Service.

Self-Study Programme 276

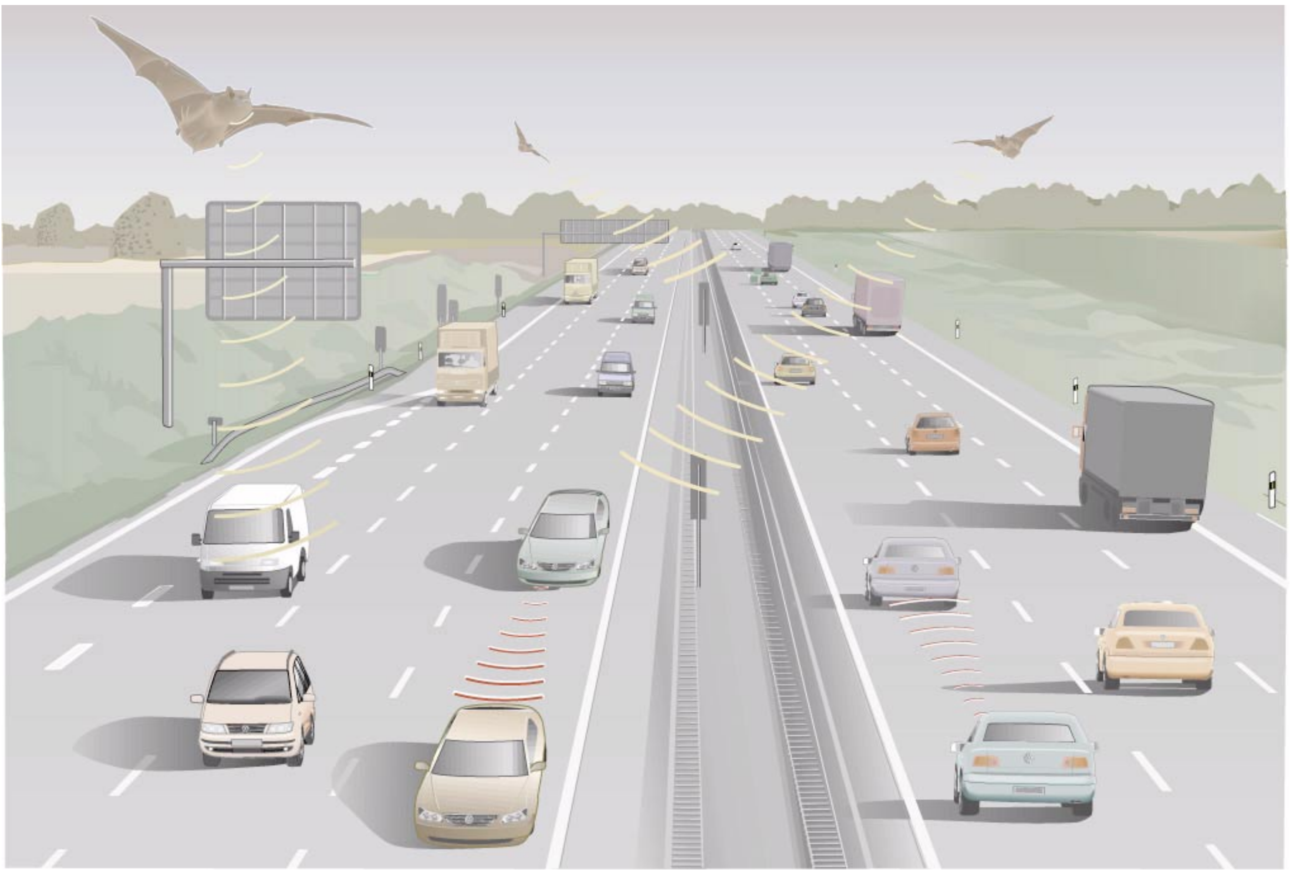
The Phaeton
Automatic Proximity Control (APC)

Design and Function

If a driver attempts to activate the vehicle's cruise control system (CCS) in the heavy traffic scenario shown below to cruise along in a relaxed manner, he will soon have to brake because of the frequently changing distances to vehicles ahead.

The APC system has learned its lesson from bats. In much the same way as bats use ultrasonic waves to find their way about their surroundings, the Automatic Distance Control (APC) scans the traffic situation ahead of the vehicle by means of millimetre wave radar and controls the distance to the vehicle ahead on the basis of this data.

The CCS can be expanded to include a proximity-maintaining function which allows comfortable and stress-free driving even in heavy traffic.



S276_034

NEW

Important Note

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Introduction

Overview

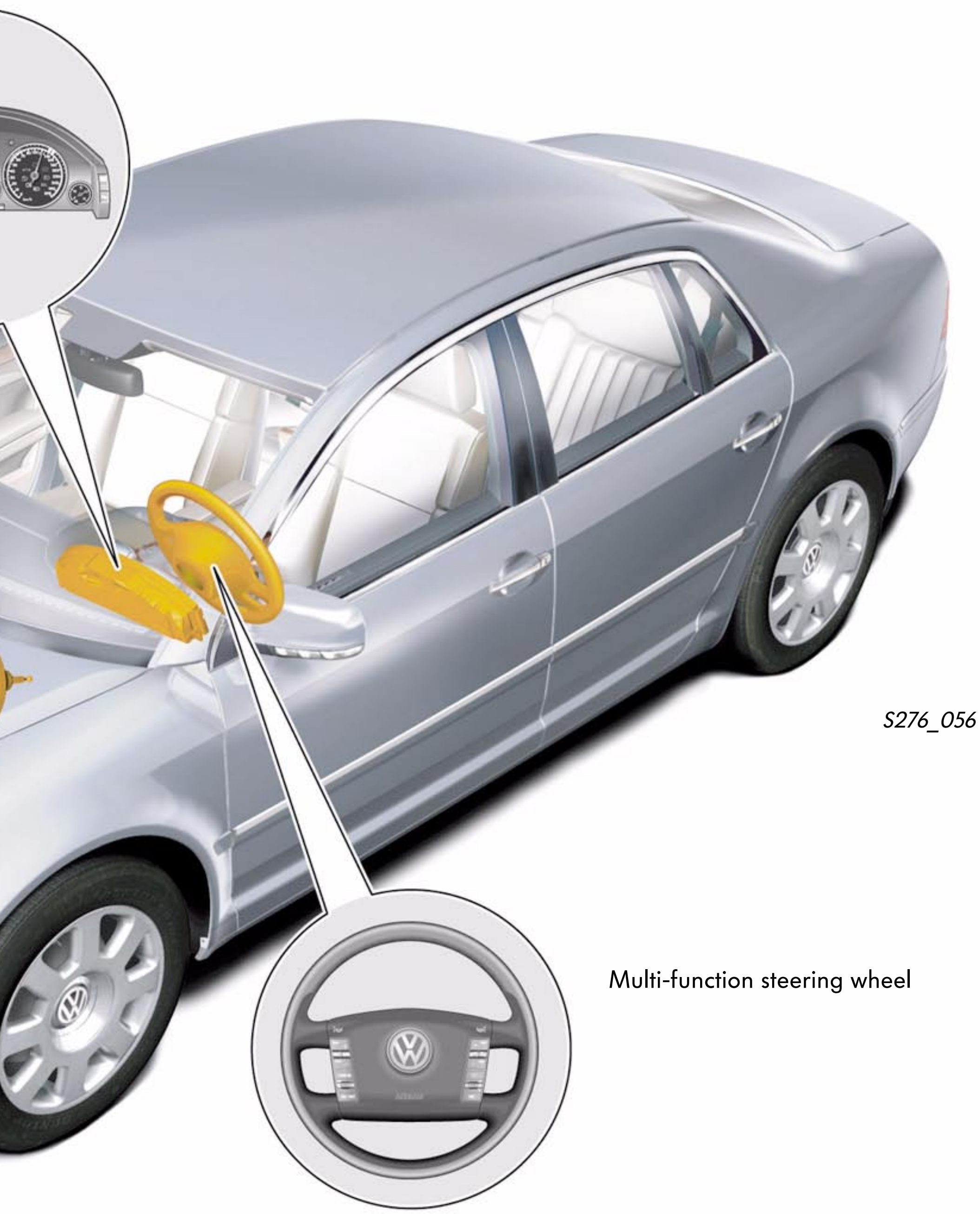
APC

The Automatic Proximity Control system is an expansion of the conventional cruise control system (CCS). The CCS adjusts the speed of the vehicle to a value preset by the driver.

The APC system implements this convenience function in the same way. In addition, the vehicle's road speed is adapted to the speed of any vehicle driving ahead if the latter is moving more slowly than one's own vehicle.

Electronic brake servo

Automatic Proximity Control is a *driver assistance system* designed for enhanced convenience.
It relieves the strain on the driver while driving and thus contributes to active safety.



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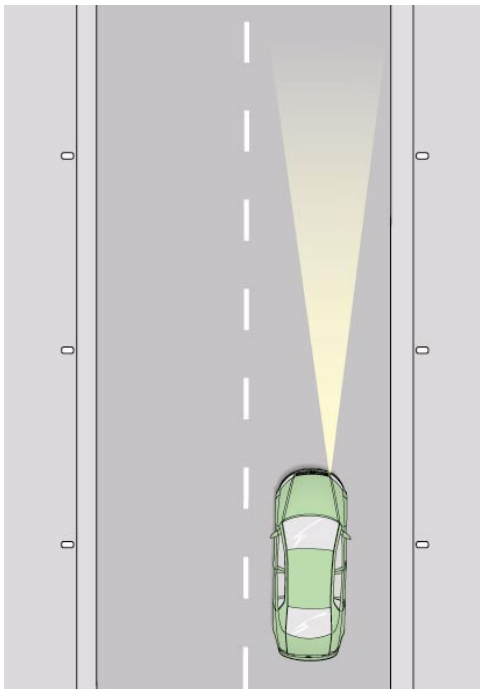
Multi-function steering wheel

Functional description

Constant speed

If no vehicle is located within the field of vision of the proximity control sender, the *desired speed* is maintained.

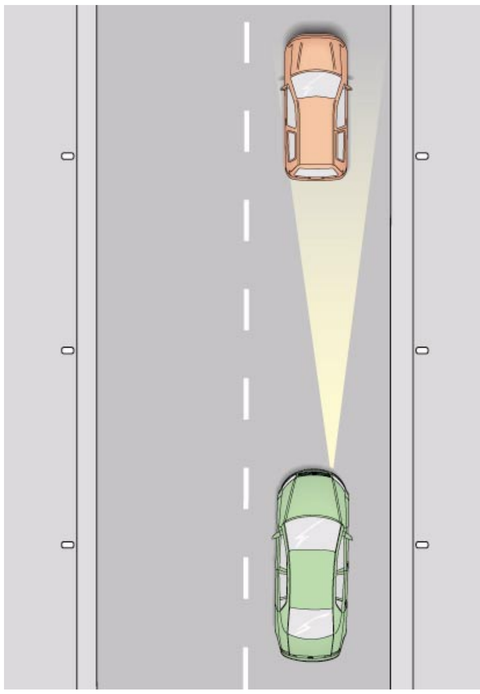


100 kph

S276_006

Deceleration

If an APC-controlled vehicle (green) detects a slower vehicle (red) ahead of it in the same lane, the APC regulates the intervehicular distance to a time-dependent value pre-selected by the driver by reducing the engine torque and, where necessary, by moderately applying the brakes.

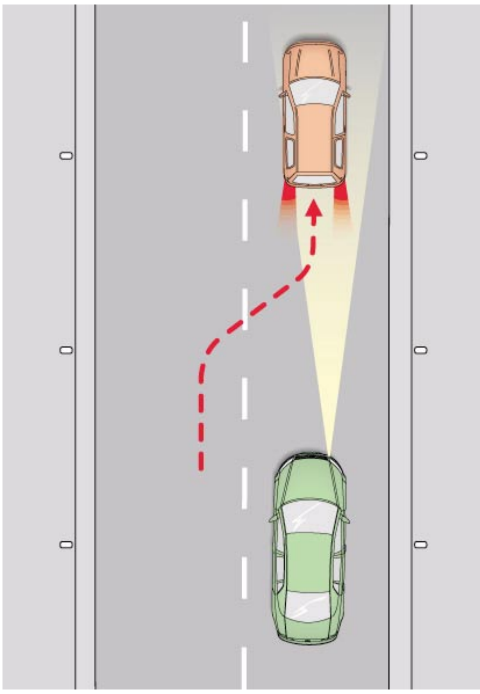


80 kph

100 kph
➔ 80 kph

S276_007

The APC also reacts to slower-moving vehicles which cut in ahead by decelerating.
The vehicle road speed is adapted accordingly.



80 kph

100 kph
→ 80 kph

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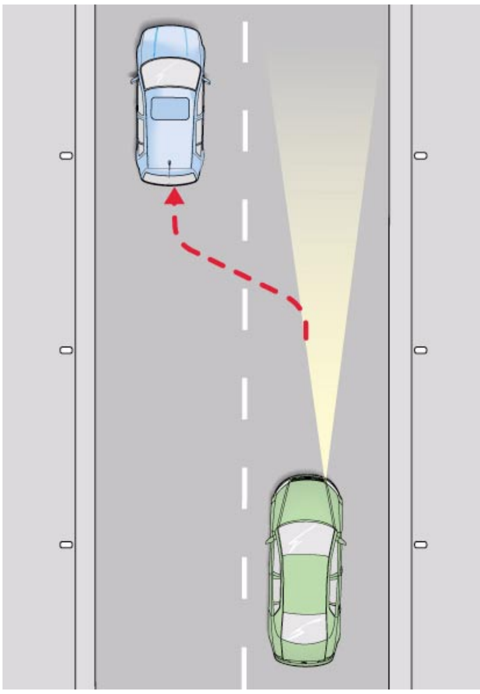
Acceleration

If the vehicle in front clears the way by accelerating or by changing lane, the APC re-accelerates to the pre-selected speed.



80 kph
→ 120 kph

80 kph
→ 100 kph

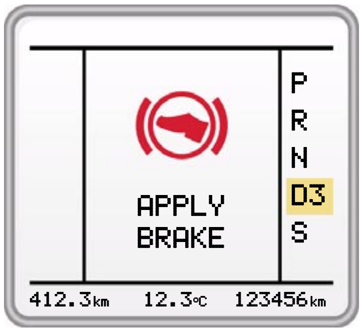
S276_009

Functional limits

The APC has an upper speed limit of 180 kph. This limit is defined by the proximity control sender's range of 150m. High speeds require a long stopping distance. A braking operation must then be initiated at a large distance to the vehicle in front.

The proximity control sender suppresses all stationary objects within its field of vision. As a result, there is also a minimum function speed of 30 kph below which the APC cannot be activated.

If the APC is in the process of decelerating from higher speeds, the driver is prompted to take over the braking when the minimum function speed is undershot.



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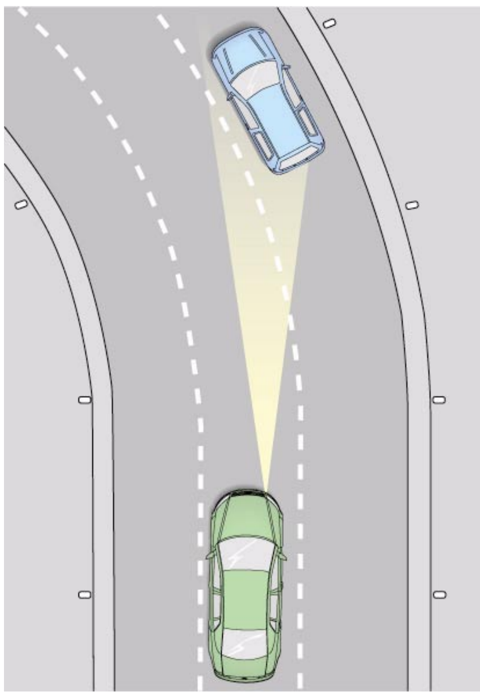
Stationary vehicles are not detected as they are approached, and the driver is required to perform a normal braking operation.

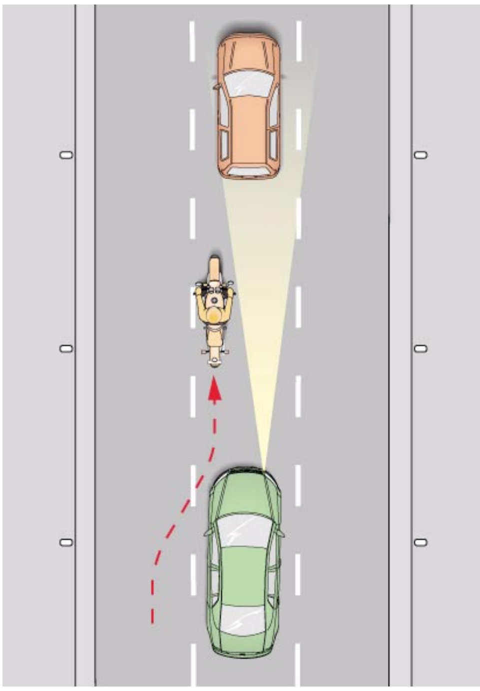
In the traffic scenario shown here, the lane ahead of the green vehicle is also clear in the curve, but the APC may possibly react to the blue vehicle in the adjacent lane on the right. The accuracy of the lane forecast comes up against its limits at increasing distances to vehicles driving ahead, particularly in left-hand curves.



S276_036

Another limitation arises from the sensor's narrow angle of vision of approx. 12°. In tight corners, the scanning range of the sensor may not be wide enough. The APC is designed for curve radii larger than 500 m.

Road users who cut in just ahead or are driving at an offset angle, such as the motorcyclist in this diagram, are outside the APC's field of vision, so it is unable to react to these objects.



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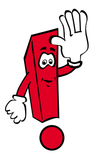
For comfort reasons, APC deceleration is limited to approx. 30% max. deceleration. However, higher rates of deceleration are necessary if the vehicle approaches a vehicle driving ahead and there is a large difference in speed between the two vehicles. The APC then prompts the driver to take over the braking operation.

It can generally be said that the APC can only react as expected if

- the proximity control sender has correctly detected the distance, relative speed and *reflection angle* of objects ahead of the vehicle and
- the electronics have assessed the situation correctly.

This is the case when a vehicle is displayed in the central display.

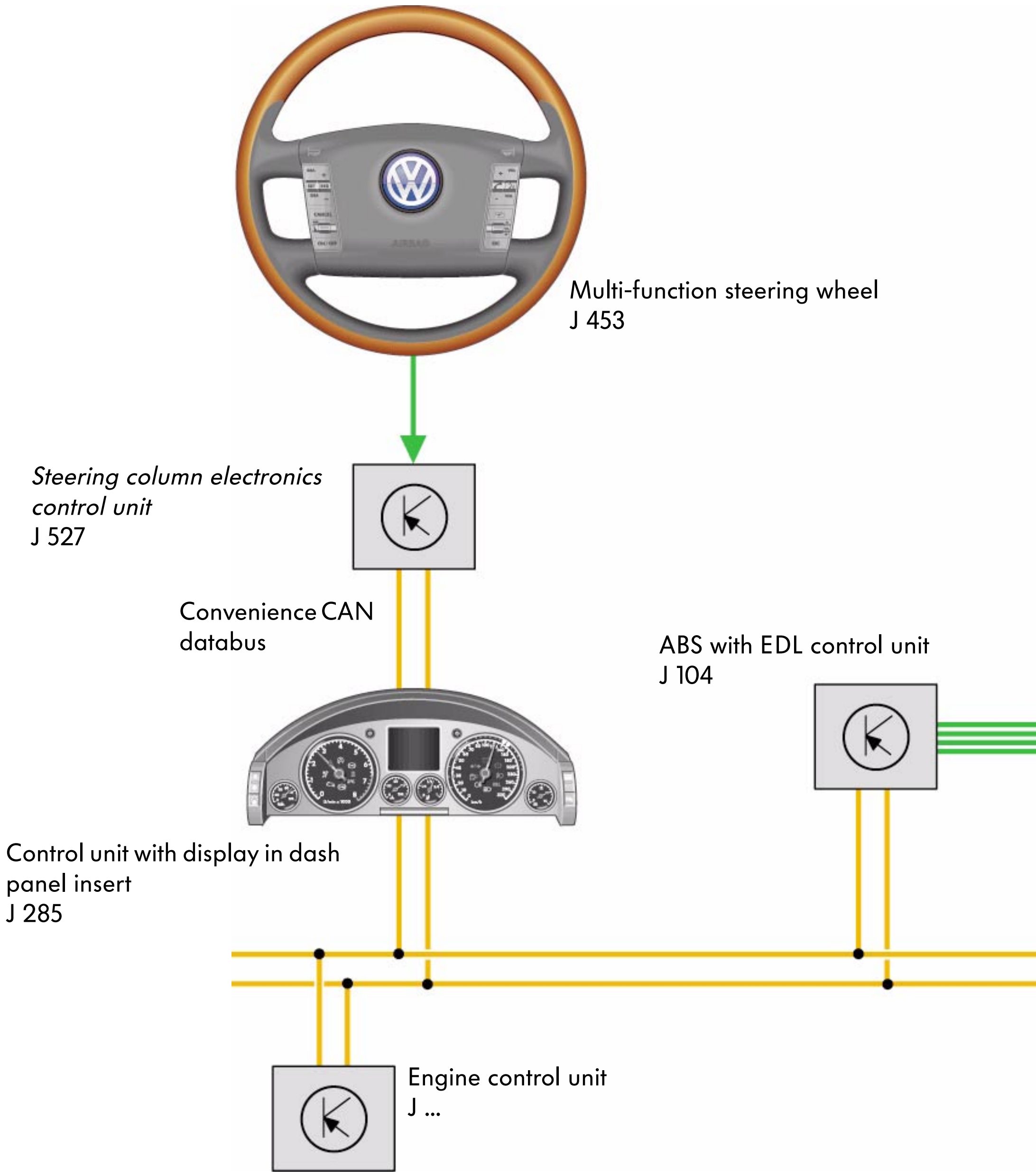


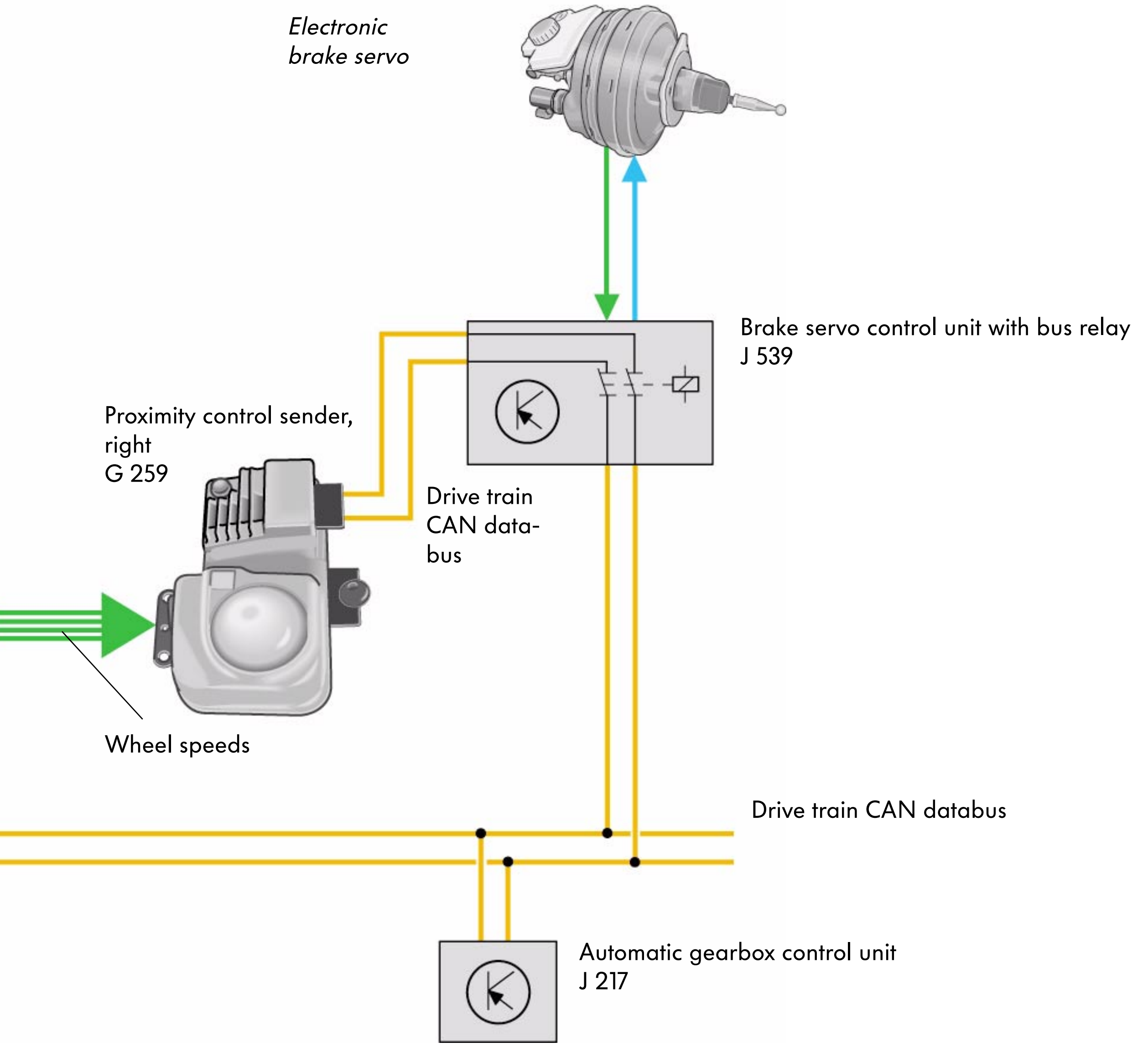
APC is designed for operation on motorways and country roads that are mainly straight.

System overview

The APC system is integrated into the vehicle's drive train electronics. Data is exchanged with the engine electronics, ESP and the gearbox control via the drive train CAN databus.

The engine speed signals generated by the wheel sensors are sent directly to the proximity control sender from the ABS with EDL control unit to ensure a sufficiently accurate *lane forecast*.




Electronic
brake servo
Brake servo control unit with bus relay
J 539
Proximity control sender,
right
G 259
Drive train
CAN data-
bus
Wheel speeds
Drive train CAN databus
Automatic gearbox control unit
J 217

S276_057

Components of the APC system

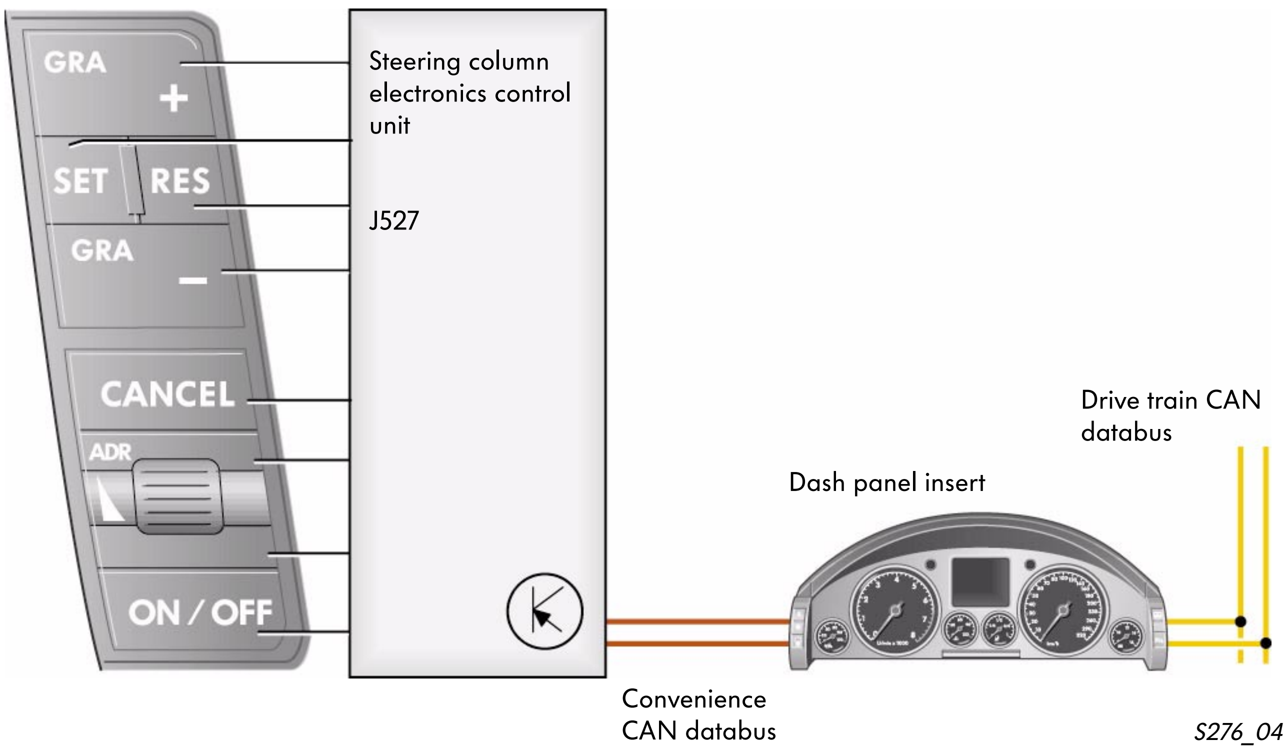
Multi-function steering wheel

The APC system is mainly operated via the buttons in the multi-function steering wheel, but it can also be operated like the cruise control system via the accelerator and brake pedal. The steering wheel buttons are connected to the *steering column electronics control unit* which sends the data to the dash panel insert via the convenience CAN databus.

The *gateway* in the dash panel insert assumes the data exchange function between the convenience CAN databus and the drive train CAN databus.

To ensure that the driver is informed about the APC's functional state at all times, the following information is displayed in the dash panel insert and partly supported by acoustic signals:

- APC status
- Driver inputs
- Warnings



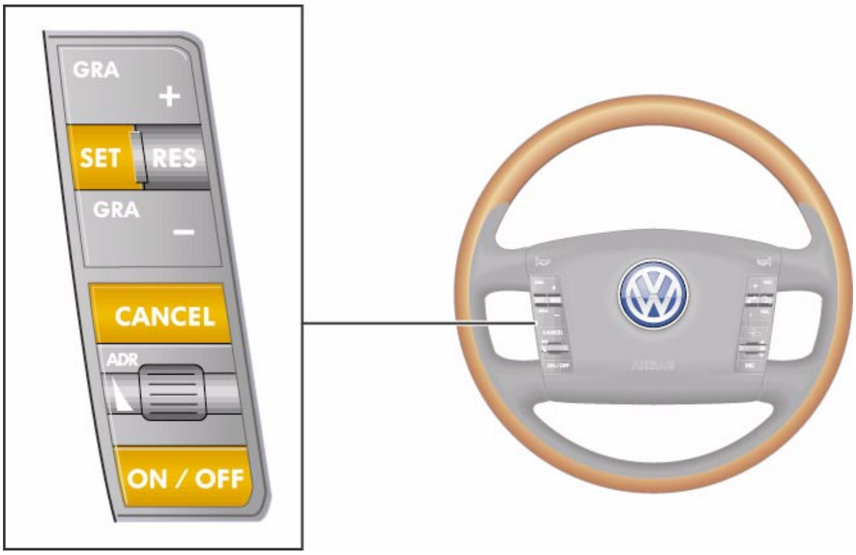
S276_041

The APC system is mainly operated by means of the left button cluster on the multi-function steering wheel. However, the brake and accelerator pedals, as well as the gear selector lever position, also have an influence on the APC system.

When the engine is started, the APC is always in the "OFF" state and must be switched to "Standby Mode" by pressing the ON/OFF button. The *desired speed* memory remains empty and the following distance is set to the default value of 1.4 s.

While driving (v > 30 kph), the actual speed stored as a desired speed and the APC can be activated by pressing the SET button. The desired speed can be reduced in 1 kph increments to a minimum value of 30 kph by repeatedly pressing the SET button.

Pressing the CANCEL button switches the APC to "Standby Mode" whilst retaining the desired speed value in the memory.



S276_046

Components of the APC system

The APC can be reset to the preselected *desired speed* by pressing the RES button. The desired speed can be increased in 1 kph increments to a maximum value of 180 kph by repeatedly pressing the SET button. The desired speed can also be increased or reduced in 10 kph increments by pressing the "CCS+" or "CCS-" button.

The distance perceived by the driver to be a comfortable following distance to a vehicle ahead is speed-dependent. Higher speeds require larger distances between vehicles.

However, the *following time* which the vehicle with APC system takes to cover the distance to the vehicle ahead remains constant. The speed-dependent following distance is also known as the *time gap*.

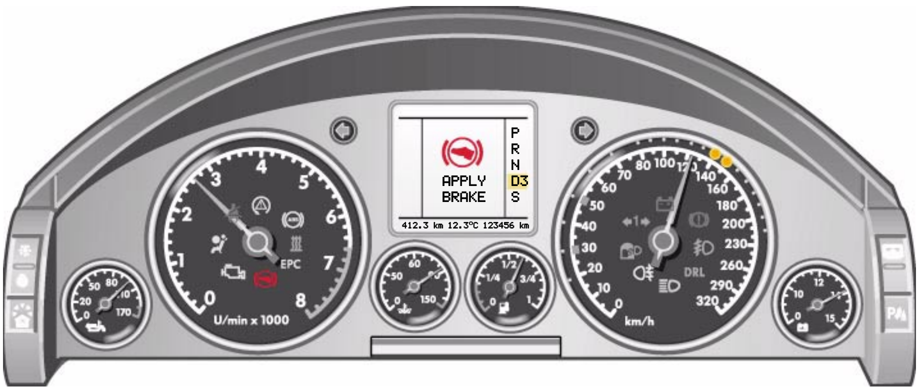
The following time can be set to a default value of 1.4 seconds by pressing the ON/OFF button and adjusted in seven steps by means of a thumbwheel to values ranging between 1 and 3.6 seconds.

S276_047

APC display in the dash panel insert

The driver receives information about the APC system on several displays, some of which are *redundant*.

- Large APC display at the centre of the colour screen
- Small APC display at the bottom left of the colour screen
- LED ring around the speedometer
- Red symbol for APC "Apply brake" in the rev counter
- Two-stage acoustic signal



S276_051

The LED ring around the speedometer and the red symbol for the APC in the rev counter are redundant and provide the minimum necessary information to the driver in case the colour screen is unavailable.

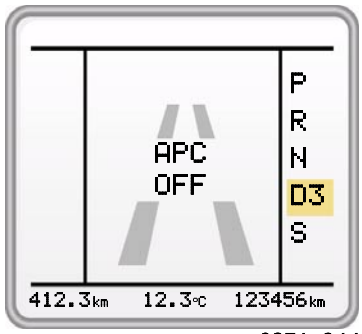
The set *desired speed* is indicated via the LED ring in the speedometer.

The optical displays are supplemented by two acoustic signals: a discrete gong and an aggressive gong. The discrete gong sounds when the APC is switched from the active state to "Standby Mode" or "OFF state". The aggressive gong sounds along with the red warning signal.

Components of the APC system

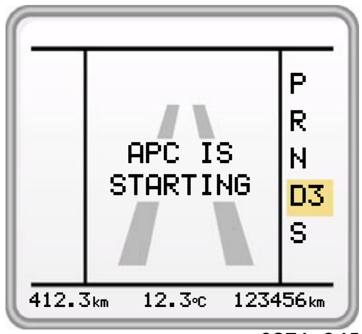
The large APC display shares the centre of the display with various Infotainment systems, i.e. it disappears when other displays are active. To maintain information flow to the driver in this case, a small APC display remains active at the bottom left of the display.
Passive display elements are coloured grey and active display elements are orange. Very important information is displayed in red.

When the APC system is inactive, the display "APC OFF" appears.



S276_064

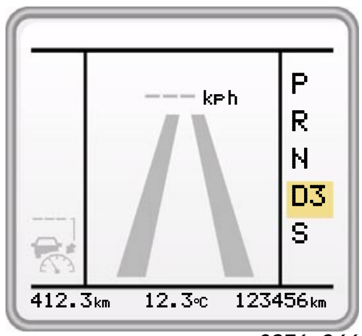
After the APC is switched on by pressing the ON/OFF button, the message "APC IS STARTING" appears for short period of time.



S276_065

The APC now switches to "Standby Mode".
In this mode, the contents of the display are represented in grey. The large display shows a stylised lane, at the end of which the *desired speed* is displayed.

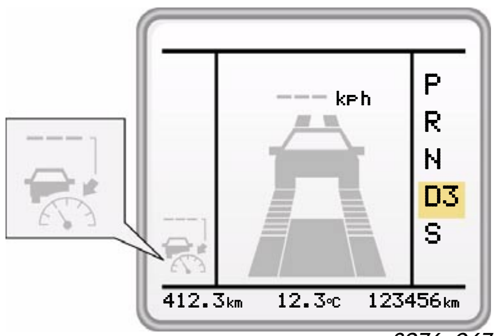
In Cruise Control Mode (CCS Mode), no vehicle ahead is detected and displayed.



S276_066

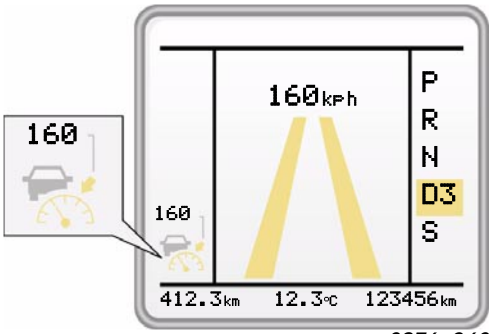
If a *relevant* vehicle ahead of the car is detected, it is also indicated.

The APC symbol represents the small display and provides information on desired speed.



S276_067

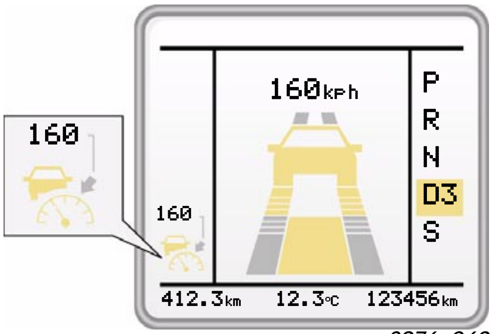
The APC is activated by pressing the SET button or the RES button. The active display elements are coloured orange.



S276_068

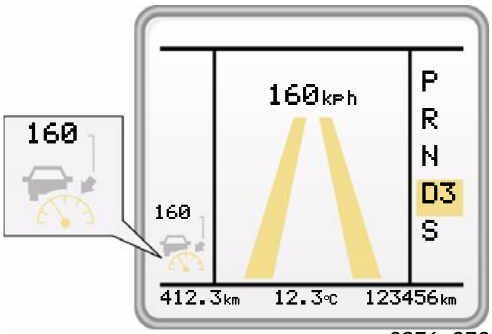
If a *relevant* vehicle is detected, it appears in the display. The colour of the kph display changes to grey since the displayed speed no longer matches the actual speed.

The *time gap* (following distance) to the vehicle in front is represented in seven steps. The time gap actively set by the driver is represented in orange. The centre bar indicates the vehicle's position in relation to the vehicle ahead.



S276_069

If the driver accelerates by pressing the accelerator, the colour of the vehicle shown in the display or, in CCS Mode, the colour of the *desired speed* changes from orange to grey.



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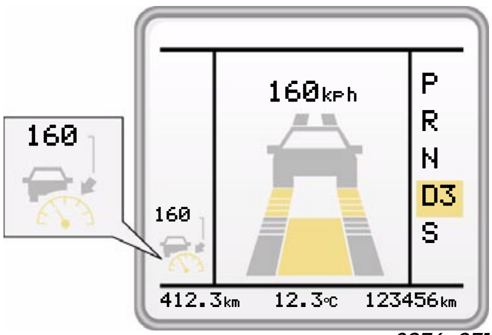
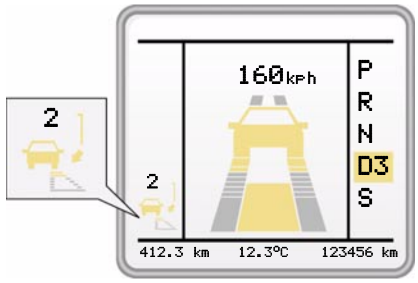


S276_071

Components of the APC system

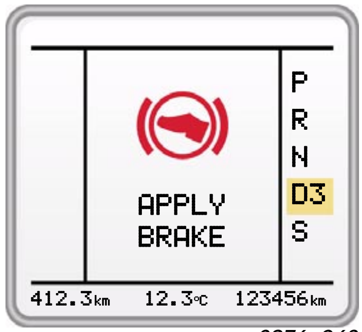
If the driver changes the *time gap* (following distance) by turning the thumbwheel, the display changes for several seconds. The time gap is now as indicated in the small display in the form of several bars and in digits in the *desired speed* display field.

S276_058



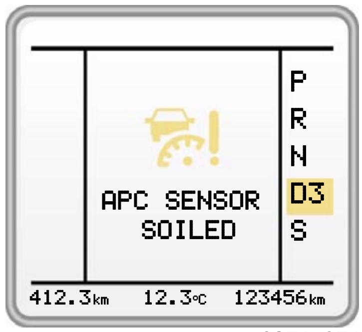
S276_072

The red warning lights up together with the red symbol for APC "Apply brake" in the rev counter and prompts the driver to take control of the vehicle by applying the brake. This is necessary when the braking performance of the APC is insufficient.



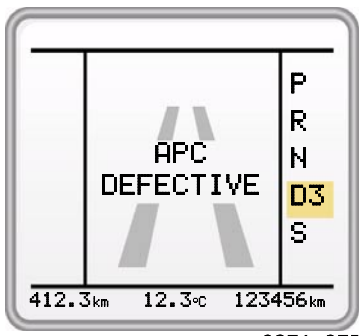
S276_063

This is not displayed if the sensor is soiled. However, the system remains active.



S276_074

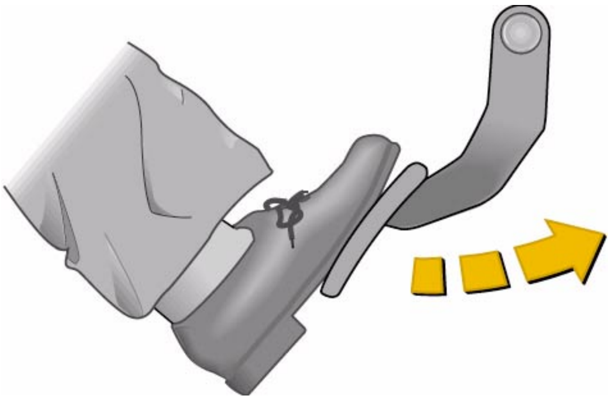
If the internal diagnostics detect a fault, it is also displayed. The system switches to "Standby Mode". After several seconds, the fault message becomes passive.



S276_075

Accelerator, brake pedal and selector lever

When the APC system is active, the APC can be deactivated and the vehicle accelerated by pressing the accelerator pedal. If the driver eases his foot off the accelerator pedal, the APC continues operation and decelerates the vehicle to the *desired speed* or to the current *time gap* (following distance).



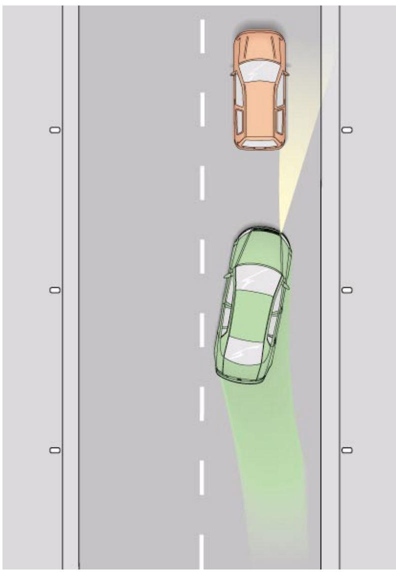
S276_048

Pressing the brake pedal deactivates the APC immediately whilst the desired speed is retained in the memory ("Standby Mode").

If the selector lever is moved from "D" position to "N", "R" or "P" position, the APC is deactivated. The APC remains active in all other selector lever positions.

S276_049

If the min. speed of 30 kph is undershot or the max. speed of 180 kph is exceeded, the APC is deactivated.
The APC system is also deactivated by intervention in the brake system by ESP, TCS, EBC or ABS, although APC braking operations in progress are completed.
Dynamic intervention is independent of any APC braking operations.

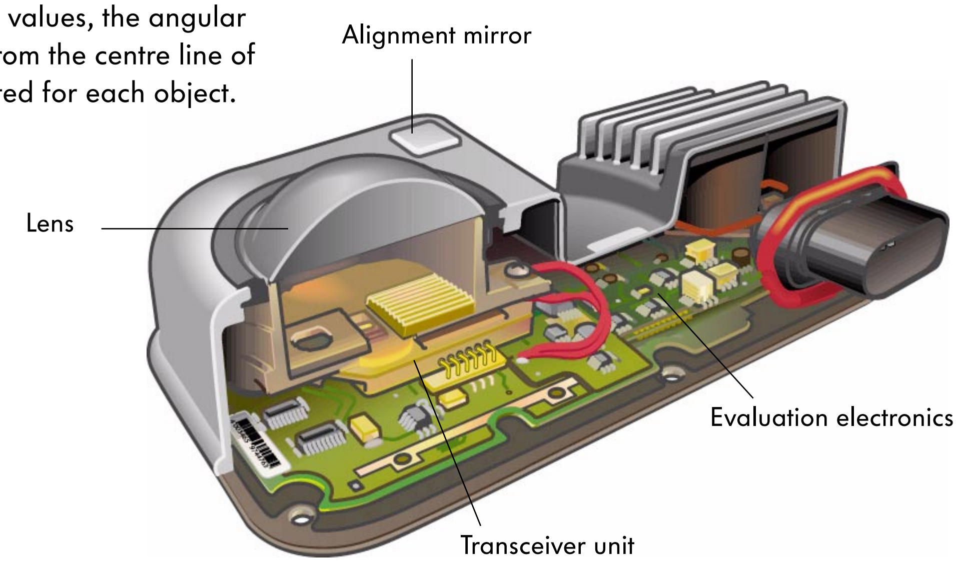


S276_050

Components of the APC system

Proximity control sender, right G 259

In the APC system, the distance is measured by a sender based on *millimetre wave* radar technology. The APC system also measures the distance to several objects in the field of vision and the relative speed along the longitudinal axis of the vehicle. From the measured values, the angular deviation *(azimuth angle*) from the centre line of the field of vision is calculated for each object.



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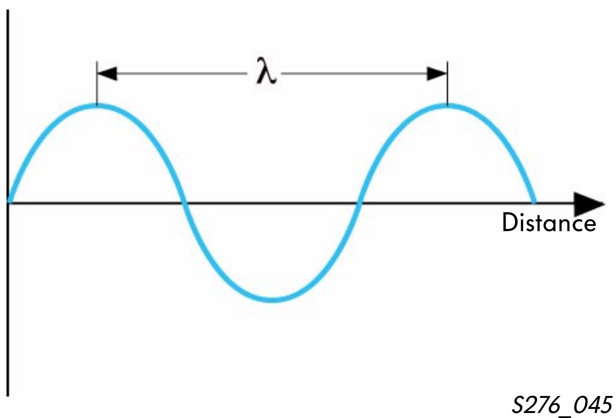
The radar system uses electromagnetic waves which propagate at the speed of light *c*.

A wave of frequency *f* requires a wavelength of λ for a wave train.
If the transmit frequency of the APC sensor is *f*=76.5GHz, the wavelength is λ=3.92mm.

Waves within a frequency range from approx. 30GHz to approx.150GHz are described as millimetre waves.



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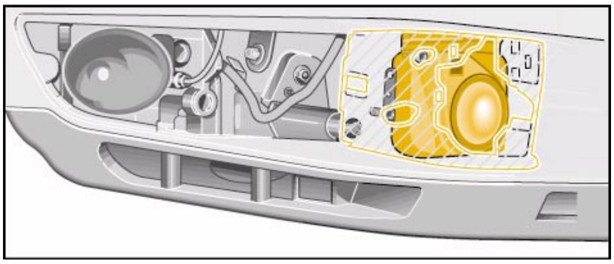
The sender is fitted behind a plastic cover in the bumper. The lens which emits the beam is easily recognisable.



S276_010

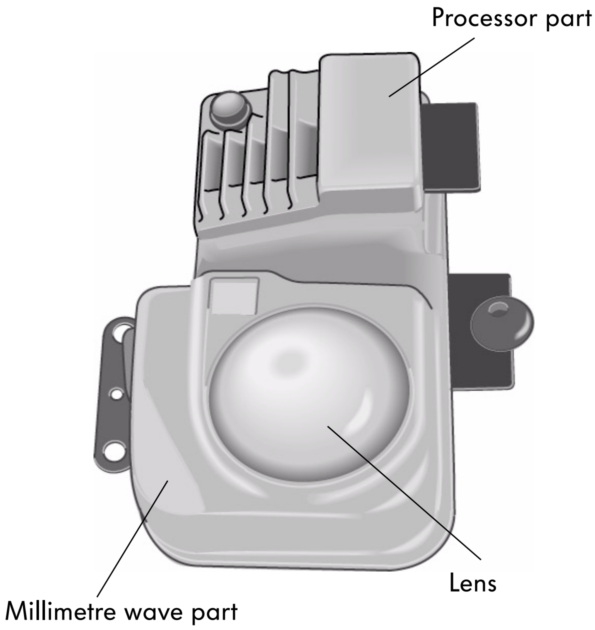
The cover may only be painted in a millimetre wave permeable colour. It may not be recoated on the inside or outside, and may not be covered. In addition, the cover must be kept free of dirt as well as ice and snow.

The sender's field of vision can be compared to the illumination zone of a highly focused headlight. As with the headlight, the centre line of the *sensor's field of vision* must be exactly aligned in the direction of travel.

Transmit frequency	76.5GHz
Optical range	150m
Horizontal angle of vision	12°
Vertical angle of vision	4°
Speed measuring range	± 180kph

A processor with high computing power is integrated in the sender housing. The following additional calculations are performed:

- *Lane forecast*
- Selection of the *relevant object*
- Distance and speed control
- Activation of the engine control unit, brake servo and dash panel insert
- Self-diagnosis



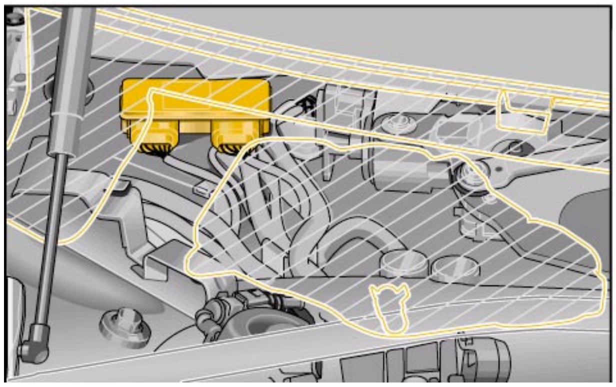
S276_003

Components of the APC system

Brake servo control unit

Fitting location

The control unit of the *electronic brake servo* is located in the plenum chamber on the right-hand side and is only accessible by removing the coolant expansion tank.



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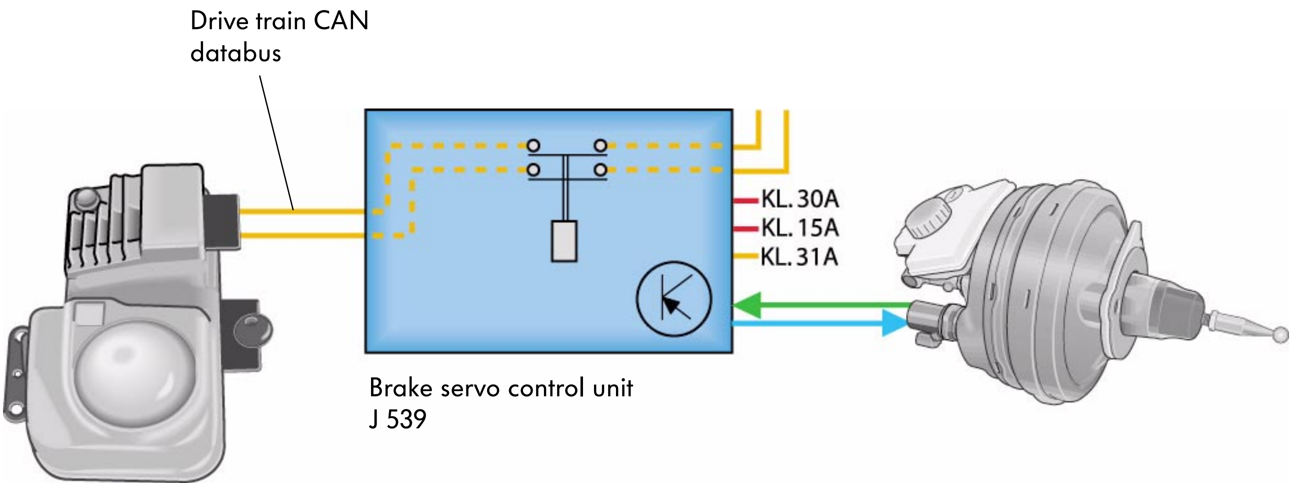
The brake servo control unit controls brake pressure build-up and relief.

For reasons of anti-theft security, the bus interface of the proximity control sender cannot be deactivated directly. Instead it can only be switched off via the brake servo control unit.



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Anti-theft alarm system

As the proximity control sender with its CAN databus connection is mounted on the exterior of the vehicle, it would be possible to interrogate the immobiliser code. To avoid impairing the immobiliser function, a special switch-on procedure is performed by means of the CAN databus relay in the brake servo control unit.

t0:

- Terminal 15 is connected.
- Start of brake servo control unit initialisation.

t1:

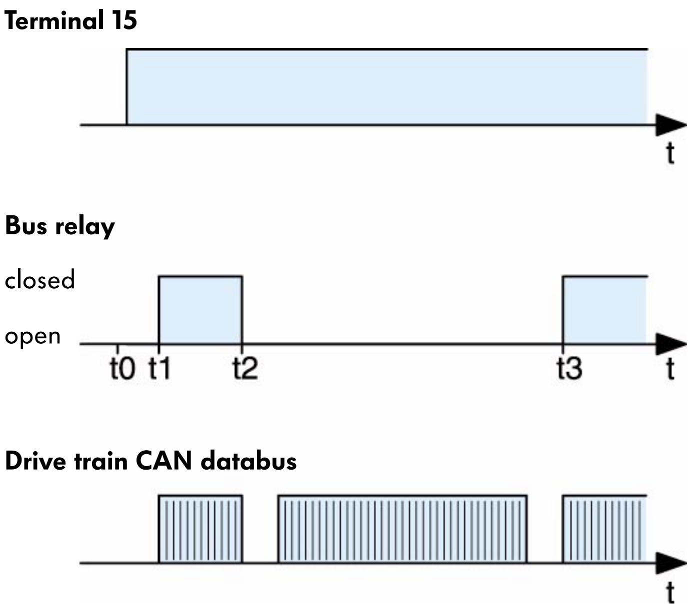
- End of brake servo control unit initialisation.
- The bus relay is closed.
- The proximity control sender transfers a system message via the CAN databus.

t2:

- The brake servo control unit indicates "Bus open" to the proximity control sender to suppress "BUS-OFF" of the CAN controller in the proximity control sender.
- The brake servo control unit opens the bus relay.
- The engine electronics interrogate the immobiliser code on the bus and communicate with the immobiliser.

t3:

- The bus relay is closed.
- Normal operation commences.



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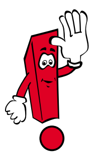


As the bus relay is open while the immobiliser is initialising, the immobiliser code cannot be interrogated via the proximity control sender.

Components of the APC system

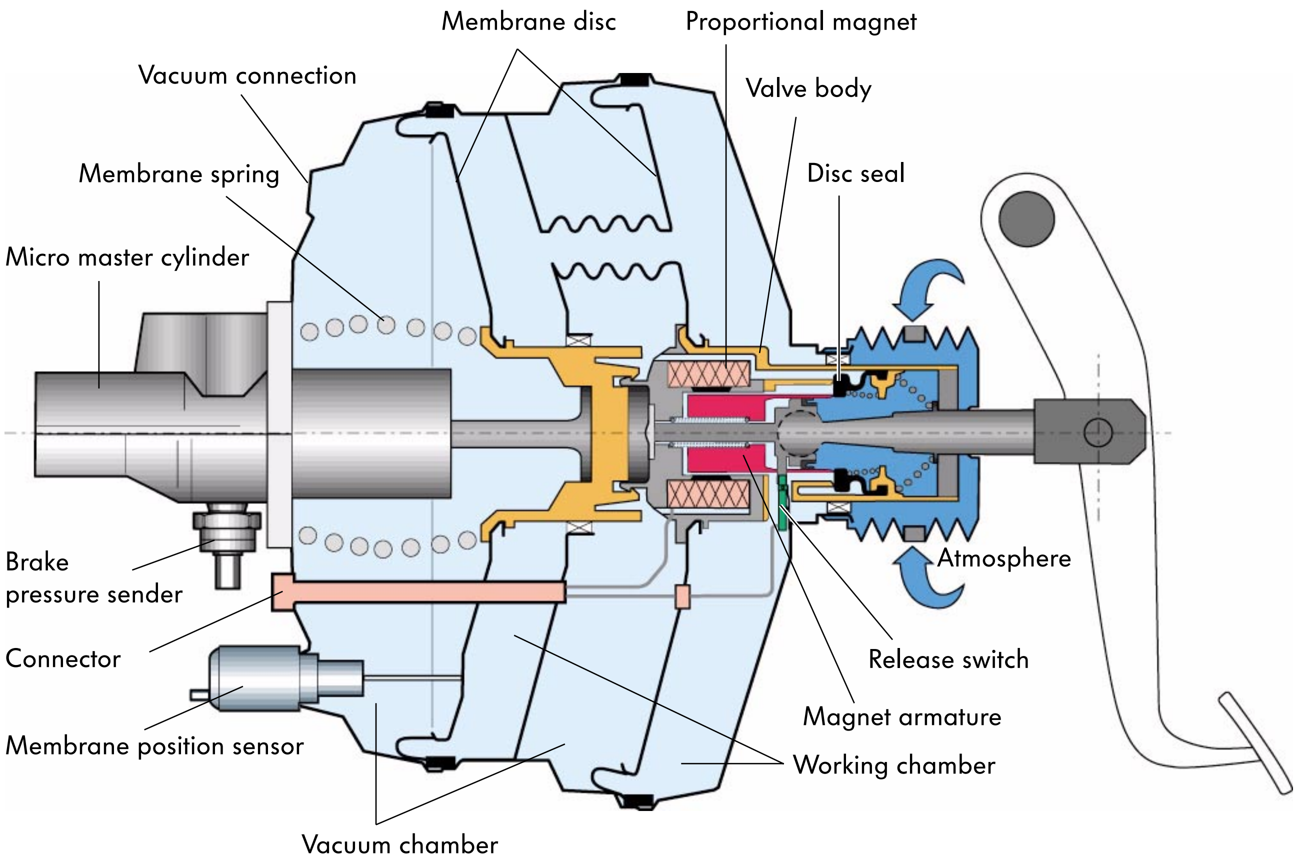
Electronic brake servo (EBS)

The *electronic brake servo* in the APC system has the task of activating the brake to control the distance to a vehicle in front. Special value is attached to soft, comfortable braking.

A *proportional solenoid* (adjustment proportional to exciter current) was integrated in the tandem servo together with the membrane position sensor (stepless potentiometer) and *the release switch*.

To achieve high braking quality, the brake pressure is controlled by measuring the brake pressure at the master brake cylinder by means of a pressure ender. At the start of the control process, the pressure controller is subjected to a membrane position control.

During an electrically activated braking operation, the brake pedal moves accordingly.



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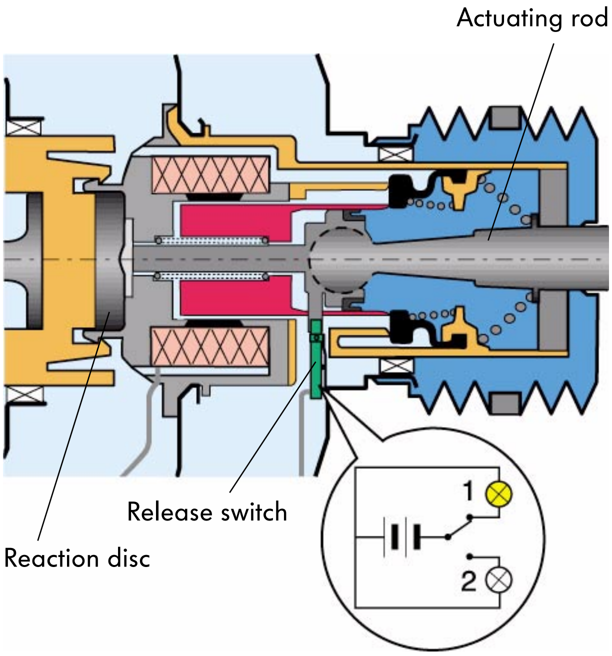
Release switch

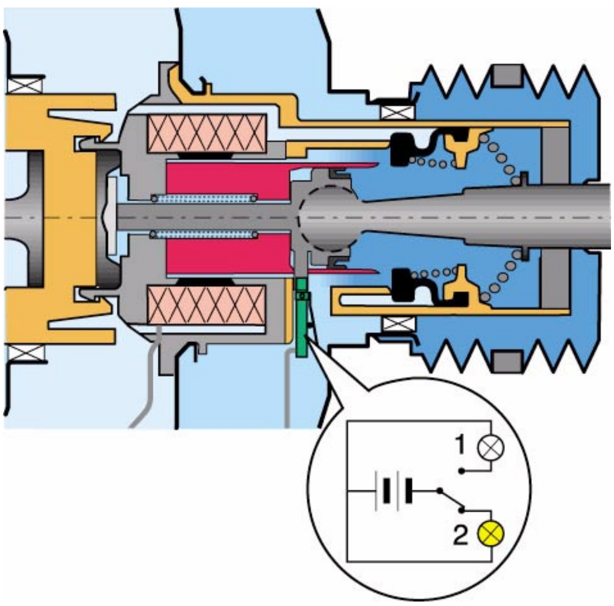
The *release switch* helps to distinguish whether the brake was electrically activated. Since the switch is a safety-critical component, it is designed as both an NC contact and an NO contact (two-way switch) in order to determine the rest and working positions.

In the rest position or when the brake servo is electrically actuated, no force is applied to the elastic reaction disc via the actuating rod, with the result that the reaction disc is pressure-relieved. In this position, the release switch rests against the housing of the brake servo and closes electric circuit 1.



S276_044

If the driver applies the brake, pressure is applied to the reaction disc via the actuating rod. The reaction disc is compressed. The release switch rises from the brake servo housing. Electric circuit 2 is closed.



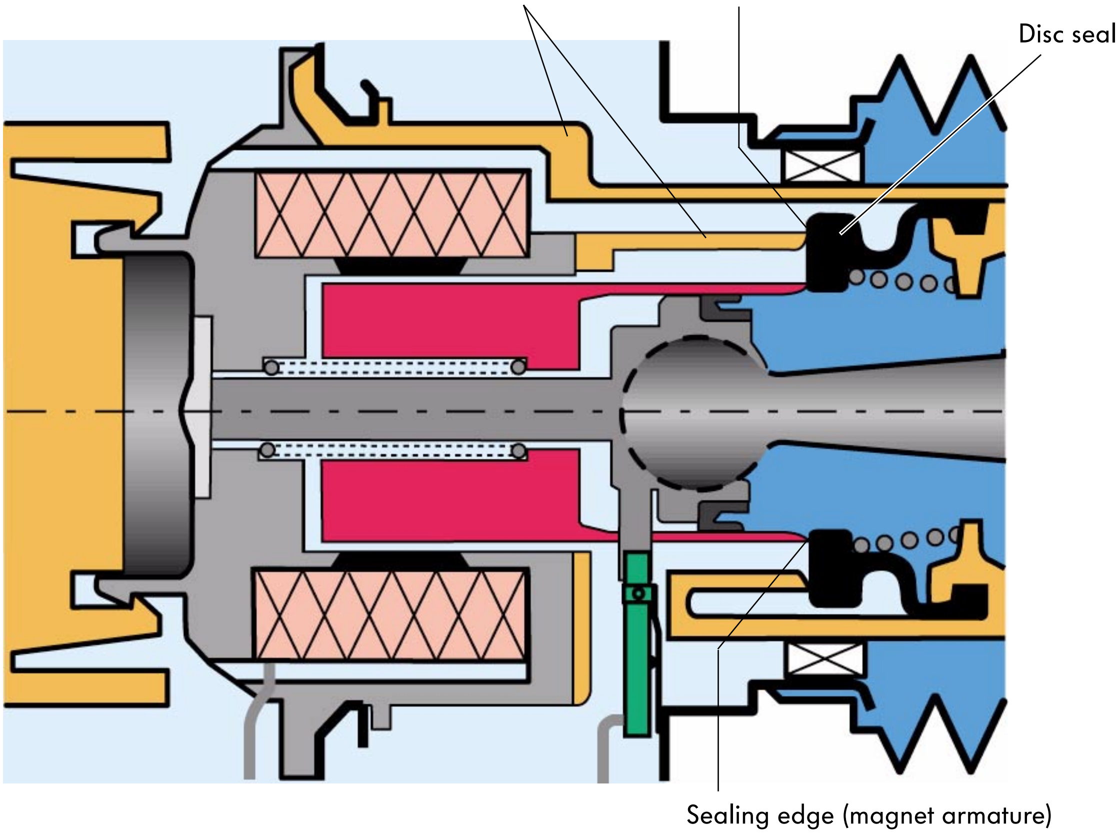
S276_062

Components of the APC system

Initial position

The amplifier is in its starting position, the vacuum has built up and the *proportional magnet* is de-energised.

The function of the *electronic brake servo* is defined by the sealing edge, which acts as a valve, and the disc seal. The pressure in the working chamber is dependent on the position of the valves.



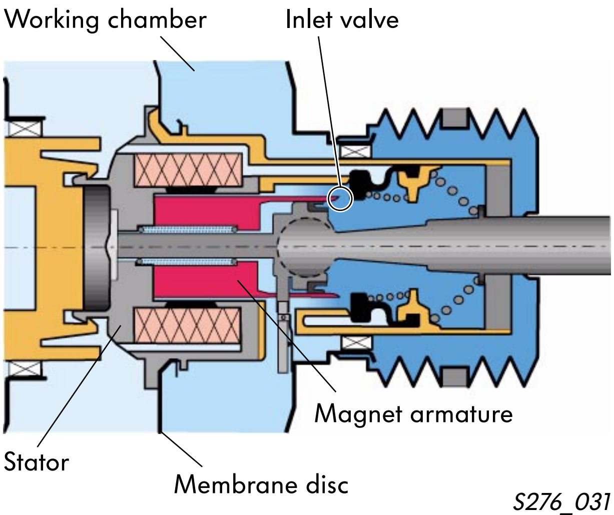
S276_043

The sealing edge of the solenoid armature acts as an inlet valve. The sealing edge of the valve body acts as an exhaust valve.

Both valves open and close when the sealing edge lifts off or rests against the disc seal.

Pressure build-up

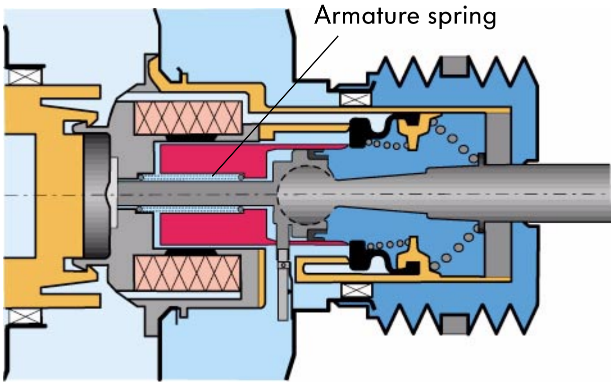
When pressure build-up is electrically activated, the *proportional magnet* is energised. The air gap between the *stator* and the magnet armature becomes smaller. The inlet valve opens, and atmospheric air flows into the working chamber. The membrane disc compresses the membrane spring. Up to approx. 30 % of the brake pressure can be achieved.



S276_031

Maintaining the pressure

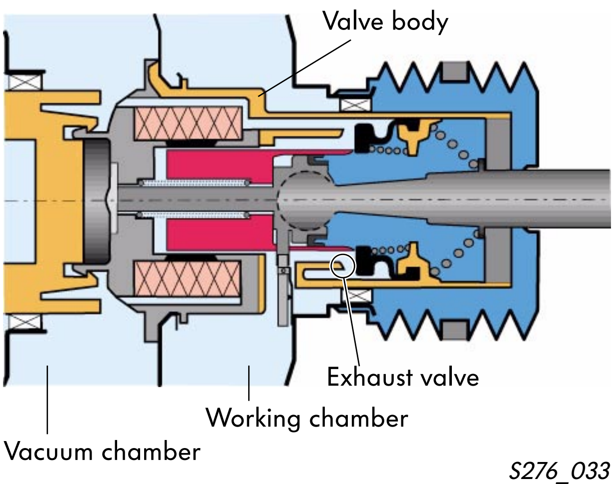
To maintain pressure, the current following through the solenoid is reduced. The armature spring pushes the stator and the magnet armature apart, thus closing the inlet valve.
The partial vacuum in the working chamber defines the position of the membrane disc.



S276_032

Pressure relief

If the solenoid is de-energised, the armature pushes the disc seal back over the sealing edge of the inlet valve. The exhaust valve is opened. The air in the working chamber flows into the vacuum chamber and is drawn off through the engine. The membrane spring relaxes.



S276_033

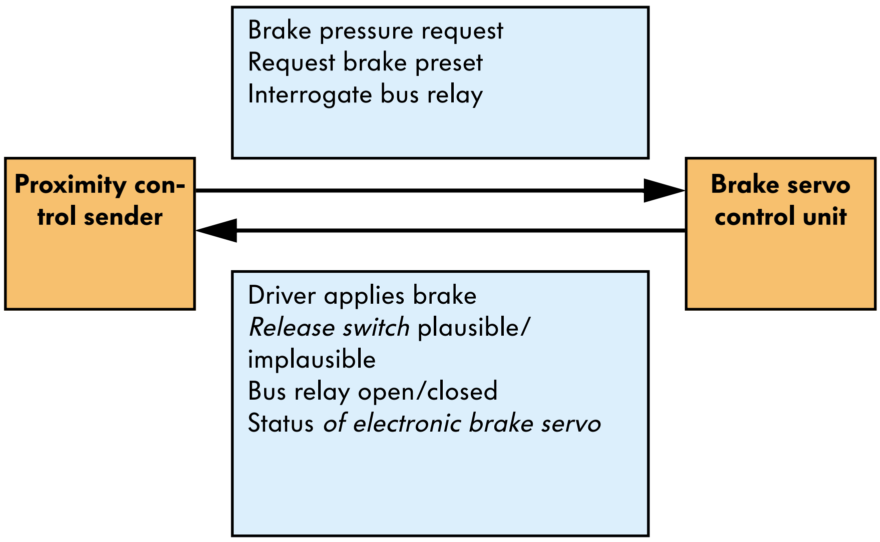
Components of the APC system

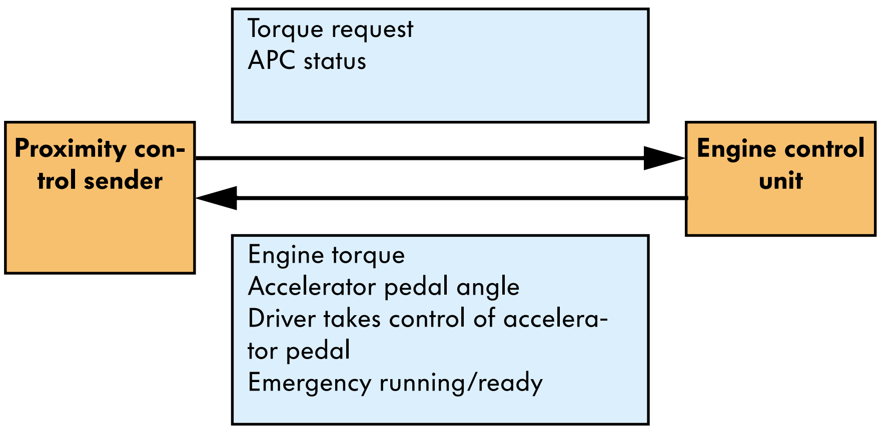
Data flow in the CAN network

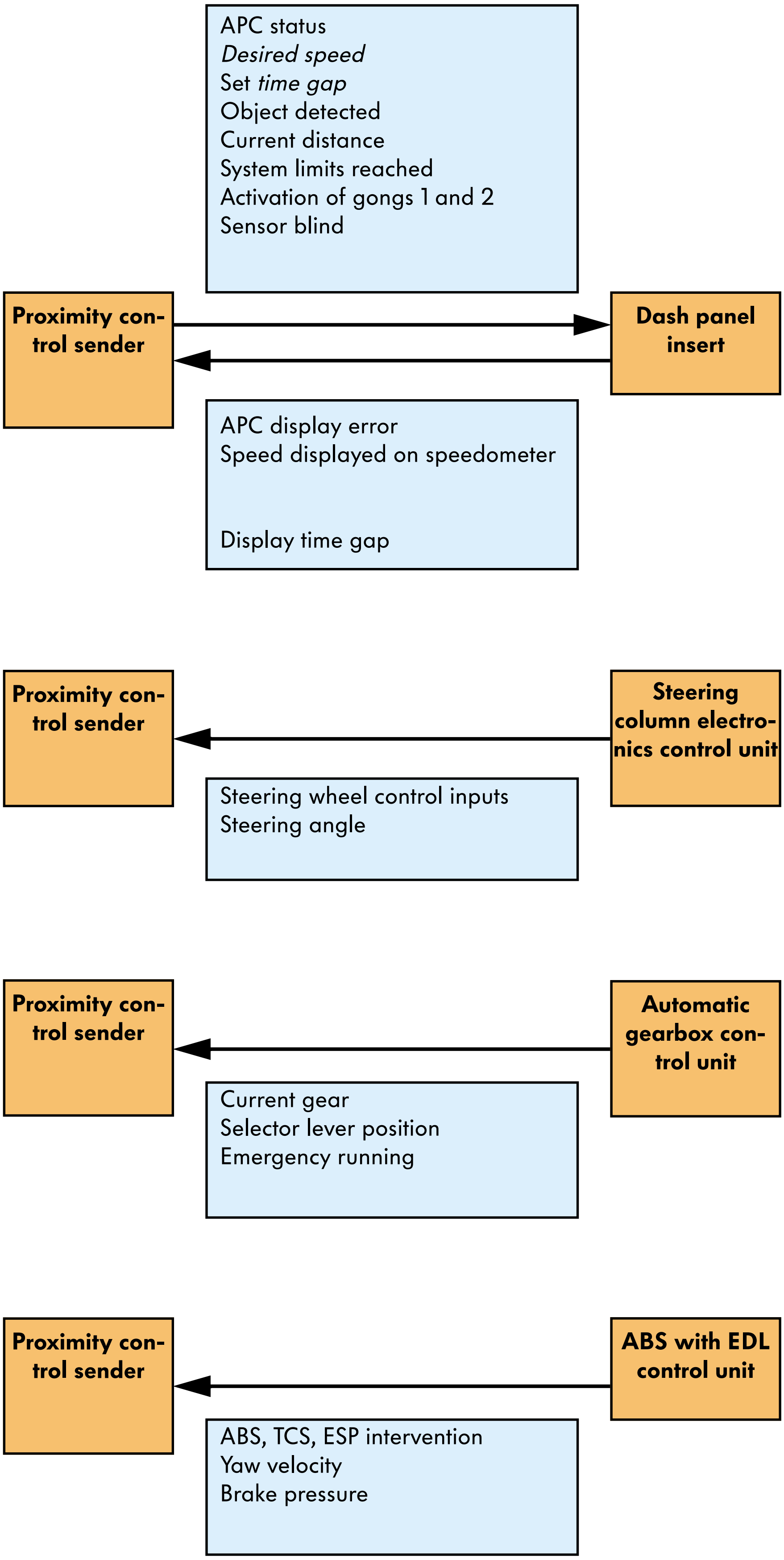
The proximity control sender is interfaced to the drive train CAN databus via the bus relay in the brake servo control unit.

The proximity control sender communicates with the control units:

- Brake servo control unit
- Engine control unit
- Dash panel insert
- *Steering column electronics control unit*
- Automatic gearbox control unit
- ABS with EDL control unit



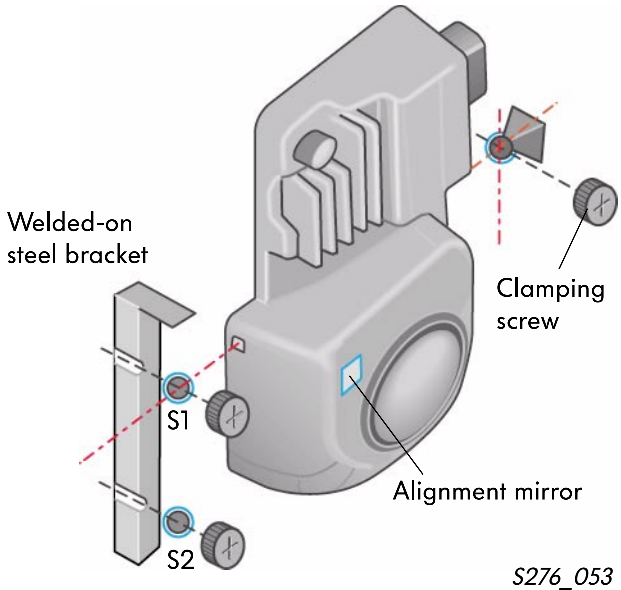



APC status
Desired speed
Set time gap
Object detected
Current distance
System limits reached
Activation of gongs 1 and 2
Sensor blind
Proximity control sender
Dash panel insert
APC display error
Speed displayed on speedometer
Display time gap
Proximity control sender
Steering column electronics control unit
Steering wheel control inputs
Steering angle
Proximity control sender
Automatic gearbox control unit
Current gear
Selector lever position
Emergency running
Proximity control sender
ABS with EDL control unit
ABS, TCS, ESP intervention
Yaw velocity
Brake pressure

Adjusting the proximity control sender

The proximity control sender is adjusted by means of two adjusting screws (S1 and S2) located on the left-hand side of the sender. The screw on the right-hand side serves as a clamping screw to of a ball joint as a third bearing point for the sender.
The adjusting screws have six detent positions per turn.

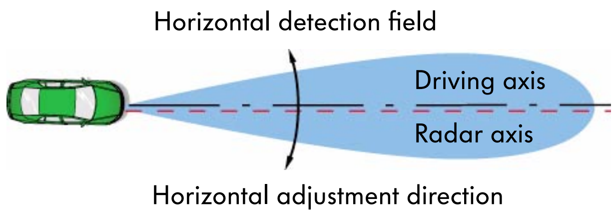
Turning adjusting screws S1 and S2 evenly swivels the sender into the horizontal plane. Turning adjusting screw S2 swivels the sender into the vertical plane.



S276_053

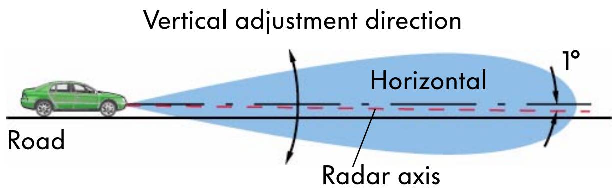
Align the centre line of the sender *detection field* both in the horizontal and vertical planes. In the horizontal plane, align the centre line (*radar axis*) in parallel to the *driving axis*. In the vertical plane, set an inclination of 1°.

Horizontal plane



S276_038

Vertical plane



S276_052

Mechanical adjustment of the proximity control sender is absolutely necessary after:

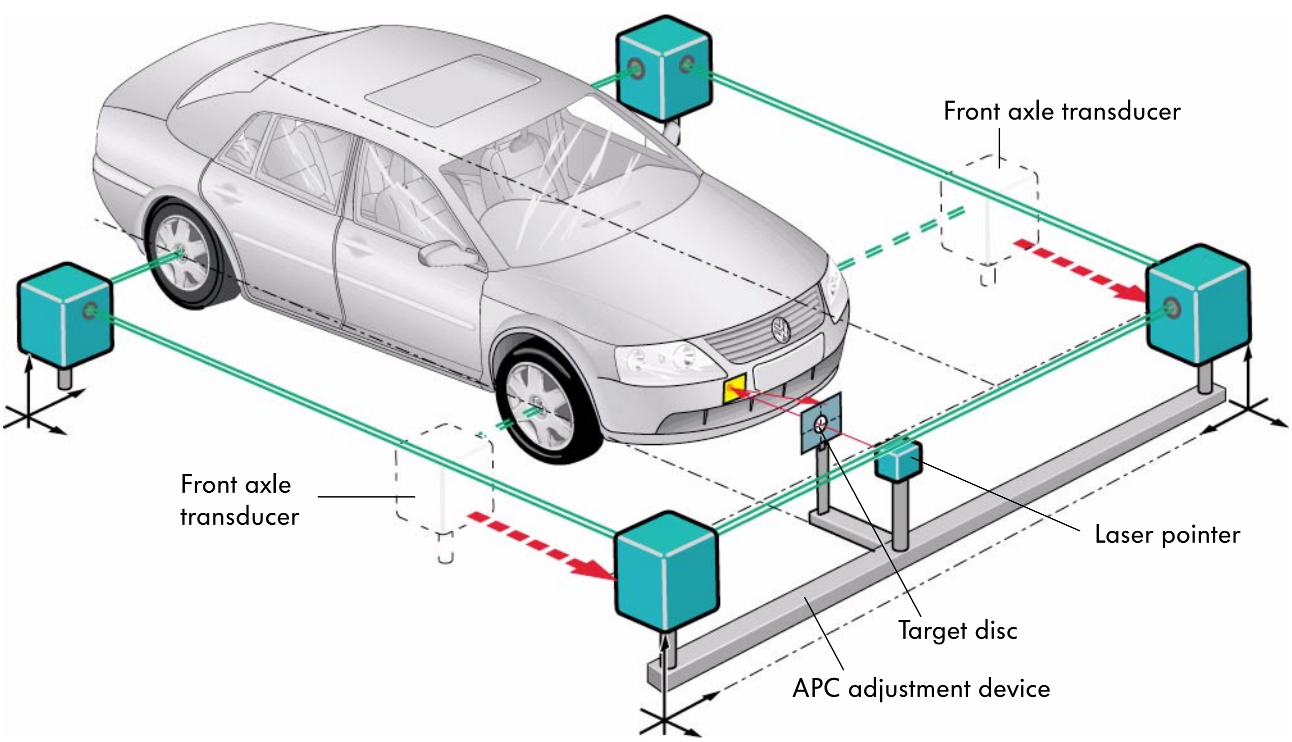
- adjustments to the suspension
- replacement of senders or cross-members
- the cross-member is subjected to mechanical stress (collision)

Measuring method

The *driving axis* is determined using a wheel alignment test stand and the APC adjustment device VAS 6041. A laser pointer is attached to the VAS 6041 level with the proximity control sender. A target disc is positioned between the laser pointer and the proximity control sender. The target disc has a centre hole through which the beam of the laser pointer impinges on the alignment mirror of the proximity control sender.

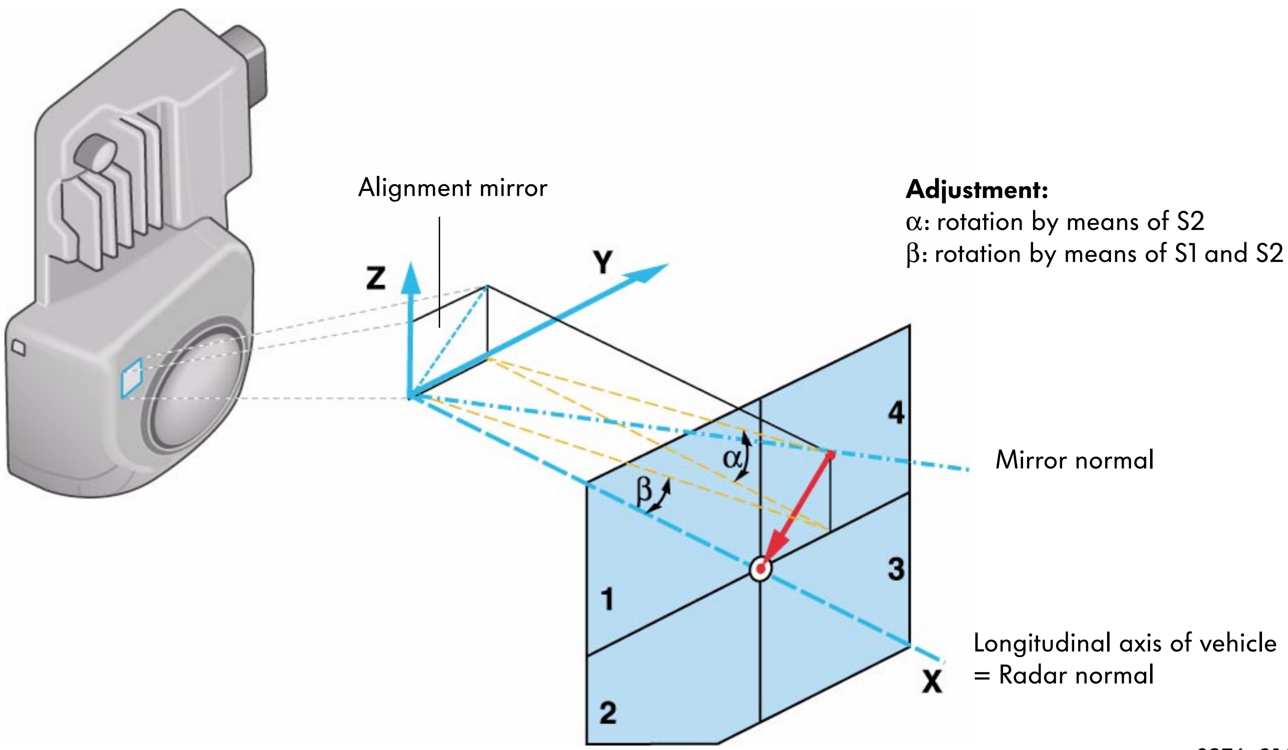
When the suspension is adjusted, the measuring equipment of the test bench is aligned in parallel with the driving axis. The APC adjustment device is aligned with the driving axis using the front axle transducers together with the remaining transducers on the rear axle.

Schematic diagram



S276_013

In the case of a perfectly aligned proximity control sender, the laser beam should be reflected through the centre hole in the target disc. If the APC is unadjusted, the laser beam impinges on the target disc in one of the
4-segment quadrants. The sender must be aligned by means of the adjusting screws such that the reflected laser beam passes through the centre hole in the target disc.



S276_014

In the horizontal plane, a high degree of adjustment accuracy is required. Only a rough adjustment can be made by means of the adjusting screws.
Fine adjustment is carried out electronically inside the sender while driving.

Correcting an indication error

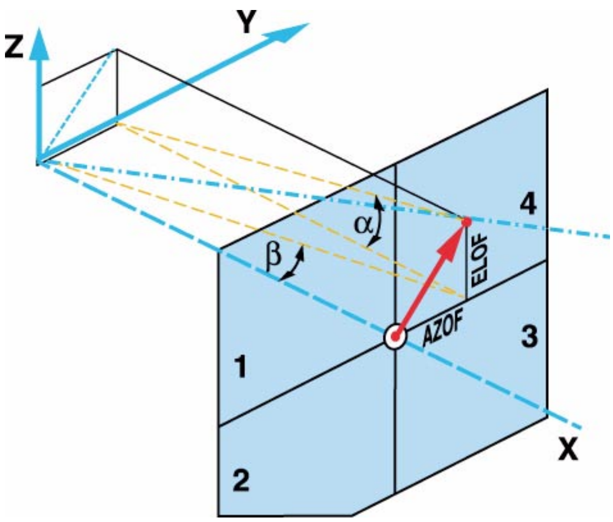
The mirror normal and the centre line of the *detection field* (radar normal) do not match up for production reasons. The *indication error* in the horizontal and vertical planes is measured at the factory and stored in the sender memory as a correction value. The indication error is specified as a number of detents of the adjusting screw.

The correction values can be exported with the VAS tester.

Once adjusted by the correction values, the laser beam moves from the centre into one of the quadrants. To check that the adjusting screws have been turned in the correct direction, the target quadrant is also stored in the sender memory.

Data block 06

- Meas. value 2: AZOF Mirror indication error in the horizontal plane (AZOF = azimuth offset)
- Meas. value 3: ELOF mirror indication error in the vertical plane (ELOF = Elevation Offset)



S276_015

Adjustment:
α: rotation by means of S2
β: rotation by means of S1 and S2

You will find details in the associated Workshop Manual.

Service

System safety

A series of measures have been taken to prevent a faulty APC system from posing a danger to other road users or resulting in a breakdown.
The most important measures are briefly explained below.

Release switch in the brake servo

The switch must reliably recognise driver brake actuation in order to switch the APC system to "Standby Mode". For this purpose, the switch is designed as a two-pole two-way switch.

Coil spring in the steering wheel

Steering wheel button information is transferred via a serial bus routed via the coil spring of the steering wheel. To ensure that the APC is switched off by the ON/OFF button in the event of a bus failure, this key information is transferred *redundantly* via a separate wire of the coil spring.

Redundant display

If the display fails, the red symbol for APC in the rev counter and the LED ring around the speedometer provide the driver with the minimum necessary information about the APC system.

Coupling the APC system to the ESP function

The APC is switched off or cannot be activated when the ESP function is not available. If ESP is activated during an APC braking operation or if it fails, the APC braking operation is nevertheless completed.

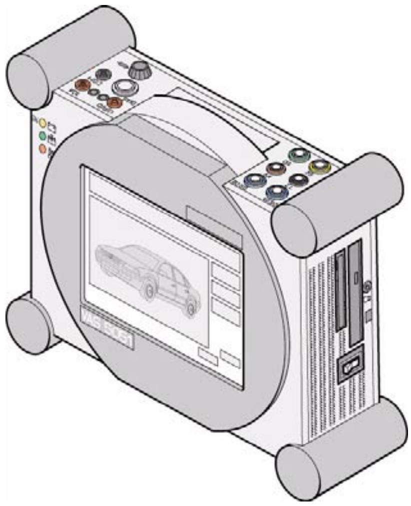
CAN databus disconnect

Since the proximity control sender must be mounted in an exposed position at the front end of the vehicle, there is a danger that it may receive damage. To prevent the vehicle from breaking down if the drive train CAN databus fails as a result of bus blockade by the proximity control sender, the sender is disconnected via the bus relay in the brake servo control unit.

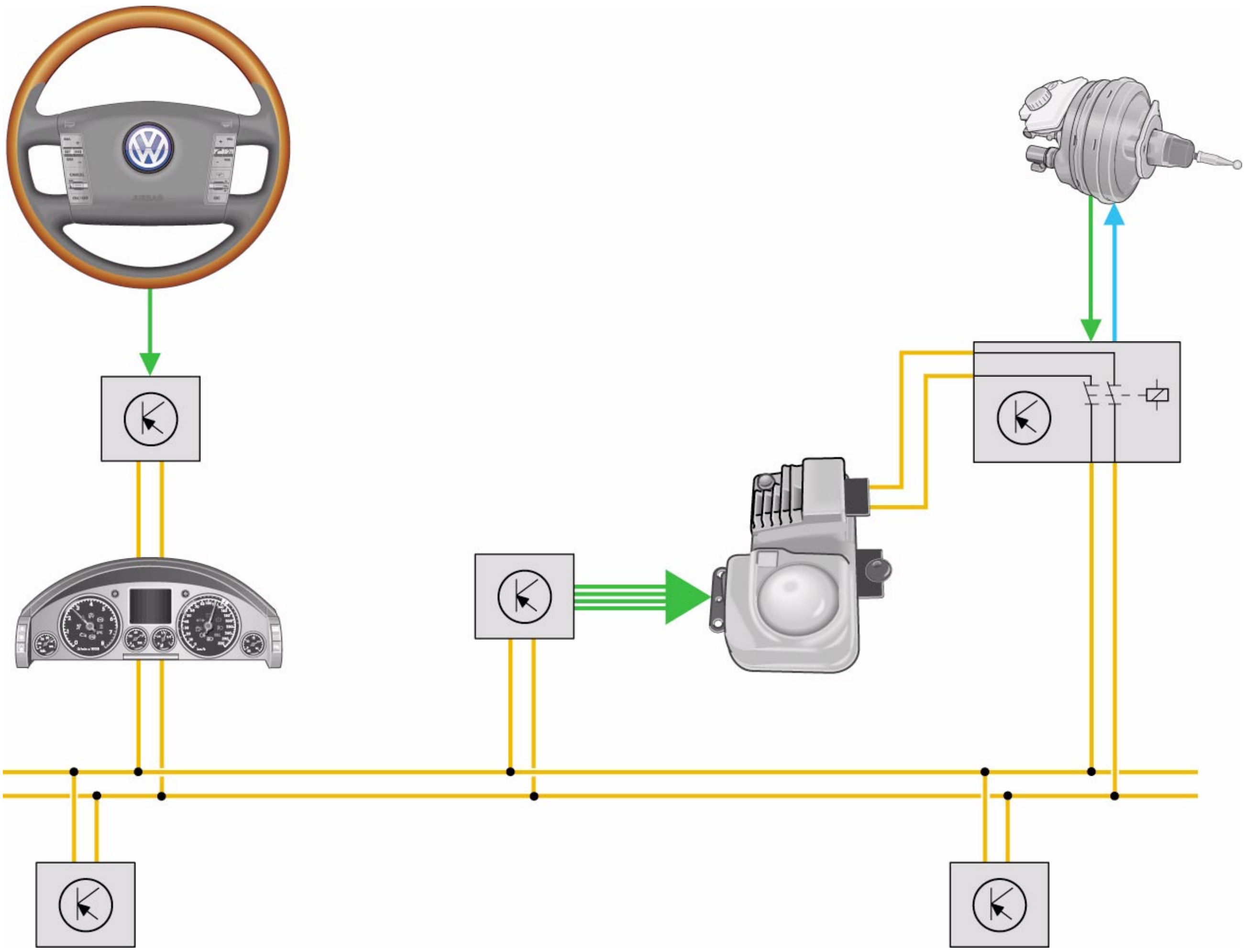
Diagnostics

The proximity control sender and the brake servo control unit continuously test for proper functioning. Any faults they detect are saved to the fault memory.

The fault memories can be read out and guided fault-finding can be performed by means of the Vehicle Diagnostic, Testing and Information System VAS 5051. You will find detailed information in the associated Workshop Manual.



S276_039



S276_057

Glossary

Azimuth angle

⇒ Reflection angle

Desired speed

The speed selected by the driver in CCS mode. In APC mode, the actual speed is less than the desired speed.

Detection field

⇒ Field of vision of sensor

Driver assistance system

Driver assistance systems are systems which support the driver however, without relieving him of his responsibility to guide the vehicle safely.

Driving axis

Direction of movement of the vehicle with the steering wheel in the straight ahead position.

Electronic brake servo

The electronic brake servo is a pneumatic brake servo which can operate the brake by means of an electromagnetic valve. A dedicated electronic control unit ensures precise brake pressure application.

Elevation angle

Vertical reflection angle

Field of vision of sensor

The region in front of the APC vehicle in which vehicle and obstacles are detected. Comparable with the illumination zone of a headlight (also referred to as detection field).

Following time

The road speed-dependent distance to a vehicle in front (also referred to as time gap).

Gateway

Electronic circuit or circuit component which facilitates data exchange between various data buses.

Indication error

Angular error in relation to the ideal direction.

Lane forecast

The APC system should only respond to vehicles driving ahead of the vehicle in the same lane. This requires a lane forecast. The system calculates the lane ahead from the measured variables wheel speeds, yaw rate and steering wheel angle.

Millimetre waves

Electromagnetic waves in the frequency range from approx. 30 to approx. 150GHz. The limits are fuzzy and are referred to as millimetre waves since their wavelength is in the millimetre range.

Mirror normal

Line vertical to the surface of the mirror.

Proportional magnet

Solenoid whose armature length is proportional to the coil current in the design range.

Proximity controller

The proximity controller in the APC system calculates the necessary engine torque or braking torque from the measured variables distance and relative speed to maintain the adjusted following time to a vehicle driving in front.

Radar axis

Axis of symmetry of the radar detection field.

Redundant

Components or signals for increasing fail safety.

Reflection angle

Horizontal angular deviation of an object in relation to the radar centre line.

Release switch

Two-way switch integrated in the electronic brake servo to detect brake application by the driver and initiate the APC brake.

Relevant object

An object that the proximity controller in the APC system uses for proximity control based on distance and relative speed.

Stator

Stators and armatures form the magnetic circuit of a solenoid whereby the stator is the stationary part and the armature is the moving part.

Steering column electronics control unit

The steering column electronics control unit comprises the steering column switch and sends steering wheel button information to the convenience CAN databus. The information provided by the steering angle sensor is sent to the drive train CAN databus.

Time gap

⇒ Following time

Test your knowledge

1. **How does the APC function as a driver assistance system?**

☐ a) It maintains the margin of safety to the vehicle ahead if necessary by means of an emergency braking operation.

☐ b) It allows the driver to drift along comfortably in the flowing traffic.

☐ c) It relieves the driver on motorways.

2. **Where does it make sense to use the APC?**

☐ a) On twisting hilly routes.

☐ b) In heavy urban traffic.

☐ c) On well-developed country roads with large curve radii > 500m.

☐ d) On motorways.

3. **What measured variables does the proximity control sender determine?**

☐ a) The distance to other road users in front.

☐ b) The time gap.

☐ c) The azimuth angle to other road users in front.

☐ d) The desired speed.

☐ e) The vehicle's speed relative to other road users in front.

4. **From what variables is the lane forecast calculated?**

☐ a) The yaw rate measured in the ESP.

☐ b) The distance to a vehicle in front.

☐ c) Steering wheel angle.

☐ d) Wheel speeds.

5. **What are sensors used to ensure the high braking quality of the electronic brake servo?**

☐ a) The brake pressure sender G 201.

☐ b) The release switch.

☐ c) The membrane position sensor.

6. **When is it necessary to readjust the proximity control sender?**

☐ a) After replacing the sender or cross-member.

☐ b) After minor damage to the rear end.

☐ c) After adjusting the suspension.

7. When is adjustment of the proximity control sender completed?

☐ a) When the laser beam which passes through the centre hole on the target disc is reflected by the APC adjustment device.

☐ b) When the adjusting screws are tightened as far as the stop.

☐ c) When the laser beam impinges on the specified quadrant after turning the adjusting screws according to the values in data block 06. Provided that the adjustment procedure begins in the position in which the laser beam passing through the centre hole on the target disc is reflected by the APC adjustment device.

8. What is the function of the bus relay?

☐ a) It replaces the gateway and connects the convenience CAN bus to the drive train CAN bus.

☐ b) The solenoid valve in the electronic brake servo is activated via this relay.

☐ c) It helps to preserve theft protection by preventing the immobiliser code from being interrogated at the proximity control sender.

☐ d) Vehicle availability increases because a defective CAN databus of the proximity control sender does not the impair the drive train CAN bus.

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

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240.2810.95.20 Technical status: 02/02

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