Design and function

Air drier

The air in the pressure system must be dehumidified to avoid problems with

– corrosion and
– freezing

due to condensation water.

An air drier is used to dehumidify the air.

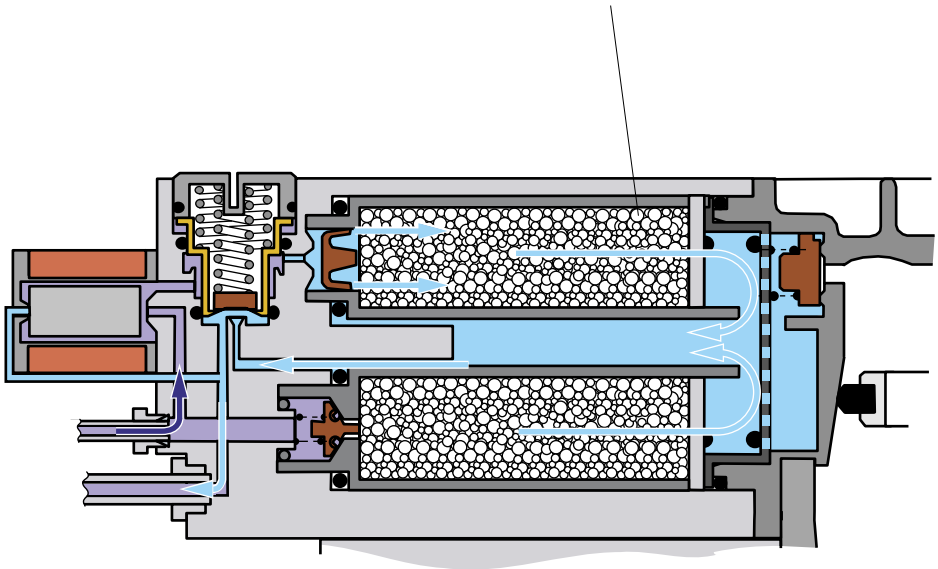
The air drier uses a regenerative process, i.e. the air compressed in the self-levelling suspension system is ducted through a silicate granulate and dried in the process.
This granulate is able to absorb atmospheric humidity amounting to over 20 % of its natural weight, depending on temperature.
If the dried air is discharged again due to operating requirements (to lower the springs), it flows back through the granulate and extracts from it the moisture which it has absorbed when it is discharged to atmosphere.
As a result of this regenerative process, the air drier requires no maintenance.
It is not subject to a replacement interval.

Since the air drier is only regenerated via discharged air, the compressor must not be used to fill other vessels with compressed air.

Water or moisture in the system are signs that the air drier or system has malfunctioned.

275_033

Air drier with granulate filling



275_045

Pressure accumulator

Extraction of compressed air from the pressure accumulator allows the vehicle level to be raised quickly with a minimum of noise.
The pressure accumulator is only filled while the vehicle is moving. As a result, compressor operation is barely audible.

Provided that sufficient pressure is available in the pressure accumulator, the vehicle level can be raised even if the compressor is not running. Pressure is sufficient when the pressure difference between the pressure accumulator and the air springs is at least 3 bar before increasing the level.

The pressure accumulator is made of aluminium and has a capacity of 5 litres.
The maximum operating pressure is about 16 bar.

Air supply strategy

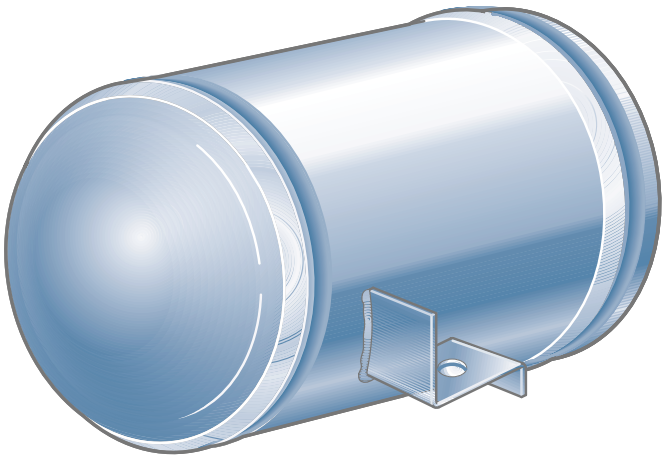
At road speeds of < 35 kph, air is primarily supplied via the pressure accumulator (provided that sufficient pressure is available).

The pressure accumulator is only filled when the vehicle is travelling at speeds above > 35 kph.

At road speeds > 35 kph, air is primarily supplied by the compressor.

This supply strategy ensures that the system operates silently and conserves vehicle battery capacity.

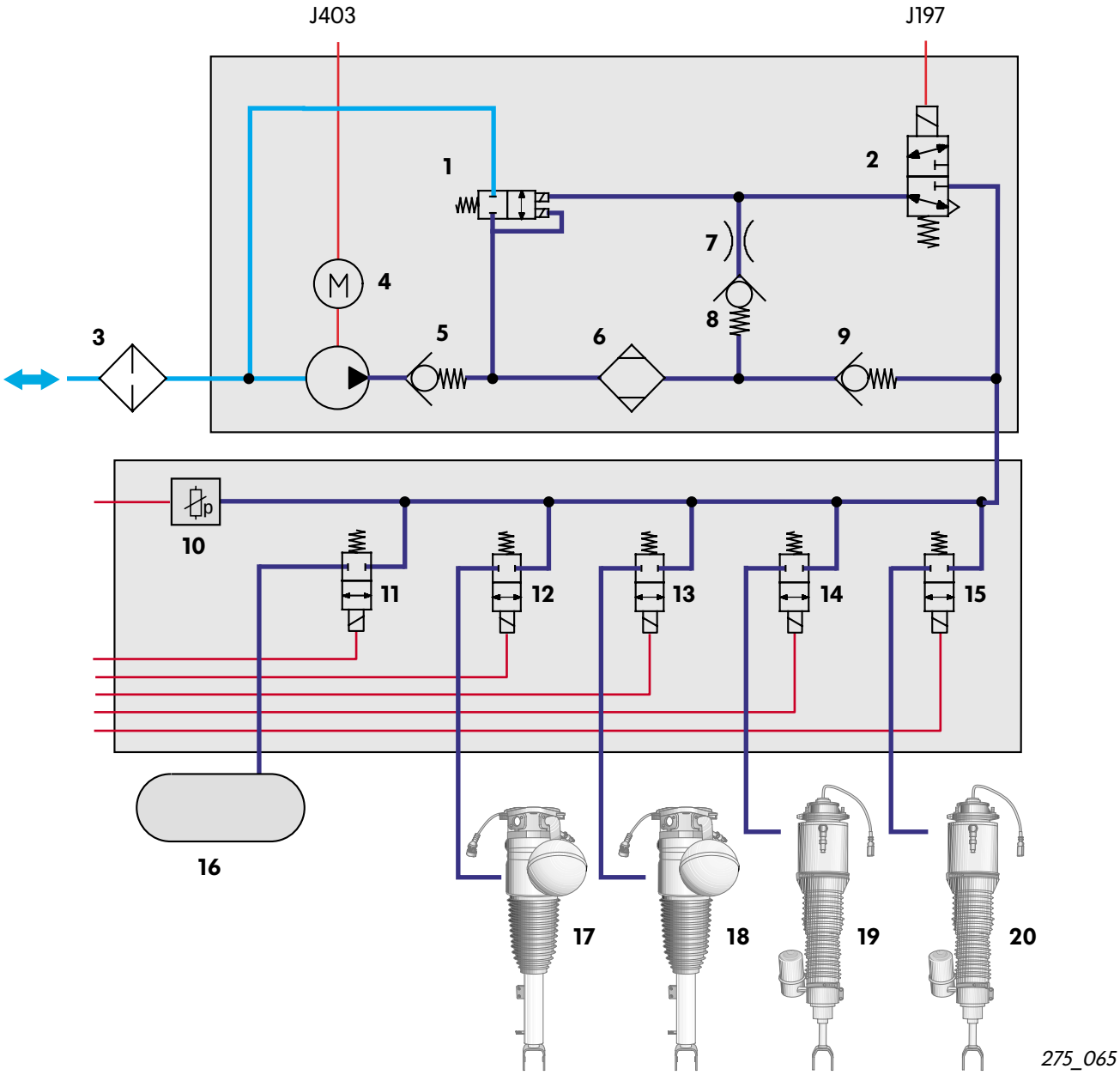
The compressor starts running when compressed air is extracted from the pressure accumulator even if the driver has not adjusted the vehicle's level.



275_064

Pneumatic diagram

1 - Pneumatic drain valve
2 - Electric drain valve N111
3 - Silencer/filter
4 - Compressor V66
5 - Non-return valve 1
6 - Air drier
7 - Drain restrictor
8 - Non-return valve 3
9 - Non-return valve 2
10 - Pressure sender G291
11 - Pressure accumulator valve N311
12 - Suspension strut valve, rear left N150
13 - Suspension strut valve, rear right N151
14 - Suspension strut valve, front left N148
15 - Suspension strut valve, front right N149
16 - Pressure accumulator
17 - Strut, rear left
18 - Strut, rear right
19 - Strut, front left
20 - Strut, front right



Solenoid valves

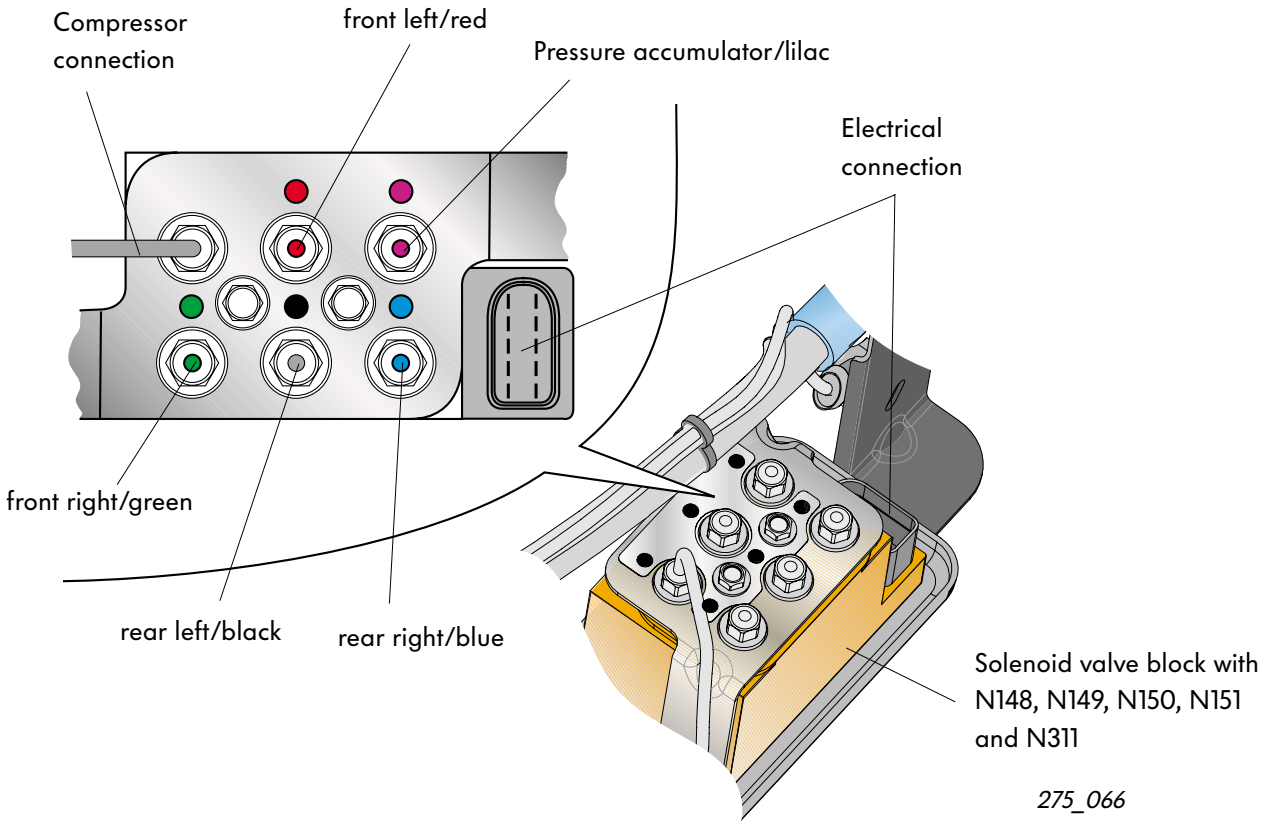
All in all, the air suspension has six solenoid valves.

The drain valve N111 together with the pneumatic drain valve form a functional unit which is integrated in the drier housing. The drain valve N111 is a 3/2 way valve and is de-energised when closed.

The pneumatic drain valve has two tasks: to limit pressure and to maintain residual pressure.

Together with the self-levelling suspension pressure accumulator valve N311, the four air spring valves N148, N149, N150 and N151 are combined in the solenoid valve block. The valves in the solenoid valve block are designed as 2/2 way valves and are de-energised when closed.
The pressure on the air spring side/accumulator side acts in the closing direction.

To avoid confusion when connecting the pressure lines, the pressure lines are colour coded.
The matching connections on the solenoid valve block are also colour coded.

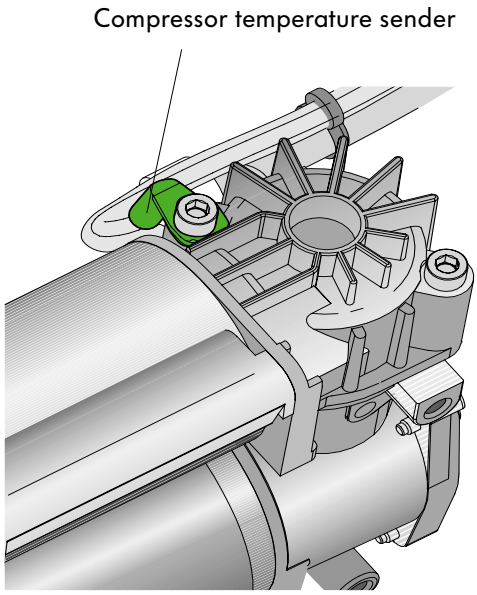


Design and function

Compressor temperature sender G290 (overheating protection)

To ensure system availability, compressor temperature sender G290 is attached to the compressor cylinder head.

The control unit J197 shuts the compressor down and inhibits starting when a max. permissible compressor temperature is exceeded.



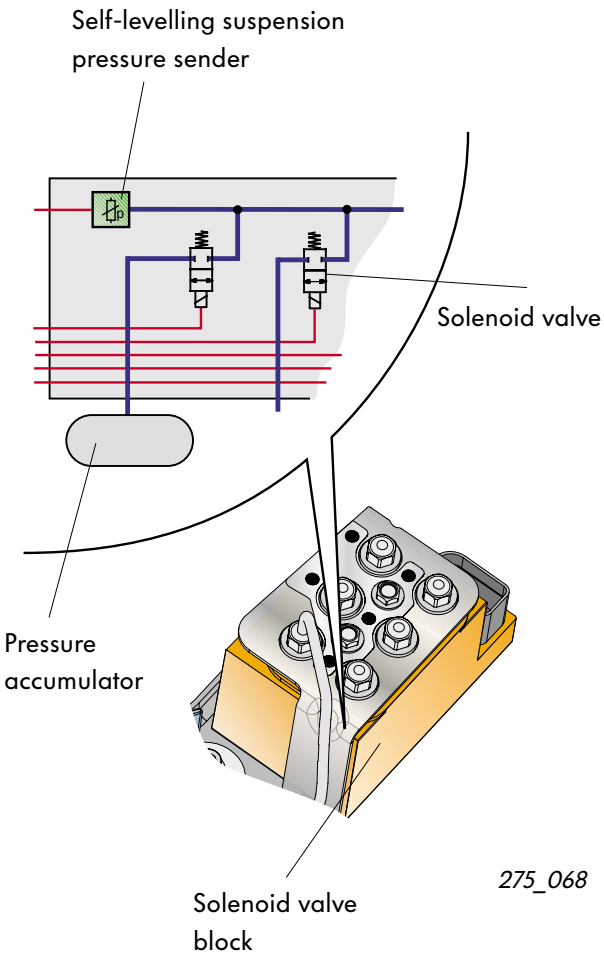
275_067

Self-levelling suspension system pressure sender G291

The pressure sender G291 is integrated in the valve unit and monitors pressure in the pressure accumulator and the air springs. Information on accumulator pressure is required to make plausibility checks on the up-control functions and perform self-diagnosis. The individual pressures of the air springs and the pressure accumulator can be determined by activating the solenoid valves accordingly.

The individual pressures are measured while evacuating or filling the air springs or the pressure accumulator. The pressures determined in this way are stored and updated by the control unit.
Accumulator pressure is additionally determined every six minutes (updated) during vehicle operation.

G291 generates a voltage signal proportional to the pressure.



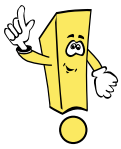
275_068

Vehicle level senders G76, G77, G78, G289 (level sensors)

The vehicle level senders are so-called wheel angle sensors. Changes in the level of the vehicle body are registered and converted to angular changes by means of the coupling rod kinematics.

The wheel angle sensor used operates according to the induction principle.

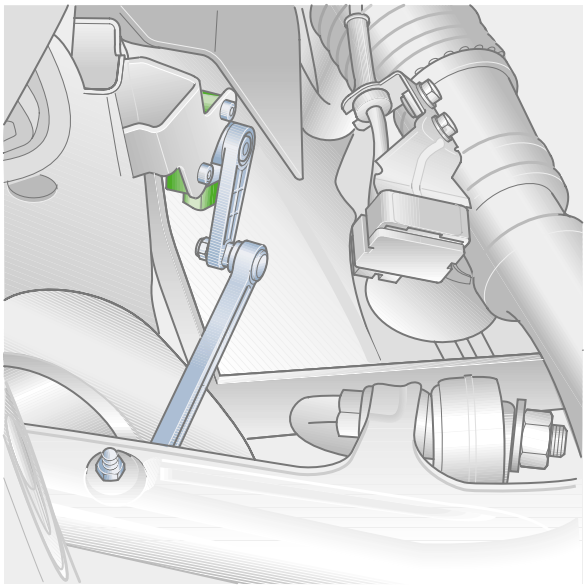
The signal output provides an angle-proportional PWM (pulse-width modulated) signal for the self-levelling suspension.



The four level sensors are identical; only the mountings and the coupling rod kinematics are specific for each side and axle.

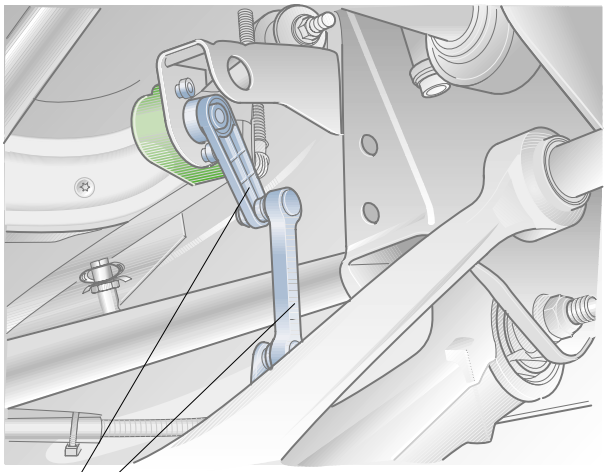
Deflection of the sender crank, and hence the output signal, is opposed on the left and right. As a result, the output signal rises on one side and drops on the other side during suspension compression, for instance.

Vehicle level sender, front axle



275_075

Vehicle level sender, rear axle



275_076

Actuating lever (coupling rods)

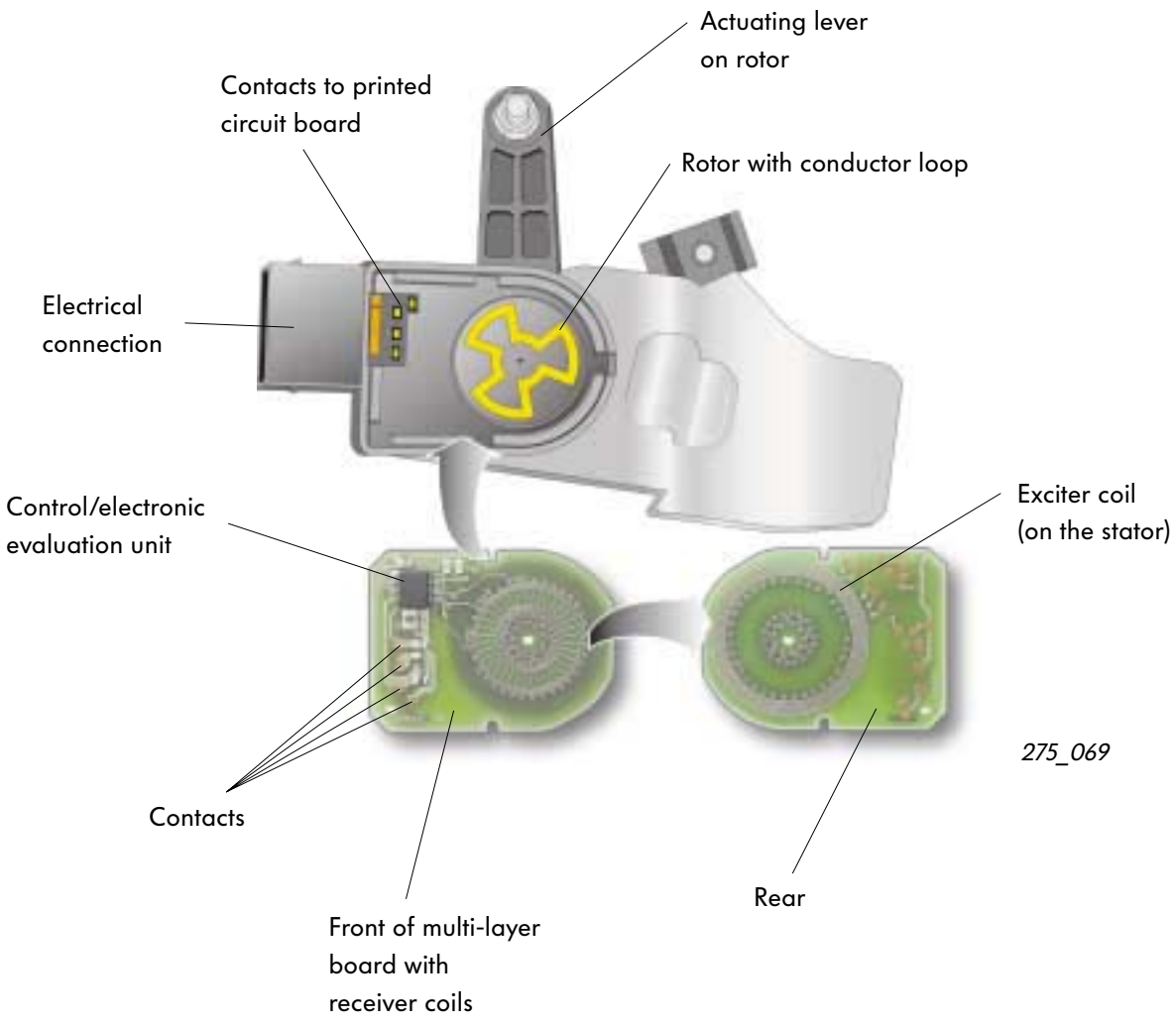
Design and function

Design of level sensors

A sensor basically comprises a stator and a rotor.

The stator comprises a multi-layer board that houses the exciter coil and three receiver coils, as well as the control and electronic evaluation unit. The three receiver coils are star-shaped and arranged in an offset pattern.
The exciter coil is located on the back of the board (stator).

The rotor is connected to the actuating lever and moves with it.
A closed conductor loop is located on the rotor. The conductor loop has the same geometric shape as the three receiver coils.



Function

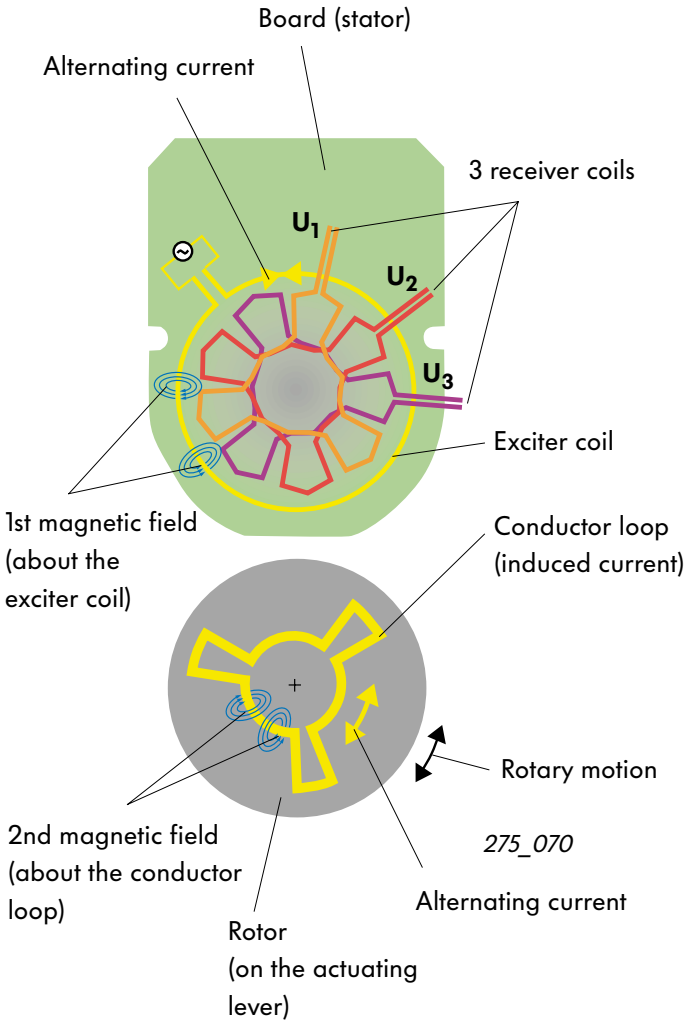
An alternating current flows through the exciter coil (stator) and produces an electromagnetic alternating field (1st magnetic field) about the exciter coil. This alternating field permeates the conductor loop of the rotor.

The electric current induced in the conductor loop of the rotor produces, in turn, an electromagnetic alternating field (2nd magnetic field) about the rotor conductor loop.
The alternating fields of the exciter coil and the rotor act upon the three receiver coils and induce position-dependent AC voltages in the receiver coils.

Whereas induction in the rotor is independent of the rotor's angular position, induction in the receiver coils is dependent on their distance from the rotor, and hence their angular position in relation to the rotor.

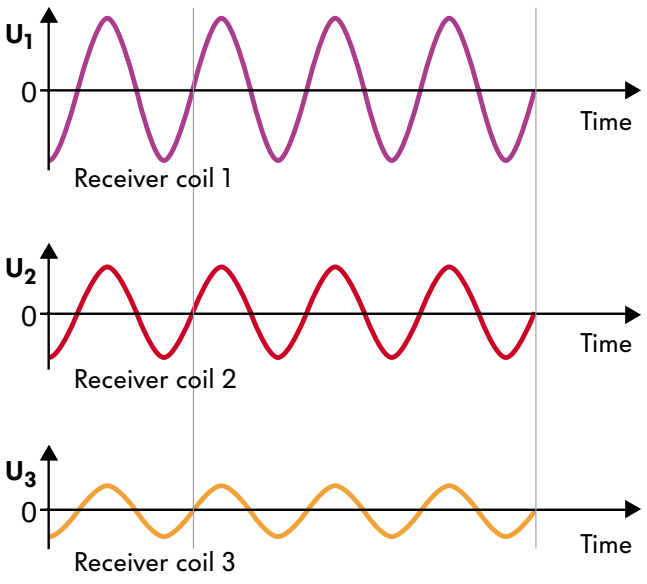
Since rotor overlap in relation to the individual receiver coils varies depending on angular position, the induced voltage amplitudes in the receiver coils vary according to their angular position.

The electronic evaluation unit rectifies and amplifies the AC voltages of the receiver coils and proportions the output voltages of the three receiver coils (ratiometric measurement). After the voltage is evaluated, the result is converted to output signals from the level sensor and made available to the control units for further processing.



275_070

Voltage amplitudes in the receiver coils depending on rotor position (example)



275_071

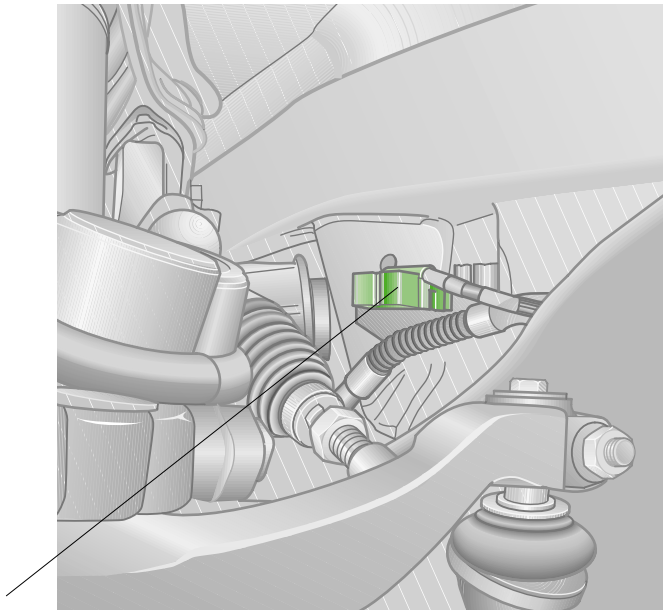
Body acceleration senders
G341, G342, G343

The body acceleration senders measure the vertical acceleration of the vehicle body.
The senders are located:

– in the front left wheel housing G341 and in the front right wheel housing G342

and

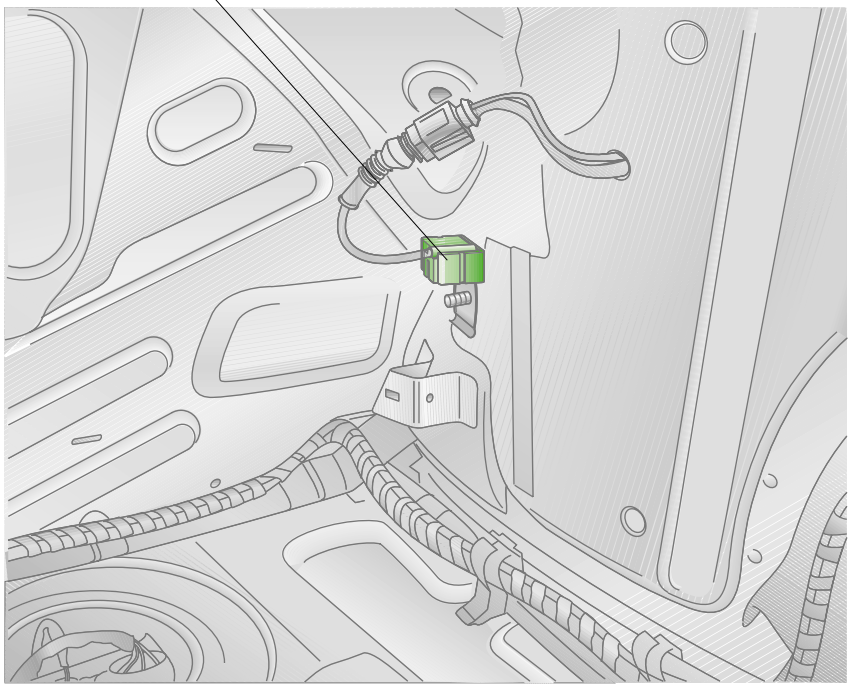
– in the luggage compartment at the front right, behind the luggage compartment lining G343.



Body acceleration sender in front left wheel housing

275_079

Body acceleration sender in luggage compartment

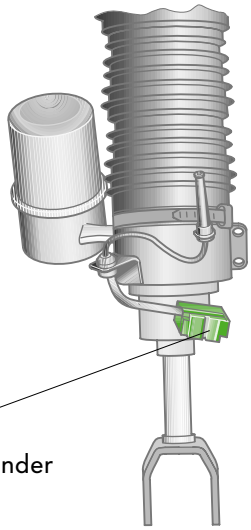


275_080

Wheel acceleration senders
G337, G338, G339, G340

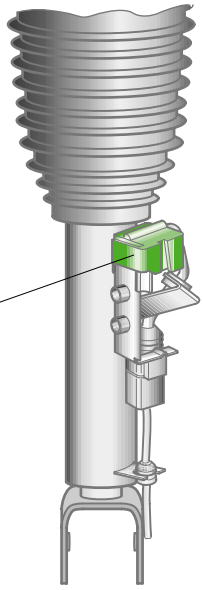
The wheel acceleration senders are mounted directly on the air spring struts of the front and rear axles.

They measure wheel acceleration.
The self-levelling suspension control unit utilises these signals along with body acceleration signals to calculate the direction in which the struts are moving in relation to the vehicle body.



Wheel acceleration sender
front axle

275_088



Wheel acceleration sender
rear axle

275_089

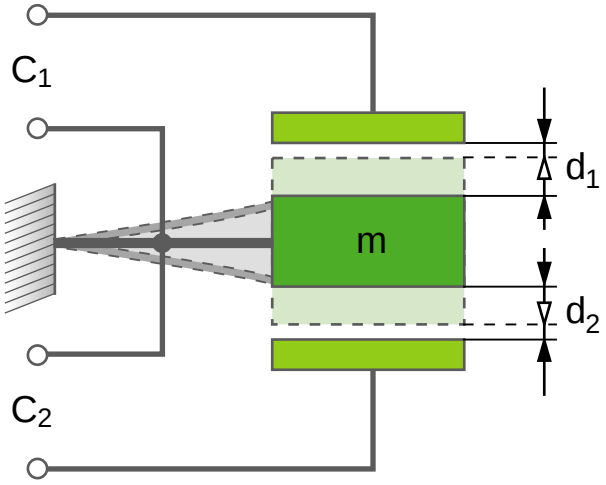
Design and function

Function and design of the acceleration senders

The body and wheel acceleration senders are identical.

The acceleration senders operate according to the capacitive measurement principle.
A flexibly mounted mass **m** acting as a centre electrode oscillates between capacitor plates and detunes the capacitance of capacitors $\mathbf{C_1}$ and $\mathbf{C_2}$ in the opposite direction at the same rate as their oscillation.
The plate distance $\mathbf{d_1}$ of the one capacitor increases by the same amount as the distance $\mathbf{d_2}$ decreases in the other capacitor.
The capacitance in the individual capacitors change as a result.
An electronic evaluation unit supplies an analogue signal voltage to the self-levelling suspension control unit.

Capacitive measurement principle of the acceleration senders



275_091

The senders have different mechanical attachments and measurement ranges (sensitivity).

Sender measurement ranges:

Sender for ...	Sender measurement range
... body acceleration	± 1.3 g
... wheel acceleration	± 13 g

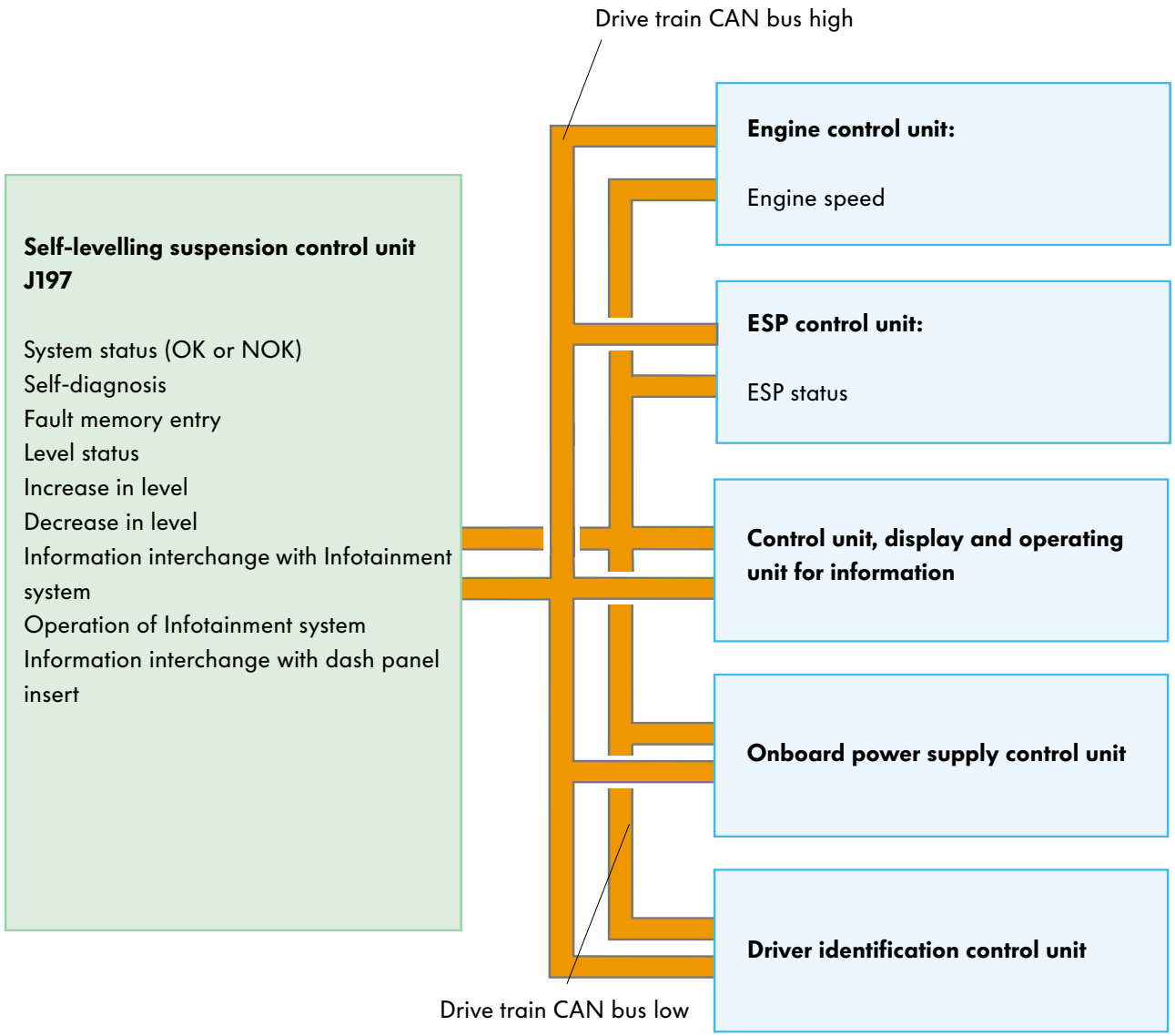
g = unit of measurement for acceleration
1 g = 9.81 m/sec^2 = standard value of acceleration due to gravity

Interfaces

CAN information exchange

Information on air suspension and damping control is exchanged between the self-levelling suspension control unit J197 and the networked control units via the drive train CAN bus, with the exception of a few interfaces.

The system overview shows by way of example the information provided via the CAN bus and received and used by the networked control units.



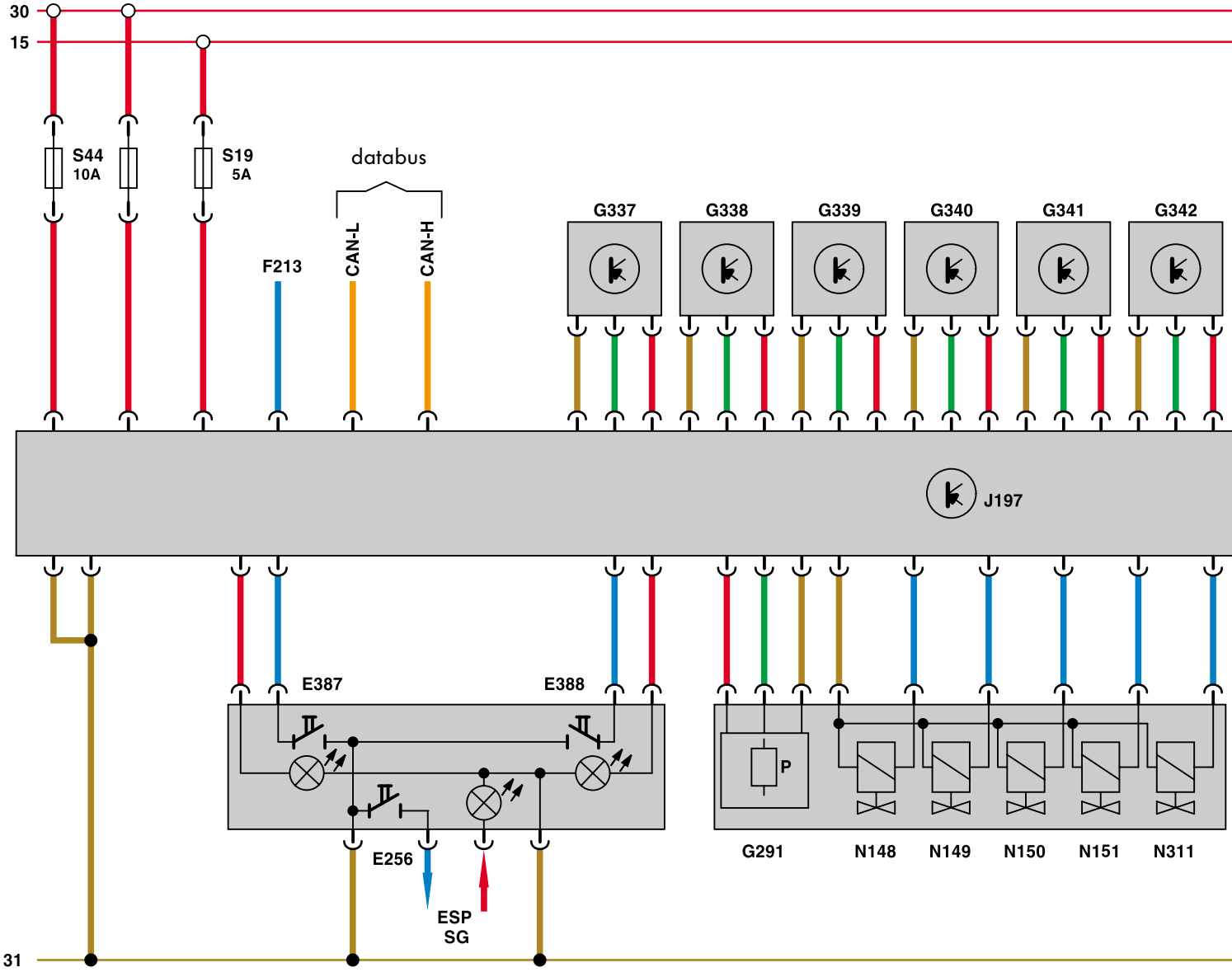
275_074

Information sent from control unit J197.

Information received and evaluated by control unit J197

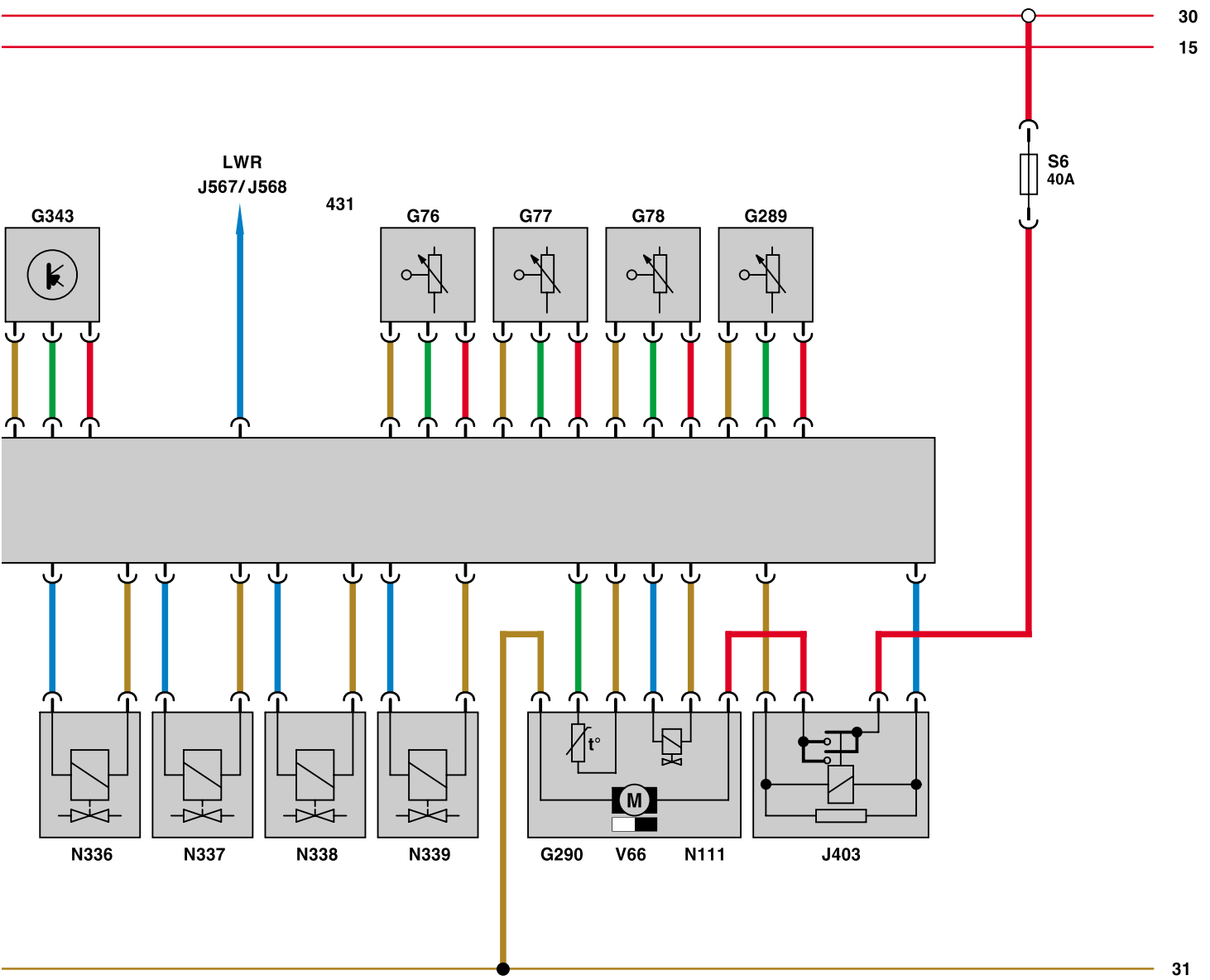
Design and function

Function diagram



Legend:

E256 - TCS/ESP button
E387 - Damper adjustment button
E388 - Button for self-levelling suspension
F213 - Driver's door contact switch
G76 - Vehicle level sender, rear left
G77 - Vehicle level sender, rear right
G78 - Vehicle level sender, front left
G289 - Vehicle level sender, front right
G290 - Compressor temperature sender, self-levelling suspension
G291 - Self-levelling suspension system pressure sender
G337 - Wheel acceleration sender, front left
G338 - Wheel acceleration sender, front right
G339 - Wheel acceleration sender, rear left
G340 - Wheel acceleration sender, rear right
G341 - Body acceleration sender, front left
G342 - Body acceleration sender, front right
G343 - Body acceleration sender, rear
J197 - Self-levelling suspension control unit
J403 - Self-levelling suspension compressor relay
J567 - Gas discharge lamp control unit with HRC and J568 in the associated headlight unit



275_073

N111 - Self-levelling suspension drain valve
N148 - Suspension strut valve, front left
N149 - Suspension strut valve, front right
N150 - Suspension strut valve, rear left
N151 - Suspension strut valve, rear right
N311 - Pressure accumulator valve, self-levelling suspension
N336 - Damper adjustment valve, front left
N337 - Damper adjustment valve, front right
N338 - Damper adjustment valve, rear left
N339 - Damper adjustment valve, rear right
V66 - Self-levelling suspension compressor motor

= input signal
= output signal
= positive
= earth
= CAN databus

Further interfaces

Door contact signal

This signal is an earth signal from the onboard power supply control unit. It indicates that a vehicle door or the bootlid has been opened.

It serves as a "wake up signal" for the transition from Sleep Mode to Standby Mode.

Terminal 50 signal (via CAN)

This signal indicates that the starter has been activated. It shuts down the compressor during the start-up routine.

This safeguards the start-up routine and conserves the battery.

K wire

Self-diagnosis information is exchanged between the self-levelling suspension control unit J197 and the Diagnostic Testing and Information System via the CAN connection (Key Word Protocol 2000) to the dash panel insert and from there to the Diagnostic Testing and Information System via the K wire.

Headlight range control signal

Level height adjustments are made for each axle. This would temporarily reduce the range of vision while driving at night.
The Phaeton is equipped with a headlight range control (HRC).
The automatic dynamic headlight range control keeps the light cone at a constant angle.

To avoid constant, unnecessary adjustments in level height due to surface unevenness, such as bumps or potholes, the self-levelling suspension has long reaction times when the vehicle is travelling at relatively constant road speed and if there is little or no wheel acceleration.

If level height is adjusted in Motorway Mode for example, the air suspension control unit J197 sends a voltage signal to the headlight range control unit J431.
The HRC reacts immediately and adjusts the angle of the light cone depending on the change of body position.

Level change procedure

Raising - the rear axle is raised followed by the front axle.

Lowering - the front axle is lowered followed by the rear axle.

Emergency running mode

Both the air spring control system and the damping control system adopt stored emergency running strategies in the event of faults in the sensors, the actuators or internal faults in the control unit.
Control actions are limited under certain circumstances and an entry is made in the fault memory.

In these cases, a warning

"Level Fault" or "Damper Fault"

is issued and a warning symbol appears in the dash panel insert.

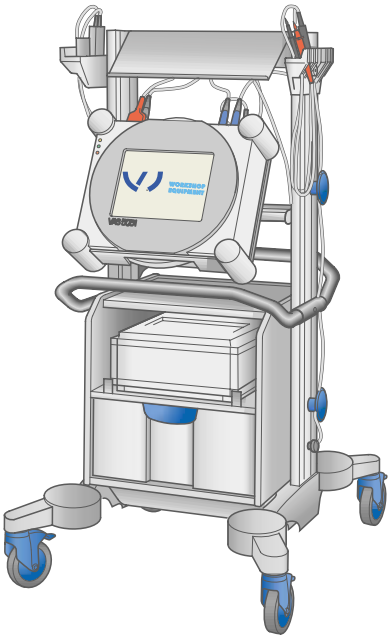
The vehicle must be taken to the workshop for repair.

Self-diagnosis

Self-diagnosis

Address word: 34 - Self-levelling suspension

Diagnostic Testing and Information Systems VAS 5051 and VAS 5052 are suitable for communication with the air suspension control unit.



275_050a

Resetting the adjustment position

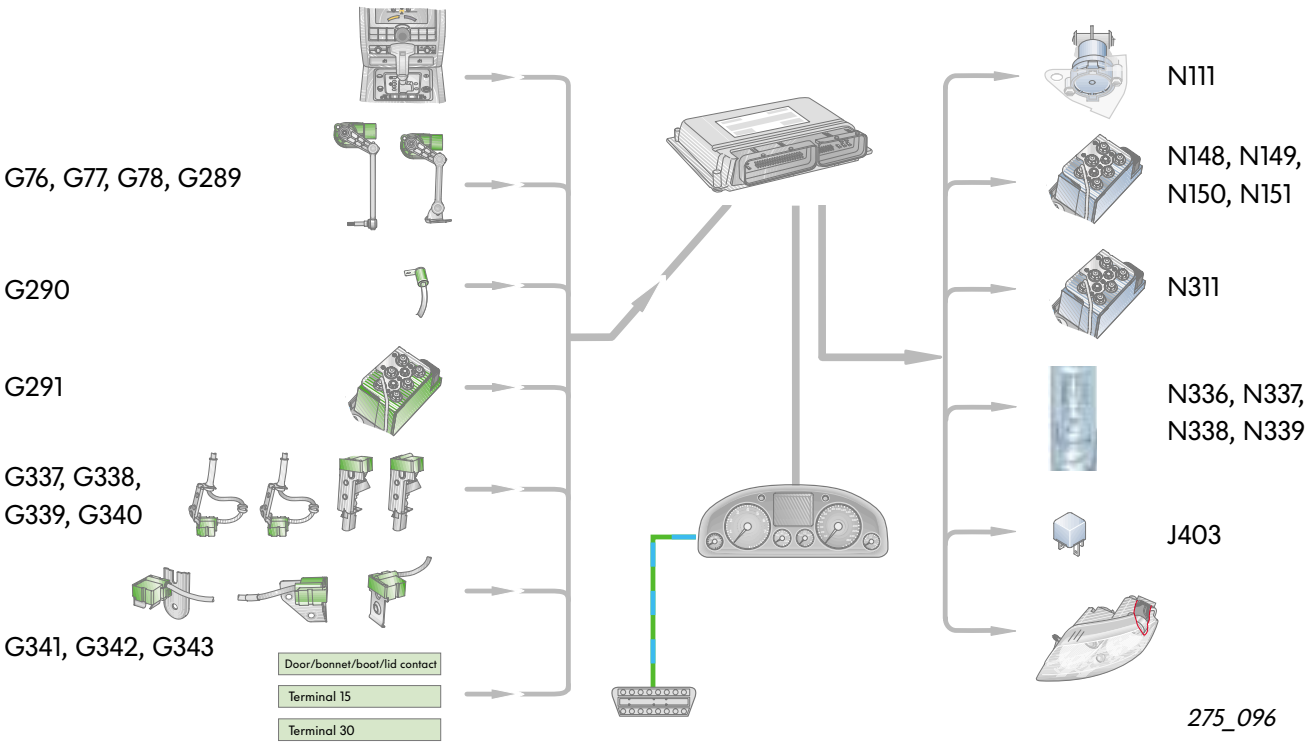
If the control unit, a vehicle level sender or the entire air supply unit are replaced, then the adjustment position must be reset.

The adjustment position is reset using the "Basic setting" function (see "Guided fault-finding").

275_050b

Please note that Repair Group 01 is integrated in "guided fault-finding".

The colour coded sensors, actuators and auxiliary signals are tested as part of the self-diagnosis and "guided fault-finding".



G76, G77, G78, G289	-	Vehicle level sender, front axle and rear axle
G290	-	Compressor temperature sender
G291	-	Self-levelling suspension system pressure sender
G337 ... G340	-	Wheel acceleration senders, front axle and rear axle
G341 ... G343	-	Body acceleration sender
J403	-	Self-levelling suspension compressor relay
N111	-	Self-levelling suspension drain valve
N148 ... N151	-	Suspension strut valves, front axle and rear axle
N311	-	Pressure accumulator valve
N336 ... N339	-	Damper adjustment valve
Auxiliary	-	Door/bonnet/bootlid contact signal terminal 15 and terminal 30

Test your knowledge

Which of the following answers is true?

One or more, or even all, answers may be true.

1. The self-levelling suspension system fitted in the Phaeton is

☐ a) "full load-bearing".

☐ b) "partial load-bearing".

☐ c) "self-supporting".

2. The auxiliary accumulators attached to the struts serve

☐ a) as a back-up for the central pressure accumulator of the self-levelling suspension system.

☐ b) to increase the effective air spring volume of the individual suspension struts.

☐ c) as air cushions during assembly work.

3. The driver can actively select the

☐ a) low suspension level (TN).

☐ b) normal suspension level (NN).

☐ c) high suspension level (HN).

4. The air drier in the air supply unit

☐ a) must be maintained at regular intervals.

☐ b) is not subject to a maintenance interval on account of its regenerative drying process.

☐ c) must be replaced after 30,000 km.

5. The signals generated by the vehicle level sender are used for

☐ a) self-levelling suspension.

☐ b) headlight range control.

☐ c) seat height adjustment.

6. The controlled position must be reset after

☐ a) replacing the self-levelling suspension control unit.

☐ b) replacing the convenience control unit.

☐ c) replacing a vehicle level sender.

7. The air supply unit compressor starts

☐ a) only when activated by the driver.

☐ b) after turning off the ignition.

☐ c) whenever required for air supply control.

8. Before commencing work on the lifting platform

☐ a) only the air supply unit compressor need be shut off.

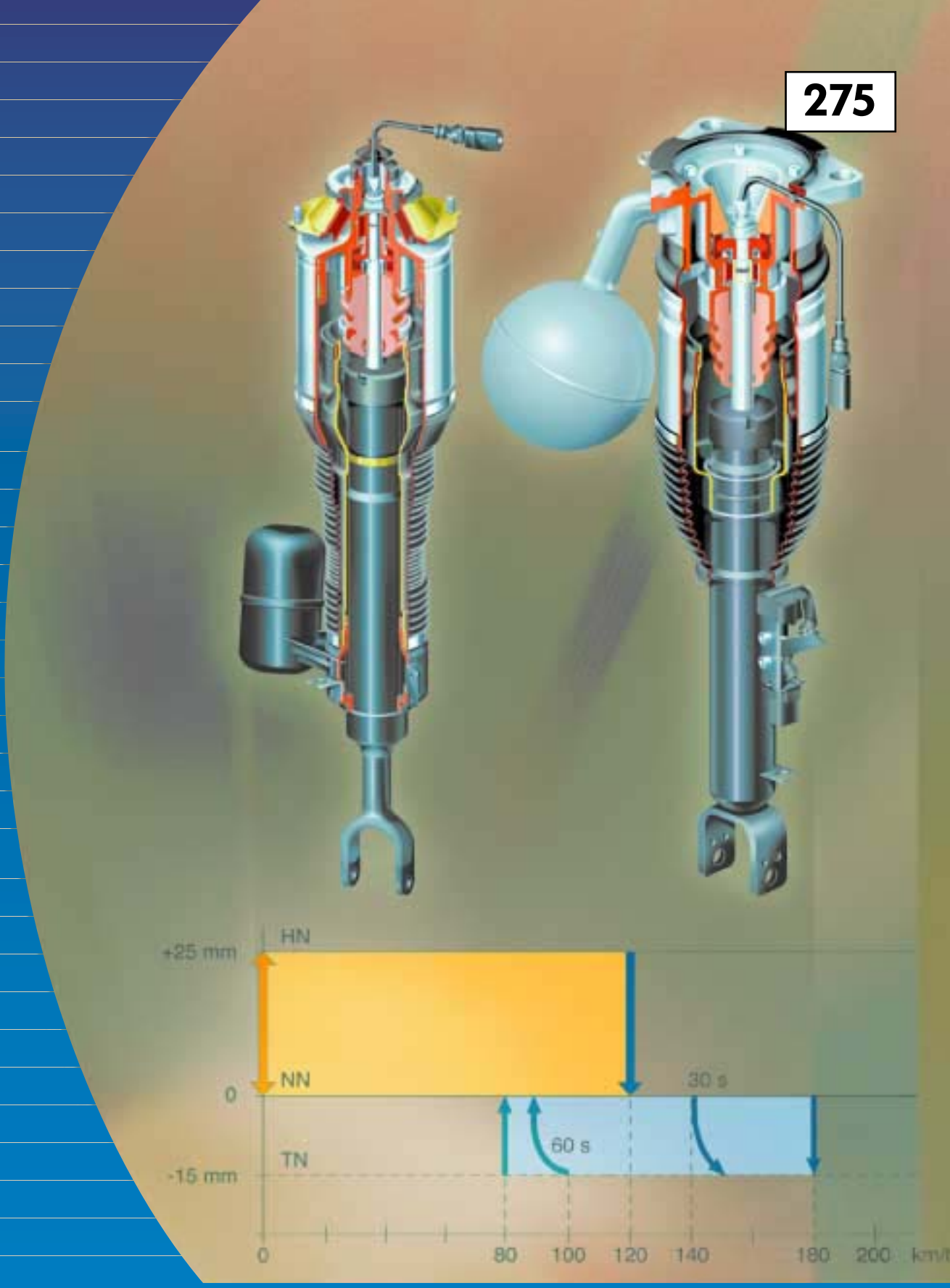
☐ b) the self-levelling suspension must be deactivated.

☐ c) no special precautions are necessary.

Solutions:
1. a; 2. b; 3. b, c; 4. b; 5. a, b; 6. a, c; 7. b, c; 8. b

Service.

275



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