
Table of Contents

F01 KAFAS

Subject	Page
Introduction	3
Multifunction Video Camera	3
System Overview	5
Lane Departure Warning and High-beam Assistant	5
System Components	9
Lane Departure Warning	9
High-beam Assistant	11
Functional Principle	12
Lane Departure Warning	12
Lane Detection	15
Roadway Marking	16
Physical Limitations of the Optical System	16
Display and Control Concept	16
Lane departure warning displays	16
Displays of the lane departure warning/ Active Cruise Control with Stop & Go	18
Warning	19
Signal path for controlling the vibration actuator	21
High-beam Assistant	22
Operation and Indication	24
Detection of Light in the Field of View of the Video Camera	26
Evaluation of Image Data	28
Control of the High-beam Headlights	29
System limitations	29
Service Information	30
Lane Departure Warning	30
High-beam Assistant	30
Low-sensitivity Mode	30
Check Control Indicator	31

KAFAS

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the systems that are part of the KAFAS system
- Understand the Headlight Assistant (FLA) on the F01/F02
- Understand the Lane Departure warning on the F01/F02
- Identify the components of the KAFAS system

Introduction

Multifunction Video Camera

With the F01/F02, the customer is able to choose from a comprehensive range of optional driver assistance systems.

The individual systems and function units are becoming ever more densely networked as a result of the shared use of components and signals in some areas.

Depending on the combination of the available options installed, the functions in the F01/F02 are implemented as camera-based systems, both sharing the same camera and the one control unit, the KAFAS control unit.

KAFAS is the Camera Assisted Driver Assistance System.

KAFAS is used for the following combined functions:

- Lane departure warning
- High-beam assistant.




FLA (high beam assistant) is part of the ZDA Driver Assistance Package option and will not be available separately on the F01/F02.

The ZDA Driver Assistance Package option includes the following:

- High-beam Assistant
- Lane Departure Warning
- Active Blind Spot Detection

The vehicle comes fitted with the KAFAS control unit and camera. The high-beam assistant option shares the KAFAS camera and the KAFAS control unit with the lane departure warning system.

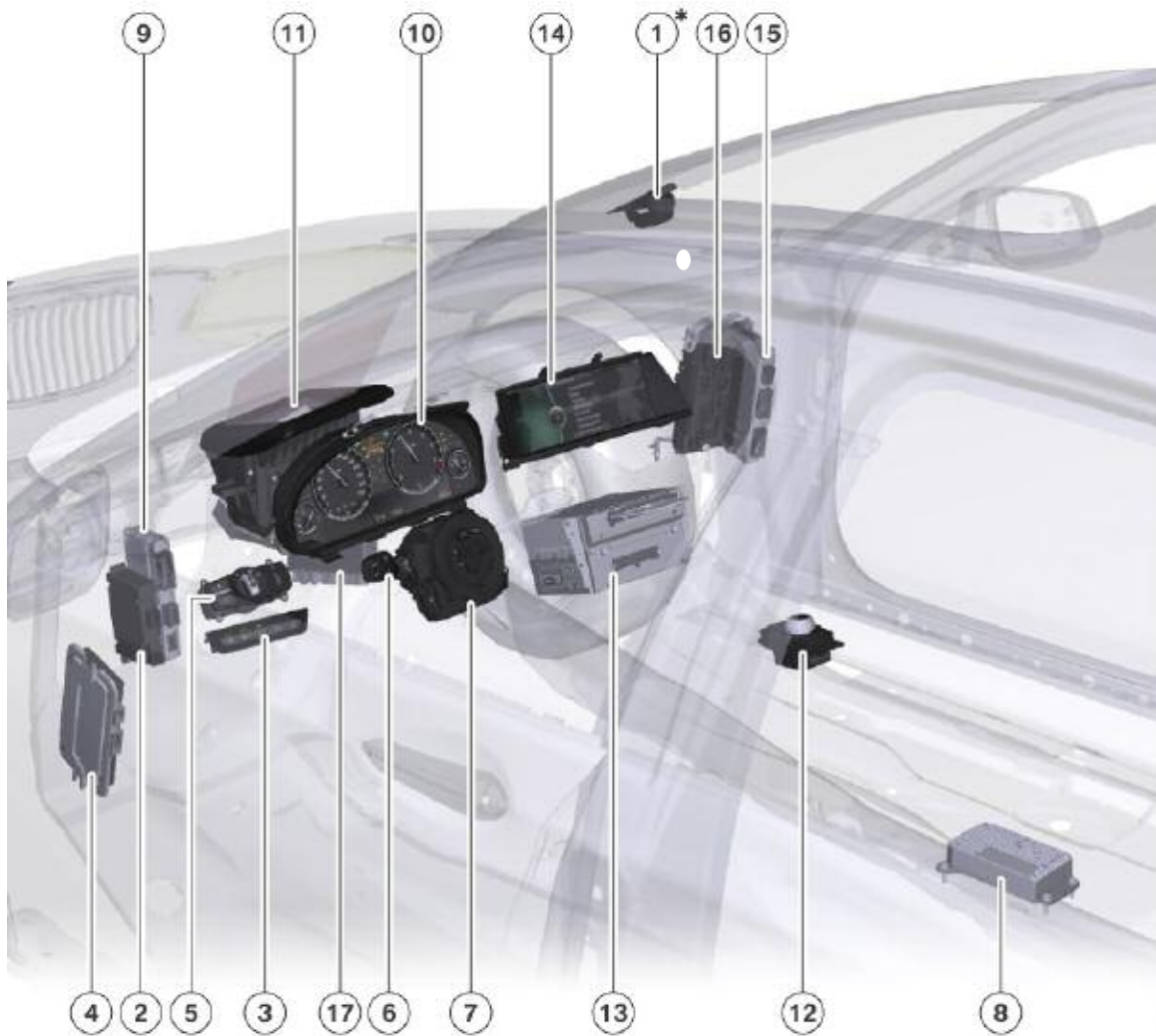
Options/Technical specification	
	<p>KAFAS</p> <p>1 camera 1 control unit 2 functions</p>
Lane departure warning	X
High-beam assistant	X

System Overview

Lane Departure Warning and High-beam Assistant

The overview below illustrates the components used in combining these systems.

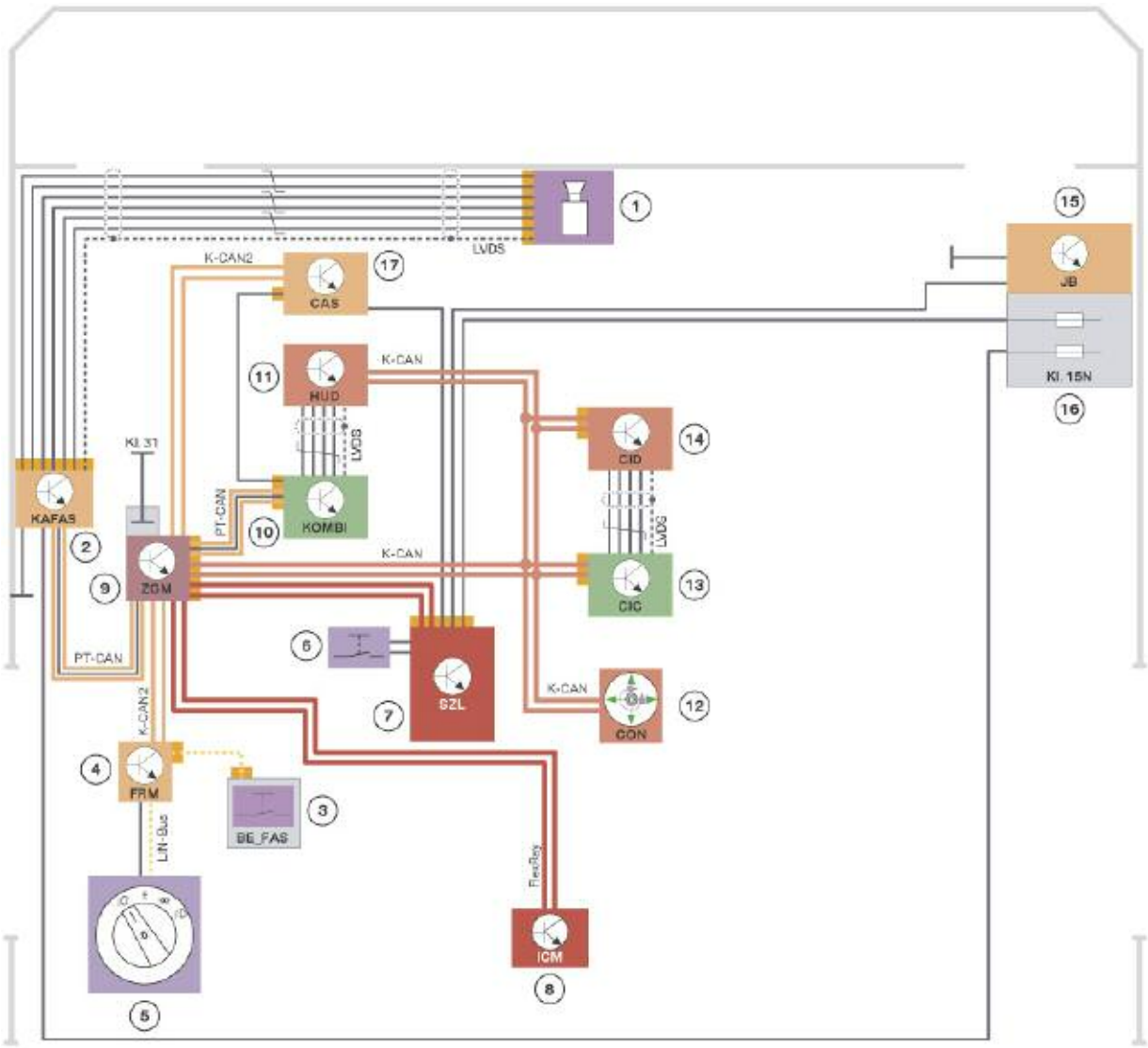
System overview of KAFAS components



System overview of KAFAS components legend

Index	Explanation	Index	Explanation
1	Lane departure warning/High-beam assistant forward-pointing video camera	10	Instrument cluster Function display
2	KAFAS control unit (Equipment specification with lane departure warning, evaluation of image data)	11	Head-up display (HUD) Function display
3	Driver assistance systems operating unit Lane Departure Warning on/off button	12	Controller
4	Footwell module (FRM) High-beam headlights on/off	13	Car Information Computer (CIC) navigation system, navigation system data
5	Light switch (High-beam assistant function in position A or position II)	14	Central Information Display (CID)
6	High-beam assistant on/off button on the turn signal stalk on the steering column	15	Junction box electronics
7	Steering column switch cluster (SZL) with turn signal stalk on the steering column	16	Front distribution box
8	Integrated Chassis Management (ICM) Road-speed signal	17	Car Access System (CAS)
9	Central gateway module (ZGM)		

Circuit diagram KAFAS with lane departure warning and high-beam assistant



Circuit diagram KAFAS with lane departure warning and high-beam assistant legend

Index	Explanation	Index	Explanation
1	Lane departure warning/ High-beam assistant forward-pointing video camera	10	Instrument cluster Function display
2	KAFAS control unit (Equipment specification with lane departure warning, evaluation of image data)	11	Head-up display (HUD) Function display
3	Driver assistance systems operating unit Lane Departure Warning on/off button	12	Controller
4	Footwell module (FRM) High-beam headlights on/off	13	Car Information Computer (CIC) navigation system, navigation system data
5	Light switch (High-beam assistant function in position A or position II)	14	Central Information Display (CID)
6	High-beam assistant on/off button on the turn signal stalk on the steering column	15	Junction box electronics
7	Steering column switch cluster (SZL) with turn signal stalk on the steering column	16	Front distribution box
8	Integrated Chassis Management (ICM) Road-speed signal	17	Car Access System (CAS)
9	Central gateway module (ZGM)		

System Components

Lane Departure Warning

In the F01/F02, a front facing video camera and the corresponding button in the BEFAS control panel indicate that the vehicle is equipped with the lane departure warning.

Video camera for lane departure warning

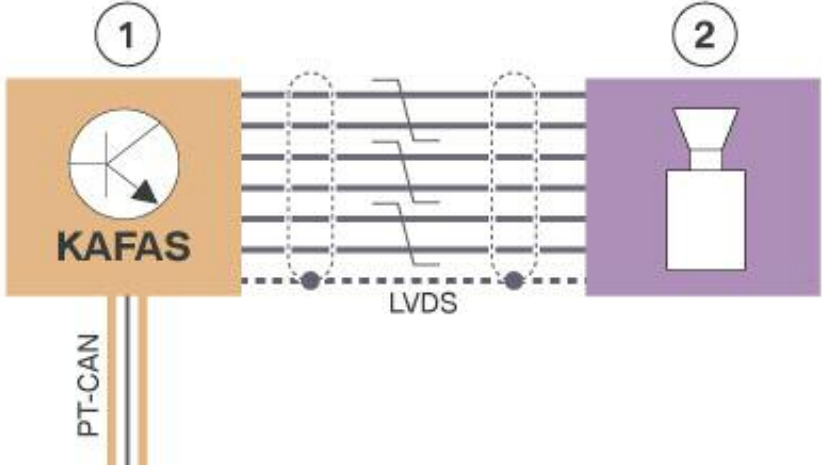


Driver assistance control panel with lane departure warning

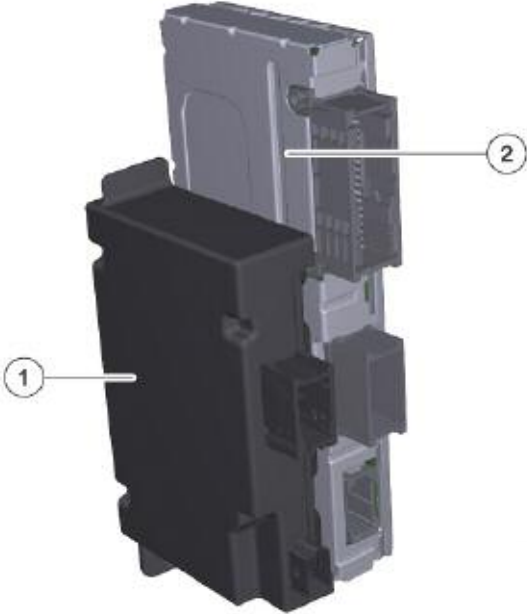


The image data recorded by the video camera are transmitted to the KAFAS control unit along an LVDS data line. The video camera and the control unit are the components that are fundamental to the lane departure warning's range of functions.

KAFAS control unit and video camera in the F01/F02



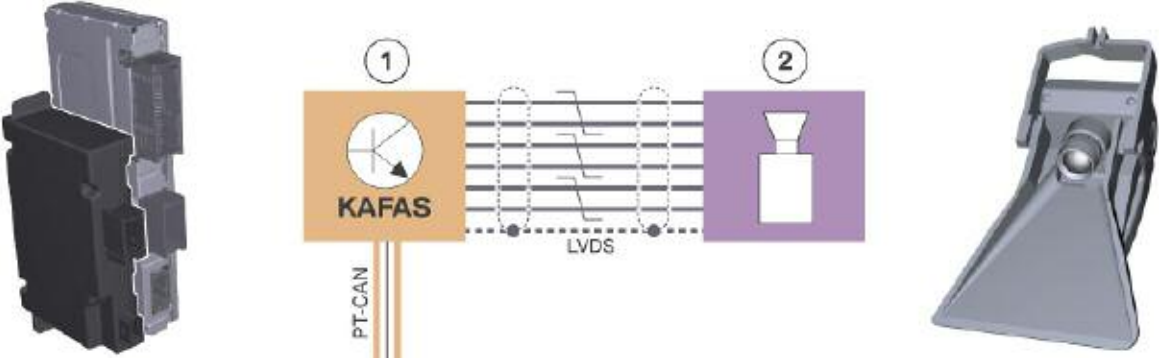
Index	Explanation	Index	Explanation
1	KAFAS control unit with PT-CAN	2	Lane departure warning video camera with LVDS connection to KAFAS control unit



Index	Explanation	Index	Explanation
1	KAFAS control unit Driver's footwell	2	Central gateway module (ZGM)

High-beam Assistant

In combination with the lane departure warning, the high-beam assistant function shares the same video camera and the same KAFAS control unit.



Index	Explanation	Index	Explanation
1	KAFAS control unit with PT-CAN	2	Lane departure warning video camera with LVDS connection to KAFAS control unit

Functional Principle

Lane Departure Warning

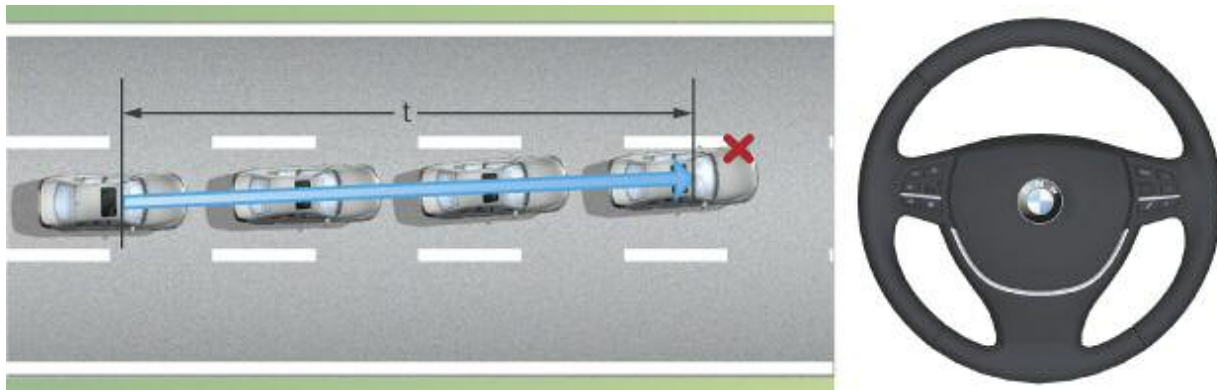
The lane departure warning causes the steering wheel to vibrate to warn the driver that the vehicle is threatening to leave the current lane without driver intending it to do so. The prerequisite for this function to work is the presence of road or lane markings that can be recognized by the control unit based on an evaluation of the images recorded by the forward facing video camera.

The system is therefore intended to assist the driver in case of a lapse of attention. Nevertheless, the driver continues to bear full responsibility for the vehicle.

The system is designed to assist the driver on highways, major roads and well maintained country roads. Warnings are given, therefore, only at speeds of over 44 mph.

The driver activates the system using the lane departure warning button in the BEFAS driver assistance control panel.

F01/F02 Lane departure warning



Driver assistance systems control panel in the F01/ F02



The “system ON” state is indicated in the instrument cluster and, where applicable, in the head-up display by the following symbol.



Lane departure warning switched on

The activated system is ready as soon as lane markings are detected by the control unit and the vehicle is travelling faster than 44 mph.

The ready state of the system is represented by additional arrow symbols in the display.



Lane departure warning ready

If the vehicle threatens to drive over a lane marking and leave the lane without the driver intending it to do so, the driver is alerted by a vibrating of the steering wheel.

The lane departure warning senses an intentional change of lane made by the driver from the activation of the turn signal. In this case there is no warning when the vehicle is driven over the lane marking.

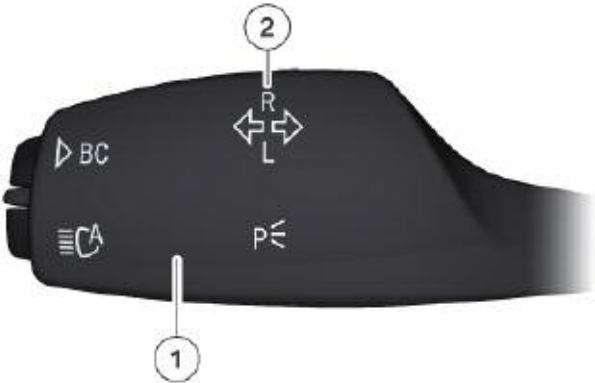
Warning the driver by vibrating the steering wheel in the F01/F02



Index	Explanation	Index	Explanation
1	Steering wheel electronics	2	Vibration actuator for the lane departure warning

Turn signal/high-beam stalk on the steering column/intention to change lane

Index	Explanation
1	Turn signal/high-beam stalk on the steering column in the F01/F02
2	Turn signal



Lane Detection



F01/F02 Lane departure warning video camera

The lane departure warning video camera integrated into the base of the rear-view mirror on the windshield monitors the area ahead of the vehicle. The video camera captures the roadway up to approximately 131ft. to the front of the vehicle and up to approximately 5m/ 16.4 ft to the right and left.

The image data is sent to the KAFAS control unit along an LVDS data line for analysis. Using image processing technology, the control unit scans the images recorded by the video camera for lane and roadway markings.

The software in the control unit also checks which lane markings apply to the current lane in which the vehicle is driving.

First, the control unit calculates the vehicle's position relative to the lanes detected in the camera images and then uses this position as basis for converting the data into a lane departure warning.

The fundamental parameters for this calculation are the road speed and steering angle of the vehicle.

Roadway Marking

The roadway markings in the image may differ greatly depending on the country, type of road or prevailing environmental conditions. The system is capable of recognizing a wide range of roadway markings and types of marking.

An analysable lane marking is subject to unequivocal recognition by the video camera and control unit first. The lane traveled must have an average width of at least 2.5m.

Physical Limitations of the Optical System

The lane departure warning functions under a wide range of different environmental conditions.

Due to the physical limitations of the system, system availability may be affected by specific road and environmental conditions, such as snow, fog, rain, or glare and dazzle.

Display and Control Concept

The lane departure warning can be switched on as of terminal 15 ON.

When the ignition is switched on, the lane departure warning system always reverts to the state that was active when the vehicle was last switched off.

Provided lanes can be detected, the lane departure warning is “primed” (ready) above a speed of 40 mph.

■ Lane departure warning displays

System Active



System Ready



If the lane departure warning is switched on at speeds of under 40 mph, a message will appear in the instrument cluster for 3 seconds indicating availability above a speed of 40 mph.



Message indicating the availability of the lane departure warning above 44mph.

In vehicles equipped with a combination of the lane departure warning and Active Cruise Control with Stop & Go, the displays of each of these systems are also combined.



Displays of the lane departure warning with ACC

■ Displays of the lane departure warning/ Active Cruise Control with Stop & Go

The graphics indicating system active and system ready are displayed in the instrument cluster and also in the head-up display, if the vehicle is equipped with this option.

Lane departure warning display in the instrument cluster of the F01/ F02

Index	Explanation
1	Lane departure warning ready
2	Speed Limit Information (Not for US)



Display in the head-up display of the F01/F02



The driver can activate or deactivate the display for the lane departure warning in the head-up display from the Central Information Display using the controller.

■ **Warning**

The active system is ready whenever the prerequisites for a lane departure warning have been fulfilled: Lane detected and $V > 40$ mph.

If the vehicle threatens to drive over the lane marking, the system warns the driver by causing the steering wheel to vibrate.

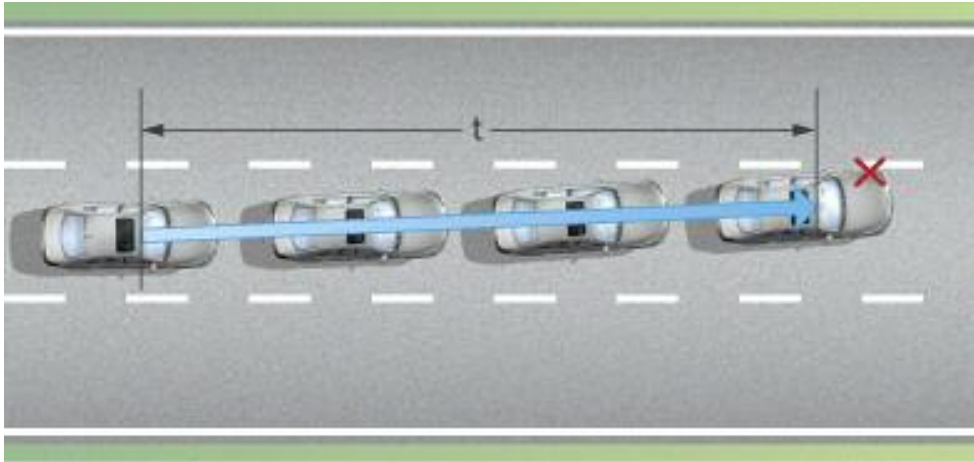
Based on the detection of one or two lanes, the system first calculates the position of the vehicle in relation to these lanes.

Using the vehicle's steering angle and road speed, the system calculates the time (t) remaining before the vehicle would cross the lane marking.

The warning is output in time before the vehicle crosses the marking.



Lane departure warning vibration actuator



F01/F02 Lane departure warning

A warning is output only once on approach to a roadway marking. The warning lasts a maximum of 2.5s. No more warnings are output if the vehicle then continues to drive along the lane marking.

A new warning can only be issued if the vehicle has been steered back into the lane or the vehicle has completed a change of lane.

No warning is given if the control unit has received an input signal indicating the activation of the turn signals because this signal announces that the driver is about to change lane intentionally.

Similarly, no warning is given if the hazard warning lights are switched on.

The warning ends when:

- The driver steers back into the lane
- A lane change is completed
- The vehicle drives along the line for longer than 2.5 seconds
- The turn signal is operated to indicate a change of lane
- The brake pedal is depressed with force (brake-pressure-dependent).

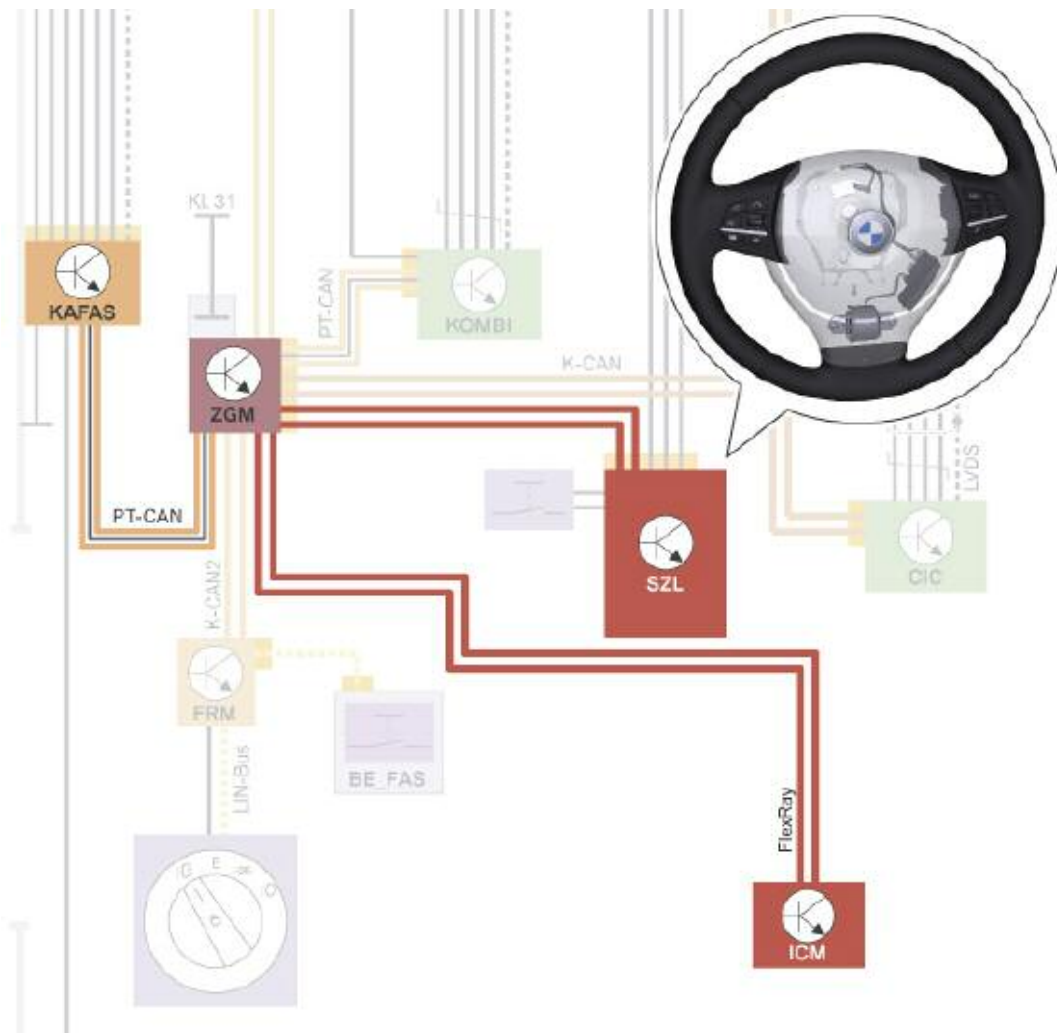
Activation/ threshold	Deactivation/threshold
40 mph	37 mph

■ Signal path for controlling the vibration actuator

Control of the vibration actuator in the steering wheel is initiated by the KAFAS control unit in interaction with the ZGM, ICM and SZL.

The ICM is always included in the control of the vibration actuator so that, in vehicles equipped with both the optional lane change warning and the lane departure warning, the driver is able to distinguish between the warnings of these similar systems.

Control of the lane departure warning vibration actuator in the F01/F02



Index	Explanation	Index	Explanation
KAFAS	KAFAS control unit	SZL	Steering column switch cluster
ZGM	Central gateway module	ICM	Integrated Chassis Management

The fundamental prerequisites for system activation and ready state are:

- Road speed higher than 40 mph.
- Left lane, right lane or both lanes are detectable by the system with a sufficient level of certainty.

The local roadway markings, environmental conditions and the physical limitations of an optical system must all be taken into consideration

- The lane departure warning system has been calibrated correctly (see “Service information”).
- There is no fault in the system.

High-beam Assistant

The high-beam assistant (FLA) assists the customer in the use of the high-beam headlights. Depending on the traffic situation, the prevailing ambient light conditions and which lights on the vehicle have been switched on, the FLA switches on the high-beam headlights automatically and thereby relieves the customer of having to switch the high-beam headlights on manually.

High-beams can still be switched on and off manually as usual. The driver always has the capability, and indeed the obligation, to override the system whenever the situation requires it.

High-beam assistant display and button

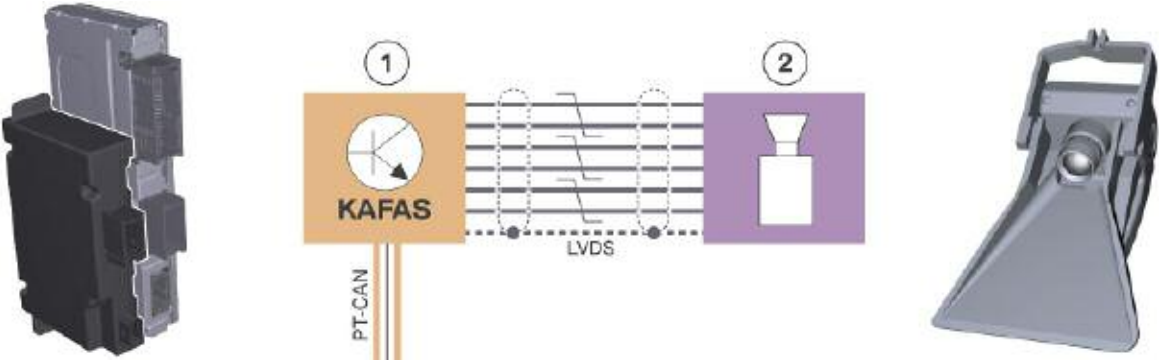
Index	Explanation
1	Steering column stalk
2	High-beam assistant button
3	Display when high-beam assistant activated
4	Display when high-beam headlights on



In the F01/F02, the high-beam assistant option is implemented differently depending on the equipment combination.

In combination with the lane departure warning, the high-beam assistant function shares the same video camera and the same KAFAS control unit.

High-beam assistant with the video camera of the lane departure warning and the KAFAS control unit in the F01/F02



Index	Explanation	Index	Explanation
1	KAFAS control unit with connection to vehicle electrical system on PTCAN	2	Video camera for lane departure warning and high-beam assistant. The image data sent from the video camera to the KAFAS control unit along the LVDS data line

Operation and Indication

In order for the driver to be able to activate and use the high-beam assistant, the light switch must first be set to Automatic or light switch position II.

In the F01/F02, the high-beam assistant has its own activation button in the turn signal/high-beam stalk on the steering column.

While the high-beam assistant can be activated at any time with the light switch in position II, there is an additional prerequisite in the Automatic position whereby the automatic driving lights controller must have already switched on the lights.

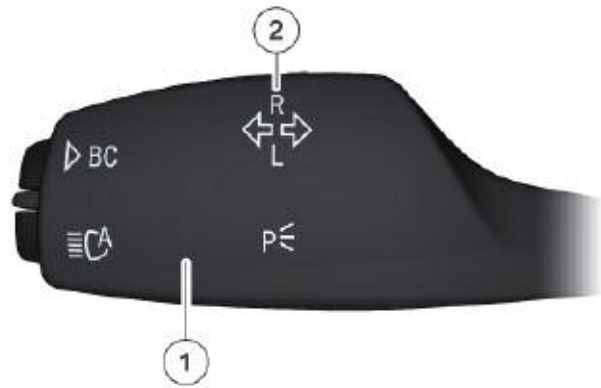


Light switch in position A



Light switch in position II

Index	Explanation
1	Turn signal/high-beam stalk on the steering column in the F01/F02
2	High-beam assistant on/off button



Turn signal/high-beam stalk on the steering column in the F01/F02

An active system is indicated by the following symbol in the instrument cluster.



Display when high-beam assistant activated in the F01/F02

Depending on the traffic situation, the prevailing ambient light conditions and which lights on the vehicle have been switched on, the high-beam headlights of the vehicle are switched on or off automatically by the footwell module at the request/activation recommendation of the KAFAS control unit.



Display when high-beam headlights ON F01/F02

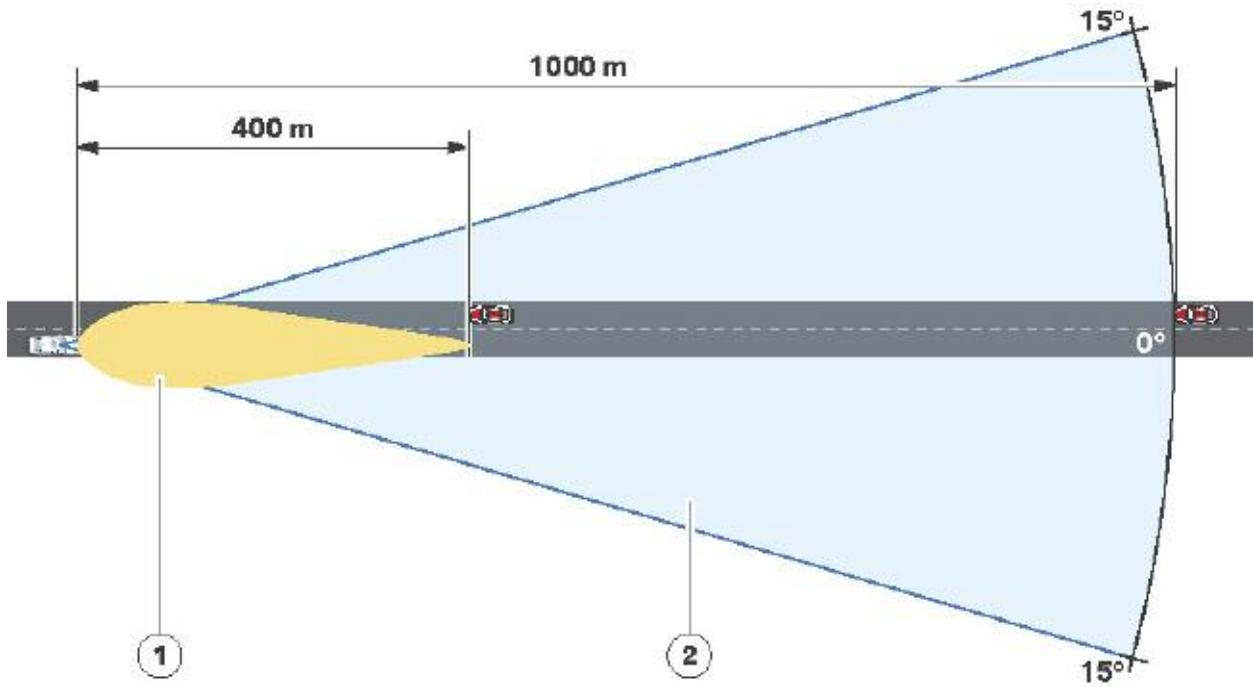
The switching on and off of the high-beam headlights is indicated by the conventional symbol in the instrument cluster.

Detection of Light in the Field of View of the Video Camera

The video cameras monitor the area ahead of the vehicle for light sources. Vehicles travelling in front and oncoming traffic become recognizable at distances of up to approximately 400m/437yd. The detection range of the video camera is approximately 1,000m/1093yd. The video camera has a horizontal viewing angle of approximately 15° to the left and right and a vertical viewing angle of approximately 5° up and down.

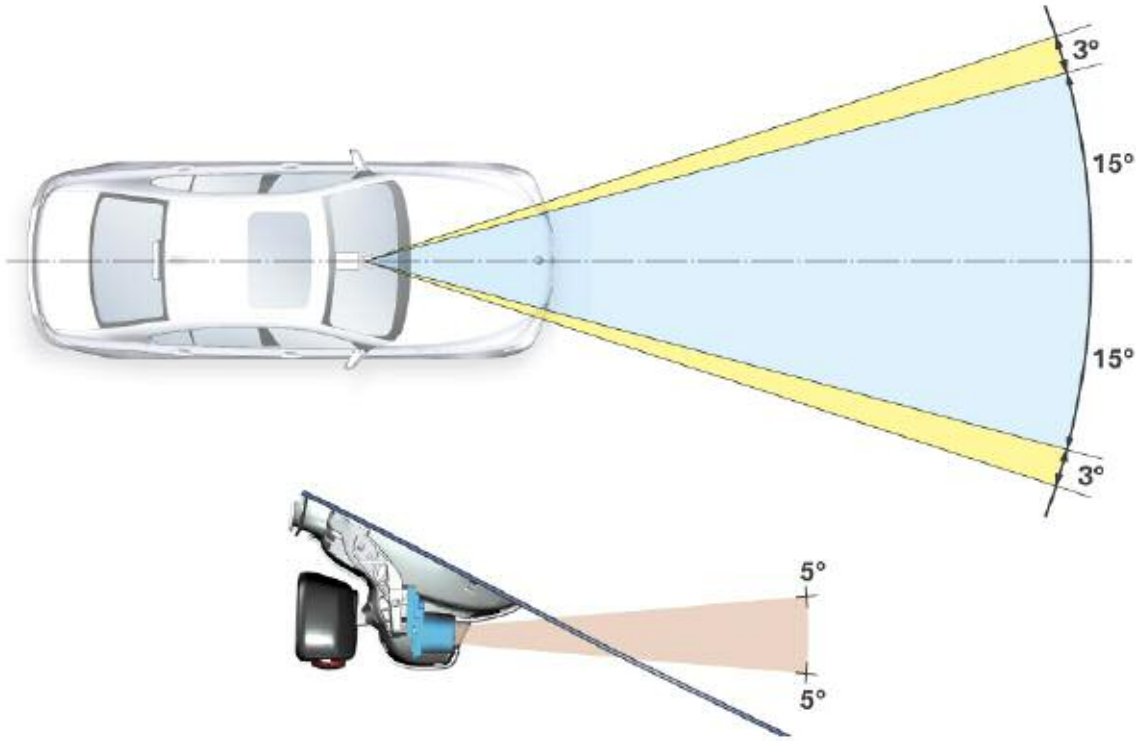
When active, these special video cameras capture dots of light and, in the process, are able to distinguish between various parameters, e.g. light color and light intensity.

Field of view of the video camera in the F01/F02



Index	Explanation	Index	Explanation
1	Recognition range	2	Detection range

Horizontal/vertical field of view of the video camera in the F01/F02



Evaluation of Image Data

The various dots, colors and intensities of light captured by the camera are evaluated by the control unit and, based on the control unit's assessment, a switch-on or switch-off recommendation is sent from the KAFAS control unit to the footwell module.

In addition to the switch-on/switch-off recommendation, road speed is also taken into account.

At speeds below 24mph, the FLA is switched off; at speeds higher than 31mph, it may be switched on, depending on all other parameters.

If the vehicle is in an environment with adequate light, the high-beam headlights do not switch on. The KAFAS control unit sends a switch-off recommendation to the footwell module.

These conditions could be:

- Daylight
- Twilight
- Road lighting
- Illuminated places

The system is designed to switch off the high-beam headlights automatically in response to the following conditions.

- Oncoming traffic
- Preceding traffic
- Detection of background brightness
(twilight, street lamps, illuminated places, etc.)
- Driving speed too low

Control of the High-beam Headlights

At the request of the FLA (KAFAS) control unit, the actual switching on and off of the high-beam headlights is always carried out by the footwell module, which is responsible for all of the exterior lighting.

The FLA control unit uses its own image data to assess background brightness.

The decision of the FRM to activate the dipped-beam headlights in A mode is made in the FRM independently of the FLA function. The FRM receives the light signal from the RLSS.

■ System limitations

In various situations, and under specific environmental conditions, the limitations of a camera-based system begin to impact on functionality.

These limitations may be reached in the following situations.

- Extremely bad weather conditions (e.g. fog or heavy snowfall).
- Poorly illuminated road users (e.g. riders on small motorcycles, cyclists, pedestrians).
- Individual driving situations (e.g. sharp bends, steep hills, traffic coming at right angles from left or right).
- Differentiation between different light sources, reflective traffic signs, etc.
- No recognition of oncoming traffic is possible if only the cone of light is within the video camera's field of view.
- Recognition is possible only if the light source itself is within the field of view of the video camera.

The driver is able to intervene at any time and override the assistance system by switching the high-beam headlights on and off manually.

The driver always bears sole responsibility for the vehicle and the control of the vehicle's lighting.

Service Information

Lane Departure Warning

The lane departure warning can be ordered has been available:

- Since 03/07 in the
 - E60
 - E61 and
- Since 09/07 in the
 - E63
 - E64

In the event of a replacement of components, the different features of the variants as described in the parts catalogue, and the instructions for the necessary coding and calibration routines stored in the diagnostics and programming system must be observed.

You will also find information on the lane departure warning in the “E60/E61 Lane departure warning” training Information.

High-beam Assistant

The high beam assistant was introduced for the first time in the E60, E61, E63 LCI, E64 LCI BMW models from 2007 Model Year.

The high-beam assistant is not available separately for the F01/F02 and is part of the ZDA Driver Assistance Package option.

Low-sensitivity Mode

A low-sensitivity mode has been implemented in order to comply with the US statutory requirements. In this mode, the sensors are less sensitive.

To activate this mode, the driver must press the turn signal stalk on the steering column forwards for 10 seconds with the vehicle stationary, the lights switched off and terminal 15 ON.




As soon as the high-beam assistant is activated, the driver receives a Check Control message indicating that low-sensitivity mode is active.

The high-beam assistant reverts to its basic state following a power cycle.

Check Control Indicator

The Check Control may display messages under the conditions described below.

Cause	Condition	Sending unit
Hardware/software defect	"Internal fault"	FLA or footwell module
Sensor field covered	FLA detects covered windshield	FLA

Check Control message	Condition	Information in Central Information Display
	High-beam assistant not active	High-beam assistant not active. Sensor field covered. Manual activation and deactivation of high-beam.
	High-beam assistant defective	High-beam assistant defective. Have the system checked by the nearest BMW Service.
	Sensitivity adjusted	High-beam assistant sensitivity adjusted for automatic high-beam headlights. Possible risk of dazzling oncoming vehicles.