Service Training

Das Auto.

Self Study Program 890253

Volkswagen Driver Assistance Systems

Design and Function

Version 2

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Contents

This Self-Study Program provides information regarding the design and function of new models.
This Self-Study Program is not a Repair Manual. This information will not be updated.

For maintenance and repair procedures, always refer to the latest electronic service information.

Note

Important!

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Introduction

Did You Know?

An on-board computer requires 0.25 seconds to react to an impending danger. A person only overcomes their surprise and reacts after about a one-second delay.

Driver Assist System Development

Increasing traffic density, higher travel speeds, increasing mobile and vehicle alerts all place extra pressure on the driver. Passive safety systems such as Anti-Lock Braking Systems (ABS), side impact protection or airbags have all helped in significantly reducing the number of accidents resulting in severe, or even fatal, injuries. However, these systems cannot alert a driver to impending dangers.

The history of the automobile is a history of technical progress. Improving safety and comfort has always been an important part of this progress. The very first "seat belt" was patented in 1903. The invention of ABS in the 1960's was an important step for increasing safety when driving and reducing the number of accidents. Scientific studies have revealed that over 50% of all collisions are caused by a delayed response, or reaction failure of the driver. The weakest link in the chain when reacting to dangerous situations is, and will remain, the driver. Driver Assist systems make the best co-drivers due to their ability to process information at a higher rate of speed and accuracy than their human counterpart.

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Driver Assist systems help the driver avoid accidents by providing alerts, and in some cases intervening when the driver reaction is delayed and/or when the driver fails to respond. Today, Driver Assist systems can analyze the traffic situation, estimate dangers correctly, and in some cases, take appropriate action to mitigate damage and/or serious injuries.

It is important to note that no electronic system can relieve the driver of this responsibility. These systems can merely help drivers to remain focused on and be aware of their responsibility. The driver always retains legal responsibility for actions and vehicle behavior on the road.

Introduction

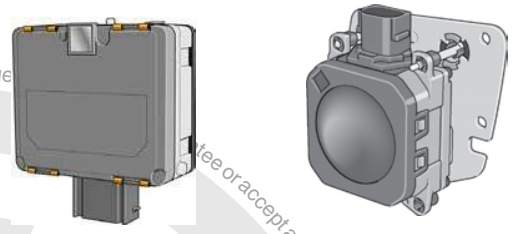
The Drive Assist Sensor Overview

To understand the different Driver Assist vehicle functions, we must first cover there the sensors are located on the vehicle, and how the sensors may vary between models. 2016 models feature several radar and camera sensor configurations that monitor the surrounding area.

Drive Assist Sensor Overview

Front Sensors

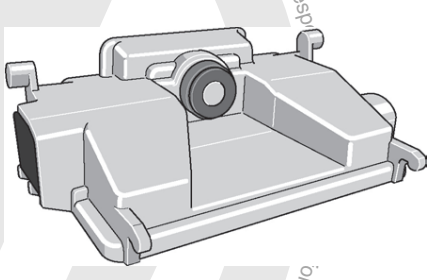
For 2016, many Volkswagen vehicles have a single mid-range radar sensor. The Touareg has a different system with two long-range radar sensors . These radar sensors are used for the Adaptive Cruise Control (ACC) and/or Front Assist functions.



Multifunctional Front Camera

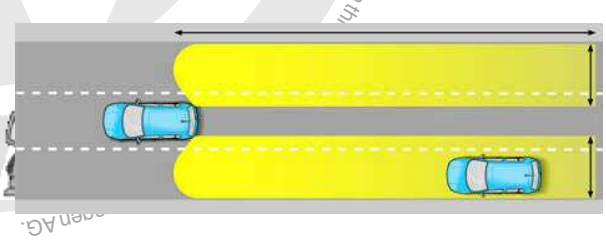
This camera detects vehicles that may be invisible to the front radar system by using an actual camera to monitor the area in front of the vehicle.

The camera monitors the area in front of the vehicle when stationary, preparing for a restart of the ACC system. It can also detect lane markings for lane departure warning (Lane Assist).



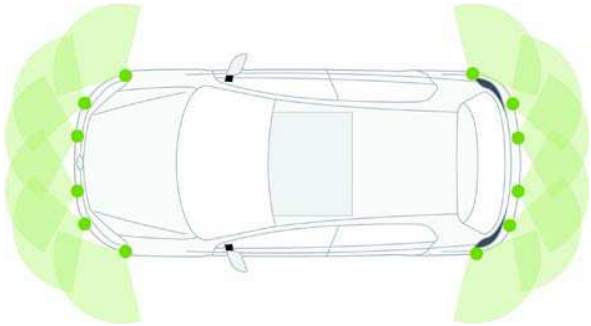
Rear Radar Sensors

Some vehicles have Blind Spot Monitoring and Rear Traffic Alert. These systems have two radar sensors under the rear bumper that scan traffic behind the vehicle.



6-Channel Ultrasound Sensors

For vehicles with Park Assist, two 6-channel ultrasound systems are used to monitor close range objects. This allows for assisted parallel and perpendicular parking.



Forward Radar Systems

Front Radar Sensors

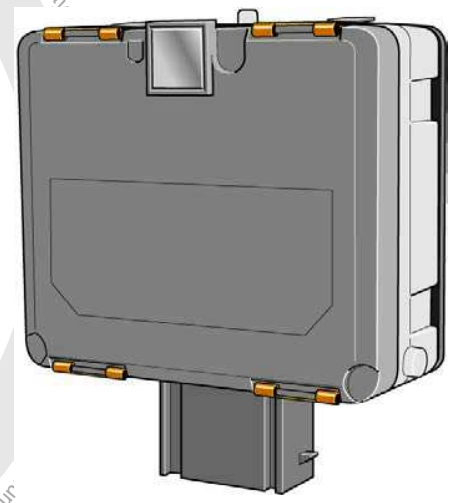
There are two different types of front radar sensors, the Mid-Range Radar and the Long-Range Radar sensors.

Mid-Range Radar (MRR) Sensor

The MRR Distance Regulation Control Module J428 is located at the front center of the vehicle, either behind the VW emblem, or below the VW emblem in the center of the bumper cover.

This is a radar sensor that detects vehicles and obstructions in front of the vehicle. It is used differently for different systems. It has the following features:

- It has a frequency of 77 GHz
- To keep ice off at lower temperatures, the MRR has a heater
- Range: Up to 525 ft (160 m)
- Speed: 0 - 100 mph (0 - 160 km/h)



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The MRR sensor is not standard equipment. However, it is used on many 2015 and newer vehicles, with the exception of the Touareg.

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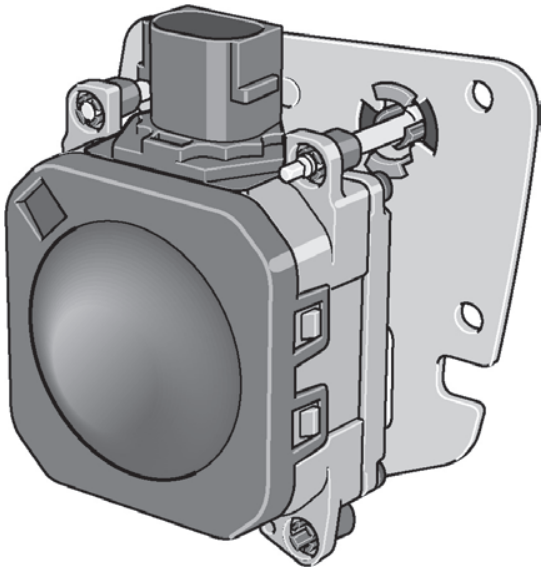
S470_028

Image of 2015 Jetta J428

Long-Range Radar (LRR) Sensor

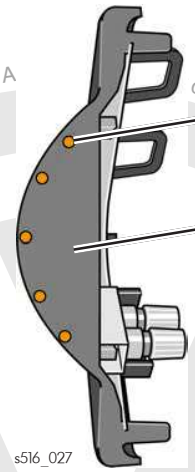
The Touareg uses two long-range radar sensors located next to the fog lamps. They are 3rd Generation radar sensors with the following features:

- Each sensor has four radar aerial units
- They have a frequency of 77 GHz
- To keep ice off at lower temperatures, the LRR has a heater
- Range: Up to 656 ft (200 m)
- Speed: 0 - 130 mph (0 - 210 km/h)



This new generation of dual radar sensors allows the entire width of a three-lane road to be scanned, from 99 feet (30 m) away.

The Distance Regulation Control Module J428 is the master, and it is located inboard of the right fog lamp. Distance Regulation Control Module 2 J850 is the slave and is located inboard of the left fog lamp.



A heater integrated in the sensor surface prevents or reduces ice and snow deposits. The LRR sensor is shown, however, both types of sensors are heated.

Image of 2015 Touareg J850

Forward Radar Systems

Forward Collision Systems

The front radar sensor does not mean that the vehicle has all possible forward radar functions. Two types of Forward Collision Warning are available:

- Forward Collision Warning
- Front Assist (including Forward Collision Warning and Autonomous Emergency Braking)

Front Assist

Front Assist monitors the distance to the vehicle ahead and recognizes if the following distance is too close. It warns the driver of a possible collision with a vehicle on the road ahead.

If there is a risk of rear-end collision, the Front Assist system can help (within the limits of the system) to reduce the severity of the accident, or in an ideal case, prevent the collision altogether.

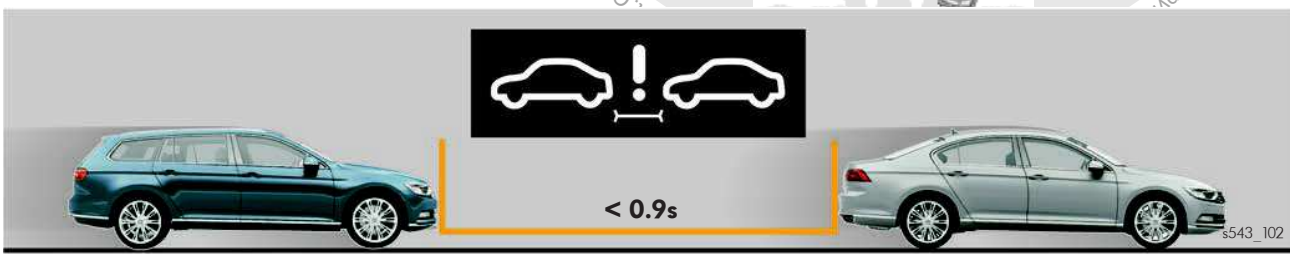
The Front Assist system does not brake the vehicle and is not a substitute for the driver's full concentration. The driver must always be prepared to take full control of the vehicle.

Front Assist Features:

- Distance Warning
- Advance Warning

Front Assist Distance Warning Function

The Front Assist Warning Function only issues a visual alert to drivers when the driver is following a vehicle in front at a distance less than 0.9s. This system prompts the driver to increase the following distance.



Function

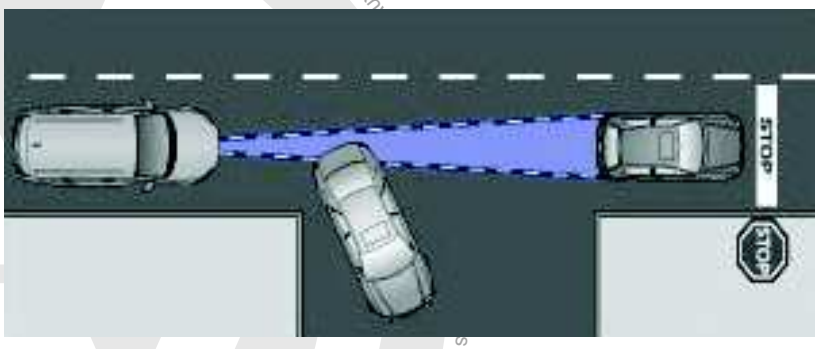
The distance warning system uses the radar sensor at the front of the vehicle to measure the distance to the vehicle in front. The distance warning software has software maps that compare speed and following distance.

If the system identifies a safety risk because of close following distance, the driver is warned by an image in the MFD of the instrument cluster. There is no audible alert for the distance warning.

Forward Radar Systems

Front Assist Advance Warning Function

The Advance Warning system issues a visual and audible alert to driver when the system detects a potential collision with a vehicle ahead. A warning chime sounds and an advance warning message appears in the instrument cluster display.



Function

The advance warning system also uses the radar sensor at the front of the car to constantly scan for possible collisions with other vehicles. The advance warning software has software maps that compare speed and following distance.

Unwanted Warnings

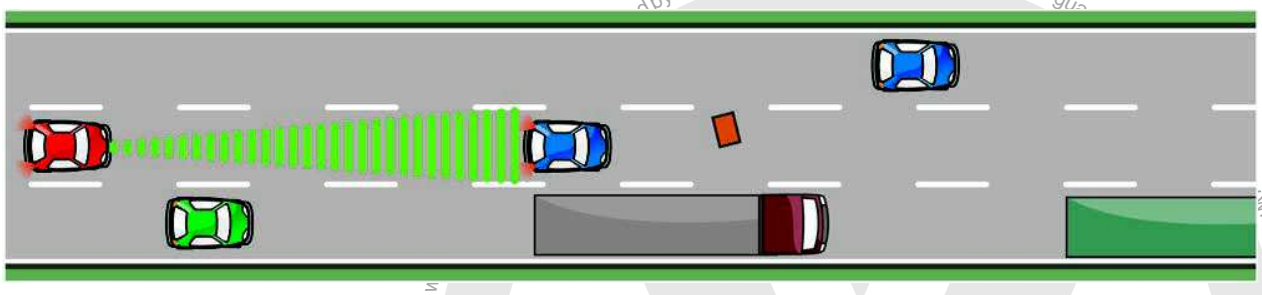
Because the radar system cannot predict the intent of either driver, unwanted warnings may occur. These can happen when vehicle turns off of the road or when overtaking another vehicle.

Front Assist with Autonomous Emergency Braking

The purpose of the Front Assist system is to avoid rear-end collisions. It uses a front radar and front camera (depending on equipment) to detect vehicles ahead and alert the driver to any critical situations.

The Distance Warning function of Front Assist is the same as described earlier in this SSP, however, the Advance Warning for Front Assist adds the following:

- Advance Warning with Autonomous Emergency Braking
- City Emergency Braking
- Braking Support



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Front Assist Functions

The ACC and Front Assist functions are integrated into the same control module. However, they operate independently of each other. Front Assist is active even when ACC is deactivated.

Advance Warning

If the vehicle is traveling between 18-130 mph (29-210 km/h) the system warns the driver with a warning chime and a message in the instrument cluster display of the system detects a possible collision ahead.

Intermediate Warning

If the driver fails to respond to the Advance Warning between approximately 80-100 mph (130-160 km/h), Front Assist can initiate a short active braking maneuver. This appears as a brake "jerk" to warn the driver of an impending collision.

Autonomous Emergency Braking

If the driver fails to react to the Intermediate Warning between 3-100 mph (5-160 km/h), Front Assist can initiate a braking maneuver that applies continuous elevated braking force. This occurs shortly before a collision and is designed to reduce vehicle speed and to reduce the effects of a collision.

Autonomous Emergency Braking Below 18 mph

If there is an impending collision between 3-18 mph (5-30 km/h), Front Assist can initiate an automatic braking maneuver without the distance, advance or intermediate warnings to reduce vehicle speed and help to minimize the effects of a collision.

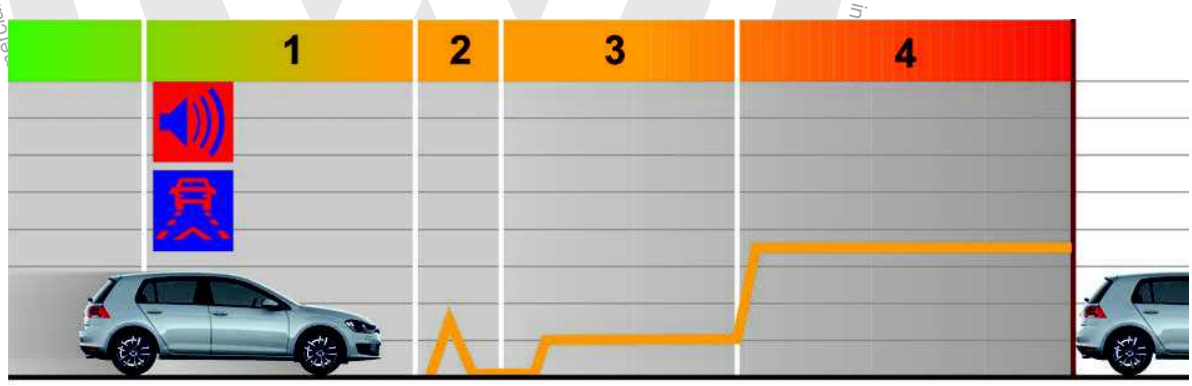
Forward Radar Systems

Front Assist with Braking: Golf Family

When the risk of a collision is identified, the brake system is prefilled. The triggering threshold for the brake assist system is lowered, and the driver is warned visually and acoustically. Additionally, an automatic jolt of the brakes warns the driver of the danger.

If the driver reacts by braking too gently, the vehicle automatically generates the brake pressure required for the situation.

If the driver fails to react to the warning jolt at speeds above 18 mph (30 km/h), the Front Assist system decelerates the vehicle up to 6 m/s² by braking automatically. This helps avoid a collision in the best case scenario or, at the very least, to reduce the severity of the accident.



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1. Advance Warning

- Brake Assist system:
  - Brakes are prefilled
  - Brake Assist system threshold switchover to Level 1
  - Visual and acoustic warning

2. Main Warning

- Brake Assist system:
  - Brake Assist system threshold switchover to Level 3
  - Brake jolt

3. Automatic Partial Braking

- Brake Assist system:
  - Automatic deceleration if the driver fails to react (up to 6 m/s²)
- Brake Assist system (less than or equal to 19 mph (30 km/h)):
  - Automatic deceleration if the driver fails to react (up to 8 m/s²)

4. Target Braking

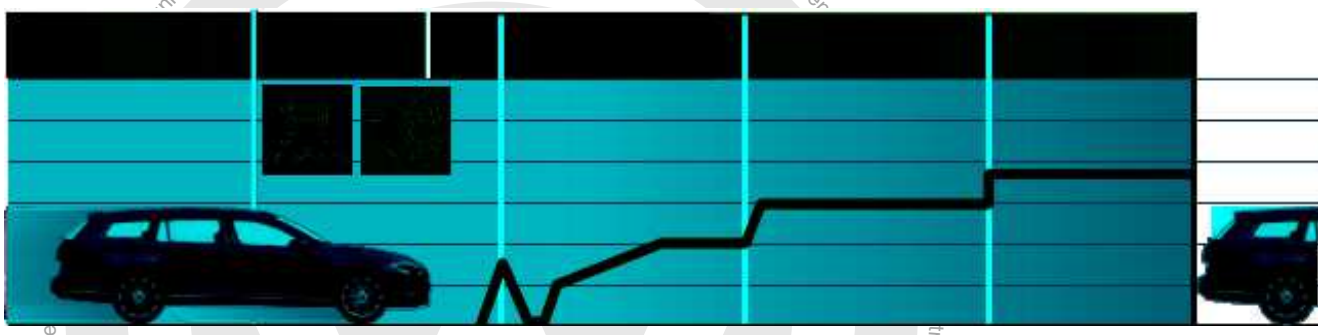
- Brake Assist system:
  - Enhancement of driver's braking maneuver to prevent a collision

Front Assist with Braking: 2016 Passat NMS

When the risk of a collision is identified, the brake system is prefilled. The triggering threshold for the brake assist system is lowered, and the driver is warned visually and acoustically. Additionally, an automatic jolt of the brakes warns the driver of the danger.

If the driver reacts by braking too gently, the vehicle automatically generates the brake pressure required for the situation.

If the driver fails to react to the warning jolt at speeds above 18 mph (30 km/h), the Front Assist system decelerates the vehicle by braking automatically. This helps to avoid a collision in the best case scenario or, at the very least, to reduce the severity of the accident.



Conditions

- Paused and moving vehicles
- Traffic 19-155 mph (30-250 km/h) speed range

1. Warning

- Prefill of the brake + brake assist threshold switching Level 1
- Optical and acoustic warning

2 Preparation

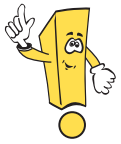
- Automatic partial braking
- Brake switch threshold Level 3

3. Brake Jolt

- Automatic braking of 3.5 m/s^2 building to:
- Automatic braking 6.0-8.0 m/s^2

4. Target Braking

- Full braking in order to avoid a collision



European Passat shown.

Forward Radar Systems

City-Emergency Braking: 2016 Passat NMS

The City-Emergency Brake is an extension of the Front Assist system, however it functions at lower speeds. Its functions are monitoring and automatic delay:

Monitoring

- The city-emergency braking function continuously monitors the distance to the traffic ahead.

Automatic Delay

- If the driver does not respond to the warnings, emergency braking is automatically initiated.

Timing of a Critical Approach (City-Emergency Braking)

Conditions

- Paused, moving and stationary vehicles
- Speed range 2-19 mph (4-30 km/h)

1. Warning

- Prefill the brake + Brake Assist threshold switching to Level 1

2 Preparation

- Brake Assist threshold switching Level 3

3. Automatic Partial Braking

- Braking at 8.0 m/s^2

4. Target Braking

- Braking at 8.0 m/s^2

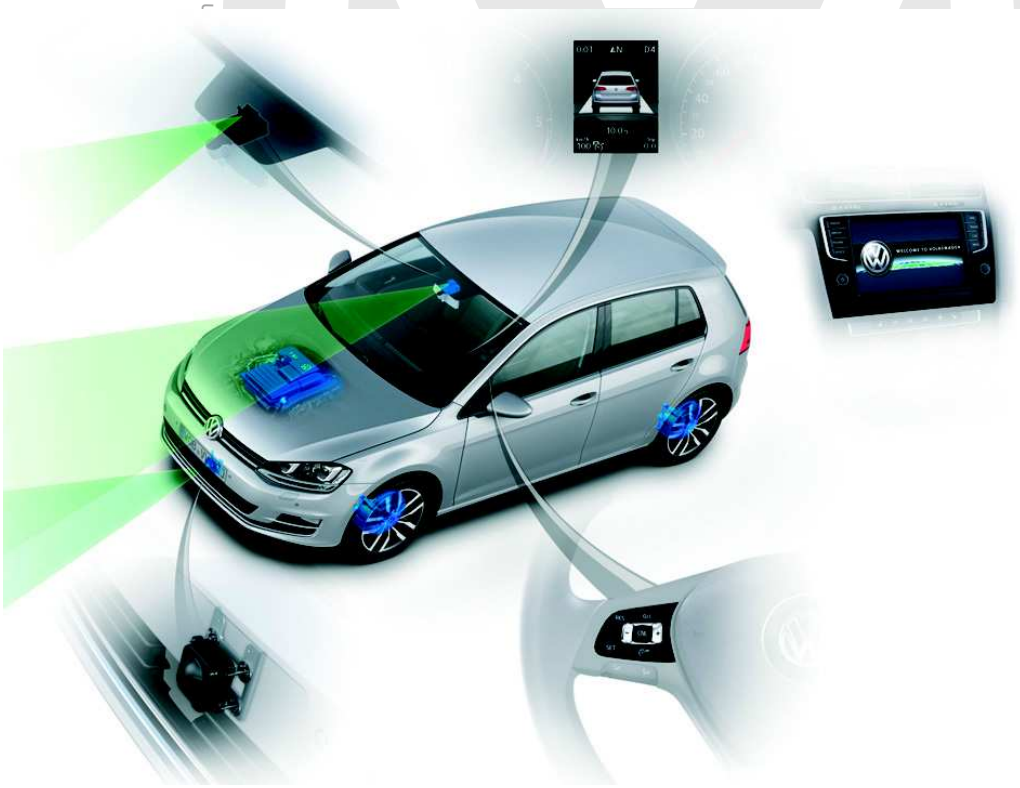
Adaptive Cruise Control (ACC)

Adaptive Cruise Control (ACC) is an intelligent cruise control system that can automatically regulate vehicle speed to maintain a selectable distance to the vehicle ahead. It adapts to current traffic conditions and adjusts the cruise control speed without driver intervention.

Design and Function

A radar sensor located at the front of the vehicle is constantly scanning to detect objects or vehicles ahead. The ACC multifunction steering wheel controls or stalk on the steering column allow for activation, deactivation and setting a preferred distance to the vehicle ahead.

ACC operates like cruise control, maintaining a preset speed. However, when a slower vehicle is ahead the ACC system reduces the vehicle speed to maintain a preset following distance. Some systems can even reduce the vehicle speed to a complete stop. When the area ahead of the vehicle clears, the ACC system accelerates to the preset speed again.



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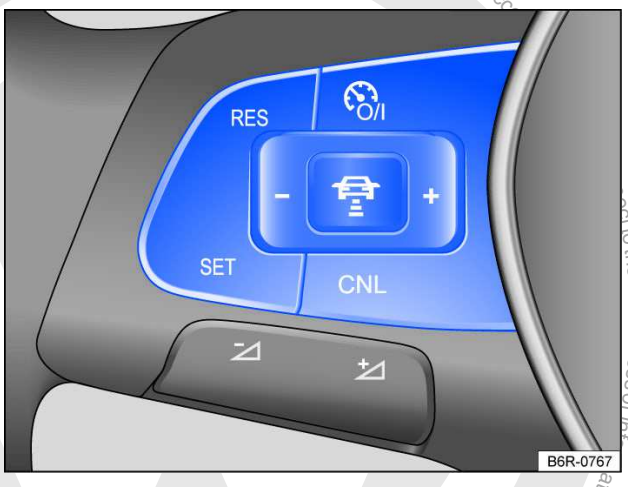
Forward Radar Systems

All system information, such as the preferred speed and warning messages, is displayed in the instrument cluster.

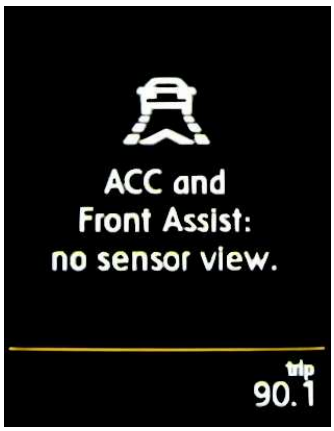
The ACC driving mode and the distance to the vehicle ahead may be configured in the infotainment system on certain systems. The Distance Regulation Control Module J428 transmits the preferred speed and distance values to the ECM. The ECM takes charge of coordinating acceleration and braking.

As with any driving situation, the driver is responsible for all vehicle operations. ACC can be immediately overridden using the brake or accelerator. During operation, the ACC system has limits. If these limits are reached or exceeded, the driver is informed and visually prompted to take control.



Operating Limits

If radar sensor operation is impaired by heavy rain, snow or dirt, ACC automatically deactivates. The message "ACC – no sensor image" appears in the dash panel insert. When the cause of the impairment has been eliminated, the driver can reactivate the ACC regulation.



Operation and Display

Function	Multifunction Steering Wheel Buttons	ACC Stalk Button or Action	Action
Activate ACC			The system is activated. Activation alone does not result in a speed being stored, ACC is not controlling the vehicle speed.
Set ACC Speed			The current speed is stored and speed regulation begins.
Switch off ACC temporarily			Speed regulation is temporarily deactivated. The preferred speed remains stored. **Stalk:** • By pressing further, ACC turns off
Resume ACC			The stored speed preference is resumed and regulated. If no speed preference has been stored, the ACC uses the current vehicle speed.
Accelerate (during ACC control)			• Pressing briefly (pull on stalk) increases the preset speed by 1 mph and stores it. • Pressing and holding (up on the stalk) increases the preset speed in 5mph increments as long as the button is held.
Decelerate (during ACC control)			• Pressing briefly (set on stalk) decreases the preset speed by 1 mph and stores it. • Pressing and holding (down on stalk) decreases the preset speed in 5 mph increments as long as the button is held.
Deactivate ACC			• Pressing briefly temporarily cancels ACC during active ACC control. Pressing briefly again turns off ACC. • Pressing and holding turns off ACC during active ACC control.
Increase/ Decrease Distance to Vehicle Ahead	 		• Pressing briefly increases the distance to vehicle ahead by one increment. • Pressing and holding cycles through following distances. **Stalk:** • Roll to the right to increase distance to the vehicle ahead. • Roll to the left to decrease distance to the vehicle ahead.

Forward Radar Systems

Controls and Display

ACC Following and Acceleration Control

The time interval to the vehicle driving in front can be set in five levels as displayed in the horizontal lines of the image below:

- 1.0 seconds
- 1.3 seconds
- 1.8 seconds
- 2.4 seconds
- 3.6 seconds

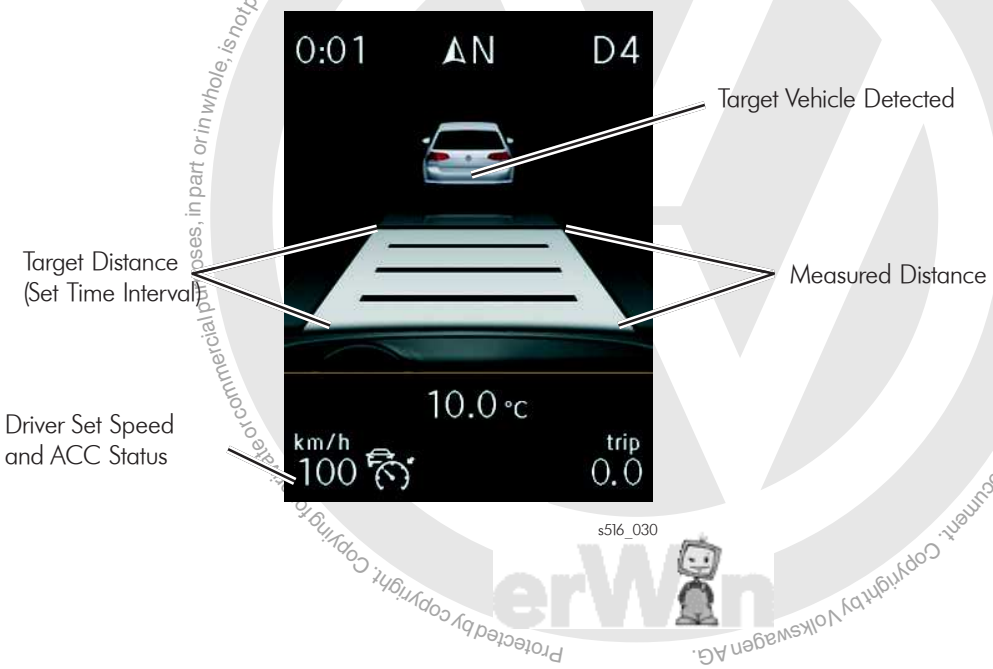
The vehicle driving mode can be set to three different acceleration characteristics:

- Normal
- Sport
- Eco

The driving mode can be changed in Multifunction display in the instrument cluster or in the infotainment system (if equipped).

Display Image

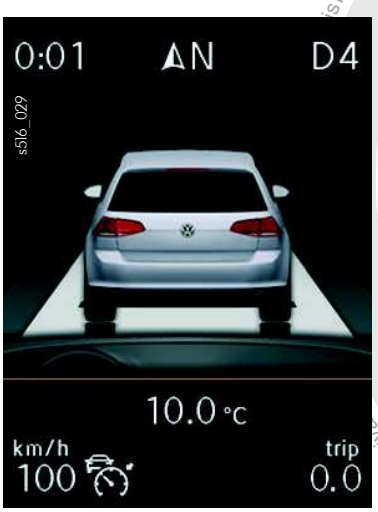
A vehicle driving ahead is displayed in the dash panel insert. The set speed and system status is displayed in the lower part of the screen.



Display Options

Adaptive Cruise Control can be displayed on both Premium and black and white instrument clusters.

- This is an example of the Premium instrument cluster ACC display

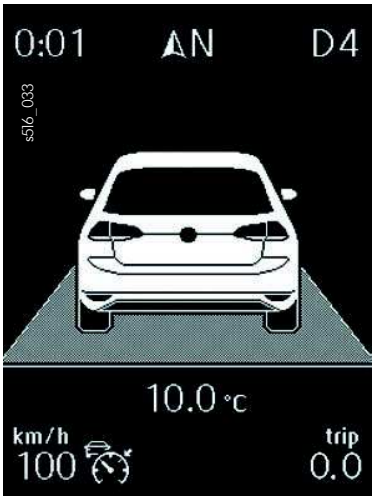


Distance control – small actual distance, large target distance

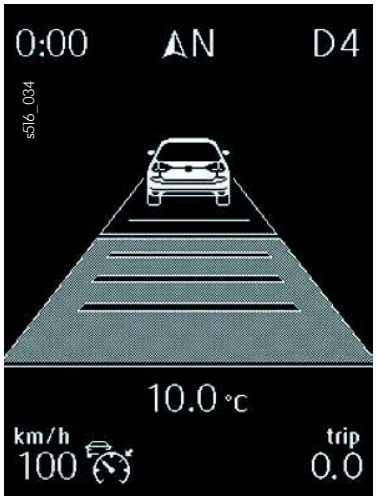
Distance control – large actual distance, large target distance (TI 4)

No distance control – no target object, large target distance (TI 5)

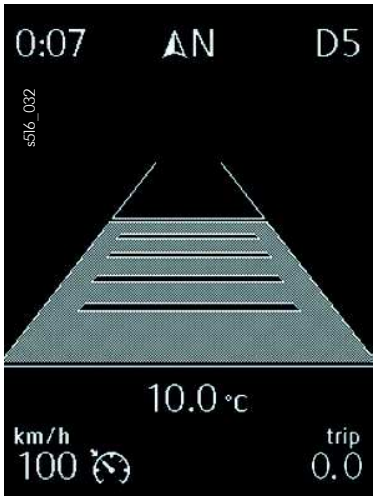
- This is an example of the black and white instrument cluster ACC display



Distance control – small actual distance, large target distance



Distance control – large actual distance, large target distance (TI 4)



No distance control – no target object, large target distance (TI 5)

Forward Radar Systems

ACC Variants:

There are three primary variants of Adaptive Cruise Control. For our purposes, we will call them:

- ACC Basic
- ACC Stop and Go
- ACC for Touareg

ACC Basic

When the ACC is actively regulating vehicle speed and the vehicle ahead slows, ACC can only reduce the speed to about 12 mph (18 km/h) before ACC speed regulation is deactivated and the driver is prompted to take control by visual and audible signals. ACC does not reduce vehicle speed to a standstill. The brake pedal must be pressed by the driver to fully stop the vehicle.

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Technical Data

- Speed 0-100 mph (0–160 km/h)
- Can be activated > 18 mph (30 km/h)
- Range 394 ft (120 m)
- Mid-range radar sensor with a frequency of 77 GHz
- Deactivates at 12 mph (19 km/h)

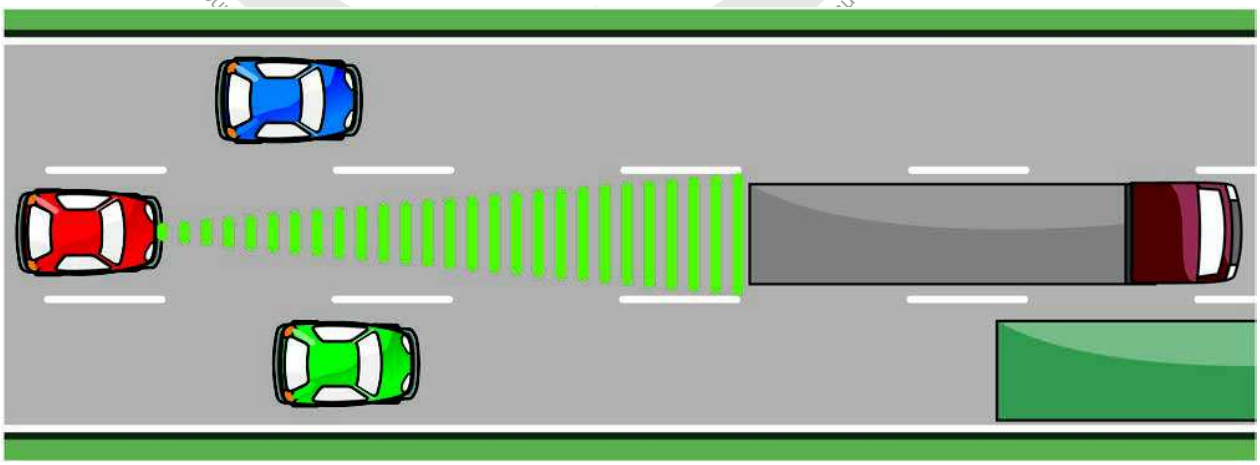
ACC Stop and Go

Task

The ACC system is different from the ACC Basic system because it brings the vehicle to a complete stop if the vehicle ahead comes to a complete stop. When the vehicle ahead begins to move, the speed increases to match the speed and following distance of the vehicle ahead. Parking aid sensors are not used for this function.

Function

When the vehicle ahead is slowing, the vehicle reduces engine torque and applies the brakes if necessary, to match the vehicle speed ahead. If the vehicle ahead comes to a complete stop, the engine goes to idle, and the brakes remain applied using the ABS Control Module.



The ACC System Identifies Vehicles Driving in Front

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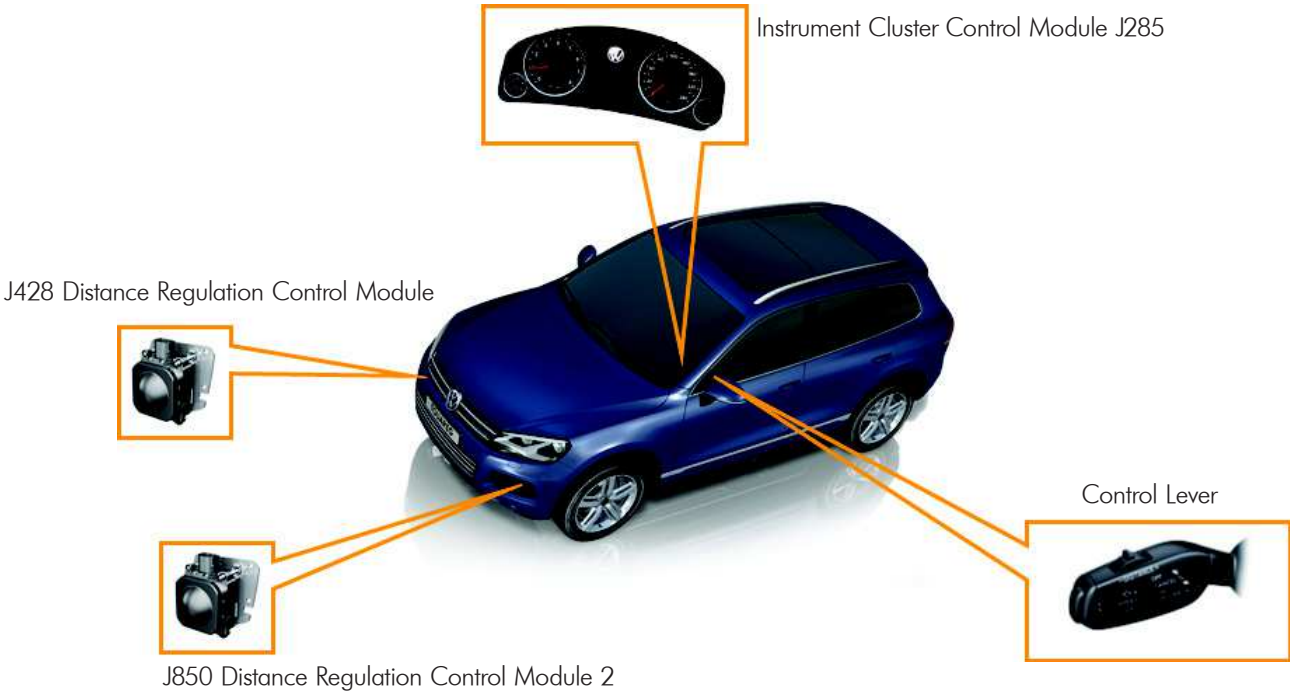
Technical Data

- Speed 0-100 mph (0–160 km/h)
- Can be activated > 18 mph (30 km/h)
- Range 492 ft (150 m)
- Mid-range radar sensor with a frequency of 77 GHz

Forward Radar Systems

ACC for Touareg



The Touareg uses a Stop and Go ACC system. During ACC operation the vehicle follows another vehicle (distance-controlled) and can brake to a standstill, if required. After a vehicle standstill has been detected, the vehicle is held by the hydraulic brake system (similar to Auto Hold function). The driver must give a brief tap or push of the accelerator pedal to continue distance regulation.

Advantages

- The dual LRR antenna design enables a range of up to 656 ft (200 m) and a 42° field of view
- The overlap angle has been substantially increased using two radar sensors. At 90 ft (30 m) ahead, the detection range is wider than a 3-lane highway with a width of approximately 52.5 ft (16 m)

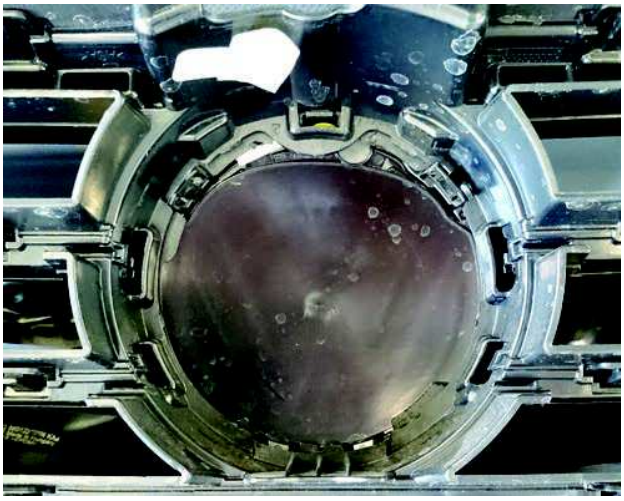
Limitations

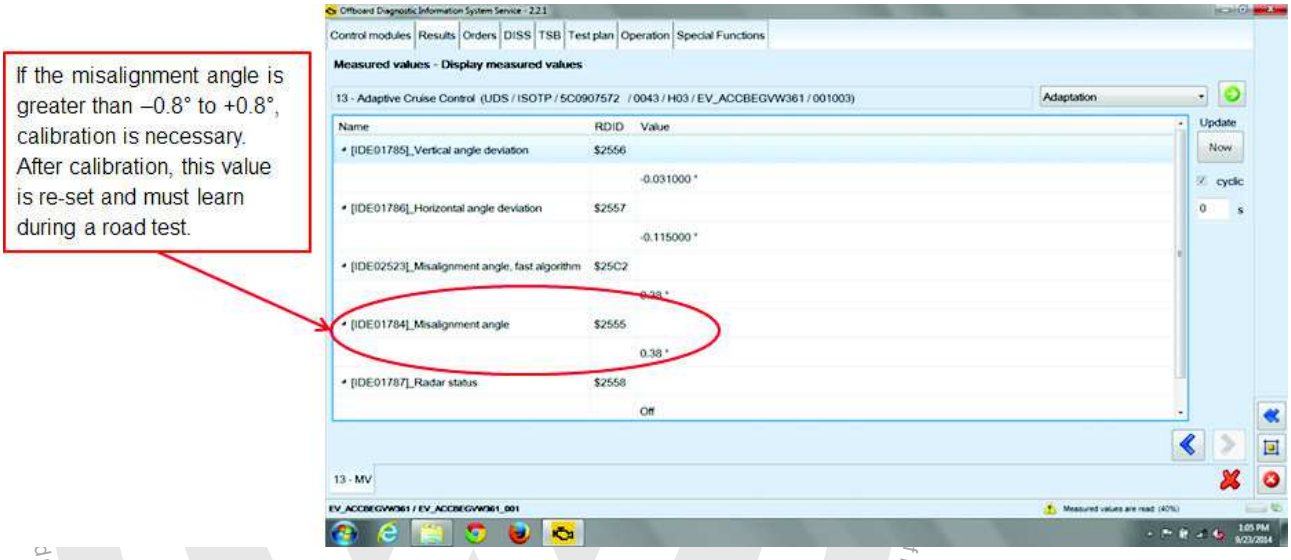
- The accelerator pedal must be pressed to activate ACC following distance)
- ACC is only capable of providing approximately 30% of the vehicle maximum brake force

Calibration Requirements for Forward Radar Sensors

Calibration of the forward radar sensor is required if any of the following occur:

- Rear axle toe setting has been adjusted (thrust angle)
- The Distance Regulation Control Module J428 has been removed and reinstalled
- The front bumper support has been removed and installed
- The front bumper support has become loose or has been moved
- The misalignment angle is greater than –0.8° to +0.8° (see below)
- The vehicle has been brought into the service position
- When performing an alignment





Multi-Function Camera

Front Camera (except Touareg)

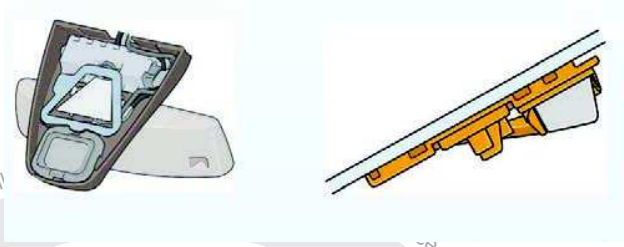
Location

The front camera is located on the inside of the windshield above the rear view mirror.

Task

The Driver Assistance Systems Front Camera R242 provides image information to the following driver assist systems:

- Lane departure warning (Lane Assist)



Function

The front camera supplies a grey scale image with an additional red filter to improve the contrast. A special exposure control system provides sharp pictures of the area in front of the vehicle – even when the vehicle is moving.

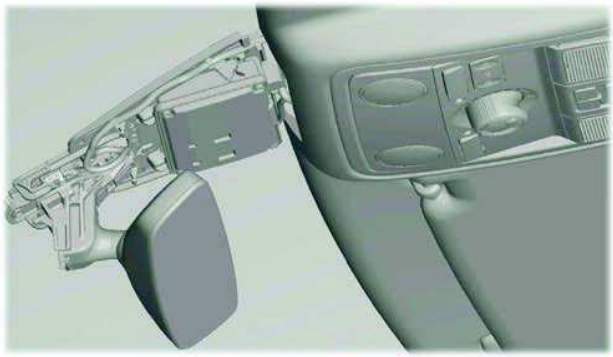
The object recognition system uses image processing. An object list is integrated into the R242 module.

The position of any detected object is captured by the camera and then transferred to the Distance Regulation Control Module J428. J428 compares (merges) the camera object data with the data of objects detected and mapped using radar.

The front camera can detect a variety of objects, such as lane markers and contrasting lane boundaries.

The front camera has its own heating unit. The Window Defogger for Front Sensor System Z113 prevents the part of the windscreen directly in front of the camera from misting up or icing over.

R242 and the Camera Control Module J852 are part of the same module. With the Operating and Display Protocol (ODP), J852 sends information via the extended CAN-Bus to be used by the lane departure warning system.

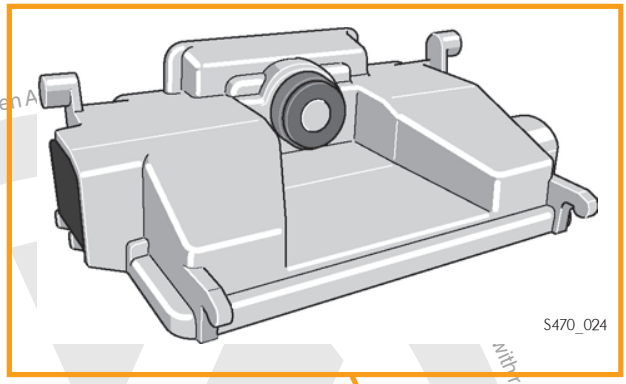


Multi-Function Camera

Touareg Front Camera

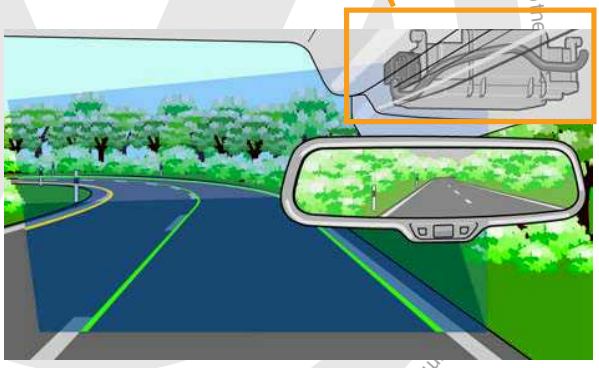
The front camera for the Touareg is the same as other front camera systems. It is integrated into the mirror base and has the following features:

- It is a color camera with 1024 x 512 resolution
- The range can be up to 2624 ft (800 m)
- The horizontal opening angle is 42° and the vertical angle is 21°


S470_024

The camera in the Touareg provides image information for the following driver assist systems:

- ACC with Front Scan with reduced stopping distance 196 ft (60 m)
- Lane Assist 262 ft (80 m)
- Traffic sign/marking recognition (later introduction)


S470_034

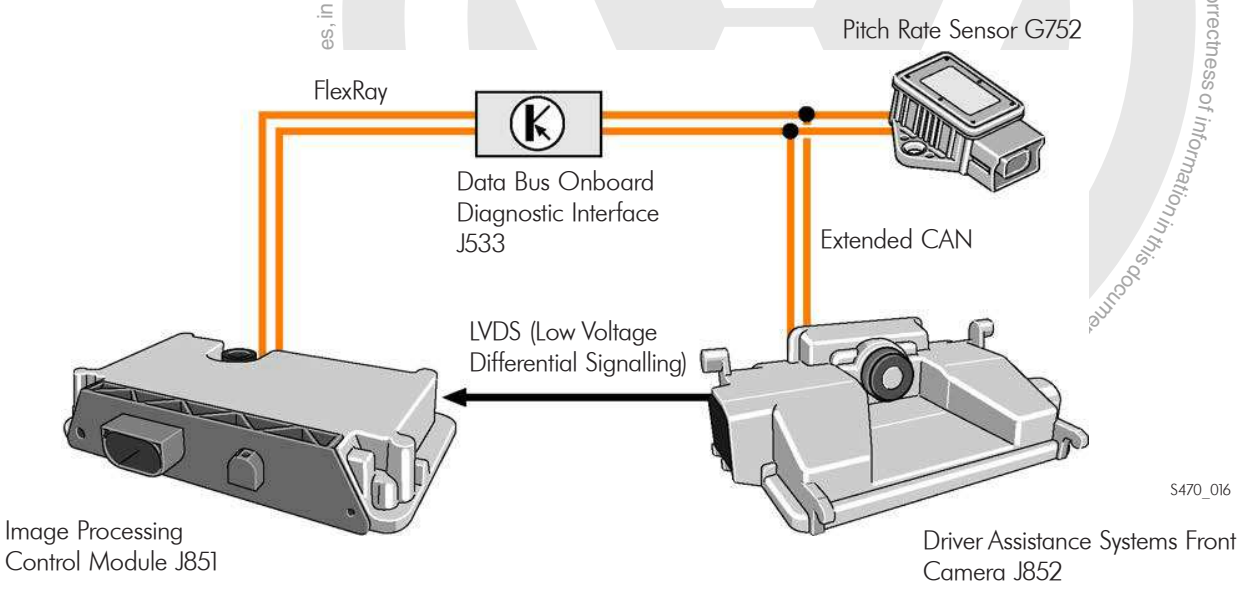
Multi-Function Camera

Touareg Front Camera

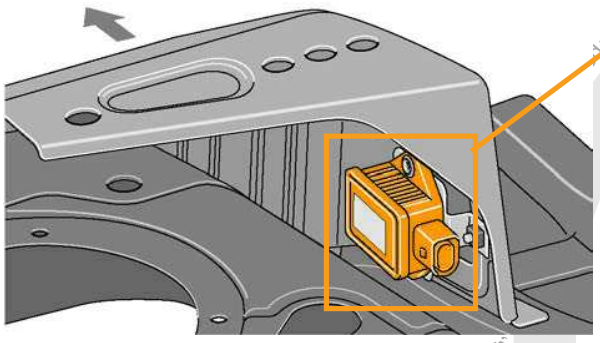
If the Touareg has ACC, there are additional components and image processing. The Image Processing Control Module J851 is used to process the images received by J852. J852 sends the image information via a fast LVDS (Low Voltage Differential Signalling) line.

Safety-relevant signals are sent along the fast FlexRay Data-Bus, supplying information to control modules J428 Distance Regulation Control Module and J850 Distance Regulation Control Module 2.

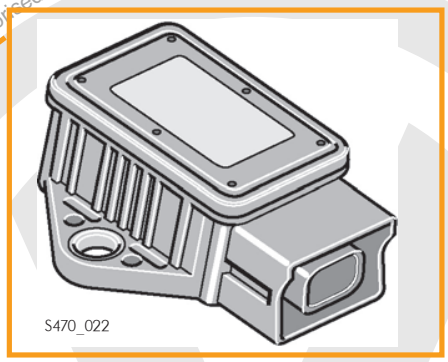
To calculate the dive angle of the vehicle about the Y-axis with greater speed and safety, the camera control module has a Pitch Rate Sensor G752, which is connected via the Extended CAN.



Pitch Rate Sensor G752



S470_020



S470_022

The Pitch Rate Sensor G752 is located on the right rear bench seat support panel.

It provides the vehicle y-axis rotation rate and transfers this information through the Extended CAN exclusively to the front camera J852.

The camera needs the dive angle for image processing functions.

The pitch rate sensor is not capable of self-diagnosis and does not have its own diagnostic address. Diagnosis is possible through J852 using address code 85.

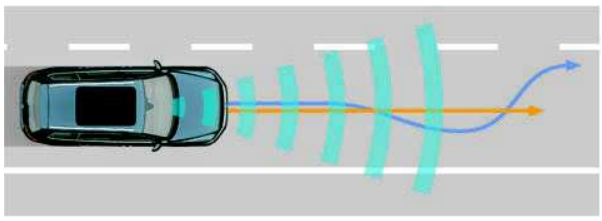
Multi-Function Camera

Lane Assist (Lane Departure Warning)

There are Lane Assist systems with different capabilities. This section focuses on the Lane Assist system that can both warn the driver and turn the steering wheel.

Function

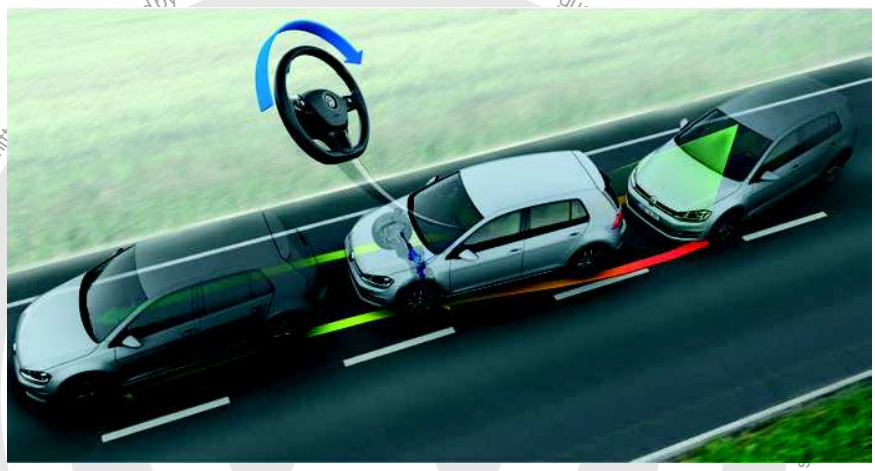
The front camera on the windshield identifies lane markings on the road. It processes these lane markings with other signals to determine if the vehicle is staying in the lane, or leaving the lane.



s543_021

If the vehicle seems likely to leave the lane without driver input, the system automatically counteracts the steering to keep the vehicle in the lane. This countersteering is continual and gentle. However, it can be overridden by the driver at any time with relative ease.

This system does not relieve the driver of any driving responsibilities.



s516_021

System and Operating Conditions

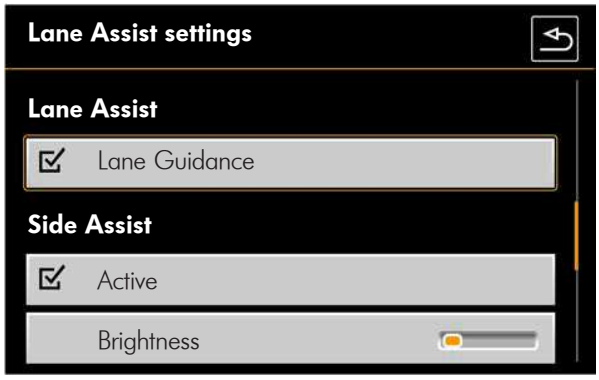
- Both single and double road marking lines are identified using the front camera
- Active at speeds of 40 mph (65 km/h) or higher
- Warns driver to take control before deactivating
- The steering wheel may vibrate in some situations to alert the driver to take over steering

System Limitations

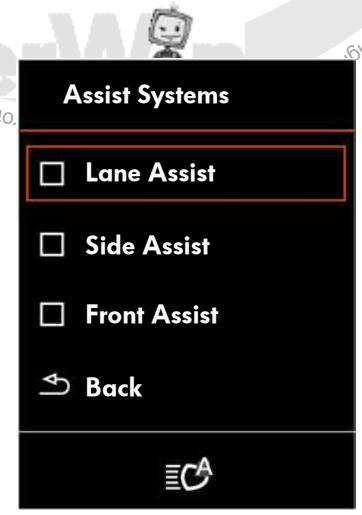
Lane Assist switches to passive mode when:

- Speed falls below 40 mph (60 km/h)
- Distance to the next lane marking is too large
- No lane markings can be detected
- The radius of a lane marking bend is too small
- Driver overrides the corrective steering moment using steering wheel force
- Driver uses the turn indicator
- System cannot identify a clear, active driver steering movement for a long period of time
- Driving style is highly dynamic or aggressive

Operation



s516_044

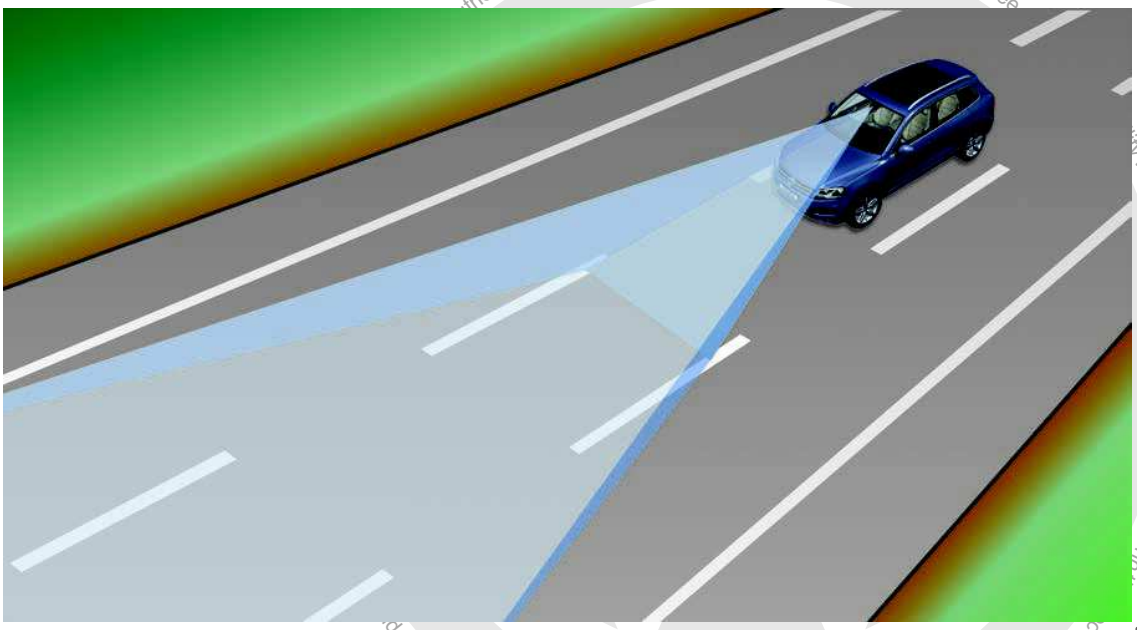


s516_046

Lane Assist can be activated or deactivated using the MFD menu. Additional Lane Assist functions are activated through the Infotainment system.

Multi-Function Camera

Lane Assist (Touareg)



S470_013

Lane Assist in the Touareg has the same basic function of the other Lane Assist systems, but it does not control the steering wheel. Instead, it vibrates the steering wheel to alert the driver when the vehicle appears to be leaving the lane unintentionally.

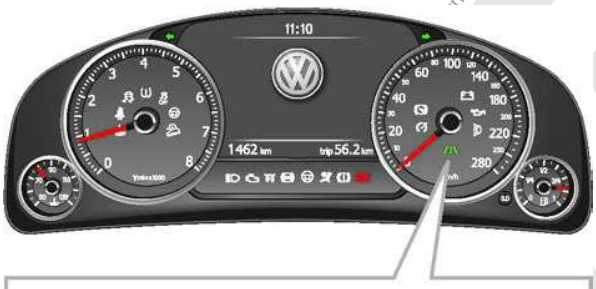
The system has a camera at the base of the rearview mirror to monitor the lane lines on the road up to approximately 260 ft (80 m) ahead. Warnings are displayed in the instrument cluster, and the steering wheel has a motor for vibration.

Area of use

- Freeways and major roads
- Activation speed 40-155 mph (65-250 km/h)
- During deceleration, the system remains active up to 37 mph (60 km/h)
- Curve radius > 820 ft (250 m)
- Lane widths of 8.2-16 ft (2.5-5.0 m)
- A lane marking on one side is sufficient to detect the lane

The system may not provide a lane departure warning when there are poor conditions, such as insufficient road markings, dirty or snow-covered road surfaces, excessively narrow lanes or poor road markings.

Lane Assist (Touareg)



The Lane Assist Control Lamp

Lane Assist OFF

Lane Assist ON and in Passive Mode

Lane Assist ON and in Active Mode

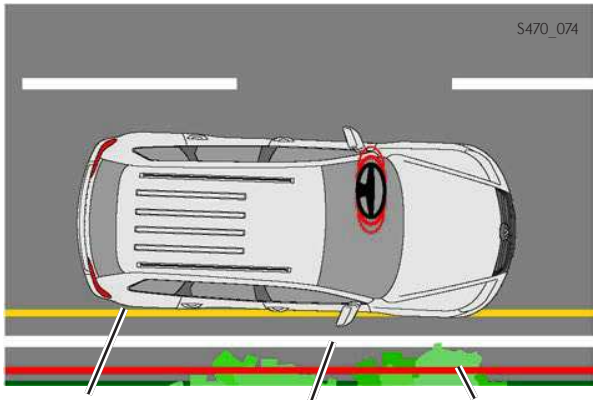
S470_072

Operation

Activation and Deactivation

The Lane Assist function is activated through the MFD and the button on the front of the turn signal lever. As soon as the lane departure warning system detects clear road markings within its system limitations, it changes from a passive (at least one condition has not been met) to an active operating mode.

The light in the instrument cluster indicates the status of Lane Assist.



Warning Level Adjustment

The driver can choose from three different warning levels using the infotainment system:

- Early warning level: The virtual boundary is set approx. 20 cm (2 in) before the lane marking
- Normal warning level: The virtual boundary is the same as the lane marking
- Late warning level: The virtual boundary is set approx. 20 cm (2 in) after the lane marking

When the virtual boundary is crossed, a warning is issued.

Multi-Function Camera

System Function

When Lane Assist is active, the system scans and evaluates the path of the road using the camera. If the vehicle gets close to a recognized boundary line and there is a threat of it departing the lane, the driver is warned by a vibration in the steering wheel.

The system only warns once. A second warning is only issued if the vehicle has moved sufficiently away from the relevant boundary line and has then approached it again. This avoids continual warnings when driving parallel to a road marking.

If, while the system is active, a turn signal is activated before a boundary line is driven over, the warning is suppressed. The system assumes that the lane departure is intentional.

Aside from the steering wheel vibration, the driver of the Touareg can see a visual representation of detected and violated (driven over) boundary lines in the instrument cluster display.

System Messages

S470_062

Active mode:

- Road marking detected on left and right

S470_064

Active mode:

- Road marking detected on right
- Road marking not detected on left

S470_066

Passive mode:

- Road marking not detected on left or right

S470_068

Active mode:

- Road marking detected on left and right
- Warning threshold on right exceeded

S470_070

Active mode:

- Road marking detected on right
- Road marking not detected on left
- Warning threshold on right exceeded

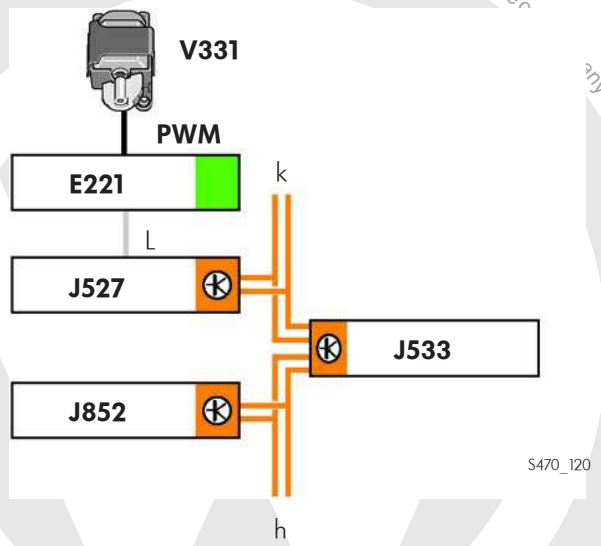
A warning will only be issued if a road marking is detected or the boundary line is crossed.

System Design

Networking

Key

E221	Control Unit in Steering Wheel
J527	Steering Column Electronics Control Module
J533	Data Bus Onboard Diagnostic Interface
J852	Camera Control Module
V331	Steering Wheel Vibration Motor
h	Extended CAN-Bus
k	Convenience CAN-Bus
L	LIN-Bus



Steering Vibration Motor

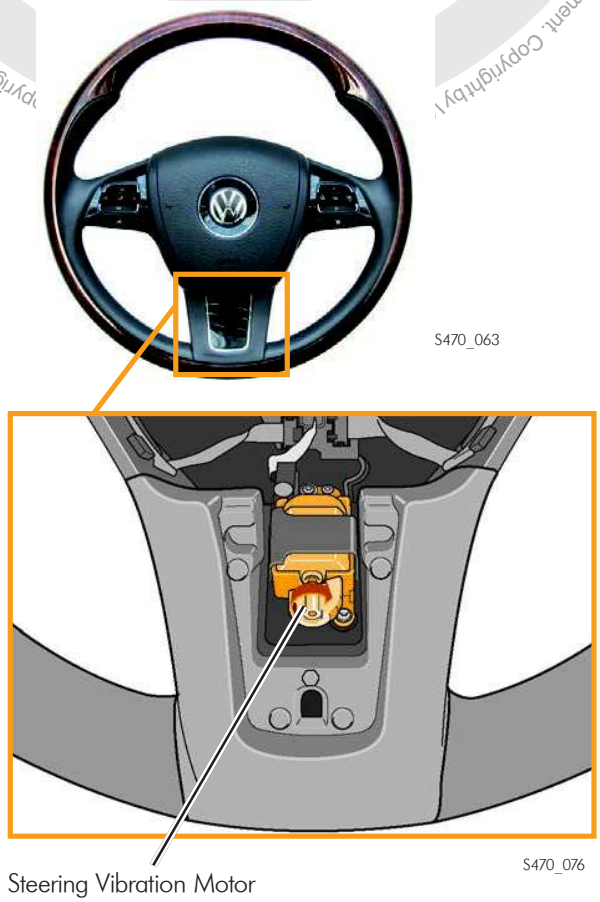
The Steering Wheel Vibration Motor V331 is located in the bottom spoke of the steering wheel. It is activated by a signal from the Camera Control Module J852 that travels through the CAN-Bus, then through the Steering Column Control Module J527 via LIN.

The driver can choose from three vibration levels with different frequencies:

1. Weak level – 29hz
2. Medium level – 34hz
3. Strong level – 44hz

These levels are adjusted using the Infotainment touchscreen.

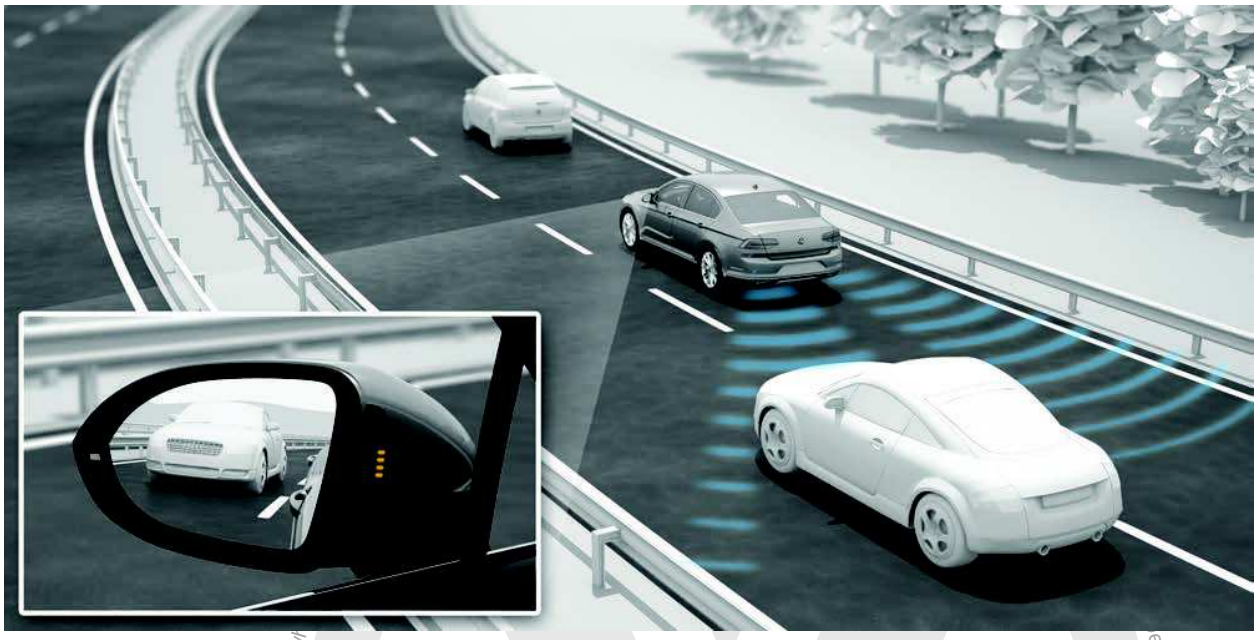
The different frequencies are achieved by varying the PWM signal to the Steering Wheel Vibration Motor E331.



Rear Radar

Blind Spot Monitor with Rear Traffic Alert

The Bind Spot Monitoring system helps drivers by warning when a vehicle is in a "blind spot," helping to avoid accidents.



s543_085

Technical Data

- Two radar sensors are located under the rear bumper on each side of the vehicle
- 24 GHz radar sensors have excellent performance and less interference from false targets
- Speed range > 6 mph (10 km/h)
- Scanning range approx. 164 ft (50 m)
- The scanning angle of the radar sensors is approximately 110°
- The system remains active even when the ignition is cycled
- The brightness of the warning lamps in the mirror base can be adjusted

If a fault occurs and/or one of the radar sensors is replaced, the system must be calibrated.

Rear Radar

Function

s543_079

Two radar sensors installed under the bumper monitor the traffic next to and to the right and left behind the vehicle.

The system has an information stage and a warning stage.

If the system detects a potential risk without a lane change being indicated (turn signal not activated), the driver is informed by the warning lamp in the corresponding exterior mirror housing.

Warning

s543_081

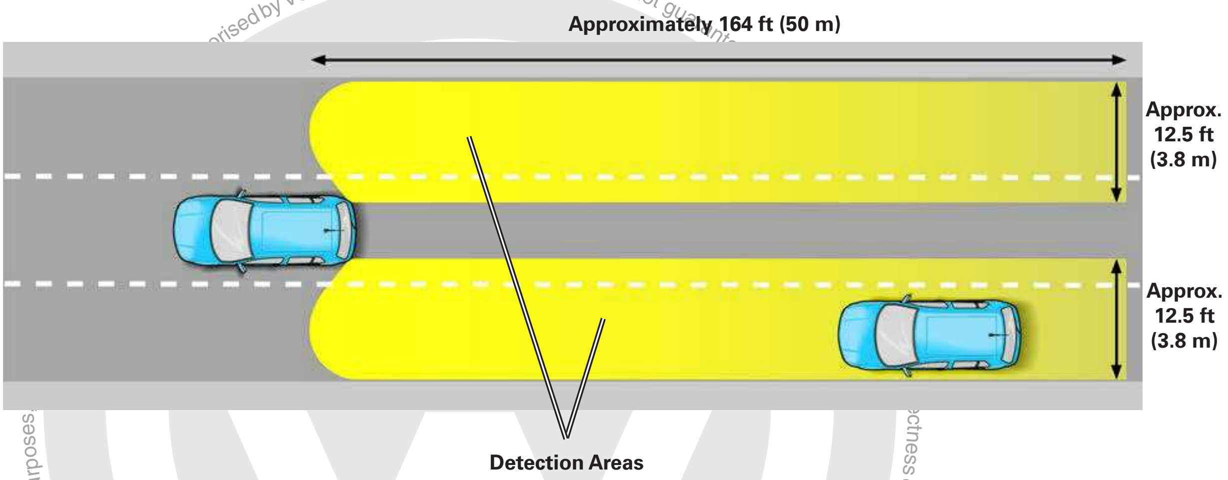
The warning stage is activated if there is a potentially hazardous situation and the driver indicates a lane change by using the corresponding turn signal.

If the car has Lane Assist, the warning stage is also activated when the driver turns the steering wheel to the side where the hazard has been detected (even without the turn signal being used). If the vehicle leaves the lane, it is automatically steered in the opposite direction.

Rear Radar

Area Monitored by the Radar Sensor

The area monitored (on each side of the vehicle) includes the side and rear. The side area extends from the rear corner of the vehicle to about the level of the B-pillar.



The illustration above shows the sensor monitoring area on a straight road. On winding roads, the Blind Spot Monitoring system operates up to a minimum curve radius of about 558 ft (170 m). If the curve radius is below the 558 ft limit, the system switches to a deactivated state since the radar beams being transmitted can no longer scan the full rear monitoring area.

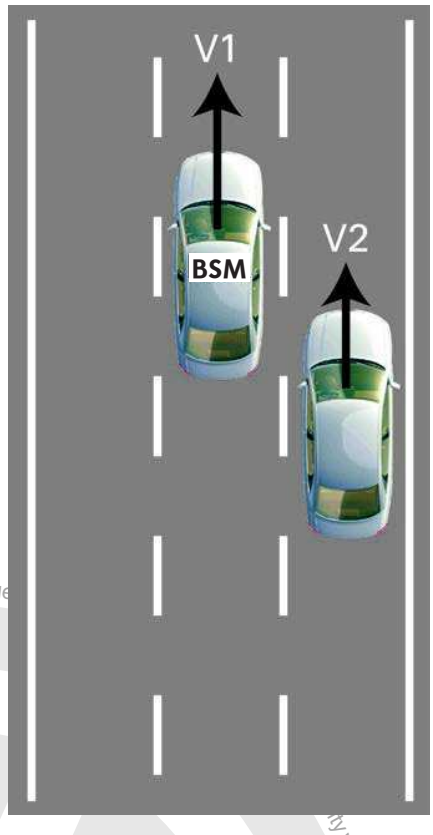
This deactivation threshold has a lag of 98 ft (30 m). This means that the system, deactivated because of a short curve radius, is reactivated only once a radius of more than 655 ft (200 m) is reached.

The control module calculates the path of the road from the yaw rate and the individual wheel speeds from ABS Control Module J104.

When driving on winding roads, the curved monitoring area is converted by the software to the image of a straight road. This way, the basis for the warning algorithm's decision to warn the driver or not remains the same on a straight road or when driving around bends.

Two Typical Traffic Situations

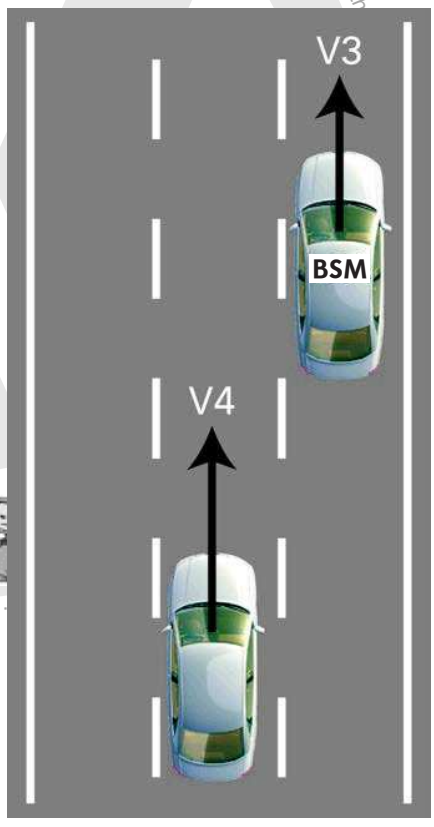
Two typical traffic situations are described below, which can result in warnings.



Scenario 1

The vehicle with Blind Spot Monitoring (BSM) is travelling in the center lane of a three-lane freeway and is just passing the vehicle on the right. The speed differential between the car with BSM and the vehicle being passed is less than 9.3 mph (15 km/h).

As a result of the small speed differential, the passing maneuver takes some time, and the vehicle being passed disappears at some point in the "blind spot." In this situation, the warning lamp in the right exterior mirror informs the driver that the right lane is occupied. If the driver of the BSM-vehicle now uses the right turn signal, the driver is warned by the lamp in the right exterior mirror flashing four times.



Scenario 2

The vehicle with the BSM is traveling at medium speed in the right lane of a three-lane freeway. A vehicle approaches from the rear in the center lane at a clearly higher speed. The approaching vehicle is detected by the lane change assistance system. The system activates the warning lamp in the left exterior mirror. If the left turn signal is now used, a flashing warning lamp warns the driver against making a lane change because of the danger of a collision.

The distance between the vehicles at which the warning lamps are activated depends on the speed differential. The greater the speed differential, the higher the distance between the two vehicles at which the driver is informed of the danger of a potential collision.

Rear Radar

Rear Traffic Alert

Some vehicles that have Blind Spot Monitoring also use those sensors for Rear Traffic Alert. Rear Traffic Alert warns of approaching vehicles when backing out of a parking spot.

The radar sensors measure the distance and the speed difference between your vehicle and an approaching object and use this to calculate the time until a possible collision ("Time to Collision").

Technical Data and System Limitations

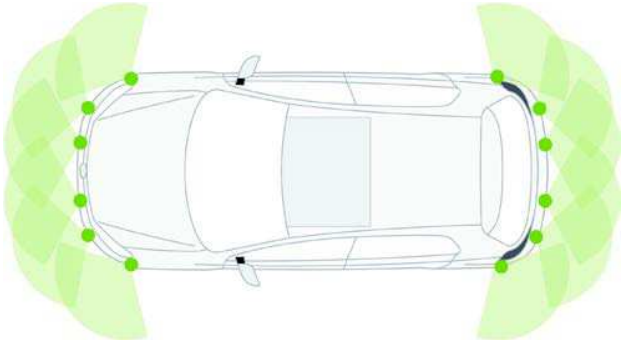
- Detection angle of the radar sensors approx 110°
- Detection area approximately 65 ft (20 m) range
- Speed range for own vehicle from 1-7.5 mph (1-12 km/h)
- Speed range for the detected vehicle > 2.5 mph (4 km/h)
- Reverse gear must be engaged

Warning Sounds

- An acoustic warning from the dash panel insert, if Park Distance Control is not installed
- Beeping noise, if Park Distance Control is installed
- Automatic braking approx. 0.8 s before a possible collision (braking to reduce accident severity – required maximum brake power = max. 12 m/s²)
- Automatic braking does not occur if the brake pedal is being pressed

Park Distance Control 360°

Park Distance Control uses ultrasonic sensors to alert the driver of objects in front of and behind the vehicle when parking or backing up. In this section we will discuss the system that has 360° visibility.

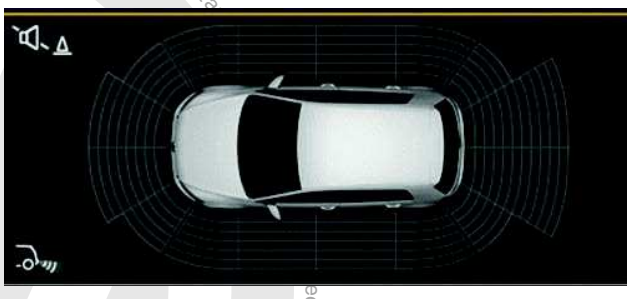


Function

The 360° PDC monitors and displays the front, rear and sides of the vehicle.

The system is activated and deactivated:

- Using the Parking Aid Button E266 or
- By engaging Reverse gear or
- When the vehicle rolls backwards or
- When the system detects an obstacle in the front area at speeds below 6 mph (10 km/h), for example, when driving slowly into a garage
- If a door is opened
- If a PDC sensor fails



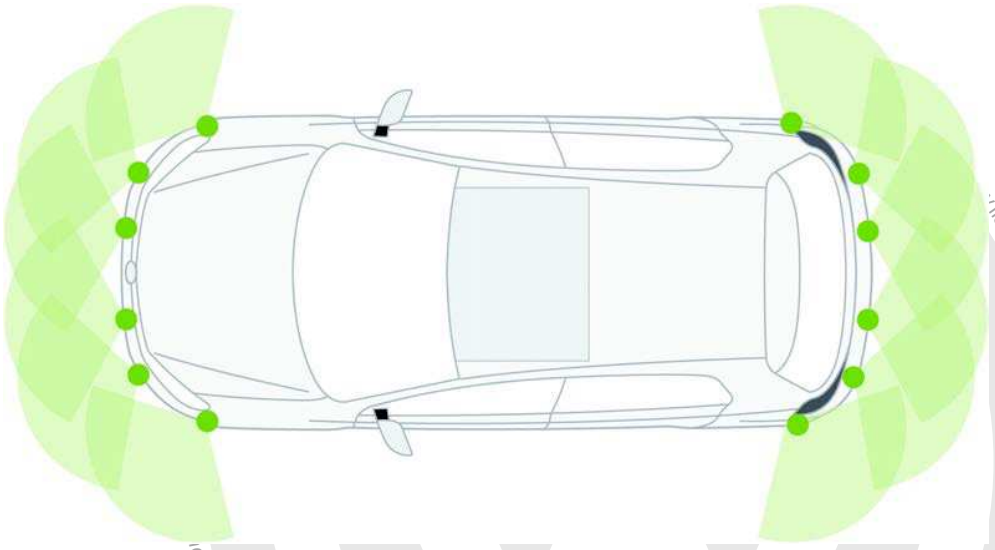
The Infotainment display of the side areas is calculated from the PDC sensors because their scanning does not include the vehicle sides. Objects that appear on the sides are remembered from the front or rear sensors, and move along the side based on driving direction, steering angle and the ABS system (distance).

Ultrasonic Sensor

Park Assist

Park Assist helps the driver to park a vehicle in parallel or perpendicular parking spots. It controls the vehicle steering while the driver must control the accelerator and brake inputs.

This semi-automatic parking system allows for perpendicular parking (spaces 90° to the lane) and parallel parking on the right or left of the lane. It will not only park the vehicle, but can also be used to get the vehicle out of parking spots.



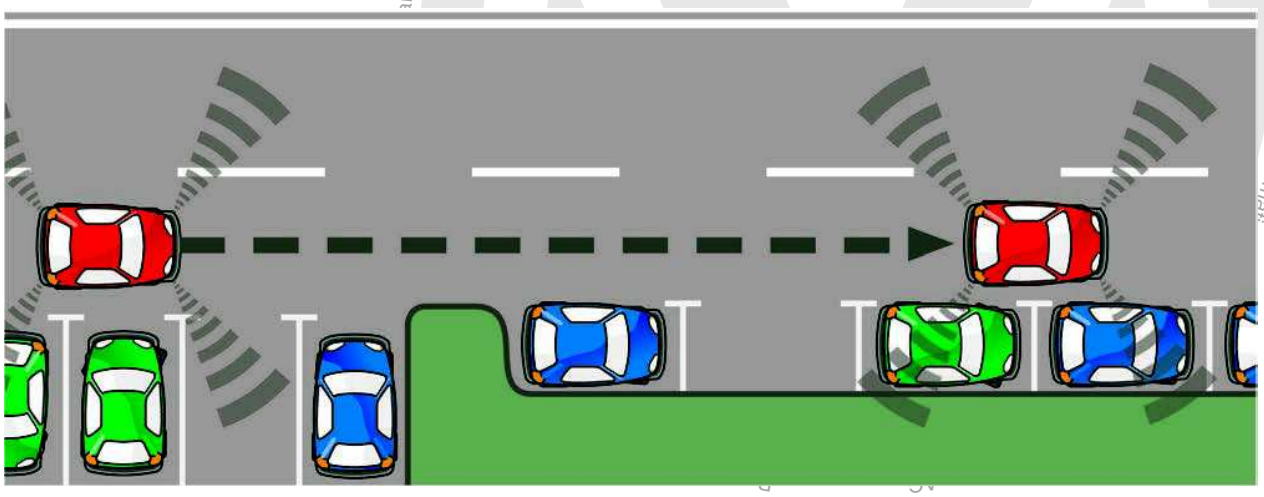
Parking Distance Control (PDC) sensors sense the vehicle and open areas. This system has six sensors, just like the PDC 360° system. For vehicles with a four-channel system, there are two additional sensors on each side of the vehicle. These side sensors are used to detect open spaces when the system is active.

The sensor information, vehicle speed from the ABS Control Module and the steering angle is used to calculate the location of an open spot relative to the vehicle.

Operation:

Park Assist is enabled using the button next to the selector lever. Pressing the button causes a MFD screen to appear. Pressing the button multiple times allows the driver to scroll through either parallel or perpendicular parking.

Depending on the system, the vehicle may automatically search for parking spaces on the right side of the vehicle. However, the right turn signal may be required to search for spaces on the right side of the vehicle. Using the left turn signal will search for parking spaces on the left side of the vehicle.



s516_037

When the system is active it calculates the size of the parking spot. The calculations are:

- Vehicle length plus,
- Extra space of at least 1.3 ft (0.4 m) at both the front and rear for maneuvering and safety
- Maximum speed of 25 mph (40 km/h)

Ultrasonic Sensor

Parallel Parking

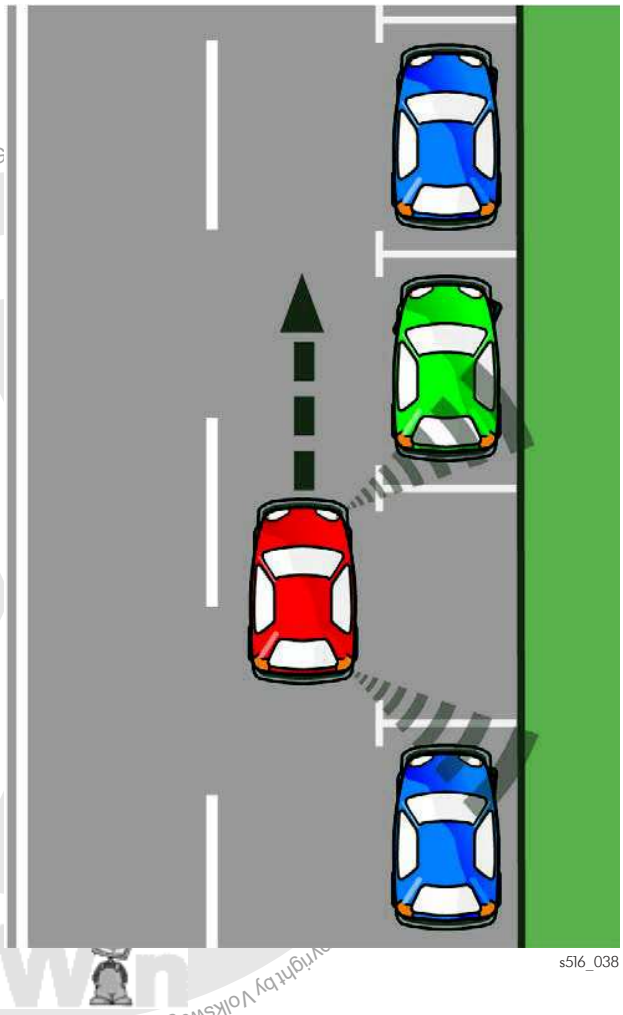
The ideal starting position for parking in parallel parking spaces is facing the direction of travel with a distance at the side of 1-6.6 feet (0.5-2.0 m) to any vehicles already parked.

When a suitable space is identified, the driver is prompted through the MFD:

- When to stop the vehicle
- To move the selector lever into Reverse
- To begin moving backwards
- When to move the selector lever into Drive
- When the process is complete

The steering wheel rotates on its own to maneuver the vehicle into the parking spot. The driver is responsible for all accelerator and braking inputs. This system does not stop the vehicle from impacting other vehicles.

Audible signals are used from the PDC sensors to help the driver determine the distance to the other vehicles.



s516_038

Exiting the Parking Space

To exit the parking space, start the vehicle and press the Park Assist button. The system calculates if there is enough room to exit the space. If there is enough room, the system displays prompts in the MFD to exit the space.

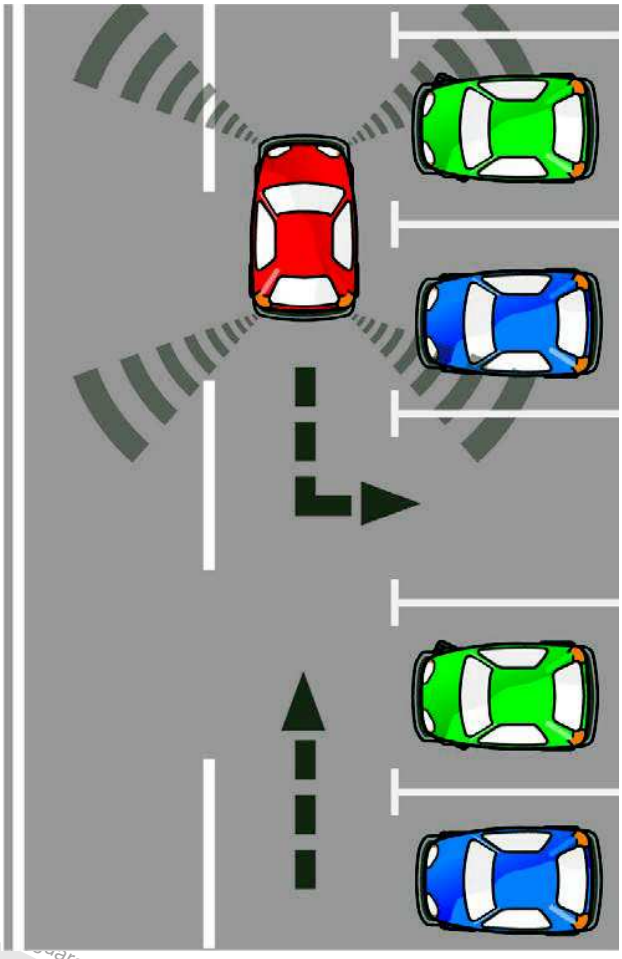
The system cancels its operation when the vehicle has left the parking space.

If the steering wheel is used by the driver during any Park Assist function, the Park Assist feature will immmediately cancel.

Perpendicular Parking

The minimum suitable size for a perpendicular parking space is the vehicle width plus clearance to the left and right of at least 1.1 feet (0.35 m) for maneuvering and safety.

As with parallel parking, the MFD prompts the driver through the necessary steps. Occasionally, the vehicle may have to adjust by moving forward and backward multiple times.



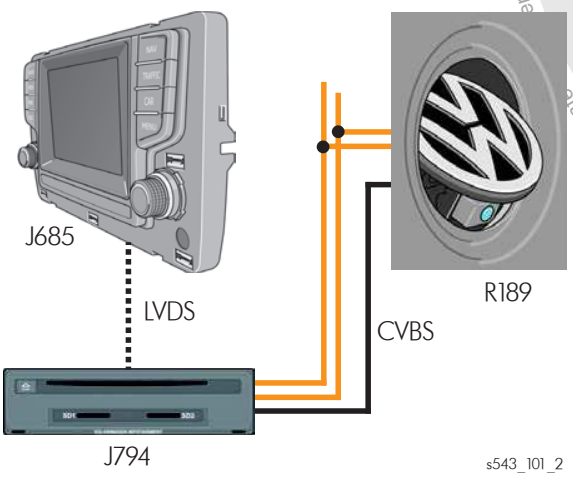
s516_039

Exterior Camera

Reverse Camera

The reverse camera is located at the rear of the vehicle. In most vehicles, it is located under the pivoting VW logo. The location helps to keep the camera free from dirt and debris. On models without the pivoting VW logo, the camera is located next to the rear lid/trunk opening switch.

When the selector lever is moved into Reverse, the camera activates. It captures the video signal, and overlays the colored "helper" lines. It sends this combined signal to the Information Electronics Control Module 1 J794, which in turn relays it to the Front Information Display Control Head J685 for the driver to view.



s543_101_2

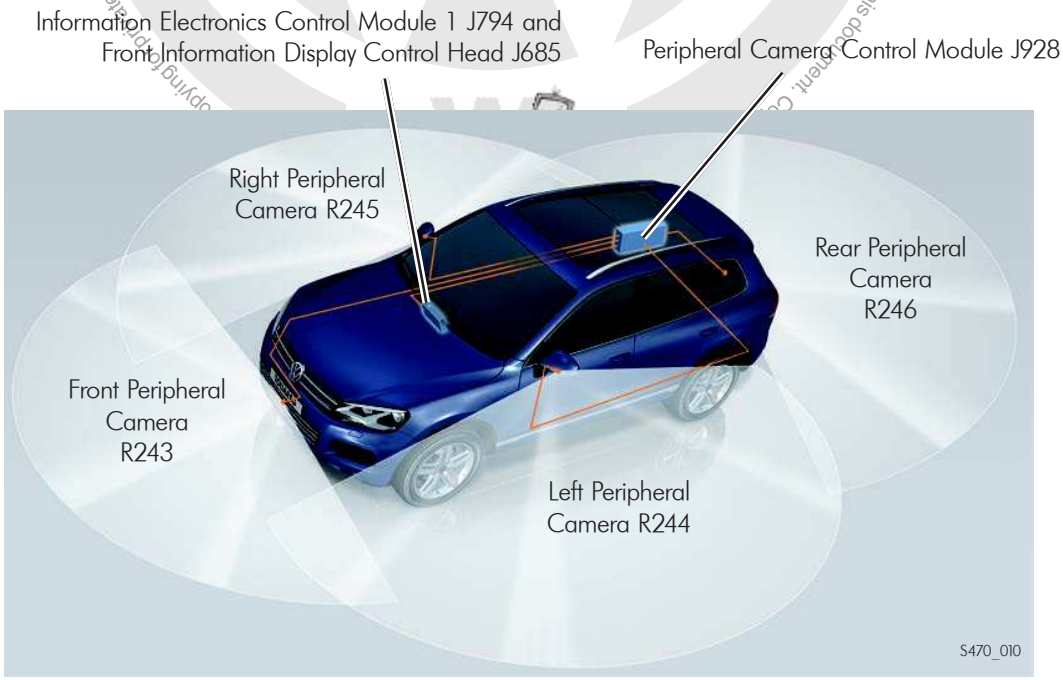
Key

J685	Front Information Display Control Head
J794	Information Electronic Control Module 1
R189	Rearview Camera
LVDS	Low-Voltage Differential Signalling
CVBS	Color Video Blanking Signal
	CAN bus wire

Area View

Area View enhances the Rearview Camera system by displaying video of the area surrounding the entire vehicle. It offers the driver numerous views and settings.

Area View System Design



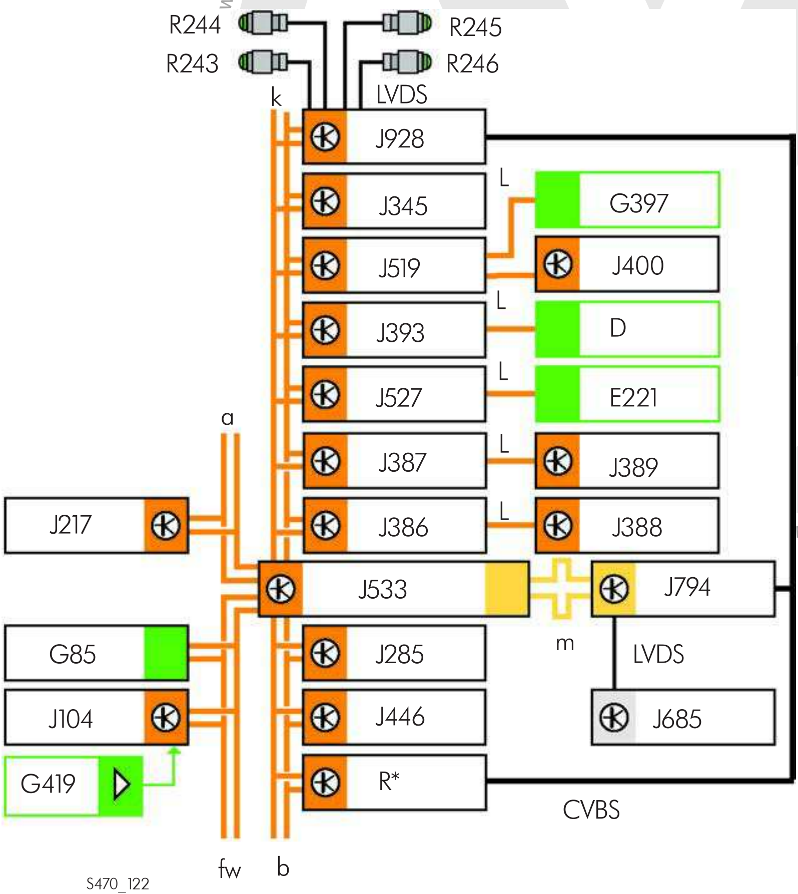
The view around the vehicle is captured with four cameras. The front camera is located in the front grille, the rear camera is in the handle of the rear lid and the side cameras are installed underneath the side mirrors.

The cameras have wide-angle lenses and capture the whole area around the vehicle, enabling areas to be viewed that are either difficult to see or cannot be seen at all. Since the camera capture areas overlap, an accurate and realistic optical transition between the visual ranges of the different cameras can be created (so-called bird's-eye view).

The diagnosis address is 6C.

Exterior Camera

Networking



S470_122

Key

D	Ignition/Starter Switch
E221	Control Unit in Steering Wheel
G85	Steering Angle Sensor
G397	Rain/Light Recognition Sensor
G419	ESP Sensor Unit
J104	ABS Control Module
J217	Transmission Control Module
J285	Instrument Cluster Control Module
J345	Towing Recognition Control Module
J386	Driver Door Control Module
J387	Front Passenger Door Control Module
J388	Left Rear Door Control Module
J389	Rear Right Door Control Module
J393	Comfort System Central Control Module
J400	Wiper Motor Control Module
J446	Parking Aid Control Module
J519	Vehicle Electrical System Control Module
J527	Steering Column Electronics Control Module
J533	Data Bus Onboard Diagnostic Interface
J685	Front Information Display Control Head
J794	Information Electronics Control Module 1
J928	Peripheral Camera Control Module
R243	Front Peripheral Camera
R244	Left Peripheral Camera
R245	Right Peripheral Camera
R246	Rear Peripheral Camera
a	Powertrain CAN-Bus
b	Infotainment CAN-Bus
fw	Chassis CAN-Bus
k	Convenience CAN-Bus
L	LIN-Bus
m	MOST Data Bus

The cameras are connected via HSD (High Speed Data) wires to the Peripheral Camera Control Module J928. These wires supply power to the cameras, control them and transfer video signals using LVDS (Low Voltage Differential Signalling).

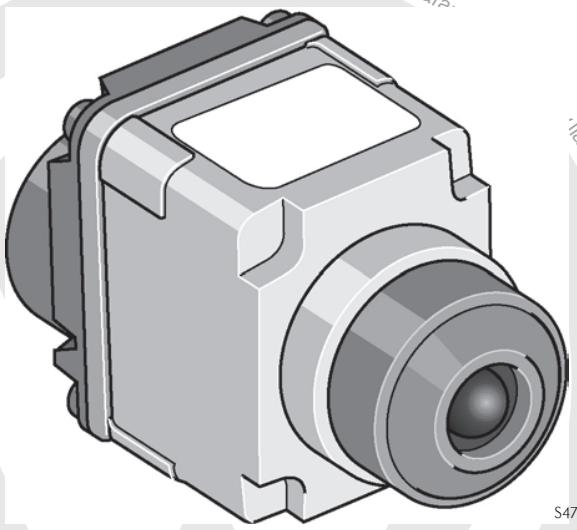
The Information Electronics Control Module 1 J794 and J928 are connected by a coaxial cable and the CVBS composite video signal is sent across this cable. The data transfer rate of the CVBS cable is approx. 6MBit/s.

Although J928 relies on signals from many other control modules, it does not have any influence on these other control modules. For example it receives a signal from the steering angle sensor, but does not control any steering functions.

VGA Camera

Area View has four cameras with wide-angle lenses with the following features:

- Resolution: 640 x 480 pixels (VGA resolution)
- Opening angle: 190°
- ¼ inch CMOS image chip
- Temperature range: from - 40-85°C (-50-185°)F

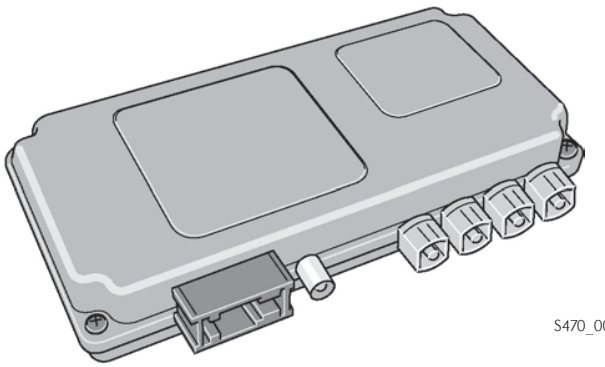


S470_006

Peripheral Camera Control Module J928

The control module processes the images supplied by the cameras and prepares them for display on the infotainment screen. This includes removing any distortion from the supplied images, converting or changing to individual perspectives and also displaying static and dynamic guidelines.

The control module works with a microcontroller to regulate the processes and a 600 MHz DSP (Digital Signal Processor) to process the camera images.



S470_004

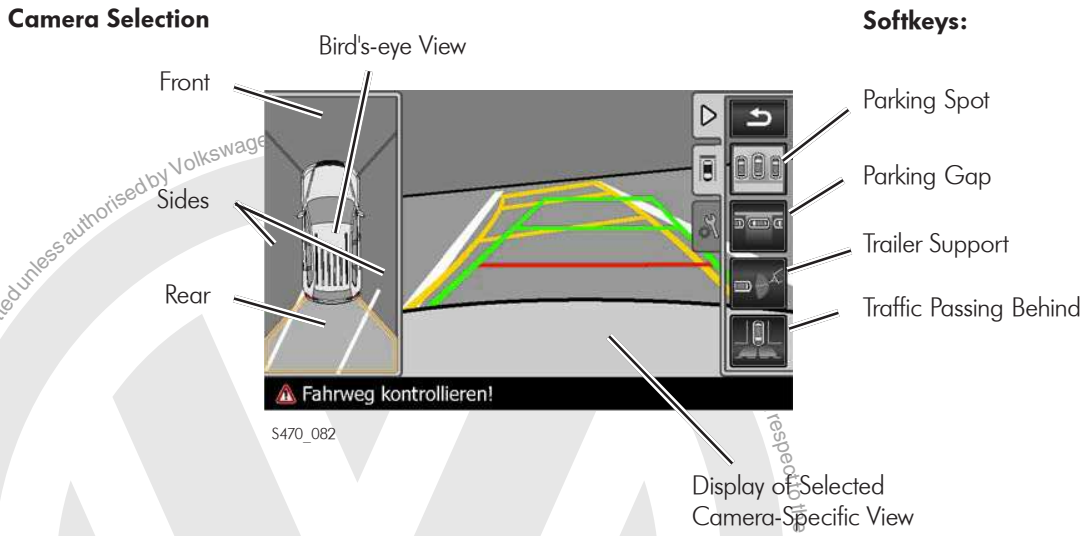
Exterior Camera

Operation

When Reverse is selected, or the Park Distance Control button is pressed, the exterior view is displayed on the Infotainment screen. There is a mini bird's-eye view on the left of the display. When selected, a detailed perspective can be selected by touching the relevant area (front, rear, left or right of vehicle). When touching the roof of the vehicle in this view, the whole view of the vehicle from above is displayed.

When a particular region is selected using the mini bird's-eye view, the display changes to split screen. A detailed view of the selected area around the vehicle is shown in the right half of the display. In a second step, softkeys in a pulldown menu on the right side of the screen is used to select different views. In the mini bird's-eye view shown below, the camera selection and camera perspective can be selected.

Rear Sector Example



Function

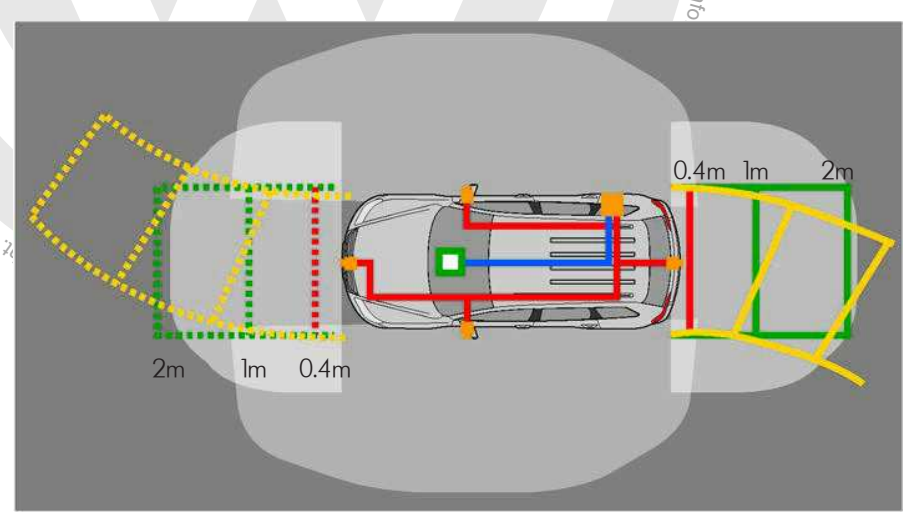
Area View works between 0-9 mph (0- 5 km/h). When activated, the cameras capture the area around the vehicle. The captured images are straightened out by the Peripheral Camera Control Module J928 because the raw images from the wide-angle lens cameras are heavily distorted. The angle of view is then adapted to the desired perspective, also using image processing. Finally, this corrected image is enhanced with “Helper” lines depending on the selected view. These lines show the distances and to project the path ahead. Then the prepared image is displayed.

If there is a visible distortion of the image in the area where the camera views overlap, recalibrate the system. Perform inspection for image distortion once the air suspension has settled at normal level and with the dampers set to "Comfort."

Guidelines

Depending on the selected view, static and dynamic guidelines are displayed.

These guidelines make it easier to estimate distances (red and green guidelines) and show the potential path depending on the steering angle (yellow guidelines).

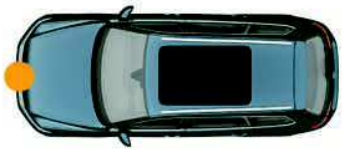


S470_132

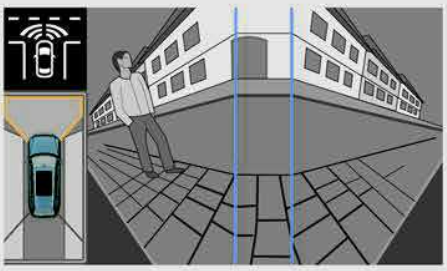
Exterior Camera

Views on Display

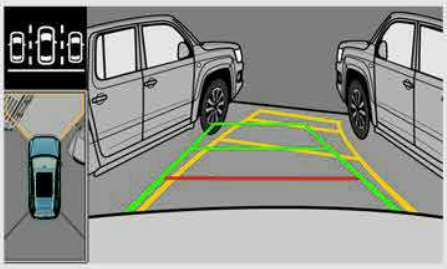
Front Camera



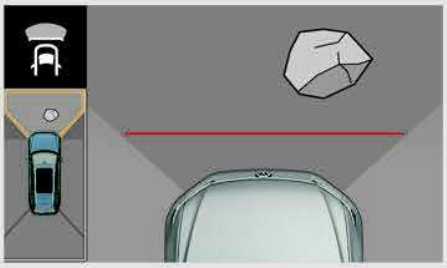
Cross Traffic



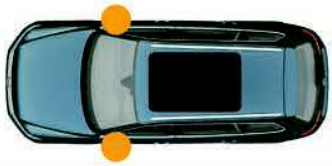
Parking Space



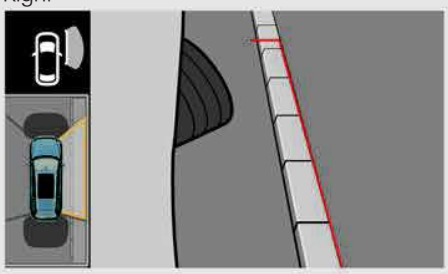
Area in Front



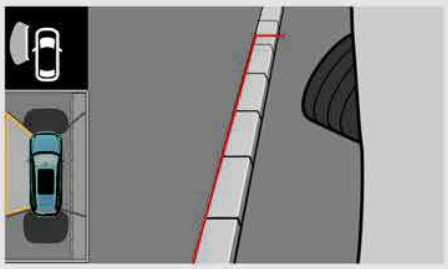
Side Camera



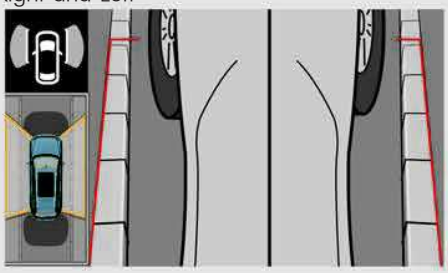
Right



Left



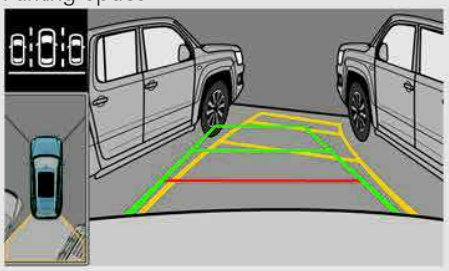
Right and Left



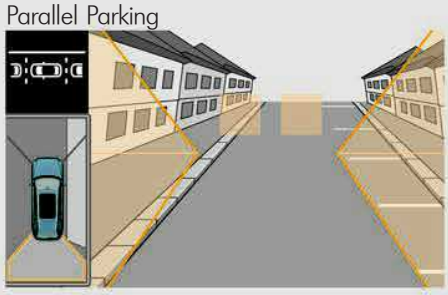
Exterior Camera

Rear Camera

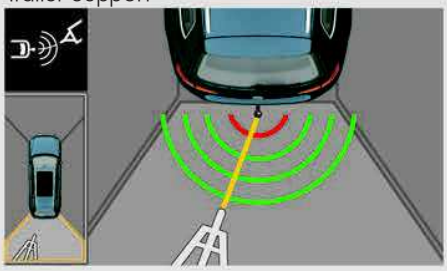
Parking Space



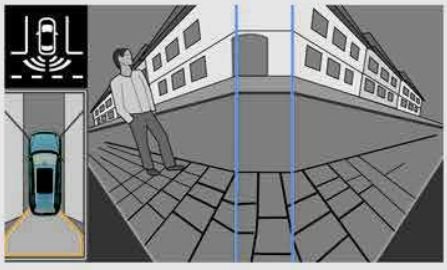
Parallel Parking



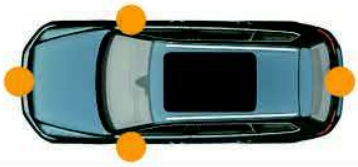
Trailer Support



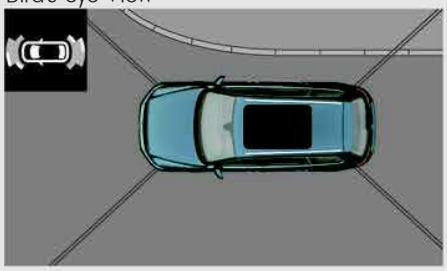
Cross Traffic



All Cameras



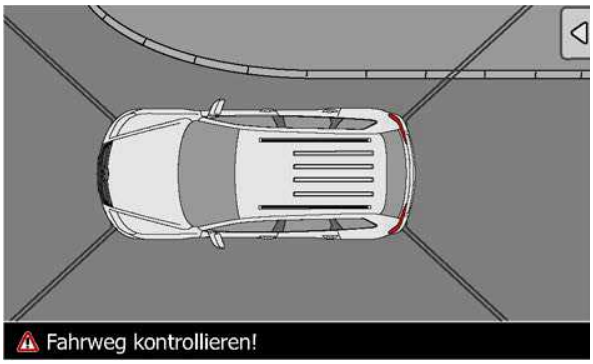
Bird's-eye View



s543_022

Exterior Camera

Display view



S470_084

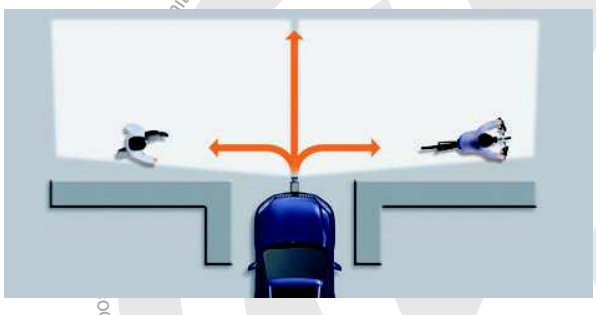
Display Views

Bird's-eye View

Using the four camera images, the control module calculates an overall view of the area surrounding the vehicle as seen from above through a virtual camera. A high quality image is generated and particular attention is given to smoothing the transitions between the four camera views. In this view, the vehicle is superimposed on the screen.

The driver can see the area around the vehicle from a bird's perspective.

Situation

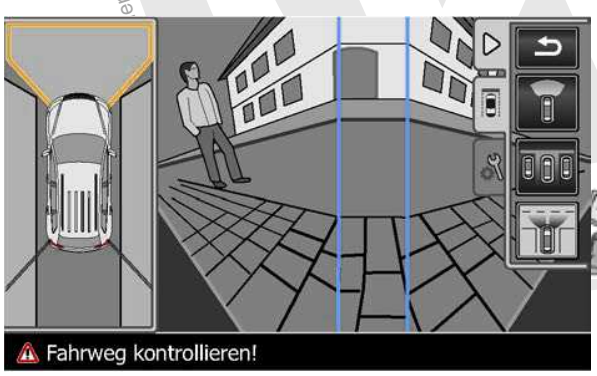


S470_021

"Cross-Traffic" View

This function allows the driver to look 90° to the left and right from the front of the vehicle. It's like looking around the corner, even though the driver is approximately six feet back. This makes it easier to see out of narrow or shrouded entrances and exits.

Display View



S470_086

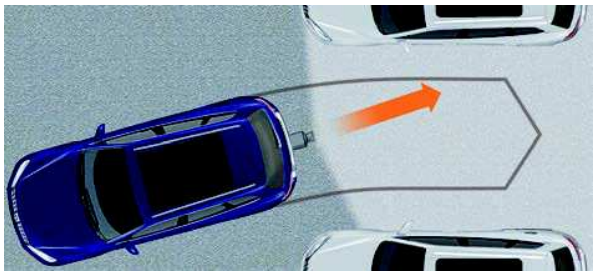
For the "rear cross traffic" view, the rear camera is used. It allows the driver to see what is happening from the rear of the vehicle.

"Parking Spot" View

This view supports the driver when driving forwards or backwards into a parking space. The front and rear cameras can be used, depending on the situation.

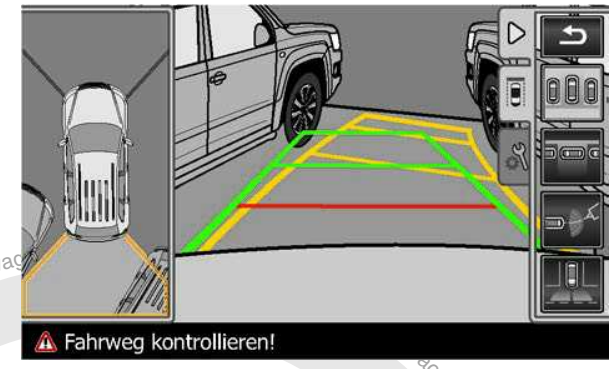
When parking forwards, the view is activated by pressing the Park Distance Control button. When parking backwards, the view is activated by engaging Reverse.

Situation



S470_041

Display View



S470_088

"Left and Right Side" View

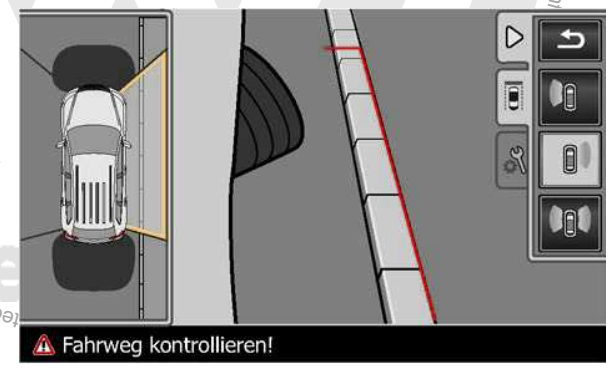
With this view, side cameras help the driver when parking. Static "Helper" lines help the driver determine the distance to an obstacle, such as a curb.

Both side views can be activated simultaneously using the side softkeys.

Situation

S470_045

Display View



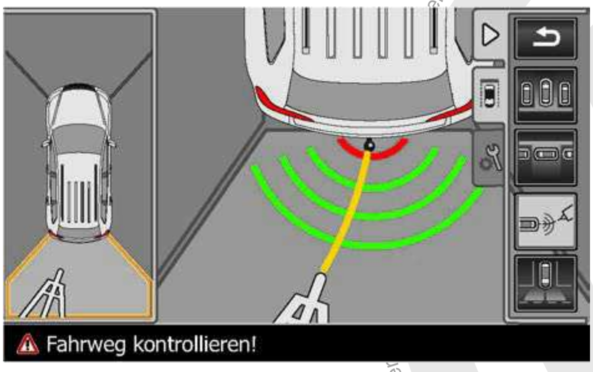
S470_090

Exterior Camera

Situation

S470_025

Display View



S470_092

"Trailer Support" View

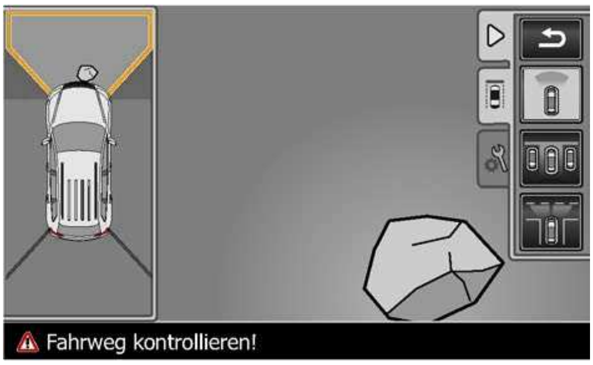
This view uses the rear camera to make it easier for the driver to connect a trailer. The driver sees the area behind the vehicle from above. Green guidelines in the image help to assess the distance from the hitch to trailer. A yellow line shows the driver in which direction the vehicle will move with this steering angle.

This specific display must be selected. It does not automatically display when a trailer is present.

Situation

S470_029

Display View



S470_094

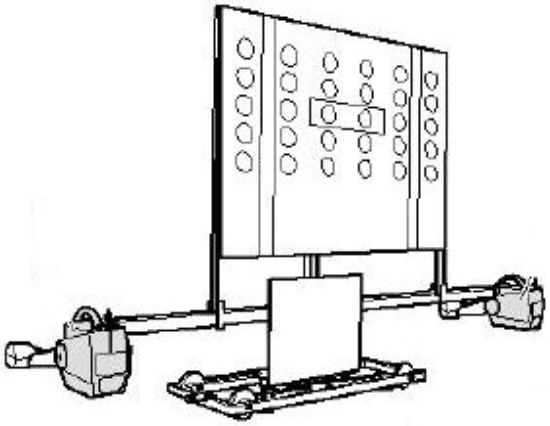
"Offroad" Display

This view supports the driver when driving offroad and if difficult obstacles are encountered by displaying the area directly in front of the vehicle from a bird's-eye view.

Front Radar Calibration Tools

VAS 6292

VAS 6430/3



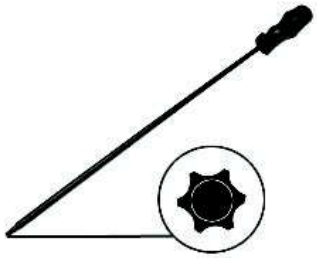
HUN2018351

VAS 6430/1

VAS Scan Tool w/ ODIS Service

VAS 6190/2

T10113 or T20 Driver

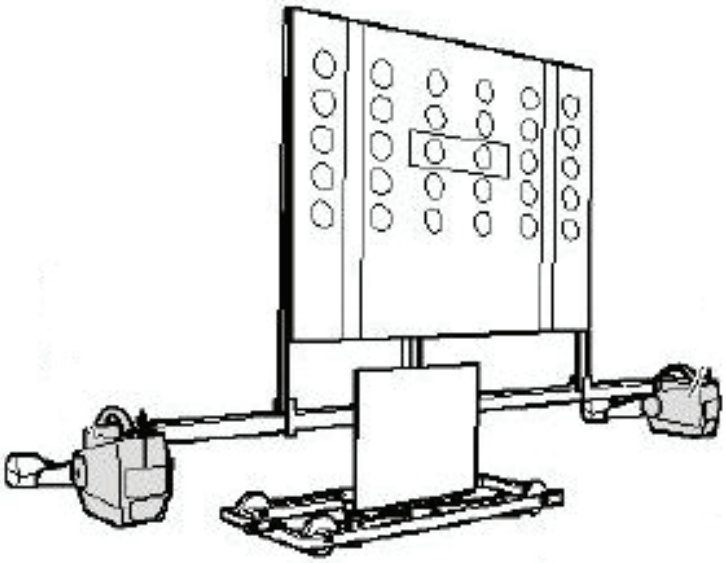


Service

Front Multifunction Camera Calibration Tools

VAS 6292

VAS 6430/4



VAS 6430/1

HUN2018351

VAS Scan Tool w/ ODIS Service

Rear Radar Calibration Tools

VAS 6350/4

VAS 6350/2

VAS Scan Tool w/ ODIS Service

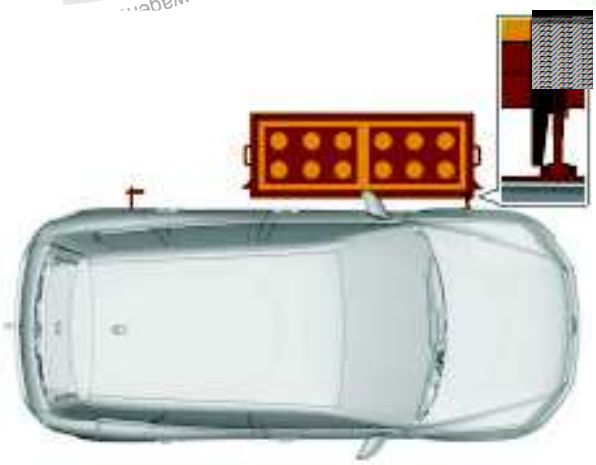
VAS 6350

Service

Camera Calibration Tools

VAS 6350

VAS 6350/6



Glossary

ABS

(Anti-lock Braking System)
Traction control system which prevents the wheels from locking when braking.

ACC

(Adaptive Cruise Control)

BAS

(Brake Assist System)
Traction control system for reducing braking distances.

CAN

(Controller Area Network)
Standardised, digital twin-wire data network used in vehicle electronics.

DSG

(Dual Clutch Gearbox)
A dual clutch gearbox is an automated manual gearbox. It features two gear train halves which allow fully automatic gear changes.

ElsaPro

Electronic Service Information System.

ESC

(Electronic Stabilisation Control)
Electronic stabilisation program, as in its previous abbreviation, ESP.

Front Assist

Electronic area monitoring system.

CCS

(Cruise Control System)
An initialism for an assist system for fixing or limiting the driving speed.

Glossary

Lane Assist

Lane departure warning)
Electronic driver assist system which draws the driver's attention to any departure from a lane and which compensates for minor deviations within the scope of the system limits.

MFD

(Multifunction Display)
Short designation for the display in the dash panel insert.

MIB

(Modular Infotainment System)
Designation for a multi-brand and multi-model modular system for the infotainment components in a vehicle.

MQB

(Modular Transverse Matrix)
Designation for a multi-brand and multi-model modular system in vehicle development and production.

PLA

(Park Assist System)
Driver assist system which actively supports the driver when parking or leaving a parking space, depending on the system version.

PDC

(Park Distance Control)
Parking aid which monitors the area around the vehicle for potential obstacles using ultrasonic sensors.

Knowledge Assessment

An on-line Knowledge Assessment (exam) is available for this Self-Study Program.

The Knowledge Assessment may or may not be required for Certification.

You can find this Knowledge Assessment at:

www.vwwebsource.com

For Assistance, please call:

Volkswagen Academy

Certification Program Headquarters

1-877-791-4838

(8:00 a.m. to 8:00 p.m. EST)

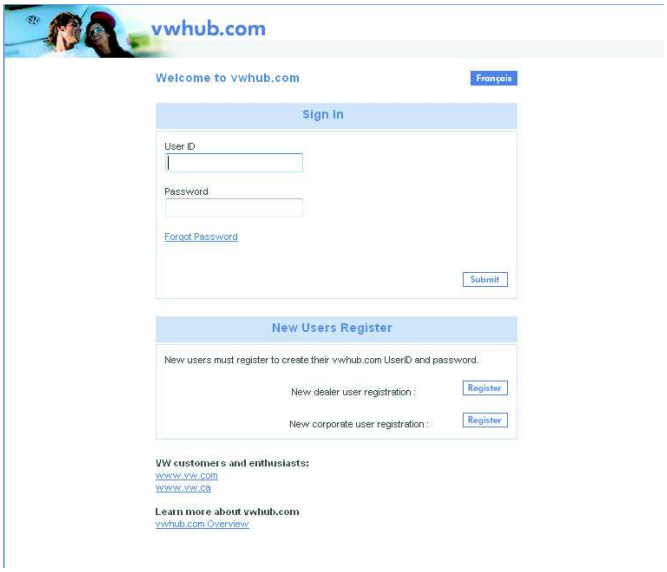
Or, E-mail:

concierge@volkswagenacademy.com

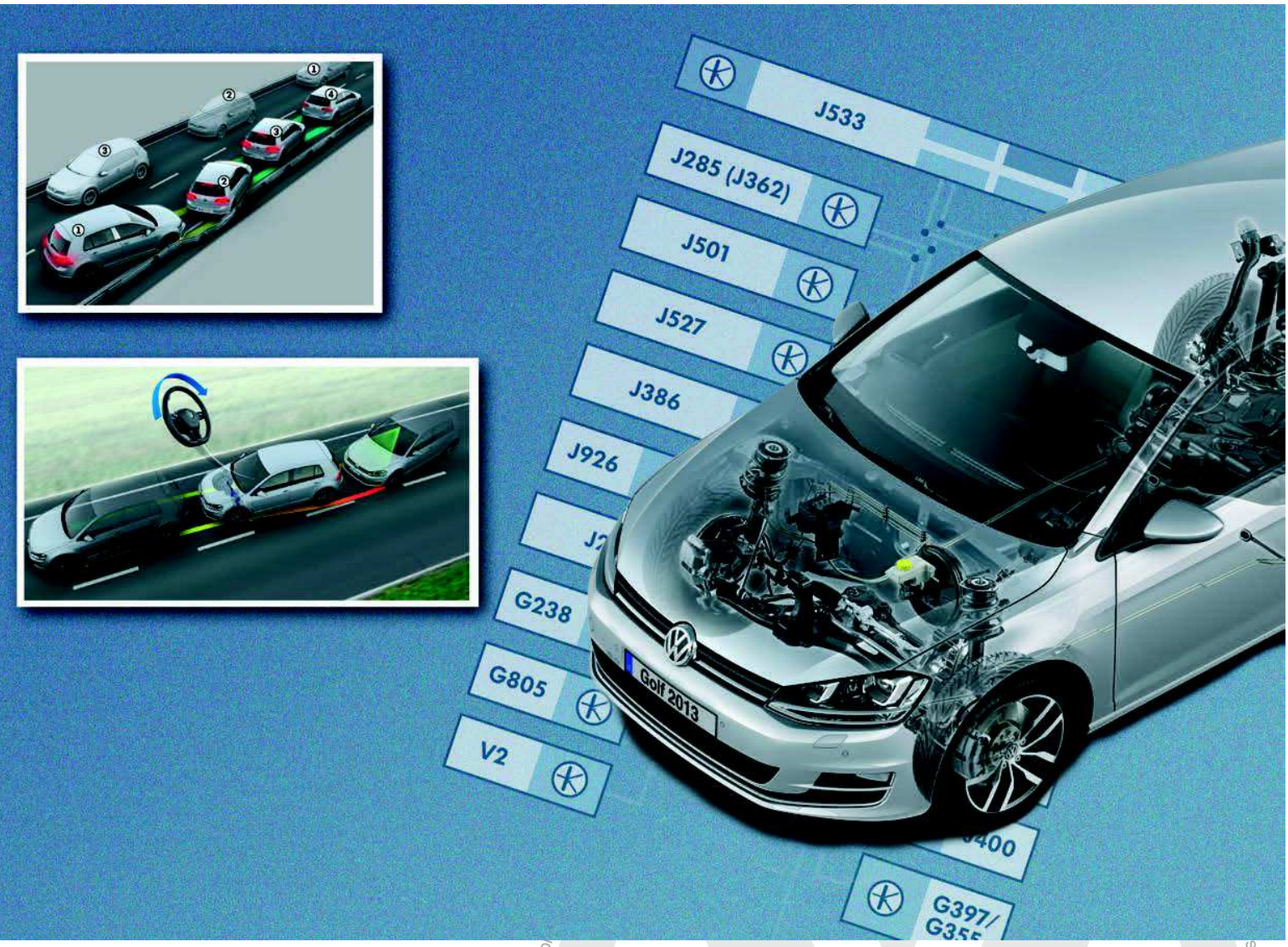
Important Links

https://www.datarunners.net/vw_crc/default.asp?pageid=home

www.vwwebsource.com



www.vwhub.com



Volkswagen Group of America
2200 Ferdinand Porsche Drive
Herndon, VA 20171
May 2016

Cautions & Warnings

Please read these WARNINGS and CAUTIONS before proceeding with maintenance and repair work. You must answer that you have read and you understand these WARNINGS and CAUTIONS before you will be allowed to view this information.

- If you lack the skills, tools and equipment, or a suitable workshop for any procedure described in this manual, we suggest you leave such repairs to an authorized Volkswagen retailer or other qualified shop. We especially urge you to consult an authorized Volkswagen retailer before beginning repairs on any vehicle that may still be covered wholly or in part by any of the extensive warranties issued by Volkswagen.

- Disconnect the battery negative terminal (ground strap) whenever you work on the fuel system or the electrical system. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

- Volkswagen is constantly improving its vehicles and sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, part numbers listed in this manual are for reference only. Always check with your authorized Volkswagen retailer parts department for the latest information.

- Any time the battery has been disconnected on an automatic transmission vehicle, it will be necessary to reestablish Transmission Control Module (TCM) basic settings using the VAG 1551 Scan Tool (ST).

- Never work under a lifted vehicle unless it is solidly supported on stands designed for the purpose. Do not support a vehicle on cinder blocks, hollow tiles or other props that may crumble under continuous load. Never work under a vehicle that is supported solely by a jack. Never work under the vehicle while the engine is running.

- For vehicles equipped with an anti-theft radio, be sure of the correct radio activation code before disconnecting the battery or removing the radio. If the wrong code is entered when the power is restored, the radio may lock up and become inoperable, even if the correct code is used in a later attempt.

- If you are going to work under a vehicle on the ground, make sure that the ground is level. Block the wheels to keep the vehicle from rolling. Disconnect the battery negative terminal (ground strap) to prevent others from starting the vehicle while you are under it.

- Do not attempt to work on your vehicle if you do not feel well. You increase the danger of injury to yourself and others if you are tired, upset or have taken medicine or any other substances that may impair you or keep you from being fully alert.

- Never run the engine unless the work area is well ventilated. Carbon monoxide (CO) kills.

- Always observe good workshop practices. Wear goggles when you operate machine tools or work with acid. Wear goggles, gloves and other protective clothing whenever the job requires working with harmful substances.

- Tie long hair behind your head. Do not wear a necktie, a scarf, loose clothing, or a necklace when you work near machine tools or running engines. If your hair, clothing, or jewelry were to get caught in the machinery, severe injury could result.

- Do not re-use any fasteners that are worn or deformed in normal use. Some fasteners are designed to be used only once and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow the recommendations in this manual - replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.

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- Illuminate the work area adequately but safely. Use a portable safety light for working inside or under the vehicle. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

- Friction materials such as brake pads and clutch discs may contain asbestos fibers. Do not create dust by grinding, sanding, or by cleaning with compressed air. Avoid breathing asbestos fibers and asbestos dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.

- Finger rings should be removed so that they cannot cause electrical shorts, get caught in running machinery, or be crushed by heavy parts.

- Before starting a job, make certain that you have all the necessary tools and parts on hand. Read all the instructions thoroughly; do not attempt shortcuts. Use tools that are appropriate to the work and use only replacement parts meeting Volkswagen specifications. Makeshift tools, parts and procedures will not make good repairs.

- Catch draining fuel, oil or brake fluid in suitable containers. Do not use empty food or beverage containers that might mislead someone into drinking from them. Store flammable fluids away from fire hazards. Wipe up spills at once, but do not store the oily rags, which can ignite and burn spontaneously.

- Use pneumatic and electric tools only to loosen threaded parts and fasteners. Never use these tools to tighten fasteners, especially on light alloy parts. Always use a torque wrench to tighten fasteners to the tightening torque listed.

- Keep sparks, lighted matches, and open flame away from the top of the battery. If escaping hydrogen gas is ignited, it will ignite gas trapped in the cells and cause the battery to explode.

- Be mindful of the environment and ecology. Before you drain the crankcase, find out the proper way to dispose of the oil. Do not pour oil onto the ground, down a drain, or into a stream, pond, or lake. Consult local ordinances that govern the disposal of wastes.

- The air-conditioning (A/C) system is filled with a chemical refrigerant that is hazardous. The A/C system should be serviced only by trained automotive service technicians using approved refrigerant recovery/recycling equipment, trained in related safety precautions, and familiar with regulations governing the discharging and disposal of automotive chemical refrigerants.

- Before doing any electrical welding on vehicles equipped with anti-lock brakes (ABS), disconnect the battery negative terminal (ground strap) and the ABS control module connector.

- Do not expose any part of the A/C system to high temperatures such as open flame. Excessive heat will increase system pressure and may cause the system to burst.

- When boost-charging the battery, first remove the fuses for the Engine Control Module (ECM), the Transmission Control Module (TCM), the ABS control module, and the trip computer. In cases where one or more of these components is not separately fused, disconnect the control module connector(s).

- Some of the vehicles covered by this manual are equipped with a supplemental restraint system (SRS), that automatically deploys an airbag in the event of a frontal impact. The airbag is operated by an explosive device. Handled improperly or without adequate safeguards, it can be accidentally activated and cause serious personal injury. To guard against personal injury or airbag system failure, only trained Volkswagen Service technicians should test, disassemble or service the airbag system.

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- Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 16.5 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time.

- Never use a test light to conduct electrical tests of the airbag system. The system must only be tested by trained Volkswagen Service technicians using the VAG 1551 Scan Tool (ST) or an approved equivalent. The airbag unit must never be electrically tested while it is not installed in the vehicle.

- Some aerosol tire inflators are highly flammable. Be extremely cautious when repairing a tire that may have been inflated using an aerosol tire inflator. Keep sparks, open flame or other sources of ignition away from the tire repair area. Inflate and deflate the tire at least four times before breaking the bead from the rim. Completely remove the tire from the rim before attempting any repair.

- When driving or riding in an airbag-equipped vehicle, never hold test equipment in your hands or lap while the vehicle is in motion. Objects between you and the airbag can increase the risk of injury in an accident.

I have read and I understand these Cautions and Warnings.

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