Technical training.
Product information.

F01/F02 LCI Driver Assistance Systems

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Technical Training
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BMW Service

General information

Symbols used

The following symbol/schematic diagram is used in this document to facilitate better comprehension or to draw attention to very important information:

Contains important safety information and information that needs to be observed strictly in order to guarantee the smooth operation of the system.

Information status and national-market versions

BMW Group vehicles meet the requirements of the highest safety and quality standards. Changes in requirements for environmental protection, customer benefits and design render necessary continuous development of systems and components. Consequently, there may be discrepancies between the contents of this document and the vehicles available in the training course.

This document basically relates to the European version of left-hand drive vehicles. Some operating elements or components are arranged differently in right-hand drive vehicles than shown in the graphics in this document. Further deviations may arise as a result of the equipment specification in specific markets or countries.

Additional sources of information

Further information on the individual topics can be found in the following:

- Owner's Handbook
- Integrated Service Technical Application.

Contact: conceptinfo@bmw.de

The information contained in this document forms an integral element of the technical training of the BMW Group and is intended for the trainer and participants in the seminar. Refer to the current respective information systems of the BMW Group for any changes/additions to the technical data.

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F01/F02 LCI Driver Assistance Systems

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F01/F02 LCI Driver Assistance Systems

1. Introduction

The comprehensive driver assistance package of systems for the F01/F02 LCI has been modified and supplemented.

The driver assistance systems facilitate driving of the vehicle by:

- providing the driver with information
- giving the driver suggestions or
- automatically intervening in the driving process.

This training manual provides an overview of the driver assistance systems which are new or whose function has been modified:

- BMW Night Vision with pedestrian detection (option 6UK)
- Lane departure warning with camera-based collision warning —
  is Lane Departure Warning w/Collision Mitigation (option 5AS) and is included in the optional ZDA (Driving Assistance Package)
- Speed Limit information (option 8TH) — is also included in the optional ZDA (Driving Assistance Package
- ACC Stop & Go —
  is referred to as Enhanced Active Cruise Control (option 5AT) and can only be ordered in combination with ZDA (Driving Assistance Package)
- Collision warning with braking function —
  is an integral part of the Enhanced Active Cruise Control (option 5AT)
- Ranging information —
  is also an integral part of the Enhanced Active Cruise Control (option 5AT)

For further information on the driver assistance systems, please refer to the following ST811 F01 Complete Vehicle training manuals available on TIS and ICP:

- BMW Night Vision 2
- F01/F02 KAFAS
- F01 Cruise Control Systems
- F01 Dynamics Driving Systems

F01/F02 LCI Driver Assistance Systems

2. BMW Night Vision

BMW Night Vision detects (in optimum nighttime conditions) persons up to 100 m (328 ft) away within the system's warning range. The warning range is dependent on the driving speed and the steering angle. If there is a person within the warning range, they are categorized as being in potential danger and the system then issues a pedestrian warning.

2.1. BMW Night Vision with pedestrian detection

The operation and the warning function of the optional equipment BMW Night Vision with pedestrian detection (option 6UK) have been modified.

The pedestrian warning is now issued as early and acute warnings irrespective of how the Night Vision camera image is shown in the central information display (CID).

The warning is no longer shown in the CID, but instead appears exclusively in the instrument cluster or in the head-up display.

For further information on BMW Night Vision with pedestrian detection, please refer to the “BMW Night Vision 2” in the F01 training material.

2.1.1. Operation

Pedestrian detection (or the pedestrian warning) function is automatically activated after each engine start via the START/STOP button.

When the Night Vision button is pressed in the driver assist system operating facility, the image from the Night Vision camera is shown in the central information display (CID). The driver can adjust the brightness and the contrast from here.

The pedestrian warning is activated and deactivated as described below.

Vehicles with BMW Night Vision without collision warning

When the Intelligent Safety button is pressed in the driver assist system operating facility, the pedestrian warning front protective function is deactivated or activated:

- Pedestrian warning deactivated: LED above the button is off.
- Pedestrian warning activated: LED above the button lights up.

Vehicles with BMW Night Vision and with collision warning

When the Intelligent Safety button is pressed in the driver assistance system operating facility, the information screens for the collision warning and pedestrian detection functions are shown in the CID. The driver can deactivate or activate the pedestrian warning from here.

When the LED above the Intelligent Safety button in the driver assist system operating facility lights up, at least one front protective function is activated.

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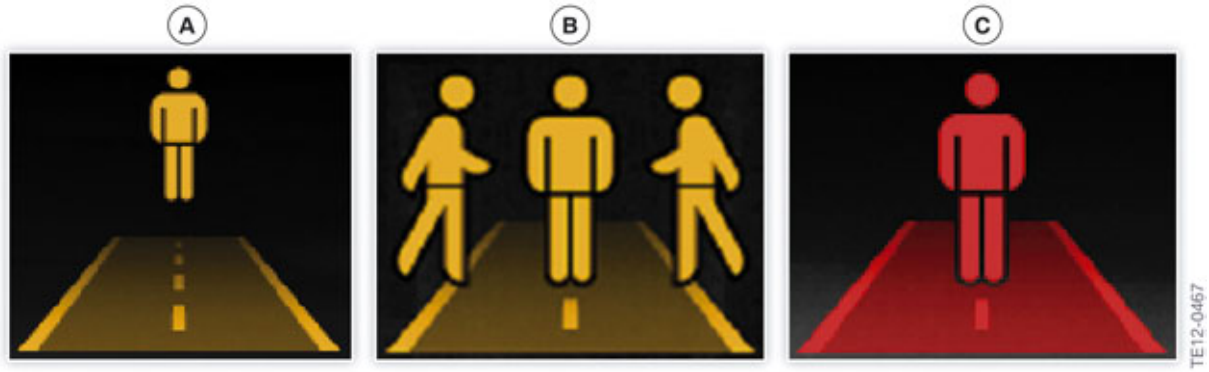
2. BMW Night Vision

2.1.2. Warning function

The system issues a pedestrian warning when BMW Night Vision detects a person (pedestrian) within the warning range. The pedestrian warning appears in the instrument cluster or in the head-up display. The pedestrian warning can be deactivated via the Intelligent Safety button in the driver assistance system operating facility or directly in the CID.



F01/F02 LCI - Pedestrian warning in the instrument cluster display or in the head-up display

Index	Explanation
A	Stage 1: Early warning, person is a long distance away from the vehicle
B	Stage 1: Early warning, person is a short distance away from the vehicle or is crossing the road
C	Stage 2: Acute warning, flashing person in red and acoustic warning signal

Early warning

The early warning is issued for the close range and the long-distance range when a person is detected within the warning range. The early warning shows - depending on where the person is situated - a person lit yellow who is located within the lane or is moving on it. If the early warning shows a person clearly above the roadway, they are still too great a distance away. If the early warning shows a person inside the roadway, the person at risk is already at close range.

In both cases the driver must brake or make an evasive maneuver.

Acute warning

The acute warning is issued by the system as late as possible and only if there is an immediate danger of a collision. The point at which the acute warning is issued is calculated in such a way that a collision can only be avoided by immediate emergency braking or by an evasive maneuver.

The acute warning shows a person flashing red within the roadway. In addition, an acoustic warning signal is sounded.

The acute warning does not relieve the driver of their responsibility to adapt their driving speed and driving style to the road and traffic conditions.

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3. KAFAS

3.1. Lane departure warning

The lane departure warning is an integral part of the optional equipment ZDA (Driving Assistance Package **option 5AS)** in which its basic system operation remains unchanged. The lane departure warning warns the driver by vibrating the steering wheel in the event of the unintentional departure from a given lane. The prerequisite for this is the presence of suitable roadway or lane markings, that can be recognized with the KAFAS video camera of the control unit.

The system cannot replace a personal assessment of the roads and traffic situation. The lane departure warning merely supports the driver in the event the vehicle wanders away from the driven lane.

Please refer to “Functional limitations” section at the end of the chapter “KAFAS” for further information.

For further information on lane departure warning, please refer to the “KAFAS - Camera-based Driver Assist Systems F01/F02” training material available on TIS and ICP.

3.2. Collision warning (camera-based)

The camera-based collision warning is an additional function of the lane departure warning and therefore is an integral part of the optional ZDA [Driving Assistance Package (option 5AS) Lane Departure Warning with Collision Mitigation]. The collision warning alerts the driver of a possible collision danger and is realized using the KAFAS system. The camera-based collision warning is issued **without** an automatic braking function.

3.2.1. Operation

The collision warning is automatically activated after each engine start via the START/STOP button.

Vehicles with camera-based collision warning w/o Night Vision

When the Intelligent Safety button is pressed in the driver assist system operating facility, the collision warning function is deactivated or activated:

- Collision warning deactivated: LED above the button is off.
- Collision warning activated: LED above the button lights up.

The status of the collision warning is also displayed in the CID. In addition, when the collision warning is activated the driver can set the time of the early warning in three stages. The “late” setting corresponds to the point of the acute warning. The setting of the time of the early warning is saved for the current driver profile.

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3. KAFAS

Vehicles with camera-based collision warning with Night Vision

When the Intelligent Safety button is pressed in the driver assist system operating facility, the information screen for the collision warning and pedestrian detection functions are shown in the CID. The driver can deactivate or activate the collision warning and the pedestrian detection from here.

In addition, when the collision warning is activated the driver can set the time of the early warning in three stages. The “late” setting corresponds to the point of the acute warning. The setting of the time is saved for the current driver profile.

When the LED above the Intelligent Safety button in the driver assist system operating facility lights up, at least one front protection function is activated.

3.2.2. Operating principle

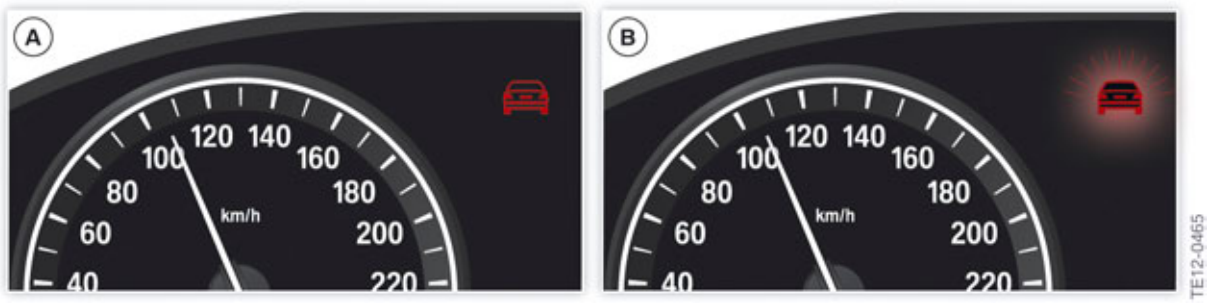
The system warns of a possible collision in two stages starting from a speed of about 15 km/h (9.3 mph).

The KAFAS video camera records the scenery ahead of the vehicle and uses image processing to detect the complete rear views of moving and stationary vehicles in the field of view. The corresponding warning stages are output in critical situations on the basis of the calculated positions, distances and relative speeds of the other vehicles. In addition to the warnings, the vehicle's brakes are prepared for emergency braking and the activation thresholds of the brake assistant are decreased. However, in contrast to Collision Warning with braking function, there is **NO** automatic brake intervention by the system.

The collision warning function is automatically activated after each engine start via the START/STOP button.

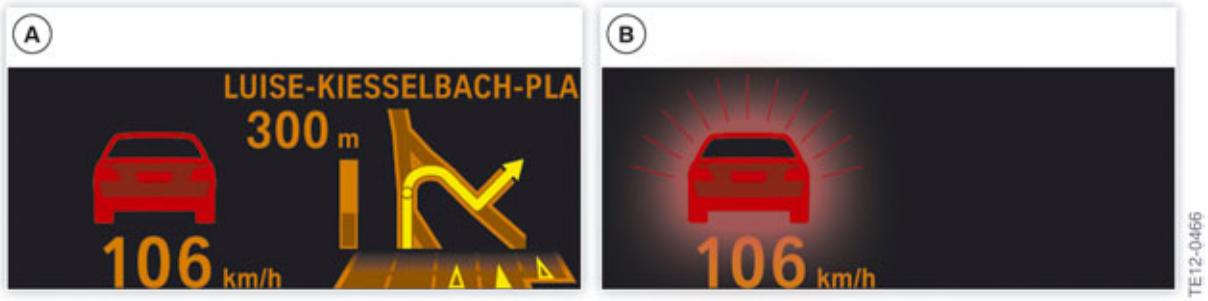
3.2.3. Warning function

The warning function is divided into two stages. It appears in the instrument cluster or in the head-up display.



F01/F02 LCI - Collision warning in the instrument cluster

F01/F02 LCI Driver Assistance Systems
3. KAFAS



F01/F02 LCI - Collision warning in the head-up display

Index	Explanation
A	Stage 1: Early warning, vehicle in red
B	Stage 2: Acute warning, flashing vehicle in red and acoustic warning signal

Early warning

The early warning is issued, for example, in the event of an imminent danger of collision on account of a high differential speed to the vehicle driving ahead or in the event of a very small distance to the vehicle driving ahead.

The early warning is indicated by a vehicle permanently illuminated in red in the instrument cluster or in the head-up display.

The time of the early warning can be configured in the CID. When the “late” setting is selected, the time of the early warning corresponds to that of the acute warning.

The collision warning is dependent on the vehicle's inherent driving speed. The distance calculated for the collision warning is much lower than the minimum distance required by law. It is therefore still the driver's responsibility to maintain the legal minimum distance.

Acute warning

The acute warning is issued by the system as late as possible and only if there is an immediate danger of a collision when the vehicle is approaching the vehicle driving ahead at relatively high differential speed. The point at which the acute warning is issued is calculated in such a way that a collision can only be avoided by immediate emergency braking or by an evasive maneuver. The acute warning therefore cannot be deliberately brought about or monitored.

If the vehicle is for example approaching at very low speed the vehicle driving ahead, no acute warning is issued either when the distance to the vehicle ahead is very small. This deliberately brought-about driving situation merely triggers off the early warning. In this way, less sensible and thus more annoying acute warnings are avoided by the system.

The acute warning cannot be deactivated. Nor can the time of the acute warning be set. If the acute warning is not to be issued, the collision warning front protective function must be deactivated.

An acute warning is indicated to the driver by a red flashing vehicle in the instrument cluster. In addition, an acoustic warning signal is sounded.

In contrast to Collision Warning with braking function, the camera-based collision warning system (5AS) does NOT automatically apply brake intervention.The acute warning does not relieve the driver of their responsibility to adapt their driving speed and driving style to the road and traffic conditions.

In towing or tow-starting situations the collision warning system must be deactivated in order to avoid malfunctions.

3.2.4. System limits

System limitations mean that warnings may under certain circumstances not be issued or are issued too late or without authorization. The driver must therefore always remain alert and observant so that they can actively intervene at any time so as to avoid the risk of an accident.

Range of detection

The collision warning has a limited capacity for detection.

This means that warnings sometime may not be issued or may be issued late.

The following vehicles may not be detected:

- A vehicle travelling at slow speed when approaching at high speed
- Vehicles that cut in suddenly or are heavily decelerating
- Vehicles with an unusual rear view or with poorly visible rear lights
- Partially concealed vehicles
- Two-wheeled vehicles travelling ahead.

Please refer to the Collision Warning w/Brake Application section for more information.

3.3. Speed Limit Information

The optional equipment Speed Limit Information (8TH) is referred to in the following section as road sign recognition for short. Current speed limits and bans on passing/overtaking are shown in the instrument cluster or in the head-up display. In this way, road sign recognition helps the driver to adhere to and not to exceed the maximum speed limit.

Road sign recognition (option 8TH Speed Limit Information) is only available in conjunction with the navigation system (standard) and it is part of the optional ZDA Driver Assistance Package.

F01/F02 LCI Driver Assistance Systems

3. KAFAS

The responsibility for the vehicle and for the speed that is adopted rests exclusively with the driver.

The control unit for the road sign recognition function is the KAFAS control unit.

The display of the speed limit signs is based on the evaluation of data from the navigation system and the evaluation of image data recorded by the KAFAS video camera.

The maximum allowable speed of the road currently driven is displayed in the instrument cluster and in the head-up display.

The KAFAS uses the video camera to monitor the road signs at the side of the road and takes into account the information from the navigation system (609). Thus, for example in some areas, the applicable maximum speed is displayed without there being actual recognizable road signs stipulating the speed.

Speed limit information displayed on the HUD **(F30 graphic shown)**

Speed limit information displayed on the instrument cluster **(F30 graphic shown)**

F01/F02 LCI Driver Assistance Systems
3. KAFAS

3.3.1. System limits

The system has a detection rate of around 90 to 95%.

Road signs for speed limits which do not conform to the legal standards, especially those which do not have square borders, are not always recognized. The same applies to road signs which are fully or partially concealed by stickers, dirt or vegetation.

Long distances to the road sign, high driving speeds and poor weather conditions, particularly at night, make it more difficult for the system to recognize road signs reliably.

The data in the navigation map must be up to date in order for the current speed limit to be correctly displayed. If the current place has not yet been incorporated for navigation purposes, for example when driving in development areas, on new roads or on roads where the routing has been changed, a recognized road sign for speed limits can only be displayed for the next 500 m (547 yds).

Supplementary sign recognition

The system can only recognize signs that are included in its database. Text references to supplementary signs cannot be read or interpreted. Before speed limits with limiting validity are displayed, the system scans further information from the vehicle electrical system.

The system can't read text, it can only recognize a sign that is included in the "sign database" – therefore the system was programed extensively in 48 US states + western/eastern Canada therefore all speed limit signs (10-80 mph + signs as e.g. "Trucks", "Trailers", "School", "Construction area") are normally (when conditions allow) recognized by the camera.

The trailer signal for vehicles in towing mode is not evaluated for the display of speed limits, as the speed limits for vehicles with trailers differ from country to country and are dependent on the trailer type.

Supplementary signs are not recognized. The speed limit is then displayed as currently valid without the supplementary sign being interpreted.

Road signs on parallel, branching-off or merging roads and on exits

Parallel roads are not recognized neither with the KAFAS video camera nor with the aid of the navigation map. Signs posted there can be recognized and displayed as speed limits for the road currently being driven.

Speed limits for branching-off or merging roads are usually also adopted and displayed for the road currently being driven.

Speed limits on highway exits with or without an arrow as a supplementary sign are usually correctly evaluated and suppressed in the displayed when the exit is driven past. This is only the case if the data in the navigation map is up to date.

In the case of overhead highway signs with different, lane-specific speed limits, the speed limit nearest to the lane the vehicle is driving in is displayed. The display is not modified after a later lane change.

Information signs in the road sign surroundings

Information signs with speed limits at border crossings with references to the different legal maximum speeds for ordinary roads and highways, can be mistakenly recognized as currently valid and displayed. The same applies to information signs set out only in different colors, e.g. for minimum or recommended speeds.

Stickers on vehicles

Stickers showing a speed limit on vehicles driving ahead or on overtaken vehicles, e.g. on trucks, buses, trailers and construction machinery, can be mistakenly recognized as the currently valid speed limit and displayed.

Town/city limits

If the town/city limits sign is not clearly recognized and the data in the navigation map are not up to date, the speed limit at town/city limits may be incorrectly displayed.

Legal changes

If maximum speeds prescribed by law are changed, these are only available after a navigation software update. The original, but no longer valid speed limits are displayed until the update is issued.

The system can only currently detect speed limit signs and no other traffic signs.

This system cannot replace the driver's personal assessment of the road and traffic situation. Speed Limit Information supports the driver but does not is not intended to replace the human eye.

3.4. Functional limitations

The function of the KAFAS video camera and thus also the function of the corresponding driver assistance systems may be impaired in the following situations:

- heavy fog, rain, spray or snow
- strong light in the camera lens
- if the field of view of the KAFAS video camera or the windshield is dirty or concealed
- on sharp corners
- up to 10 seconds after engine starting via the START-STOP button
- during the calibration process of the KAFAS video camera immediately after vehicle delivery or a camera change.

System and functional limitations mean that warnings and bans may under certain circumstances not be issued or are issued too late or without authorization. The driver must therefore always remain alert and observant so that they can actively intervene at any time so as to avoid the risk of an accident.

F01/F02 LCI Driver Assistance Systems

4. High-beam Assistant

In vehicles without adaptive headlights (option 524) and without adaptive LED headlights (option 552) the function of the high-beam assistant (option 5AC) remains unchanged at two stages. The high-beam headlights are automatic switched on and off.

For further information on the high-beam assistant in this case, please refer to the “KAFAS - Camera-based Driver Assistance Systems” ST811 F01 Complete Vehicle training material available on TIS and ICP.

The high-beam assistant cannot replace a personal decision on the use of the high-beam headlight. In some situations, manual dipping is required as otherwise there is a safety risk.

F01/F02 LCI Driver Assistance Systems

5. ACC Stop & Go

Active cruise control with Stop & Go function (ACC Stop & Go) has enhanced functionality in the F01 LCI. Option 5AT (Enhanced Active Cruise Control) requires the optional ZDA Driving Assistant Package.

ACC Stop & Go adjusts a driver-specified desired speed and, if required by the traffic situation, also the preselected following distance automatically to the vehicle driving ahead. Passenger cars, trucks and motorcycles are detected. The scope of this application ranges from high speeds down to a full stop. Depending on the stationary time, driving off from a standstill is performed automatically or in response to a prompt by the driver.

The F01/F02 LCI ACC Stop & Go system can (for the first time) not only detect slowly stopping vehicles but also vehicles that are already stationary and therefore can react to these situations accordingly. The detection of stationary vehicles is a unique feature as the function of this application is also extended to include high-capacity urban (arterial) and ring (loop) roads.

The reaction to transverse movements has also been improved. This enables the system to react more swiftly to vehicles that are veering in and out of our lane or turning.

By connecting the KAFAS video camera to the ACC Stop & Go system we extend the scope of this application. In addition to the radar data, the image data from the video camera is now evaluated in ACC Stop & Go. This combination of image and radar data facilitates the clear identification of lane markings and distinction between stationary vehicles and other immobile objects.

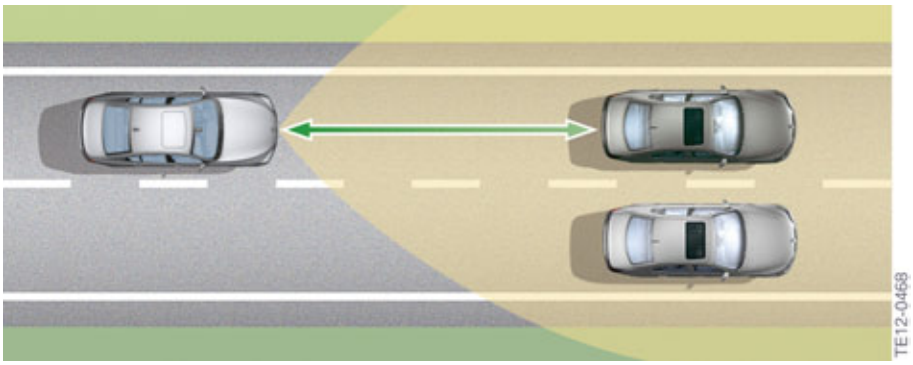
In addition, the adjustment range for the set speed has been increased from 180 km/h to 210 km/h (112 mph to 130 mph).

The acceleration behavior of ACC Stop & Go is also adapted for ECO PRO mode. ACC Stop & Go accelerates the vehicle in ECO PRO mode much more smoothly for optimized fuel consumption. The ECO PRO instructions regarding the accelerator pedal position are suppressed (not displayed) when ACC Stop & Go is activated.

5.1. Introduction

ACC Stop & Go offers the driver optimum support not only in flowing traffic, but also in traffic jam situations.

The scope of application of ACC Stop & Go ranges from high speeds down to a full stop. The distance and the speed are automatically adjusted in this range.



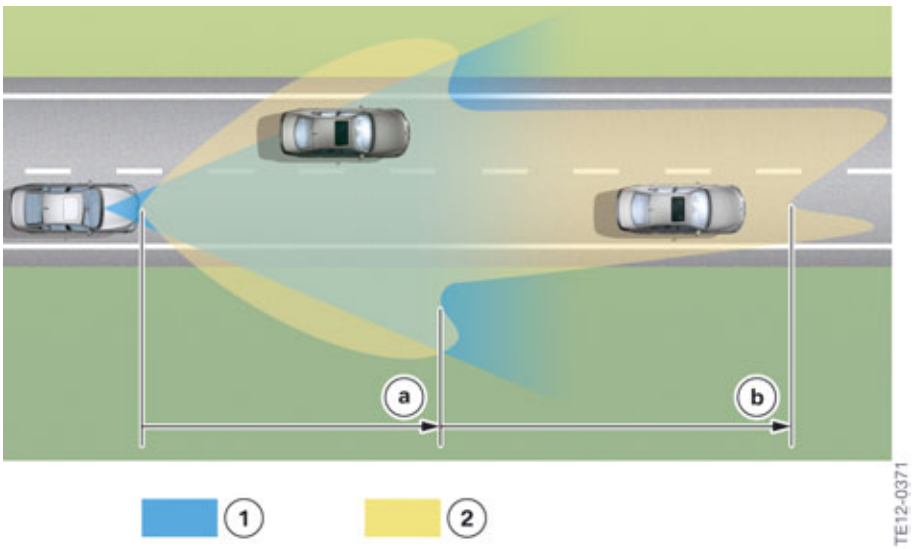
F01/F02 LCI - Active cruise control

F01/F02 LCI Driver Assistance Systems

5. ACC Stop & Go

ACC Stop & Go controls the speed if there is no vehicle driving directly ahead and automatically switches to distance control (ranging) if the radar sensor detects a slower vehicle in its lane.

A 77 GHz radar sensor in the system can identify vehicles up to 200 m (218.7 yd) ahead; this sensor can operate largely independently of weather conditions. Thanks to the radar sensor's improved detection capability and the calibration with the image data from the KAFAS video camera, even vehicles in the neighboring lanes are detected. If these vehicles drive into the subject vehicle's own lane, ACC Stop & Go adapts the speed to vehicles veering in or driving ahead. Consequently the time interval selected by the driver is maintained constant.



F01/F02 LCI - Schematic diagram of monitoring ranges

Index	Explanation
a	Close range
b	Long-distance range
1	Detection range of KAFAS video camera
2	Detection range of radar sensor

The detection range (cone) of the radar sensor is up to 60 m (65.6 yd) wider in the close range than in the long-distance range. This provides for wider lane coverage. Within this range the radar data or detected objects are verified with the image data from the KAFAS video camera.

The KAFAS control unit can detect transverse movements better, assign lanes and clearly identify vehicles. In this way, vehicles veering in and out at close range can be detected earlier and much more quickly. The combination of radar and video data also facilitates the clear identification of stationary vehicles.

The system's Stop & Go function brings the vehicle to a complete stop if necessary. If the vehicle in front starts again after a standstill, information is output to the driver. To drive off again, the driver must acknowledge this information. Only if the duration of the standstill is very short does the starting process take place fully automatically by ACC Stop & Go.

In this way, ACC Stop & Go supports the driver not only in flowing traffic, but also in traffic jam situations, both on multiple-lane highways and ordinary roads and on urban arterial and ring roads.

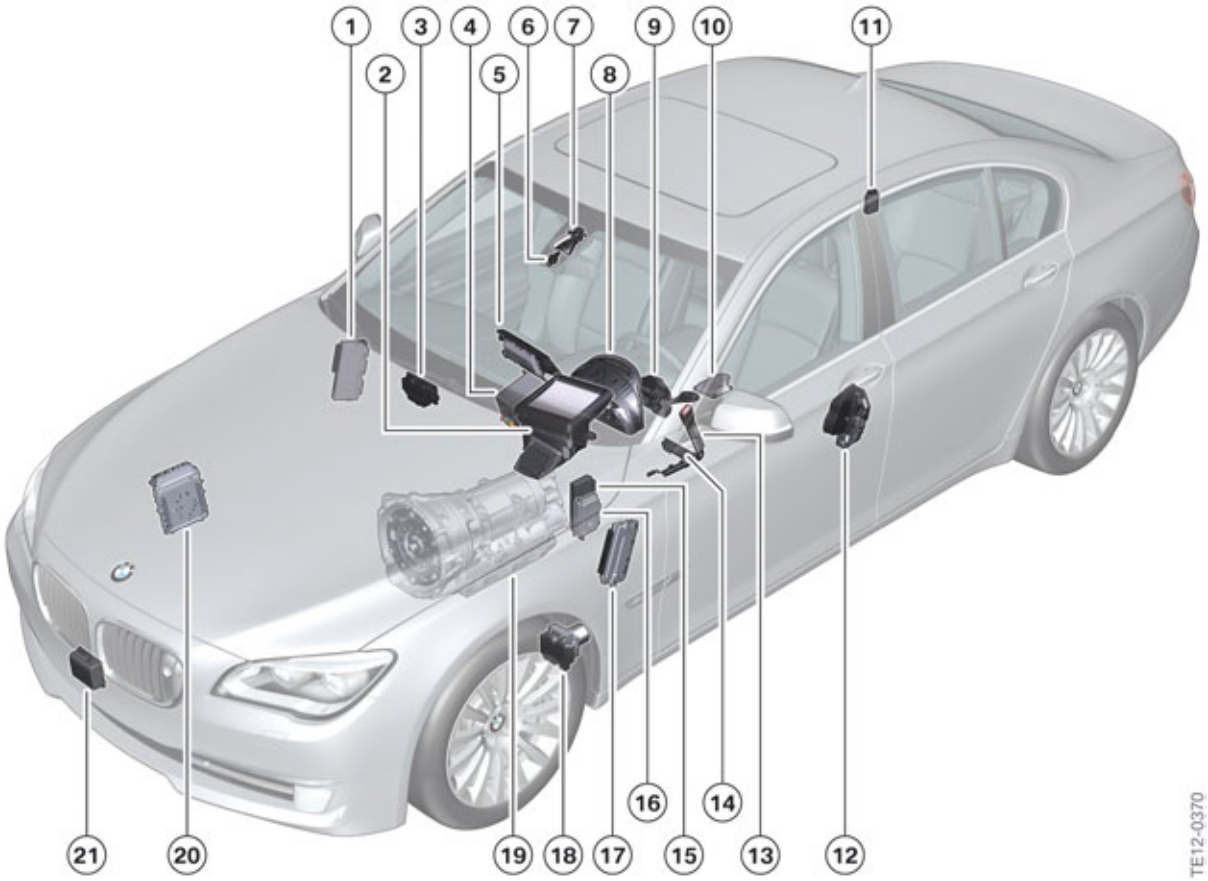
F01/F02 LCI Driver Assistance Systems

5. ACC Stop & Go

Further consideration should be given here to the following areas of the driver assist system ACC Stop & Go:

- System components
- Information from the vehicle environment
- Control functions
- Operation and display
- Behavior when driver intends to exit
- Monitoring functions.

5.2. System components



F01/F02 LCI - System components, ACC Stop & Go

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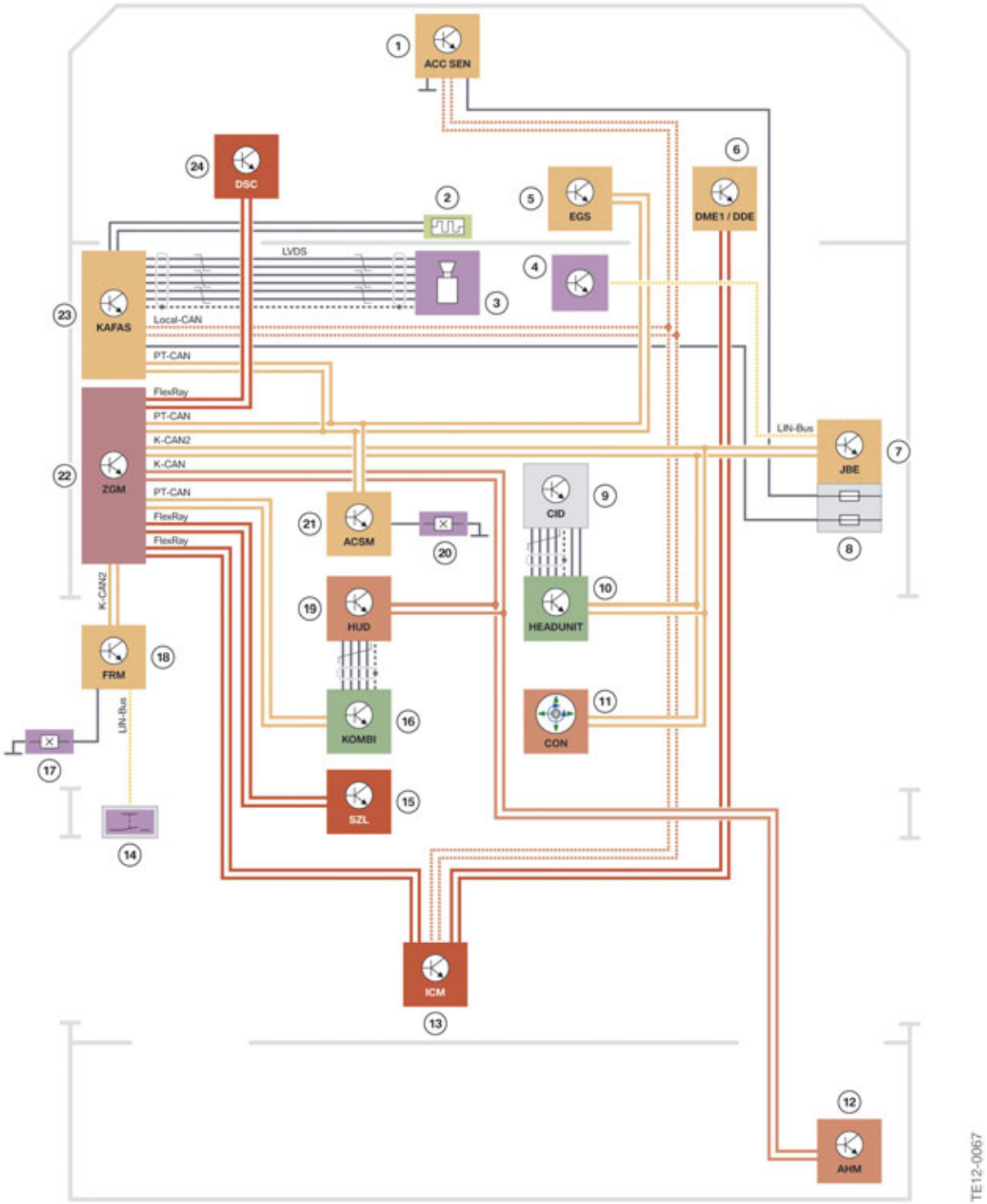
5. ACC Stop & Go

Index	Explanation
1	Junction box electronics (JBE) and power distribution box
2	Head-up display (HUD)
3	Crash Safety Module (ACSM)
4	Headunit
5	Central information display (CID)
6	Rain-light-solar-condensation sensor (RLSBS)
7	KAFAS video camera
8	Instrument cluster (KOMBI)
9	Steering column switch cluster (SZL)
10	Integrated Chassis Management (ICM)
11	Trailer module **(Not for US)**
12	Door contact driver's door
13	Seat belt buckle contact, driver
14	Operating facility for driver assist systems
15	Central gateway module (ZGM)
16	KAFAS control unit
17	Footwell module (FRM)
18	Dynamic Stability Control (DSC)
19	Electronic transmission control (EGS)
20	Digital Engine Electronics
21	Radar sensor for ACC Stop & Go

F01/F02 LCI Driver Assistance Systems

5. ACC Stop & Go

5.2.1. System wiring diagram



F01/F02 LCI - System wiring diagram, ACC Stop & Go

F01/F02 LCI Driver Assistance Systems
5. ACC Stop & Go

Index	Explanation
1	Radar sensor for ACC Stop & Go
2	Video camera heater
3	KAFAS video camera
4	Rain-light-solar-condensation sensor (RLSBS)
5	Electronic transmission control (EGS)
6	Digital Engine Electronics
7	Junction box electronics (JBE)
8	Junction box for the power distribution box
9	Central information display (CID)
10	Headunit
11	Controller
12	Trailer module **(Not for US)**
13	Integrated Chassis Management (ICM)
14	Operating facility for driver assist systems
15	Steering column switch cluster (SZL)
16	Instrument cluster (KOMBI)
17	Door contact driver's door
18	Footwell module (FRM)
19	Head-up display (HUD)
20	Seat belt buckle contact, driver
21	Crash Safety Module (ACSM)
22	Central gateway module (ZGM)
23	KAFAS control unit
24	Dynamic Stability Control (DSC)

5.2.2. Radar sensor for ACC Stop & Go

The radar sensor sends out bundled electromagnetic waves. The echoes reflected by objects are received and evaluated by the radar sensor. Information on objects located in front of the radar sensor can be achieved in this way. This information includes size, distance and the speed derived therefrom.

For the first time in the F01/F02 LCI the radar sensor receives additional information from the KAFAS control unit via its own sensor bus. This information is lane information on transverse movements and information on vehicle identification. The information supports the radar sensor in detecting and evaluating objects and facilitates clear vehicle identification. This video data is required for the reaction to stationary vehicles.

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5. ACC Stop & Go

F01/F02 LCI - Radar sensor for ACC Stop & Go

The radar sensor is located behind a removable grill on the front bumper.

F01/F02 LCI - Installation location of radar sensor

Index	Explanation
1	Radar sensor for ACC Stop & Go
2	Removable grill

5.2.3. KAFAS video camera and control unit

The KAFAS control unit detects vehicles when their rear ends are recorded by the video camera. The KAFAS control unit also supplies lane information and thus helps the radar sensor to determine vehicle position and movement much more quickly. The data is transmitted via the sensor bus to the radar sensor.

5.2.4. Integrated Chassis Management (ICM)

For a detailed description of Integrated Chassis Management (ICM), please refer to the “F01 Dynamic Driving Systems” in ST811 F01 Complete Vehicle training material available on TIS and ICP. The following text provides a brief overview and addresses the particulars connected with the topics presented here.

The ICM in the F01/F02 LCI calculates the control functions, sensor data and vehicle values used to influence longitudinal and transverse dynamics. Also integrated in ICM are micromechanical sensors which supply driving dynamics signals.

Two different ICM versions are used in the F01/F02 LCI, a basic version for vehicles without ACC Stop & Go and a high version for vehicles with ACC Stop & Go.

5.3. Information from the vehicle environment

Information on road users ahead is required for the ACC Stop & Go function. This information is obtained with the aid of the radar sensor for ACC Stop & Go and prepared in ICM.

5.3.1. Recording objects

The detection of the road users ahead is one of the most important functions of the Active Cruise Control. For the Stop & Go function, this task must be done not only in the long-distance range, but also in close range up to directly in front of the vehicle. This is necessary as at low speeds one can drive up very close to the vehicle ahead.

The radar sensor for ACC Stop & Go records the close range and long-distance range ahead of the vehicle with the aid of radar waves. In addition to detecting objects, the position of objects in the x and y directions the radar sensor for ACC Stop & Go can also determine the relative speed of a particular vehicle. With the aid of the image data from the KAFAS video camera, objects can be clearly identified as vehicles and transverse movements as lane changes.

The radar sensor for ACC Stop & Go also uses the driving speed to calculate the acceleration of the vehicles driving ahead in relation to the subject vehicle. These values are required for distance control (ranging).

5.3.2. Processing object data

The object data vehicle detection, position and motion variables are already prepared in the radar sensor for ACC Stop & Go. Individual vehicles are summarized and tracked over time in order to bypass measurement failures. The object data is subjected to an initial filtering process and then summarized again, since parts of the close and long-distance ranges overlap. This overlap occurs in particular in close range.

With the summarized object data, another filtering precess is done, which takes into account the special requirements for distance control (ranging). The filtered object data is transmitted to ICM for assessment.

5.3.3. Assessing objects

To decide which vehicle should be used for distance control, a diagnostic statistic is calculated in ICM for each vehicle from its object data.

The following two key criteria are included in the calculation:

- Position and relative movement of the vehicle driving ahead to the subject vehicle. The closer the vehicle driving ahead is to the subject vehicle and/or the faster it moves to the subject vehicle, the higher the diagnostic statistic.
- Period spent by the vehicle driving ahead in the particular lane.

The vehicle with the highest diagnostic statistic is used for distance control. Here the vehicles are also classified according to the motion status. A distinction is made between driving and stationary vehicles. For a reaction to a stationary vehicle its object data must be verified by the image data from the KAFAS video camera. If the KAFAS video camera fails, there can be no reaction to stationary vehicles. The driver is informed of the failure by means of a display in the instrument cluster and a Check Control message.

5.4. Control functions

5.4.1. Cruise control

Cruise control for ACC Stop & Go basically corresponds to (DCC) Dynamic cruise control.

5.4.2. Distance control (ranging)

Distance control (ranging) is the core function of the ACC Stop & Go system. It is integrated for ACC Stop & Go in ICM. The driver can select a desired distance in four stages using two buttons on the multifunction steering wheel. ACC Stop & Go calculates the set-point distance for the control from this preselection.

The set-point distance during the journey is proportional to the driving speed. At a lower driving speed and at standstill, the proportional distance to the driving speed is no longer used, but instead value in meters. Distance control uses the prepared vehicle object data with the highest diagnostic statistic as input variables.

Distance control takes into consideration the following situations (in particular):

- **Maximum values for acceleration and deceleration:**
  The maximum values for acceleration and deceleration below around 50 km/h (30 mph) are dynamic values. They correspond to the acceleration values which the driver himself would use and considers comfortable. Depending on the situation, ACC Stop & Go accelerates by a maximum of 2 m/s² (6.56 ft/s²) and decelerates by a maximum of 4 m/s² (13.1 ft/s²).
- **Prompt to take over vehicle handling:**

When ACC Stop & Go is no longer able to maintain a safe distance, e.g. on account of very high differential speeds or an insufficient maximum deceleration, two short warning tones sound and the orange vehicle symbol is displayed in the instrument cluster or flashes in the head-up display. The system continues to perform its control function and prompts the driver to take over vehicle handling and to keep their distance accordingly.
If the collision warning with braking function is activated, this will issue a warning if the takeover prompt is not followed and there is an imminent danger of collision. The red vehicle symbol is then displayed in the instrument cluster or in the head-up display. For further information, please refer to the chapter “Collision warning with braking function”.

5.4.3. Cruise control when cornering

Cruise control of ACC Stop & Go on bends is based on that of DCC. In the case of an object loss on the bend, it is necessary to wait a certain period of time to see whether the object reappears again (transition curve). The vehicle is accelerated only if the object no longer appears.

5.5. Operation and display

5.5.1. Activation and deactivation

Activation and deactivation of ACC Stop & Go and DCC are virtually identical as other BMW vehicles. ACC Stop & Go cannot only be activated by the driver during the journey, but also when the vehicle is at a standstill, if the system detected another vehicle before its own vehicle. To activate ACC Stop & Go at standstill, the driver must press the brake pedal and at the same time press the RES button. The following conditions must also be satisfied:

- Seat belt fastened and door closed
- Drive position “D” engaged
- Engine running
- Parking brake not activated
- No system faults detected.

The set speed can be set in a range from 30 to 210 km/h (18.6 to 130 mph). Compared to the DCC, a vehicle with ACC Stop & Go receives a keypad in the multifunction steering wheel, which also has two buttons for setting the distance.

F01/F02 LCI Driver Assistance Systems

5. ACC Stop & Go

F01/F02 LCI - Steering wheel, ACC Stop & Go

Index	Explanation
1	Button - speed SET
2	Button - decrease distance
3	± rocker switch - change speed, set speed
4	Button - increase distance
5	Button - switch ACC Stop & Go on/off
6	Button - retrieve saved speed (RES)

A (brief) press of the respective button for changing the distance increases or reduces the desired distance, which ACC Stop & Go uses for control. A total of four stages are available to the driver for this purpose. In the instrument cluster the selected stage of the distance is faded-in.

Like for DCC, it is also necessary that the symbol screen masks are complemented if necessary with notes in the instrument cluster for ACC Stop & Go. The symbol screen masks are for example the set speed and the distance bar. The displays are faded-in for about 3 seconds. For each renewed operation the display is faded-in again for another 3 seconds.

ACC Stop & Go information is also shown in the head-up display.

5.5.2. Changing the desired speed

The driver can change the desired speed of ACC Stop & Go in just the same way as for DCC if the system is switched on. Also if the particular vehicle is brought to a standstill by ACC Stop & Go, this adjustment option is given. The adjustable range of the desired speed is 30 to 210 km/h (18.6 to 130 mph).

5.5.3. Changing the desired distance

The desired distance can be changed by a brief press of the corresponding button in the multifunction steering wheel when the system is switched on. The usual four distance stages are available for selection, which are represented by bars in the instrument cluster. The change of the desired distance im-

mediately results in a noticeable vehicle response during the journey. The vehicle accelerates or decelerates slightly in order to adjust to the new desired distance. At standstill the vehicle is not set in motion by the change of the desired distance.

If ACC Stop & Go is oversteered by the driver, no change of the desired distance can be effected. During oversteering by the driver the distance bars in the instrument cluster disappear.

5.5.4. Stopping and starting

If the vehicle ahead stops, ACC Stop & Go also decelerates until at a full stop, whereby a safe distance to the vehicle ahead is observed. If the vehicle ahead starts moving again within 3 seconds, the F01/F02 LCI also starts up without intervention by the driver. If the vehicle remains stationary for longer than 3 seconds, the F01/F02 LCI no longer starts up automatically. Instead, ACC Stop & Go indicates to the driver in the instrument cluster that they can start driving again. As soon as the driver acknowledges this signal by pressing the accelerator pedal or by pressing a button on the steering wheel, the vehicle is set in motion again.

In the event of extreme external conditions, such as a sharp incline for example, the ACC Stop & Go may no longer be able to drive off. In this case, the brake pressure required to hold the vehicle is built up again. The system remains in this state until the driver switches it off or performs the starting process him/herself manually. This does not represent a fault, but a situation in which the limits for the operating range of ACC Stop & Go have been exceeded.

5.5.5. Behavior when driver gets out of the vehicle

ACC Stop & Go reliably decelerates the vehicle to standstill with help of the DSC hydraulics and stops it there. Without the supply of electrical energy, the DSC hydraulics is not able however to maintain the brake force required for stopping for a long period.

If the driver leaves the vehicle in standstill when the system is active, ACC Stop & Go is deactivated and the vehicle is permanently kept in standstill with help of the parking lock of the transmission.

The signals of the seat belt buckle contact (driver) and of the door contact (driver's door) are evaluated to detect the driver's intention to exit the vehicle. A seat occupancy detection signal (driver's seat) is not used in the F01/F02 LCI.

5.6. Monitoring functions

ICM monitors the system network to the effect that all the participating subsystems are operational, all the input signals required for the function are valid, and the electronics of the particular control unit are fault-free. When troubleshooting it is important to incorporate not only individual components, but also participating systems from the system network.

If there is a fault in the radar sensor system, the function is deactivated completely. If the video information from the KAFAS control unit fails, the function will only continue to be available with limited effect. In both cases the driver is informed of the failure by means of a display in the instrument cluster and a Check Control message. An activation will only be possible again when the fault is no longer present.

F01/F02 LCI Driver Assistance Systems

6. Collision Warning w/Brake Application

The collision warning with brake application function is a supplement function to ACC Stop & Go and uses its sensor system and components. It is an integral part of **(option 5AT Enhanced Active Cruise Control)** which can only be ordered in combination with the optional ZDA (Driving Assistance Package).

The collision warning alerts the driver of a possible danger of collision and provides assistance in an emergency in the form of an automatic brake intervention.

By combining the radar and KAFAS image data the braking deceleration of the braking function is increased up to 8 m/s² (26.2 ft/s²). This is applied differently for the lower (≤ 50 km/h/ 30 mph) and upper (> 50 km/h/ 30 mph) speed ranges as braking is now done in two stages.

6.1. Operation

6.1.1. Vehicles with collision warning w/o Night Vision

The collision warning with braking function is automatically activated after each engine start via the START/STOP button.

When the Intelligent Safety button is pressed in the driver assist system operating facility, the collision warning with braking function is deactivated or activated:

- Collision warning deactivated: LED above the button is off.
- Collision warning activated: LED above the button lights up.

The status of the collision warning with braking function is additionally displayed in the CID. In addition, when the collision warning is activated the driver can set the time of the early warning in three stages. The “late” setting corresponds to the point of the acute warning. The setting of the time of the early warning is saved for the current driver profile.

6.1.2. Vehicles with collision warning and with Night Vision

The collision warning with braking function is automatically activated after each engine start via the START/STOP button.

When the Intelligent Safety button is pressed in the driver assist system operating facility, the information pages for the collision warning and pedestrian detection functions are shown in the CID. The driver can deactivate or activate the collision warning with braking function and pedestrian detection from here.

In addition, when the collision warning is activated the driver can set the time of the early warning in three stages. The “late” setting corresponds to the point of the acute warning. The setting of the time is saved for the current driver profile.

When the LED above the Intelligent Safety button in the driver assist system operating facility lights up, at least one front protective function is activated.

F01/F02 LCI Driver Assistance Systems

6. Collision Warning w/Brake Application

6.2. Operating principle

The system warns of a possible collision from a speed of around 15 km/h (9.3 mph) initially with an early warning and then if the danger persists with an acute warning.

The collision warning is also available when cruise control is deactivated.

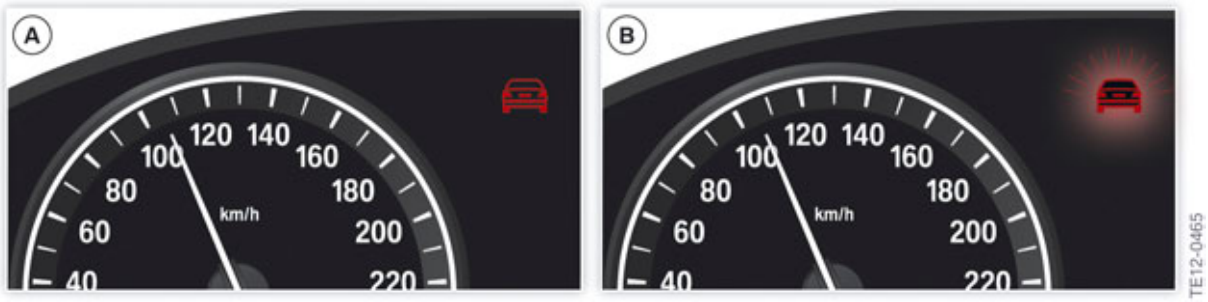
Stationary as well as moving vehicles are taken into consideration.

In addition to the warnings, the vehicle's brakes are prepared for emergency braking and the activation thresholds of the brake assistant are decreased. In an emergency an automatic brake intervention is performed by the system.

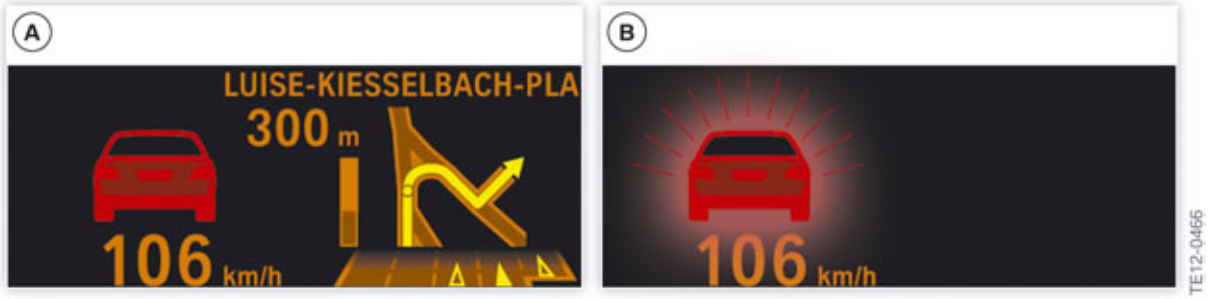
In the event of a deliberate forward collision with a vehicle, the system sensitivity is reduced and thus the warnings are not displayed.

6.3. Warning function

The warning function is divided into two stages. It appears in the instrument cluster or in the head-up display.



F01/F02 LCI - Collision warning in the instrument cluster



F01/F02 LCI - Collision warning in the head-up display

Index	Explanation
A	Stage 1: Early warning, vehicle in red
B	Stage 2: Acute warning, flashing vehicle in red and acoustic warning signal

6.3.1. Early warning

The early warning is issued, for example, in the event of an imminent danger of collision on account of a high differential speed to the vehicle driving ahead and in the event of a very small distance to the vehicle driving ahead or stationary vehicle.

The early warning is indicated by a vehicle permanently illuminated in red in the instrument cluster or in the head-up display.

The time of the early warning can be configured in the CID. When the “late” setting is selected, the time of the early warning corresponds to that of the acute warning.

6.3.2. Acute warning

The acute warning is issued by the system as late as possible and only if there is an immediate danger of a collision when the vehicle is approaching the vehicle driving ahead at relatively high differential speed. The point at which the acute warning is issued is calculated in such a way that a collision can only be avoided by immediate emergency braking or by an evasive maneuver.

The acute warning issues a prompt for intervention and is usually supported in the event of a danger of collision by a two-stage brake intervention. Brake intervention is limited in time to about 3 seconds and must end when by vehicle has been decelerated by around 50 km/h (30 mph). This avoids additional dangers for the following traffic.

In the lower speed range up to 50 km/h (30 mph) brake intervention is applied initially with a brake force of 5 m/s². When the target object is verified by the camera data, brake intervention is applied after about 0.5 seconds at max. 8 m/s² (26.2 ft/s²). The vehicle can therefore be braked to a full stop in the lower speed range ≤ 50 km/h (30 mph).

At a driving speed in excess of 50 km/h (30 mph) brake intervention is applied initially with a brake force of 4 m/s² (13.1 ft/s²). When the target object is verified by the camera data, brake intervention is applied after about 0.5 second at max. 6 m/s² (19.6 ft/s²).

At a driving speed in excess of 210 km/h (130 mph) the speed reduction is limited to 10 km/h (6.2 mph).

Brake intervention is also applied when the driver fails to depress the brake pedal sufficiently.

Brake intervention is applied only when Dynamic Stability Control (DSC) is switched on.

An acute warning is indicated to the driver by a red flashing vehicle in the instrument cluster and in the head-up display. In addition, an acoustic warning signal is sounded.

The acute warning does not relieve the driver of their responsibility to adapt their driving speed and style to the road and traffic conditions and to maintain the prescribed safety distance.

Brake intervention can be cancelled by pressing the accelerator pedal or by applying a clear steering wheel movement.

The collision warning with braking function must be deactivated (in towing situations) in order to avoid malfunctions.

F01/F02 LCI Driver Assistance Systems
6. Collision Warning w/Brake Application

The braking function is deactivated when Dynamic Stability Control (DSC) or Dynamic Traction Control (DTC) is deactivated.

If the KAFAS video camera fails, brake intervention is applied only with a brake force of max. 4 m/s² (13.1 ft/s²) and solely in response to detected moving or stopped vehicles. In the case of vehicles which were already stationary when they entered the radar sensor's detection range, there is no braking. If the radar sensor fails, the collision warning with braking function is deactivated completely. In both cases the driver is informed of the failure by means of a display in the instrument cluster and a Check Control message.

System limitations mean that warnings may (under certain circumstances) not be issued or are issued too late or without authorization. The driver must always remain alert and observant so that he/she can actively intervene at any time to avoid the risk of an accident.

6.4. History

The collision warning with braking function (formerly known as the adaptive brake assistant) was introduced for the first time in 2007 with the E60 LCI. The table below describes the various development stages, their features and their initial implementation in BMW models.

Features	Adaptive brake assistant	Adaptive brake assistant with warning function	Collision warning with braking function	Collision warning with braking function Latest generation
Initial implementation	03/2007 E60 LCI	08/2009 F01	01/2010 F10	07/2012 F01/F02 LCI
Pre-pressurizing of brake system	X	X	X	X
Adaptation of brake assistant	X	X	X	X
Early and acute warnings				
in response to moving/stopped targets		X	X	X
in response to stationary targets			X	X
Braking				
in response to moving/stopped targets			X	X
in response to stationary targets				X

F01/F02 LCI Driver Assistance Systems

6. Collision Warning w/Brake Application

Features	Adaptive brake assistant	Adaptive brake assistant with warning function	Collision warning with braking function	Collision warning with braking function Latest generation
at max. 3 m/s² (9.8 ft/s²)			X	
at v ≤ 50 km/h (30 mph) at max. 8 m/s² (26.2 ft/s²) two-stage **to a full stop**				X
at v > 50 km/h (30 mph) at max. 6 m/s² (19.7 ft/s²) two-stage				X

F01/F02 LCI Driver Assistance Systems

7. Distance Ranging Information

Distance ranging information utilizes the sensor system and components of the active cruise control (ACC Stop & Go).

Thus it is an integral part of the optional equipment Enhanced Active Cruise Control (option 5AT), available only with ZDA Driving Assistance Package

When ACC Stop & Go is deactivated, the distance ranging information notifies the driver if their vehicle is too close to the vehicle driving ahead. Here the distance can be smaller than a minimum distance required by law. The distance ranging information is removed as soon as the distance is increased again.

The indication appears only in the head-up display. The display can be deactivated via the CID.

F01/F02 LCI - Distance ranging information in the head-up display

The distance ranging information symbol is only displayed in the following situations:

- ACC Stop & Go is deactivated
- ranging information is activated
- the vehicle is being driven faster than 70 km/h (43.4 mph)
- the distance is too small for several seconds.

Distance ranging information does not relieve the driver of their responsibility to adapt their driving speed and driving style to the road and traffic conditions and to maintain the prescribed safety distance.

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