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F01 Active Blind Spot Detection System

Initial Print Date: 01/09 Revision Date:

Active Blind Spot Detection System

Model: F01/F02

Production: From Start of Production

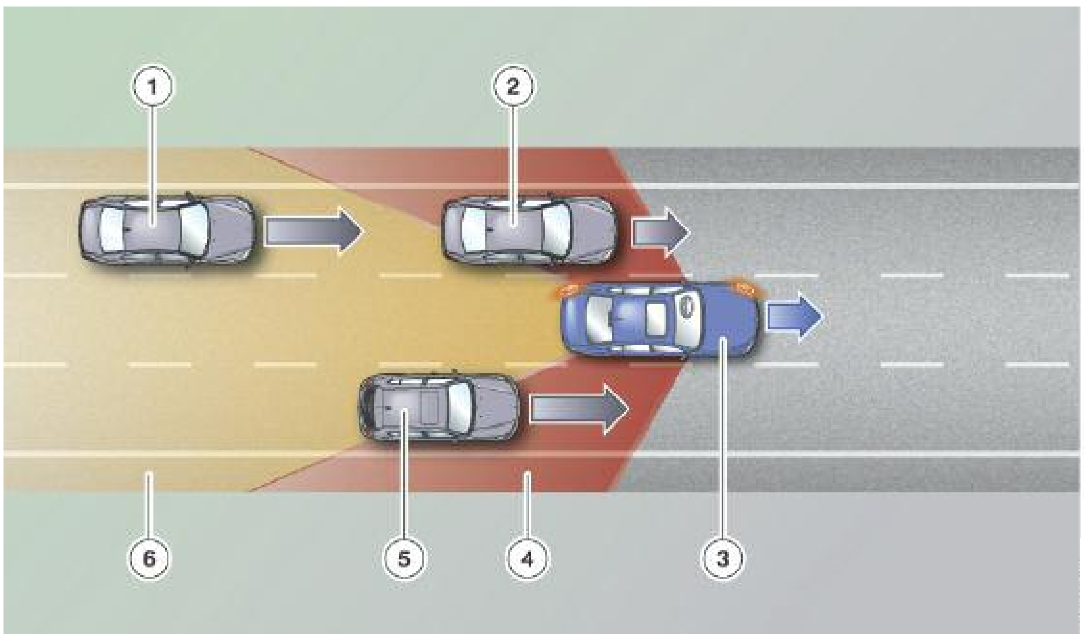
OBJECTIVES

After completion of this module you will be able to:

- Describe the Active Blind Spot Detection System in the F01/F02
- Describe the function of the Active Blond Spot detection System of the F01/F02
- Identify the components of the Active Blond Spot detection System of the F01/F02

Introduction

Active Blind Spot Detection is a new BMW system. It is being introduced for the first time in the F01/F02 7 Series . The system is designed to assist the driver in making lane change maneuvers by monitoring traffic at the rear and sides of the vehicle. Using two radar sensors it detects vehicles traveling in the rear and along side our vehicle and warns the driver of the position of any unseen vehicles around him traveling in his “Blind Spot”.



Typical traffic scenario with the Active Blind Spot Detection system

Index	Explanation
1	Fast approaching vehicle on the left-hand neighboring lane
2	Vehicle in the left-hand neighboring lane travelling at the same speed
3	Your own vehicle, with the intention of changing lanes to the left
4	Blind spot area (left/right)
5	Vehicle in the right-hand neighboring lane travelling at a faster speed
6	"Lane change zone"

The active blind spot detection system can detect traffic situations that could be dangerous if your vehicle changes lanes. The driver is informed and warned in two stages.

These kinds of traffic scenarios arise, for example, when distant vehicles rapidly approach from behind. They are then in the "lane change zone" shown in the graphic.

These kinds of situations are difficult for the driver to judge, especially after dark. The radar sensors work completely independently of the light conditions.

A second danger can arise if other vehicles are in the blind spot area. The driver can only be aware of them if he is particularly careful and cautious. However, If he has a lapse of attention, he may not see vehicles in this area.

The radar sensors of the active blind spot detection system detect other vehicles in the neighboring lanes right up to about the middle of your own vehicle. The system can therefore offer the driver valuable assistance in this situation as well.

The first stage of detection is called "information" and it is provided as soon as the system is switched on and a hazardous lane change situation is present. The information is provided by activating warning lights in the door mirrors.

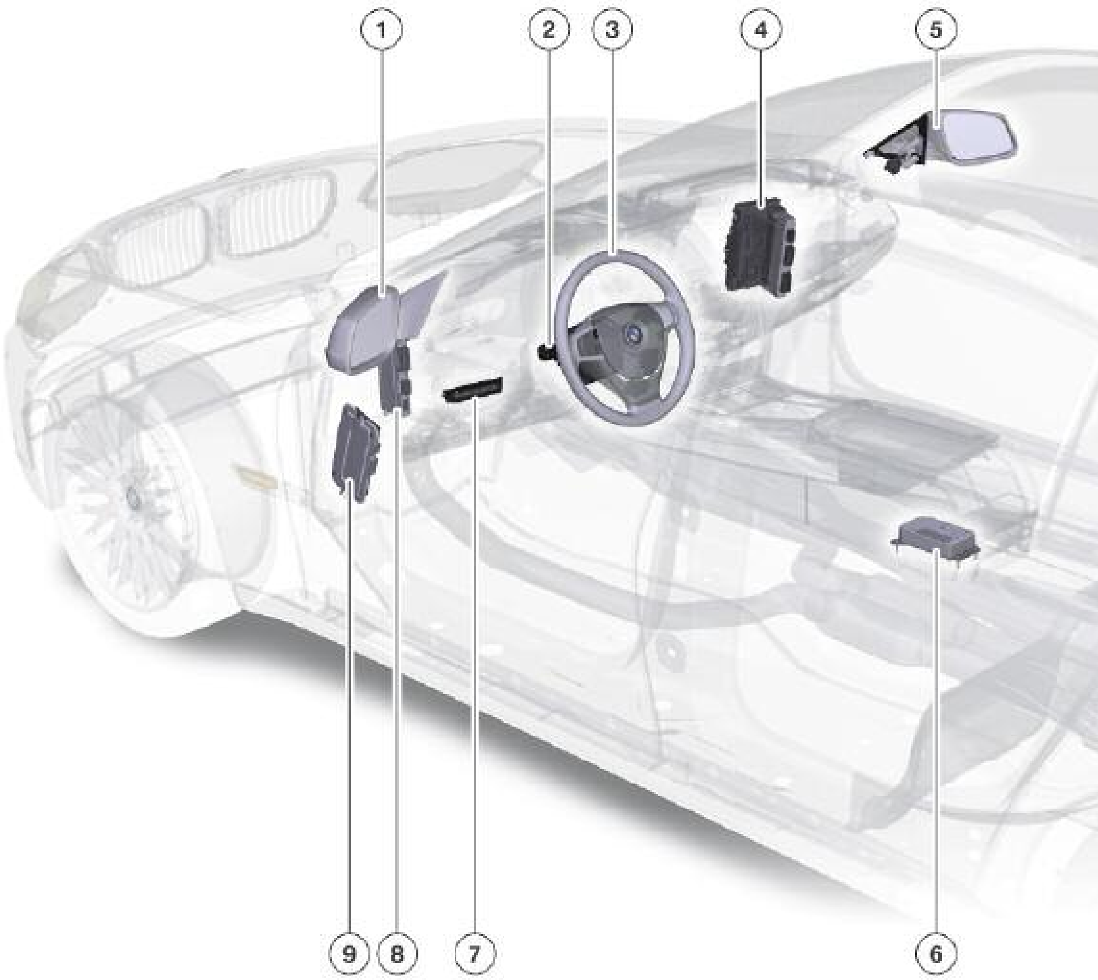
If the driver intends to make a lane change and uses the turn signal stalk to indicate this, a second, more intense stage will then be issued, the "warning".

The corresponding warning light then flashes with high intensity and the steering wheel starts to vibrate. The driver must cancel the lane change and if necessary steer back into his own lane to avoid a dangerous situation.

Note: The US marketing term for Lane Change Warning System (SWW) is Active Blind Spot Detection. These two systems are one and the same and are not to be confused with Lane Departure Warning.

System Overview

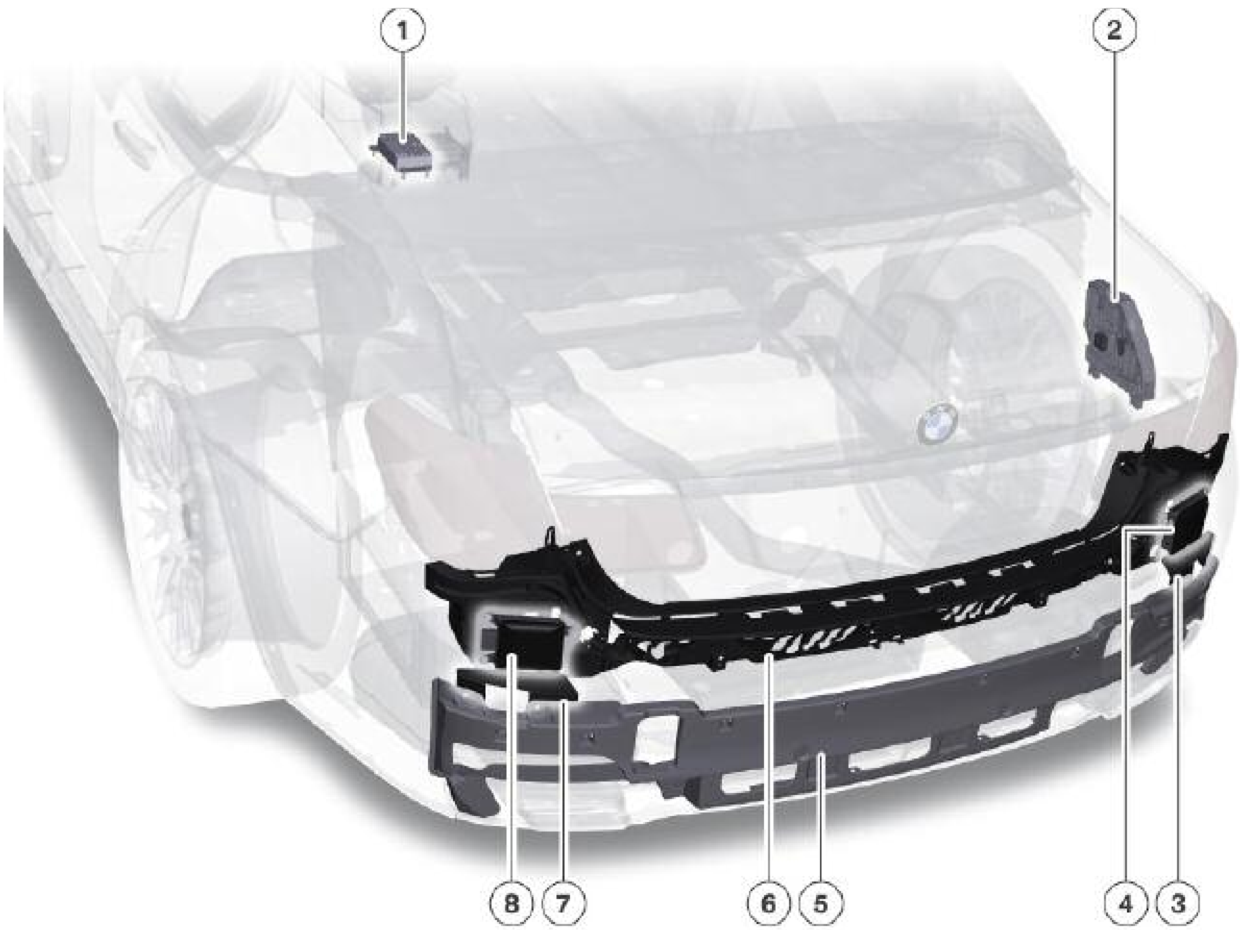
The Active Blind Spot Detection system is available as an option on the F01/F02.



Components of the Active Blind Spot Detection system in the F01/F02.

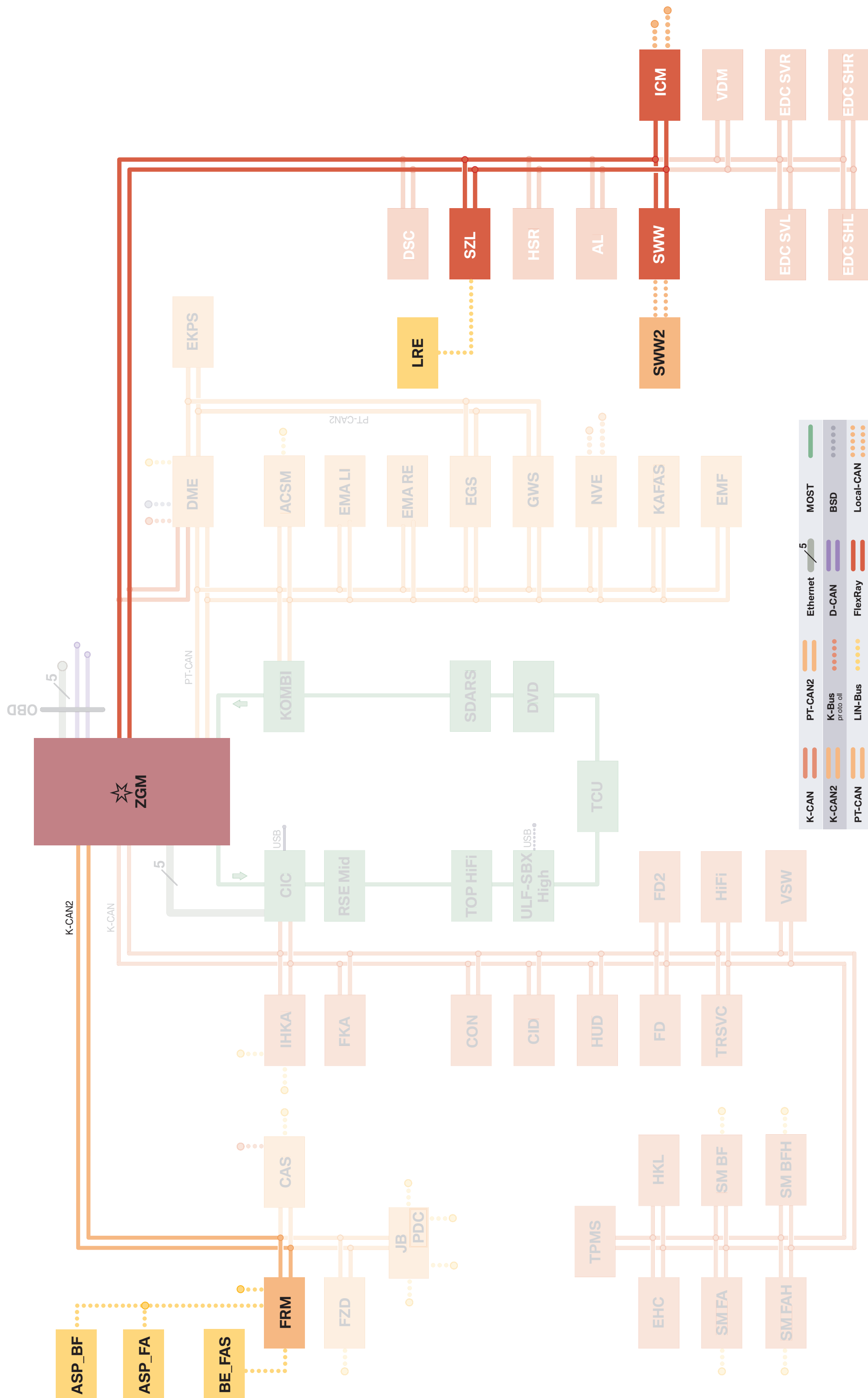
Index	Explanation
1	Driver's door mirror
2	Steering column switch cluster
3	Steering wheel with steering wheel module and vibration actuator
4	Junction box electronics and front fuse carrier
5	Front passenger door mirror
6	Integrated Chassis Management control unit
7	Operating unit for driver assistance systems
8	Central gateway module
9	Footwell module

Components of the Active Blind Spot Detection system in the F01/F02 (rear view of the vehicle)



Index	Explanation
1	Integrated Chassis Management control unit
2	Rear fuse carrier in the luggage compartment
3	Bracket for shielding the right-hand radar sensor
4	Right-hand master radar sensor
5	Rear bumper deformation elements
6	Center guide
7	Bracket for shielding the left-hand radar sensor
8	Left-hand SWW2 radar sensor

Bus System Overview

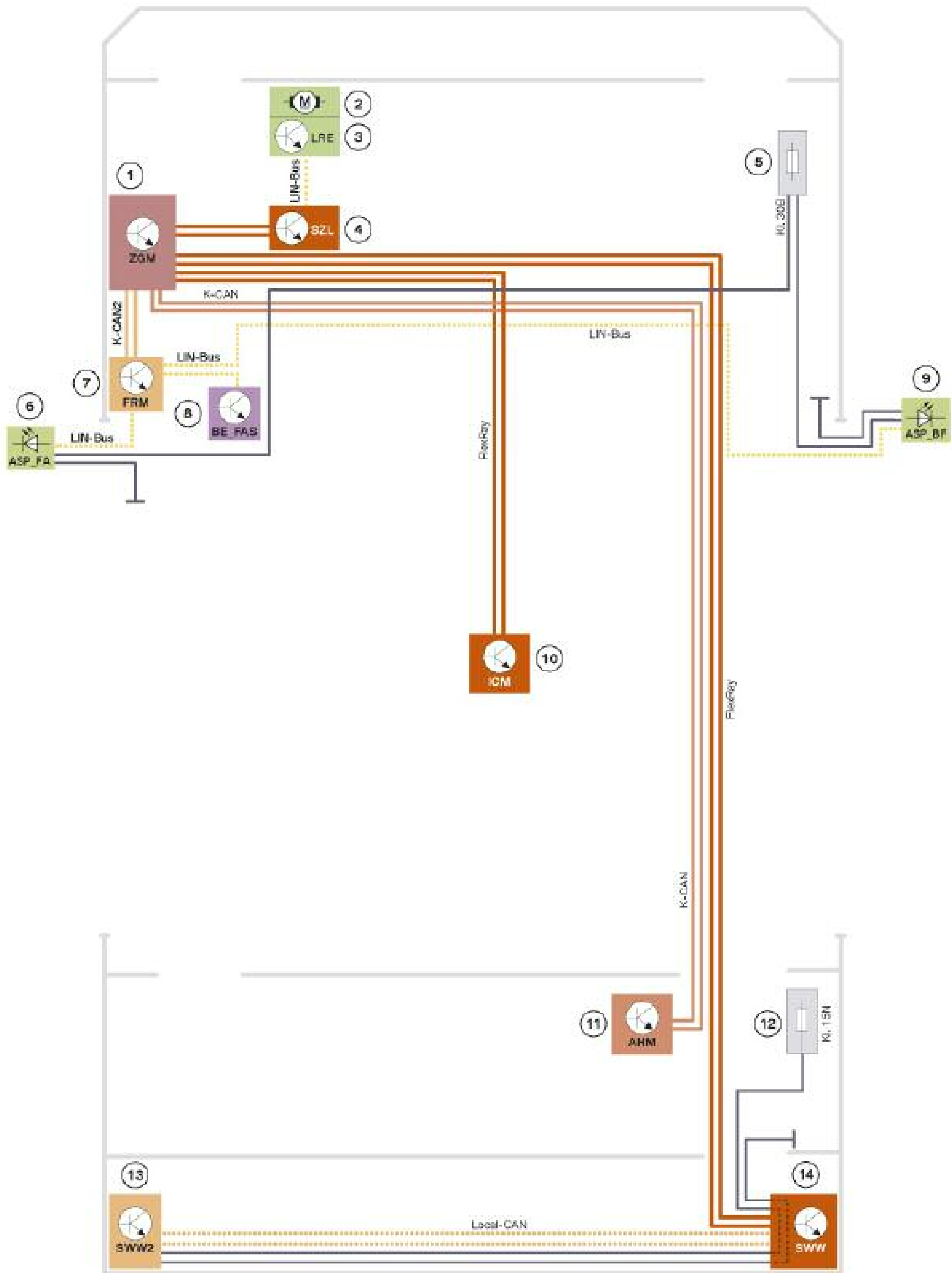


Bus system overview of the Active Blind Spot Detection system in the F01/F02

Bus System Overview Legend

Index	Explanation
ASP_BF	Front passenger door mirror
ASP_FA	Driver's door mirror
BE_FAS	Operating unit for driver assistance systems
FRM	Footwell module
ICM	Integrated Chassis Management
LRE	Steering wheel module
SWW	Master radar sensor for the Active Blind Spot Detection system
SWW2	SWW2 radar sensor for the Active Blind Spot Detection system
SZL	Steering column switch cluster
ZGM	Central gateway module

System Schematic Circuit Diagram



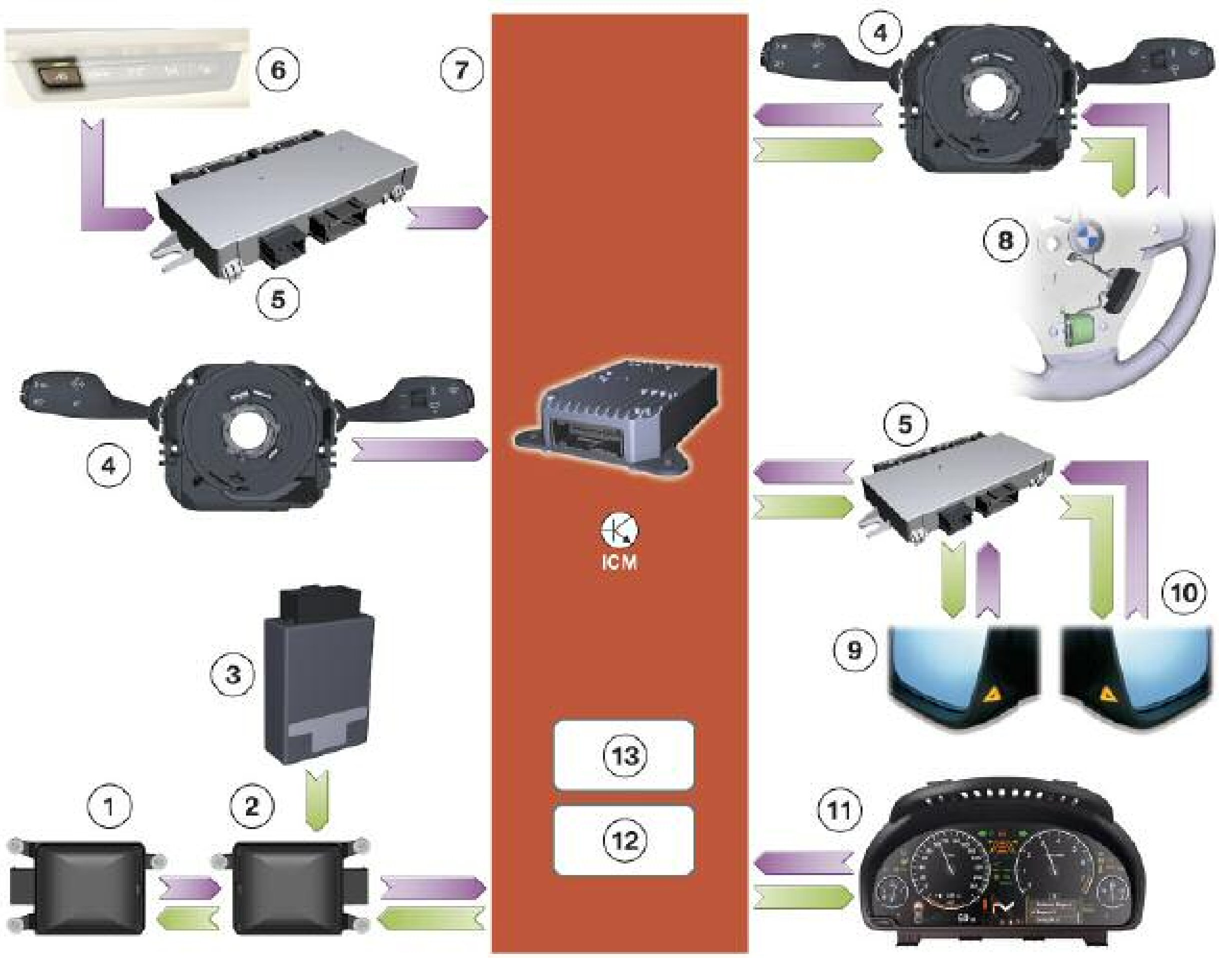
System circuit diagram for the Active Blind Spot Detection system in the F01/F02

System Schematic Circuit Diagram Legend

Index	Explanation
1	Central gateway module
2	Vibration actuator
3	Steering wheel module
4	Steering column switch cluster
5	Fuse for the driver/front passenger door mirrors (front fuse carrier, junction box electronics)
6	Warning light in the driver's door mirror
7	Footwell module
8	Operating unit for driver assistance systems
9	Warning light in the front passenger door mirror
10	Integrated Chassis Management
11	(Not for US)
12	Fuse for the radar sensors in the Active Blind Spot Detection system (rear fuse carrier in the luggage compartment)
13	SWW2 radar sensor for the Active Blind Spot Detection system
14	Master radar sensor for the Active Blind Spot Detection system

System Functions

Blind Spot detection system input/output



Index	Explanation	Index	Explanation
1	Radar sensor (SWW2)	8	Steering wheel module and vibration actuator
2	Radar sensor (master)	9	Driver's door mirror
3	Not for US	10	Front passenger door mirror
4	Steering column switch cluster	11	Instrument cluster
5	Footwell module	12	"Active Blind Spot Detection control unit function"
6	Operating unit for driver assistance systems	13	"Steering wheel vibration coordination" function
7	Integrated Chassis Management		

Detecting Road Users

Both (master and SWW2) radar sensors are used to detect road users. They operate independently of each other in their own respective areas of detection.

First, the position of the road users who have been detected is determined in a longitudinal and lateral direction. Based on this, they are assigned a lane. In doing so a distinction is made between your own lane, the neighboring lanes on the right and left and other neighboring lanes that are further away.

If road users are in your "lane change zone", their approaching speeds to your own vehicle are recorded.

If, instead, a road user is in your blind spot, it is sufficient that you are aware of their presence. His exact position or speed in such cases is not critical for the warning to be issued.

Setting the Necessity for a Warning

The necessity for a warning is determined by the master radar sensor (SWW). To do this, it uses the data which it has collected about road users itself, as well as information from the SWW2 radar sensor.

For the blind spot detection system, only the road users on the immediately neighboring lanes on both sides are relevant. In contrast, road users in your own lane and on other more distant lanes do not pose a danger when you are making a lane change.

The distance and approaching speed of road users in your lane change zone, i.e. of vehicles immediately behind your own vehicle, is a decisive factor as to whether a warning is issued or not. The time remaining for cancelling a lane change maneuver is calculated using the distance (in a longitudinal direction) and their approaching speed. If this time drops below a threshold value for any one of the detected road users, the system decides that it is necessary to give a warning.

Road users in the blind spot lead to a minimal amount of time being calculated for cancelling a lane change. This is why their exact position or speed relative to your own vehicle only has secondary importance. The mere presence of a road user in the blind spot therefore leads to the necessity for a warning.

The blind spot detection system must, of course, also be able to detect transitions from the lane change zone into the area of the blind spot and vice versa. A further challenge for the system is to determine the beginning and the end of the warning necessity when a vehicle in the neighboring lane is slowly overtaken by your own vehicle.

Vehicles that are overtaken very quickly cause the necessity for a warning to be suppressed or at least to end quickly.

In order to depict what the system is doing as reliably as possible to the driver, more than just the current measured values from the radar sensors are used, in particular in these special situations. In addition, the position and speed history of the other road users is taken into account. For example, based on a mathematical model, the system determines the point when an overtaking vehicle leaves the blind spot area and no longer poses a danger.

The master-radar sensor sends the result of the calculation as to whether the necessity for a warning is present or not, to the ICM control unit.

Switching the System On and Off

How the Active Blind Spot Detection system behaves with regard to the driver is ultimately controlled by the Integrated Chassis Management.

This includes:

- Switching it on and off
- Checking the operating conditions
- Checking for faults
- Distinguishing between information and a warning.

A button on the operating unit for the driver assistance systems is used to switch it on and off. The ICM control unit receives the signal by keystroke from the footwell module.

The ICM control unit permits it to be switched on only if no fault is present in the interconnected system and all operating conditions are satisfied.

If the ICM control unit carries out the driver's request to switch it on, the function illumination on the button is switched on as visual feedback. This is also controlled by the Integrated Chassis Management and is executed by the FRM.

If the request to switch it on cannot be carried out, the function illumination remains off. The status (switched on or off) remains key specific regardless of power cycles. If the Active Blind Spot Detection system is on in the current driving cycle, it will be on in the next driving cycle from the start.

If, after switching on the Active Blind Spot Detection, one of the operating conditions is infringed or a fault occurs, it is automatically deactivated. In such a case, the driver would not be able to tell if only the function illumination had switched off. Therefore, a Check Control message is issued (see the section entitled "system components").

Informing and Warning
The system can only generate information or a warning reliably, if the road speed is greater than 50 km/h (31 mph). The function will work at speeds under 50 km/h (31 mph), but not with the high quality and reliability required by BMW. In order not to compromise on the satisfaction of discerning BMW customers, no information or warnings are issued at speeds below 50 km/h (31 mph).

Information is the first stage of assistance that the driver receives from the Active Blind Spot Detection system. The idea is to discreetly make the driver aware of a danger that could arise if he were to change lanes. Information is produced by discreetly illuminating a yellow triangle-shaped warning light in the housing of the door mirror. The warning light is only activated on the side of the vehicle where the necessity for a warning has been detected by the master radar sensor.

Thanks to this concept, the system provides assistance to the driver as early as the preparation phase of a lane change maneuver. The driver can glance briefly in the direction of the door mirror at any to collect information from the Active Blind Spot Detection system as to whether or not a danger exists regarding a lane change.

The discreet manner of the information, on the other hand, does not cause annoyance if the driver wishes to continue to drive straight ahead without making a lane change.

The ICM control unit sends a bus signal that contains a warning request indicating in which door mirror the warning light should light up and with which intensity. In the process, the ICM control unit selects an intensity that is dependent on the surrounding brightness. To do this, it reads a bus signal from the rain/ lights/solar/condensation sensor and evaluates it.

The warning request from the ICM control unit travels via the central gateway module to the footwell module, where the signal is routed to the door mirror(s) concerned.

The information is issued to the driver in all cases where all of the following conditions have been satisfied:

- The Active Blind Spot Detection system is switched on
- The road speed is above 50 km/h (31 mph)
- The master radar sensor has detected a necessity for a warning.

The second stage, the warning, should, in comparison, be significantly more prominent than the information. It should reach the driver quickly and directly, if he is still intending to make a lane change despite an impending dangerous situation.

The warning is issued, if the following conditions have been satisfied

- The conditions for information have been satisfied:
- The turn signal is switched on the side of the vehicle where the master radar sensor detected a necessity for a warning.

The steering column switch cluster issues the signal about the status of the turn signal via the FlexRay to the ICM control unit.

The only difference in the criteria for information and a warning is thus the status of the turn signal. The rear traffic situation or your own driving conditions do not influence it.

The visual aspect of the warning is generated by the respective warning light flashing with a high light intensity. In addition, the steering wheel begins to vibrate and this produces a haptic and very direct warning signal to the driver.

Note: If the driver changes lanes without using the turn signal, he will only receive the information discreetly from the Active Blind Spot Detection system. The Active Blind Spot Detection system only sends out the more intensive warning, if the driver has switched on the turn signal when he intends to make a lane change.

Coordinating the Activation of the Vibration Actuator

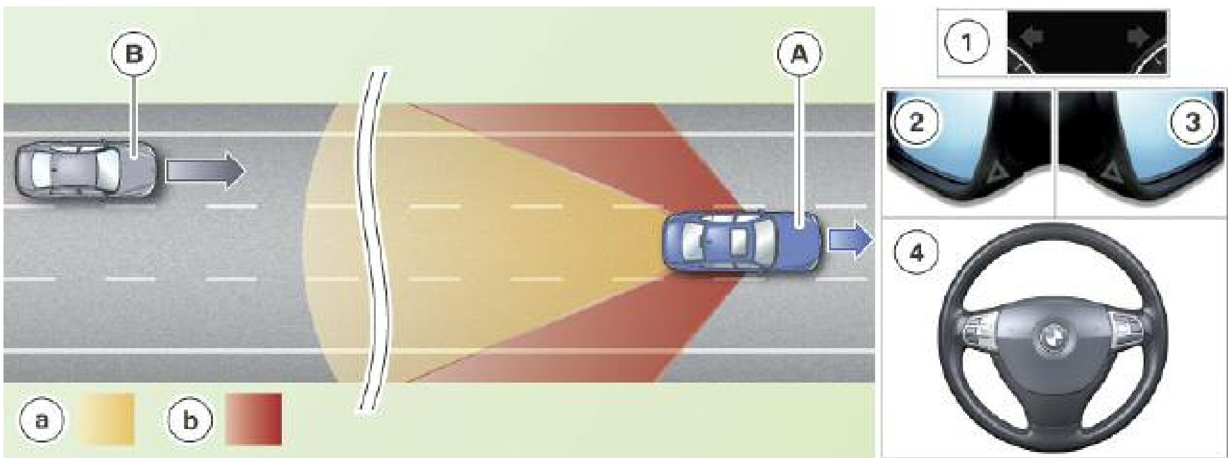
Like the blind spot detection, the lane departure warning (KAFAS control unit) also uses the vibration actuator to produce a warning signal for the driver. For this, the systems use different amplitudes of vibration.

This is why these must be a coordinator function for controlling the vibration actuator. This is integrated into the ICM control unit.

Using the FlexRay bus system, the coordinated setpoint for the vibration is communicated to the steering column switch cluster and executed via the steering wheel module (LRE) and the vibration actuator in the steering wheel.

Blind Spot Detection from the Customer's Perspective

In this section, example situations are used to explain how the Active Blind Spot Detection system behaves in different traffic scenarios. The emphasis here is not on the technology, but rather on how the customer perceives the system. In all example situations it is assumed that the driver has switched on the Active Blind Spot Detection system and that the road speed of your own vehicle is above 50 km/h (31 mph).



Traffic scenario without the a need for a warning

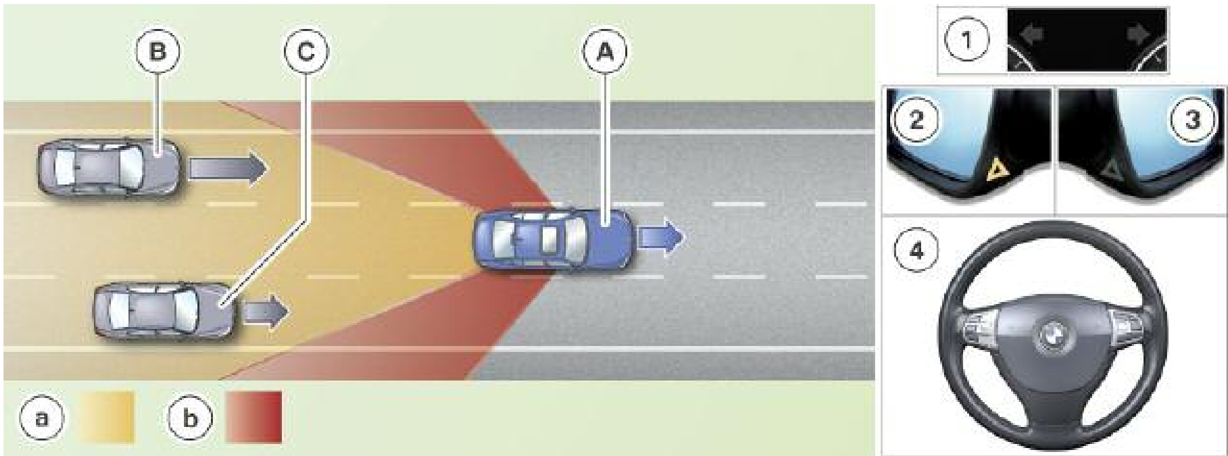
Index	Explanation
A	Your own vehicle with blind spot detection
B	Faster vehicle in the left-side neighboring lane outside of the lane change zones
a	Lane change zone
b	Blind spot area
1	Turn signal OFF
2	Warning light in the driver's door mirror OFF
3	Warning light in the front passenger door mirror OFF
4	Steering wheel not vibrating

No Necessity for a Warning

Although another vehicle in the left-hand lane is approaching your own vehicle, neither information or a warning is generated. Even if the driver were to carry out a lane change with his own vehicle, this would not result in a dangerous situation. The time it would take for the other vehicle to reach your own vehicle is considerable.

A sufficient distance will be maintained by accelerating your own vehicle slightly or by a slight deceleration of the other vehicle. There is no necessity at all for the driver to be informed by the Active Blind Spot Detection system.

Information



Traffic scenario with information from the blind spot detection system

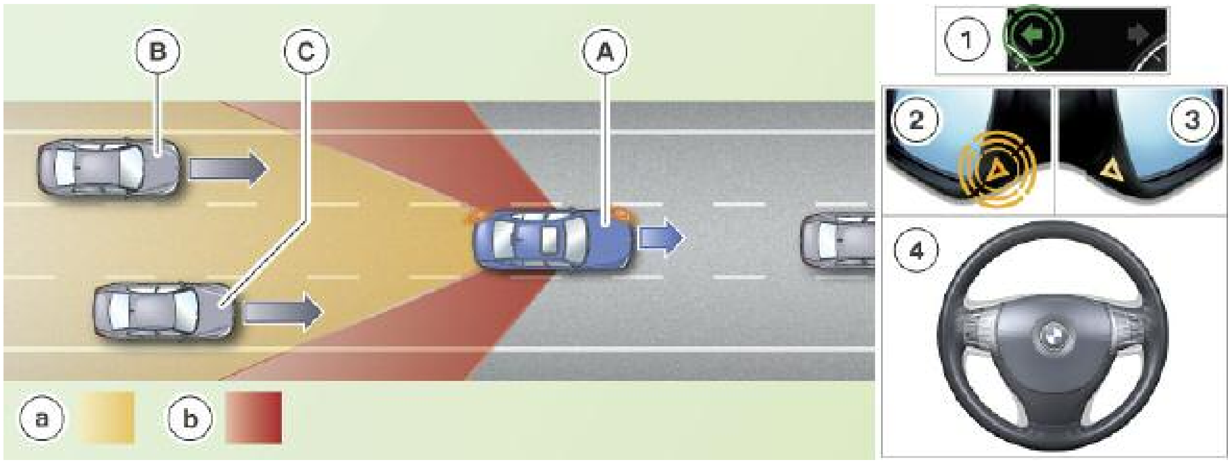
Index	Explanation
A	Your own vehicle with blind spot detection
B	Faster vehicle in the left-side neighboring lane within the lane change zone
C	Equally fast vehicle as our own, in the right-side neighboring lane within the lane change zone
a	Lane change zone
b	Blind spot area
1	Turn signal OFF
2	Warning light in the driver's door mirror lights up with low intensity
3	Warning light in the front passenger door mirror OFF
4	Steering wheel not vibrating

The vehicle in the left-hand neighboring lane is already in the lane change zone. Because it is still approaching your own vehicle at a high speed, the time the driver would have to cancel a lane change maneuver is short. The blind spot detection system detects the necessity for a warning. Because the driver in his own vehicle does not show any specific intention of making a lane change, only the information and not the warning is issued.

The vehicle in the right-side neighboring lane is at a some what shorter distance from your own vehicle than the vehicle in the left side neighboring lane. It is travelling at the same speed as your own vehicle. The distance to your own vehicle is therefore not decreasing. Thus, there is no necessity for a warning on the right-hand side.

Only the warning light in the driver's door mirror lights up and it does this with low intensity.

Warning - Lane Change Zone



Traffic scenario with a warning from the blind spot detection system

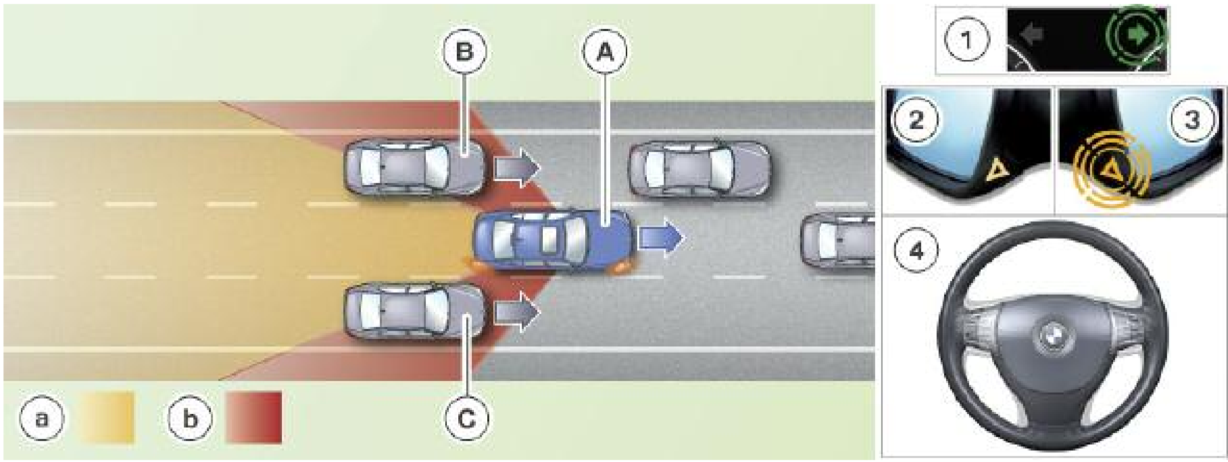
Index	Explanation
A	Your own vehicle with blind spot detection
B	Faster vehicle than our own, in the left-side neighboring lane within the lane change zone
C	Equally fast vehicle as vehicle B, in the right-side neighboring lane within the lane change zone
a	Lane change zone
b	Blind spot area
1	Left turn signal ON
2	Warning light in the driver's door mirror flashes with high intensity
3	Warning light in the front passenger door mirror lights up with low intensity
4	Steering wheel is vibrating

The vehicle in the left-hand neighboring lane is in the lane change zone and is approaching your own vehicle. There is a necessity for a warning therefore on the left-hand side.

Because the driver intends to make a lane change to the left, he has switched on the left turn signal. A lane change maneuver is therefore imminent. In order to attract the attention of the driver quickly and directly, a left-side warning is produced. This means the warning light in the driver's door mirror flashes brightly and in addition the steering wheel vibrates.

The vehicle in the right-side neighboring lane is also approaching your own vehicle at this point. Therefore, the necessity for a warning also exists on the right-hand side. However, because the driver has not switched on the right turn signal, information is issued to this side, but no warning.

Warning - Blind Spot Area



Traffic scenario with vehicles in the blind spot

Index	Explanation
A	Your own vehicle with blind spot detection
B	Vehicle in the left-side neighboring lane in the blind spot area
C	Vehicle in the right-side neighboring lane in the blind spot area
a	Lane change zone
b	Blind spot area
1	Right turn signal ON
2	Warning light in the driver's door mirror lights up with low intensity
3	Warning light in the front passenger door mirror flashes with high intensity
4	Steering wheel vibrates

Both the vehicle in the left-hand and the vehicle in the right-side neighboring lanes are in the blind spot area. Therefore, the necessity for a warning exists on both sides, independently of how quickly they are travelling.

The driver intends to make a lane change to the right and therefore switches on the right turn signal. This causes the right-side warning to be produced. The warning light in the front passenger door mirror flashes brightly and the steering wheel vibrates.

Information is issued on the left-hand side, but no warning.

System Components

Radar Sensors

Two radar sensors are fitted in the vehicle for the Active Blind Spot Detection system. The two parts are different, although visually they look the same.

There is a master sensor that is always fitted in the rear of the vehicle on the right-hand side, as well as a SWW2 that is fitted in the rear left-hand side.

The identical features of the master and SWW2 will be introduced first. Then the special features and differences between the master and SWW2 will be described.

Common Features of the Master and SWW2

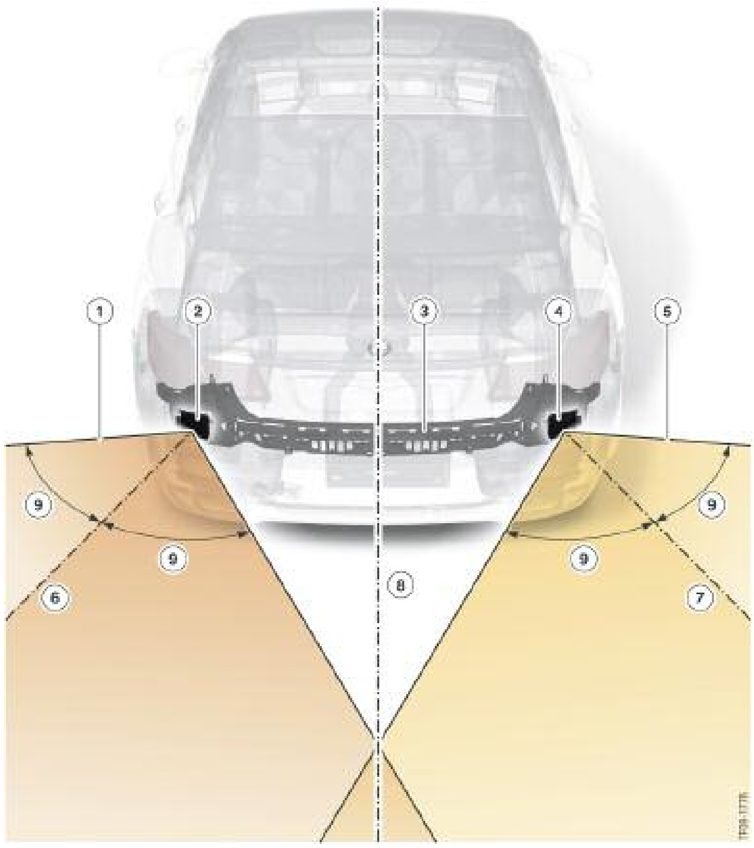
The sensors of the Active Blind Spot Detection system work according to the RADAR principle (radio detection and ranging). They have some features in common, but also some differences in comparison with the short-range radar sensors for the ACC Stop & Go function. These are listed in the following table.

Characteristic	Radar sensors of the blind spot detection system	Short-range radar sensors for ACC Stop & Go
Modulation method	LF MSK (linear frequency modulation shift keying)	PD (pulse doppler)
Mid-range transmission frequency	24 GHz	24 GHz
Bandwidth	100 MHz	> 1 GHz
Distance measurement	Based on the propagation time of one chirp *	Based on pulse propagation time
Measurement of the relative speed	Based on frequency shift (doppler effect)	Based on phase difference (doppler effect)
Angle measurement	Ratio of two phase values (two simultaneous measurements)	Ratio of two phase values (two successive measurements)
Transmission output (typical maximum value)	Approximately 40 mW (typical), approximately 100 mW (maximum)	Approximately 0.08 mW (average), approximately 100 mW (single pulse)
Range (dependent on type of object measured)	At least 50m, up to 70m	At least 10m, up to 20m
Horizontal angular width of beam	Approximately -70° to +80°	+/-40°
Vertical angular width of beam	Approximately +/-6.5°	Approximately 20°
* Characteristic signal segment with changing frequency		

The RADAR principle offers basic advantages with regard to the detection reliability of road users in poor weather conditions. Only when it is exposed to extreme conditions, for example heavy rain or snow, can a reduction in its range occur. If the sensors detect a particularly extreme situation, this status is signalled, so that the function can be switched off and the driver informed.

Both sensors have the functionality of control units. This means that they are compatible with diagnostics and can be programmed and coded.

The sensors are fitted in the rear of the vehicle above the bumper bracket. They are fitted to a large plastic component that is referred to as the "center guide". From the outside the sensors are not visible, because they are hidden by the bumper trim.



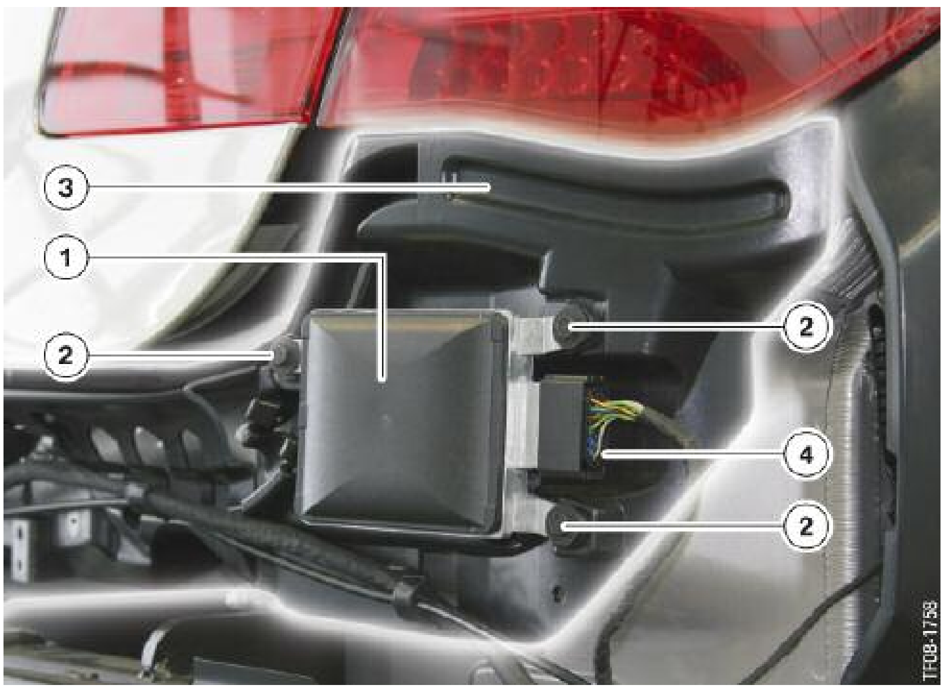
Overview and installation location of the radar sensors

Index	Explanation	Index	Explanation
1	Detection zone of the SWW2	6	Symmetrical axis of the SWW2
2	SWW2	7	Symmetrical axis of the master
3	Center guide	8	Vehicle longitudinal axis
4	Master	9	Horizontal angular width of beam
5	Detection zone of the master		

As you can see from the graphic, the detection zones of the two sensors overlap. The data on road users that have been detected can therefore not be evaluated separately from each other (for the left and right side of the vehicle). Instead the data is first collected from both sensors and evaluated. Then a decision is made whether the driver must be warned or not.

A detailed view of the installation locations of the master and SWW2 can be seen in the following:

Installation location of the master



Index	Explanation	Index	Explanation
1	Radar sensor for Active Blind Spot Detection (master)	3	Center guide
2	Mounting bolts	4	Wiring harness connector

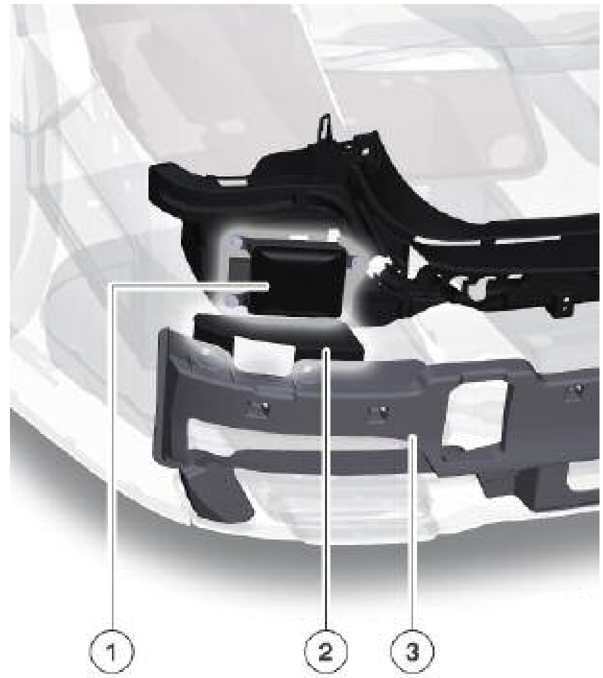
The fixtures for the sensors do not permit any mechanical adjustment. Instead of the sensors being mechanically adjusted (as is the case with the long-range area sensor in the ACC), they are calibrated using software. When this is done, the actual installation position and above all the alignment of the center axes of the sensors are determined and stored in the sensors. For details please see the section entitled "Calibrating the radar sensors".

Installation location of the SWW2

Index	Explanation	Index	Explanation
1	Radar sensor for Active Blind Spot Detection (SWW2)	3	Center guide
2	Mounting bolts	4	Wiring harness connector

Radar sensor shield

Index	Explanation
1	Radar sensor (SWW2)
2	Bracket for shielding
3	Deformation element



Two brackets are fitted to the deformation element of the rear bumper that act as a shield for the radar sensors. This prevents malfunctions when processing radar signals that could be caused, for example, by reflections from the road surface. The material used for the bracket was specially selected for this intended use. Therefore, in the event of damage to the brackets, they must be replaced with the correct new part.

Emergency repair using a different plastic part is not permitted. Both radar sensors have a similar structure. The connector and the electronics board are located on the lower section of housing. It is used both for electrical shielding and for dissipating heat.

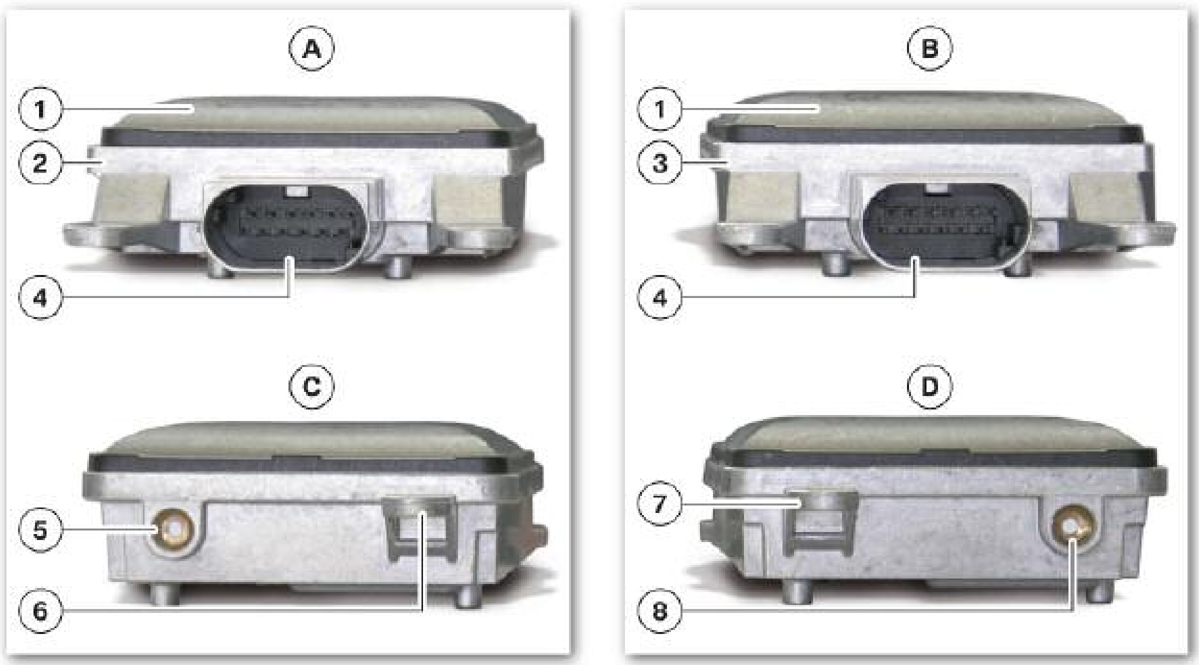
The board always has a signal processor. This evaluates the radar signals and uses them to generate a list of the objects detected by the sensor. The list contains the distance to each object in a longitudinal and lateral direction and the relative speed. In addition, information is supplied about whether the object is in the blind spot area.

The radar front-end (radome) is used to generate and send radar waves. Of course, the receive circuit is also integrated in it. Sending and receiving is carried out via a planar antenna. The radar waves are transformed into the required shape using the so-called radome.

The plastic radome therefore determines exactly the extent of the detection zone of the sensors. The bumper trim also influences the shape of the detection zone. Calibration must therefore always be done with the bumper trim mounted. If done without the bumper trim, different values are assigned to the measured distances. The measuring result would be distorted and the warning for the driver inappropriate.

The radome and the lower section of housing are cemented together. Repairs to the inside of the sensor are not intended. If the test plan of the diagnostic system requests it, then the sensor must be merely replaced in its entirety.

Side view of the radar sensors



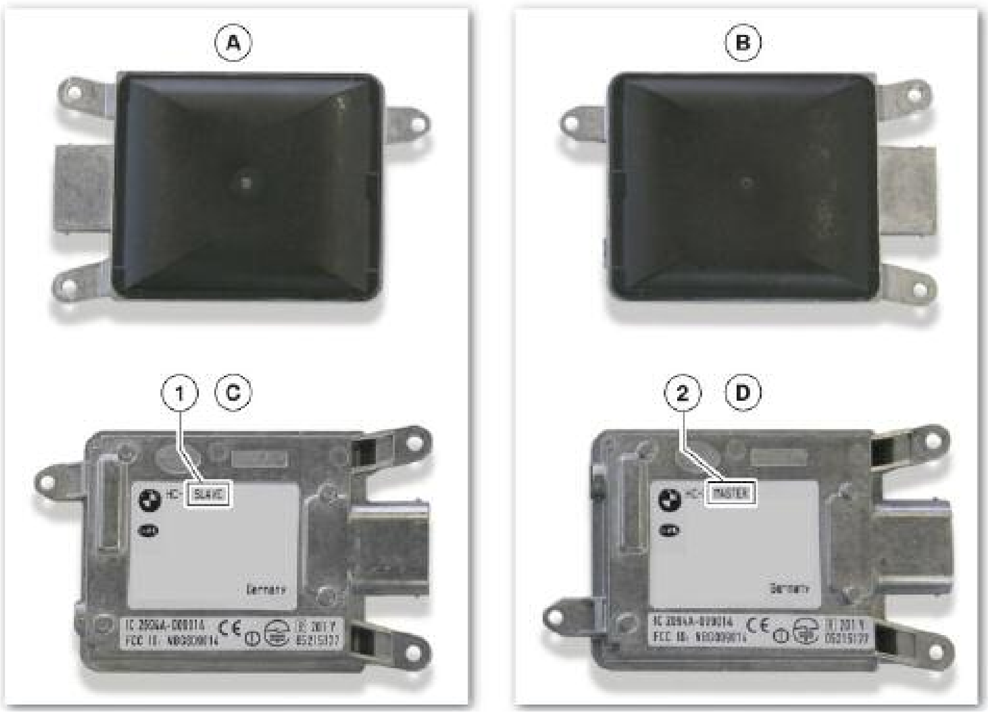
Index	Explanation	Index	Explanation
A	Outside view of the SWW2	3	Lower section of housing, master
B	Outside view of the master	4	Connector
C	Inside view of the SWW2	5	Pressure-compensating element, SWW2
D	Inside view of the master	6	Mounting eye for the SWW2
1	Radome	7	Mounting eye, master
2	Lower section of housing, SWW2	8	Pressure-compensating element, master

On one side of the lower section of housing, there is an element for producing pressure compensation both on the master and the SWW2. This element contains a membrane with a teflon coating that is permeable to air and moisture. However, water in liquid form can not permeate the membrane. Pressure compensation is required, because the sensors heat up considerably during operation as a result of electronic power conversion.

Both sensors have an identical looking connector. Even the mechanical encoding of the connector on both sensors is identical. However, the pins are wired differently for master and SWW2. This is why they should only be connected to the intended wiring harness.

How can you distinguish between master and SWW2 then?

Upper and lower section of the radar sensors for the blind spot detection system



Index	Explanation	Index	Explanation
A	Upper section of the SWW2	D	Lower section of the master
B	Upper section of the master	1	Labelling "SWW2"
C	Lower section of the SWW2	2	Labelling "master"

The mounting eyes of the lower housing sections on the master and SWW2 are located in different positions. The fixtures for the mounting bolts on the "Center guide" are appropriately positioned. This ensures that the master is mounted only on the right and the SWW2 on the left. Only after installation is complete is it recommended to connect the wiring harness to the sensors.

You can also differentiate between the sensors by using the part number and by the labelling on the lower section of the housing.

Special Features of the SWW2 Radar Sensor

The SWW2 only provides information about the road users in its detection zone. This is why the SWW2 contains only one signal processor for controlling the radar front-end and for evaluating the radar signals. A CAN controller is used to send the data to the master.

The signal processor is also capable of executing the self-diagnostics of the sensor. If SWW2 faults are detected, they are stored in its own EEPROM. They are also transferred to the master and stored there in its fault code memory.

Special Features of the Master Radar Sensor (SWW)

The master performs the same basic tasks as the SWW2 with regard to recording and evaluating data from road users. In addition, the master calculates whether a traffic scenario exists that could be dangerous in the event of a lane change. This calculation is based on data about the road users detected and the state of motion of your own vehicle. If such a situation is detected, the master sends a corresponding signal via FlexRay to the ICM control unit. In addition, the master uses the same path to send signals about the status of both sensors, for example to determine whether they are functioning correctly or there is a fault.

The master executes self-diagnostics in the same way as the SWW2. If, in the process, it detects a fault within itself or a fault is registered by the SWW2, an entry is made in the fault code memory of the master. This makes it possible to read faults with the SWW2 during servicing, even though the diagnostic system is only communicating with the master and as a result is only accessing its fault code memory.

The master contains in addition to the signal processor a further microprocessor for this purpose. This also carries out communication via the FlexRay controller with partner control units, and with the ICM control unit in particular.

Bus Connections

The sensors for Active Blind Spot Detection are connected with two bus systems:

- The master (SWW) is connected to the FlexRay and to the local CAN.
- The SWW2 radar sensor is only connected with the local CAN.

The SWW2 uses the local CAN to transmit the data of all of the road users it has detected to the master. The sensors also utilize the local CAN to exchange internal system status and control signals.

The local CAN is physically set up like the PTCAN and therefore works at a bit rate of 500 kBit/s. Master and SWW2 each have one of the two terminal resistors, each with 120 Ω.

The FlexRay represents the interface between the sensors and the whole vehicle. In this way, the sensors, or to be exact, the master sensor, receives the data about the state of motion of the vehicle (e.g. the road speed and yaw rate).

The master uses this interface to send information about whether the necessity for a warning exists to the ICM control unit.

The FlexRay is routed to the master and is fitted there with a terminating resistor. The master is therefore a terminal node in the FlexRay network.

A detailed description of new features in the FlexRay network can be found in the F01/ F02. bus systems training material in ICP and TIS.

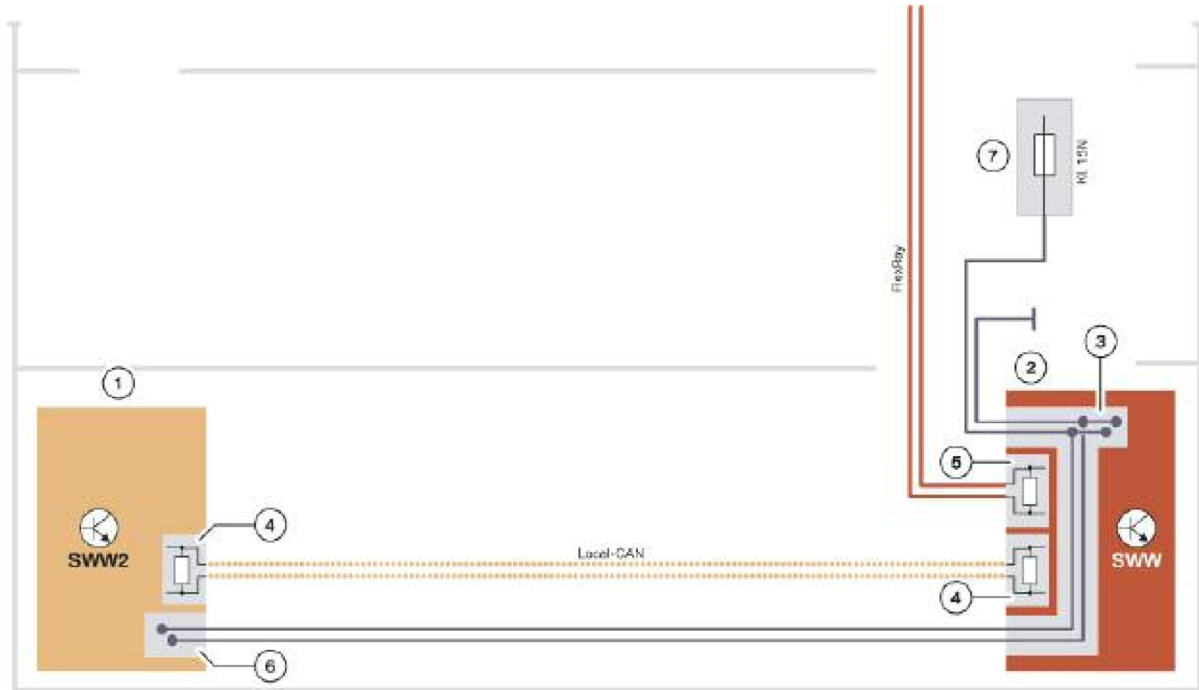
Voltage Supply

The SWW sensors are supplied with power via a common fuse with terminal 15. The fuse is located in the rear fuse carrier (in the luggage compartment). The voltage supply is routed to the master and from there to the SWW2.

The wake-up line is therefore not required on the SWW sensors.

Note: During the overrun of terminal 15 the SWW sensors save important data in the integrated EEPROM. This includes, for example, fault code memory entries and values calculated during calibration. This data is permanently stored and available again for the next driving cycle. It is therefore important to wait for the overrun from terminal 15 when work is carried out on the SWW sensors, before disconnecting the voltage supply (connector, battery).

Bus systems and voltage supply to the radar sensors of the blind spot detection system



Index	Explanation	Index	Explanation
1	SWW2 radar sensor	5	FlexRay feed line with a terminating resistor
2	Master sensor	6	Voltage supply feed line (terminal 15 and ground)
3	Feed line and continuation of the voltage supply (terminal 15 and ground)	7	Fuse for SWW sensors (rear fuse carrier in the luggage compartment
4	Local CAN feed line with a terminating resistor		

Calibrating the Radar Sensors

The calibration process is carried out with use of the ISTA diagnostic system. Calibration is performed for both sensors of the Active Blind Spot Detection system successively.

Reasons for calibration

The radar sensors of the Active Blind Spot Detection system measure the position and speed of road users approaching from the rear. This measurement is taken by the sensor housing as a reference value. In order to make a decision as to whether the driver should be warned or not, the measured data must be related to the vehicle's coordinate system. For this the exact location of the sensors must be known.

The installation location of the sensors is principally specified by the position of the retaining bore in "center guide". However, the sensor may be incorrectly aligned during installation or as a result of the tolerances of supporting parts. This applies in particular to the angle formed by the sensor axis and the vehicle longitudinal axis. If the deviation between the actual angle and the angle specified in the design is too large, this would interfere with the proper functioning of the Active Blind Spot Detection system. Warnings would either be omitted or be produced inappropriately.

The radar sensors must always be calibrated after the following:

- At least one of the radar sensors has been replaced.
- The bumper trim has been replaced.
- Repair work to the supporting parts has been carried out (e.g. to the "center guide").
- The test plan of the diagnostic system requests this due to a fault code memory entry.

Note: For more information regarding the Active Blind Spot Detection radar calibration process refer to the ISTA Diagnostic System.

Special Situations and Fault Statuses

Communication faults and internal control unit faults are not dealt with here in detail. Problem resolution is carried out in the same manner as with other control units, i.e. with the assistance of the test plan in the diagnostic system.

Instead, the emphasis here is on the statuses which apply specifically to the radar sensors of the Active Blind Spot Detection system. The material presented here should facilitate the diagnostics.

Blindness

"Blindness" here is used to denote heavy interference with the radar sensors, in which they no longer are able, for example, to detect road users at the required range. Blindness can also cause incorrect or omitted warnings.

The radar sensors contain a function which enables it to detect this status during operation. In this case, the master sends a bus signal to the ICM and the Active Blind Spot Detection system is then deactivated. The driver is informed about this by a Check Control message. The blindness status is documented with an entry in the fault code memory for a subsequent workshop visit.

Possible causes of the blindness status are:

- The sensor is covered by a sticker or by a bicycle carrier at the rear.
- Deformation (dents) in the bumper trim, even if for instance it has been repaired with plastic filler.
- Incorrect vertical alignment of the sensors (e.g. upwards) through a deformation of the supporting parts.
- Extremely thick covering of snow/slush on the bumper trim.

Errors in the sensor alignment

In the radar sensors of the Active Blind Spot Detection system, a function is calculated that can detect sensor alignment errors when the vehicle is in motion. This function monitors the data about detected objects as it is processed.

If the detected sensor alignment error is within a range that is still tolerable, the function compensates for the error. This means the data about the detected road users is corrected by the known value. If a sensor alignment error that is too large is detected, the proper functioning of the Active Blind Spot Detection system is no longer possible. The master then sends a signal to the ICM and the Active Blind Spot Detection system is switched off. The driver is informed about this by a Check Control message.

Reasons for deactivating the system due to detected sensor alignment errors include:

- A new radar sensor was installed without being calibrated (detected immediately).
- The sensor is covered by a sticker or by a bicycle carrier.
- Mechanical damage to the rear of the vehicle with deformation of the supporting parts (e.g. the "Center guide").
- Deformation (dents) in the bumper trim, even if for instance it has been repaired with plastic filler.

Some of the reasons given here could also apply to the "blindness" status.
For example, depending on the extent of the deformation of the bumper trim, this can result in blindness.

This kind of deformation can distort the radar signals in such a way that the sensors detect a sensor alignment error.

Rear damage

Two kinds of damage are plausible which require different repair measures:

- Damage exclusively to the bumper trim in the area where the sensor is installed.
- Additional deformation of the bumper bracket or other supporting parts.

Damage to the bumper trim

Of course only damage in the area where the radar waves are emitted from the sensors are relevant. If the bumper trim is deformed there, scratched extensively or it has an uneven thickness due to repairs to the plastic, can interfere with the proper functioning of the radar sensors. Bumper stickers placed over the area can also cause radar interference.

These situations may result in a reduced range, the omission of warnings or the incorrect production of a warning.

In the event of this kind of damage, you must ensure that the sensor installed behind the bumper trim has not been damaged in any way.

The repair entails restoring the original position and the original shape of the bumper trim to ensure proper system operation.

Note: The US marketing term for Lane Change Warning System (SWW) is Active Blind Spot Detection. These two systems are one and the same and are not to be confused with Lane Departure Warning.

■ **Damage to supporting parts**
If a supporting part (e.g. the bumper bracket or the trunk trim fitted to the "Center guide") is deformed, the sensors for the Active Blind Spot Detection system are probably no longer correctly aligned. This leads to the omission of warnings or that warnings are incorrectly produced.

Your first option is to attempt a calibration. To do this, the bumper trim must be mounted. If the calibration is performed successfully, the misalignment was so small that it could be compensated for in the calibration (using software).

If the calibration produces a deviation in the sensor alignment that is larger than specified by the design, the "center guide" must be correctly realigned. Because the "center guide" acts as a carrier for the sensors, aligning the "Center guide" also repositions the sensors correctly. This process is described in detail in the Repair Instructions.

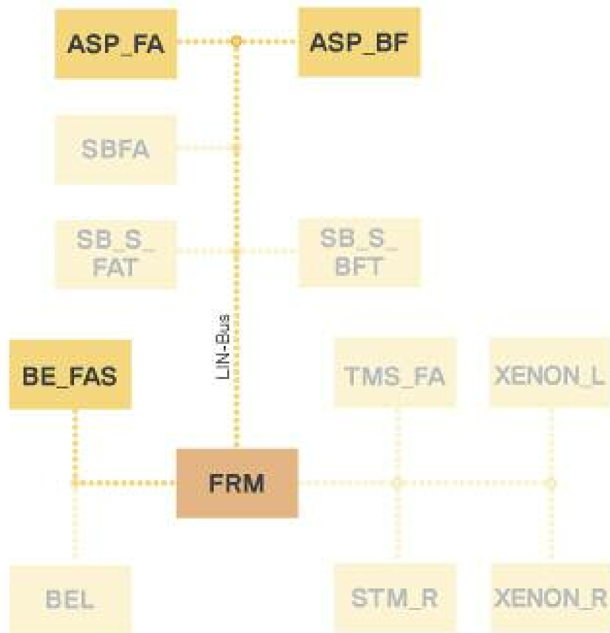
Based on the spacers that act as gauges, the correct alignment can be restored. In any case, after this kind of body repair, the sensors will have to be calibrated.

Display and Control Elements

Operating unit for driver assistance systems

Index	Explanation
1	Function illumination
2	Active Blind Spot Detection button

LIN-bus Connections



LIN bus connections at the footwell module

Index	Explanation
ASP_FA	Driver's door mirror
ASP_BF	Front passenger door mirror
BE_FAS	Operating unit for driver assistance systems
FRM	Footwell module

The operating unit for the driver assistance systems is fitted with a button that can switch the Active Blind Spot Detection system on and off.

The operating unit is connected via the LIN bus to the footwell module (FRM). A bus signal from the FRM to the ICM is used to inform that the button has been pressed.

The ICM only permits the Active Blind Spot Detection to be switched on, if the system is working faultlessly. Only then does it send a positive response via a bus signal to the FRM, to activate the function illumination on the button.

If instead there is a fault with the system, the function illumination remains off despite being pressed. The driver will then know that the system is not available.

Warning Light in the Driver's Door Mirror

There is a triangular-shaped warning light in the left and right door mirror. This lights up two-dimensionally and can be activated in different intensities.

The ICM sends a request together with the requested intensity to the footwell module.

Using the LIN bus, the request is passed on to the electrical system of the respective door mirrors. Amplitude-modulated control is used to light up the LEDs in the door mirror.

Vibration Actuator in the Steering Wheel

The vibration actuator is housed in the six o'clock spoke of the steering wheel. It has the task of causing the steering wheel to vibrate.

The Lane Departure Warning and Active Blind Spot Detection systems use this vibration, in order to alert the driver of dangerous situations. In both systems, the warning is executed by vibrating the steering wheel.

The steering wheel module that controls the vibration actuator is also housed in the interior of the steering wheel. This produces an alternating voltage that causes the vibration actuator to oscillate. The frequency of the alternating voltage is not changed during operation. It is designed so that oscillations from the vibration actuator fit perfectly to the overall steering wheel system.

The amplitude of the alternating voltage can be changed using the steering wheel module. Therefore, you have the option of different systems with varying oscillating amplitudes available to you for the warning.

Steering wheel with vibration actuator

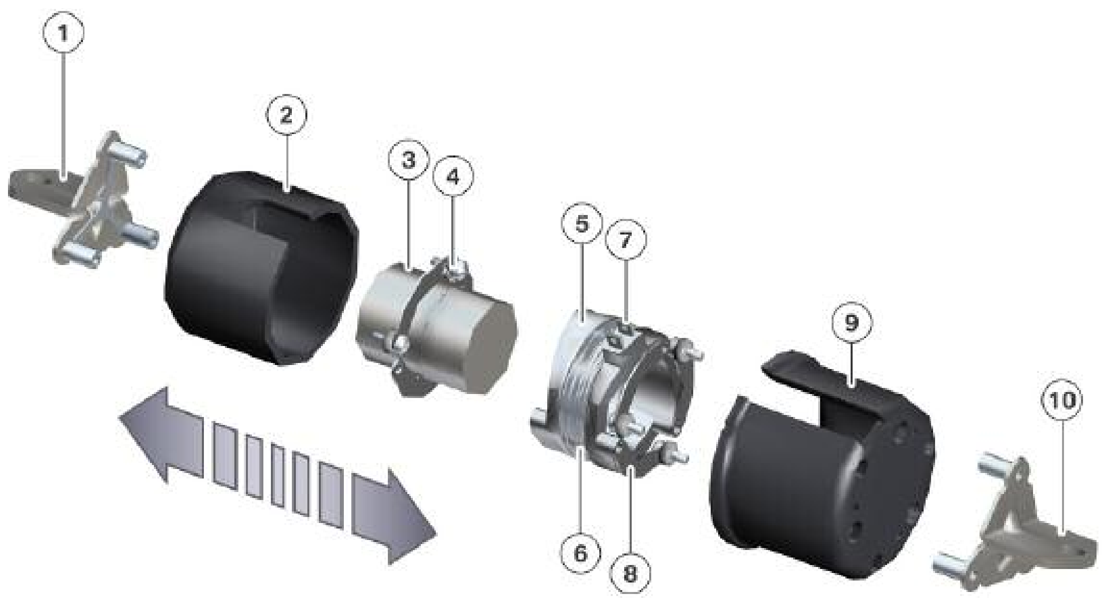
Index	Explanation
1	Steering wheel module (LRE)
2	Vibration actuator

The E6x LCI is already equipped with the driver assistance system called lane departure warning which has already used steering wheel vibration to warn the driver in a similar way. Here a vibration motor is used as the vibration actuator. An unbalance mass is located on the shaft. If the vibration motor is activated, the unbalance mass rotates and thus produces the vibrations.

The vibration actuator in the F01/F02 has undergone a significant advancement in comparison with the vibration motor. Instead of the unbalance motor, a structural element is used that only oscillates in a longitudinal direction. For this reason, it is known as a "longitudinal oscillator". This active principle has the advantage that the vibrations are only induced in this one direction. The vibration actuator is built into the steering wheel so that the direction of its oscillations corresponds with the direction of rotation of the steering wheel. This provides an ideal expression of the warning and the driver is made immediately aware that he must use the steering wheel to avert the dangerous situation. In addition, this principle to a large extent avoids unwanted side-effects such as noises or oscillations that could be transferred in other directions to the body.

The two brackets connect the vibration actuator with the steering wheel. However, the brackets on the vibration actuator are not screwed to the case, but to the coil carrier.

Exploded view of the Vibration actuator



Index	Explanation	Index	Explanation
1	Left bracket	6	Coil
2	Left case section	7	Electrical connection
3	Permanent magnet	8	Spring
4	Spring	9	Right case section
5	Coil carrier	10	Right bracket

This means the coil carrier is fixed in place. The permanent magnet can move instead. It is set into an oscillating motion in the direction shown, when alternating voltage is applied to the coil. The longitudinal movement of the permanent magnet is transferred to both case sections due to its length. This is why the case sections also have a long slot in the electrical connection area to the coil. The springs ensure that the case sections do not hit against their end positions and therefore prevent noises.

The request to activate the vibration actuator is sent from the Integrated Chassis Management over the FlexRay to the steering column switch cluster (SZL). The SZL guides this request via LIN bus further to the steering wheel module (LRE).

LIN bus subscribers at the steering column switch cluster

Index	Explanation
LRE	Steering wheel module
SZL	Steering column switch cluster

Instrument Cluster

There are no function displays for the Active Blind Spot Detection system in the instrument cluster (different to the lane departure warning). Instead Check Control messages are displayed in the instrument cluster, when the Active Blind Spot Detection system is not available. A distinction is made between two possible causes:

	
Active Blind Spot Detection deactivated (due to functional peripheral factors such as, blindness)	Active Blind Spot Detection failure (due to real faults or defects with components)

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