Service Training

Self-Study Programme 331

Variable Anti-roll Bars on the Touareg

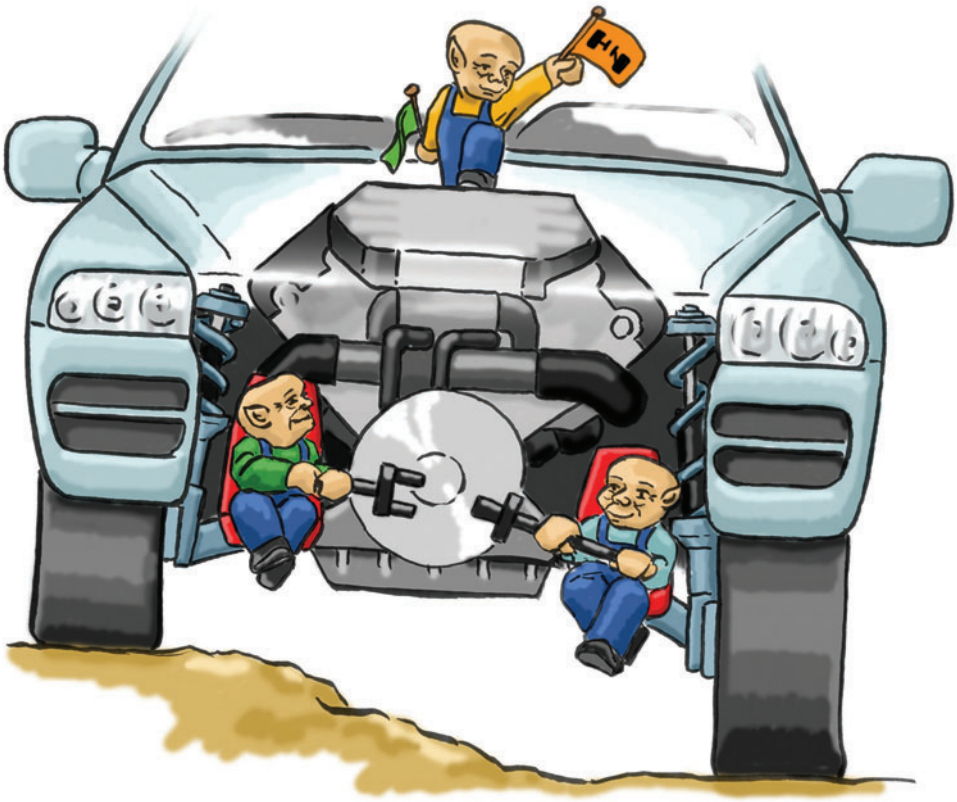
Design and Function

The running gear is a key component of the entire vehicle. It transmits all the forces acting between the road surface and the body.
It therefore has a direct effect on driving comfort and driving safety.

The Touareg is a sporty SUV off-road but also a sporty, safe car on the road, with firm suspension, stiff dampers and rigid anti-roll bars.

The best tuning for optimum off-road mobility, however, requires soft suspension with low damping factor and less rigid anti-roll bars. To solve this conflict of requirements, ThyssenKrupp has developed a variable anti-roll bar.

It consists of split anti-roll bars which are an optimal compromise between dynamic handling characteristics, driving comfort and off-road mobility - it is a coupling that is also switchable under load.



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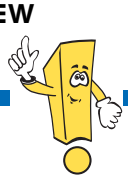

Important Note

**This self-study programme describes the design and function of new developments.
The contents will not be updated.**

Please always refer to the relevant Service Literature for all inspection, adjustment and repair instructions.

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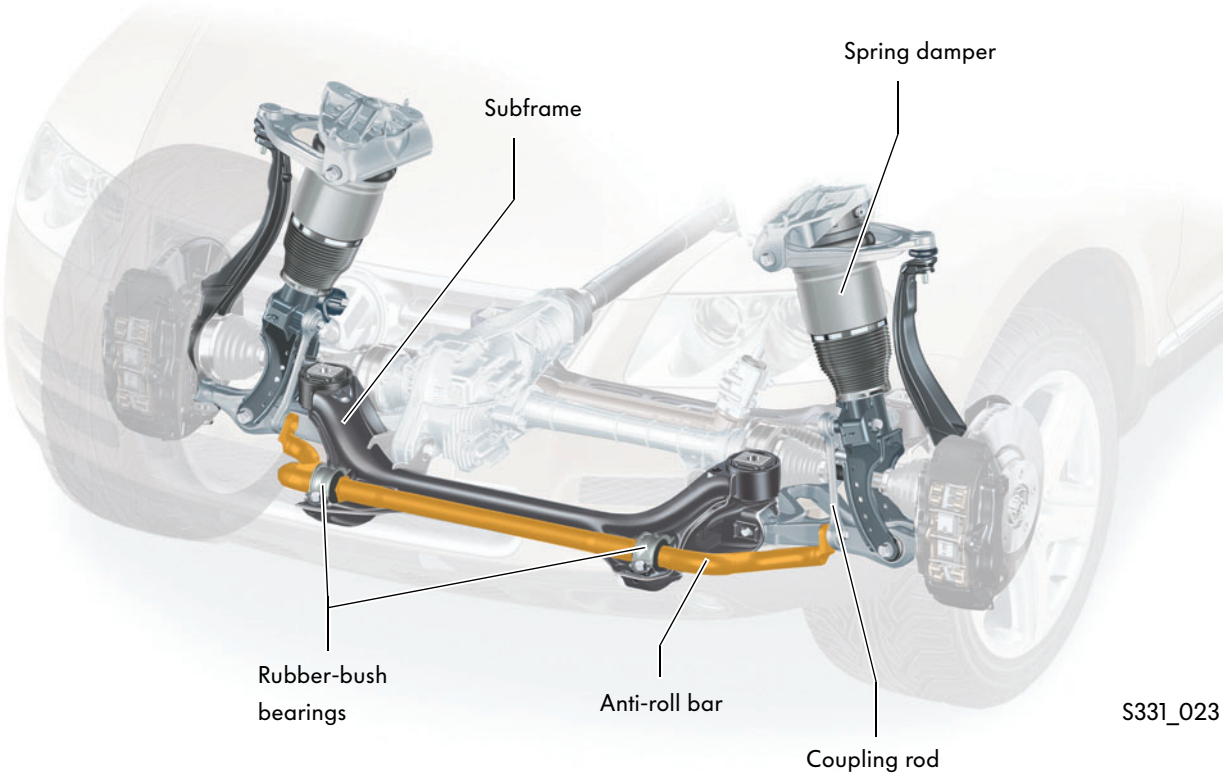
Introduction

Conventional anti-roll bar



Anti-roll bars improve cornering behaviour by reducing body roll.

An anti-roll bar consists of a U-shaped tube. The middle part of the anti-roll bar is secured to the subframe by means of rubber-bush bearings that allow rotary movement. It is also directly attached to the spring dampers by means of a coupling rod.

When the wheel on the outside of the corner bounces, the anti-roll bar reduces the rebound movement of the wheel on the other side of the axle on the inside of the corner.

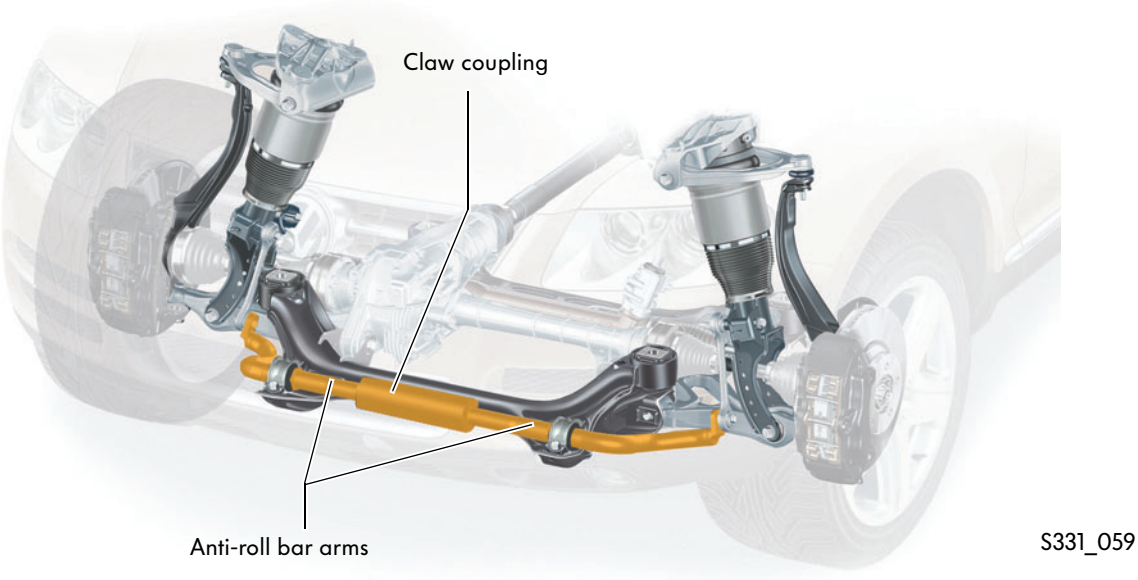
Variable anti-roll bar

An off-road vehicle requires an extremely rigid anti-roll bar on the road. This prevents extreme body roll due to the high centre of gravity when cornering at high speeds.

Off-road, anti-roll bars with low spring rates allow more torsional twist on the axle.
This achieves continuous traction and high driving comfort.

Sporty, safe on-road handling

Optimum off-road mobility with high driving comfort



The variable anti-roll bar is a suspension system for optimising on-road and off-road driving characteristics.

A hydraulically operated claw coupling couples and decouples the two anti-roll bar arms.

Driving physics

On-road driving

On-road, the anti-roll bar is coupled and extremely resistant to torsional twist (rigid). This allows sporty, safe on-road handling.

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Off-road driving

Off-road, the anti-roll bars are uncoupled. When the anti-roll bars are uncoupled, the wheels on one axle are free to bounce and rebound independently of each other. This increases off-road mobility, driving comfort and traction.

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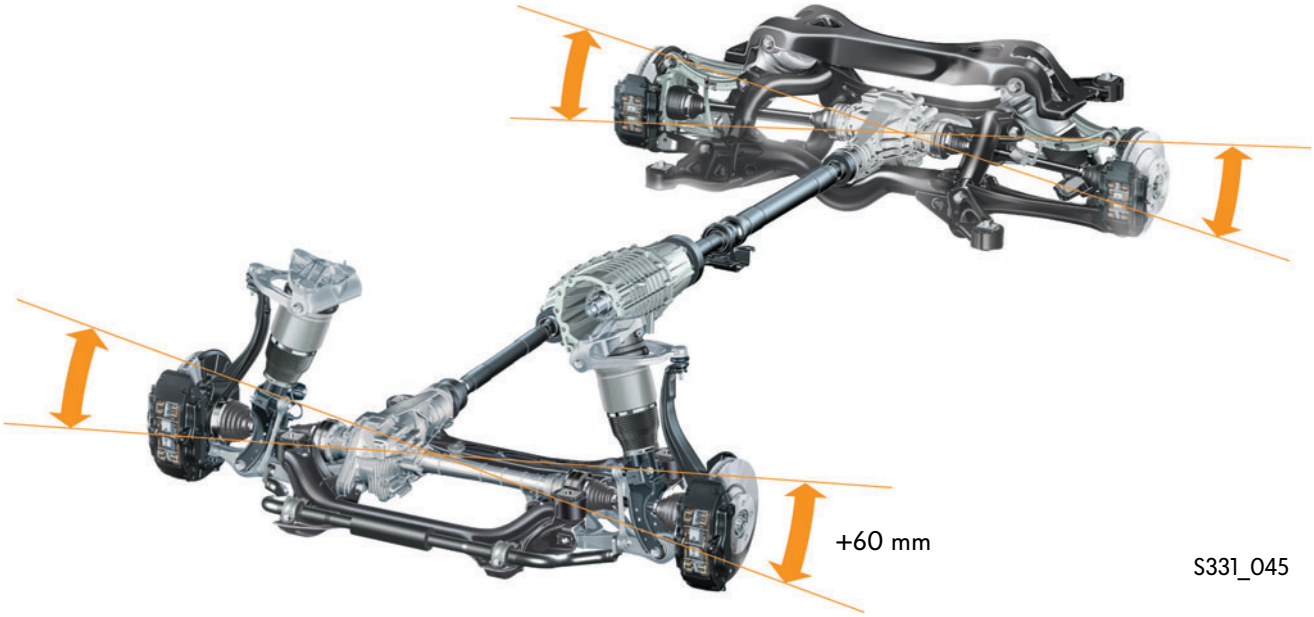
Torsional twist

When the anti-roll bars are uncoupled, the torsional twist on an axle is increased by max. 60 mm.



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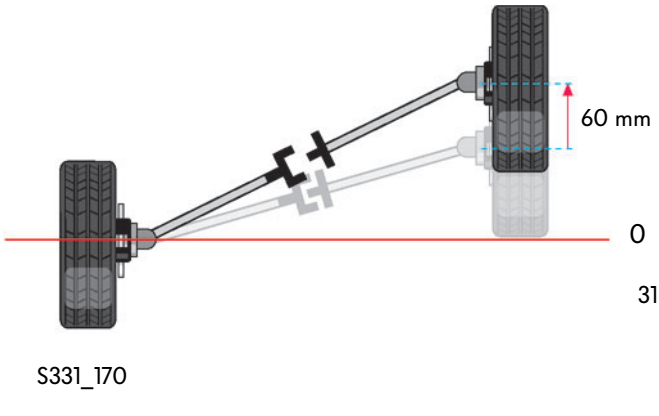
In the examples below, normal torsional twist has already been reached.
When the anti-roll bars are uncoupled, the axle can achieve an additional torsional twist of max. 60 mm either on one side or as an aggregate on both sides.



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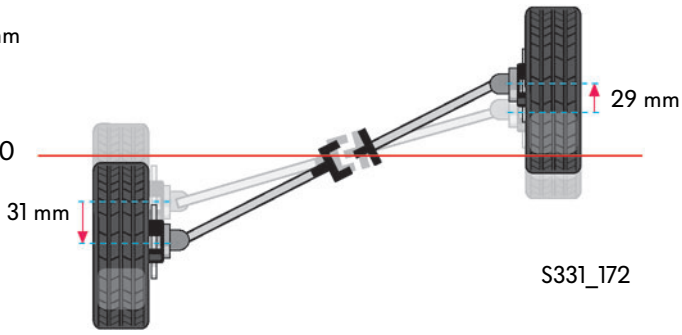

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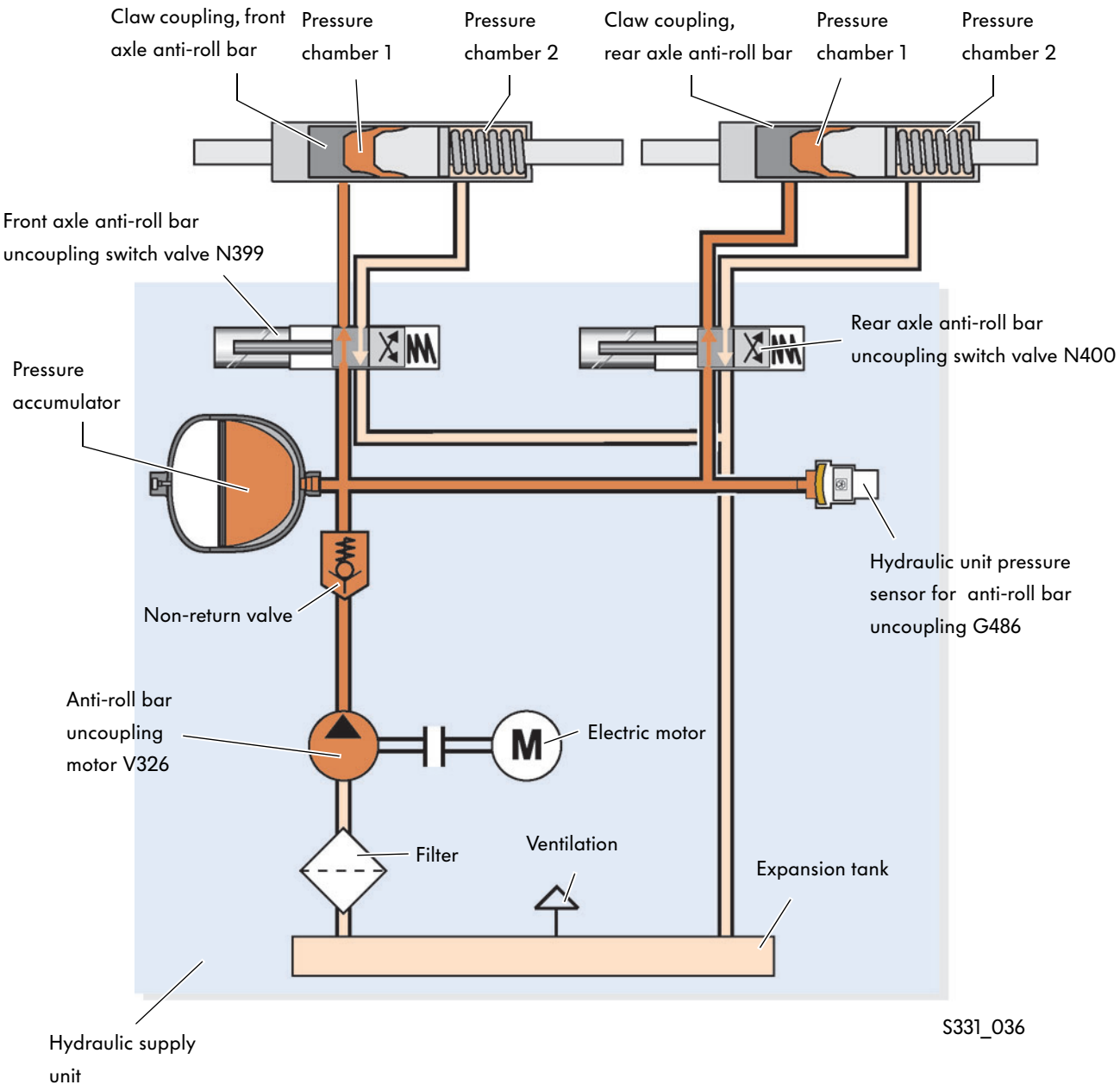
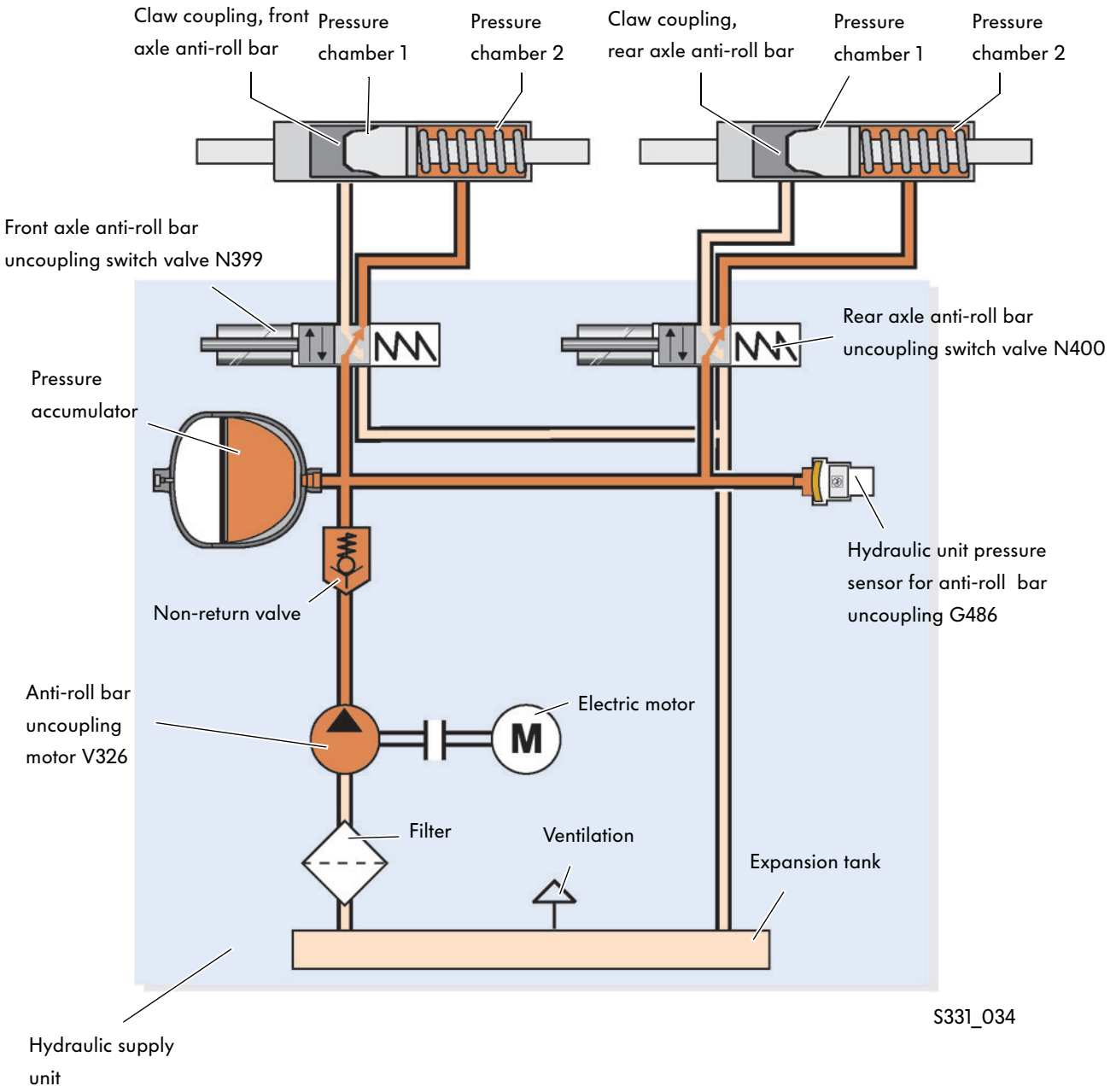
Variable anti-roll bars are available for vehicles fitted with steel and air suspension.

Block diagram

Uncoupling an anti-roll bar



Coupling an anti-roll bar



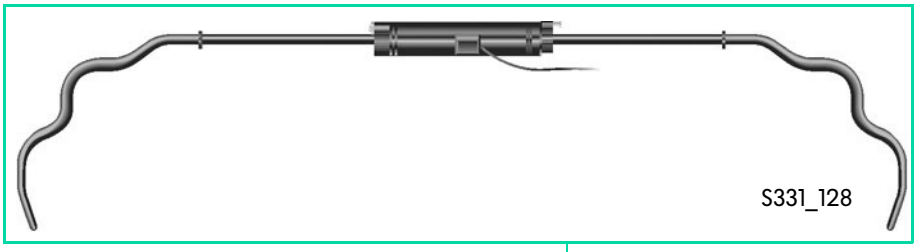
General overview

Variable anti-roll bar and its components

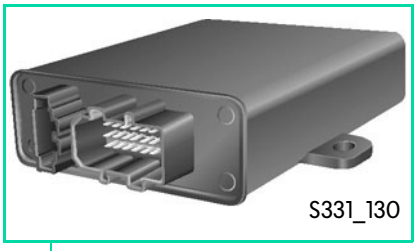
The overall system of the variable anti-roll bar consists of three main components:

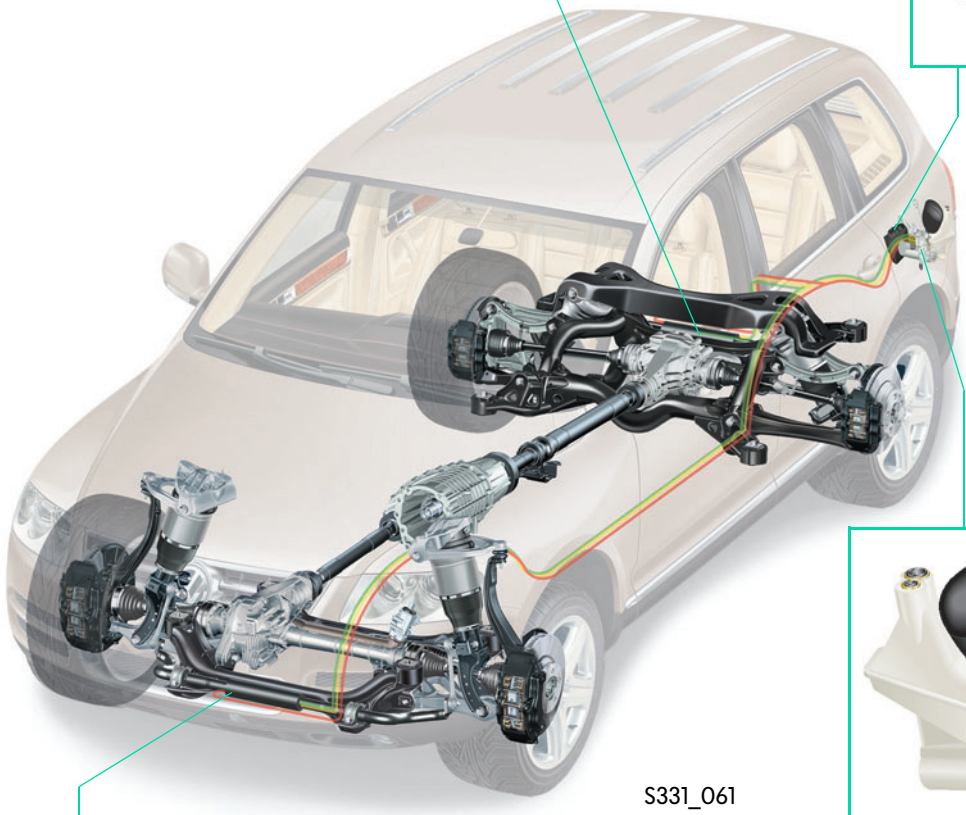
- the hydraulic supply unit
- the anti-roll bar control unit
- the variable anti-roll bars

Rear axle anti-roll bar

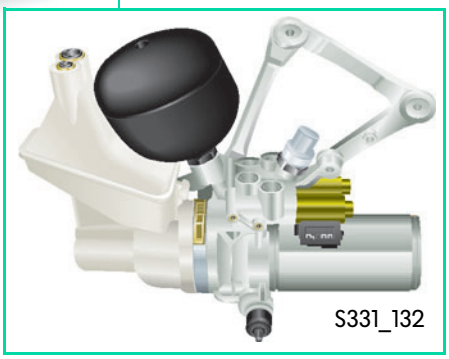


Anti-roll bar control unit

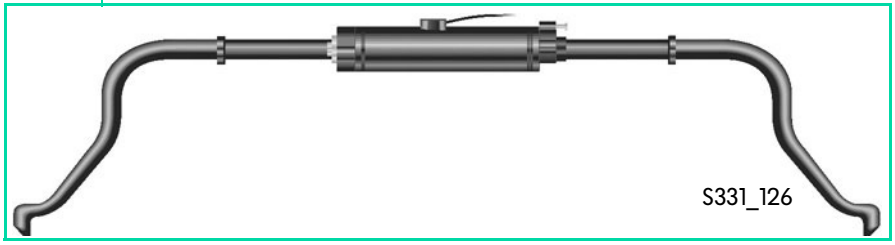




Hydraulic supply unit



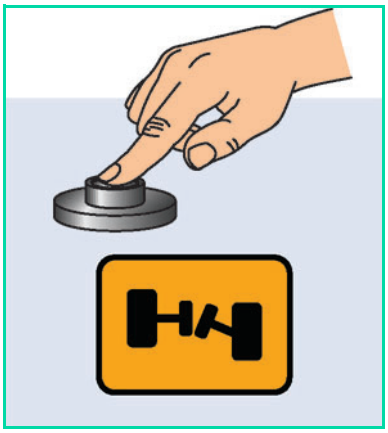
Front axle anti-roll bar



Function of the variable anti-roll bar

When the ignition is switched on, the variable anti-roll bar is functional.

Uncoupling by pressing the button



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Only when

- the vehicle road speed is less than 40 km/h,
- lateral acceleration is less than 0.5 g and
- the control unit is not in fault mode,

can the driver uncouple the anti-roll bars.

The opening pressure of the anti-roll bar is 110 bar. The coupling operation display in the dash panel insert flashes until the opening pressure has been reached.

The rear axle anti-roll bar is uncoupled first, then the front axle.
When front axle uncoupling is completed, the coupling operation display appears continuously.

The pump motor continues to run throughout the entire operation and stops when a system pressure of 145 bar has been reached to charge the pressure accumulator.

If the driver presses the coupling button again or a system fault occurs, the uncoupling operation is cancelled.

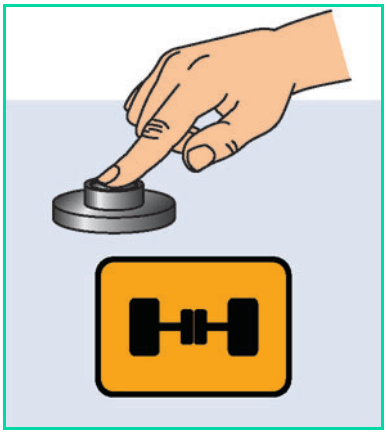
Only when the gearbox is switched to "low" will the anti-roll bar uncoupling motor switch on automatically. The pressure accumulator will charge the system without the driver having to press the button. The system can thus react very quickly if the driver presses the button to uncouple the anti-roll bars.

Function

Coupling by pressing the button

For driving dynamic reasons, the front axle anti-roll bar is coupled before the rear axle anti-roll bar.

The anti-roll bar coupling operation is indicated by the coupling operation display flashing in the dash panel insert.
When the coupling operation is completed, the associated display disappears from the dash panel insert.



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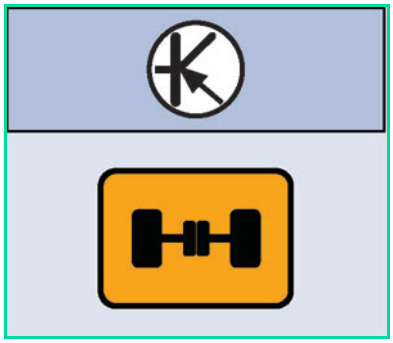
When the front axle is uncoupled and the pressure in the pressure accumulator is below 70 bar, the coupling operation for the rear axle is delayed until the pressure reaches 70 bar again. This function protects the pressure accumulator from destruction.

The pump motor continues to run during the entire operation and stops when pressure in the system reaches 110 bar.

Automatic coupling

The system couples the front and rear anti-roll bars automatically when

- the vehicle exceeds a road speed of 50 km/h,
- lateral acceleration exceeds 0.9 g at a road speed below 35 km/h or
- lateral acceleration exceeds 0.7 g at a road speed above 35 km/h.



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System pressures

Pressure	Description	
70 bar	Minimum pressure	● To protect the pressure accumulator from destruction, pressure in the system must be over 70 bar during the coupling operation. ● When the front axle is coupled and pressure in the pressure accumulator is below 70 bar, the system delays coupling of the rear axle until pressure reaches a minimum level of 70 bar.
90 bar	Minimum pressure	● When the gearbox is switched to "low", the pressure accumulator is recharged if the pressure drops below the minimum level of 90 bar.
110 bar	System pressure	● The anti-roll bar opening pressure is 110 bar. ● If the system pressure drops below 90 bar during the uncoupling operation, the pump starts and builds up system pressure to 110 bar.
145 bar	Max. system pressure	● The pump motor runs during the entire uncoupling operation and stops when system pressure reaches 145 bar in order to charge the pressure accumulator. This is monitored by the hydraulic unit pressure sensor for anti-roll bar uncoupling. ● If pressure drops below 115 bar in uncoupled mode, the system is recharged to 145 bar.

Design and function

Hydraulic supply unit

The hydraulic supply unit on the Touareg is located behind the rear left side trim panel above the rear wheel housing.

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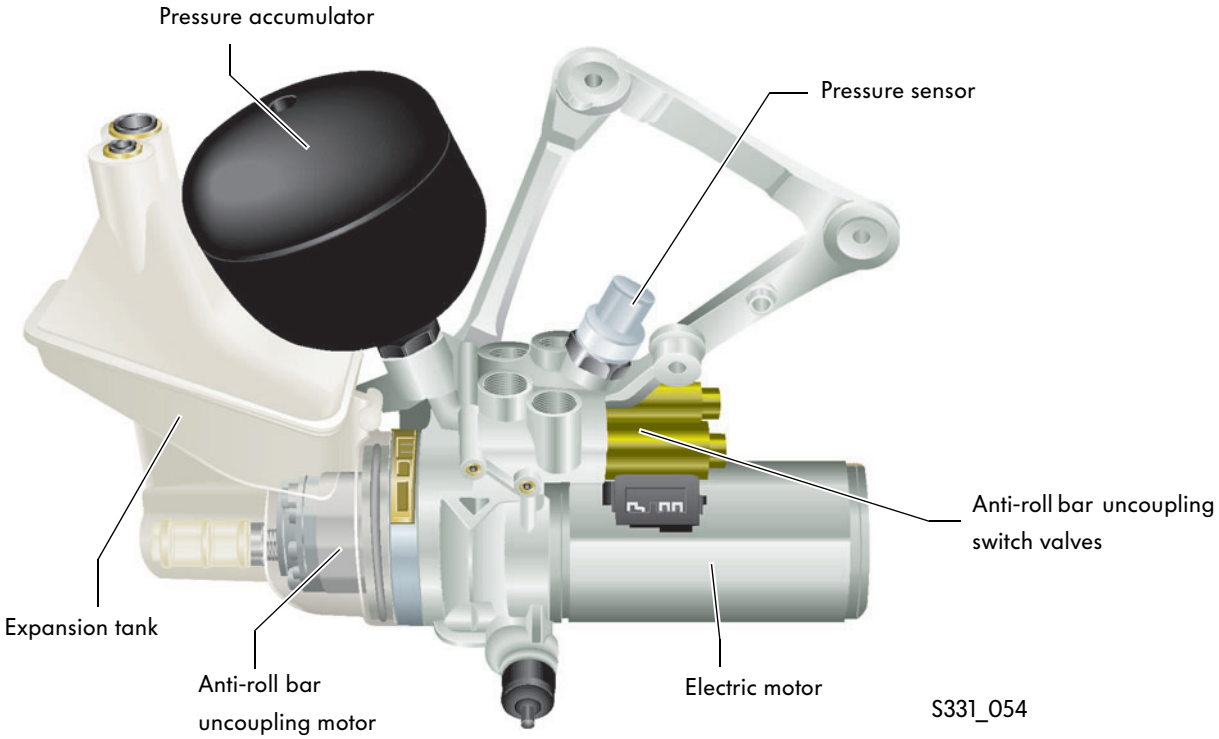

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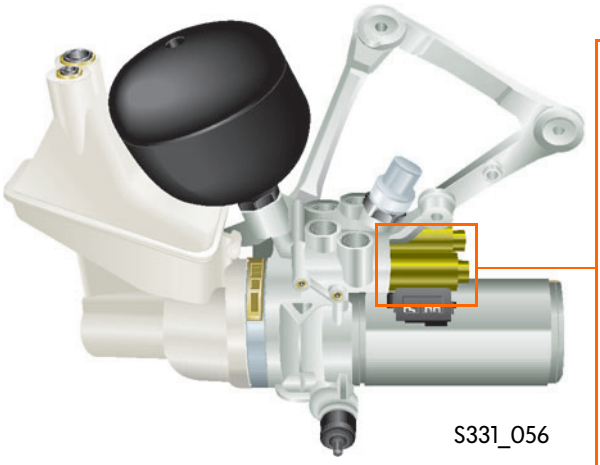
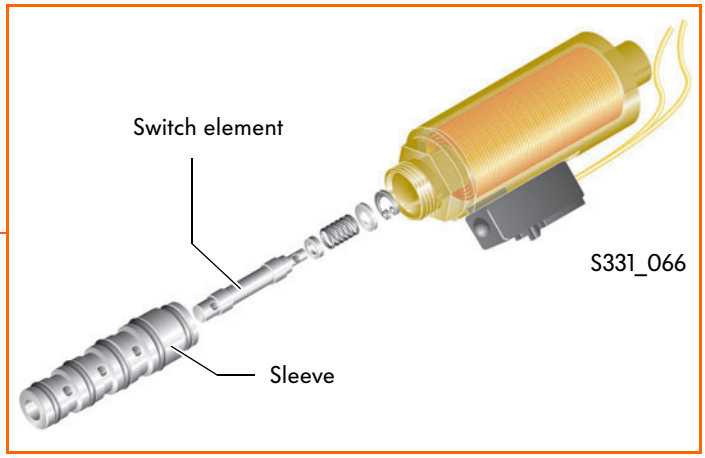
The supply unit consists of a hydraulic pump driven by an electric motor, an expansion tank, a pressure accumulator, a pressure sensor and two anti-roll bar switch valves.

This supply unit allows the rear axle and front axle anti-roll bars to be switched separately.

Anti-roll bar uncoupling switch valves N399 and N400

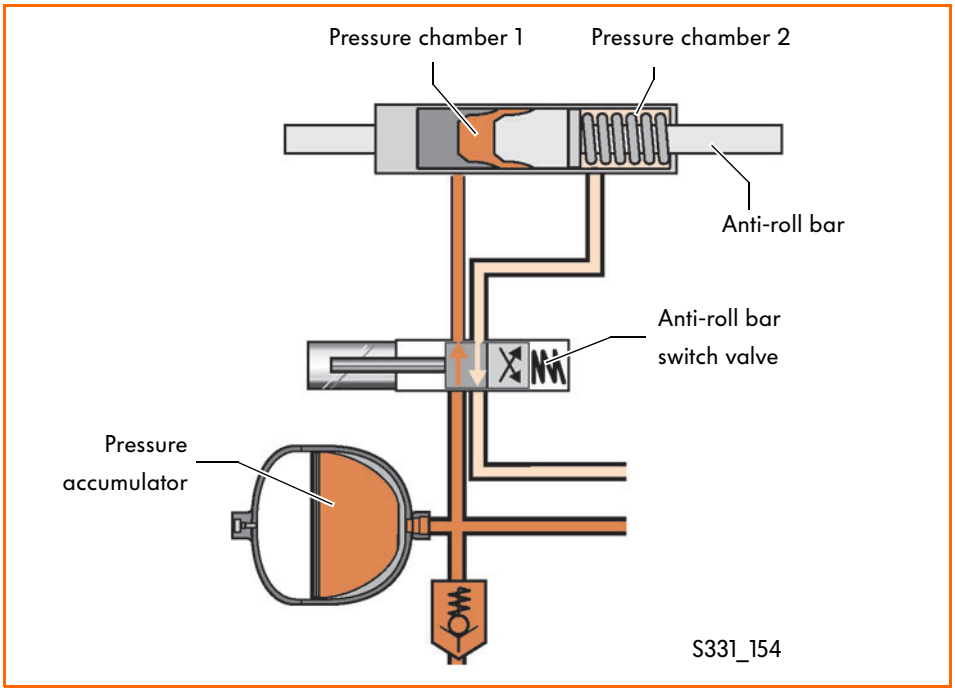




When the driver presses the anti-roll bar uncoupling button, the switch valves N399 and N400 are electrically operated.

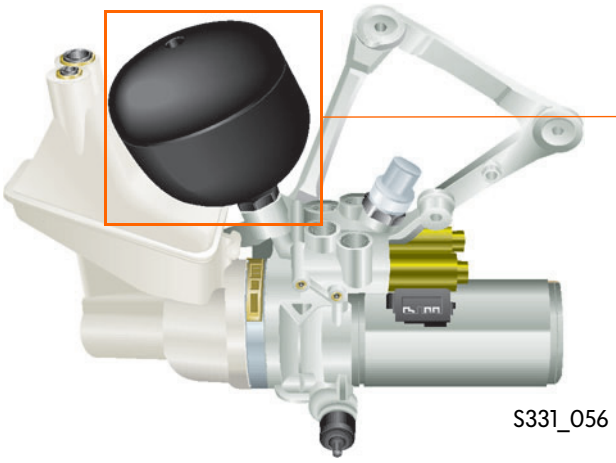
The switch element connects the duct from the pressure accumulator to the appropriate duct in pressure chamber 1 of the related anti-roll bar.

The switch valves are designed to prevent leaks almost completely. This is achieved by the gap between the switch element and the sleeve closing as a result of suspended particles in the hydraulic fluid.
System pressure can thus be maintained over a long period of time.



Design and function

Pressure accumulator



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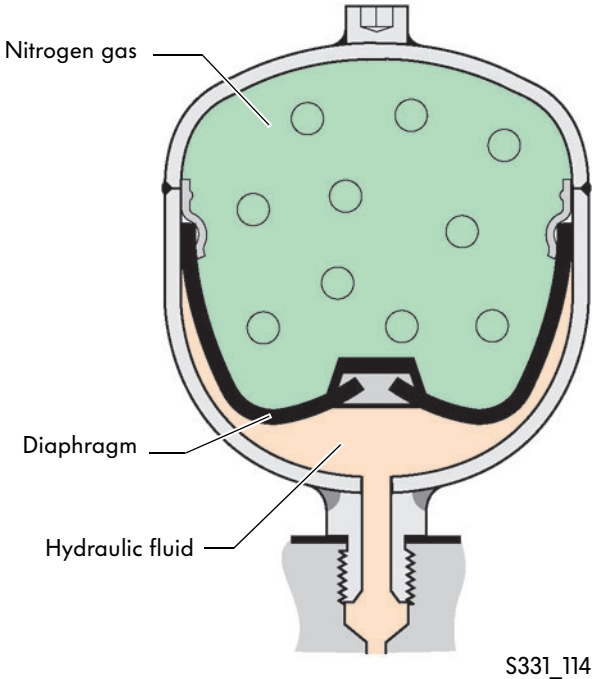
The pressure accumulator is a hydropneumatic diaphragm unit. It accumulates hydraulic pressure energy and supplies it on demand to the hydraulic supply unit.

The pressure accumulator is mounted directly on the pump housing. It is divided into two chambers by a diaphragm. The lower chamber receives the hydraulic fluid which is pumped by the anti-roll bar uncoupling motor.
The upper chamber is filled with nitrogen gas. Incorporating compressible nitrogen gas into the hydraulic circuit allows energy to be stored. This means that gas and fluid must be physically separated.



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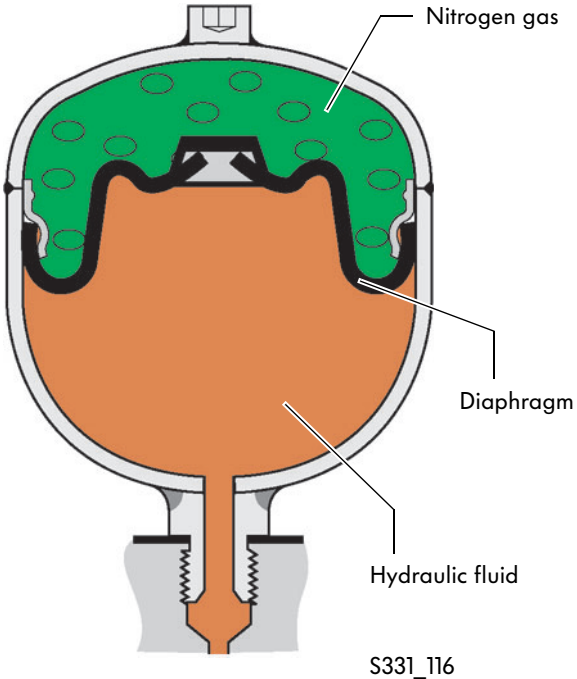

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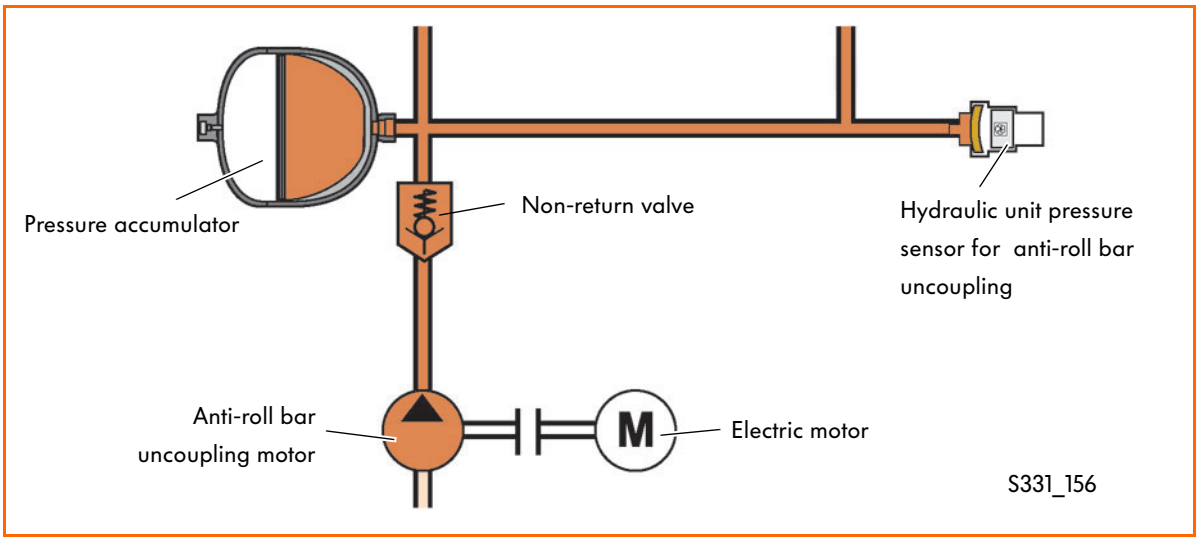
How it works

When the hydraulic fluid is pumped into the pressure accumulator via the non-return valve, pressure in the system rises in relation to the volume of fluid pumped. The nitrogen gas is compressed and the volume of the gas chamber diminishes. The fluid volume rises at the same rate until the cut-off pressure is reached. Pressure in the accumulator is maintained by the non-return valve and is supplied to the anti-roll bars via a duct.



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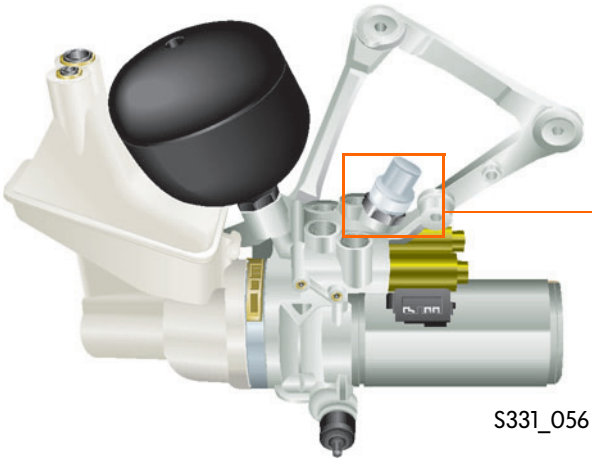
To protect the pressure accumulator, pressure in the system must be over 70 bar during the coupling operation.

Design and function

Hydraulic unit pressure sensor for anti-roll bar uncoupling G486



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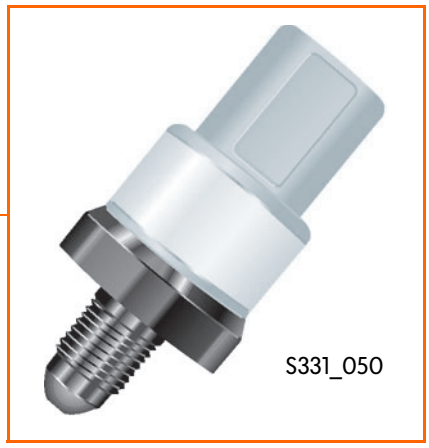

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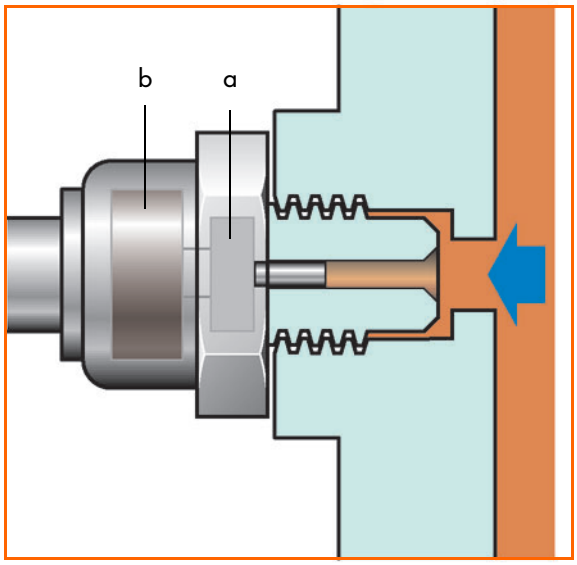
The hydraulic unit pressure sensor for anti-roll bar uncoupling monitors system pressure over a range of 0 bar to 250 bar.

The pressure accumulator is recharged if the pressure drops below a minimum of 90 bar when the anti-roll bars are uncoupled, or when the anti-roll bars are coupled and the gearbox is switched to "low".

Design

The sensor consists of the sensor electronics (b) and a piezoelectronic element (a) which reacts to the hydraulic fluid pressure.



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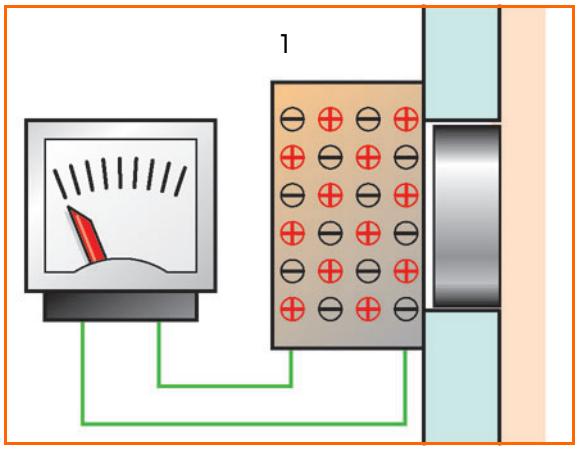

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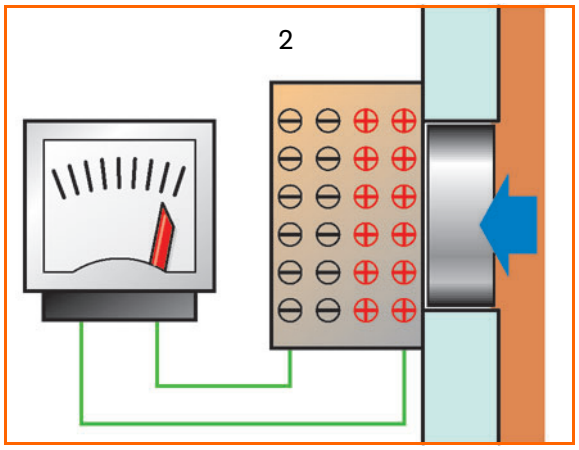

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How it works

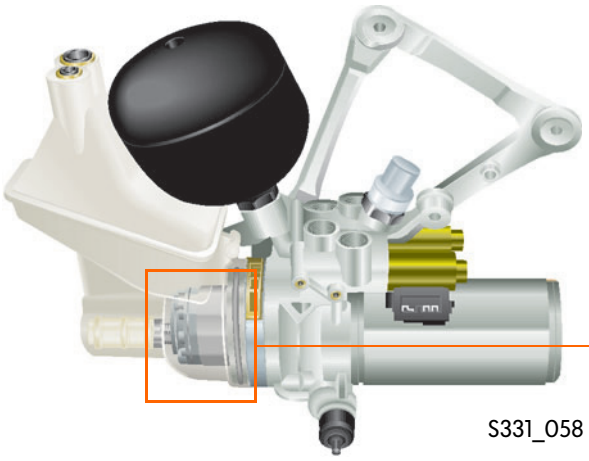
The hydraulic fluid pressing on the piezoelectric element changes the charge distribution in the element.
Without the action of pressure, the charges have an even distribution (1). If pressure starts to act, the charges change their physical position (2). This generates an electrical voltage.

The higher the pressure, the more the charges are separated. The voltage rises. It is amplified by the electronic circuits and sent as a signal to the anti-roll bar control unit.

The voltage intensity is therefore directly proportional to the hydraulic pressure.

Design and function

Anti-roll bar uncoupling motor V326



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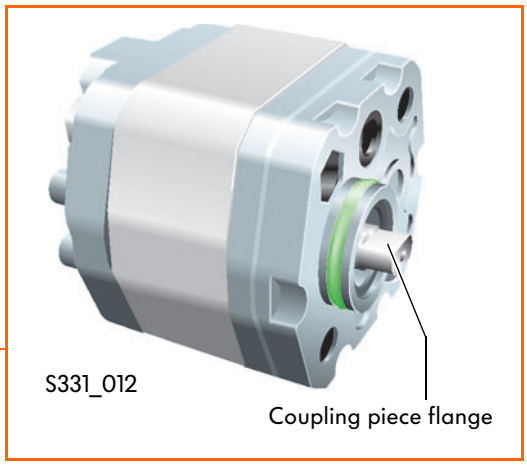
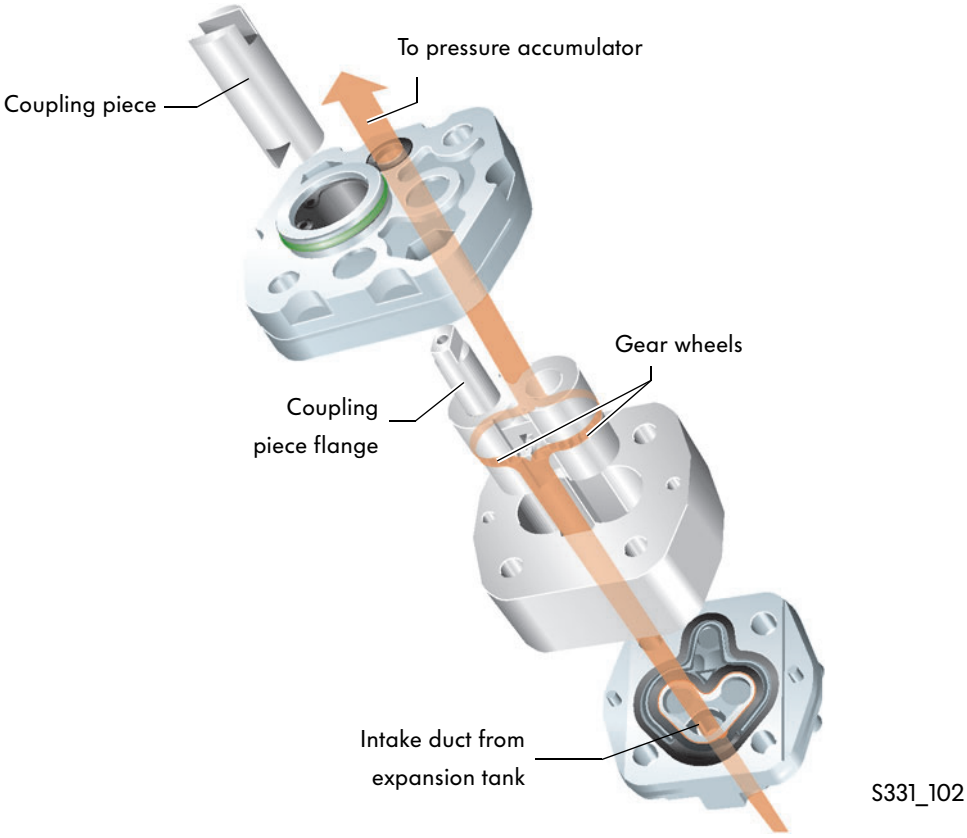


The anti-roll bar uncoupling motor is driven by the electric motor via the coupling piece.

It draws hydraulic fluid out of the expansion tank and pumps it to the pressure accumulator via a non-return valve.

Oil flow in the pump



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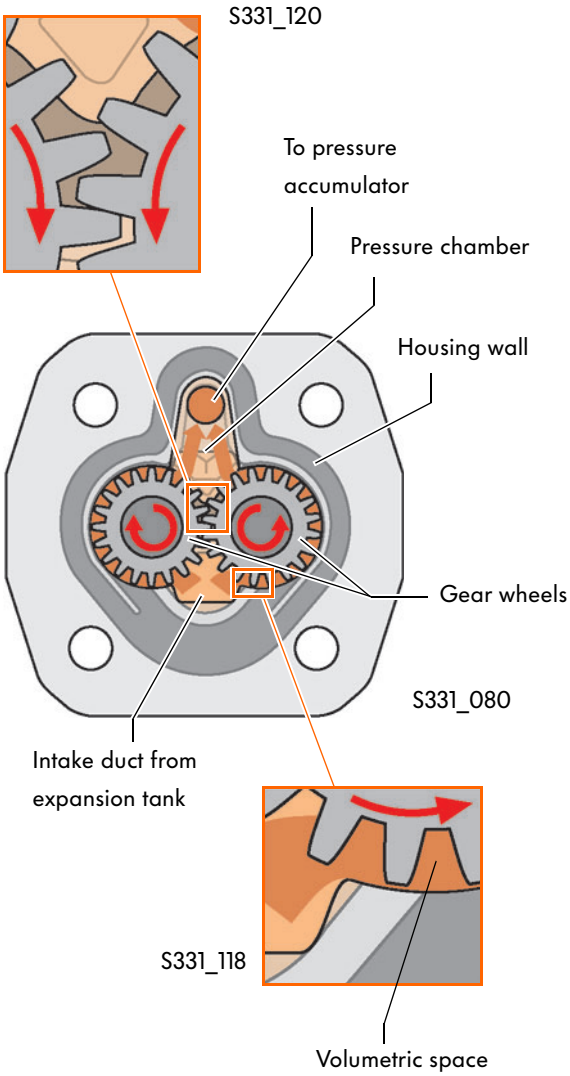


How it works

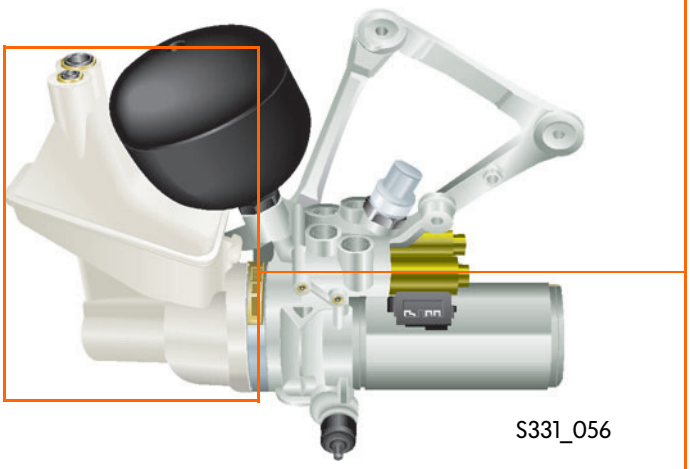
The anti-roll bar uncoupling motor is a gear pump. The opposing rotary motion of the two gear wheels pumps the hydraulic fluid along the outside of the housing wall.

A definite volume of hydraulic fluid is taken in depending on the volumetric space between the teeth and the housing wall. This volume is then pumped in the direction of rotation of the gear wheel.

The two gear wheels intermesh in the middle. The volumetric space becomes smaller and the hydraulic fluid is pressed out of the volumetric space. Pressure then rises in the pressure chamber. When the pressure has risen sufficiently, the non-return valve opens and the hydraulic fluid is pumped to the pressure accumulator.

Design and function

Expansion tank



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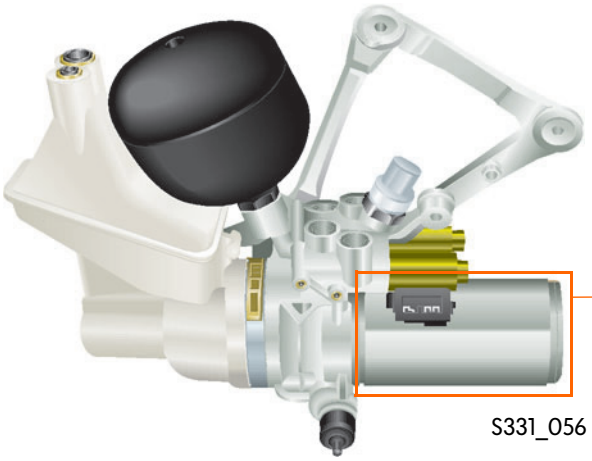
The expansion tank is inserted onto the supply unit and secured by a hose clamp. It is designed to prevent the pump from running dry in any driving situation.

There are two connections on top of the expansion tank: one is for the vent line and the other is for the supply line.

There is no min./max. marking. Oil level is checked through the supply line using a modified customary commercial plastic bottle (refer to the "Service " section on page 33).

Electric motor



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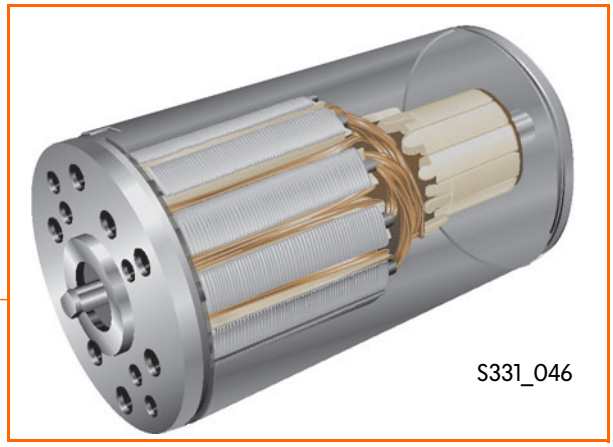

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The electric motor is a direct-current motor with a permanent magnet. It is also termed a permanently excited collector motor.

Due to its linear characteristic curves, it is an adaptable and readily controllable drive.

Anti-roll bar control unit J742

The fitting location for the control unit is in the luggage compartment under the spare wheel cover.
It is inserted on end in a moulded foam packing with the connector output pointing upwards.

The anti-roll bar control unit is connected to the vehicle's drivetrain CAN databus.

It evaluates the following signals:

- system pressure
- switching state of the anti-roll bar
- anti-roll bar uncoupling button signal

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It receives the following signals:

- road speed
- lateral acceleration
- gearbox mode (high or low)

The control unit sends a signal to the actuators depending on the result of evaluation.

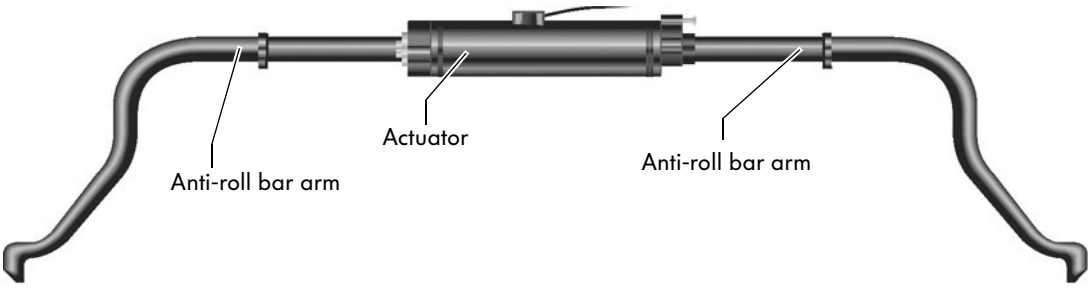
Design and function

Anti-roll bar

The key component of the variable anti-roll bar is the hydraulically operated actuator. It is positioned in the middle of the anti-roll bar.

The actuator contains a claw coupling which couples and uncouples the anti-roll bar arms.

Front axle anti-roll bar



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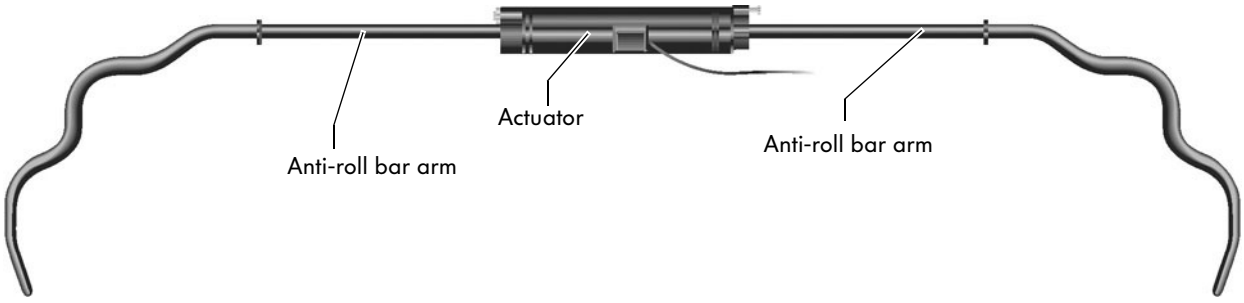
Rear axle anti-roll bar

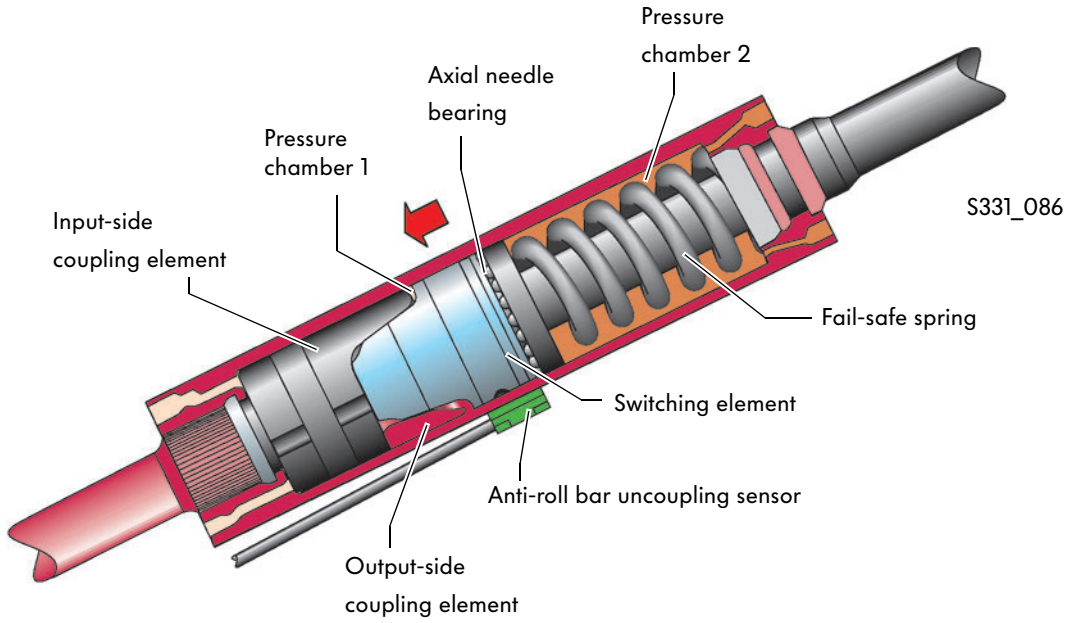


S331_082

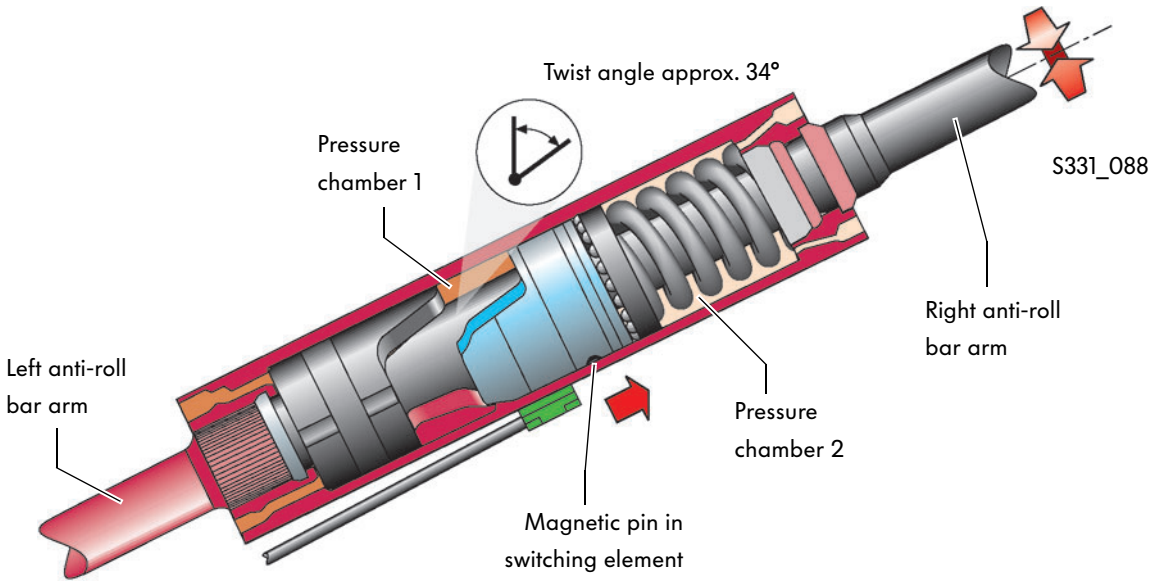
Claw coupling

The hydraulically operated claw coupling consists of input-side and output-side coupling elements, a switching element, a fail-safe spring and an anti-roll bar uncoupling sensor positioned on the housing.

Closed coupling

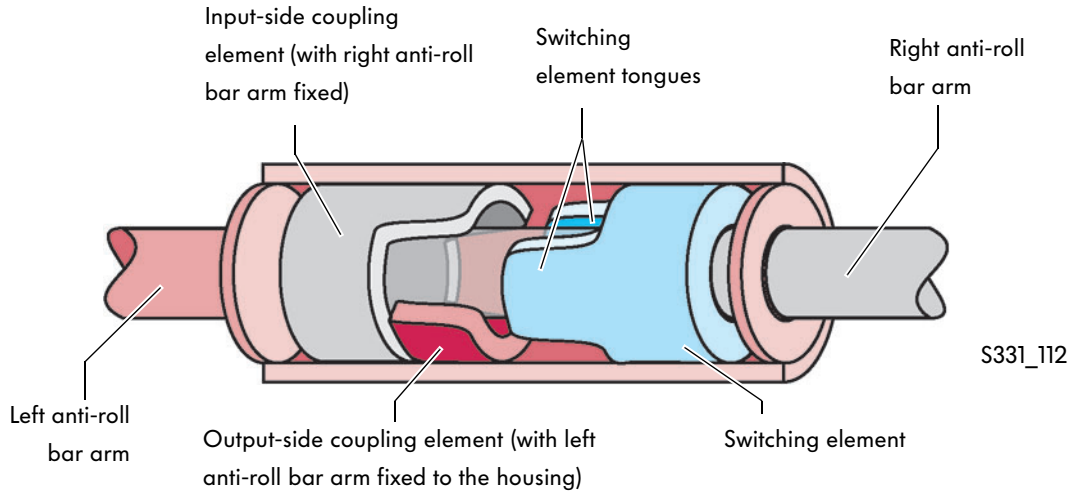


Open coupling



Design and function

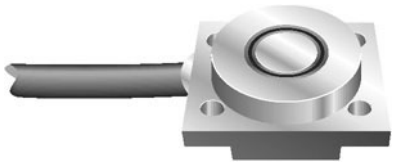
Switching element



The switching element is free to move along its axis. Its axial position is dependent on the pressure applied and in its closed position, the input-side and output-side coupling elements are fully interlocked.

The switching element does not retract completely and the two tongues overlap the coupling elements at all times. This allows a coupling operation in any driving situation. In the figure above, the two switching element tongues are depicted fully retracted from the coupling elements. This is purely to show the design of the switching element.

Anti-roll bar uncoupling sensors G484 and G485



S331_110

The "anti-roll bar coupled" switching position is signalled when the anti-roll bar sensor contacts the magnetic pin. The anti-roll bar uncoupling sensor signal is required by the anti-roll bar control unit to monitor the system.

Fail-safe spring

The fail-safe spring is a coil spring which forces the anti-roll bar closed if there are faults in the hydraulic supply or electrical defects.

An axial needle bearing is fitted between the fail-safe spring and the switching element to minimise wear.

Anti-roll bar uncoupling button E484

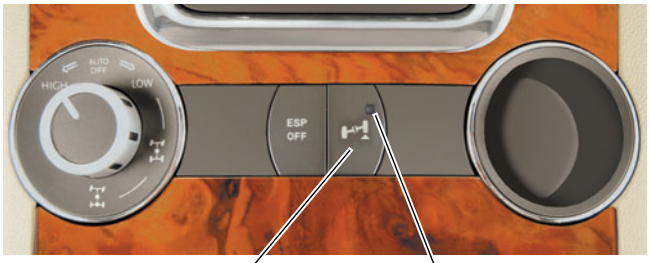
The anti-roll bar uncoupling button is located centrally on the centre console. It sends the signal indicating the driver's command to couple or uncouple the anti-roll bars to the anti-roll bar control unit.

If the driver presses the button several times, the coupling or uncoupling operation is cancelled.

If the button is pressed for longer than 30 seconds, this is detected as a system fault. An entry is made in the control unit fault memory. The anti-roll bars remain coupled.

The anti-roll bar uncoupling button is fitted with an anti-roll bar uncoupling warning lamp.

Button on vehicle equipped with steel suspension

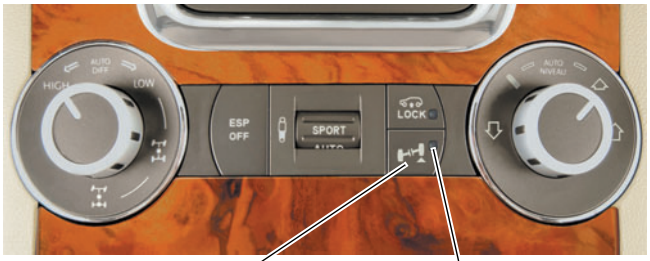


S331_033

Anti-roll bar uncoupling button

Anti-roll bar uncoupling warning lamp

Button on vehicle equipped with air suspension

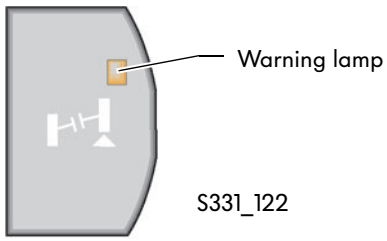


S331_013

Anti-roll bar uncoupling button

Anti-roll bar uncoupling warning lamp

Anti-roll bar uncoupling warning lamp K221



The anti-roll bar uncoupling warning lamp K221 is located in the anti-roll bar uncoupling button E484.

If the anti-roll bars are uncoupled, the display appears continuously.

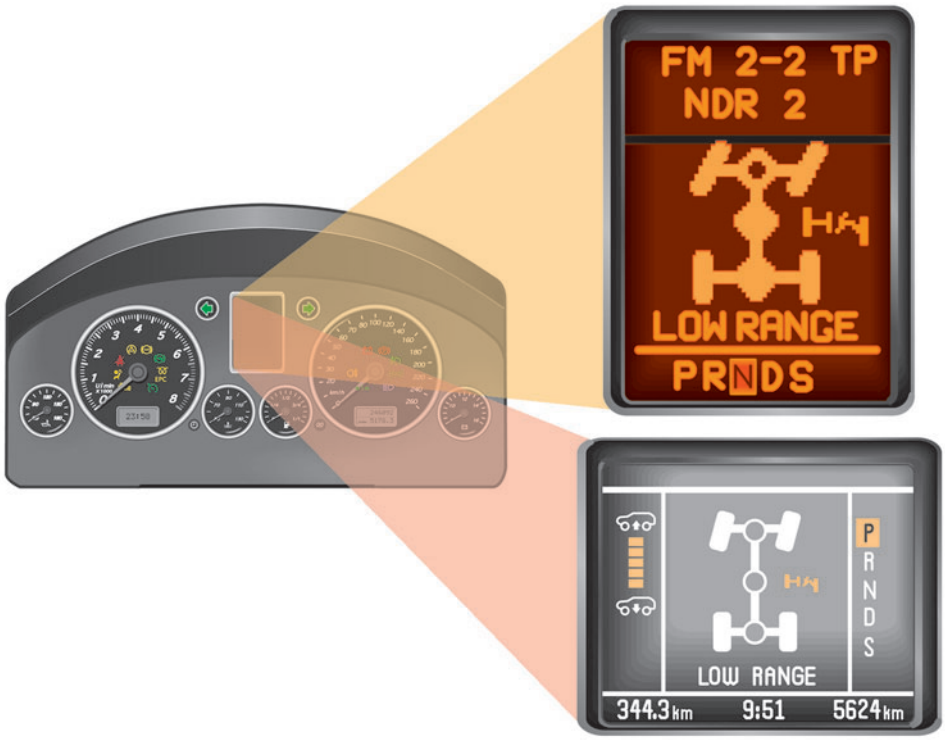
The warning lamp flashes during the coupling or uncoupling operation.

Displays in the dash panel insert

The current anti-roll bar switching state is displayed in the dash panel insert.

The symbols are different depending on the vehicle's equipment.

On the Highline dash panel insert, the symbols are displayed in pixel graphics; on the Premium equipment level, they appear on a TFT screen.



Highline equipment level

Premium equipment level

S331_163

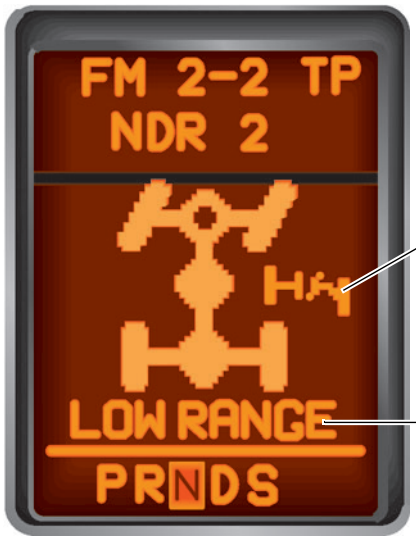
Uncoupling

The coupling operation display flashes for the entire duration of the operation. When the anti-roll bars are uncoupled, the coupling operation display is continuously lit.

Coupling

The coupling operation display flashes for the entire duration of the operation.
The display disappears only when the operation is completed and the anti-roll bars are coupled.

Highline display

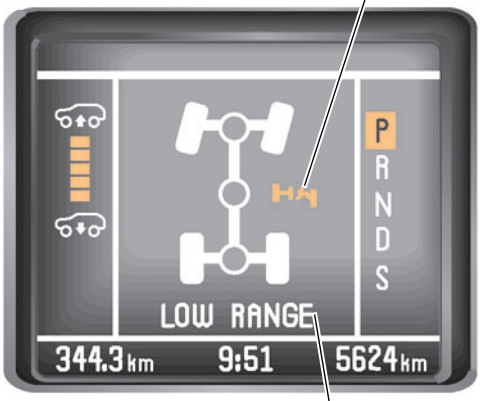


S331_078

Coupling opertion display

Gearbox mode display

Premium display

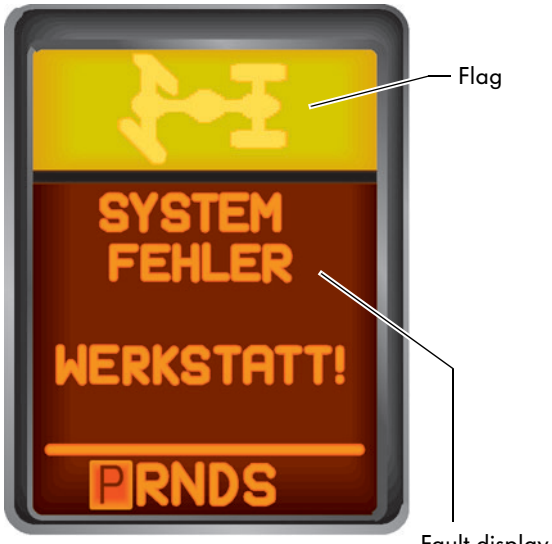


S331_074

Coupling operation display

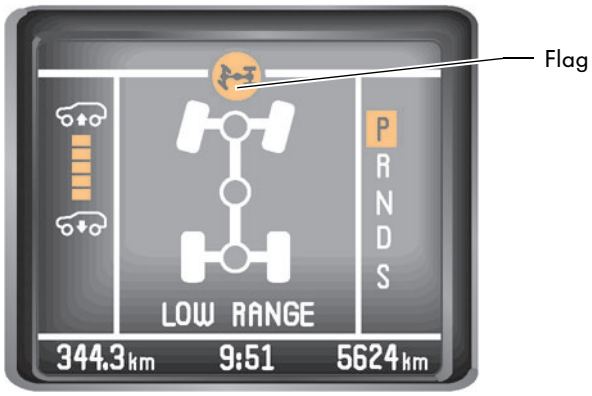
Gearbox mode display

Highline display

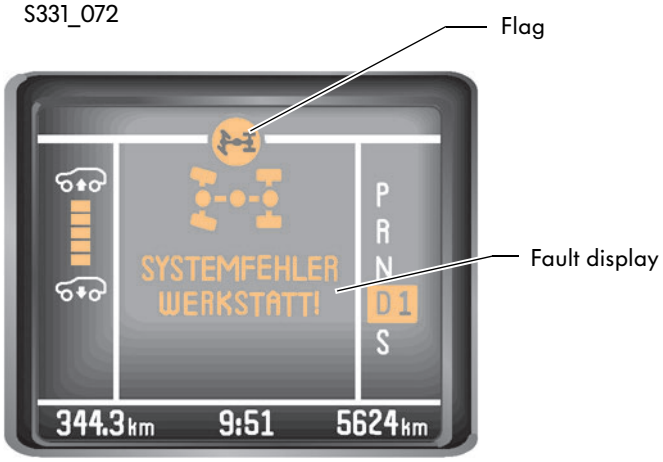


S331_076

Premium display



S331_072



S331_094

Fault display

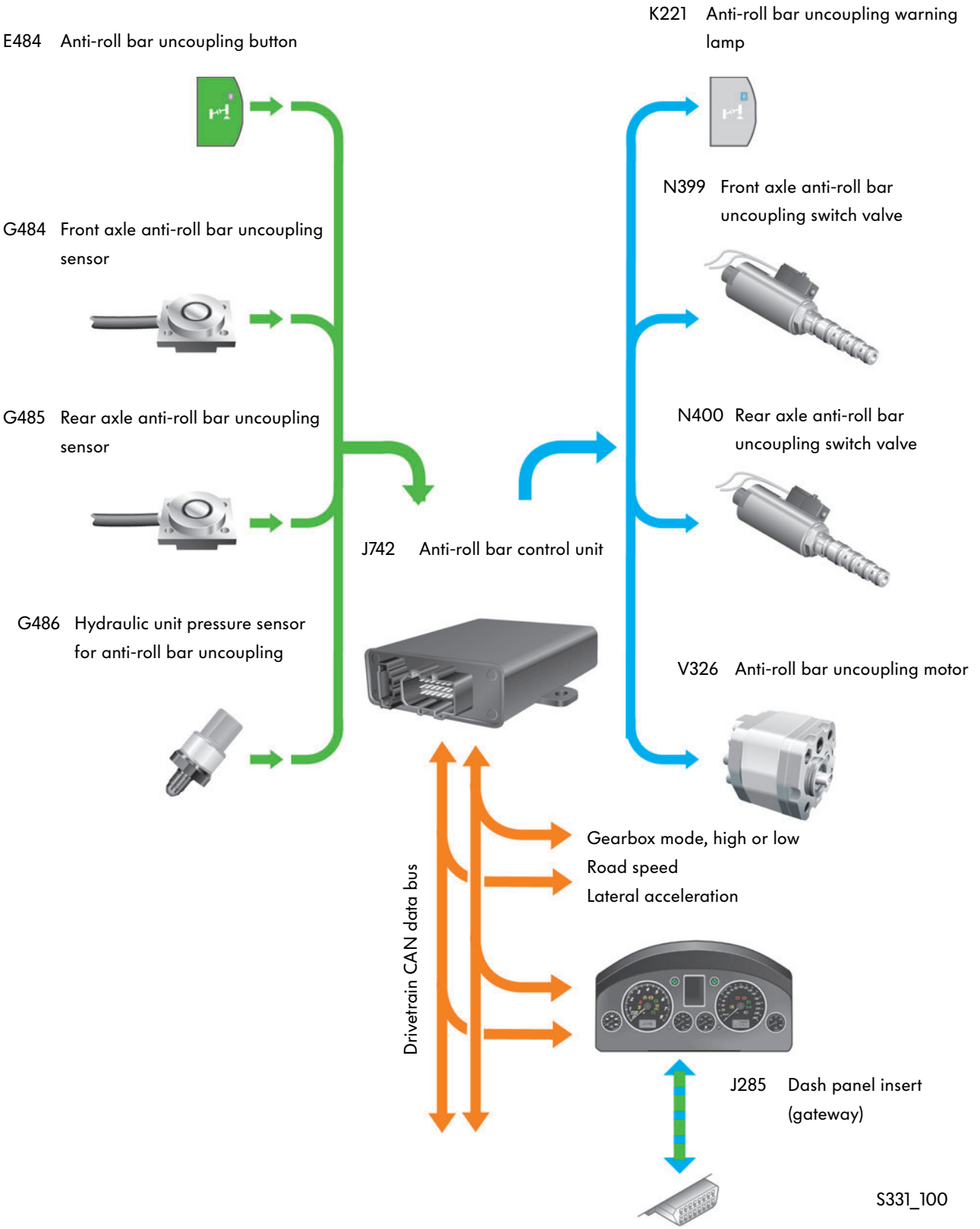
If a fault occurs during the uncoupling or coupling operation, it is displayed by a flag. At the same time, the fault display "System fault workshop" appears.

It is no longer possible to uncouple the anti-roll bars. The vehicle can still be driven.

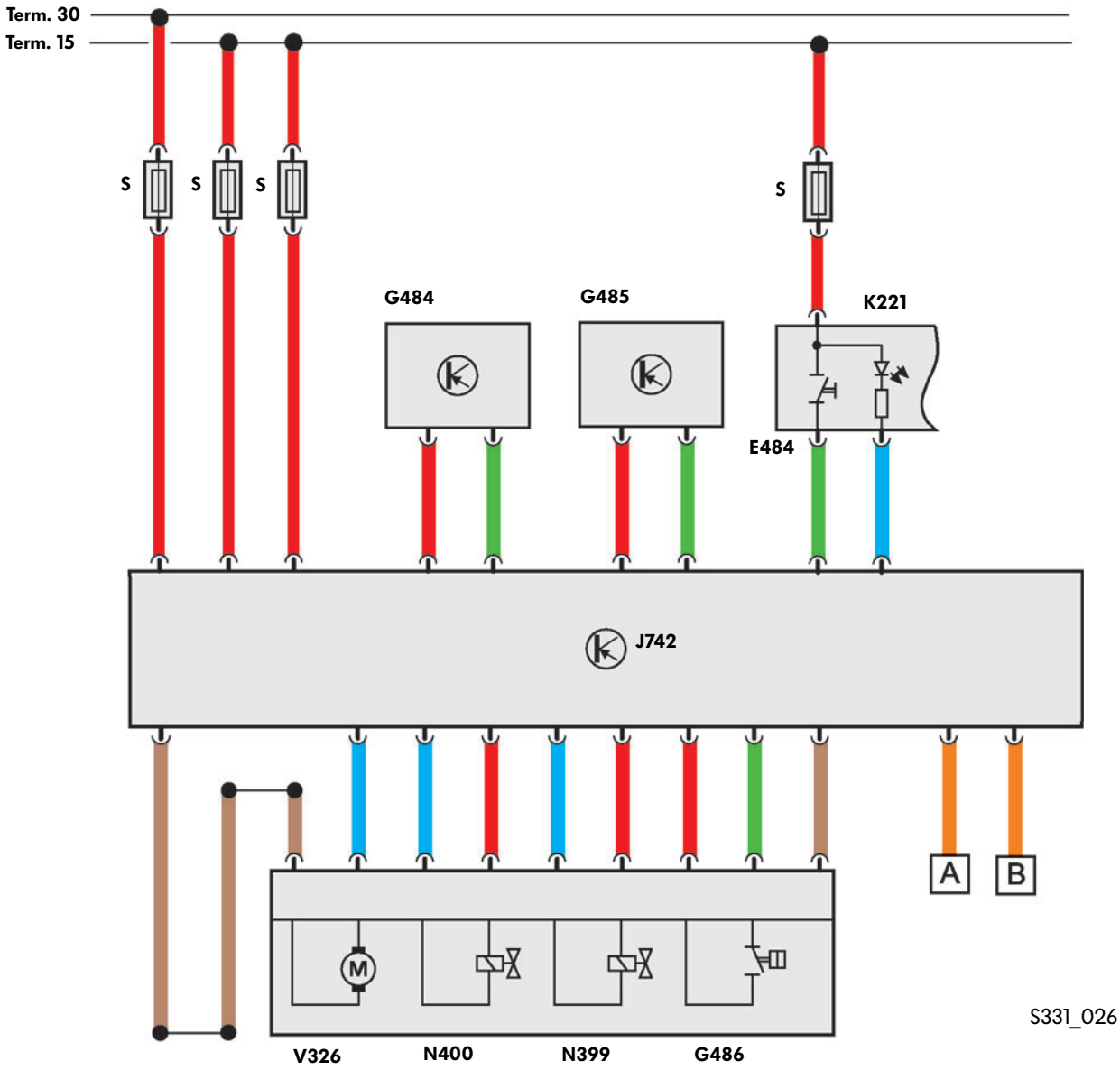
System overview

Sensors

Actuators



Function diagram

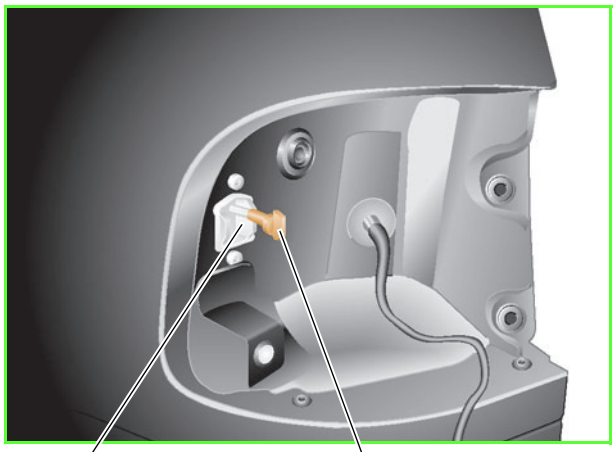


A - Drivetrain CAN databus - Low
B - Drivetrain CAN databus - High
E484 Anti-roll bar uncoupling button
G484 Front axle anti-roll bar uncoupling sensor
G485 Rear axle anti-roll bar uncoupling sensor
G486 Hydraulic unit pressure sensor for anti-roll bar uncoupling
J742 Anti-roll bar control unit
K221 Anti-roll bar uncoupling warning lamp
N399 Front axle anti-roll bar uncoupling switch valve
N400 Rear axle anti-roll bar uncoupling switch valve
V326 Anti-roll bar uncoupling motor

Colour codes/key

= Input signal
= Output signal
= Positive
= Earth
= Drivetrain CAN databus

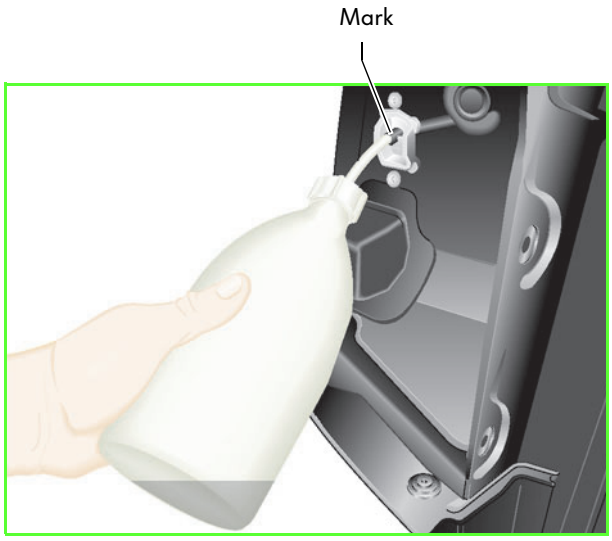
Checking the oil level



S331_136

The filler hole and plug for filling and checking the oil level is located behind the left-side tail-light.

Before the oil level can be checked, the left-side tail-lamp must be removed and the system must be depressurised, e.g. using the VAS 5051 Diagnosis Testing and Information System.



S331_138

S331_140

When checking the oil level or filling the system with oil, insert the plastic bottle hose into the filler hole up to the mark.

- The system may only be filled with central hydraulic system and power steering gear oil G002000.
- Please read the instructions in ELSA (Electronic Service Information System) for setting the mark, checking the oil level and filling the system with oil.

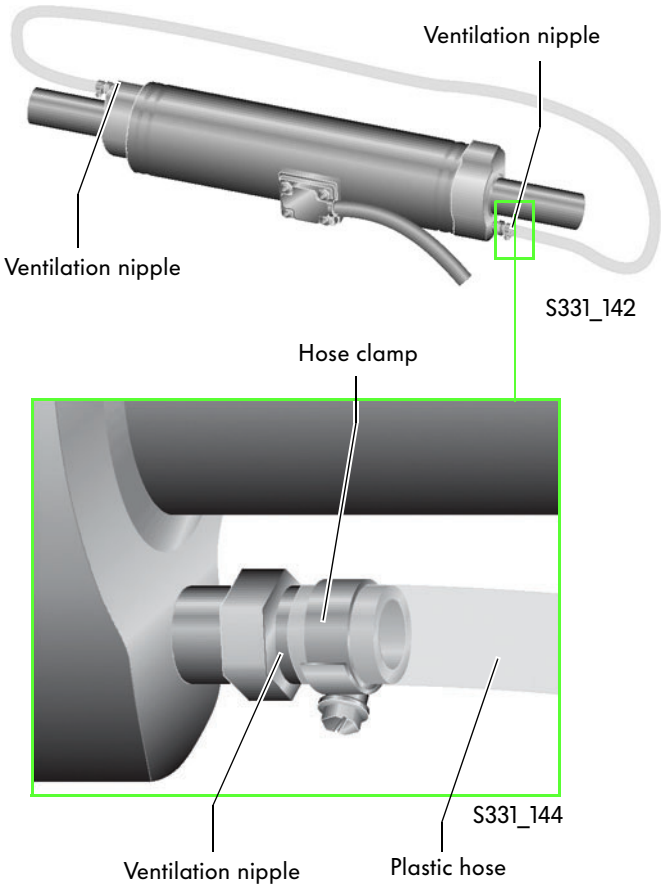
Venting the system

Before the system can be vented, it must be connected to the VAS 5051 Diagnosis Testing and Information System, for example, and depressurised.

Before venting, remove the dust caps and connect a transparent plastic hose to the ventilation nipple. As high pressures occur during the ventilation operation, the hose must be secured by a hose clamp.

Loosen the two ventilation nipples. The system can then be vented according to the instructions for using the VAS 5051 Diagnosis Testing and Information System.

After ventilation is completed, tighten the nipples and remove the plastic hose.



- Please read the instructions in the ELSA (Electronic Service Information System) carefully for venting the system and for the size of the plastic hose required.
- Please remember to check the oil level before and after the venting operations.
- When working on the running gear, e.g. removing a suspension strut or tightening bolts on rubber metal bearings, couple the anti-roll bars to prevent them from uncoupling due to inadvertent switching and injuring service personnel, and to avoid damaging the running gear.

Test your knowledge

1. How are anti-roll bars uncoupled on the Touareg?

☐ a) mechanically

☐ b) hydraulically

2. When can the driver carry out an uncoupling command?

☐ a) When the vehicle road speed is below 40 km/h and pressure in the pressure accumulator is below 70 bar to prevent destroying the gas bubble in the pressure accumulator.

☐ b) When the speed is above 50 km/h, lateral acceleration is greater than 0.7 g and the pump motor is running.

☐ c) When the vehicle road speed is below 40 km/h, lateral acceleration is less than 0.5 g and the control unit is not in fault mode.

3. The claw coupling consists of two coupling elements, a switching element, a fail-safe spring and an anti-roll bar uncoupling sensor. Why does the switching element not retract completely beyond the overlap of the tongues when the anti-roll bar is uncoupled?

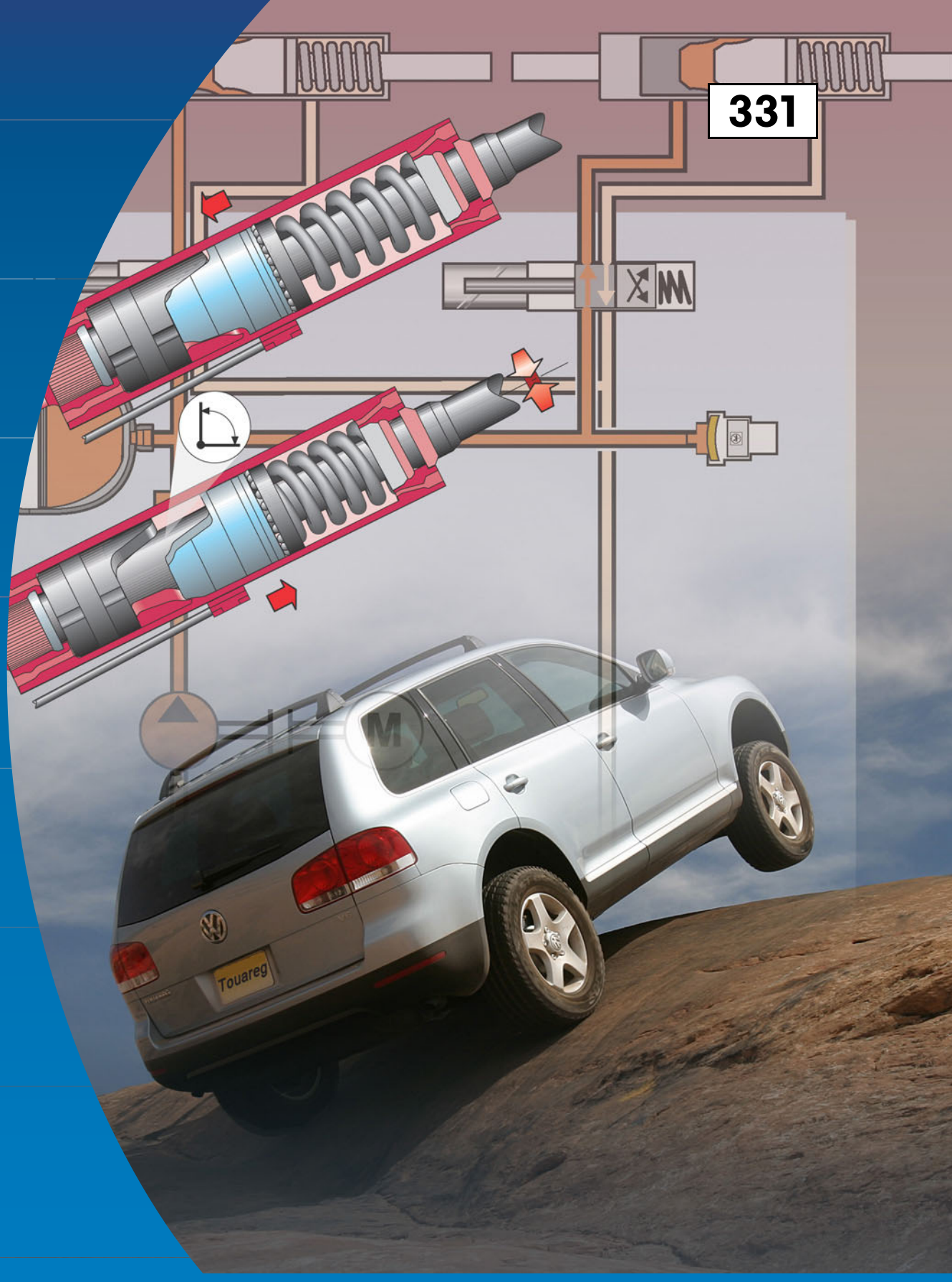
☐ a) To allow coupling in every driving situation.

☐ b) To avoid exceeding the defined maximum torsional twist of 60 mm.

☐ c) So that the anti-roll uncoupling sensor can monitor the system in every situation.

Answers

1.) b; 2.) c; 3.) a



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