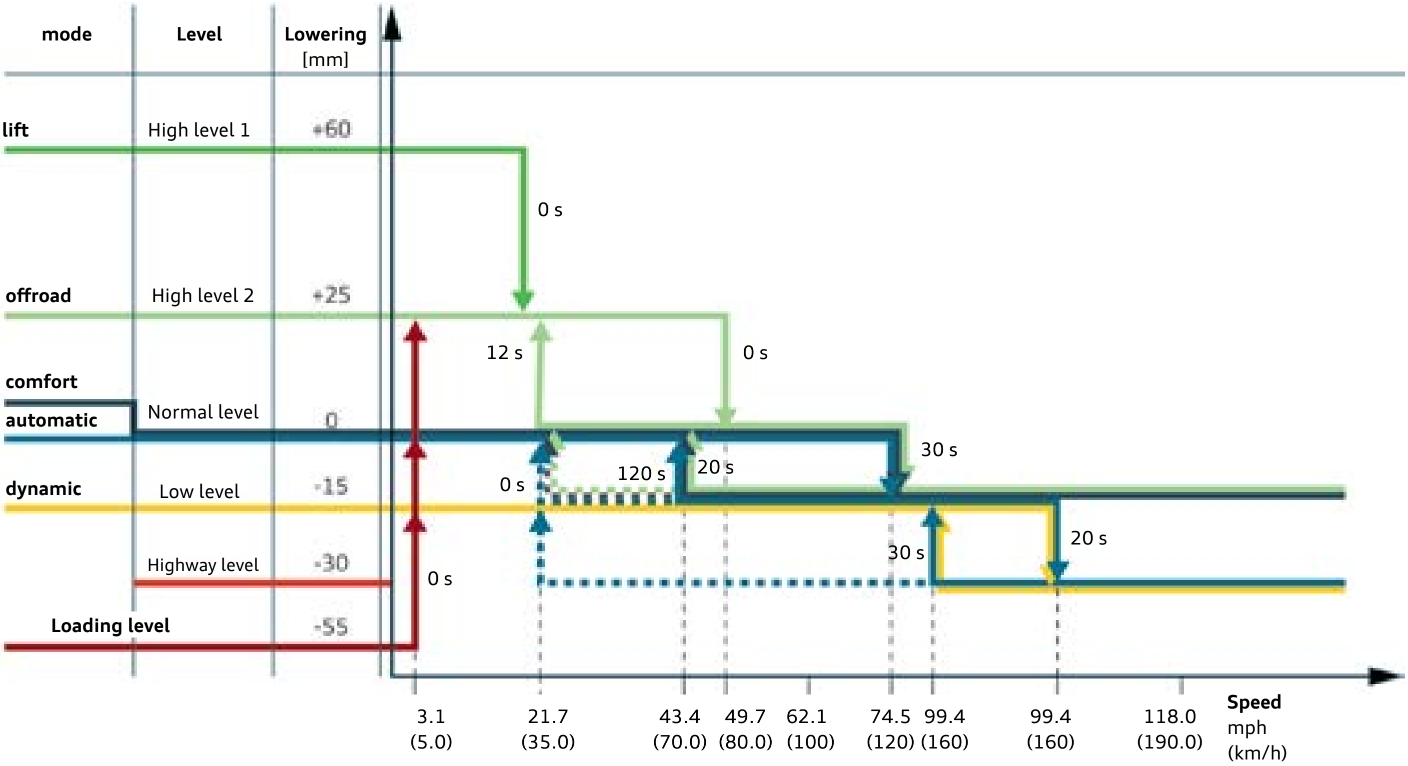
The lines interconnecting the compressor and air suspension are opened by activating the solenoid valves 1 - 4 in the solenoid valve block. To allow the compressed air to escape from the air suspension, the pneumatic switching valve 11 must be opened. This is done by activating the solenoid valve 12. The solenoid valve opens and pressure is applied to the pilot connection of the pneumatic switching valve. The switching valve is switched to the open position.

The air flows through this valve and leaves the system through the intake/ventilation connection. The dry air flows through the drier and extracts the moisture in the air from the system.

Control strategy for chassis 1BK

The control algorithms generally differ depending on the chassis versions. Differences also exist with regard to operation with and without a trailer

In general, it is not permissible to reduce the vehicle level to the low setting when towing a trailer in order to avoid variation in the load on the tow bar.



633_020

The control strategy is outline above. In principle, the control system implements six different vehicle levels. Starting from the basic level, "offroad" mode can be set by raising the vehicle 1.0 in (25 mm). This mode is immediately deactivated automatically when the vehicle reaches or exceeds a speed of 49.7 mph (80 km/h). If the vehicle's speed is subsequently reduced to 21.7 mph (35 km/h), the vehicle level is automatically readjusted to "offroad" level.

The maximum ride height of 2.3 in (60.0 mm) is achieved by activating "lift" mode. This mode is exited automatically when a speed of 18.6 mph (30.0 km/h) is reached and "offroad" mode is activated.

The basic level is used by two modes: "comfort" mode and "auto" mode. In "comfort" mode, suspension and damping are configured for maximum ride comfort.

If a speed of 74.5 mph (120 km/h) is reached, the ride height is lowered by 0.50 in (15 mm) after 30 seconds. This brings the vehicle to the same level as “dynamic” mode. Note: this happens in both “auto” and “comfort” modes.

If the speed is again reduced, the basic level is restored after 20 seconds in "comfort" mode at 43.4 mph (70 km/h) and after 120 seconds in "auto" mode.

If a speed of 99.4 mph (160 km/h) is reached after the vehicle level is reduced to dynamic level, the vehicle level is reduced by a further 0,59 in (15.0 mm) (highway level) in "auto" mode and in "dynamic" mode.

If the driver subsequently reduces speed, the system returns to dynamic level after 30 seconds at 80.7 mph (130 km/h).

The Audi Q7 also has a feature which assists loading. The rear end lowered by 2.1 in (55.0 mm) relative to the basic level. If the loading level is not deactivated again by the driver, it is done automatically after reaching a speed of 1.8 mph (2.0 km/h). The ride height is then readjusted to the last level set prior to loading.

Operation and driver information

The different suspension and damping control modes can be selected through Audi drive select. Depending on preferences, the driver can choose between comfortable (“Comfort”), sporty (“Dynamic”) or balanced (Auto”) damping set-ups. Alternately, the driver can select “offroad” mode for driving in off-road conditions or “lift mode” for even more difficult terrain. The rear of the vehicle can also be lowered to ease loading and unloading of cargo.

633_022

The rear of the vehicle can be lowered approximately 2.1 in (55.0 mm) from its ride height in “Auto” mode.

Conditions for the activation of lowering:

- All doors are closed.
- Terminal 15 "on".
- The pressure accumulator is sufficiently filled.

The operating buttons are located in the luggage compartment on the left side.

633_022a

The rear is again raised into the starting position by:

- Pushing the button.
- Selecting a different mode in Audi drive select.
- Exceeding a driving speed of approximately 1.2 mph (2 km/h).

The status of the system is indicated to the driver by a warning lamp in the button. This lamp is lit while lowering is in progress and when the rear end is lowered. If the pressure in the accumulator is too low, the warning lamp will briefly flash 3 times.

System faults are indicated to the driver by yellow or red warning symbols along with a text message in the DIS.

633_023

Diagnostic address

The air suspension system is diagnosed using the VAS Scan Tool under Address Word 74. Drivetrain Control Module J775 is integrated in the component protection system. Coding is done online.

633_006

The default suspension height is programmed after:

- Replacing Drivetrain Control Module J775.
- Removing / replacing one or more level control system sensors.
- Performing work on the suspension which involves detaching the lever of the level control system sensors on the axle carrier.
- Replacing / removing and installing the dampers.

633_025

Actuator diagnostics

The following Output checks are available:

- Actuator diagnostics for lowering vehicle.
  - Testing the air spring seal, hoses, level control system sensor for signal / adjustment direction.
- Actuator diagnostics for damper valve energization.
  - Electrical damper activation.
- Actuator diagnostics for system testing of boost function.
  - Testing of solenoid valves for boost function.
- Actuator diagnostics for system testing of compressor pressure accumulator.
  - Testing pressure buildup, compressor activation and pressure accumulator solenoid valve.

Vehicle transportation

To be able to transport the vehicle with air suspension fully evacuated, use is made of a new special tool - maneuvering aid set VAS 741013.

Note: the vehicle must not be moved or driven under engine power using VAS 741013.

Special tool VAS 741013 *633_025b*

Loading mode

When loading mode is activated, a high vehicle level is set in order to maximize ground clearance. This facilitates loading the vehicle onto a train or truck.

The loading mode is deactivated using the VAS Scan Tool. Alternatively, it is deactivated automatically when the vehicle is driven at a speed over 62 mph (100 km/h) or after traveling a distance of 31 miles (50 km).

Transport mode

When the vehicle is in Transport mode, no control operations can be performed and the damper control function is deactivated.

Notes

Brake system

Overview

The front brakes of the Q7 have lightweight aluminum calipers and lightweight brake discs. All brake pads meet the highest environmental standard and are copper-free. A paint coating on the brake disc centers contributes to the appearance of the vehicle.

The Audi Q7 is now equipped with the electronic parking brake (EPB). The foot controls and the brake servo are new developments designed with a strong emphasis on saving weight. The high performance Bosch ESP9 ESC system is used on the Q7.

Wheel braking systems

Front axle wheel brake system

Engine type	V6 3.0 TFSI V6 3.0 TDI 7-seater
Minimum wheel size	18“
Brake type	AKE fixed caliper brake
Number of pistons	6
Piston diameter	1.18/1.41/1.49 in (30/36/38 mm)
Brake disc diameter	14.7 in (375 mm)

Wheel brake AKE (fixed caliper brake)

633_046

Rear axle wheel brake system

Engine type	V6 3.0 TFSI V6 3.0 TDI 7-seater
Minimum wheel size	18“
Brake type	TRW PC44HE
Number of pistons	1
Piston diameter	1.7 in (44 mm)
Brake disc diameter	13.7 in (350 mm)

633_047

Electromechanical parking brake (EPB)

An important new feature of the Audi Q7 is the electromechanical parking brake. In terms of design, function, operation and service operations, the system is identical to that used in current Audi models. The software for activating the system is integrated ABS Control Module J104.

For detailed information about the design, function and service operations, please refer to eSelf-Study Program 960143, The 2015 Audi A3 Running Gear and Suspension.

633_049

Brake servo, master brake cylinder, pedal assembly

The TRW 9/9 brake servo is a new development. It features a weight saving aluminum housing.

The brake light switch is a carry-over from the transverse platform Audi A3, Q3 and TT and is mounted on the tandem master brake cylinder.

The brake circuit layout is new. The front and rear have separate brake circuits. These were diagonal circuits in the predecessor model.

633_050

The brake pedal is an aluminum casting while the accelerator pedal is plastic. Both pedals are suspended from a die-cast aluminum pedestal. This design was used to save weight.

633_051

ESC

System components

633_052

The Audi Q7 uses ESP9 - the new generation ESC system by Robert Bosch GmbH. In the hydraulic unit, a six-piston pump works in combination with the new hydraulic valves to meet the exacting demands on pressure buildup dynamics. Depending on the optional equipment, there are two physically different versions of the ESC system. A hydraulic unit with 3 pressure sensors is used for models with ACC. One pressure sensor measures the pilot pressure in the hydraulic system while the other two pressure sensors measure the pressure in both braking circuits. In models without ACC, only the pilot pressure is measured.

The ESC receives information on vehicle dynamics (transverse and longitudinal acceleration and the yaw rate) from Airbag Control Module J234 via the FlexRay bus. The sensors are integral with the control module.

633_053

Active wheel speed sensors with a rotation direction sensing feature are used on the Audi Q7. In terms of design and function, they are identical to the sensors used on the current Audi A6 and A7 models.

The steering angle sensor is a magnetic type. It is installed on the steering column and communicates over the FlexRay bus. It is an enhanced version of the sensor used on the Audi A6 and A7 models.

Functional principle

633_054

The ESC on the Q7 performs the basic and additional functions found on the current A6, A7, and A8 models. In addition, other driver assist and safety systems have been networked. Being networked enables the turn assist system to request corrective braking inputs from ABS Control Module J104.

The Audi Q7 is equipped as standard with the Hill Hold Control (HHC) assistance function. The hold time is approximately two seconds, after which the brake is released again and the driver must brake the vehicle if required.

The Hill Start Assist function has been improved for the Audi Q7. The switch-activated function holds the vehicle stationary if the driver brings it to a standstill by applying the brakes.

The function stays active even after the vehicle in driven away again with a forward gear selected. If, on the other hand, the vehicle is driven away again in reverse after stopping and exceeds a speed of 1.8 mph (2.0 km/h), Hill Start Assist is automatically deactivated.

This innovation significantly improves comfort during maneuvering and parking. If the vehicle subsequently exceeds a speed of approximately 6.2 mph (10.0 km/h) when driving forwards, the function is automatically reactivated.

Operation and driver information

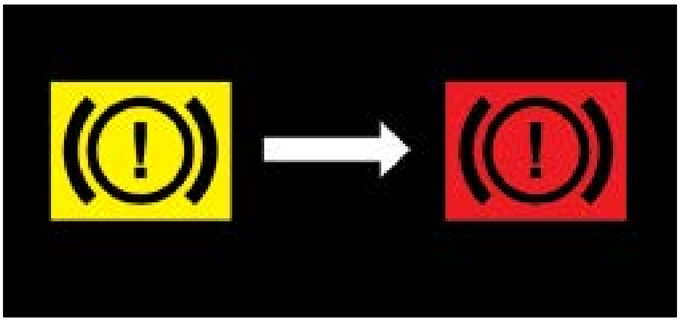
633_055

Off-road mode can be activated by pressing the ESC button for less than three seconds. In this mode, the scope of the TCS and ESC corrective inputs is limited. The control parameters are selected so the main focus is on traction.

If the ESC button is pressed for longer than three seconds, TCS and ESC are fully deactivated.

A new function generates a driver warning if the brakes reach a high temperature on descents. The brake temperature can rise rapidly, particularly on descents, if the driver fails to select a gear which does not utilize the full deceleration potential of the driveline.

If the brake servo does not provide sufficient boost, ESC generates additional braking force by actively building up brake pressure. This function is known as the "optimized hydraulic brake servo (OBBS)" and is an integral part of the ESC systems used on Audi models.



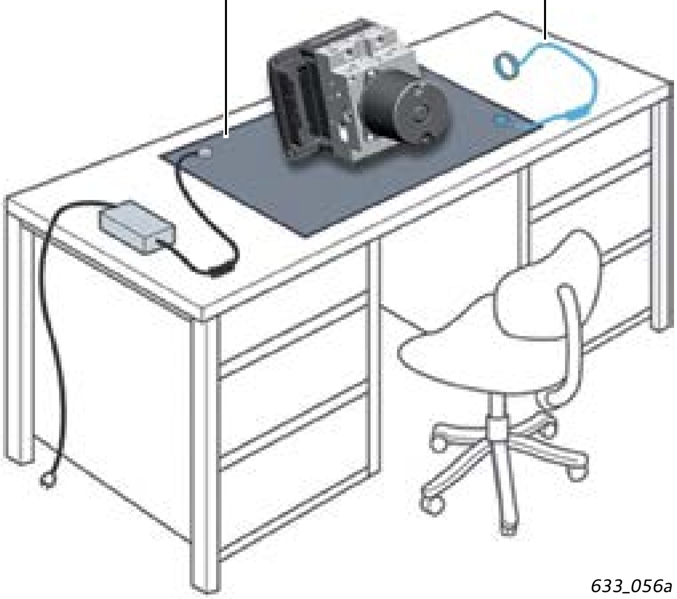
633_056

If a fault occurs in the vacuum supply system for the brake servo or in the brake servo itself, the result is an increased need for "ESC assistance". This information is provided to the driver in the form of the yellow ESC warning symbol.

In the Audi Q7, the warning symbol changes color from yellow to red if the driver ignores the warning for a lengthy period of time (after a defined number of driver braking inputs).

Service operations

The ESC service operations for the Audi Q7 are essentially identical to those of the current Audi A6, A7 and A8 models.



633_056a

The control module and hydraulic unit can be replaced separately. VAS 6613 must be used to protect the electronic components of the control module against a static charge build-up.

After replacing a control module, the system must be bled. After bleeding the system the module must be encoded online and the Steering Angle Sensor G85 must be calibrated.

Three other Basic Settings must be carried out:

- The vehicle must be raised on a hoist and checked that the hydraulic lines are not interchanged.
- The Basic Setting for the electrical parking brake must be performed.
- The Basic Setting for the TPMS must be performed.

Note: Steering Angle Sensor G85 does not lose its calibration if Terminal 30 is disconnected.

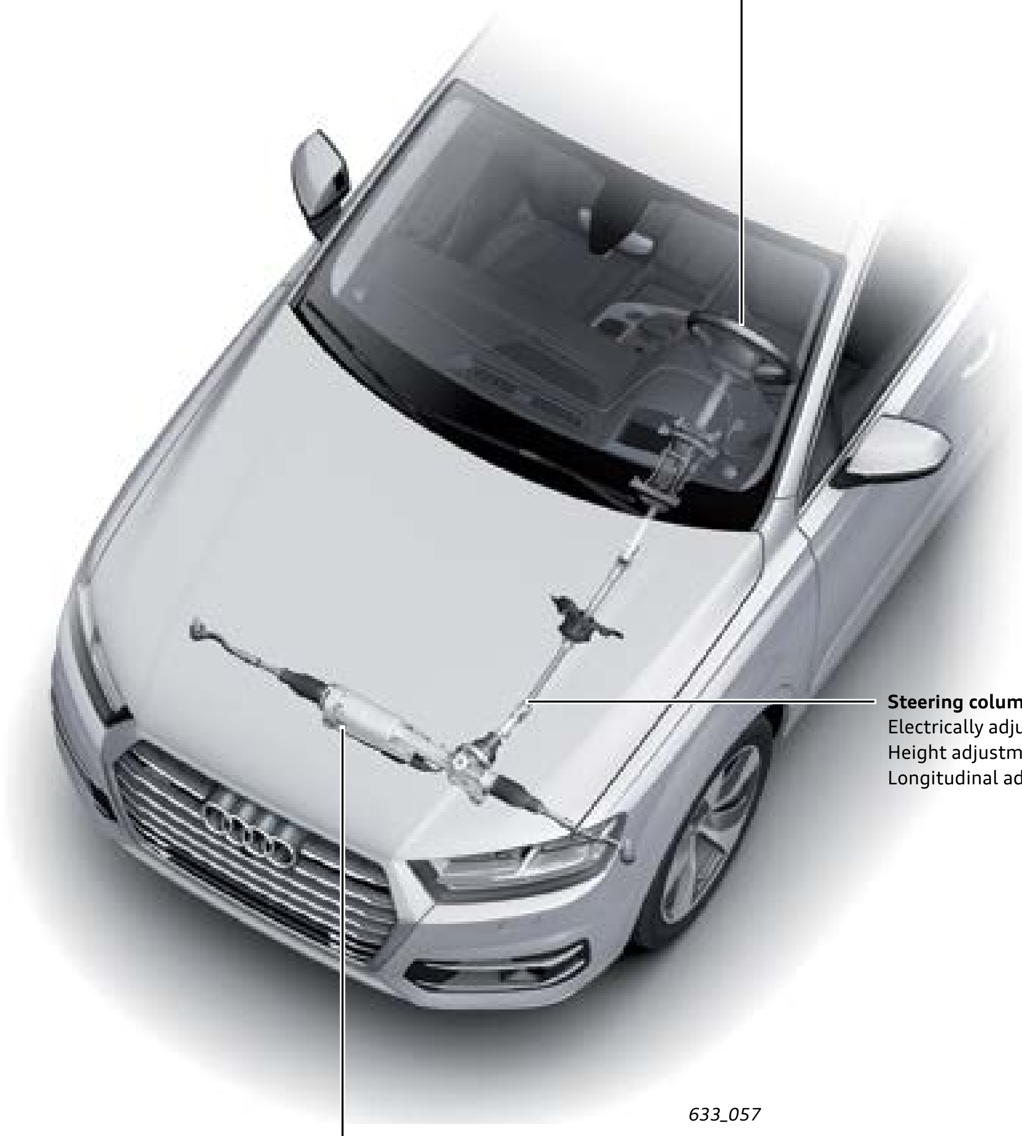
Steering system

Overview

The Audi Q7 now also has electromechanical steering (EPS).

Special steering maps can be selected using Audi drive select.

An electrically adjustable steering column is standard.



633_057

System components and operation

Electromechanical power steering gear

In terms of design, function and service operations, the electromechanical steering system is identical to the system already used on the current Audi A6, A7 and A8 models.

Refer to Self-Study Program [960143, The 2015 Audi A3 Running Gear and Suspension System].

633_058

Steering characteristics can only be selected using Audi drive select. Depending on whether "auto", "dynamic" or "comfort" mode is selected, the system activates steering maps which provide balanced, dynamic or comfort-oriented steering assistance. When "individual" mode is selected, the driver can freely select one of three maps. When "allroad" mode is selected, the map for "auto" mode is activated. When "offroad/lift" is selected, the map for "comfort" mode (comfort-oriented) is utilized.

633_022

Steering column

The electrically adjustable steering column of the Q7 is identical to that of the A6 and A7.

The following modifications were made:

- The pedal assembly is no longer attached to the steering column bracket.
- The weight has been reduced approximately 4.4 lb (2.0 kg).
- The steering lock has been modified to increase anti-theft security.
- The control module is connected to the steering column control motors by a plug and are located on the steering column.

633_058a

Steering wheel

A color coordinated, leather bound three spoke steering wheel is standard. It has Tiptronic paddles and can be ordered with a heater.

633_059a

All-wheel steering

Overview

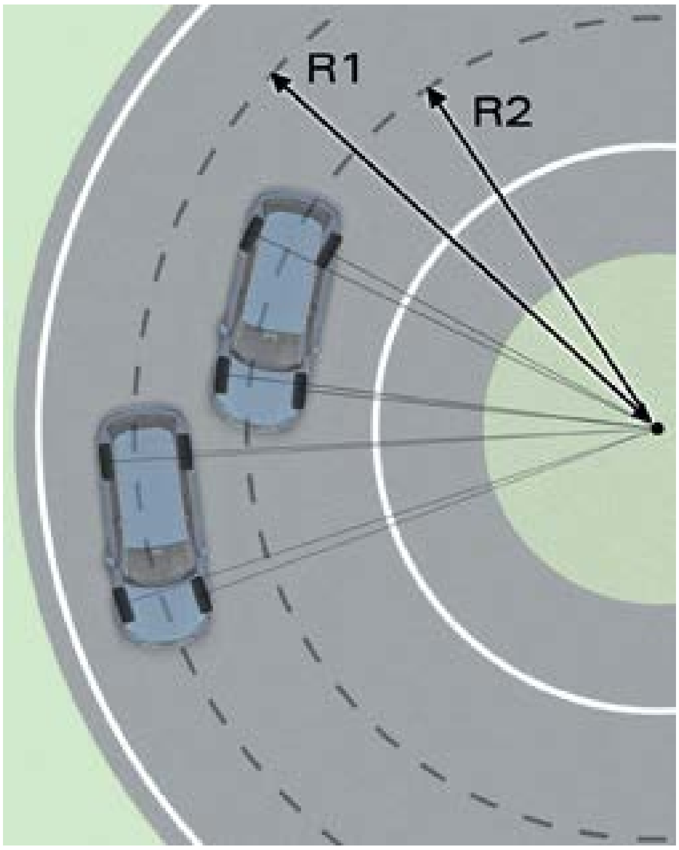
All-wheel steering is optional on the Audi Q7. Depending on the actual speed of the vehicle and the driving situation, the tracking is adjusted dynamically with the goal of improving driving dynamics and ride comfort. The control process has two different steering operations relative to the steered front wheels: parallel steering and counter-steering.

633_027

Counter-steering

The key goals of counter-steering the front and rear wheels is to improve handling at low speeds and to reduce the travel envelope of the vehicle. The advantage for the driver is that less steering effort is required given the same curve radius and the same speed. The vehicle is more maneuverable and agile. Counter-steering is only activated at speeds under 37.2 mph (60 km/h).

The illustration shows the advantage of all-wheel steering using the smallest turning circle as an example. Radius R2, which is achieved using all-wheel steering, is much smaller than the radius (R1) achievable with traditional steering.



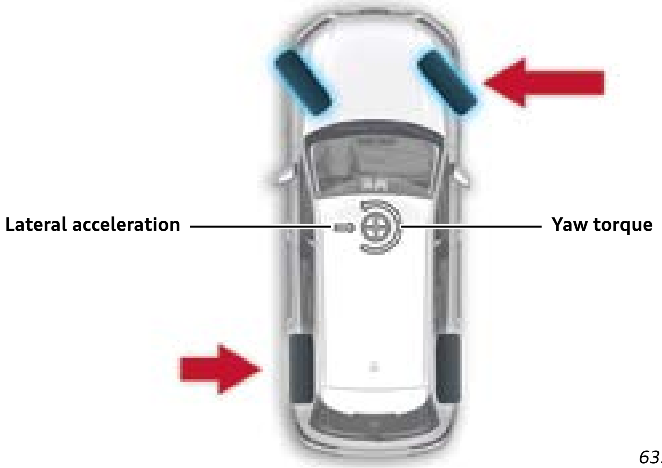
633_028

Parallel steering (in same direction)

1. Steering maneuverer with a front-steered vehicle

The driver executes a cornering maneuverer or a change in direction by turning the front wheels inwards using the steering wheel. The front wheels begin to transmit lateral friction force due to the (enforced) deformation of the tire contact surface when turning the wheels inwards.

To generate yaw motion about the vehicle's vertical axis, the rear wheels must be able to absorb sufficient lateral friction force.



633_029

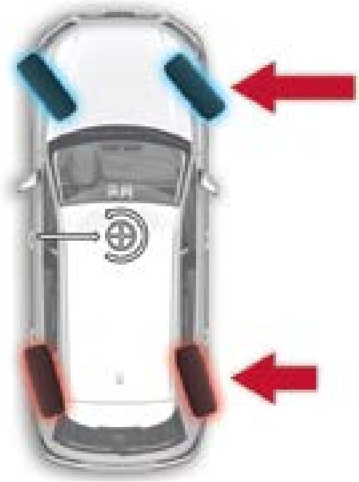
The lateral friction force now changes direction due to the mass of the vehicle pushing towards the outside of the corner, with the result that lateral acceleration can now be generated.

Initiating the change in direction of travel at the front axle alone produces a relatively high yaw torque (torque about the vehicle's vertical axis) until a steady-state condition has been reached. This can have a detrimental effect on comfort and cause the vehicle to become unstable. If for example the driver performs a sudden steering movement in order to avoid an obstacle, unintentional vibration about the vehicle's vertical axis can adversely affect driving stability.

633_030

2. Steering maneuverer with a rear-steered vehicle

The driver executes a cornering maneuverer or a change in direction by turning the front wheels inwards using the steering wheel. The system responds to the steering input by initiating parallel steering of the rear wheels. Because of the (enforced) deformation of the tire contact surfaces at all 4 wheels, the equi-directional lateral friction forces take effect parallel to the front axle wheels due, also, to the rear wheels. The resulting yaw torque is much lower than in a vehicle with front-steered wheels only. The immediate buildup of lateral (cornering) force at both axles significantly reduces the transition time from the initial steering input to the steady-state condition - a well-known effect which occurs in purely front-steered vehicles. The change in the direction of travel is initiated much more harmoniously and comfortably and the danger of yaw oscillation is reduced



633_031

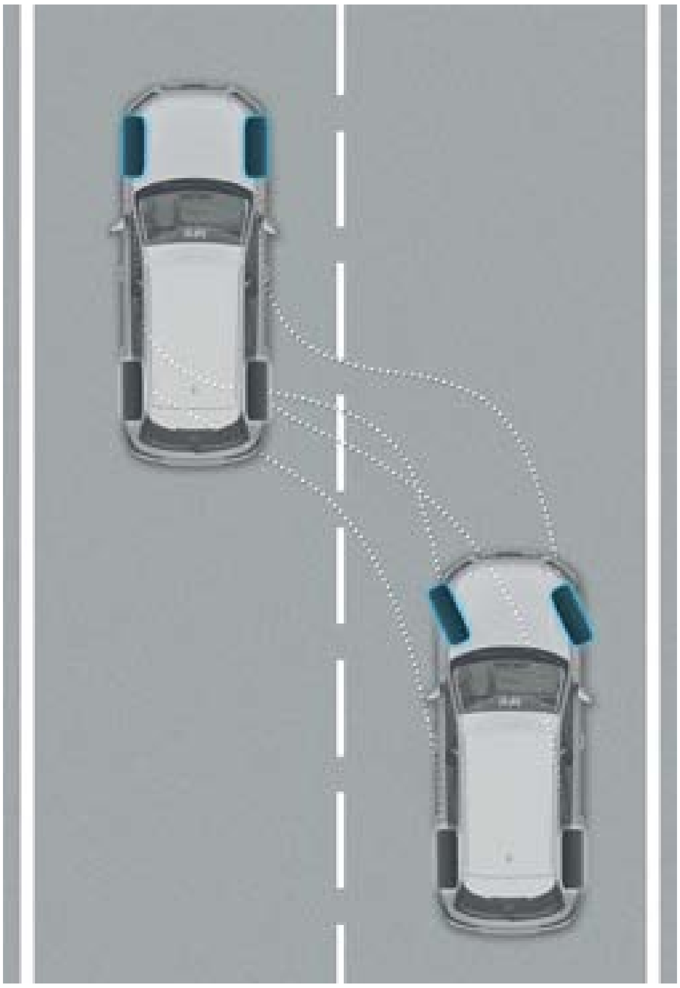
A steady-state condition has been reached and the vehicle is following the trajectory defined by the driver.

633_032

Lateral friction forces

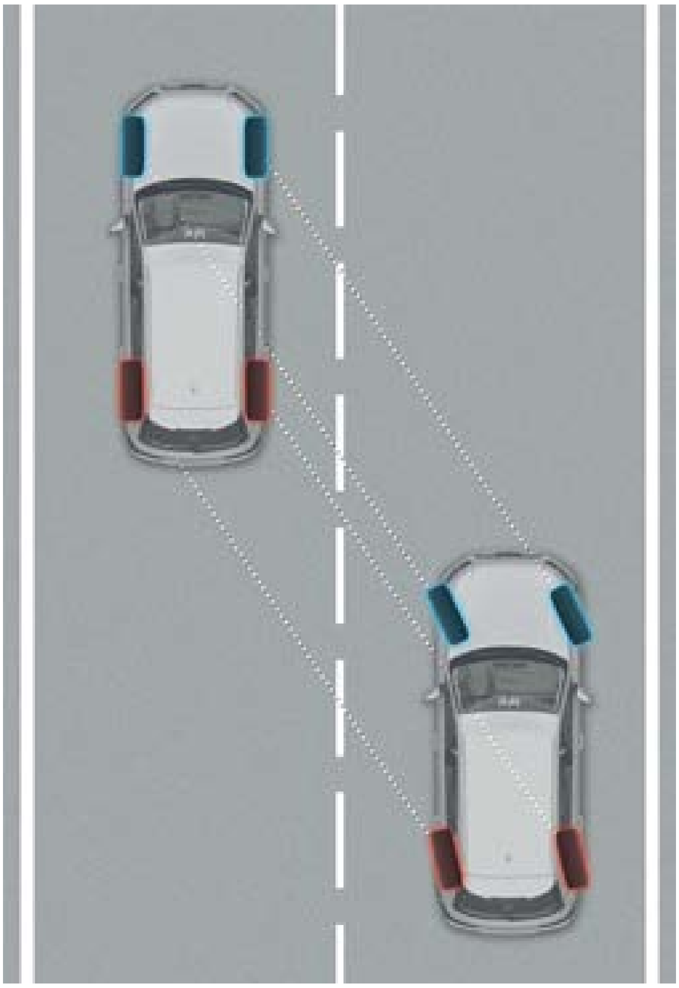
Counter-steering of the rear wheels is used in the low speed range while parallel steering is used at higher speeds.

In addition to the above-mentioned advantages, the system also limits the yaw rate when the driver takes sudden evasive action. In these situations, over-proportional parallel steering of the rear wheels helps to increase driving stability.



633_033a

Evasive action/lane change of a car with conventional steering.



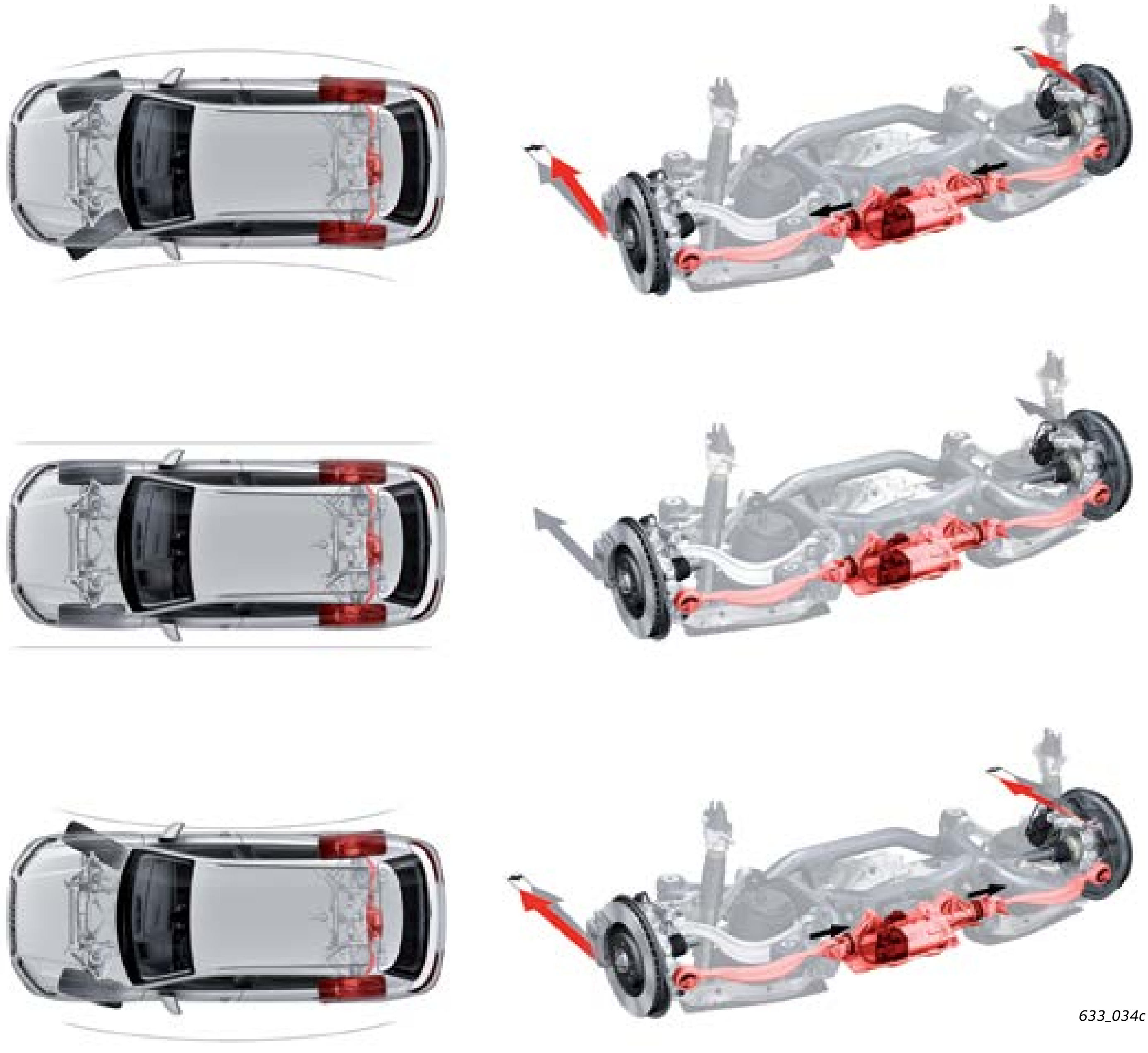
633_033

Evasive action/lane change with all-wheel steering.

Technical implementation

The tracking values of the rear wheels are modified by an active control element. As with a conventional rear axle, the track rods are mounted in rubber-metal bearings on the wheel carriers. They are not attached directly to the sub-frame like a conventional axle, but are attached to both sides of the control element by rubber-metal bearings.

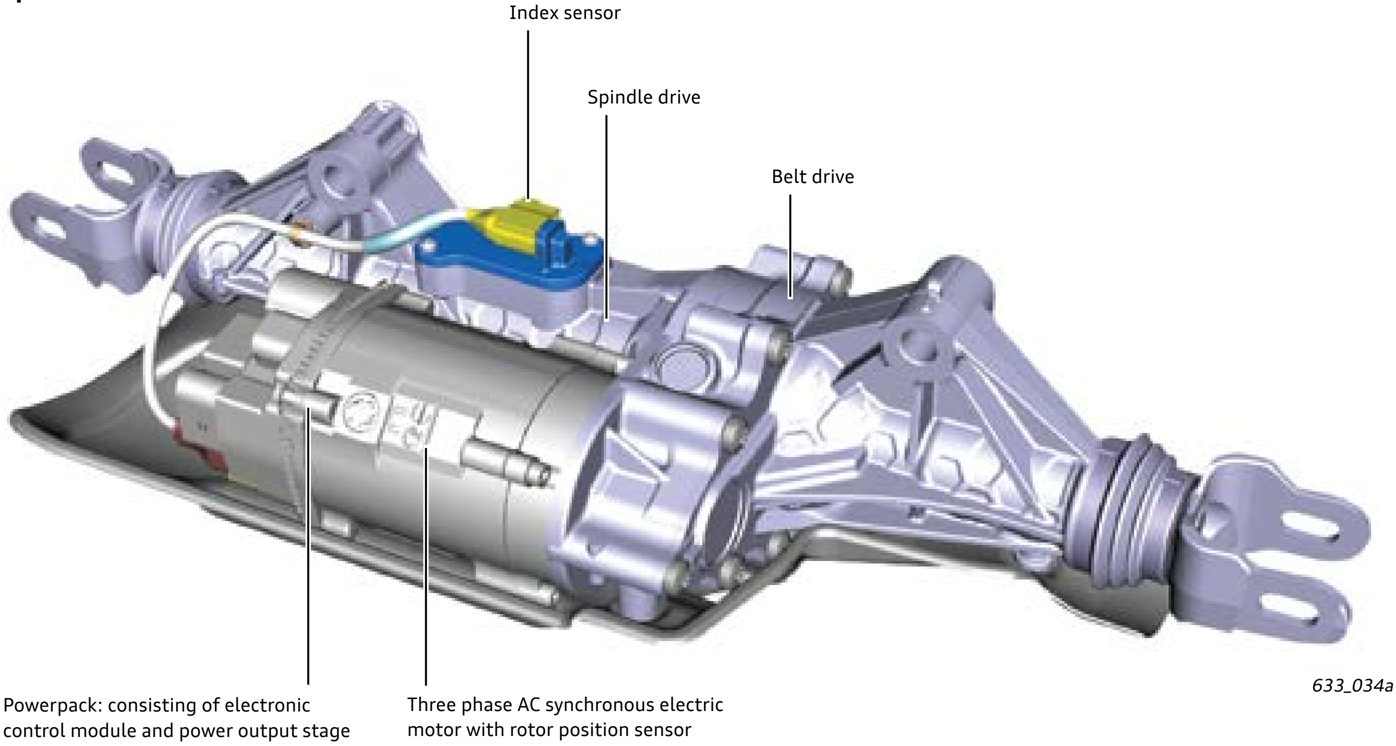
The entire unit comprised of the control element, drive and electronic controller is attached to the sub-frame and simultaneously steers both wheels through the same angle. Given that the maximum tracking angle adjustment is only approximately 5°, it is not necessary to use a pivot bearing on the front axle. The angular adjustments are made by utilizing the elasticity of the link/wheel carrier bearing elements.



633_034c

System components

Spindle drive

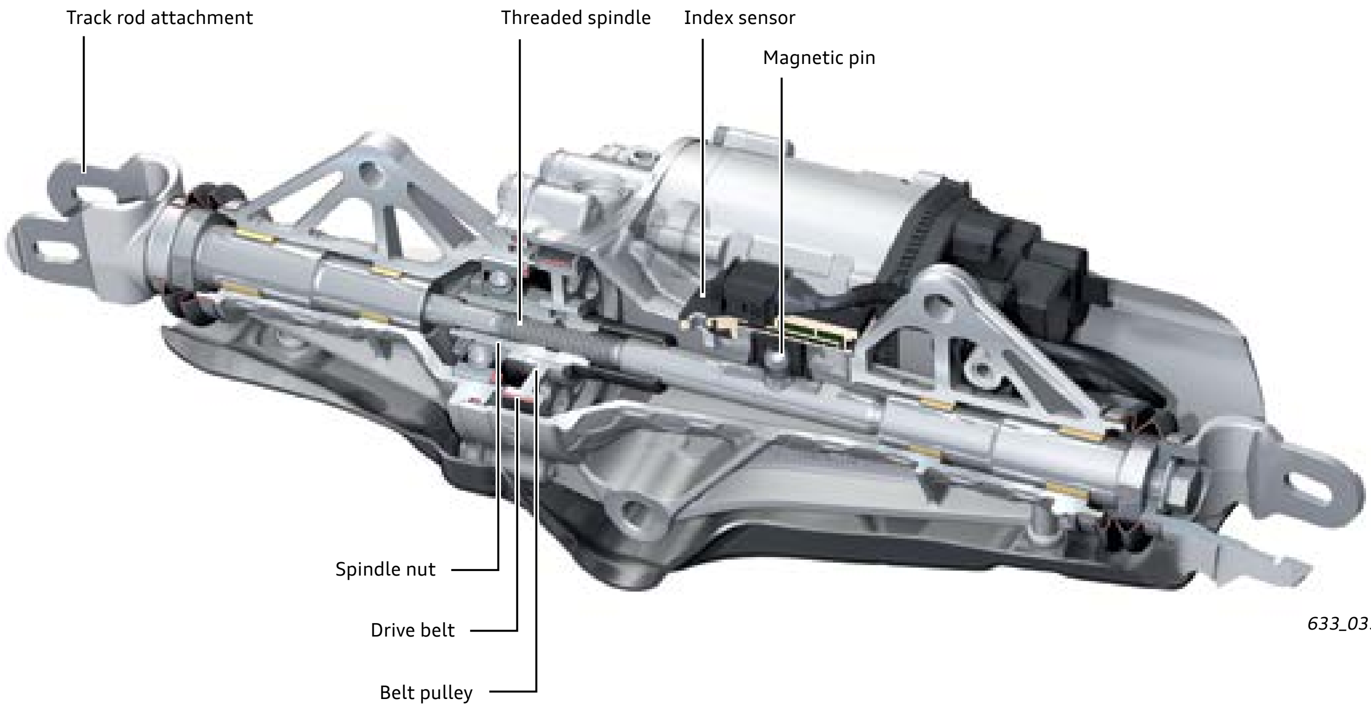


633_034a

The electric motor drives the spindle nut via the drive belt. The rotational movement of the spindle nut is converted to linear movement of the spindle. The connected track rods transmit the linear movement to the wheel carriers and the wheels are steered in parallel to the right or left (depending on the direction of rotation of the electric motor). The system is self-locking due to the transmission ratio and the trapezoidal thread of the spindle and the spindle nut.

The electric motor is only activated during the adjustment process and otherwise stays inactive. The stopping forces are generated solely through the self-locking of the screw drive.

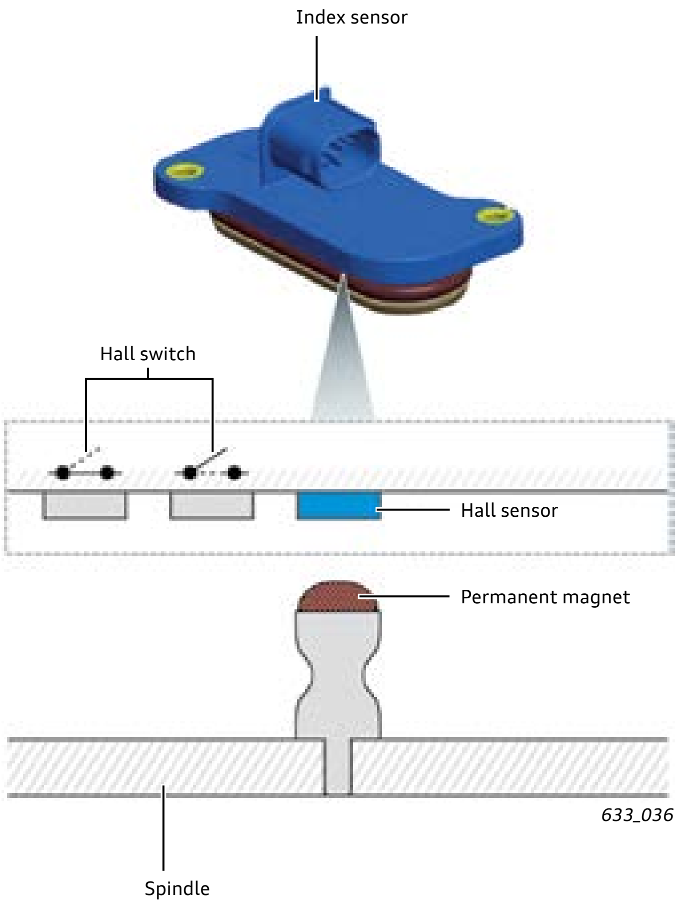
The maximum adjustment travel of the spindle (from the center position) is approximately 0.35 in (9.0 mm), which is equivalent to a maximum wheel movement of approximately 5°.



633_035

Index sensor

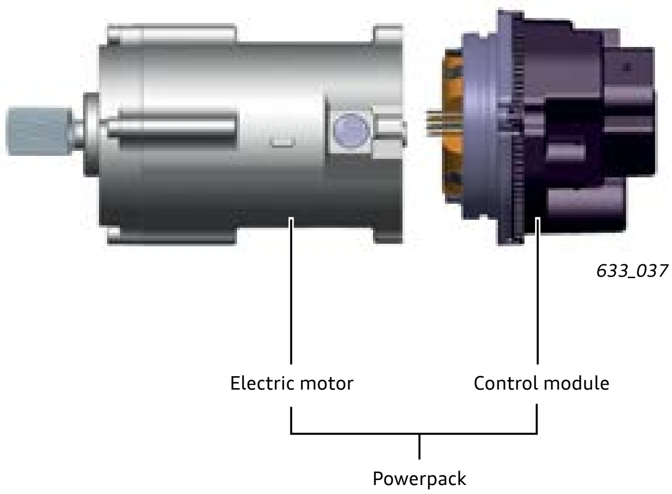
The index sensor senses the zero position, that is the "center position", of the spindle drive in the non-steered/ neutral state. The sensor works on the basis of the Hall-effect principle. To do this, the spindle has a pin to which is attached a permanent magnet. Spindle position sensing is performed in an analog fashion within a small angular range about the zero position. The actual Hall effect sensor is preceded by a two additional Hall effect switches on the sensor printed circuit board (PCB). These switches are used to detect the direction of movement of the spindle.



633_036

Electric motor

A brushless three-phase AC synchronous motor is used. The three-phase current is produced by an AC/DC converter in the drive unit. A rotor position sensor is integrated in the motor. This sensor determines the position of the rotor with high precision.



633_037

Rear Axle Steering Control Module J1019

The control module and the drive unit are bolted to the electric motor as a compact unit sealed against water spray and moisture. It is connected to the FlexRay bus as a low ohm end user. It computes the drive currents required for the electric motor on the basis of defined input information. An AC/DC converter supplies the alternating voltage to drive the motor.

Function of the overall system

The rear axle steering system requires the following measurement data/information:

Wheel speeds

Information on wheel speeds is placed on the FlexRay bus from ABS Control Module J104. From this, Rear Axle Steering Control Module J1019 determines the vehicle reference speed, which, to provide redundancy, is compared with the vehicle reference speed determined by the ESC system.

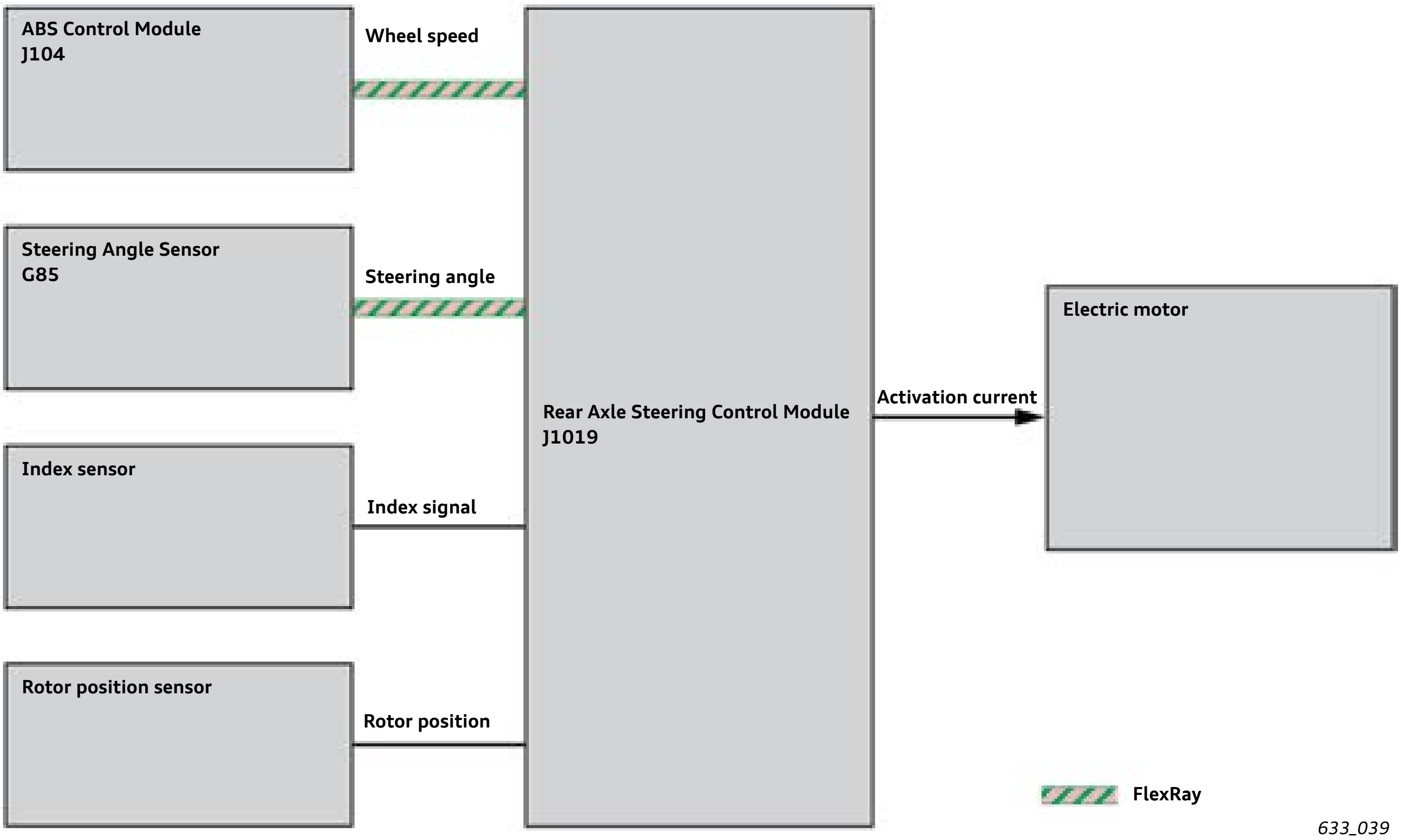
Steering angle

The steering angle is measured by Steering Angle Sensor G85 and is sent via the FlexRay bus. The control module determines the required rear steering angle from the "master information", that is, speed of vehicle and steering angle of front axle wheels.

Terminal 15 behavior

When the ignition is switched on (terminal 15 message via FlexRay), the control module checks to see if the following requirements for operation of the rear steering have been met:

- The steering assistance provided by the electromechanical steering at the front axle is greater than 20 % of maximum steering assistance.
- The vehicle battery (Terminal 30) is connected and intact.
- The control module and steering unit have not been replaced (comparison of stored vehicle identification number (VIN) with the VIN of the current vehicle received via the FlexRay bus).
- The rear steering has been correctly programmed/encoded.



633_039

Response to steering inputs by the driver

When the control module is encoded, maps defining the steering angle of the rear axle as a function of vehicle speed and front axle steering angle are stored. The maps differ with regard to the desired steering/driving behavior (driver input). Depending on the Audi drive select setting, there are various maps which support driving styles ranging from comfort-oriented to sporty.

If steering inputs are made by the driver at low speeds (up to approx. 37.2 mph (60.0 km/h [1]), the rear wheels are counter-steered relative to the front wheels up to a maximum angle of approximately 5° [1].

The steering angle of the rear wheels increases with the steering angle of the front wheels (steering angle applied by the driver), with additional allowance being made for the speed of the vehicle.

At higher speeds (upwards of approx. 43.4 mph (70 km/h[1]) , parallel steering movements of the rear wheels are made with much smaller steering angles.

[1] The specified values differ depending on optional equipment and serve only to convey a basic understanding of the functional principle.

Basic function

Behavior when vehicle is stationary

When the vehicle is stationary, the rear wheels are always set to the neutral position (starting position). The exact position is determined by evaluating the measurement data supplied by the index sensor and the rotor position sensor.

In isolated cases, a complete reset may not be possible due to insufficient resetting force. The behavior described is mainly due to the load state (higher vehicle weight) and the road surface characteristics (high friction coefficient). In these cases, the rear wheels are reset to the neutral position during the next driving cycle. This "misalignment" is indicated to the driver by a message in the DIS.

Additional functions/special operating states

Inputs from other vehicle systems

The Audi parking system (APS) may "request" certain rear axle steering angles. The control modules in question can specify exact steering angles, which are then implemented by Rear Axle Steering Control Module J1019.

ESC can also influence the rear axle steering. If beneficial to driving stability, ESC can also suppress certain steering movements of the rear wheels.

Operation and driver information

The driver can directly influence the function of the rear axle steering by selecting a drive mode in Audi drive select. Depending on the setting selected, the system supports a sporty, balanced or comfortable steering response.

When "individual" mode is selected, the driver can freely select one of 2 maps. When "allroad" mode is selected, the map for "auto" mode is activated.

When “offroad/lift” is selected, the map for “comfort” mode (comfort-oriented) is used.

The driving mode to vehicle behavior/map assignments are, therefore, identical to those of the electromechanical front axle steering (EPS).

The driver receives information on the rear axle steering only in the event of system malfunctions. Depending on the severity and priority of the fault, a yellow or red warning symbol is displayed. This warning symbol is identical to the symbol used already by the electromechanical front axle steering. The following additions are new: "Adapt driving style. Turning circle larger" and "Please stop vehicle. Note distance to side." These texts are only activated in conjunction with faults at the rear axle.

633_042

633_043

Service operations

The rear axle steering system has the production control number (PR number) 0N5.

It is diagnosed with the VAS Scan Tool using Address Word CB.

The system leaves the factory in the starting position (zero position). The starting position is determined/calibrated by the system supplier. It is not necessary to carry out service work on the system for this purpose. The system can only be adapted to the vehicle by setting the tracking values of the rear wheels. This setting is achieved by turning the designated eccentric screws in the same way as on a vehicle without rear axle steering.

Installation and removal/replacement of the steering module

The rear axle steering is only available as a complete module. No provision has been made for the removal/ replacement of individual components.

A special tool is required when installing the unit in the vehicle to ensure exact positioning.

If the module is not positioned exactly, the positions in the z direction of the track rod attachment points may differ on the left and right hand sides of the vehicle. This will result in unwanted differences in tracking angle on the left and right rear wheels when the springs compress and rebound.

After the unit is replaced, the new control module is encoded online. In the process, the vehicle-specific data-set is downloaded from the vehicle database.

A wheel alignment rack is required for subsequent adjustment the rear axle tracking angles.

Before beginning the alignment procedure, the exact center position of the steering system must be set using the VAS Scan Tool and the Test Plan “active steering to center of steering rack”.

The center position of the steering rack is set with high precision because the tolerance range is much smaller. An entry is made in the DTC memory and the yellow warning symbol is activated. After completing the adjustment, the Basic Setting is deactivated and the DTC memory cleared. The warning symbol is deactivated after cycling the ignition (Terminal 15).

633_044

To interchange modules, it is necessary to carry out the basic setting procedure "reset/program VIN" and to subsequently encode the control module online.

Note
Please keep in mind that the complaint "steering wheel is off-center" may also be due to in-exact setting of the rear axle steering starting position due to system parameters.

Adaptive Cruise Control (ACC)

System overview

The 2017 Q7 uses the fourth generation ACC system. The modified design provides an extended range of functions. comfort.

System availability has also been increased. A system shut-down due to insufficient sensor vision now takes place much later than before. System limitations have been reduced by the modified hardware. For example, radar signal reflection (which can lead to misinterpretation when driving through tunnels) has been minimized and unlikely to cause a shut down.

New functions include the system response to stationary vehicles. The measurement data generated by the ACC is an important basis for the new and traffic jam assist functions.

As previously with the A6, A7 and A8 models (including the S and RS models), a master/slave concept with 2 radar units is also implemented on the Audi Q7. As before, each radar unit has its own integrated control module. Data is exchanged via the FlexRay bus.

633_060

Note

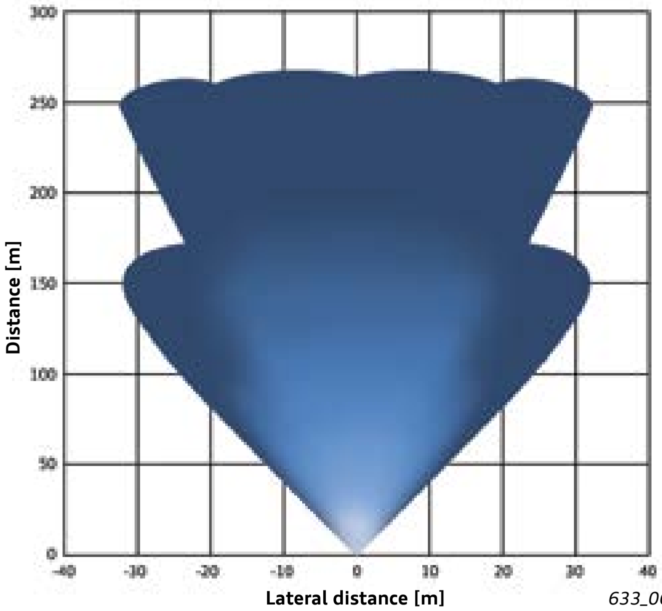
Like all other assistance systems, ACC also operates within certain system limits. The responsibility for driving the vehicle in traffic remains with the driver.

Design and basic function of system components

Distance Regulation Control Modules J428 and J850

The physical structure of both radar units is identical and the only differences are of a functional nature in the software.

A key modification is the use of six horizontally aligned radar transceiver units and an additional vertical transceiver unit. At close range (up to approximately 164.0 yds (150 m), this gives horizontal and vertical radar visibility ranges/coverage of ± 22° and ± 3°, respectively. The range has been extended to about 273.4 yd (250 m). The sensors are positioned on the outer edges of the vehicle in order to extend the visibility range. This makes it possible, for example, to "look beyond" a column of vehicles ahead. Vehicles in adjacent lanes are detected at an even greater distance within the limitations of the system.

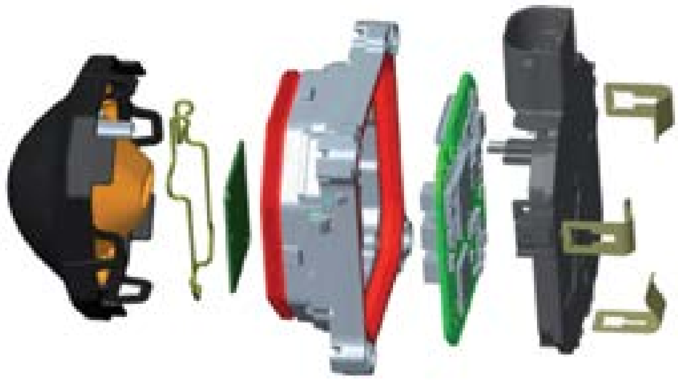


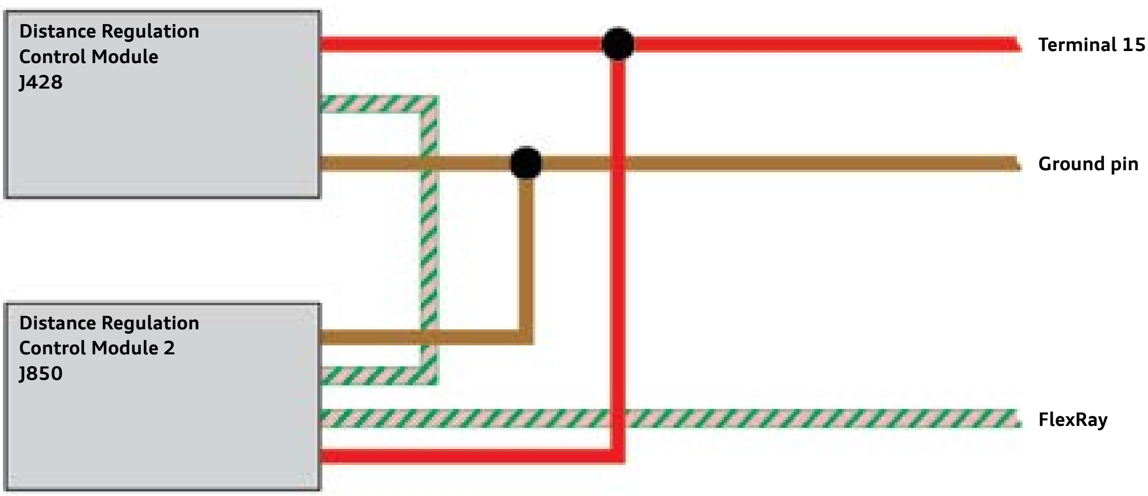
633_061

Propagation characteristic of the radar beams

The ACC master and ACC slave are autonomous control modules/sensors which independently pick up radar reflection within their radar visibility range. Information is exchanged via the FlexRay bus. The slave supplies the master with measurement data. The information generated by both sensors is collated in the master.

The functions available to the driver (ACC, traffic jam assist, Aud PreSense etc.) and the driver information displays are implemented by the driver only. The following figures give an idea of the complexity of the detection and control processes. To function properly, ACC system needs to exchange data with 22 other control modules. In the process, the ACC master control module receives and processes around 1000 signals/messages and sends approximately 500. The ACC slave control module can simultaneously detect up to 32 objects.


633_062



633_063

ACC basic function

The same physical functional principle of earlier systems also applies to the fourth generation ACC. Targets ahead of the sensor reflect the radar signal, and the reflected signal components are evaluated with regard to amplitude and frequency. Relative speeds and distances are determined by utilizing the Doppler effect (or Doppler shift). For detailed information, please refer to eSelf-Study Program 979443, Audi ACC Systems.

633_064

The ACC is operated using the control stalk. A new feature is that five distances can now be set relative to a vehicle ahead (previously four).

The ACC program is coupled to the Audi drive select mode. Alternatively, ACC can be configured independently using the "Individual" setting. The driver displays relevant to ACC are largely identical to those on current Audi models equipped with ACC.

633_022

ACC auxiliary functions

The following additional ACC functions are implemented on the Audi Q7.

- ACC Stop & Go
- Distance indicator/distance warning
- Collision avoidance assist
- Turning assist
- Traffic jam assist
- Control response when cornering[1]
- Boost function[1]
- Overtaking assistance[1]
- Start-off monitoring[1]
- Lane change assistance [1]
- Right lane overtaking prevention [1]

ACC also supplies important information which is required to implement for Audi pre sense front.

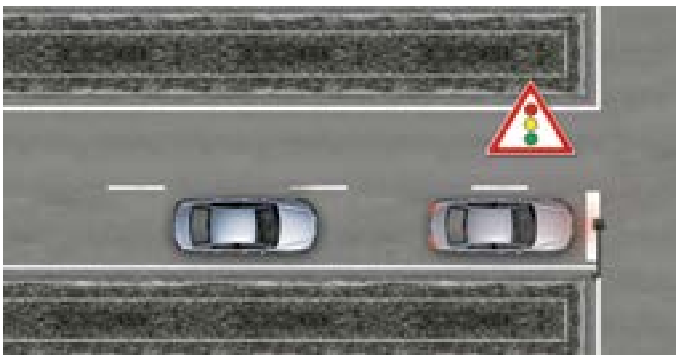
[1] The functional principle is identical to that of same-named functions on other current Audi models. For detailed information, please refer eSelf-Study Program 979443, Audi ACC Systems.

633_064b

ACC Stop & Go

For the first time, ACC also brakes the Audi Q7 in response to vehicles stationary at the time of object detection. The following conditions must be met:

- The vehicle has been detected by ACC and classified as a stationary object.
- The vehicle has also been detected and classified by the Driver Assistance Systems Front Camera R242.
- The detected object has been communicated between ACC and the camera.
- The vehicle is in the same lane.
- It is not possible to bypass the vehicle within the same lane.
- The vehicle must not be travelling faster than 31.0 mph (50 km/h).



633_064b

Distance indicator/distance warning

This new function informs the driver about the current distance to a preceding vehicle and issues a warning if the distance is less than that set by the driver.

A condition is that ACC has not been activated by the driver.

No vehicle in front

Distance indicator if no preceding vehicle is detected

633_065

Distance indicator

ACC evaluates the measurement data generated by the radar sensors. As soon as the vehicle's speed exceeds 37.2 mph (60.0 km/h), the distance to a preceding vehicle is indicated graphically on the display of the DIS.

Vehicle in front

Distance indicator in case of vehicle in front

633_066

Distance warning

The driver can set different distance warning thresholds in the range between 0.6 s and 3.0 s in the MMI.

If ACC determines that the distance to the preceding vehicle is less than the preset distance, a warning is issued on the display of the DIS.

Warning

Distance warning if the distance to the preceding vehicle is less than the distance set by the driver

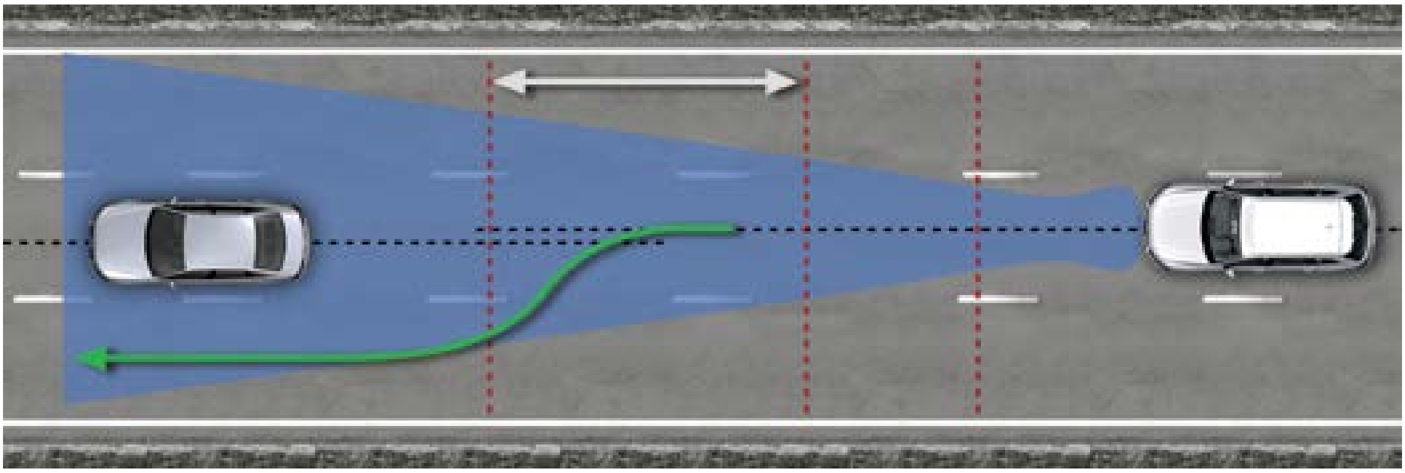
633_069

Collision avoidance

This new function assists the driver during an evasive maneuver. The ACC control module calculates a suitable lane for the evasive action on the basis of the ACC measurement data and the data generated by the front camera. In the process, the relative speeds, the distance to the preceding vehicle, its width and the transverse offset of the vehicle are factored in.

After a warning jolt is issued, collision avoidance assist is available within a speed range from 18.6 - 93.2 mph (30 - 150 km/h), regardless of whether ACC is switched on or off.

Collision avoidance assist is only activated if the driver has initiated an evasive maneuverer. The driver thus determines the evasion direction. The ACC control module "instructs" Power Steering Control Module J500 of the electromechanical steering to provide a defined amount of steering torque not exceeding approximately 2.21 lb ft (3.0 Nm). The driver receives effective support which enables the vehicle to leave its lane and to bypass the preceding vehicle while maintaining the appropriate safety distance. If ACC ascertains that evasive action is no longer possible and a collision is unavoidable, collision avoidance assist is no longer activated.



633_070

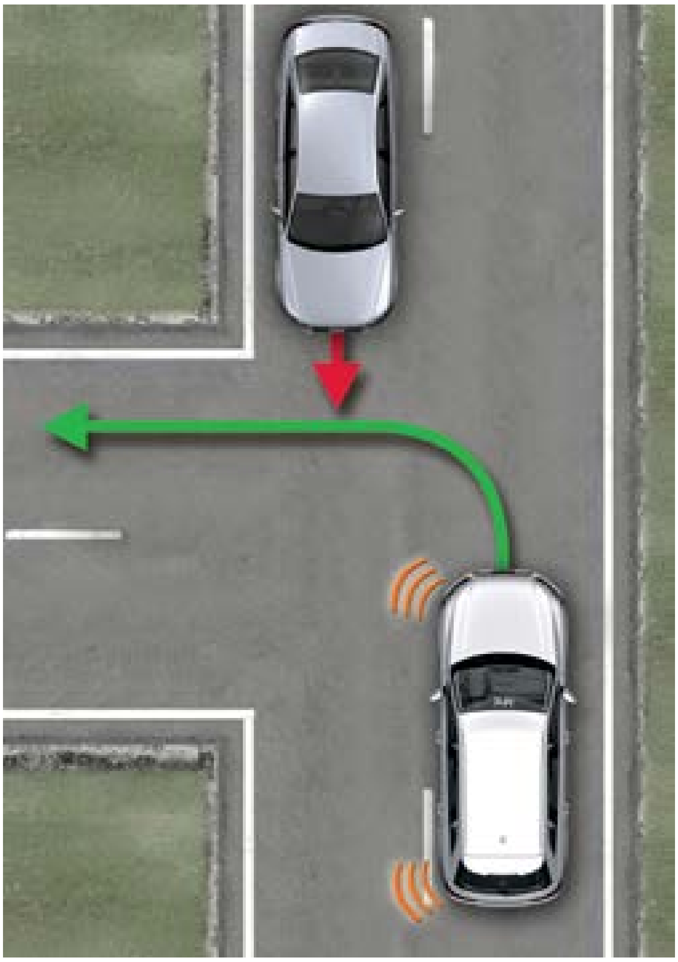
Turning assist

Turning left is potentially hazardous because the vehicle has to cross the oncoming lane. Collisions involving oncoming vehicles are statistically among the most common causes of accidents. Turning assist was developed specially to make turning left safer.

The function utilizes the radar signals and the data generated by Driver Assistance Systems Front Camera R242 to scan the lane ahead, lane markings and oncoming traffic.

The monitoring of oncoming traffic is initiated by operating the turn signal. The data is evaluated in the ACC control module. The function is active in a speed range of 1.2 - 6.2 mph (2 - 10 km/h).

If a collision hazard is detected, the ACC control module instructs ABS Control Module J104 to build up brake pressure. The vehicle is then braked to a standstill in its own lane. If the vehicle has already left its lane, turning assist is deactivated.



633_071

Note

The collision avoidance assist and turning assist functions are components of Audi pre sense front. For further information, please refer to eSelf-Study Program 970363, The 2017 Audi Q7 Occupant Protection and Infotainment System.

Traffic jam assist

Function

This new function aids the driver in traffic jam situations and in slow-moving traffic up to a driving speed of 40.3 mph (65.0 km/h). The function is identical to the existing stop & go function, with additional lateral guidance of the vehicle. This means that the vehicle is guided centrally behind a column (at least 2 vehicles) of vehicles ahead. This does not, however, necessarily mean that the vehicle is guided in the center of its own lane.

633_072a

System limitations

Under certain conditions it is not possible to execute the functions described here. This is the case if:

- No counter-torque is sensed at the steering wheel (the driver does not have a hand on the steering wheel) for a set amount of time.
- The lane has a radius of less than 164.0 yds (150.0 m).
- The available lane width is insufficient.
- The lane cannot be scanned far enough ahead.
- The distance between the vehicle and the edge of the lane is too small.

If a system limitation is reached or exceeded, the driver is prompted both audibly and visually to take control of the vehicle. If the driver does not respond to this prompt, ACC instructs ESC to comfortably brake the vehicle to a standstill (deceleration approximately -2 m/s^2). When the vehicle comes to a standstill, the hazard warning flashers are activated.

633_072

Traffic jam assist

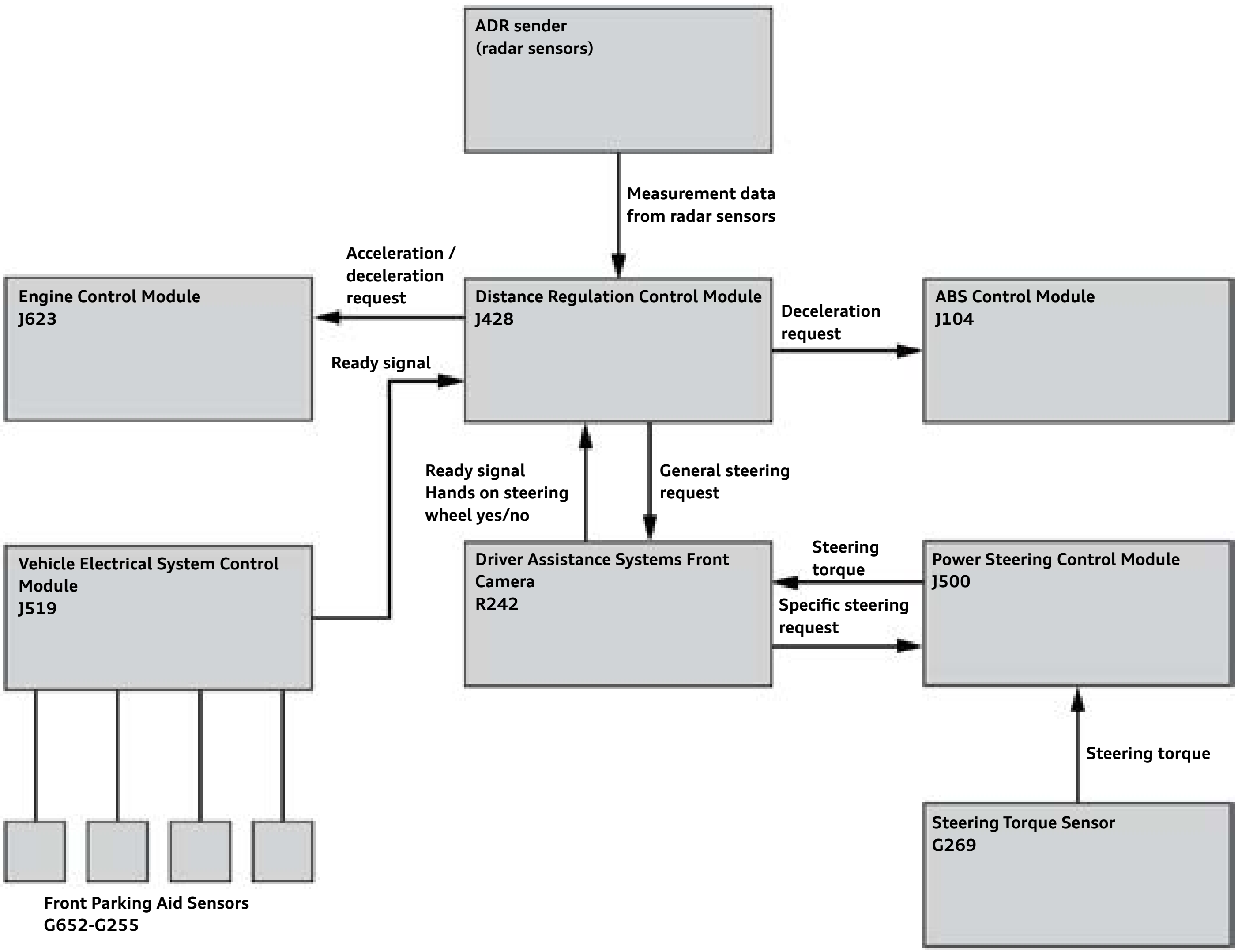
Function

The ACC control module processes the measurement data generated by the wheel sensors, the ultrasound sensors (for sensing that the vehicle is ready to go) and Driver Assistance Systems Front Camera R242. The ACC control module calculates from this information the traffic flow ahead (distances and speeds of vehicles and relative speeds), as well as the length and width of the lane/travel envelope. To achieve exact guidance of the vehicle in the calculated lane, ACC determines the control requirements for steering, drive motor and ESC. The ACC control module transfers the general steering control inputs to R242. The camera calculates exact specifications (steering direction, steering angle) and sends this information to the Power Steering Control Module J500.

If ACC, by evaluating the signals from the ultrasound sensors and the measurement data supplied by the camera, acsertains that the vehicle is ready to go, ACC sends a specific acceleration request to the ECM. If acceleration and deceleration is requested by ACC, special software in the ECM decides what adjustments are needed to meet the engine torque demand.

Power Steering Control Module J500 evaluates the measurement data from the steering torque sensor and sends it to Driver Assistance Systems Front Camera R242.

The latter evaluates on the basis of the measurement data whether counter-steer torque is present, that is, whether the driver or not has his hands on the steering wheel. The ACC control module receives this information continuously from the camera. If the driver has not placed a hand on the steering wheel within a set amount of time, a braking request is sent to the ESC after audible and visual warnings have been issued.



633_073

Operation and driver information

A requirement for the activation of traffic jam assist is that the function is switched on in the MMI.

633_074a

If ACC is switched on and active, traffic jam assist is switched on by pressing the button on the turn signal stalk.

633_074b

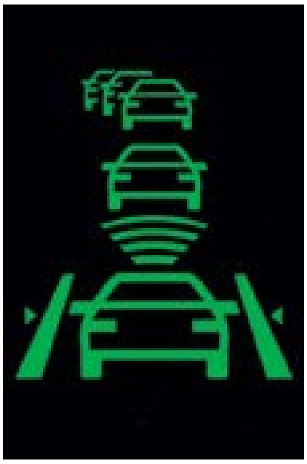
If a traffic jam situation is detected, it is indicated to the driver by a "ready" message.

A condition for the detection of a traffic jam situation is the detection of vehicles ahead by both ACC and Driver Assistance Systems Front Camera R242.

633_074

When traffic jam assist is active, it is indicated to the driver in the DIS.

If "Car" - "Driver assist" is also activated on the MMI display, a corresponding graphic is generated. The two green lines at the sides indicate that lateral vehicle guidance is active.



633_076

633_075

If a driver action in necessary, it is indicated audibly and visually in the DIS.

If "Car" – "Driver assist" is also activated on the MMI display, a corresponding diagram is generated in this case too.

633_064e

633_064d

Service operations

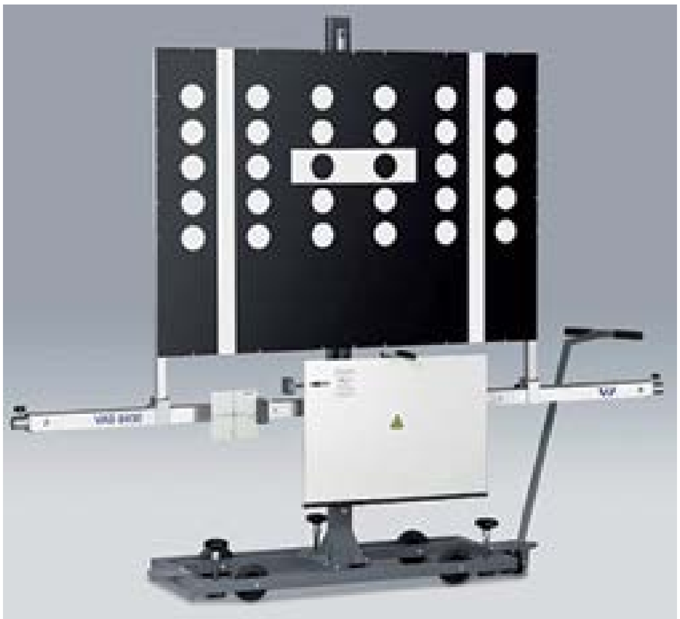
The fourth generation ACC system is diagnosed using the VAS Scan Tool. Distance Regulation Control Module J428 is diagnosed using Address Word 13 while Distance Regulation Control Module 2 J850 is diagnosed using Address Word 8B.

633_085

The system monitors the horizontal and vertical settings of the radar sensors (senders) on the basis of a statistical evaluation of the objects detected. The system is deactivated upwards of a horizontal misalignment angle of ± 2.0° and upwards of a vertical misalignment angle of ± 3.0°. Both radar sensors are adjusted in service centers.

It is necessary to adjust the radar sensors if certain types of work are performed on the vehicle (for example, collision repair or vehicle suspension alignment).

The adjustment is made according to the known procedure using setting device VAS 6430/1 with ACC reflector mirror VAS 6430/3. The only difference is that a new setting tool is used. Instead of the 3.5 mm hexagon socket wrench used previously, a Torx T20 tool is now used.



633_067

Wheels and tires

The Audi Q7 comes as standard with 19" wheels. The 20” and 21” wheels are optional. The range of tires for the engine versions available at launch extends from 255/60 R18 to 285/40 R21.

19" and 20" tires with run-flat properties and 20" offroad tires with reinforced sidewalls are standard or optional in certain markets.

The "Tire Mobility System" is standard equipment as well as a tool kit and vehicle jack.

A.

B.

C.

	PR Code	Q7 3.0T	Q7 TDI®
A. 8.5” x 19” 5-V-spoke design wheels 255/55 R19 111H XL all-season tires	**CH6** **H79**	■	■
B. 9.0” x 20” 10-spoke-star design wheels (Gray/Polished finish) 285/45 R20 112H XL all-season run-flat tires	**F06** **H93**	□	□
C. 9.5” x 21” Audi Sport® 5-twin-spoke design wheels 285/40 R21 109Y XL summer performance tires	**F50** **H2Q**	□	□
D. 255/55 R19 111H XL all-season run-flat tires (not shown)	**H92**	□	□

■ = Standard

□ = Optional

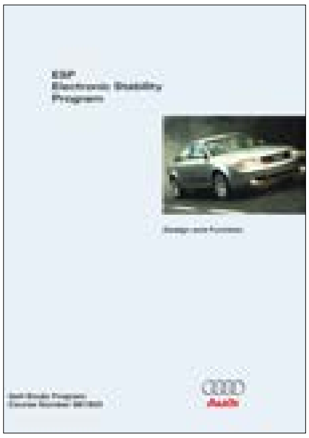
Low tire pressure indicator

The second-generation low tire pressure indicator (RKA+) is standard equipment for the Audi Q7. In terms of design, function, operation, driver information, servicing and diagnostics, this system is identical to the system already in use on other Audi models.

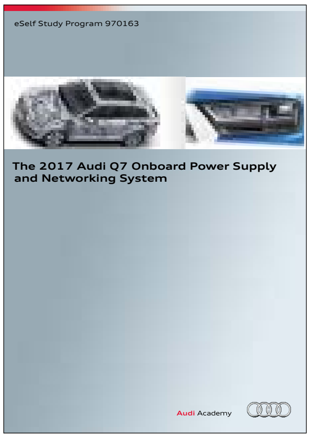
633_088

Self-Study Programs

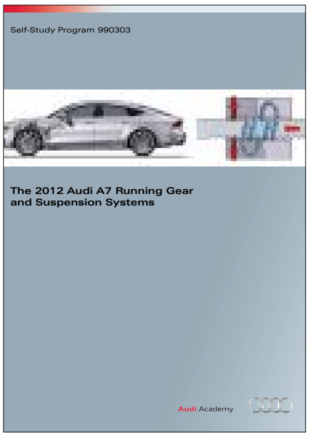
For further information, please refer to the following eSelf-Study Programs:



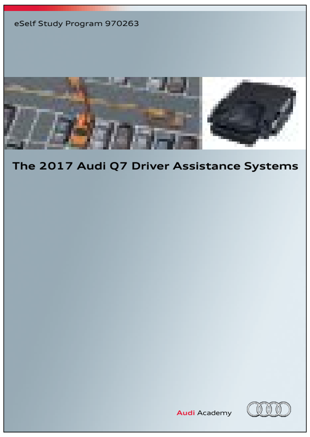
SSP 961903
ESP Electronic Stability Program



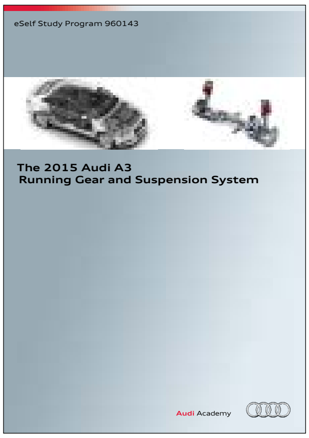
SSP 970163
The 2017 Audi Q7 Onboard Power Supply and Networking System



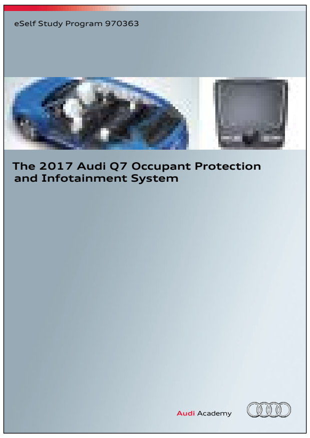
SSP 990303
The 2012 Audi A7 Running Gear and Suspension Systems



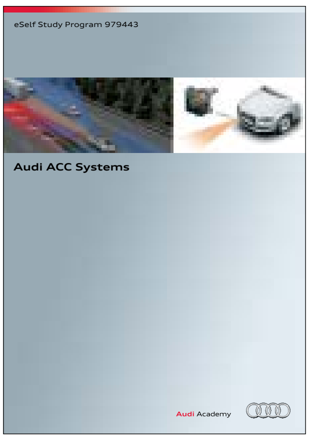
SSP 970263
The 2017 Audi Q7 Driver Assistance Systems



SSP 960143
The 2015 Audi A3 Running Gear and Suspension Systems



SSP 970363
The 2017 Audi Q7 Occupant Protection and Infotainment System



SSP 979443
Audi ACC Systems

Knowledge assessment

An On-Line Knowledge Assessment (exam) is Available for this eSelf-Study Program.

The Knowledge Assessment is required for Certification credit.

You can find this Knowledge Assessment at:
www.accessaudi.com

From the accessaudi.com Homepage:

- Click on the "ACADEMY" tab
- Click on the "Academy site" link
- Click on the Course Catalog Search and select "960163 - The 2017 Audi Q7 Running Gear and Suspension System"

Please submit any questions or inquiries via the Academy CRC Online Support Form
which is located under the "Support" tab or the "Contact Us" tab of the Academy CRC.

Thank you for reading this eSelf-Study Program and taking the assessment.

Audi
Truth in Engineering

960163

Audi of America, LLC
2200 Ferdinand Porsche Drive
Herndon, VA 20171