Reference Manual

F01
COMPLETE VEHICLE

Technical Training

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F01 Introduction

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Introduction

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the changes to the 7-Series for 2009
- Understand dimensional changes as compared to the previous 7-Series
- Understand body construction and assembly techniques
- Understand the mix of body materials
- Understand interior changes

The New 7-Series

Introducing the F01/F02

In autumn 2008, the F01 will be in production in the Dingolfing plant. At the same time, the F02 (long-wheelbase version) will start coming off the assembly line.

The range will be represented by the 740i, 740iL and 750i and 750Li models. The F01/F02 is lower in height than the E65/ E66 and it has an improved rear passenger compartment (space for head/knees). The wheelbase too is considerably longer. Headroom and luggage-compartment capacity are more or less the same as in the E65.

F01

F02

Dimensional Comparison, F02 vs F01

The following text describes the dimensional differences between the F01 and the longer wheelbase version, the F02:

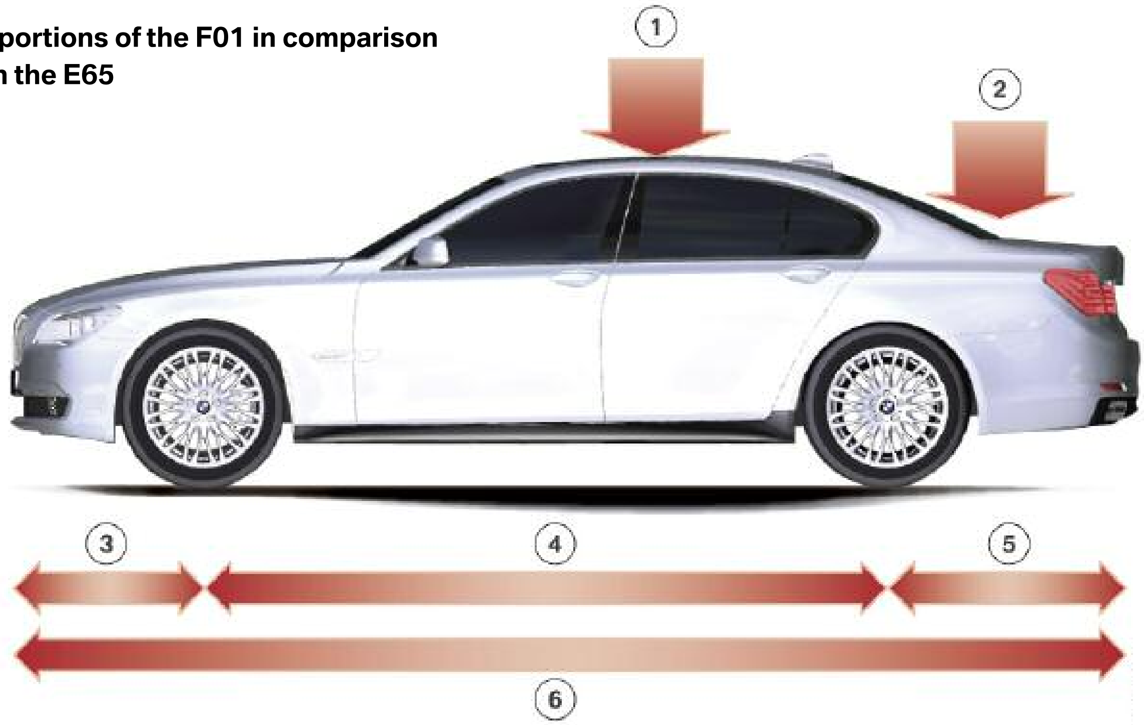
- Wheelbase longer by 140 mm
- F02 rear axle with pneumatic springs and self-levelling suspension as standard
- F02 has more rear-passenger orientation and a multifunction seat with improved comfort.

The F01/F02 is characterized by highly efficient petrol and diesel engines (more power in combination with lower fuel consumption).

The suspension damping is variable, with 3stage adjustment. The steering is an Integral Active Steering configuration with steerable rear axle.

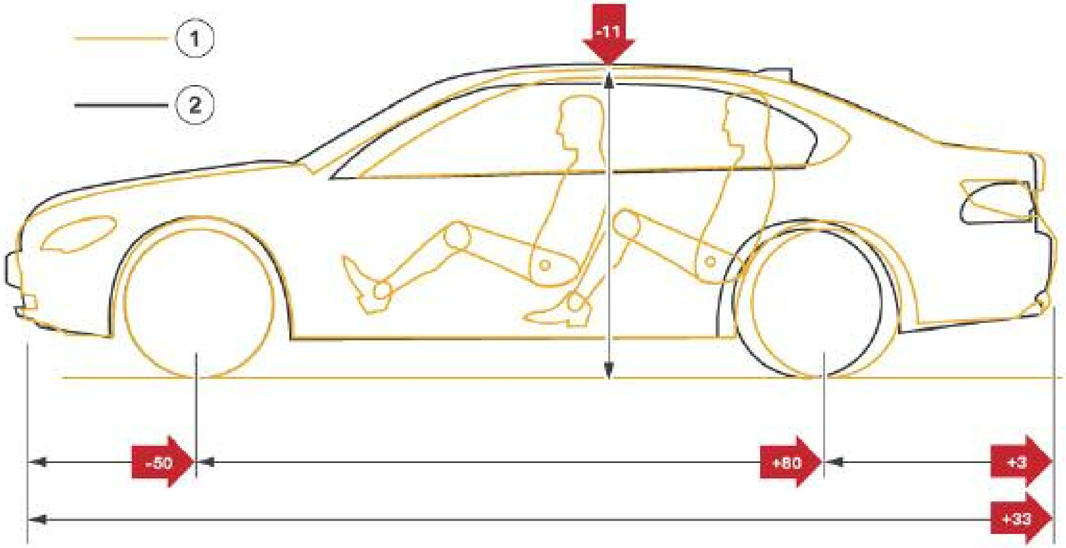
Drive assistance systems and a cockpit arrangement with driver orientation and a selector lever set in the center console are distinct from the E65.

Proportions of the F01 in comparison with the E65



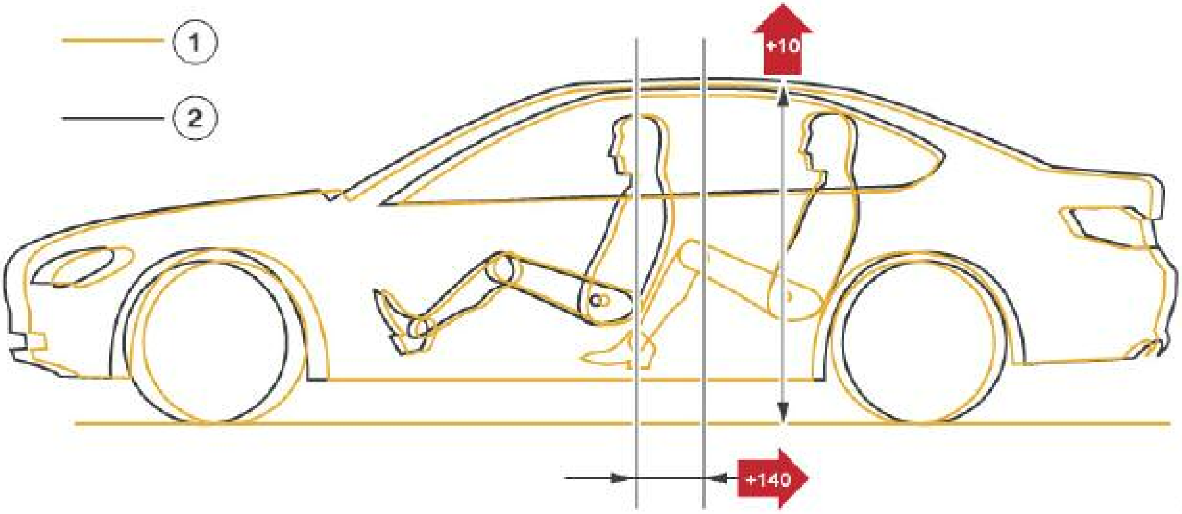
Index	Explanation	Index	Explanation
1	Lower	4	Longer wheelbase
2	Flatter	5	Longer
3	Shorter	6	Longer

The illustrations below, compare the F01 with the E65 (facelift) as well as the F01 and F02:



Dimensions of the F01 in comparison with the E65 facelift (in mm)

Index	Explanation	Index	Explanation
1	E65 facelift (LCI)	2	F01



Dimensions of the F01 in comparison with the F02 (in mm)

Index	Explanation	Index	Explanation
1	F01	2	F02

As the graphic indicates, in comparison with the F01 from the B-pillar back the rear-seat passengers of the F02 have 140 mm more length and 10 mm more height at their disposal.

New Options

There are several new systems and functions available for the F01. The items listed below were not available on the previous 7-Series (E65):

- Head-Up Display
- Massage function for comfort seats in the rear
- Sideview and rear view cameras
- 4-zone air conditioning
- Instrument panel finished in leather
- Ceramic secondary controls
- Lane Departure Warning
- Active Blind Spot Detection (a.k.a. Lane Change Warning)
- Night Vision with person recognition
- Integral Active Steering
- ACC with Stop&Go function.

Body Overview

Bodyshell (body-in-white)

As with other models, the use of lightweight materials was a major requirement in the F01/ F02 design brief. This was achieved by the intelligent use of high-strength multiphase steels and very-high-strength hot-formed steels (strength of the body structure has again been increased over that of the predecessor model).

The lightweight materials contribute significantly to the overall reduction in gross vehicle weight and in combination with the rigidity of the bodywork skeleton they also contribute significantly to the car's drive dynamics.

Highlights:

- Cast-aluminum spring mounts and aluminum roof (4 % of the body skeleton weight)
- High proportion of multiphase steels (18 % of the body skeleton weight)
- High proportion of hot-formed steels (16 % of the body skeleton weight)

Function

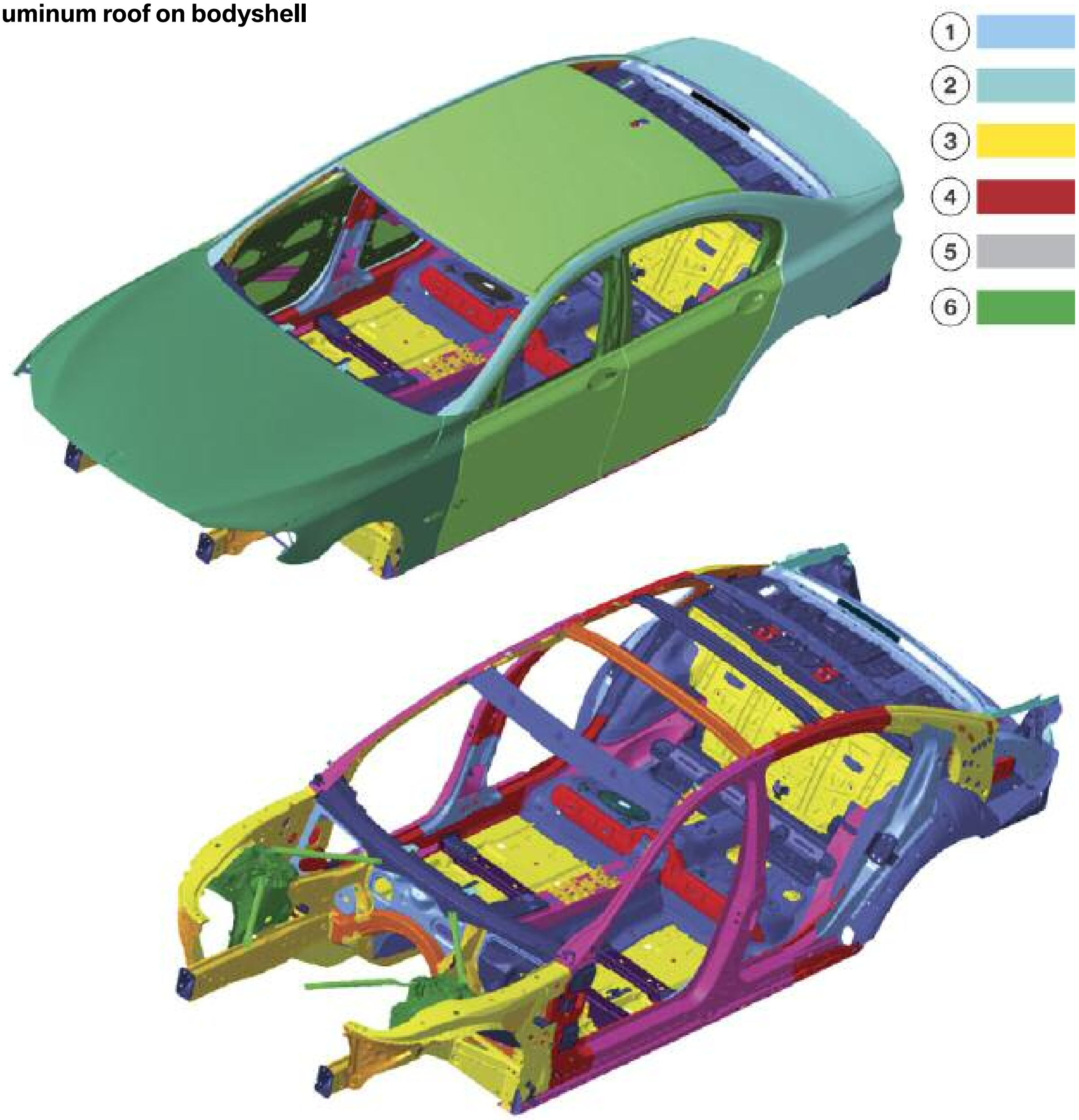
The cast-aluminum spring mounts strengthen the front section and improve drive dynamics. Lightweight construction with aluminum in the front section contributes to uniform axle load distribution.

The aluminum roof lowers the center of gravity of the vehicle as a whole, thus contributing positively to drive dynamics.

The increased-strength multiphase steels and very-high-strength hot-formed steels combine low weight with maximum strength for the safety passenger cell, thus contributing very significantly to passive safety.

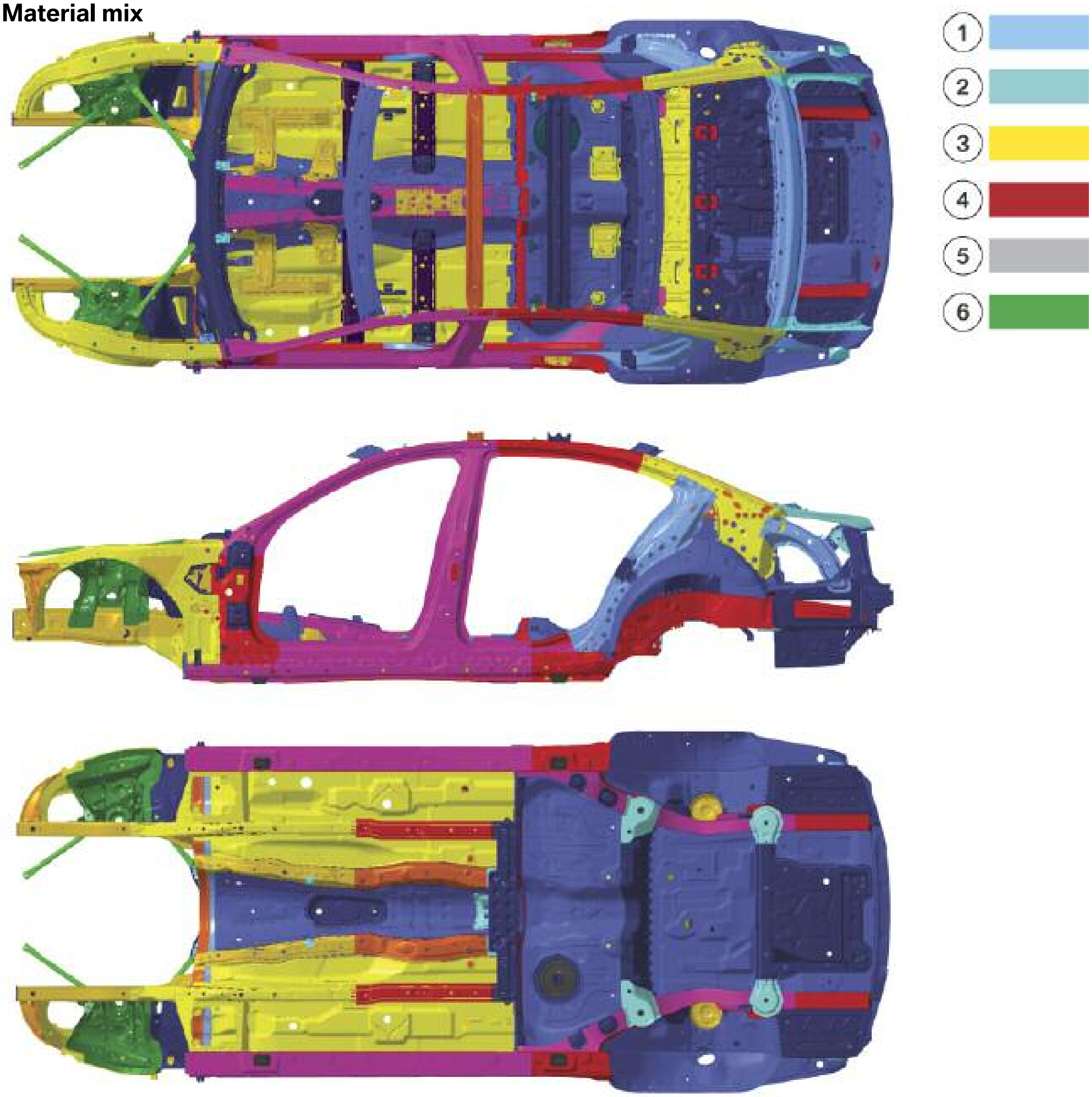
Interested readers will find a wealth of background information on nomenclature and abbreviations in the Product Information entitled "Basics of High-Strength Steels".

Aluminum roof on bodyshell



Index	Explanation	Index	Explanation
1	HC180BD, HC220BD, HC220YD, HC260BD, HC260LAD, HC260X, HX260BD	4	HC400T, HC420LAD, HC450X, HC600C, HD680C, HC900WD, HC950W, Docol 1200
2	DX54D	5	Others
3	HC300BD, HC300LAD, HC300X, HC340LAD, HC340X, HC380LAD	6	Aluminum

Material mix



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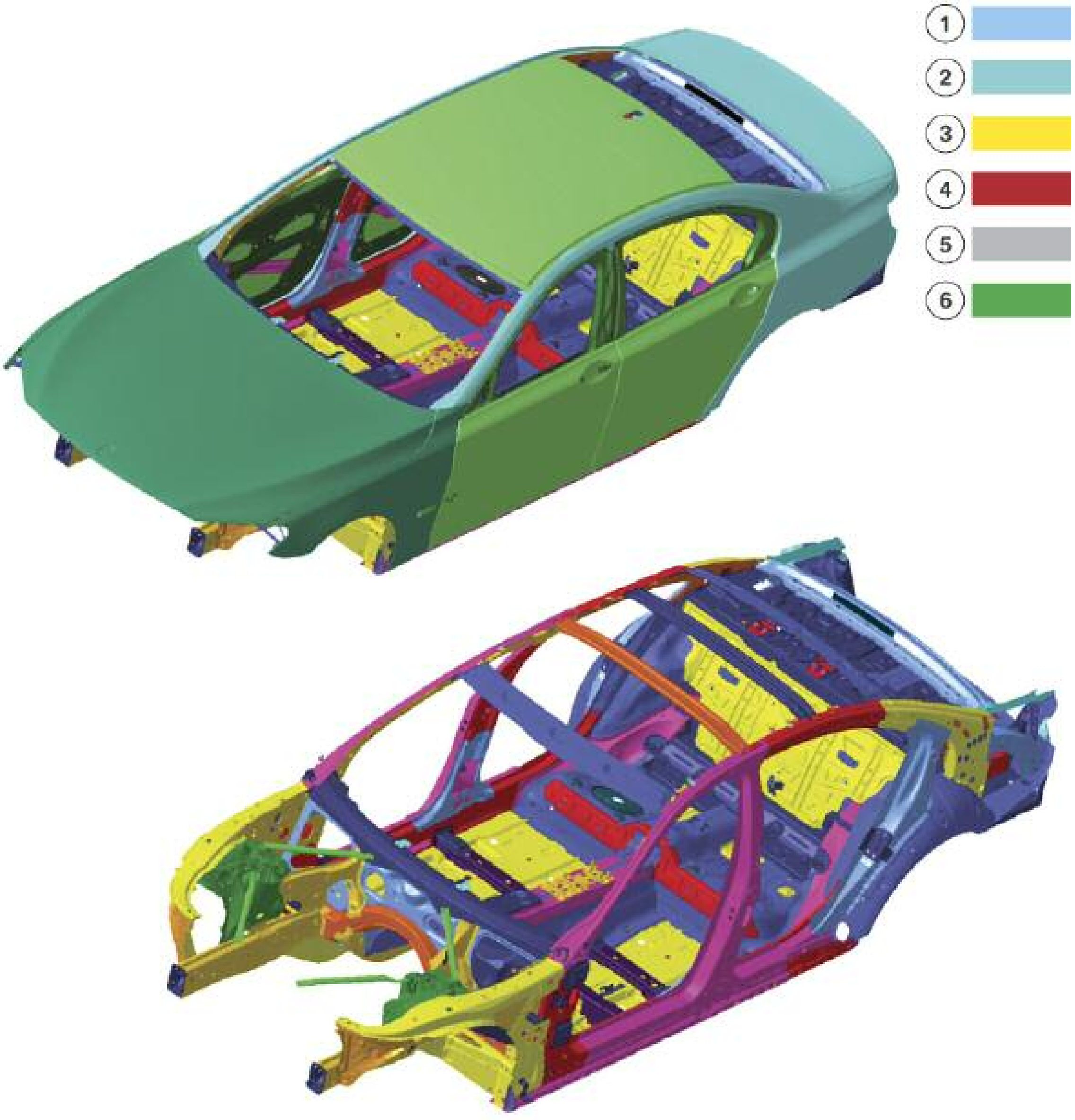
2	DX54D	5	Others
3	HC300BD, HC300LAD, HC300X, HC340LAD, HC340X, HC380LAD	6	Aluminum



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2	DX54D	5	Others
3	HC300BD, HC300LAD, HC300X, HC340LAD, HC340X, HC380LAD	6	Aluminum

In order to optimize anti-corrosion protection, the bodywork of the F01/F02 is constructed primarily from fully galvanized sheet, special-steel sheet and aluminum sheet. Welding, adhesive bonding and riveting are the connection techniques used.

Where sheets are doubled up the design is such as to minimize the contact surfaces. This helps prevent bondline corrosion.

All other anti-corrosion protection and sealing measures depend on the extent to which the doubled sheets are exposed to moisture/ water.

In particularly critical areas, expanding foam parts are used to seal the body cavities against the ingress of water. All doubled sheets in wet zones are double-sealed and, if necessary, they are also treated with wax as an extra sealant.

Doubled sheets in dry zones (above the waistline) are sealed not against corrosion as such, but if necessary to avoid the ingress of dust.

Corrosion-critical material pairing is avoided. The combinations of material substrates and joining technique were chosen with meticulous care in order to avoid corrosion risks.

Coating process

In the painting process the bodyshell is dipped and:

- Alkaline-cleaned
- Phosphated (roughening of the surface so the coating forms a good key) and
- Cathodic-dip coated (anticorrosion coating that coats the insides of all body cavities).

The organic paint coat is then baked on.

In follow-up processes the body is sealed with PVC and protected by filler and topcoat paints on the outer skin.

Critical parts of the body of the F01/F02 are specially treated with cavity sealant.

The objectives are:

- 3 years without any visible corrosion whatsoever
- 12 years without rust penetration
- High level of seal efficiency against increase of water and dust.

The design implements the following measures aimed at controlling acoustic effects and vibrations in the F01/F02 bodyshell:

- Narrow engine-mount base to reduce structure-borne sound transmission to the front of the car
- Longer rear-axle mount base; solution of the trade-off between liveliness of response on the one hand and acoustics on the other

- Rolling acoustics with runflat tires on a par with those of non-runflats
- Optimized vehicle insulation, even though the roof is aluminum
- Double bulkhead panel with need-oriented acoustic insulation
- High static and dynamic body stiffnesses; homogeneous flex line
- Outstanding idling comfort
- Acoustically insulating glass available as an optional extra
- V8 and larger engines: hydraulically damped gearbox mounts: solution of trade-off between shake vs. acoustics.

Separating the roof from the bodyshell

The aluminum roof is one of the engineering highlights of the F01/F02 bodyshell.

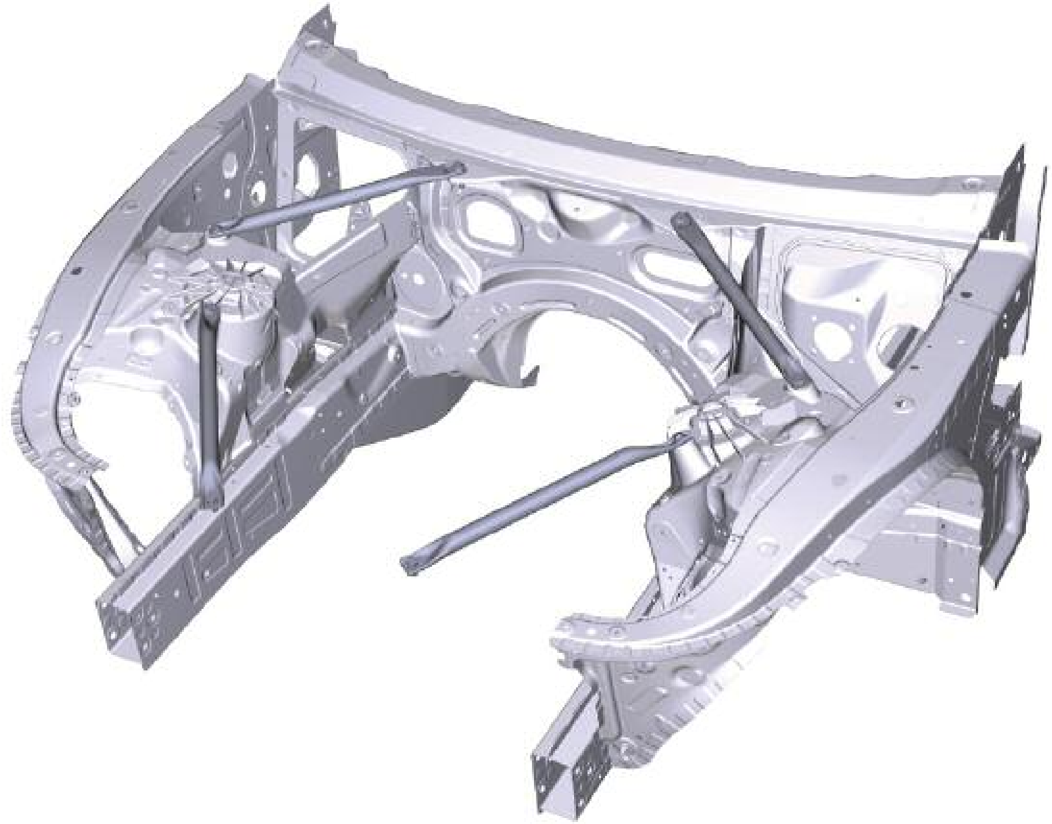
- Aluminum roof on steel body in series production
- Weight saving (8.4 kg for the slide/tilt sunroof version)
- Lowers the car’s center of gravity > drive dynamics, CO2
- Adhesive-bonded aluminum roof; this also means optimum anti-corrosion protection in mixed-material construct
- Top part of frame riveted (slide/tilt sunroof version)
- Patented shaping to compensate for thermal expansion and contraction
- Use of a newly developed adhesive generation (“expansion/contraction vs. strength”, shear modulus over temperature, long-term strength)
- Spacer nubs integrated into roof ensure correct gap for the adhesive
- Assurance of a roof-rack concept (100 kg load-bearing capacity).

The aluminum roof can be separated from the bodyshell by heating the adhesive and inserting wooden wedges to open a gap between the aluminum roof and the bodyshell.

Separating roof from bodyshell

Front End

The F01/F02 share the same front end of the bodyshell.

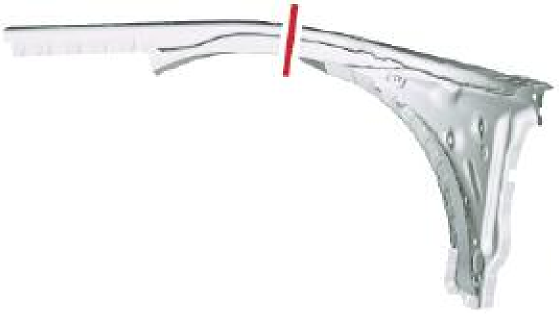


The engine supports are shorter than those of the E65. Consequently, there is no repair section for the engine bearers for the F01/ F02.

The wheel housing is similar in design to that of the E70 (cast-aluminum spring mount). In most instances in which the wheel housing requires repair, engine and gearbox can remain installed in the car.

There are repair sections for the top support.

The front side panel is a bolt-on aluminum panel. There are spacers between the side panel and the bodyshell.

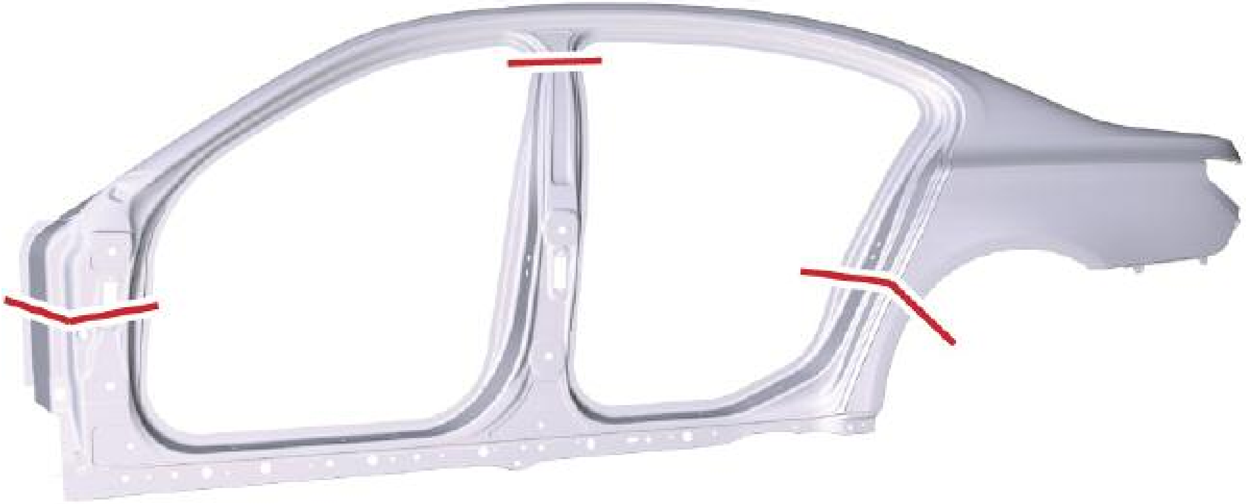


Section through top support

Side Frame

As in the predecessor model, the B pillar of the side frame is made of very-high-strength steel. A new feature is that the sill is made of the same material as the B pillar.

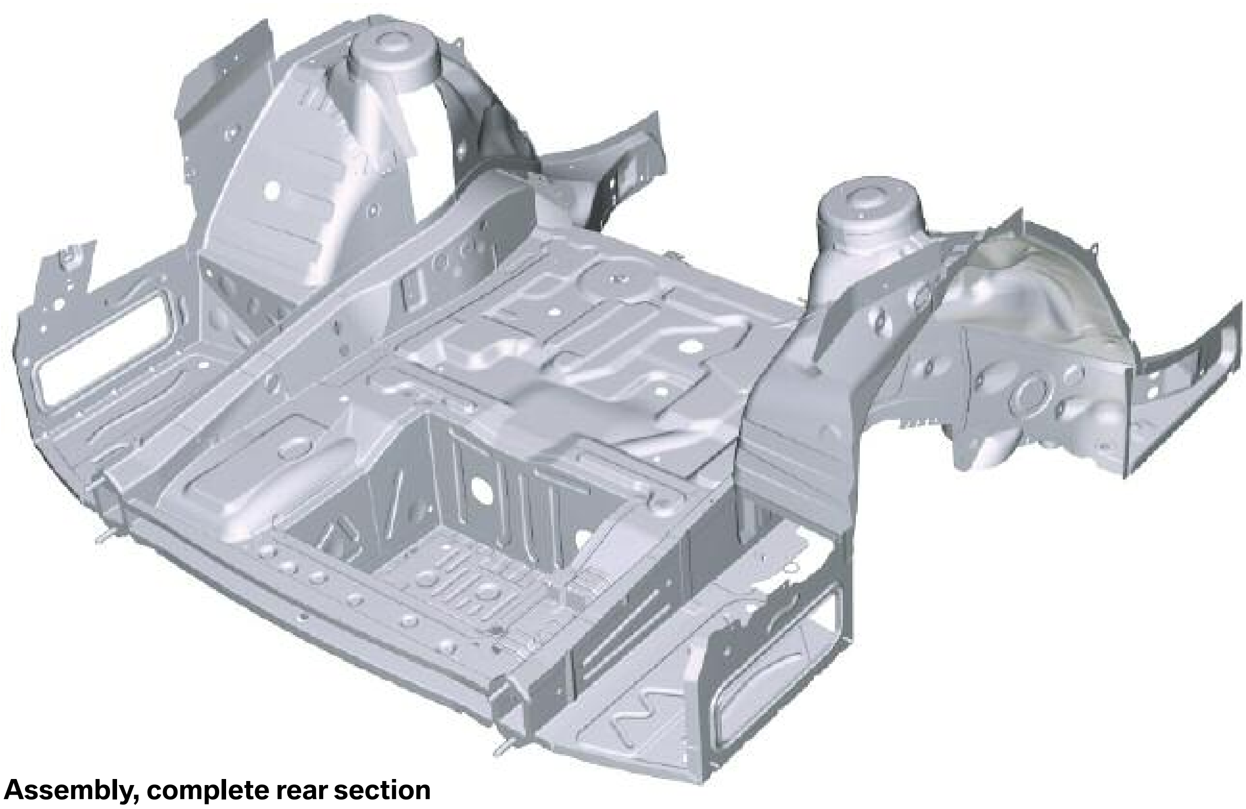
■ **Repair sections, side frame F01/F02**
The following sections have been defined for parts-replacement repairs of the side frame:



Repair sections, side frame F01/F02

Rear, F01/F02

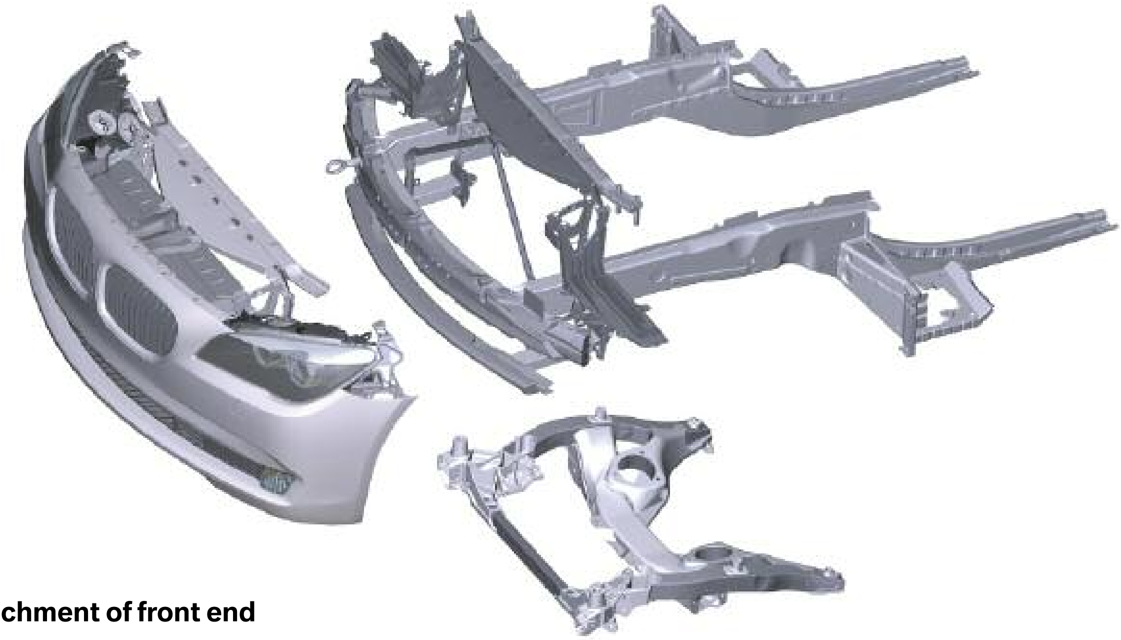
The rear of the F01/F02 is a conventional structure. With regard to repair procedures, there are no major innovations as compared to the E65/E66.



Assembly, complete rear section

Front end

The front end of the F01/F02 can be completely separated from the rest of the car. It consists of the front bumper, the lights and numerous sensors and the diverse cover panels.



Attachment of front end

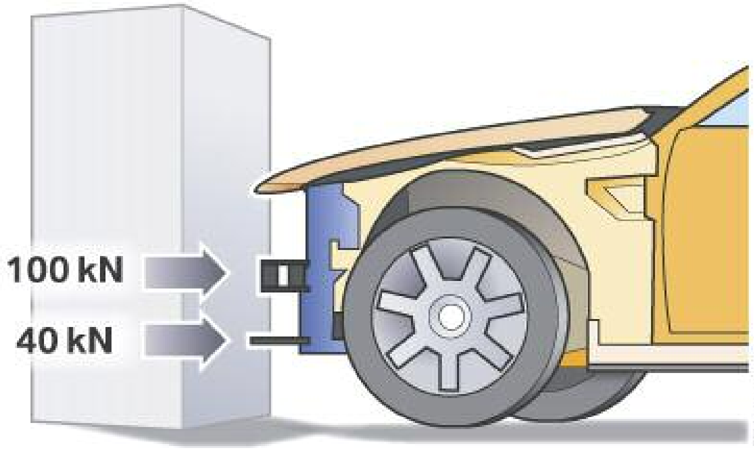
The front end is attached by means of the engine carrier and the front axle. This is new.

Removing the front end entails releasing the threaded fasteners at the engine carrier.

The threaded fasteners of the front-axle mounts also have to be undone.

The threaded fasteners of the radiator bracket also have to be undone (do not open the cooling circuit). The final steps are to release the support of the lock and remove the wheel-arch panels.

The advantage of having the front end attached by means of the engine carrier and the front axle is that in the event of a collision, there is a second load path to dissipate the collision forces.



This makes for better results in the statutory crash tests and advantages in terms of pedestrian protection and the high-speed crash requirements.

Another interesting point is the material mix in the threaded-fastener concept of this mounting system. The engine carrier is made of increased-strength steel, while the bumper mounts and the front-axle anchorages are aluminum.

Doors

The F01/F02 has aluminum doors with sheet-metal shell window frames. The advantages of this configuration are as follows:

- Improved visibility to the outside and upward
- Window frames look lighter and slimmer when the doors are closed
- When the doors are open, the window frames look solid with a high-quality appeal
- More light can make its way into the passenger compartment
- Interior impression with improved feeling of space.

Front door

The doors are made of large, sheet-metal shells to transmit force. The corpus of the door is characterized by high rigidity and component quality, ensured by the closest possible tolerances. Numerous advantages derive from this make-up:

- Compliance with the highest requirements for rigidity at the window frames, because the frame is a single section made of only two sheet-metal parts with minimum dimensions and good manufacturability
- Implementation of the premium design/ form language in the exterior by realization of extreme deep-draw dimensions and a new component separation (hinge reinforcement and door inside panel)
- Maximum geometrical stability of the individual parts with one-piece door inside panel (window frame and door corpus)
- Lowest possible number of components for the door structure
- Laser welding and structural adhesive bonding as the joining technologies of the door structure.

Rear door

BMW has often used aluminum door structures in the past, for example for the Z8. Until now, however, aluminum doors were manufactured only for models produced in relatively small numbers of units.

The development objective for the F01/F02 door structure, therefore, was to implement a concept for an aluminum door that can be manufactured in larger numbers at acceptable costs.

However, aluminum is not as easy to shape as steel, so aluminum sheet shell parts are much more difficult to manufacture than counterpart steel components, particularly when the deep-drawing depths are considerable.

Despite these difficulties, the development of a new structure concept with large shells to transmit force sufficed to improve the manufacturability of the components, without necessitating a departure from the proven sheet-metal shell structure. A new cross-section at the window frame achieves high rigidity and good manufacturability; there are only 2 parts and dimensions are minimized. In this way, the intensive form language typical of BMW's exterior lines is carried over into the material aluminum, bringing dimensional minimization to the visually sensitive area of the window frames and utilizing high deep-draw depths to preclude the possibility of taking up more space.

As regards the interior parts of the doors, it is noticeable that unlike the E65, there are no airbags in the door trim. Again at variance with the E65, the outside mirrors can be removed without the necessity of removing the door trim.

The sound-deadening mats and the fasteners for the wiring harness in the door are also of new design. The installation and removal of the exterior door handle are slightly more difficult than is the case with the E65.

Window lifts and locks are similar to those of the E65. A new roller sunblind is a feature of the rear door. The mounting elements are of modified design.

Interior Equipment

The interior of the F01/F02 has evolved again beyond that of the E65/E66. There is more knee-room for the rear-seat passengers. The same also applies to headroom in the rear. By the same token, the steering column adjusts over a longer range than in the predecessor model.

Interior equipment, F01/F02

The following are available for stowage inside the passenger compartment:

- Oddments tray with hinged lid on the left beside the steering column
- Folding-lid compartment in center console with mobile-phone adapter
- Large glove box
- DVD changer in directly accessible compartment with lid
- Large pockets in the doors.

The driver assistance systems available are:

- Head-up display
- Night Vision II
- ACC
- Lane-departure Warning and Active Blind Spot Detection

An improved multimedia interface offers even more convenience and additional freely programmable buttons.

The F01/F02 offers perceptible driver orientation, for example gear-selector switch, actuating switch for the electromechanical parking brake and drive-dynamics switch in the center console.

The passenger compartment also features multimedia functions such as USB, hard-disc drive and multimedia changer (including DVD). A slimmer instrument panel without emphatic double dome over the instruments expresses the higher tone. Similarly, there is no slot for the ignition key (I.D. transmitter) Passive Go is now standard.

Seats

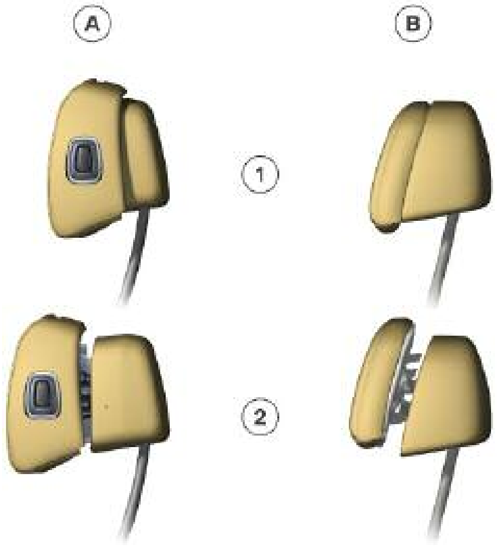
The front seating on the F01 consists of the multifunction seats. This seat features a side airbag integrated into the seat backrest.

If the Rear Seat Entertainment option is installed the backrest head of each front seat has a rear-facing monitor set in the rear. Ambience lights for the rear compartment are also set in the back panel of each front seat.

The seat-adjustment switches have been relocated and are now back on the seats themselves, whereas the seat function switches are again set in the door trim.

The front seat features crash-active headrests. There is also a choice between basic and high versions for the rear seats.

Crash-active headrest, basic seat/multifunction seat



Index	Explanation	Index	Explanation
1	Comfort precision advance	A	Basic seat
2	Crash advance	B	Multifunction seat

The “Comfort seat, rear” is available as part of the “Luxury Rear Seating” package only in the F02. The comfort seat is a two-seat configuration for more passenger comfort . Between the seats there is a small console with a storage compartment and lid.

The center armrest has a recess cover. The cover moves into position to cover the recess when the armrest is extended. There is also a cupholder integrated into the center armrest.

Complete seat system, rear comfort seats

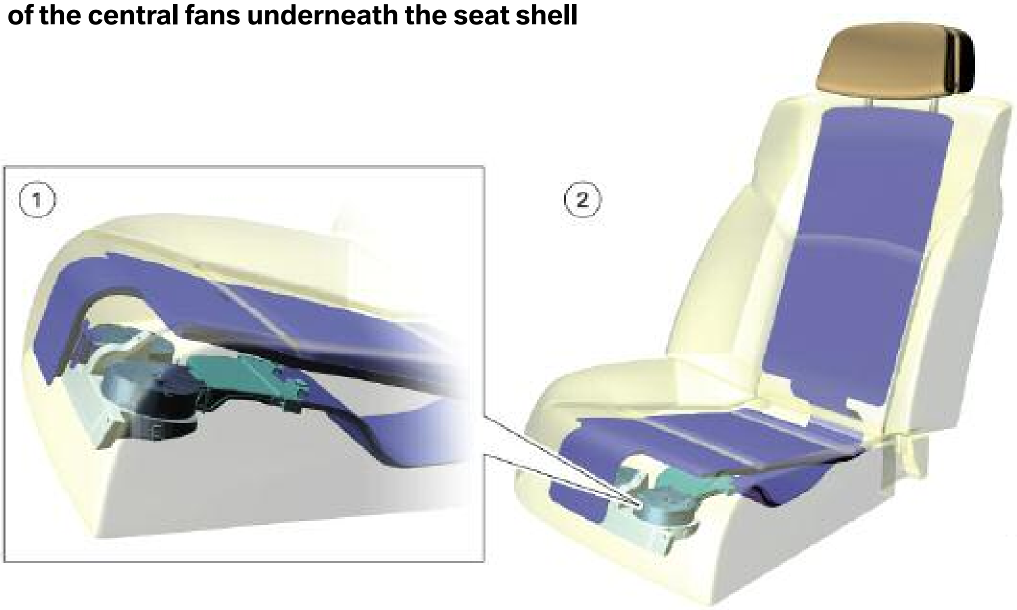
Index	Explanation	Index	Explanation
1	Console with storage compartment	3	Center arm rest with recess cover
2	Cupholder		

The rear luxury seating package includes the rear seat ventilation system which directs air to different parts of the seat. This is accomplished by air mats perforated at defined points to direct the air to the seat occupant’s body.

The cooled air is drawn in from the passenger compartment at the bottom of the B pillar. This new concept has a significantly better cooling effect than the configuration in the E65, especially in hot climates.

The diverse individual fans in the acclimatized seat of the E65 are replaced by two central fans per seat. These fans draw in air cooled air from the passenger compartment through the shared box.

Location of the central fans underneath the seat shell



Index	Explanation	Index	Explanation
1	Location of the two central fans underneath the seat shell	2	Ventilation mats for seat cushion and backrest

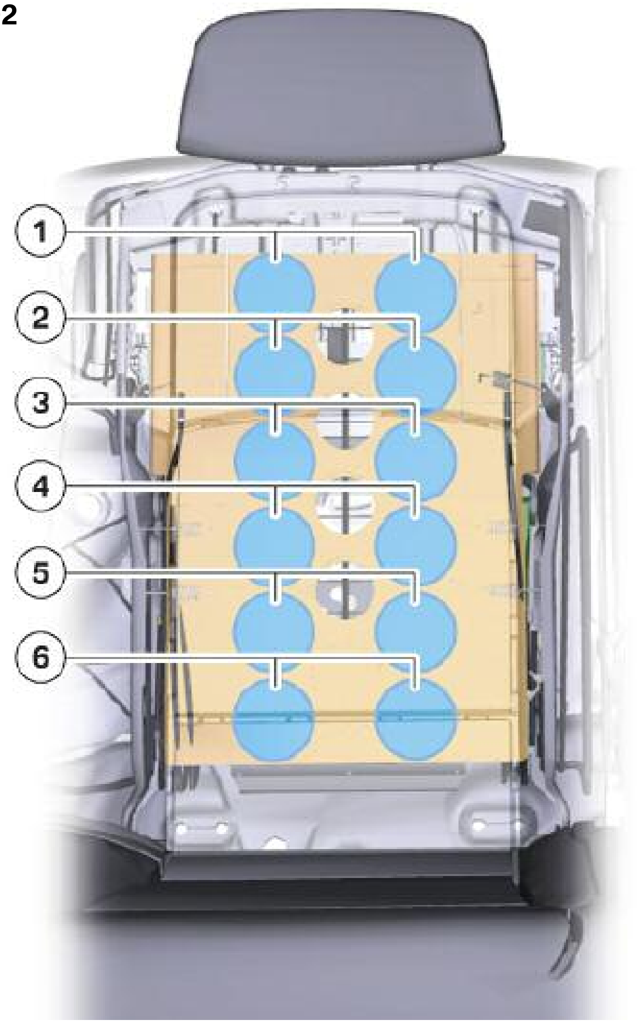
The fans blow air toward the seat occupants. Fan speed varies as a function of the seat's surface temperature.

The rear massage seat is a new optional extra. 12 inflatable massage pads relax the musculature of the seat occupant's back with a wavelike downward massaging action. The rotary mobilization function is produced by 6 pads. These pads are set in the outer-shoulder area and in the middle of the thorax and in the lower lumbar region.

To achieve segment rotation, the left shoulder pad is inflated with the right lumbar pad and the left thorax pad. This changes periodically with the opposite set of pads.

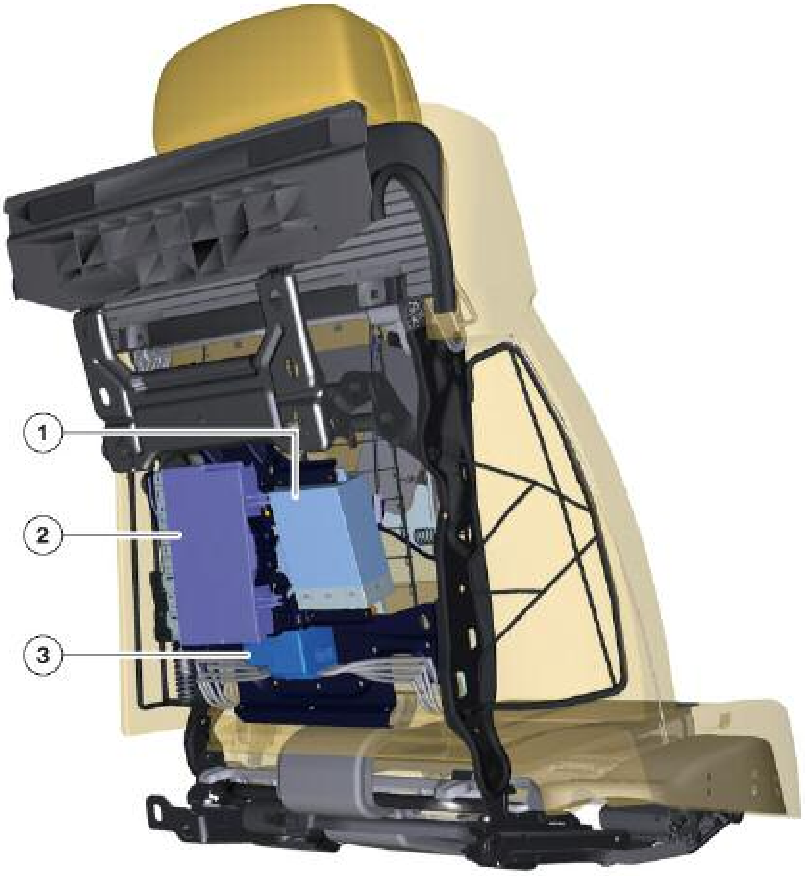
A complete massage cycle takes 64 seconds, then the process starts again at the beginning.

Massage seat, F01/F02



Index	Explanation
1-6	Massage pad

Pressure distribution module, F01/F02



Index	Explanation	Index	Explanation
1	Lumbar pump	3	Pressure distribution module, massage pads/lumbar support
2	Seat module		

Electric backrest tilt and seat-length adjustment and backrest-head and headrest lifter round off the technical features of these seat versions for the rear passengers.

Even the rear-seat passengers of the F01/F02 can enjoy the comfort of the lumbar-support adjustment option.

Comfort seat, rear

Index	Explanation	Index	Explanation
1	Memory buttons	2	Button for seat adjustment functions

The impression of space in the rear of the F02 is improved considerably by comparison with the E66, on account of the multifunction seat and the rear air-conditioning system.

By the same token, the ambience enjoyed by the rear-seat passengers reflects the most exacting standards. This starts with the vanity mirror in the headliner, continues through the controls for the rear-seat air-conditioning system through to the 9” screens and DVD drives that are standard with the Rear Seat Entertainment optional extra.

These screens are set in the backrests of the front seats.

The Controller and numerous other secondary controls are set in the rear center armrest. In conjunction with the ambience lights package, these features combine to give a higher feeling of sumptuous luxury even than the E65.

Belt System

The F01/F02 has electric belt reels (EMA) for the driver's and front passenger's seat belts. In this arrangement the B pillar accommodates an electric motor with control unit. This is an automatic belt reel with a motor/gear unit.

Seat belt with electric reel

Index	Explanation	Index	Explanation
1	EMA control unit	3	Automatic reel
2	Electric motor	4	EMA gear unit

The EMA offers two functions:

- Comfort function Belt slack is taken up when the seat occupant buckles the belt: the electric motor reels in the slack to tighten the belt
- Pre-crash function In a hazard situation the occupant is brought to the crash position at which the restraint systems can operate at maximum efficiency. This function is reversible.

Luggage Compartment

At 500 liters, luggage-compartment capacity is the same as that of the E65.

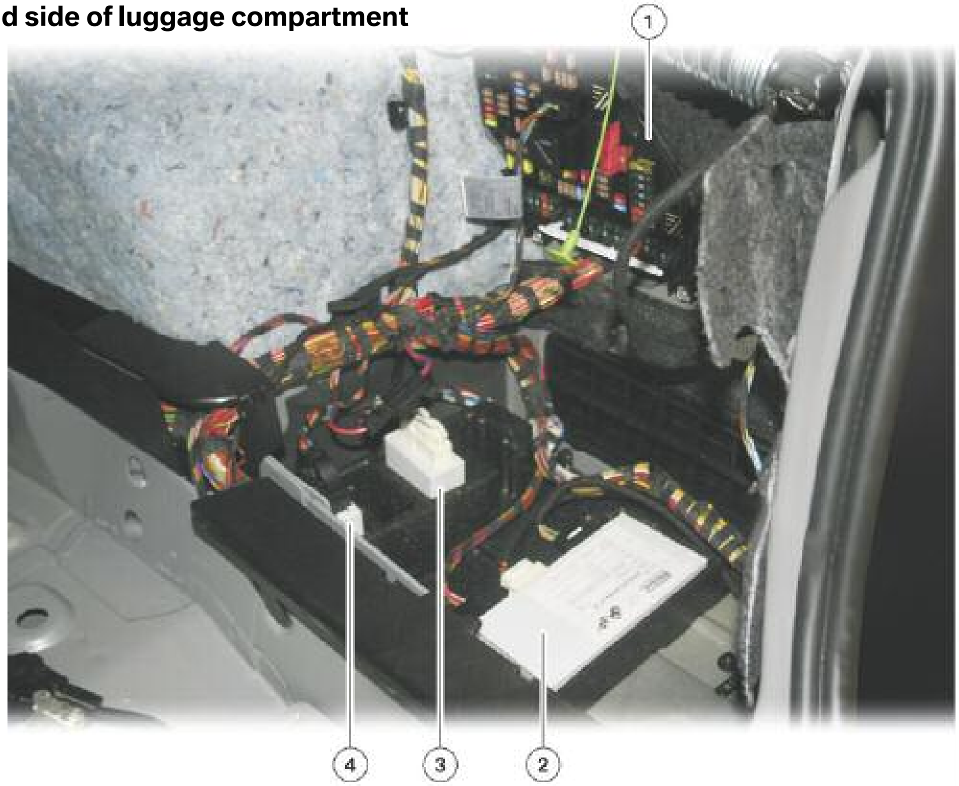
The following luggage-compartment versions are available:

- Luggage compartment with rear-compartment air conditioning and cool box
- Luggage compartment with cool box
- Luggage compartment with rear-compartment air conditioning
- Luggage compartment without rear-compartment air conditioning/and without cool box. In this configuration the capacity of the luggage compartment has a capacity of 500 liters.

It will accommodate 1 medium-sized and 2 small cases and a cosmetic case. Alternatively, 4 golf bags or 2 pairs of skis or 1 snowboard can be transported.

The are compartments with storage trays underneath and a height-adjustable net offer practical possibilities for stowage. The toolkit and warning triangle are now again stowed in the luggage compartment lid.

Right-hand side of luggage compartment



Index	Explanation	Index	Explanation
1	Power distribution box, rear	3	Not for US market
2	HKL control module	4	Not for US market

The power distribution box, the control unit for the luggage compartment lid lift (HKL) and the rear-axle pneumatic springs (EHC) are also on the right-hand side of the luggage compartment.

Left-hand side of luggage compartment

Index	Explanation	Index	Explanation
1	Not for US market	4	HiFi Amplifier
2	Telematics Control Unit	5	Sideview control module (TRSVC)
3	Fan		

The HiFi amplifier, the sideview control unit as well as the changeover valve for the exhaust-flow control are located on the left hand side along with the M-ULF High, TCU and Combox .

Middle of luggage compartment

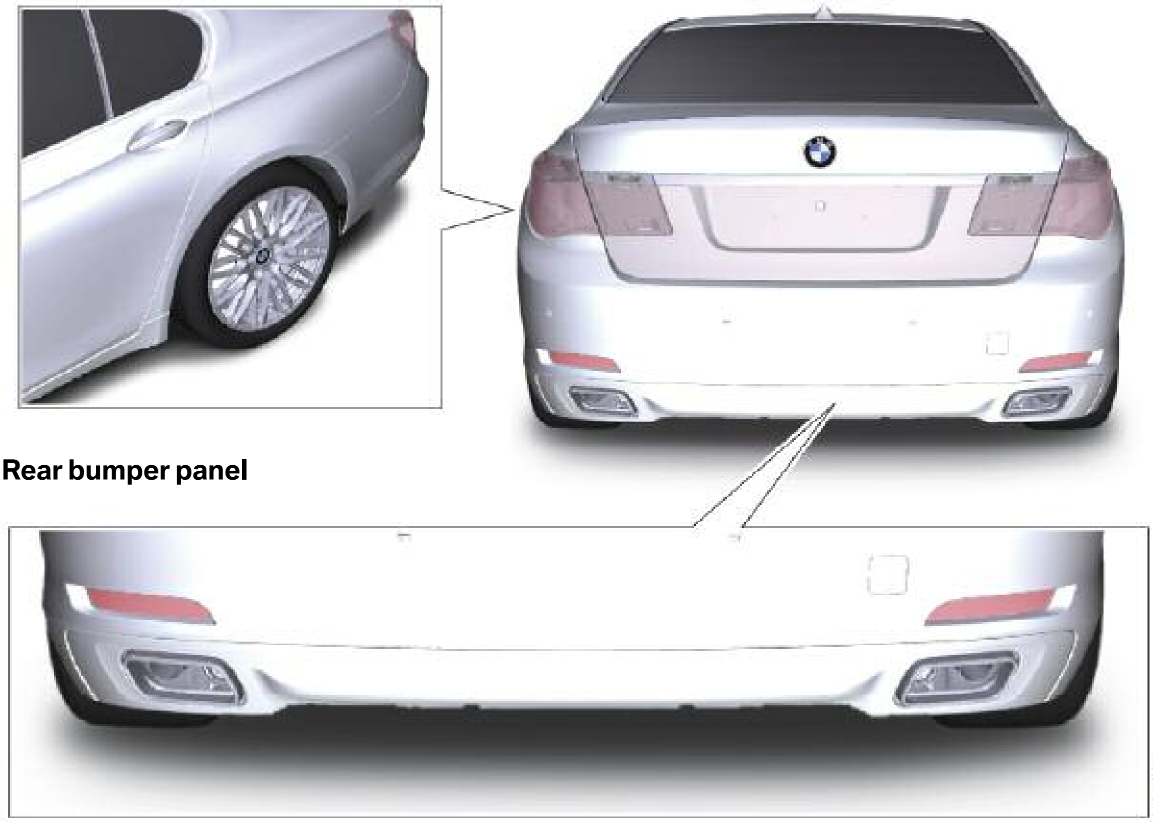
Index	Explanation	Index	Explanation
1	Power distributor, battery	3	EKP module
2	Battery 90Ah		

The battery, the EKP and HSR control units (HSR, rear axle angle control) are all in the and the luggage-compartment. This is also where the cut-off relay for the electric fans and the luggage compartment antennas for the Passive Go system are located.

Rear Bumper

The bumper panel of the rear bumper is a no-gap fit to the side frame. The reflectors are integrated into the bumper panel. The bottom part of the panel is also finished in the body color. Chrome-plated stainless steel end-silencer covers are integrated into the bottom part of the bumper panel.

Model differentiation is carried though by various details for the 8-cylinder and the future 12-cylinder power plants. An extra chrome finisher for the 12-cylinder emphasizes the top-of-the-line engine.



Rear bumper panel

The bumper panel's overhang past the luggage compartment lid is minimal in combination with the finisher panel for the luggage compartment lid. There is a seamless transition between rear-light unit and bumper panel.

The bumper carrier (with the shock absorber) is bolted to the bodyshell structure. It can absorb low-speed impacts without damage to the bodywork (at least 2.5 mph).

The bumper system is a consumer-protection-complaint design that prevents damage to the car's body structure. Deformation elements specifically designed for the purpose make for low repair costs.

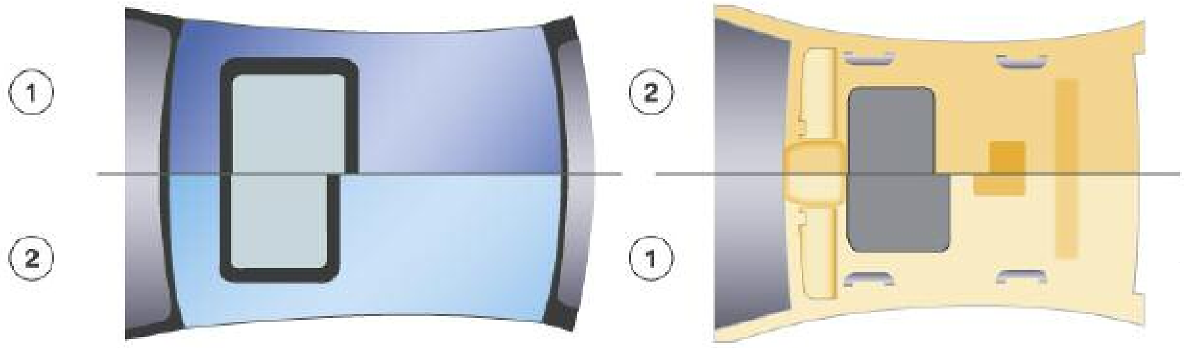
Slide/tilt Sunroof

The F01/F02 has an evolved sliding sunroof system, known as the contour roof.
The contour roof has a larger area of glass than a conventional sliding sunroof system, so it contributes positively to the interior effect and to the feeling of space inside the car.

The headliner panel is electrically operated, and since this means that there is no grip in the panel the impression of interior space is even further enhanced, because the sliding headliner panel now integrates into the interior design of the headliner as a homogeneous surface, underscoring the premium luxury effect.

When we turn our attention to the exterior we see that the design integration of the glass into the car's skin is effected by the contour curvature of the glass sunroof. At its leading edge, it is oriented in parallel with the leading edge of the roof at the transition to the windscreen, contributing to the harmonic appearance of the car as a whole.

In order to maintain a pleasant level of background noise with the glass sunroof fully open, the contour roof features a speed-dependent combination slipstream deflector.



Index	Explanation	Index	Explanation
1	Contour roof	2	Standard, slide/tilt sunroof

The contour roof features an inside-mount slide/tilt sunroof. Glass panel, sliding headliner panel and combination slipstream deflector are all-electric and are operated by a switch set in the roof-functions overhead console (FZD), in line with BMW's usual control and operation logic for the sliding sunroof:

- To open the roof -> Push the switch to the rear
- To close the roof -> Push the switch forward
- Set roof to vent position -> Push the switch up.

The operation and control logic for opening the sliding headliner panel is analogous to that familiar from the BMW panorama-roof configurations. The direction in which the control is moved corresponds to the direction in which the component is to be moved, so this logic is easy for customers to grasp.

To exclude the risk of possible injury, the entire range of movement of the glass roof panel and the sliding headliner panel has a trap release function with a special electronic controller in accordance with international legal requirements.

When the glass sunroof panel and the sliding sunroof panel are both fully closed, the material of which the sliding sunroof panel is made keeps the background noise level on a par with that of a car with normal roof.

The combination slipstream deflector can move to either of 2 possible positions, depending on the speed of the car, positively influencing the aero-acoustics of the car when the glass sunroof panel is fully open. This effectively reduces the annoying low-frequency “blattering” that can occur in the speed range around 70 km/h (43 mph), as well as the high-frequency whine that is typical at speeds around 120 km/h (75 mph).

Dimensions

- Glass panel length: 601 mm
- Glass panel width: 919 mm

Aperture size

- Glass panel fully open: 390 mm

Glass panel in vent position

- Vent gap of glass panel: 19 mm
- Vent gap of sliding sunroof panel: 80 mm

The contour roof is moved by 2 electric Glass panel in vent position motors.

Table of Contents

F01 Powertrain

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Powertrain

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Identify components related to the F01 powertrain
- Understand changes to the N63 engine
- Understand transmission related changes on the F01

Introduction

The New Flagship

As ever, developing a new 7 Series is a special challenge because this vehicle represents the pinnacle of technical achievement and, in this class, the demands placed on a wide variety of qualities are particularly high. During this development, we were faced with having to outdo not only the competition but also an excellent predecessor.

The drive train was particularly challenging in this respect. Here, superior dynamics meet ultra-smooth performance. Increasingly, however, fuel economy is also playing an ever more important role. And this is exactly where the “Efficient Dynamics” development strategy comes in. It combines improved driving performance with reduced fuel consumption.

The F01/F02 sets new standards in all of these areas. “Efficient Dynamics” is a strategy that aims not to find a compromise, but to achieve the best of all worlds.

Drive Train Variants

At the time of market launch, the models of the 7 Series will be available with the following drive train variants:

F01/F02	750i/750Li
Engine	N63B44O0
Power output [kW/bhp]	300/400
Torque [Nm]	600
Exhaust emission standard	ULEV II
Gearbox	GA6HP26TU
Rear axle differential	Rear diff 225AL
Final drive ratio	3.462:1

Modifications as compared to the predecessor

This document describes the modifications to the F01 drive train by comparison with its predecessor, the E65. New or modified systems and components are also explained.

The following table shows an overview of the changes/modifications relative to the E65. Their descriptions are distinguished by various categories:

- New development denotes a new technology that has never before been used at BMW.
- Change denotes a component that was specifically developed for the F01 engine but does not represent a technological innovation.
- Carry-over denotes a component already fitted in other BMW models

Component	New development	Change	Carry-over	Remarks
N63B44O0 engine			●	The N63 engine fitted to the E71 has now been carried over to the F01/F02. Only the intake air duct and the exhaust system are vehicle-specific, and the engine management is now connected to the FlexRay.
Fuel preparation	●			Fuel preparation has been further improved in the area of the breather system. At the same time, the security against escaping fuel or fuel vapors has been further increased.
Automatic transmission			●	The 6HPTU has been carried over from the E70. On the F01/F02, too, the transmission is now controlled using the gear selector switch also adopted from the E70.
Rear axle differential	●			The F01/F02 are equipped with new final drives. It is the first time that BMW has fitted rear differentials having an aluminum casing. They have also been optimized for low-friction operation.
Shafts		●		The propeller shaft has a push-fit connection to the rear axle differential as it does on the E70. For the first time, this connection has a flexible coupling. The drive shafts have a push-fit connection at both the differential end and at the wheel end. Both hollow and solid shafts are used.

N63B44O0 Engine

The 750i/Li also underwent a series of downsizing measures, although its increased power output is more immediately obvious than its reduced engine capacity.

The N63 engine makes use of the same technology for mixture preparation as the N54 engine, i.e. twin-turbochargers and High Precision Injection (HPI) operating permanently in homogenous mode.

The engine is relatively new to the market. It was introduced in May 2008 under the hood of the X6 xDrive50i, where it would deliver breathtaking performance.

N63 engine

The N63 engine's most extraordinary feature has to be the location of its turbochargers - in the engine valley - hence the arrangement of the cylinder heads where the hot exhaust side is turned inwards. It is the first automobile gasoline engine in the world to have such an arrangement.

By positioning the turbochargers and the catalytic converters in the engine valley, it was possible to make optimum use of this space to bring essential turbocharging components together.

Consequently, only the relatively small intake manifolds (due to turbocharging) are present on the outside of the engine. This enables the engine to be integrated into a range of different vehicle and drive train concepts without any major modifications being required.

Particular challenges are faced, however, in the cooling system and charge-air line.

Vehicle-specific Modifications

The N63 is a relatively new engine. For use in the F01/F02, hardly any modifications were required.

The following components were adapted:

- Oil sump
- Intake air duct
- Exhaust system
- Cooling system
- Engine electrical system.

Technical Data

Model Vehicle	750i/Li E65/E66	750i/Li F01/F02
Engine	N62B48O1	N63B44O0
Engine type	V8	V8
Displacement [cm3]	4799	4395
Stroke/bore [mm]	88.3/93	88.3/89
Output at engine speed [kW (bhp)] [rpm]	270 (367) 6300	300 (407) 5500
Torque at engine speed [Nm] [rpm]	490 3400	600 1750
Compression ratio [ ]	10.5	10.0
Fuel specification [RON]	98	98
Fuel [RON]	91 - 98	91 - 98
Digital motor electronics	ME9.2.2	MSD85
Exhaust emission standard	ULEV II	ULEV II
Acceleration 0-100 km/h (0-62mph) [s]	5.9/6.0	5.2/5.3

Air Intake and Exhaust System

Intake Air Duct

The intake air duct in the F01/F02 differs negligibly from that of the E71. In the interests of space-saving, the unfiltered air duct has been relocated. Now air is taken in from the side of the BMW kidney grille. Also evident is the one resonator on each of the two unfiltered air pipes. The upper section of the intake silencer has also undergone a vehicle-specific modification.

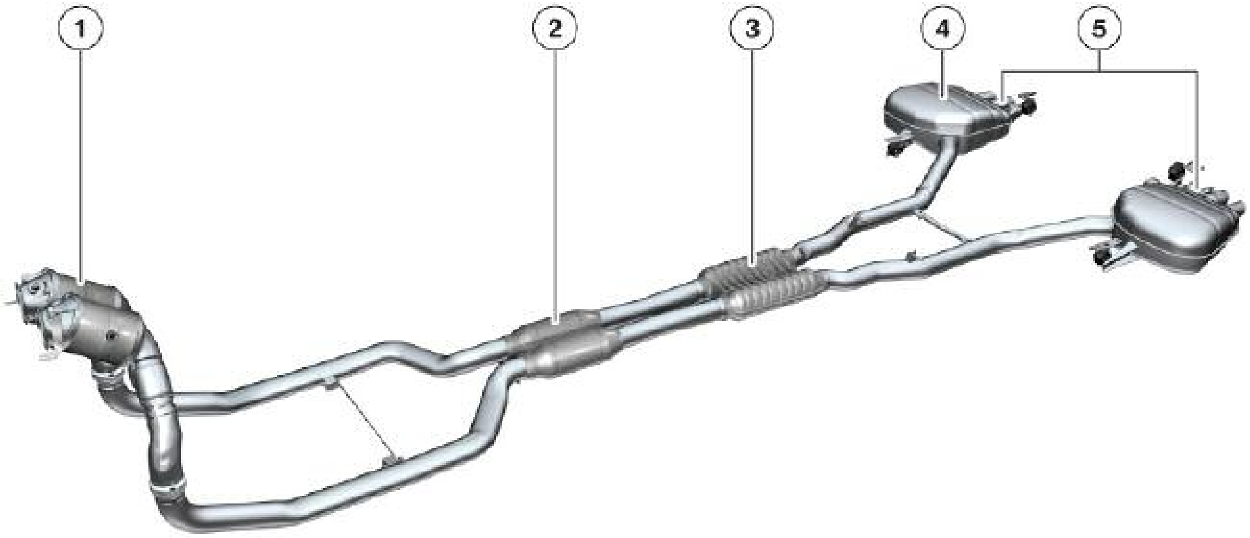
Index	Explanation	Index	Explanation
1	Unfiltered air intake	4	Intake silencer
2	Unfiltered air resonator	5	Hot-film air mass meter
3	Unfiltered air pipe	6	Purified air pipe

Exhaust System

When designing the dual outlet exhaust system in the underbody area, our development engineers focused on achieving optimum pipe routing and the optimum pipe diameter.

The design of the silencers meets the high demands for low noise levels in this vehicle class. Jutting out of each of the two rear silencers are two tailpipes, each of which contains an exhaust flap. The exhaust flaps are map-controlled by the DME, making it possible to achieve the sound behavior you would expect from the vehicle.

Exhaust system of the N63 engine



Index	Explanation	Index	Explanation
1	Catalytic converter	4	Rear silencer
2	Front silencer	5	Exhaust flaps
3	Center silencer		

With the E71, this was characterized by high load feedback, i.e. a powerful V8 sound under acceleration, settling down to a more comfortable noise level during constant speed travel. In the tuning of the F01/F02, we accomplished a V8 sound that meets the high demands for comfort in this vehicle class.

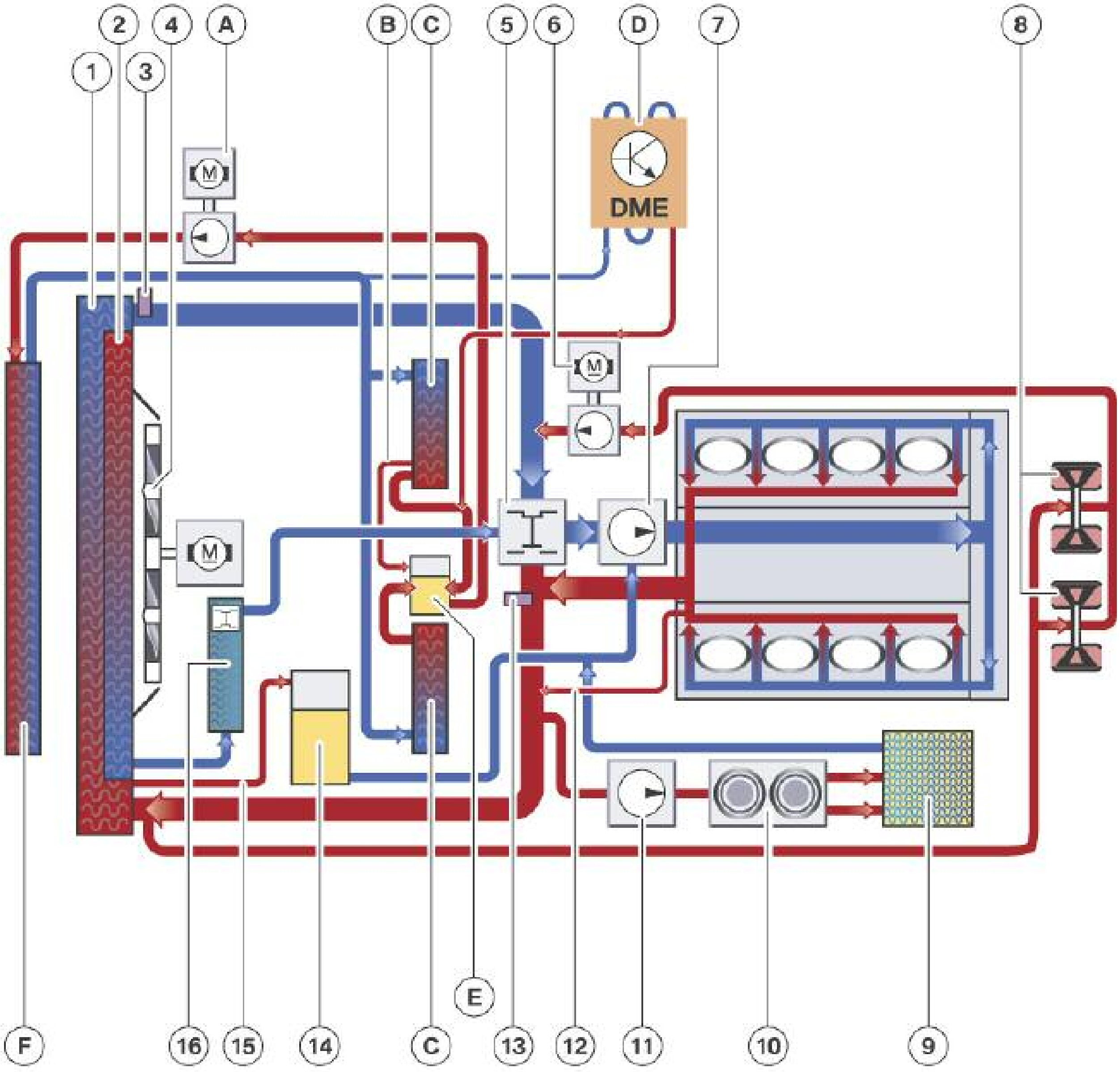
The F01/F02 fully complies with the ULEV II emission standards. Connected downstream of the turbochargers are the near-engine catalytic converters. The exhaust system is dual pipe design throughout. There are two front silencers, one center silencer and two rear silencers.

The four tailpipes project into two chrome trims integrated into the rear apron.

Cooling System

In principle, the complex cooling system of the N63 engine is a carry-over from the E71. Nevertheless, there are a few differences:

- no separate auxiliary coolant radiator
- engine oil radiator to the front of the left-side wheel housing
- there is an additional engine oil radiator to the front of the right-side wheel housing
- liquid-cooled engine control module.

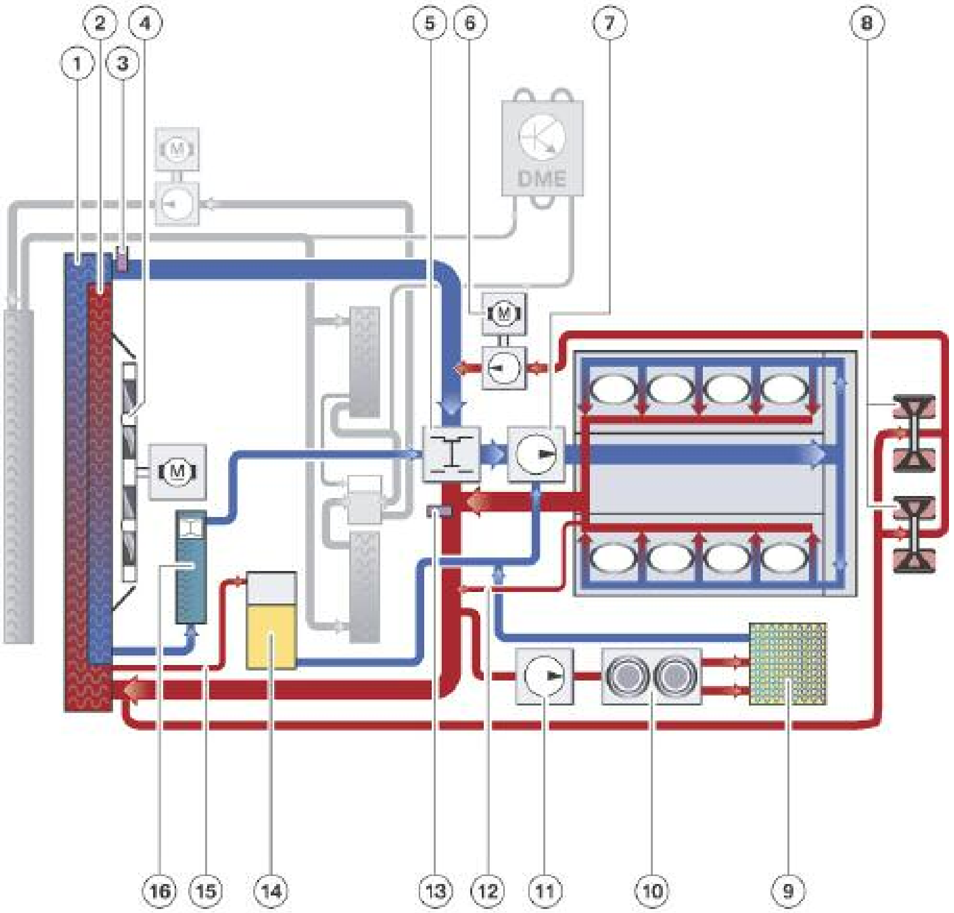


Cooling system of the N63 engine in the F01/F02

Index	Explanation	Index	Explanation
1	Radiator	12	Bleed line
2	Radiator for transmission cooling	13	Coolant temperature sensor at engine outlet
3	Coolant temperature sensor at radiator outlet	14	Expansion tank
4	Electric fan	15	Bleed line
5	Characteristic map thermostat	16	Transmission fluid-to-coolant heat exchanger
6	Electric auxiliary coolant pump for turbocharger cooling	A	Electric coolant pump for charge air cooling
7	Coolant pump	B	Bleed line
8	Exhaust turbocharger	C	Charge-air cooler
9	Heating heat exchanger	D	Digital motor electronics (DME)
10	Duo-valve	E	Expansion tank for charge air cooling
11	Electric auxiliary coolant pump for vehicle heating	F	Radiator for charge air cooling

The cooling system comprizes two separate cooling circuits as it did before. One cools the engine, one cools the charge air. For a clearer overview, the two cooling circuits are illustrated separately on the pages that follow.

Engine Cooling



Cooling circuit of the N63 engine in the F01/F02

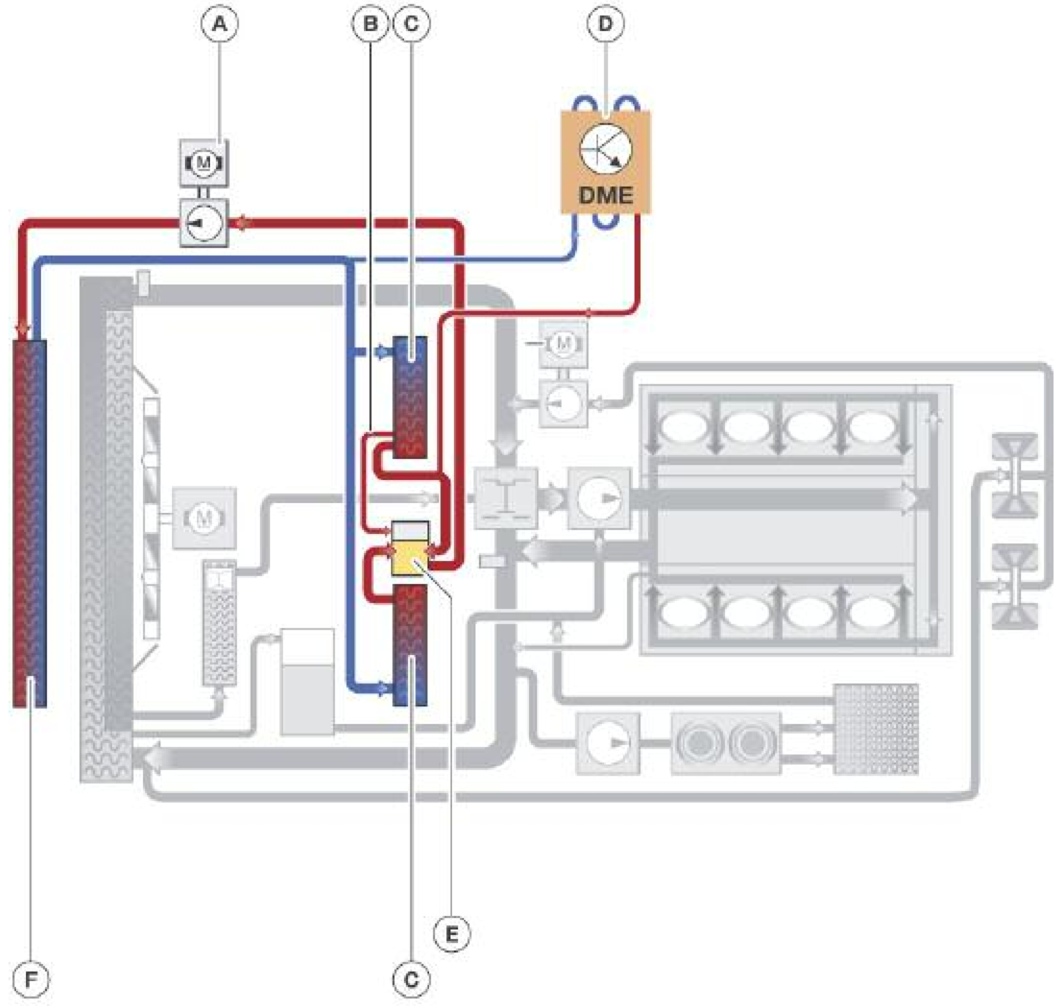
Index	Explanation	Index	Explanation
1	Radiator	9	Heating heat exchanger
2	Radiator for transmission cooling	10	Duo-valve
3	Coolant temperature sensor at radiator outlet	11	Electric auxiliary coolant pump for vehicle heating
4	Electric fan	12	Bleed line
5	Characteristic map thermostat	13	Coolant temperature sensor at engine outlet
6	Electric auxiliary coolant pump for turbocharger cooling	14	Expansion tank
7	Coolant pump	15	Bleed line
8	Exhaust turbocharger	16	Transmission fluid-to-coolant heat exchanger

For the most part, the layout of the N63 engine cooling circuit in the F01/F02 corresponds to that of the E71. The only obvious difference is that no auxiliary coolant radiator is used in the F01/F02. This is made possible by the use of high-performance coolant radiators. These also have a more compact height, which is essential when it comes to pedestrian safety.

As usual, the coolant radiator has an integrated low-temperature section for transmission cooling. Thanks to the on-demand control of the electric fan, the characteristic map thermostat and the electric auxiliary coolant pump, we were able to realize a thermal management system that yields benefits in terms of fuel economy, comfort and power output.

The entire cooling module and the engine oil radiator and its lines are decoupled from the body in order to optimize sound characteristics in the passenger compartment.

Charge Air Cooling



Index	Explanation	Index	Explanation
A	Electric coolant pump for charge air cooling	D	Digital motor electronics (DME)
B	Bleed line	E	Expansion tank for charge air cooling
C	Charge-air cooler	F	Radiator for charge air cooling

As it did in the E71, the turbocharged N63 engine operates with an indirect form of charge air cooling. Heat from the charge air is transferred to the coolant, then the hot coolant radiates heat into the ambient air. There is a dedicated coolant circuit for this function. In the F01/F02, the cooling for the DME is also integrated into this coolant circuit. For the first time at BMW, the engine control unit is liquid-cooled.

Engine Electrical System

Engine Control Unit

In the F01/F02, too, the N63 engine is controlled by the MSD85 as is the case in the E71. This control unit has been modified to make it compatible with the FlexRay used in the F01/F02.

As with the other engine variants, the control unit is located to the front of the right-side spring strut dome. By contrast with the other two engine variants, however, this control unit is liquid-cooled rather than air-cooled.

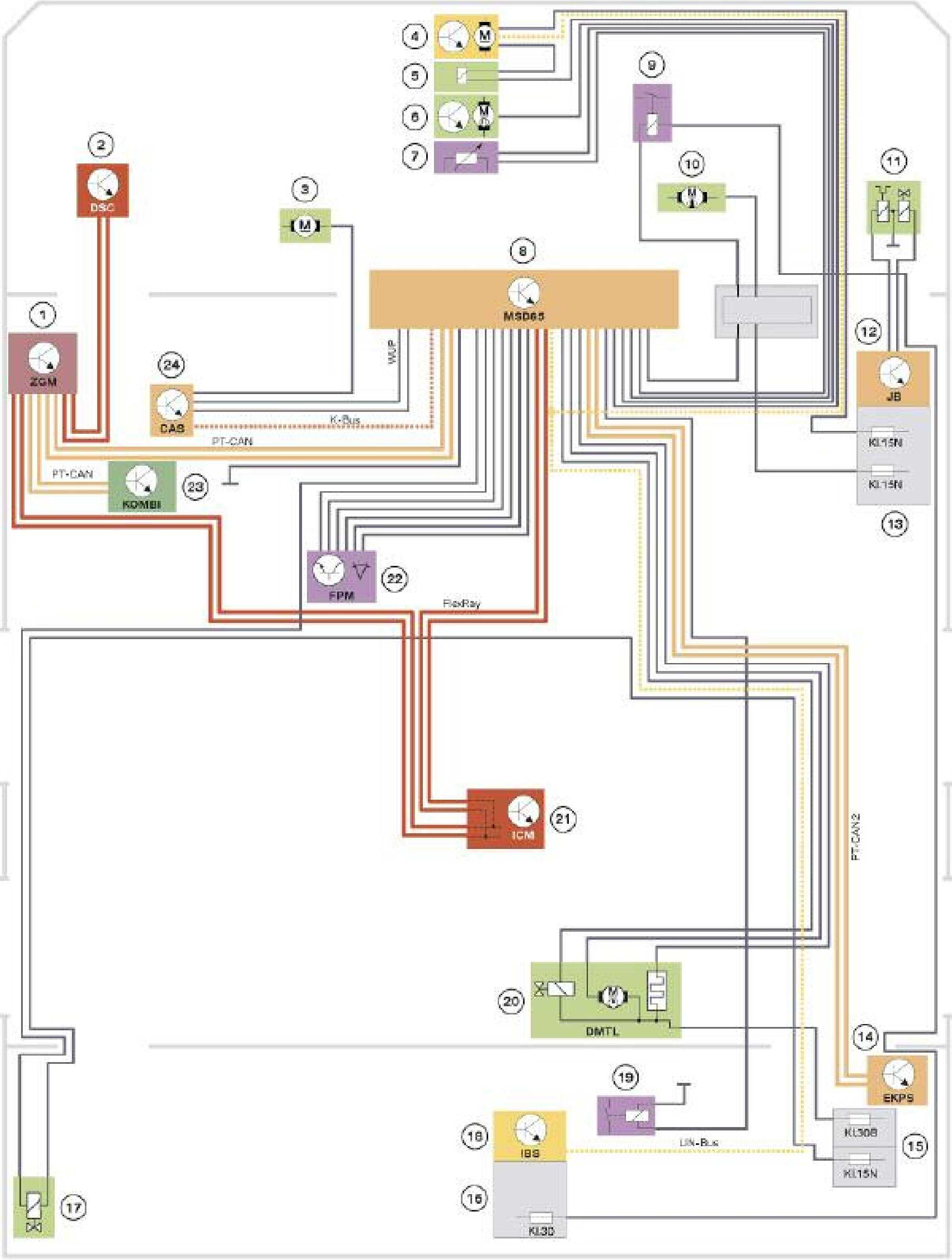
Cooling of the engine control unit of the N63 engine

Index	Explanation	Index	Explanation
1	Sealing frame	5	Coolant line
2	Electronics box cover	6	Engine control unit
3	Coolant return	7	Electronics box
4	Coolant supply		

For this purpose, the housing of the control unit features two windings in the one coolant line, which is connected to the low temperature cooling circuit for charge air cooling.

The lower section of the electronics box is open to the outside. The upper section, which contains the connections, has a watertight seal.

System Overview



Connection of the N63 engine to the on-board network

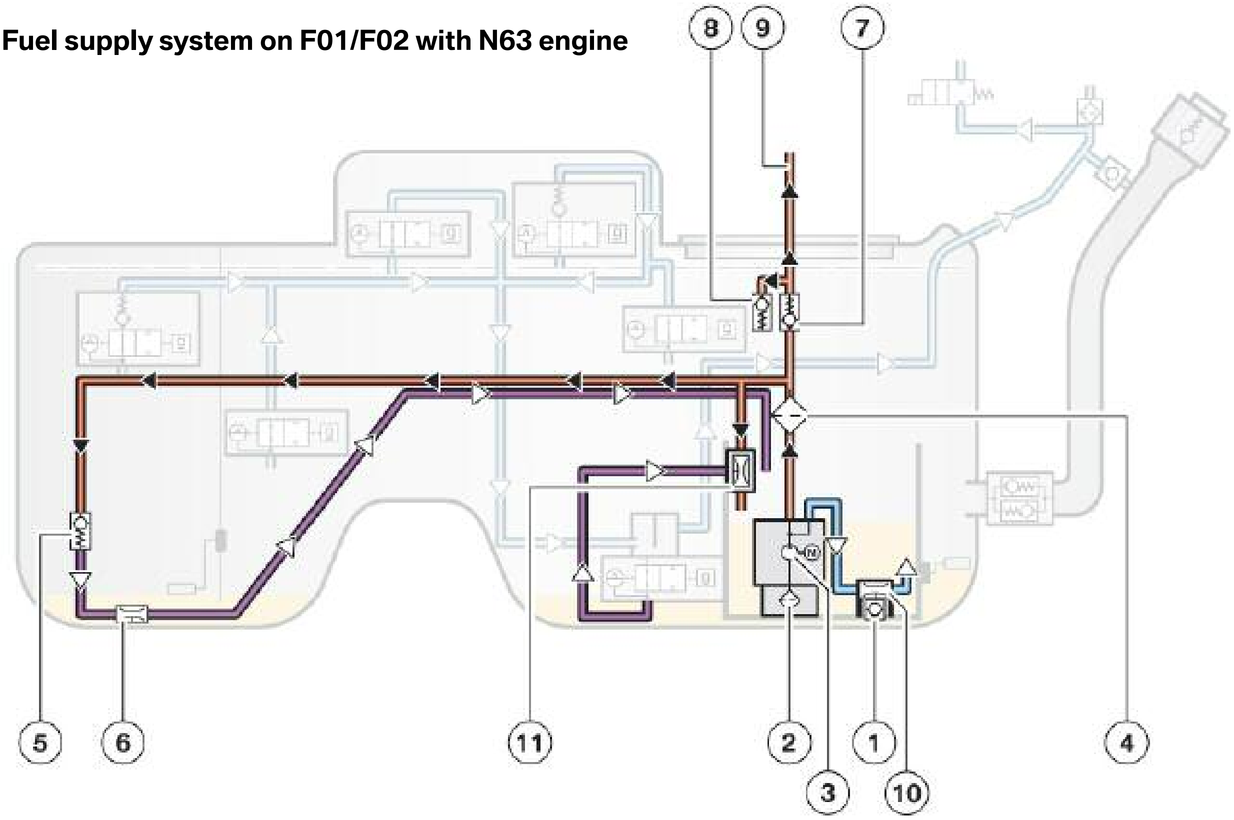
Index	Explanation	Index	Explanation
1	Central gateway module	13	Junction box power distributor
2	Dynamic Stability Control	14	Electronic fuel pump controller
3	Starter	15	Power distributor, rear right
4	Active cooling air flaps	16	Power distributor, battery
5	Passive cooling air flaps	17	Exhaust flaps
6	Electric fan	18	Intelligent battery sensor
7	Coolant temperature sensor at radiator outlet	19	Electric fan relay
8	MSD85	20	Fuel tank leak diagnostic module
9	Electric auxiliary coolant pump for charge air cooling	21	Integrated Chassis Management
10	DME main relay	22	Accelerator pedal module
11	A/C compressor	23	Instrument cluster
12	Junction box electronics	24	Car Access System

Fuel Supply System

Due to the nature of the installation space in the vehicle, the fuel tank is divided into two chambers. The fuel supply system has two delivery units that are accommodated in the right and left fuel tank halves.

In the event of the surge chamber being completely empty, initial fill valve (1) enables fuel to enter the surge chamber during the refueling process.

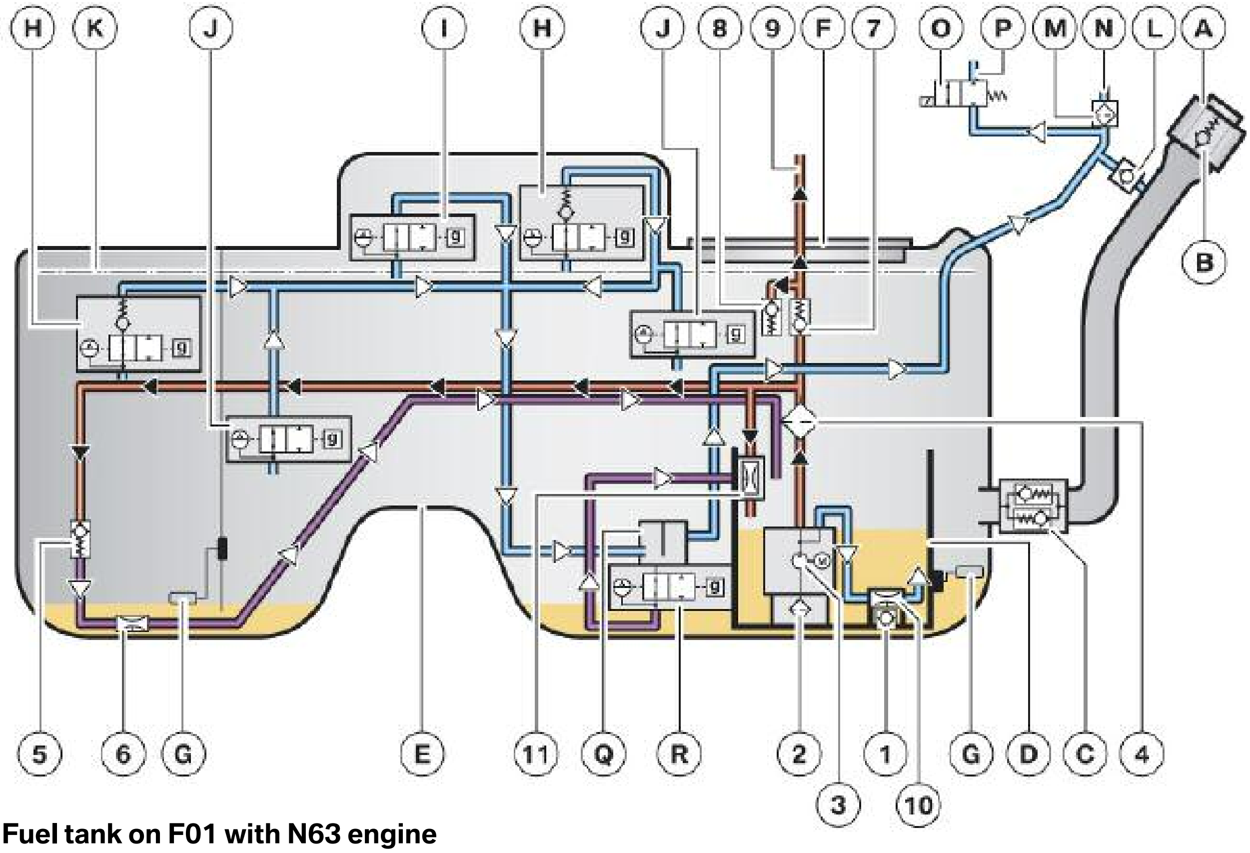
Fuel supply system on F01/F02 with N63 engine



Index	Explanation	Index	Explanation
1	Initial fill valve	7	Anti-leak valve
2	Intake mesh filter	8	Pressure limiting valve
3	Fuel pump	9	Feed line
4	Fuel filter	10	Suction jet pump
5	Non-return valve	11	Suction jet pump
6	Suction jet pump		

Fuel Supply System for the N63 Engine

System Overview



Fuel tank on F01 with N63 engine

Fuel passes through suction strainer (2) and enters fuel pump (3) and is then pumped to feed line (9) through fuel filter (4). The fuel pump resides in the surge chamber. A pressure limiting valve (8) is integrated into the feed line in the fuel tank.

For the first time for a gasoline engine, we are no longer using a pressure regulator. Instead, operation of the electric fuel pump is pressure-regulated. In response to the signal from the low-pressure fuel sensor, the speed of the electric fuel pump is adjusted to achieve the desired delivery pressure upstream of the high-pressure pump.

A further line branches off downstream of the fuel pump into the left half of the fuel tank and carries fuel from the left half into the surge chamber by way of a non-return valve (5) and suction jet pump (6).

Index	Explanation	Index	Explanation
A	Fuel cap	P	Purge air line
B	Pressure relief valve	Q	Fuel trap
C	Non-return flap with pressure relief valve	R	Roll-over valve
D	Surge chamber	1	Initial fill valve
E	Fuel tank	2	Intake mesh filter
F	Service cover	3	Electric fuel pump
G	Lever-type sensor	4	Fuel filter
H	Service breather valve with over fueling protection	5	Non-return valve
I	Filler breather valve	6	Suction jet pump
J	Service breather valve without over fueling protection	7	Anti-leak valve
K	Maximum fill level	8	Pressure limiting valve
L	Non-return valve	9	Feed line
M	Carbon canister (AKF)	10	Suction jet pump
N	Opening	11	Suction jet pump
O	Fuel tank vent valve (TEV)		

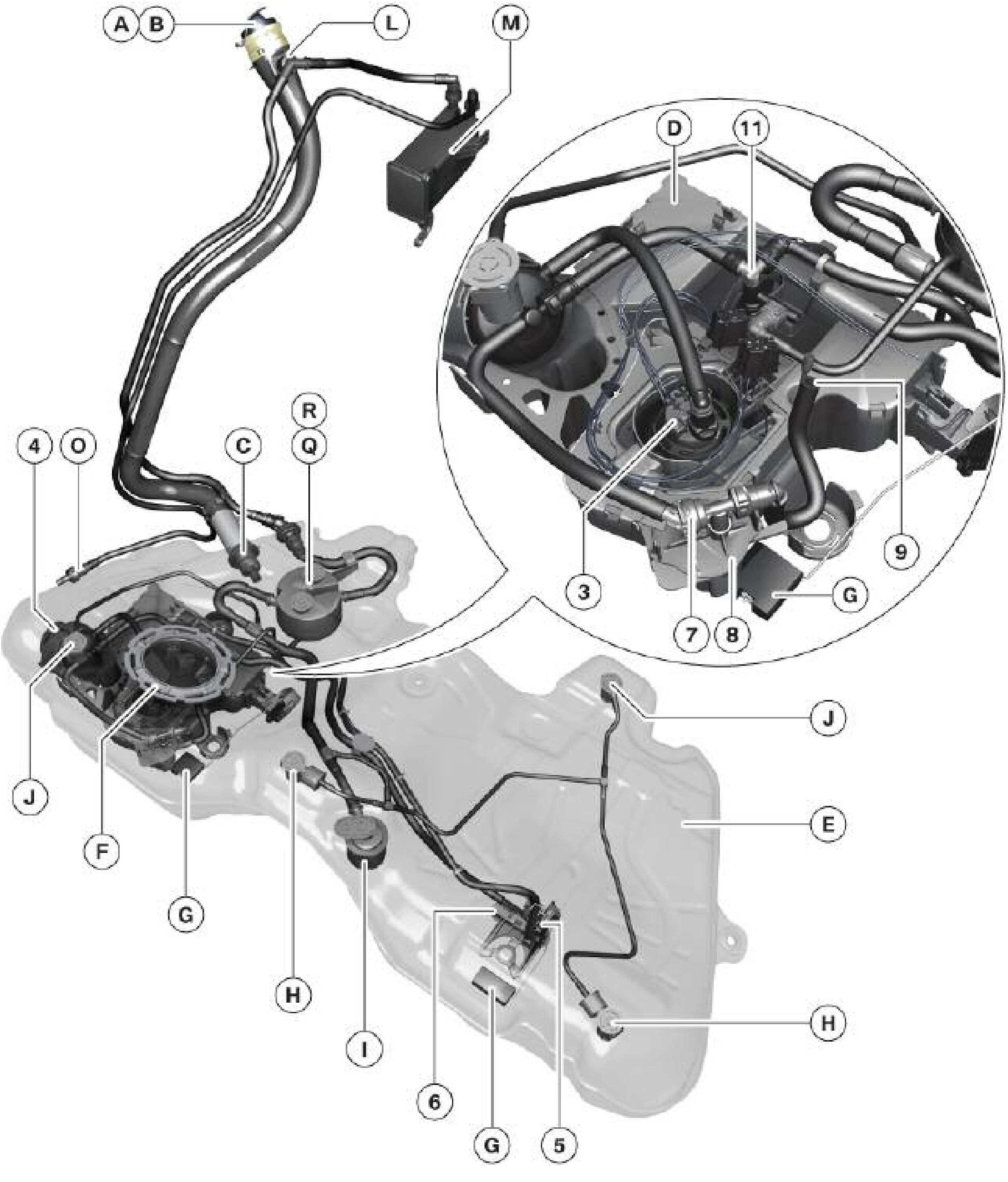
The non-return valve (5) prevents fuel from flowing back from the right half to the left half of the fuel tank while the engine is switched off.

When you switch off the engine, the feed line is depressurized but cannot run dry because, with the system being airtight, no air is able to enter the line. Anti-leak valve (7) prevents the fuel tank from leaking in the event of damage to the lines on the engine or underbody.

A further line en route to the left half of the fuel tank branches off to another suction jet pump (11), which sucks fuel out of the fuel trap and delivers it to the surge chamber.

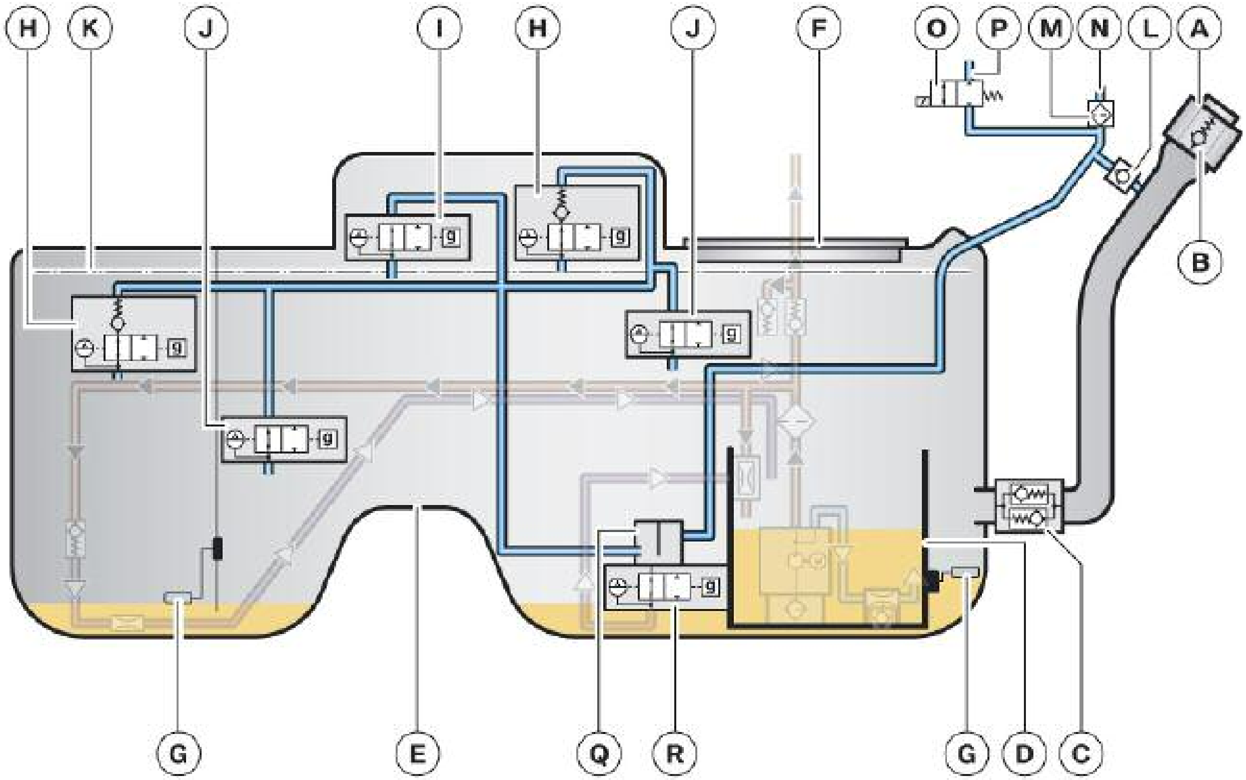
Another line exits the pump carrying fuel pumped from the fuel tank to the surge chamber by suction jet pump (10).

Fuel tank overview on F01 with N63 engine



Index	Explanation	Index	Explanation
A	Fuel cap	P	Purge air line
B	Pressure relief valve	Q	Fuel trap
C	Non-return flap with pressure relief valve	R	Roll-over valve
D	Surge chamber	1	Initial fill valve
E	Fuel tank	2	Intake mesh filter
F	Service cover	3	Electric fuel pump
G	Lever-type sensor	4	Fuel filter
H	Service breather valve with over fueling protection	5	Non-return valve
I	Filler breather valve	6	Suction jet pump
J	Service breather valve without over fueling protection	7	Anti-leak valve
K	Maximum fill level	8	Pressure limiting valve
L	Non-return valve	9	Feed line
M	Carbon canister (AKF)	10	Suction jet pump
N	Opening	11	Suction jet pump
O	Fuel tank vent valve (TEV)		

Fuel tank breather system and functions



Fuel tank breather system on F01/F02 with petrol engine

Index	Explanation	Index	Explanation
A	Fuel cap	J	Service breather valve without over fueling protection
B	Pressure relief valve	K	Maximum fill level
C	Non-return flap with pressure relief valve	L	Non-return valve
D	Surge chamber	M	Carbon canister (AKF)
E	Fuel tank	N	Opening
F	Service cover	O	Fuel tank vent valve (TEV)
G	Lever-type sensor	P	Purge air line
H	Service breather valve with over fueling protection	Q	Fuel trap
I	Filler breather valve	R	Roll-over valve

Fuel filler cap (A) has an integral pressure relief valve (B) to the protect fuel tank (E) from excess pressure. At the end of the fuel filler neck, there is a non-return flap with a pressure relief valve (C). The non-return flap prevents fuel from sloshing back into the fuel filler neck. The non-return flap is sealed closed by a spring. In the event of a build-up of pressure in the fuel tank, the pressure relief valve in the non-return flap ensures that the excess pressure can escape through the fuel filler pipe and out of the fuel filler cap through the pressure relief valve.

The components in the fuel tank are accessible through the service cover (F). The fuel level is detected by the two lever-type sensors (G).

The surge chamber (D) ensures that the fuel pump never pumps dry. The surge chamber is permanently connected to the fuel tank and cannot be replaced separately.

The F01/F02 has a whole range of breather valves in the fuel tank. In principle, all of these valves fulfil the breather function, both during vehicle operation and during refueling.

Despite this, they are named to reflect their main purpose. They are therefore divided into filler valves and service breather valves. The service breather valves have a smaller opening, which means that, during refueling, they alone would not be able to let air escape from the fuel tank fast enough. There are service breather valves with and without over fueling protection.

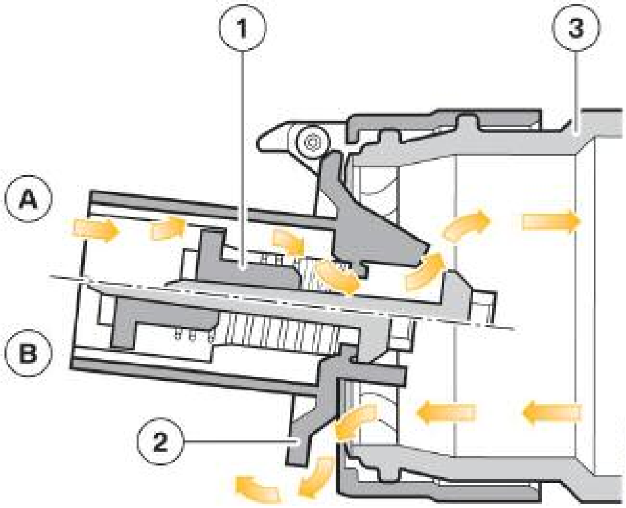
The service breather valves are arranged in such a way that air can still be released even if the vehicle is parked up on one side.

The filler breather valve is located at a high position. If the fuel level rises to this height during refueling, the valve closes. Air can no longer escape from the fuel tank fast enough, which causes fuel to rise up the filler pipe and switch off the fuel nozzle.

To enable the release of air to continue, there is a service breather valve located at the highest point. However, the presence of the valve in this location means that the fuel tank could be overfilled in the event of persistent refueling. Consequently, fuel would enter the activated charcoal filter and ultimately flow back out of the opening. To prevent this, the highest service breather valve is equipped with over fueling protection like the one on the left-hand side of the vehicle (as a safeguard if the vehicle were parked up on one side).

Fuel that is carried along with the release of air is collected in a fuel trap and pumped back into the surge chamber.

Non-return Flap



Index	Explanation
A	Pressure relief valve open
B	Pressure relief valve closed
1	Pressure relief valve
2	Non-return flap
3	Fuel filler pipe

The non-return flap forms a tight seal. A force of approximately 0.15 N is required to open the non-return flap. This force is slightly exceeded during any type of refueling.

The non-return flap on the F01 is equipped with a pressure relief valve. The purpose of this pressure relief valve is to prevent excessive pressures from building up in the fuel tank. If the pressure in the fuel tank rises to over 150 mbar, the pressure relief valve opens and the pressure is able to escape through the fuel filler pipe and the breather line/pressure relief valve in the fuel cap.

The pressure relief valve in the non-return flap on the F01 is a new concept because the breather line is not protected by the body along its entire length. In the event of an accident, therefore, the breather line could be squeezed closed.

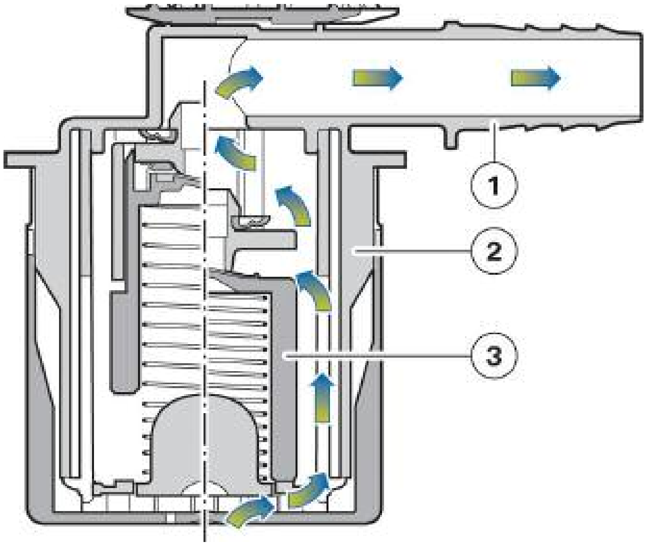
Filler Breather Valve

The filler breather valve has several functions. As the name suggests, the valve fulfils the filler-neck breather function. In addition, however, it also performs the service breather function It also has a rollover function.

The filler breather valve is notable for its large opening, which allows air to escape rapidly from the tank during refueling. If, during refueling, the float of the filler breather valve ascends with the rising fuel level and thereby closes the breather hole, fuel will rise up the fuel filler pipe and switch off the fuel nozzle.

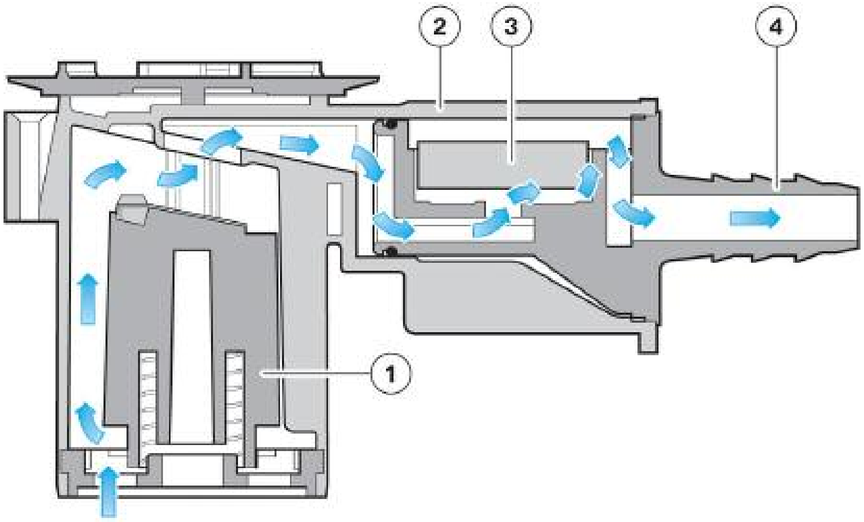
During vehicle operation, the pressure in the fuel system can rise as a result of the increase in temperature. This pressure is allowed to escape through the filler and service breather valve and the fuel trap. Fuel that is carried along in the process is collected in the fuel trap and sucked back while the fuel pump is in operation.

Filler breather valve



Index	Explanation
1	Connection to fuel trap
2	Breather connection
3	Casing

Service breather valve with over fueling protection



Index	Explanation	Index	Explanation
1	Float/roll-over valve	3	Plate
2	Casing	4	Connection to fuel trap

The service breather valve with over fueling protection is responsible for the release of air during vehicle operation. It also has a roll-over function.

A feature worth noting is the integrated over fueling protection. The service breather valve with over fueling protection is fitted with a plate that seals the breather hole under its own weight. During refueling, this plate is lifted by the build-up of excess pressure in the fuel tank and the resultant flow of air, and the filler breather valve is then able to fulfil the purpose for which it was designed.

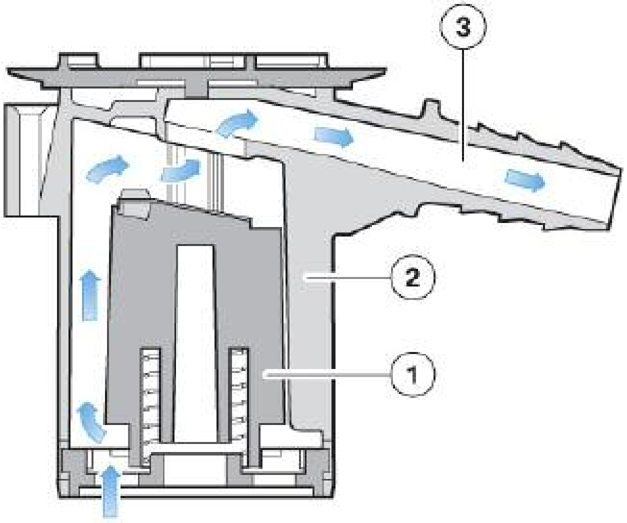
If the float of the filler breather valve now ascends with the rising fuel level and thereby closes the breather hole, fuel will rise up the fuel filler pipe and switch off the fuel nozzle.

As soon as the fuel in the tank settles down, the fuel level drops slightly and the float no longer obstructs the filler breather hole. It would now be possible to refuel a little more. This refueling needs to be prevented, which is where the plate plays its part. As refueling involves only a low volumetric flow of fuel, the plate's opening pressure is not reached, so no air can escape, the fuel level in the fuel filler pipe rises again and the fuel nozzle switches off again.

During vehicle operation, the pressure in the fuel system can rise as a result of the increase in temperature. If the pressure in the complete fuel tank (fuel level above service breather valves) rises approximately 55 mbar above atmospheric pressure, the plate is lifted and the pressure can escape through the fuel trap. Fuel that is carried along in the process is collected in the fuel trap and sucked back while the fuel pump is in operation.

In this way, air can still be released even if the fuel tank is full with no risk of over fueling.

Service breather valve without over fueling protection



Index	Explanation
1	Float/roll-over valve
2	Casing
3	Connection to fuel trap

The service breather valve without over fueling protection is responsible for the release of air during vehicle operation. It also has a roll-over function.

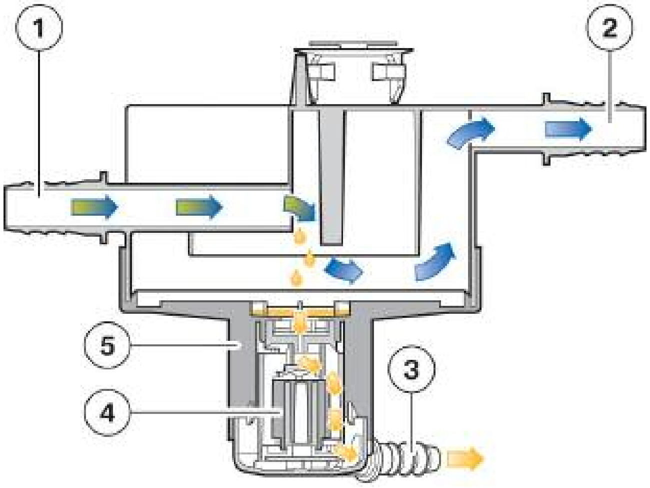
The service breather valve without over fueling protection also makes it possible for air to enter the fuel tank.

During refueling, the rising fuel level lifts the float of the filler breather valve, which seals the breather hole. The fuel nozzle does not switch off, however, because there are other breather valves located higher up the fuel tank.

Fuel Trap

With the fuel tank full, the fuel trap is located below the fuel level. The service breather valve and filler breather valve may inevitably allow some fuel to enter the fuel tank breather system. This fuel is captured by the fuel trap at the lowermost point of the fuel tank breather system. From here, it is sucked up by a suction jet pump fitted near the fuel pump and pumped back into the surge chamber. As a result, no air is able to leak out of the vehicle, even if the vehicle were to overturn.

A float in the fuel trap prevents fuel from entering the liquid trap through the return line when the fuel level is high. The float is designed to also act like a roll-over valve, sealing the fuel tank from the breather line in the event of the vehicle overturning.



Index	Explanation
1	Connection to breather valves
2	Breather connection
3	Suction jet pump connection
4	Float (roll-over valve)
5	Casing

Fuel Pump

The electric fuel pump (EKP) is controlled by the EKP control unit by means of a PWM signal. The EKP control unit in turns receives a request from the ECM (DME).

This request used to be based on load and engine speed. Now the regulation is pressure-sensitive. For this purpose, a fuel pressure sensor is fitted to the fuel line directly upstream of the high-pressure pump.

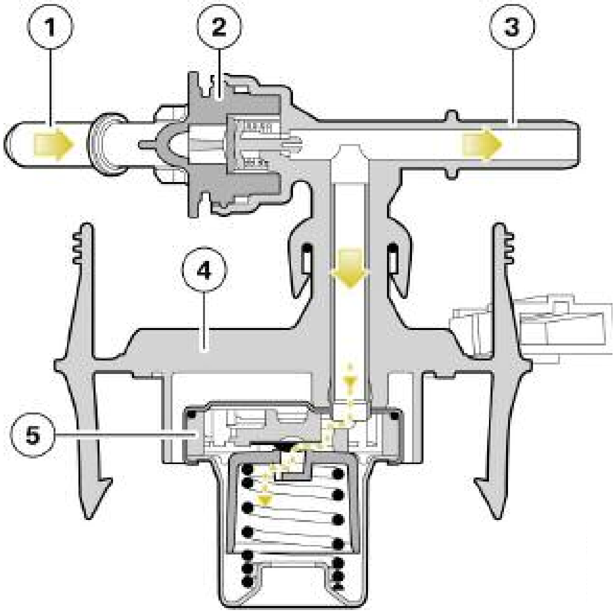
This allows the electric fuel pump to be controlled on demand. This reduces the energy consumption of the fuel pump, which improves fuel economy.

Pressure Limiting Valve

The pressure limiting valve is connected to ground by the plug-in contacts on the service cover. This prevents electrostatic charge on the valve.

The pressure limiting valve keeps fuel pressures in the feed section lower than to a maximum of 5.8 bar (approximate).

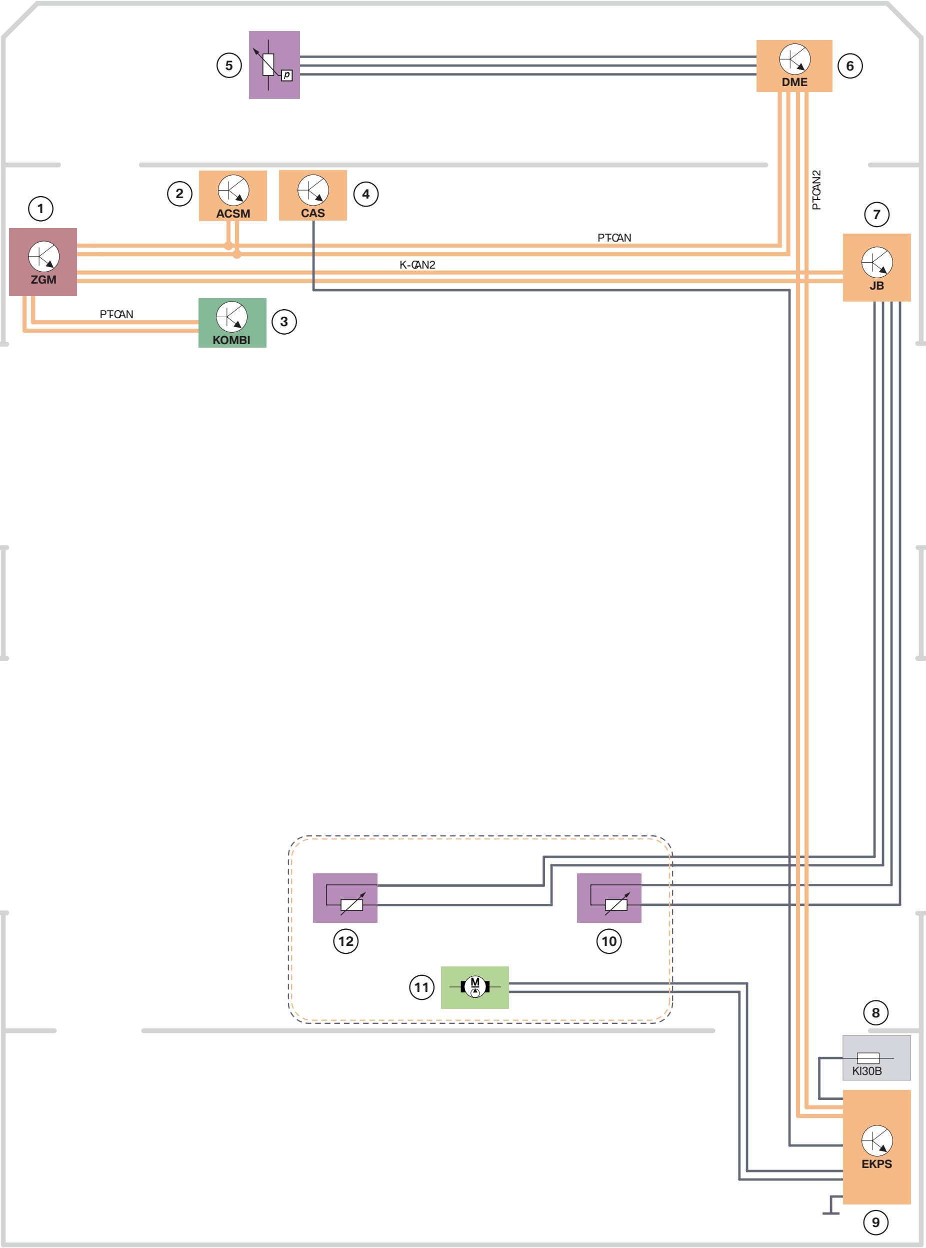
This prevents excess pressures from building up in the feed line. Excess pressures would otherwise occur if the fuel filter were to become blocked, which would place the feed section of the fuel system under unnecessarily heavy loads.



Index	Explanation
1	Connection from electric fuel pump
2	Anti-leak valve
3	Connection to fuel filter
4	Casing
5	Pressure limiting valve

Pressure limiting and anti-leak valve

Fuel Supply and Control Schematic Overview



Index	Explanation	Index	Explanation
1	Central Gateway Module	7	Junction Box Electronics
2	Advanced Crash Safety Module	8	Power distribution box, right rear
3	Instrument Cluster	9	Electric Fuel Pump Module
4	Car Access System	10	Fuel level sensor, right
5	Fuel pressure sensor	11	Electric fuel pump
6	Engine Control Module (DME)	12	Fuel level sensor, left

Automatic Transmission

The F01/F02 is available exclusively with an automatic transmission. The transmission is GA6HP26TU that was introduced with the E70 and was subsequently fitted in many model series since.

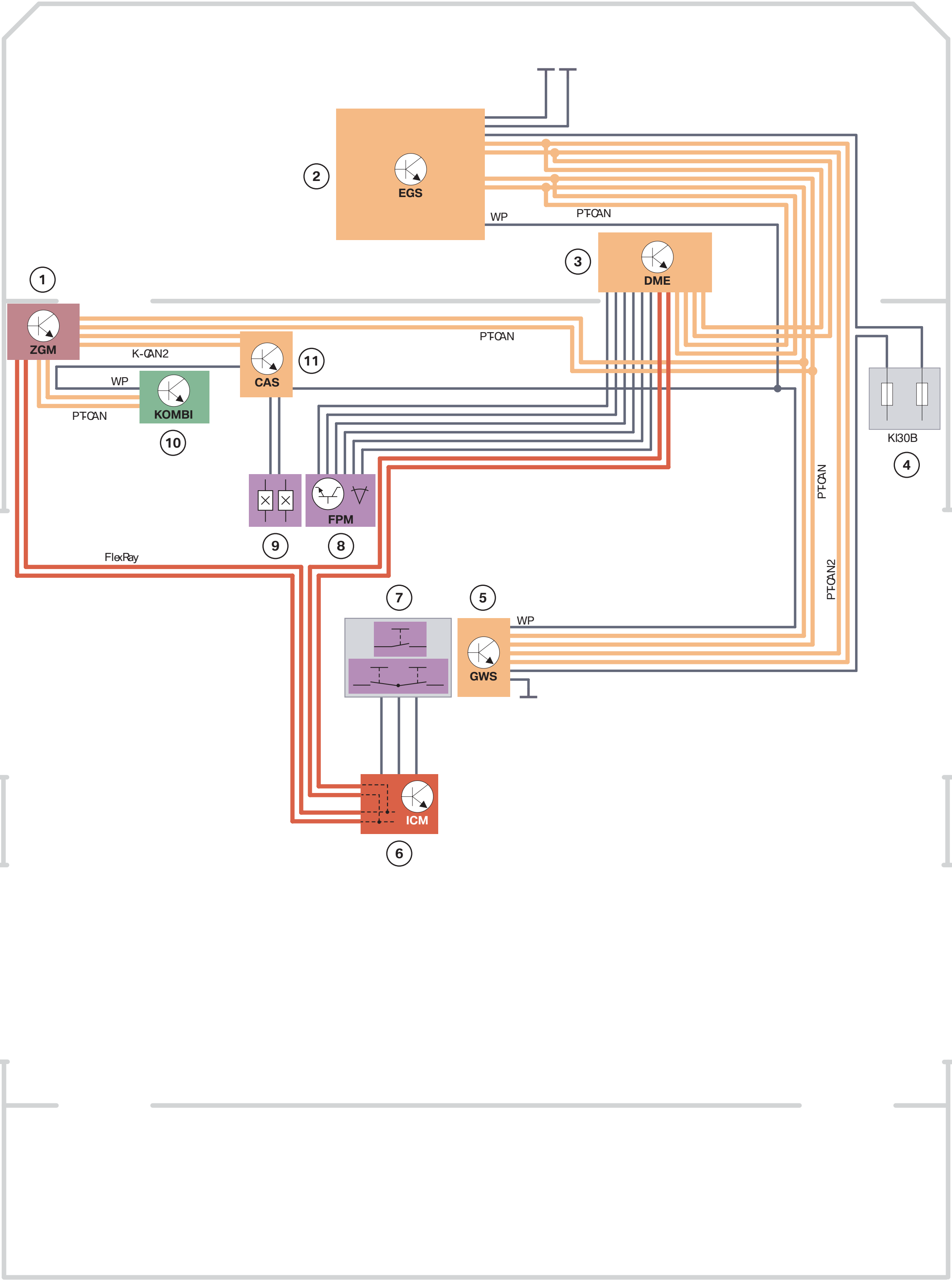
GA6HP26TU

The basic transmission (GA6HP26) was introduced with the E65/E66. Even then, they featured an electronic gearshift. The F01/F02 has an electronic gearshift as well, but the gear selector switch has been relocated to the center console, as it is in the E70/E71 or E60/E61 LCI.

Technical Data

	750i/Li
Gearbox	GA6HP26TU
Transmission type	Automobile automatic transmission with six forward gears and one reverse gear in standard arrangement.
Transmission capacity in kW	300
Transmission capacity in Nm	650
Torque converter	ZDW260
Maximum permissible constant speed of the torque converter in rpm	7000
Transmission gear ratio	
• 1st gear	4.171
• 2nd gear	2.340
• 3rd gear	1.521
• 4th gear	1.143
• 5th gear	0.867
• 6th gear	0.691
• Reverse gear	3.403
Transmission weight including oil in kg	92.4
Control	Electrohydraulic with electronic gearshift control
Towing capability	500 km at up to 80 km/h
Maximum uphill/downhill gradient during a journey	50 %
Maximum gradient from a standing start (forwards/reverse)	32 %

Transmission Control Schematic Overview



Index	Explanation	Index	Explanation
1	Central gateway module	7	Dynamic driving switch and DSC button
2	Electronic gearshift control	8	Accelerator pedal module
3	Engine control unit	9	Brake light switch
4	Junction box power distributor	10	Instrument cluster
5	Gear selector switch	11	Car Access System
6	Integrated Chassis Management		

Gear Selector Switch

The gear selector switch on the F01/F02 has been carried over from the E6x and E7x. In both automatic and manual mode, operation of the switch is monostable. In other words, the selector lever always returns to its original position.

The gear selector switch also contains the control unit (GWS), which is connected to the electric gearshift controller by the PT-CAN like it was before. The second, redundant connection, however, is no longer connected by the LIN bus as used to be the case, but by the new PT-CAN 2.

Emergency release of the F01/F02 automatic transmission

Emergency Release

As you would expect, the F01/F02 has an emergency release for the automatic transmission. This functions in much the same way as that of the E70. The emergency release is located under the ashtray to the front of the gear selector switch.

Rear Axle Differential

The key aim in the development of the final drive in the F01/F02 was to make considerable savings on weight at the same time as increasing the maximum torque transmission capacity.

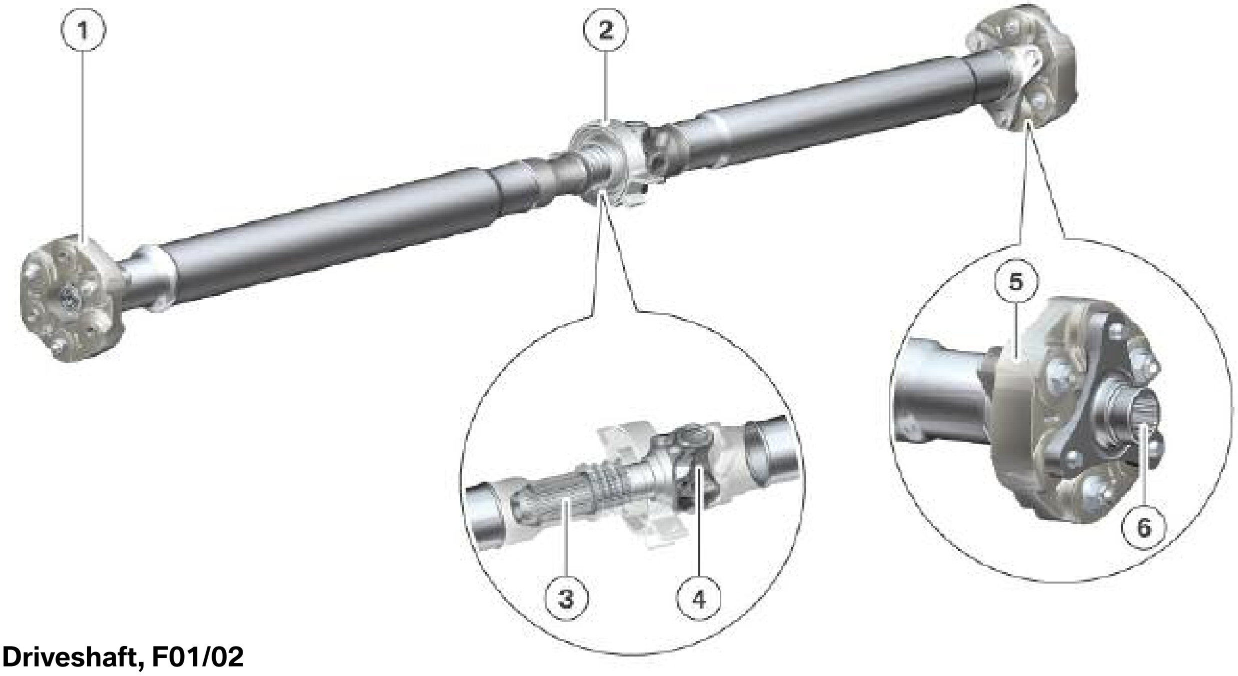
In addition, efficiency was further improved by efforts to achieve optimum spline geometries. The result is a new generation of final drives, which are also notable for their new aluminum casing. These differentials are recognizable by the letters "AL" in their designation (A = aluminum casing, L = low-friction).

The new differential in the F01/02 is designated "225 AL" and weighs approximately 29.7 kilograms (approximately 65 lbs.)

Thanks to cutting edge development methods, a differential casing was made of aluminum for the first time. This has helped to achieve a weight reduction of approximately 15 % compared with previous differentials.

To satisfy the high demand for low noise levels in this vehicle class, a comprehensive range of decoupling measures were required on the vehicle. Through the use of efficient bearings, optimum spline geometries in the oil circuit and an optimum oil volume in the differential, it was possible to reduce friction losses and churning losses and to thereby increase efficiency even further. Together with better heat dissipation, this has contributed to lower oil temperatures.

Driveshafts and Axles Shafts



Driveshaft, F01/02

Index	Explanation	Index	Explanation
1	Flexible coupling on automatic transmission	4	Universal joint
2	Center connection	5	Flexible coupling on rear axle differential
3	Slide-piece connection	6	Push-fit connection

Driveshaft

For the F01/02 the driveshaft is made from steel and designed meet the higher torque requirements.

In addition to torque transfer, key aims in the designing of the driveshaft for the F01/ F02 were to satisfy demands for comfort in terms of noise and vibration.

The joints, shaft junctions and shaft diameters were designed in such a way that no disturbance noise or vibrations at the connecting points are transmitted through the body.

On the F01/F02, the driveshaft is connected to the automatic transmission and rear axle differential exclusively by flexible couplings. This minimizes high-frequency gear teeth noise at the rear axle differential.

The connection to the automatic transmission is a screw-fitted one. At the rear axle differential end, it is push-fitted as it is on the E70. However, this is the first time that a push-fit connection with flexible coupling has been used. The center connection is a slide piece connection with universal joint.

The driveshaft absorbs some of the impact energy in the event of a head-on collision. Improvements have been made to the properties of this crash function, which is integrated into the forward driveshaft tube. The compression force under which the forward driveshaft tube is meant to deform has been further reduced with no effect on torque transfer capability.

Despite increased demands in terms of torque and comfort, it was possible to reduce weight by comparison with the predecessor model.

Axle Shafts

The F01/F02 has axle shafts that are push-fit at each end, i.e. wheel end and differential end. The axle shafts for the N63 engine on the F01 are solid.

The journal at the rear axle differential end depends on the size of the rear axle differential. The journal at the wheel hub end comes in only the one size.

Due to the position of the rear axle differential, the drive shafts on the left and right have a different overall length.

Table of Contents

F01 Bus Systems

Subject **Page**

Initial Print Date: 01/09 Revision Date: 11/09

Bus Systems

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

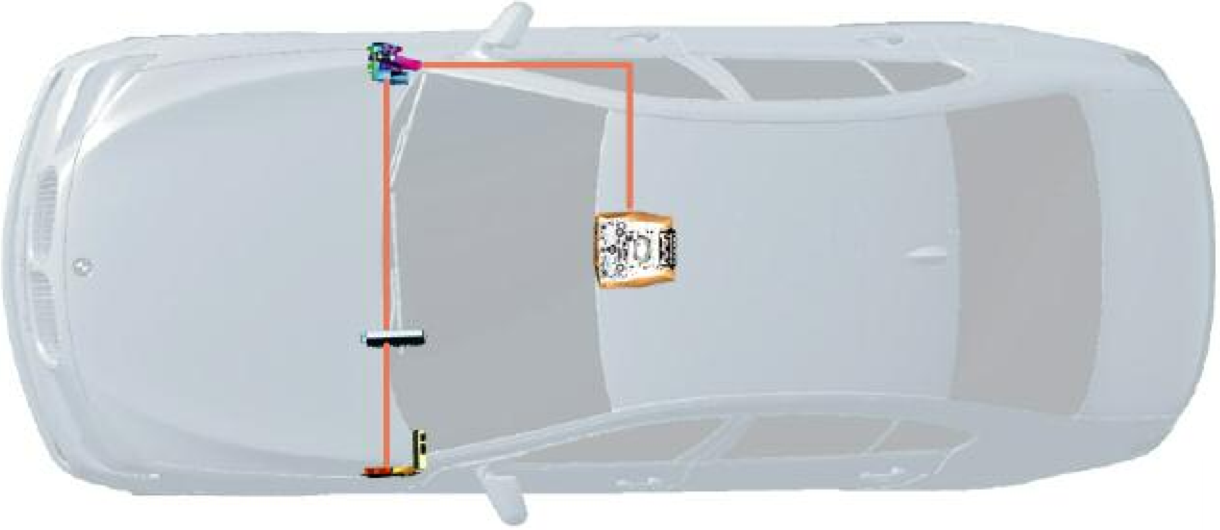
- Understand the changes to the bus systems on the F01/F02
- Understand the expansion of FlexRay
- Understand the use of Ethernet in the F01/F02
- Understand LIN-Bus changes

Bus Systems F01/F02

In order to integrate the latest electronic features, there have been numerous developments to the bus network as compared to the previous 7-series (E65). Continuing with the philosophy of “distributed functions”, there has been more consolidation of various functions. Some bus systems, such as ***byteflight,*** have been eliminated while recent developments such as FlexRay have been expanded. The following innovations have been implemented in the bus systems in the new BMW F01/F02:

- Powertrain CAN PT-CAN has been expanded to include a second PT-CAN 2 bus.
- K-CAN has been expanded to include a second K-CAN 2 bus with 500 kBits/s.
- FlexRay has been expanded and has replaced the F-CAN
- Ethernet has been adopted for faster programming access
- LIN-Bus system with extended functions.

Example of bus system, K-CAN 2

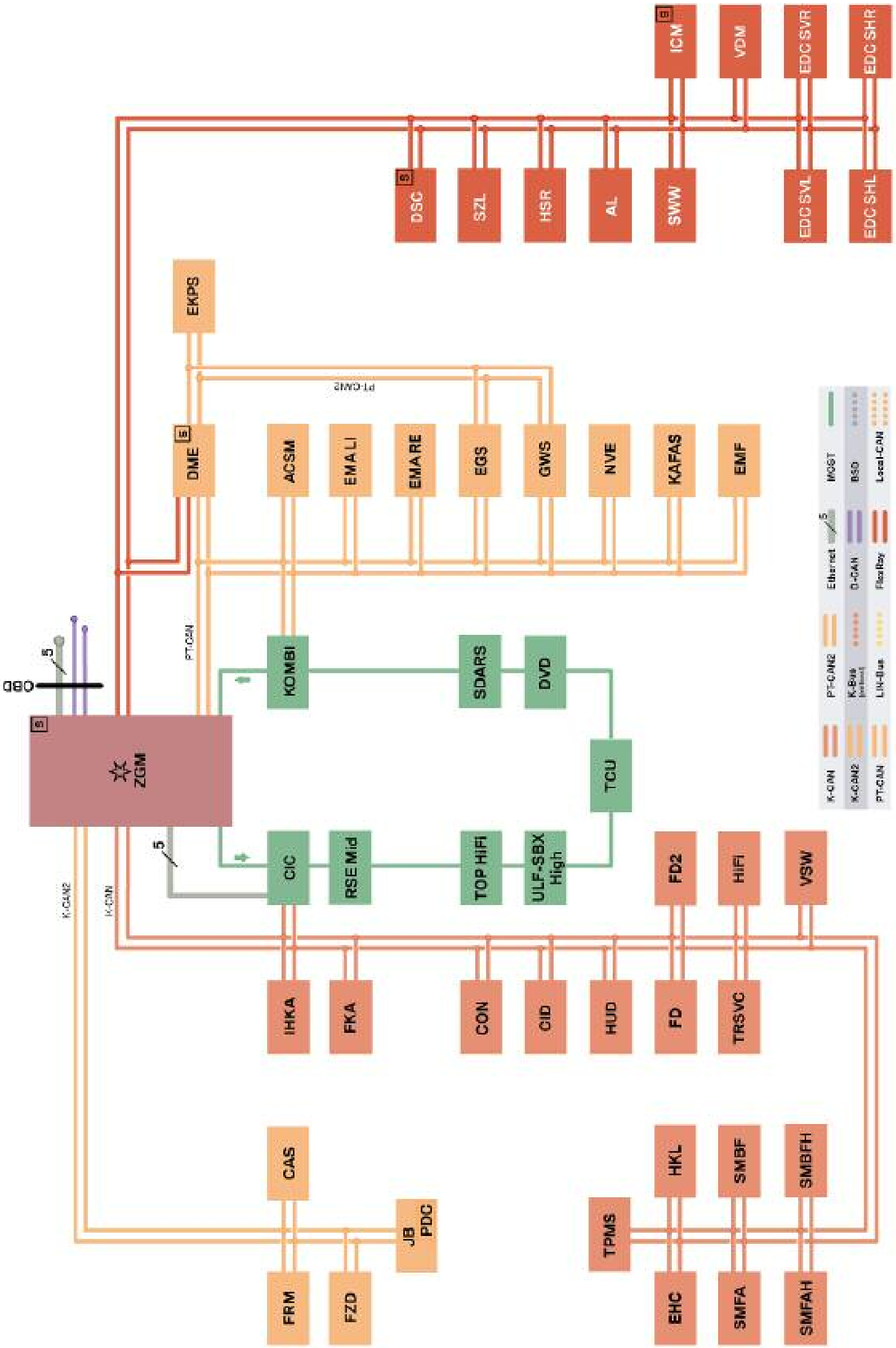


Structure in Vehicle

With deployment of the central gateway module (ZGM), the F01/F02 has a newly linked bus structure. The engine management and chassis control systems are linked across the PT-CAN (or PT-CAN 2) and the FlexRay bus system to the central gateway module (ZGM). The control units of the general vehicle electrics are connected across the K-CAN and K-CAN 2.

The MOST is the information carrier for the majority of control units in the area of information and communication technologies. The vehicle diagnosis communicates across the D-CAN. The vehicle is programmed / encoded via the Ethernet access point.
The sub-bus system LIN has other links.

Overall Bus Overview F01/F02



Index	Explanation
ACSM	Advanced Crash Safety Module
AL	Active steering
CAS	Car Access System (CAS 4)
CIC	Car Information Computer
CID	Central information display
CON	Controller
DME	Digital Motor Electronics
DSC	Dynamic Stability Control
DVD	Digital video disc
EDC SHL	Electronic damper control, satellite rear left
EDC SHR	Electronic damper control, satellite rear right
EDC SVL	Electronic damper control, satellite front left
EDC SVR	Electronic damper control, satellite front right
EGS	Electronic transmission control
EHC	Electronic height control
EKPS	Electrical fuel pump
EMA LI	Electrically motorized reel, left, (seat belt)
EMA RE	Electrically motorized reel, right, (seat belt)
EMF	Electromechanical parking brake
FD	Rear display
FD2	Rear display 2
FKA	Rear compartment heating/air conditioning
FLA	High-beam assistant
FRM	Footwell module
FZD	Roof functions center
GWS	Gear selector lever
HiFi	HiFi amplifier
HKL	Trunk lid lift
HSR	Rear-axle drift angle control (Rear steering control module)
HUD	Head-up Display
ICM	Integrated Chassis Management
IHKA	Integrated heating and air conditioning
JB	Junction box electronics
KAFAS	Camera assisted driver assistance systems
KOMBI	Instrument cluster
NVE	Night Vision electronics
PDC	Park Distance Control
OBD	On board diagnostic connector

Index	Explanation
RSE-Mid	Rear seat entertainment (Mid)
SDARS	Satellite radio
SMBF	Seat module, passenger
SMBFH	Seat module, passenger rear
SMFA	Seat module, driver
SMFAH	Seat module, driver side rear
SWW	Lane change warning (Active blind spot detection)
SZL	Steering column switch cluster
TCU	Telematics control unit
TOP-HIFI	Top-HiFi amplifier
TPMS	Tire Pressure Monitoring System
TRSVC	Top Rear Side View Camera Module (for rear/side view camera)
ULF-SBX High	Interface box - high version
VDM	Vertical dynamics management
VSW	Video switch
ZGM	Central gateway module

Key to abbreviations - bus overview

Index	Explanation
BSD	Bit-serial data interface
D-CAN	Diagnosis-on CAN
Ethernet	Fast data protocol
FlexRay	FlexRay bus system
K-CAN	Body CAN
K-CAN 2	Fast body CAN (500 KB)
LIN	Local Interconnect Network
Local CAN	Local CAN bus (in the F01/F02 for environment sensors)
MOST	Media Oriented System Transport
PT-CAN	Powertrain CAN
PT-CAN 2	Powertrain CAN 2
WUP	Wake-up line
✡	Star coupler - distributor for the FlexRay connections in the central gateway module.
S	Startup node -control units responsible for starting up and synchronizing the FlexRay bus system.

Overall Network of the F01/F02

The overall network in the F01/F02 consists of various bus systems that enable communication between the individual control units. In view of the increasing interconnection of the control units, it is possible to use the sensors of one system throughout the network.

The sensors are connected to the control unit that initially requires the information logic-based and virtually in real time. This information, however, can also be made available to other control units.

Using the example of the vertical dynamics management (VDM), initially, the VDM control unit picks up the ride-height levels of the wheels using height-level sensors.

The automatic headlight vertical aim control can also use this information for the purpose of adapting the beam throw of the headlights. The VDM makes available the information via the corresponding bus systems (VDM -FlexRay - ZGM - K-CAN 2 - FRM) to the footwell module.

Apart from the Ethernet, all bus systems in the F01/F02 are already known from other BMW models. This section provides an overview of all bus systems of the F01/F02.

This Product Information contains a detailed description of the Ethernet system, of the FlexRay bus and of the LIN-Bus sub-bus system.

Overview of Bus Systems

In principle, a distinction is made between two groups of bus systems:

- Main bus systems such as Ethernet, FlexRay, KCAN, K-CAN 2, MOST, PT-CAN and PTCAN 2
- Sub-bus systems such as BSD, D-CAN, LIN, Local-CAN.

Main-bus systems are responsible for the data exchange between the control modules throughout the vehicle system. This includes system functions such as diagnosis, programming and encoding.

Sub-bus systems exchange data within one function group.

For example, the data of the rain-light-solar condensation sensor are read in by the junction box electronics, processed and forwarded to the wiper module. The connection between the control units of the rain-light-solar-condensation sensor and junction box electronics is a sub-bus and designed as a LIN-Bus.

Main Bus Systems

Main-bus system	Data rate	Bus topology
D-CAN (diagnosis-on CAN)	500 kBit/s	Linear, two-wire
Ethernet	100 MBit/s	Linear
FlexRay	10 Mbits/s	Mixed topology, two-wire (see section dealing with FlexRay)
K-CAN (body CAN)	100 kBit/s	Linear, two-wire, single-wire mode possible for emergency operation
K-CAN 2 (fast body CAN)	500 kBit/s	Linear, two-wire
MOST (Media-Oriented System Transport bus)	22.5 MBit/s	Ring, optical fiber
PT-CAN (chassis CAN)	500 kBit/s	Linear, two-wire
PT-CAN 2 (powertrain CAN)	500 kBit/s	Linear, two-wire

The main bus systems are responsible for cross-system data exchange.

Changes to main bus systems

The most important changes to the changes systems in the F01/F02 are:

- Ethernet -fast vehicle programming access
- Powering up certain bus systems also possible without wake-up line (new now KCAN 2).

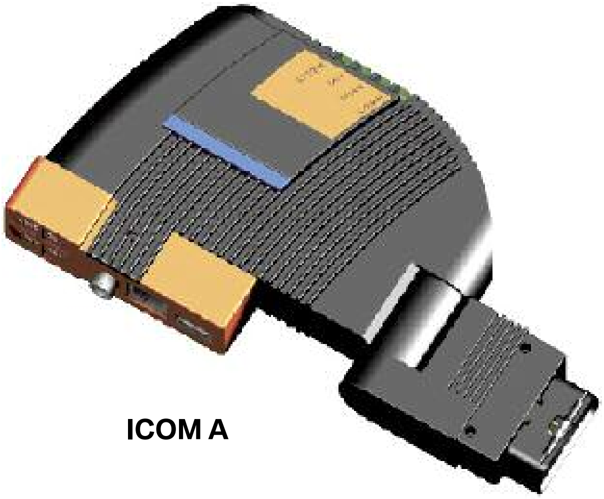
The central gateway module interlinks all the main bus systems.

Diagnosis CAN

After connecting a BMW diagnostic system, the gateway (central gateway module) places the requests of the BMW diagnostic system on the internal buses. The responses undergo the same process in opposite direction.

Only the one new communication protocol will be used for diagnosis. Worldwide, the D-CAN (Diagnostics-on CAN) has replaced the previous diagnostic interface and its protocol which is based on KWP 2000 (Keyword Protocol 2000).

The reason for the changeover was a new legal requirement in the USA requiring that all vehicles be equipped with the D-CAN as from model year 2008. The transitional phase began in September 2006. The E70 was the first vehicle equipped with D-CAN. This modification was then phased in on all new BMW models.

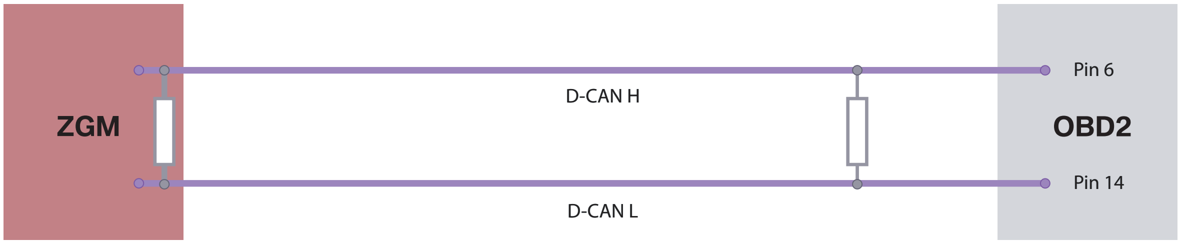

ICOM A

To ensure complete diagnosis for the F01/ F02, an ICOM A is required as diagnosis adapter.

The terminal resistors for the D-CAN are located in the following components:

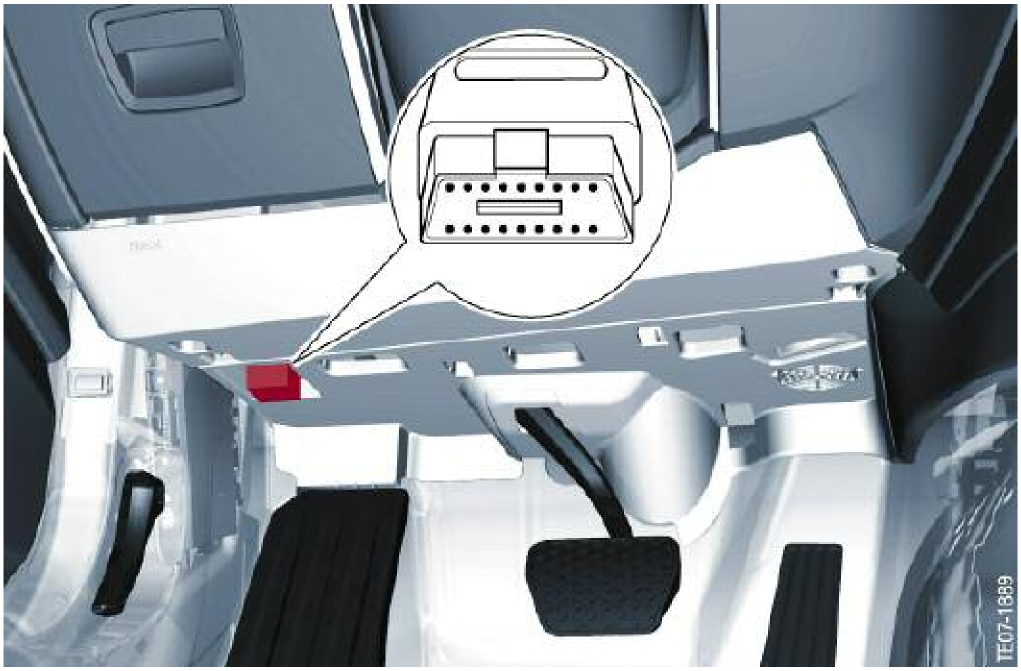
- Central gateway module
- OBD2 connector (on wiring harness side).

Diagnosis access



Location of D-CAN connection

The diagnosis socket is located under the dashboard on the driver's side. The ICOM A is used as the interface to the BMW diagnosis system.



Diagnosis access in vehicle

OBD access in the vehicle will remain unchanged. The pin assignments are as follows:

- 3, 11, 12, 13 = Ethernet connections.
- 16 = Terminal 30
- 5 = Terminal 31
- 14 + 6 = Communication connections
- 8 = activation of Ethernet.

Body CAN

The bus systems used to date are also used in the F01/F02. The K-CAN is responsible for communication of the components with a low data transfer rate. The K-CAN is also connected to the other bus systems via the central gateway module.

The K-CAN is set up as line topology. Some control units in the K-CAN have a LIN-Bus as sub-bus. The K-CAN has a data transfer rate of 100 kBit/s and is designed as a twisted pair of wires. The K-CAN has the possibility to be operated as a single-wire bus in the event of a fault.

The K-CAN control unit is wakened via the bus, without an additional wake-up line.

The following control units are fitted in the KCAN:

- CID Central Information Display
- CON Controller
- EHC, Electronic Height Control
- FD Rear Display
- FD2 Rear Display 2
- FKA, rear heater / air-conditioning system
- HiFi, hi-fi amplifier
- HKL, luggage compartment lid lift
- HUD, Head-Up Display
- IHKA, integrated heater/air conditioning system*
- SMBF passenger seat module*
- SMBFH rear passenger seat module*
- SMFA driver seat module*
- SMBFH rear module on driver' seat side*
- TPMS, Tire Pressure Monitoring System
- TRSVC panoramic camera*
- VSW, video switch
- ZGM, central gateway module.

Body CAN 2

The K-CAN 2 is responsible for communication of the control units with a high data transfer rate. The K-CAN 2 is also connected to the other bus systems via the central gateway module (ZGM). A LIN-Bus as a sub-bus is connected to all control units in the K-CAN 2. The K-CAN 2 can be wakened via any of these sub busses, without an additional (hardwire) wake-up line. This is represented by the "wake authorized" symbol ⎍ next to all of the control units of K-CAN 2 on the Bus Overview. (See bus chart below).

To provide a rapid start enable, the CAS has an additional redundant bus connection to the DME. On this CAS bus, the data are transferred per K bus protocol.

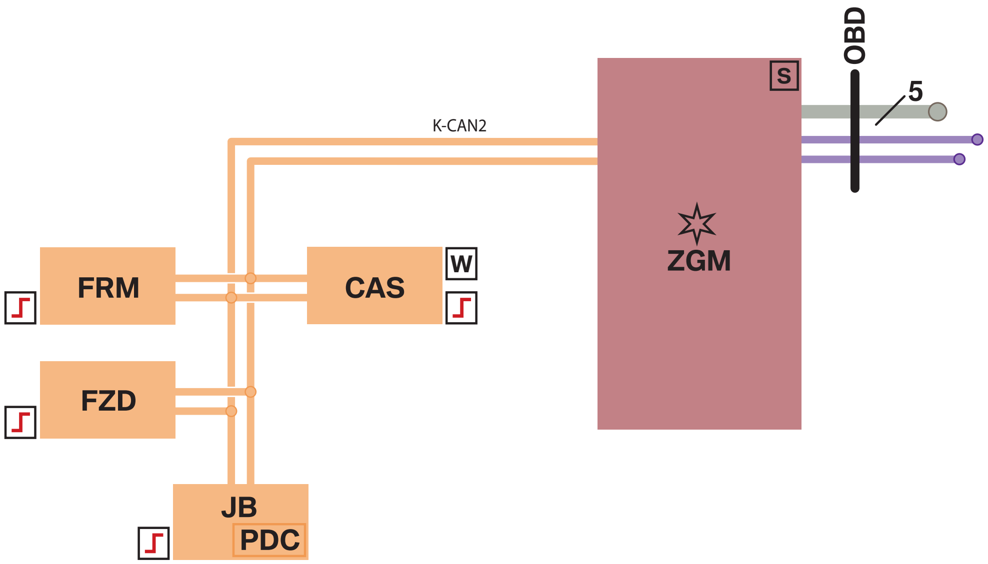
The K-CAN 2 has a data transfer rate of 500 kBit/s and is designed as a twisted pair of wires.

The following control units are fitted in the KCAN 2:

- CAS Car Access System
- FRM, footwell module
- FZD, roof functions center
- JBE, junction box electronics
- PDC, Park Distance Control (integrated in JBE)
- ZGM, central gateway module.

The terminal resistors in the K-CAN 2 are located in the following control units:

- Central gateway module
- Junction box electronics.

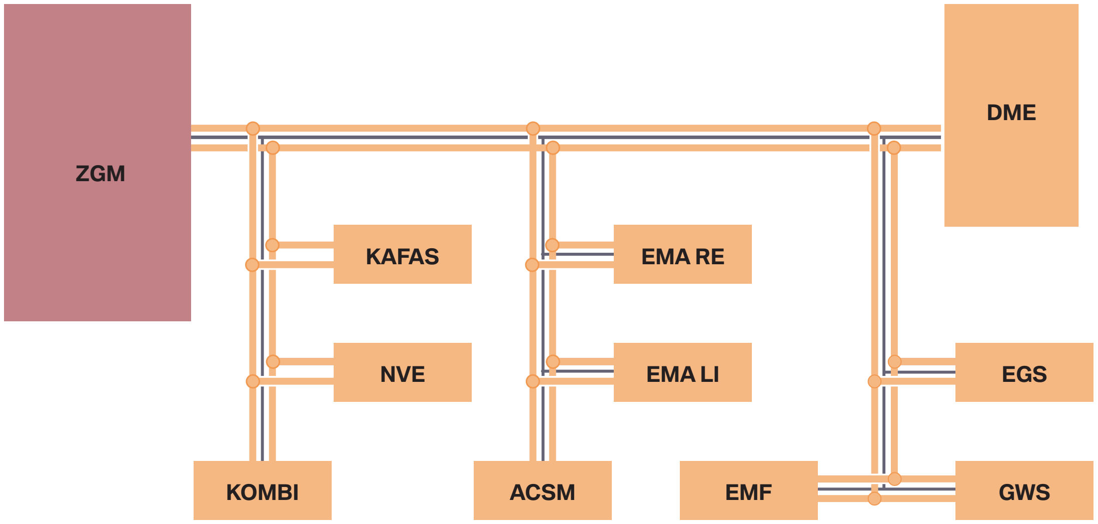


Powertrain-CAN PT-CAN

The PT-CAN connects the engine management system to the gearbox control, but now also interconnects systems in the area of safety and driver assistance systems.

It is line-based with tap lines to the individual systems. The PT-CAN has a data transfer rate of 500 kBit/s and is designed as a twisted pair of wires. Control units with a power supply via terminal 30 have an additional wake-up line (see illustration).

PT-CAN



Index	Explanation	Index	Explanation
ACSM	Crash Safety Module	DME	Digital Motor Electronics
EGS	Electronic transmission control	EMF	Electromechanical parking brake
EMA LI	Electrically motorized reel, left	EMA RE	Electrically motorized reel, right
GWS	Gear selector lever	KAFAS	Camera-based driver assistance systems
KOMBI	Instrument cluster	NVE	Night Vision electronics

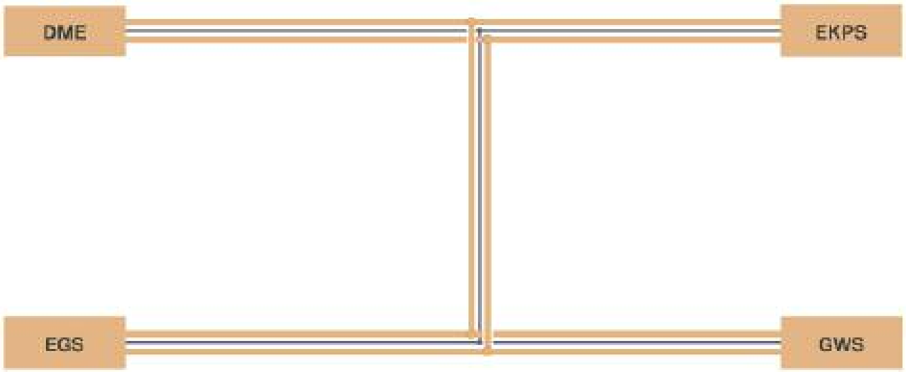
The terminal resistors in the PT-CAN are located in the following control units:

- Instrument cluster
- Electromechanical parking brake.

Powertrain-CAN 2

The PT-CAN 2 forms a redundancy for the PT-CAN in the area of the engine management system and also transfers signals to the fuel pump control. The PT-CAN 2 has a data transfer rate of 500 kBit/s and is designed as a twisted pair of wires with an additional wake-up line.

PT-CAN 2



Index	Explanation	Index	Explanation
DME	Digital Motor Electronics	EGS	Electronic transmission control
EKPS	Electronic fuel pump control	GWS	Gear selector lever

The terminal resistors in the PT-CAN 2 are located in the following control units:

- Digital Motor Electronics
- Control unit for electric fuel pump.

Ethernet - Faster Programming Access

Ethernet in the F01/F02

Ethernet is a manufacturer-neutral, cable-bound network technology. Most computer networks nowadays are based on this data transfer technology.

The so-called Ethernet was developed more than 30 years ago. Since then, the data transfer rates have multiplied. The IEEE 802.3u specification with 100 MBit/s data transfer rate is used in the F01/F02. The IEEE 802.3xx is a standard for cable-bound networks of the Institute of Electrical and Electronic Engineers. This specification is also known as "Fast Ethernet".

The transfer protocols are the protocols TCP/IP (Transmission Control Protocol/ Internet Protocol) and UDP (User Datagram Protocol).

■ Application in the F01/F02

The Ethernet in the diagnosis socket is only enabled when the BMW programming system (ICOM A) is connected. There is an activation bridge in the programming connector, between pins 8 and 16. This switches the power supply for the Ethernet controller in the central gateway module.

This means that Ethernet access to the central gateway module is disabled while the vehicle is being driven by the customer. The Ethernet connection between the information and communications systems is permanently enabled in the diagnosis socket independently of the activation bridge.

■ Security

Each participant in an Ethernet has an individually assigned identification number, an MAC address (Media Access Control). This address and the VIN (Vehicle Identification Number) identifies the vehicle to the BMW programming system on connection setup. This prevents changes to the data records and stored values by third parties.

In the same way as in a computer network in the office, each device in a network must receive unique identification. This is why the central gateway module is assigned a so-called IP address by the programming system after connection setup.

The function of an IP address in a network corresponds to that of a telephone number in the telephone network. This IP address is assigned per DHCP (Dynamic Host Configuration Protocol). This is a method of automatic allocation for IP addresses to user devices in a network.

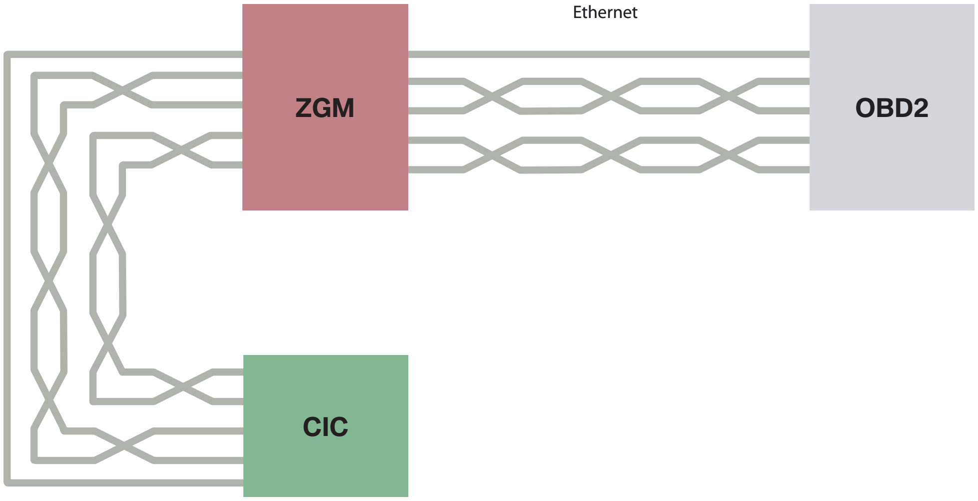
Features of Ethernet

- Very high data rate of 100 MBit/s
- System start time with connection setup and address assignment under three seconds, sleeping under one second
- System access only via BMW programming systems.

Functions of Ethernet

- Faster programming of the vehicle in Service

Ethernet



Index	Explanation	Index	Explanation
ZGM	Central gateway module	OBD2	Diagnosis socket
CIC	Central information computer		

The wiring between the diagnosis socket and ZGM is with two pairs of wires without additional shielding. There is also an activating line that supplies the Ethernet controllers in the control units with voltage.

There is a Cat5 cable between the diagnosis connector and the BMW programming system. These Cat5 cables are network cables with four twisted, unshielded pairs of wires that are approved for signal transfers at up to 100 MHz operating frequency. However, two pairs of wires are sufficient for the transfer capacity required in the F01/F02.

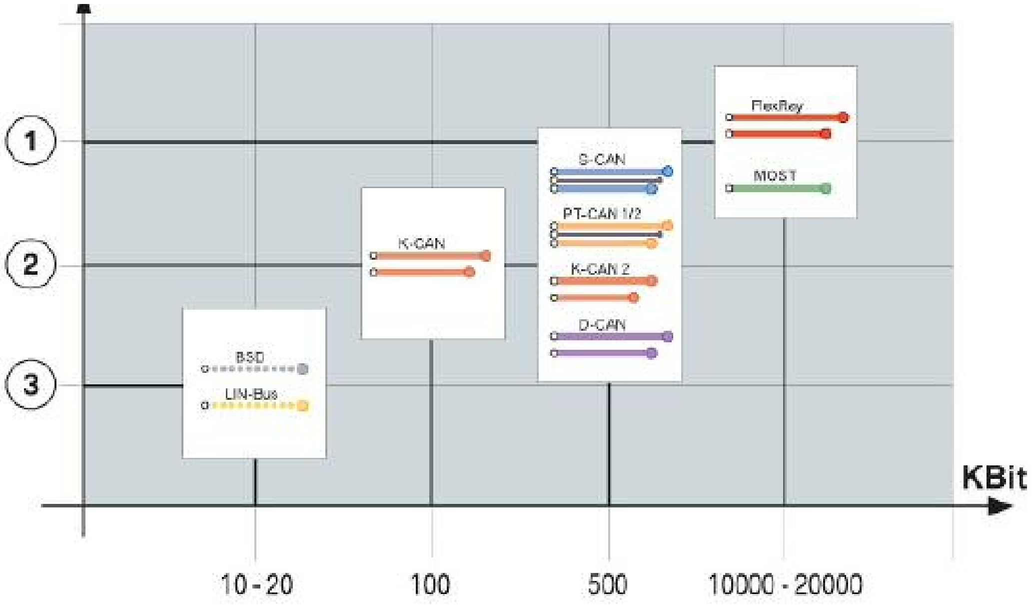
FlexRay

Features of the FlexRay

In future, driving dynamics control systems, driver assistance systems and their innovative interconnection will be ever more important for the differentiation of the BMW marque. Since networking via the CAN bus had already reached its limits, it was necessary to urgently find a suitable alternative for CAN.

In co-operation with Daimler/Chrysler AG and the semiconductor manufacturers Freescale (formerly Motorola) and Philips, BMW AG founded the FlexRay consortium in 1999 for the purpose of developing innovative communication technology.

Bus system speeds



Index	Explanation
1	Real-time capabilities, deterministic (strictly defined) and redundant
2	Conditional real-time capabilities - sufficient for control systems
3	No real-time capabilities

Bosch and General Motors joined the consortium as partners later. Since 2002, the Ford Motor Company, Mazda, Elmos and Siemens VDO have decided to join. In the meantime, almost all significant car makers and suppliers throughout the world have joined the FlexRay consortium.

FlexRay is a new communication system which aims at providing reliable and efficient data transmission with real-time capabilities between the electrical and mechatronic components for the purpose of interconnecting innovative functions in motor vehicles, both today and in the future.

Development of the new FlexRay communication system was prompted by the ever growing technological requirements placed on a communication system for interconnecting control units in motor vehicles and the realization that an open and standardized solution was needed for infrastructure systems. FlexRay provides an efficient protocol for real-time data transmission in distributed systems as used in motor vehicles.

With a maximum data transmission rate of 10 Mbits/s per channel, the FlexRay is distinctly faster than the data buses used to date in the area of the chassis, drive train and suspension of today's motor vehicles. Until now, this data rate could only be achieved with fiber-glass cables.

In addition to the higher bandwidth, FlexRay supports deterministic data transmission and can be configured such that reliable continued operation of remaining communication systems is enabled even in the event of individual components failing.

What are the Advantages of FlexRay?

- High bandwidth (10 Mbits/s compared to 0.5 Mbits/s of the CAN)
- Deterministic (= real-time capabilities) data transmission
- Reliable data communication
- Supports system integration
- Standard in automotive industry

FlexRay - A Standard in the Automotive Industry

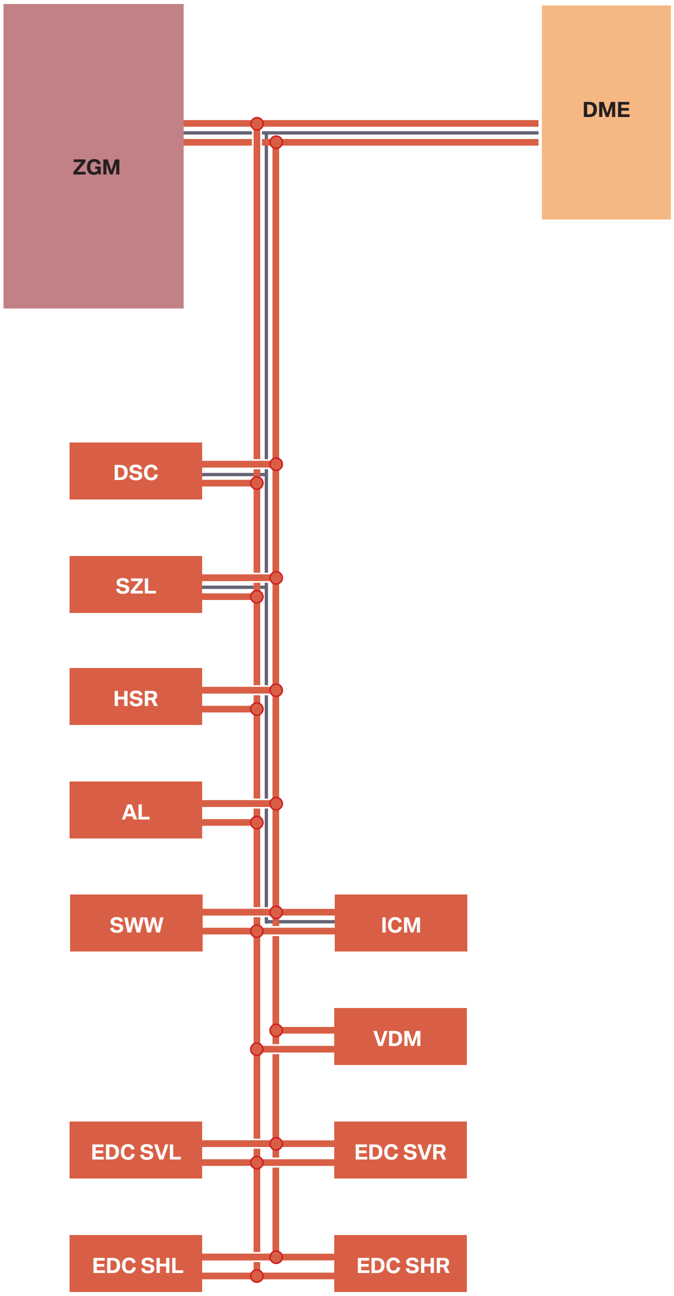
The FlexRay bus system is an industrial standard and is therefore supported and further developed by many manufacturers.

Members of the FlexRay consortium

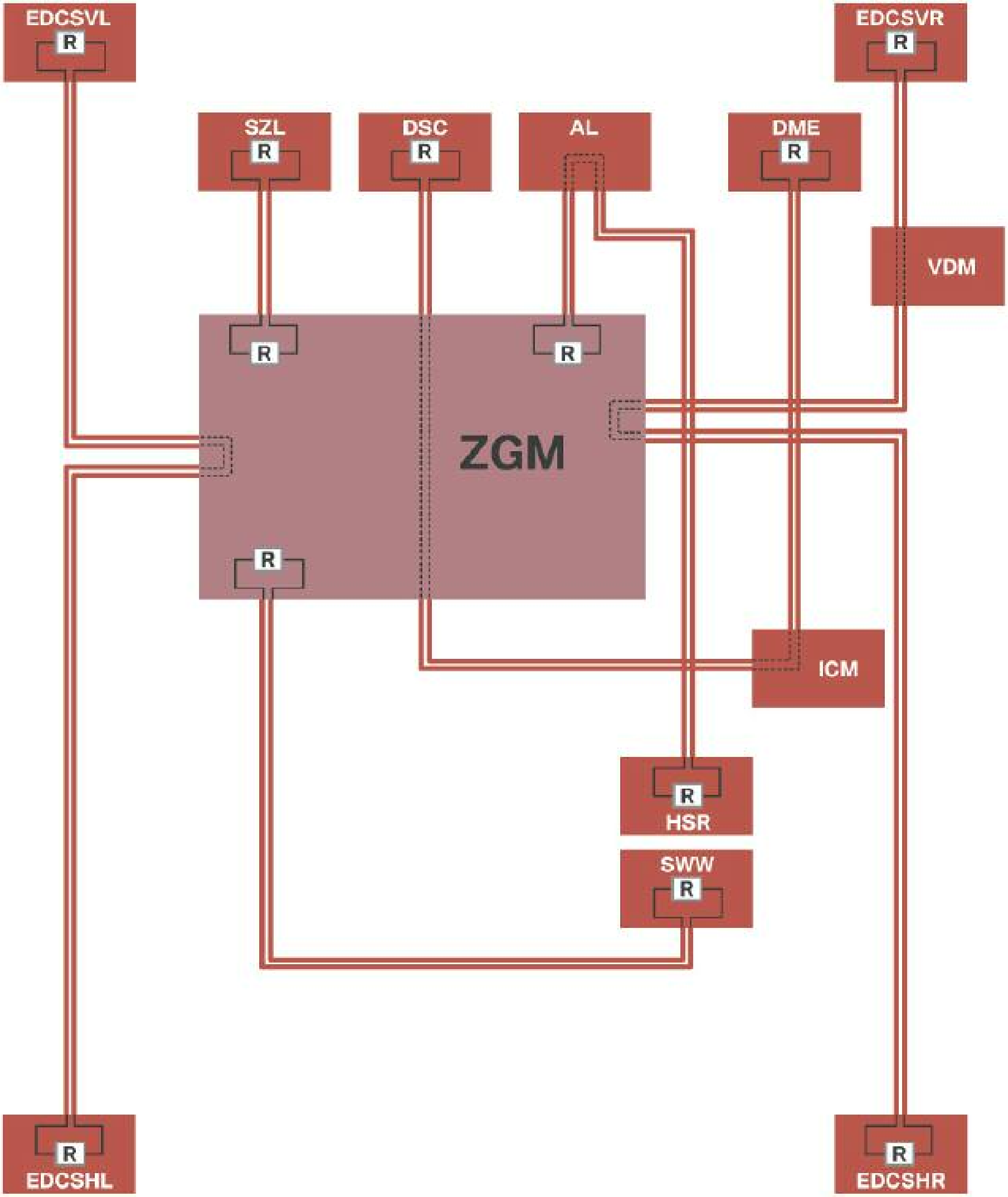
FlexRay - Application in the F01/F02

In the F01/F02, the FlexRay bus system is being used for the first time across systems to network dynamic driving control systems and the engine management system in a series vehicle. The central gateway module sets up the link between the various bus systems and the FlexRay.

FlexRay - simplified view



Physical structure of FlexRay F01/F02 (topology)



Index	Explanation
AL	Active steering system
BD	Bus driver
DM	Digital Motor Electronics
DSC	Dynamic Stability Control
EDCSH	Electronic damper control, rear left satellite
EDCSHR	Electronic damper control, rear right satellite
EDCSVL	Electronic damper control, front left satellite
EDCSVR	Electronic damper control, front right satellite
HSR	Rear-axle drift angle control
ICM	Integrated Chassis Management
SZL	Steering column switch cluster
VDM	Vertical dynamics management
ZGM	Central gateway module

FlexRay Bus Topology on the F01

The FlexRay is shown in a simplified form in the overview of the bus systems. The actual topology is shown in the graphic above.

Depending on the level of equipment of the vehicle, the ZGM contains one or two so-called star couplers, each with four bus drivers. The bus drivers forward the data of the control units via the communication controller to the central gateway module (ZGM). Depending on the type of termination the FlexRay control units have, they are connected to these bus drivers in two different ways.

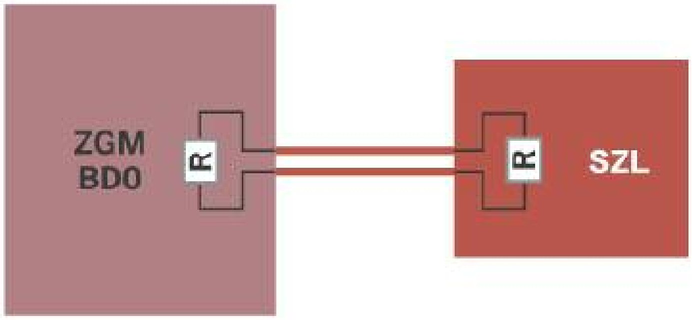
Bus Termination

In the same way as most bus systems, resistors for termination (as bus termination) are also used at both ends of the data lines on the FlexRay to prevent reflections on the lines.

The value of these terminal resistors is determined from the data transfer rate and cable lengths. The terminal resistors are located in the control units.

If only one control unit is connected to a bus driver (e.g. SZL to the bus driver BD0), the connections on the bus driver and on the control unit are fitted with a terminal resistor.

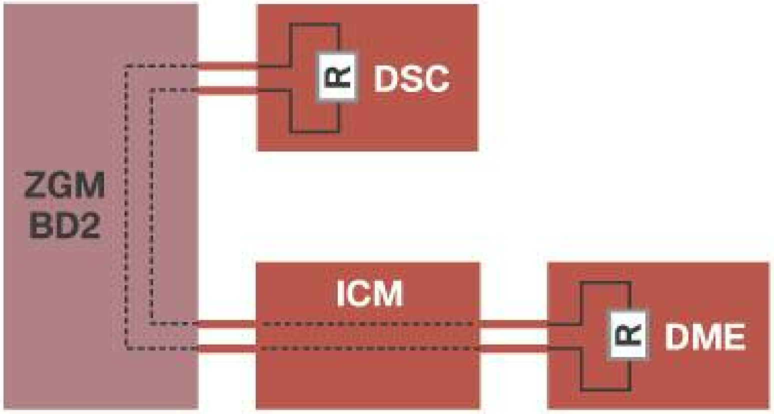
Terminal resistor



This type of connection at the central gateway module is called "end node termination".

If the connection at the control unit is not the physical finish node (e.g. DSC, ICM and DME at the bus driver BD2), it is referred to as a FlexRay transmission and forwarding line. In this case, both components must be terminated at the ends of each bus path with terminal resistors.

Through-looped FlexRay



This connection option exists for the central gateway module and a number of control units. However, the control unit with a transmission and forwarding line has a 'non-end node termination' for data pickup. This type of termination cannot be tested using measurement systems at the control unit connector due to its resistor / capacitor circuit.

To measure the (current-free) FlexRay bus to determine the line or terminating resistance, please be sure to use the vehicle wiring diagram.

Properties of FlexRay

The most important properties of the FlexRay bus system are outlined in the following:

- Bus topology
- Transmission medium - signal properties
- Deterministic data transmission
- Bus signal.

Bus Topology

The FlexRay bus system can be integrated in various topologies and versions in the vehicle. The following topologies can be used:

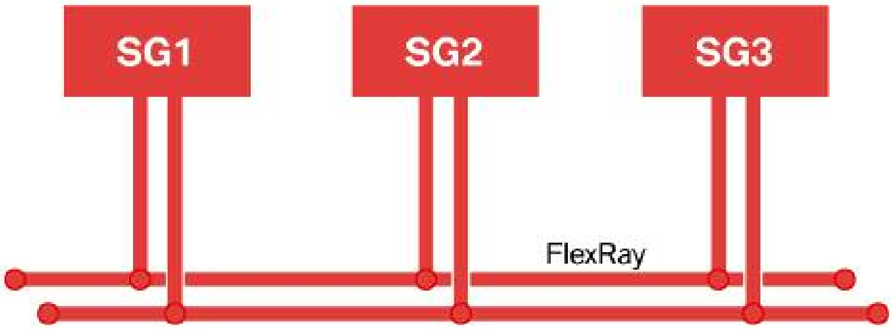
- Line-based bus topology
- Point-to-point bus topology
- Mixed bus topology.

Line-based Bus Topology

All control units (e.g. SG1 to SG3) in line-based topology are connected by means of a two-wire bus, consisting of two twisted copper cores. This type of connection is also used on the CAN-bus. The same information but with different voltage level is sent on both lines.

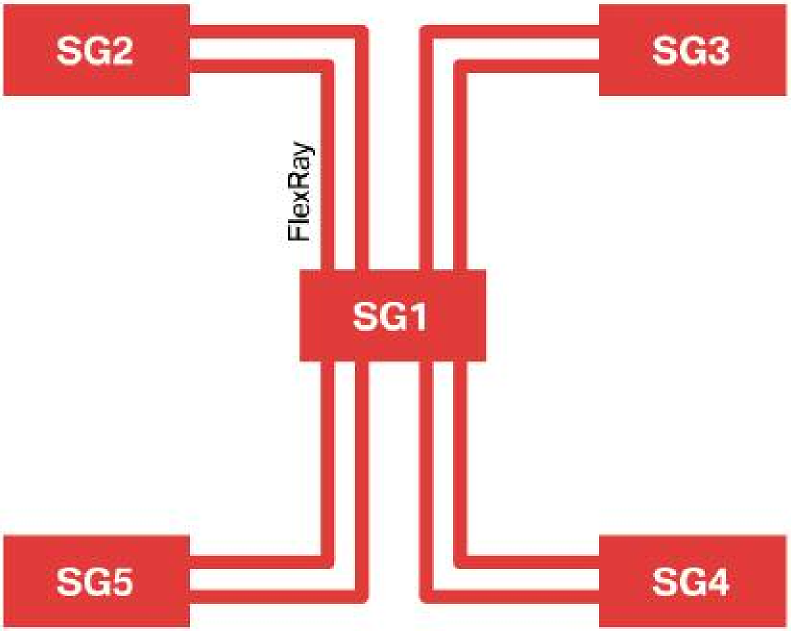
The transmitted differential signal is immune to interference. The line-based topology is suitable only for electrical data transmission.

Line-based bus topology



Point-to-point Bus Topology

The satellites (control units SG2 to SG5) in point-to-point bus topology are each connected by a separate line to the central master control unit (SG1). Point-to-point topology is suitable for both electrical as well as optical data transmission.



Mixed Bus Topology

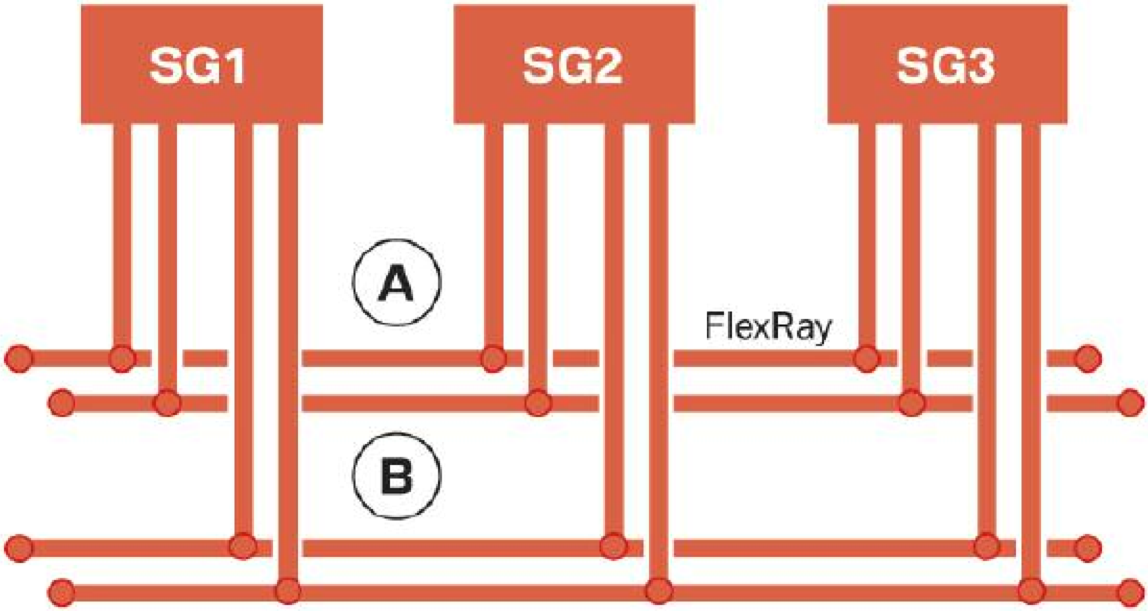
Mixed bus topology caters for the use of different topologies in one bus system.

Parts of the bus system are line-based while other parts are point-to-point.

This bus topology is applied in the F01/F02. The central gateway module (depending on the equipment version) contains one or two active neutral points, each with four bus drivers. This means that up to eight connection options are available.

Redundant Data Transmission

Fault-tolerant systems must ensure continued reliable data transmission even after failure of a bus line. This requirement is realized by way of redundant data transmission on a second data channel.



Index	Explanation
A	Channel 1
B	Channel 2

A bus system with redundant data transmission uses two independent channels. Each channel consists of a two-wire connection. In the event of one channel failing, the information of the defective channel can be transmitted on the intact channel.

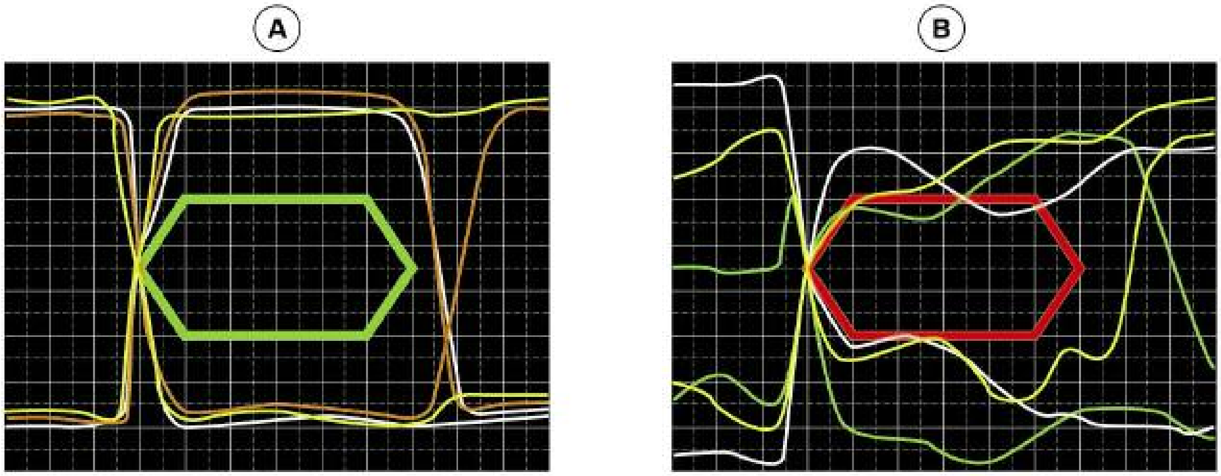
FlexRay enables the use of mixed topologies also in connection with redundant data transmission.

Transmission Medium - Signal Properties

The bus signal of the FlexRay must be within defined limits. A good and bad image of the bus signal is depicted below. The electrical signal must not enter the inner area neither on the time axis nor on the voltage axis. The FlexRay bus system is a bus system with a high data transfer rate and thus with rapid changing of the voltage level.

The voltage level as well as the rise and drop of the voltage (edge steepness) are precisely defined and must be within certain values. There must be no infringements of the marked "fields" (green and red hexagon). Electrical faults resulting from incorrect cable installation, contact resistance etc. can cause data transmission problems.

Good and bad image



Index	Explanation	Index	Explanation
A	Good image	B	Bad image

The images shown above can be depicted only with very fast (laboratory) oscilloscopes. The oscilloscope in the BMW diagnostic system is not suitable for representing such images.

The voltage ranges of the FlexRay bus system are:

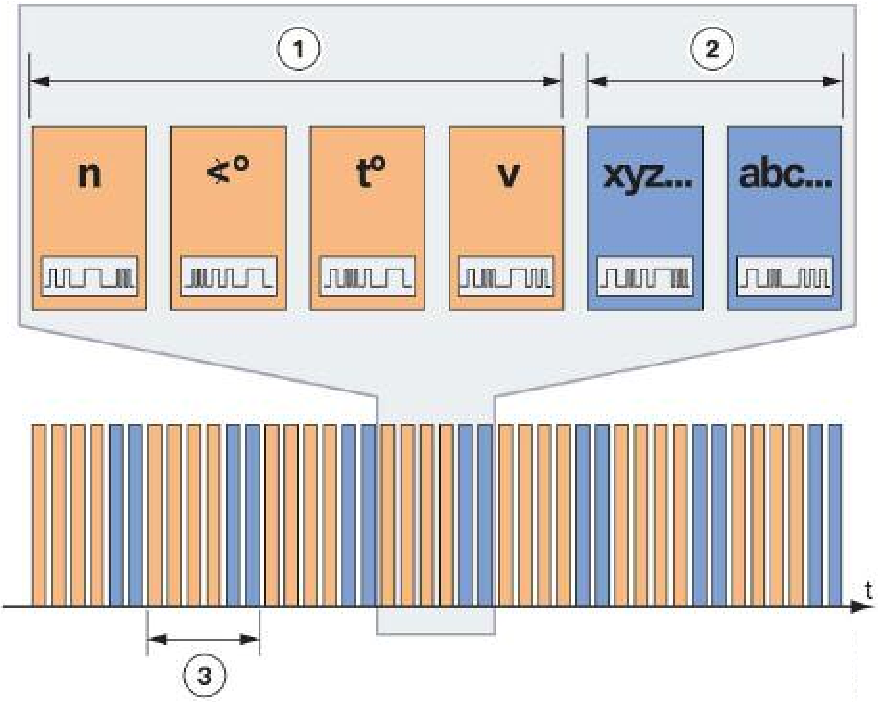
- System ON - no bus communication 2.5 V
- High signal - 3.1 V (voltage signal rises by 600 mV)
- Low signal - 1.9 V (voltage signal falls by 600 mV).

The voltage values are measured with respect to ground.

Deterministic Data Transmission

The CAN network is an event-controlled bus system. Data are transmitted when an event occurs. In the event of an accumulation of events, delays may occur before further information can be sent. If an item of information was not sent successfully and free of errors, this information is continually sent until the communication partner confirms its receipt.

If faults occur in the bus system, this event-controlled information can back up causing the bus system to overload, i.e. there is a significant delay in the transmission of individual signals. This would result in poor control characteristics of individual systems.



Index	Explanation
1	Time-controlled part of cyclic data transmission
2	Event-controlled part of cyclic data transmission
3	Cycle [5 ms total cycle length of which 3 ms static (= time-controlled) and 2 ms dynamic (= event-controlled)]
n	Engine speed
<°	Angle
t°	Temperature
v	Road speed
xyz... abc...	Event-controlled information
t	Time

The FlexRay bus system is a time-controlled bus system that additionally provides the option of transmitting sections of the data transmission event-controlled. In the time-controlled part, time slots are assigned to certain items of information. One time slot is a defined period of time that is kept free for a specific item of information (e.g. engine speed).

Consequently, important periodic information is transmitted at a fixed time interval in the FlexRay bus system so that the system cannot be overloaded.

Other less time-critical messages are transmitted in the event-controlled part.

An example of deterministic data transmission is outlined in the following.

Bus Signal

Deterministic data transmission ensures that each message in the time-controlled part is transmitted in real time. Real time means that the transmission takes place within a defined time.

Therefore, important bus messages are not sent too late due to overloading of the bus system. If lost due to a temporary problem in the bus system (e.g. EMC problem) a message cannot be sent again. A current value is sent in the next assigned time slot.

High Bandwidth

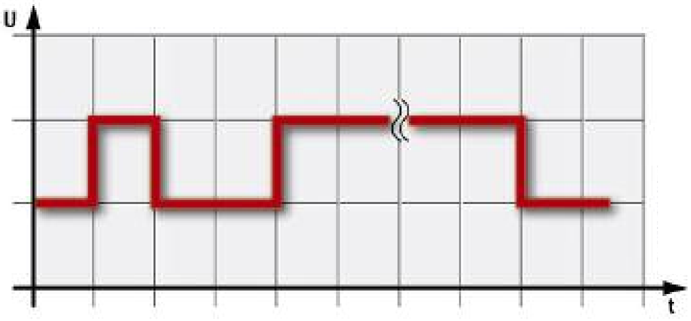
The FlexRay bus system provides a maximum data transfer rate of up to 10 MBit/s per channel. This corresponds to 20 times the data transfer rate of the PT-CAN 2 or D-CAN.

Wake-up and Sleep Characteristics

Although the FlexRay control units can be wakened per bus signal, most FlexRay control units are activated across an additional wake-up line by the CAS. The wake-up line has the same function as the previous wake-up line (15WUP) in the PT-CAN. The signal curve corresponds to the signal curve of the PTCAN.

The active steering and the VDM are not wakened via the wake-up cable, rather per bus signal. The four damper satellites are then activated directly by the VDM by switching the power supply.

The "wake-up voltage curve" graphic shows the typical behavior of the voltage curve in response to unlocking and starting the vehicle.



Wake-up signal

Phase 1:

Driver unlocks the vehicle. The CAS control unit activates the wake-up impulse and sends it across the wake-up line to the connected FlexRay control units.

Phase 2:

Car is opened, terminal R is still OFF, the voltage levels in the bus systems drop again.

Phase 3:

Car is started, terminal 15 is ON, the voltages remain at the set levels until terminal 15 is turned off again.

Phase 4:

The complete vehicle network must assume sleep mode at terminal R OFF in order to avoid unnecessary power consumption. Each control unit in the network signs off to ensure that all control units "are sleeping".

An error message is stored if this is not the case. This error message is then evaluated as part of the energy diagnosis procedure.

Synchronization

A common time base is necessary in order to ensure synchronous execution of individual functions in interconnected control units. Time matching must take place via the bus system as all control units operate with their own clock generator.

The control units measure the time of certain synchronization bits, calculate the mean value and adapt their bus clock to this value. The synchronization bits are sent in the static part of the bus message. Synchronization starts in the FlexRay after the system start between two of the control units authorized for wake-up (in the bus overview marked with "S") once the CAS control unit has sent a wake-up impulse.

When this operation is concluded, the remaining control units log on to the FlexRay in succession and calculate their differential values. In addition, there is a calculated correction of the synchronization during operation. This system ensures that even minimal time differences do not cause transmission errors in the long term.

Fault Handling

In the event of faults on the bus lines (e.g. short circuit or short circuit to earth) or on the FlexRay control units themselves, individual control units or entire branches can be excluded from the bus communication. This does not include the branch with the four FlexRay control units authorized for wake-up (ZGM, DME, DSC, ICM). If there is an interruption in the communication between these control units, no engine start is possible.

In addition, a so-called bus watchdog prevents the control units from sending messages are times when they are not authorized to do so. This prevents other messages from being overwritten.

Wiring

The wiring of the FlexRay bus in the F01/F02 is executed as a sheathed, two-wire, twisted cable. The sheathing protects the wires from mechanical damage. Some of the terminal resistors are located in the central gateway module and in the user devices. Since the surge impedance (impedance of high-frequency lines) of the lines depends on external influencing factors, the terminating resistors are precisely matched to the required resistance. The sections of line to the user devices can be checked relatively easily by means of a resistance measuring instrument (ohmmeter, multimeter). The resistance should be measured from the central gateway module. Pin assignment, see 'BMW diagnostic system'.

The terminal resistors in the FlexRay are located in the following control modules:

- Central gateway module (only end node)
- Electronic Damper Control satellites.
- Digital Motor Electronics
- Dynamic Stability Control
- Rear-axle drift angle control
- Steering column switch cluster
- Lane change warning.

Measurements on the FlexRay

For resistance measurement in the FlexRay, be sure to observe the vehicle wiring diagram!

The various termination options mean that misinterpretations of the measurement results can occur.

Measuring the resistance of the FlexRay lines cannot provide a 100% deduction in terms of the system wiring. In the case of damage such as pinching or connector corrosion, the resistance value may be within the tolerance when the system is static.

In dynamic mode, however, electrical influences can cause increased surge resistance, resulting in data transmission problems.

It is possible to repair the FlexRay bus. If damaged, the cables can be connected using conventional cable connectors. Special requirements, however, must be observed when reinstalling the system.

The wiring of the FlexRay system consists of twisted lines. Where possible, this twisting should not be altered during repairs. Repaired areas with stripped insulation must be sealed again with shrink-fit tubing. Moisture can affect the surge resistance and therefore the efficiency of the bus system.

Most Bus

MOST Bus System

Features of the MOST system

MOST is a data bus technology for multimedia applications that was specifically developed for use in motor vehicles.

MOST stands for "Multimedia Oriented System Transport". The MOST bus uses light pulses for the purpose of transmitting data and is based on a ring structure. The data are transmitted only in one direction in the ring.

MOST technology satisfies two important requirements:

1. The MOST bus transports control data as well as audio data, navigation and other services.
2. MOST technology provides a logical model for controlling the data variety and complexity, i.e. the MOST application framework. The MOST application framework organizes functions of the overall system.

MOST is capable of controlling functions that are distributed in the vehicle and to manage them dynamically.

An important characteristic of a multimedia network is that it not only transports control data and sensor data such as on the CAN bus and LIN-Bus.

In addition, a multimedia network can also transmit digital audio and video signals and transport graphics as well as other data services.

■ Features

- High data rate 22.5 Mbits/s
- Synchronous/asynchronous data transmission
- MOST assigns nodes in the bus to the control units
- Optical fiber as transmission medium
- Ring structure.

Each MOST control unit can send data on the MOST bus. Only the central gateway module can initiate data exchange between the MOST bus and other bus systems. The Car Information Computer functions as the master control unit; the gateway to the remaining bus system is the central gateway module.

The data are transmitted on various channels on the MOST bus. Corresponding to the application, the data are sent to different time windows within the data flow (channels).

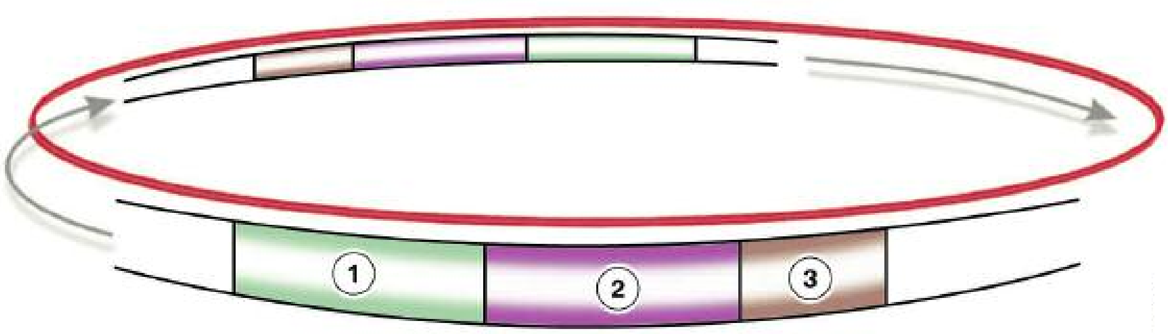
■ **Control channel**
Control signals such as volume control for the Top HiFi amplifier and data for diagnosis purposes are sent via the control channel.

■ **Synchronous channel**
The synchronous channel is mainly reserved for the purpose of sending audio data.

20 -Data transfer channels

■ **Asynchronous channel**
The asynchronous channel transfers image data from the navigation system such as the map view and direction arrows.

The control channel and the asynchronous channel are used for programming the control units on the MOST bus and correspondingly adapt it to the MOST-direct access.



Index	Explanation
1	Synchronous channel
2	Asynchronous channel
3	Control channel

Registration of ECUs in the MOST

Precisely in the same way as on the E6x models, the control units installed on the MOST bus are stored in a registration file in the master control unit. The corresponding data are stored during the production process and, in connection with control unit retrofits, after programming the respective control unit.

The ECUs and their order on the MOST bus are stored in this registration file. With the fiber optic cable connector, it is possible to connect control units in the rear area of the F01/F02 ex factory or after a repair in different order. With the aid of the registration file, the BMW diagnosis system can determine the installed control units and their order.

In addition, this registration file is also stored in the central gateway module so that there is still access to the control unit registration in the event of a fault in the MOST framework. This means that the diagnosis can be used to call up the last functional status from the central gateway module.

Although the master control unit of the MOST, the CIC, is connected to the K-CAN, it does not carry out the function of a gateway control unit. If communication on the MOST is no longer possible, the necessary data can only be read out via the central gateway module.

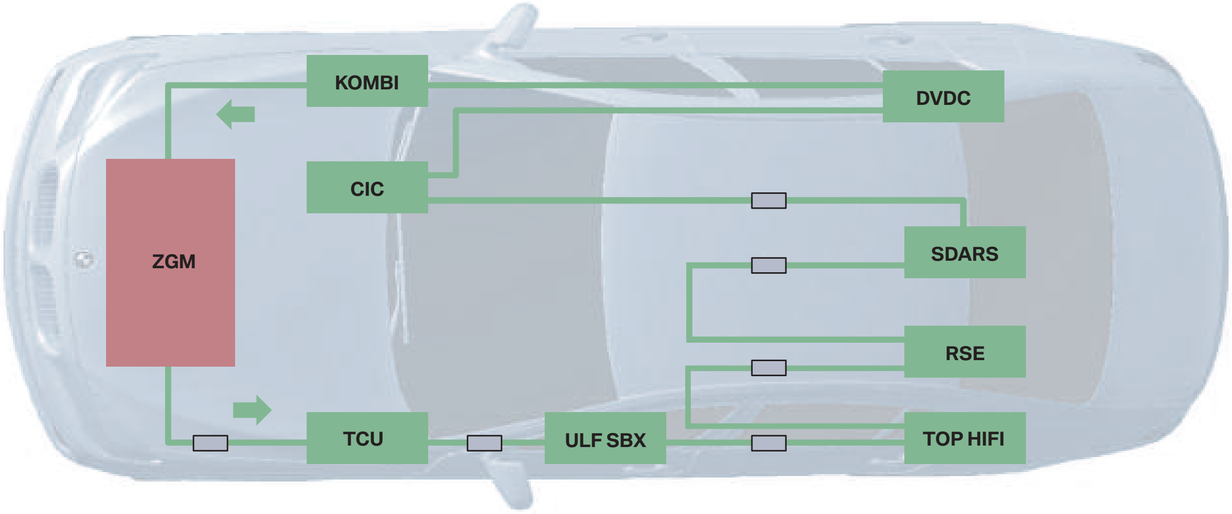
MOST control units and light direction

In the F01/F02, the MOST bus is used for the components in information/communication systems. The Car Information Computer is used as the master control unit. Other bus users may be:

- DVD changer
- Instrument cluster
- Top-HiFi amplifier
- Satellite tuner SDARS (only US version)
- Telephone

The MOST programming access used in models to date is no longer required for the F01/F02. The programming now takes place on these vehicles via the Ethernet access point.

MOST ring in the F01/F02



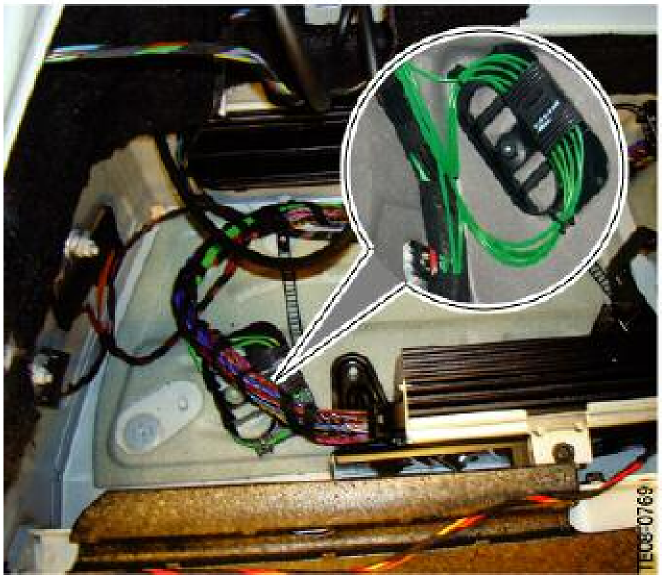
Index	Explanation	Index	Explanation
TOP HIFI	Top-HiFi Amplifier	KOMBI	Instrument Cluster
DVDC	DVD Changer	SDARS	Satellite Tuner
RSE	Rear Seat Entertainment	ULF-SBX	Interface Box
TCU	Telematics Control Unit	ZGM	Central Gateway Module
CIC	Car Information Computer		

■ **Light direction**
Data are always sent in one direction on the MOST bus. Each control unit can send data on the MOST bus.

The physical light direction runs from the master control unit (Car Information Computer) to the DVD changer, to the instrument cluster, to the central gateway module and from there to the fiber optic cable distributor. All the control units fitted in the rear end are connected at the fiber optic cable distributor. From the last control unit, the light returns to the master control unit.

Fiber Optic Connector
The use of the fiber optic connector provides the advantage of being able to easily retrofit control units in the area of the luggage compartment.

Fiber optic cable connector, rear left in the luggage compartment



The fiber optic cable connector is located in the luggage compartment of the F01/F02, to the left behind the side wall trim. The fiber optic cable connector is arranged in the MOST bus system between the front area of the vehicle (head unit, DVD changer) and the rear area of the vehicle (TCU, VM etc.).

One or two fiber optic connectors are installed corresponding to the equipment configuration. One fiber optic connector is responsible for the factory-installed control units. The other fiber optic connector is used for the preparations for options.

The ends of the fiber optic cables, for additional options, are always grouped together on the same row in the fiber optic connector to avoid damage to the ends of the fiber optic cables.

As soon as the retrofit is installed, the fiber optic connectors are reconnected according to instructions and integrated in the MOST bus. Within the framework of programming, the control unit sequence is reloaded into the master control unit.

NOTES PAGE

Sub-bus Systems

Characteristics of Sub-bus Systems

Sub-bus systems exchange data within the system. These systems are used to exchange relatively small quantities of data in specific systems.

Sub-bus systems	Data rate	Bus topology
BSD (bit-serial data interface)	9.6 kBit/s	Linear, single-wire
LIN (Local Interconnect Network)	9.6 / 19.2 / 20.0 kBit/s	Linear, single-wire
Local CAN	500 kBit/s	Linear, two-wire

BSD

The bit-serial data interface BSD is also used on the F01/F02 (due to lack of available interfaces). It makes the following connections from the engine management to the corresponding subsystems:

- Alternator regulator
- Oil condition sensor

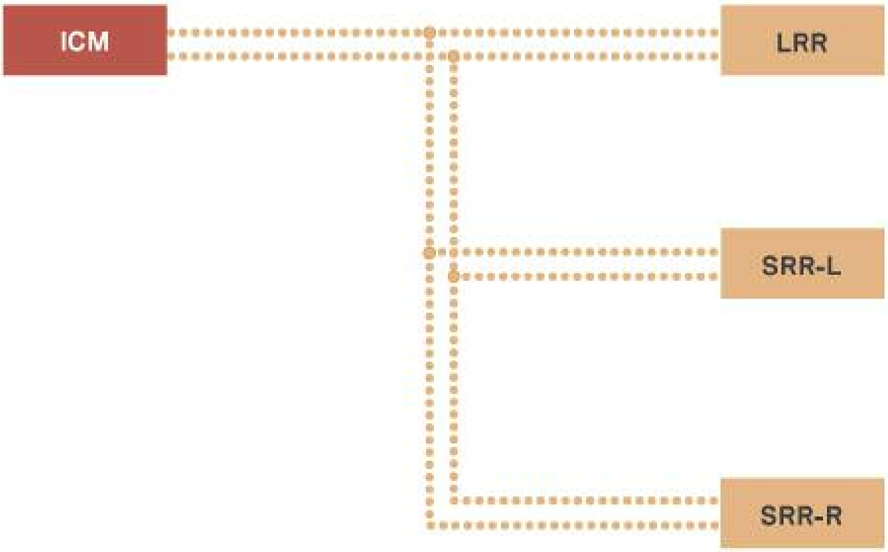
K-Bus Protocol

The term "K-Bus (protocol)" is used for a series of sub-bus systems in the bus overview. These sub-bus systems are used for various purposes. The K-Bus protocol used here is a common component already used in predecessor models. The protocol is used, e.g. on the following systems:

- Connection between ACSM and TCU
- Comfort Access
- CAS bus.
- LIN-Bus

Local CAN

The Local-CAN serves to transfer the high data volumes of the environment sensors to the ICM. (E.g.: short-range sensor to the ICM.) The Local-CAN has a data transfer rate of 500kBits/s and is designed as a twisted pair configuration.



LIN-Bus

The LIN-Bus was used for the first time on the E46 for controlling the outside mirrors. Mainly the versions V2.0 or higher are used in the F01/F02. For the F01/F02, various connections per LIN-Bus are implemented:

- E.g.: Footwell module to driver's door switch cluster
- Connection from footwell module to the outside mirrors
- Connection from roof functions center to rain-light-solar-condensation sensor
- Activation of the 16 IHKA actuator motors per "daisy chain" assignment (series connection of the signal lines).

The Local Interconnect Network was developed as a low-cost communication option for intelligent actuators and sensors in the motor vehicle sector. The LIN is standardized, which is why it is used in development, production and service. The first application of a LIN system in an automobile took place in the year 2001 with version V1.1.

The LIN is a sub-bus configured as a single-wire system. The power supply and signal excursion are at battery voltage level. In all cases, only one master control unit is fitted in a LIN assembly; up to 16 items of equipment (so-called slaves) may be attached to the bus.

There is no prescribed bus topology; only the maximum cable length in a LIN-Bus is limited to 40 meters. In the F01/ F02, the data transfer rate of the LIN ranges from 2.4 to 19.2 kBit/s. Terminal resistors are not required due to the low data transfer rate; these are not fitted in the F01/F02. On the LIN V1.x, all slaves have a fixed identifier and the data protocol only permits periodical messages to be sent.

Synchronization of the LIN takes place at the start of every message sent by the master controller. A so-called "self-synchronization" of the bus takes place without clocking quartz crystal.

The main area of deployment in motor vehicles is mechatronic applications, e.g. mirror adjustment and other actuator motors. One control unit (e.g. junction box electronics) forms the bus master controller; all other connected control units (e.g. wiper module) are the slaves.

In the F01/F02, the following control units still correspond to the V1.x specification:

- Belt hand-over
- Outside mirror
- Blower output stages
- Intelligent Battery Sensor

LIN V2.0 (or V2.1)

LIN components that correspond to the specification of data protocol LIN V2.0 or higher have extended functions.

- The LIN components for V2.x are delivered with a device ID and a base configuration. The final (dynamic) configuration and the allocation of the ID number take place on commissioning by the master control unit. If one of these components is replaced, this operation must be initiated manually by means of the BMW diagnosis system.
- The data protocol has become more variable, permitting, if required, periodic alongside sporadic messages as of specification V2.0. These "sporadic frames" are only sent if the master control unit requires data from the slave control units or outputs data. Without such a request, the time slots in the messages remain empty.
- The master control units can send so-called multiple requests to slave groups. To reduce the bus load, the contacted slaves only respond in the case of changed values (e.g. door contact).

All master control units of the LIN V2.x specification are downwardly compatible to (slave) components of previous specifications. However, all V2.0 slaves also require a V2.x master controller.

A number of the connected components are only diagnosis-capable to a limited degree, for example the rain-light-solar-condensation sensor. In this case, the master control unit serves as the gateway to the remaining bus system. The diagnosis requests from the ZGM or BMW diagnosis system are inserted in the sporadic section of a LIN frame.

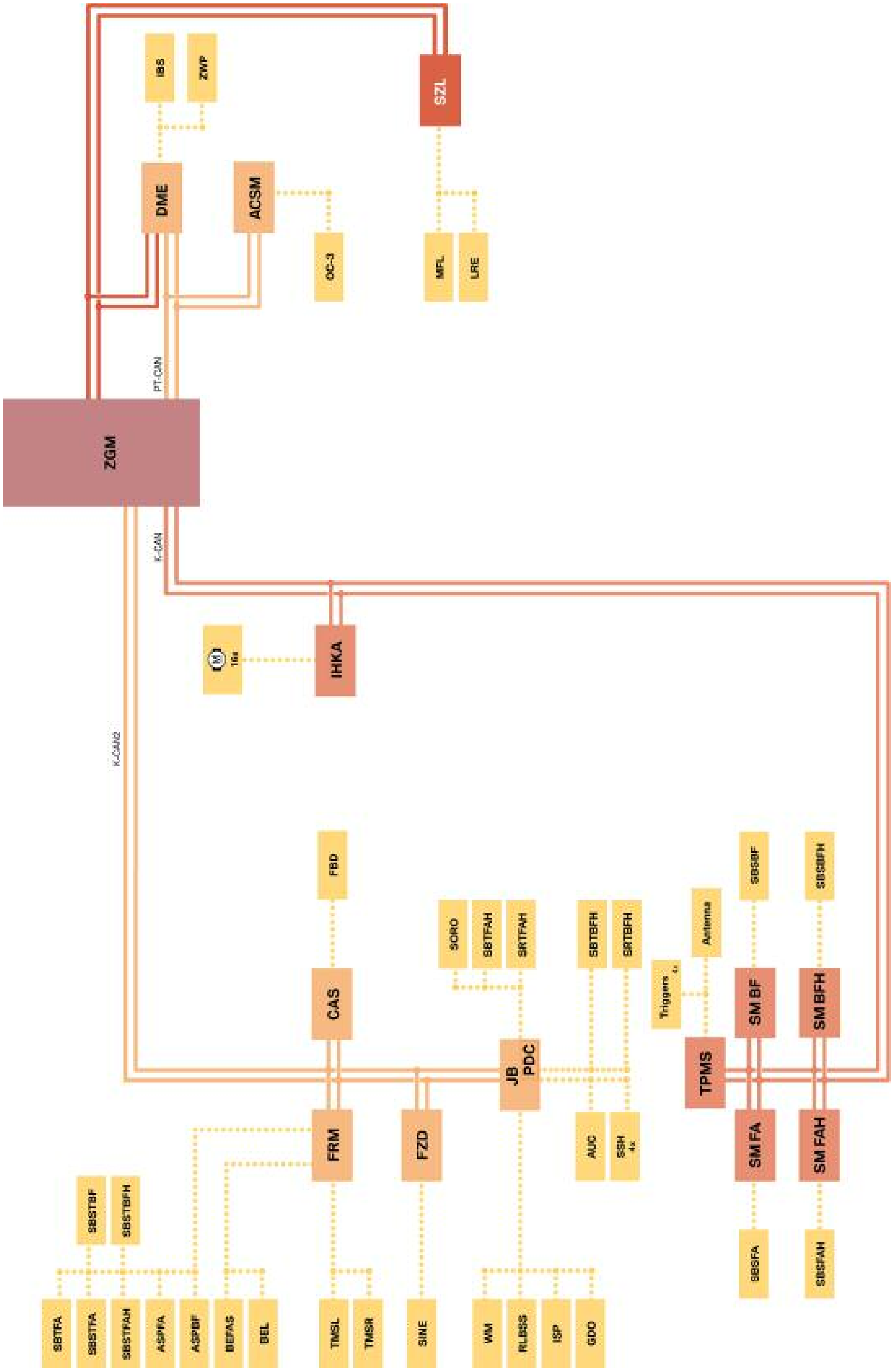
A special feature in the F01/F02 is that the data communication between the Comfort Access and diversity aerial is implemented with 20.0 kBit/s due to the large number of small data packages. The slightly higher transfer rate means that the time slots in the data protocol can be better exploited.

The master control unit sends the "sleep command" to place the LIN in the idle state. The "sleep command" can also be sent with terminal R "On", e.g. for mirror adjustment. The "wake-up command" can also be sent by a slave.

The LIN messages in the data protocol are divided into four sections:

- Synchronization
- Identifier
- Data
- Checksum

LIN-Bus Overview F01/F02



Key for LIN-Bus control units (F01/F02)

Index	Explanation
ACSM	Advanced Crash Safety Module
ASPBF	Outside mirror, passenger
ASPFA	Outside mirror, driver
AUC	Automatic recirculated air control
BEFAS	Driver assistance systems operating unit
BEL	Light operating unit
CAS	Car Access System
DME	Digital Motor Electronics
FBD	Remote Control Services
FRM	Footwell Module
FZD	Roof Functions Center
GDO	Garage door opener
IBS	Intelligent Battery Sensor
IHKA	Integrated Heating and Air Conditioning, automatic
ISP	Interior Mirror
JB	Junction Box Electronics
LRE	Steering Wheel Electronics
MFL	Multi-function Steering Wheel
OC-3	Seat Occupancy Detection, front passenger
PDC	Park Distance Control
RLSBS	Rain-light-solar-condensation sensor
SBSBF	Switch block for seat adjustment, passenger
SBSBFH	Switch block for seat adjustment, passenger’s side rear
SBSFA	Switch block for seat adjustment, driver
SBSFAH	Switch block for seat adjustment, driver’s side rear
SBSTBF	Switch block for seat memory, passenger
SBSTBFH	Switch block for seat memory, passenger’s side rear
SBSTFA	Switch block for seat memory, driver
SBSTFAH	Switch block for seat memory, driver’s side rear
SBTBFH	Switch block for windows, passenger’s side rear
SBTFA	Switch block for windows, driver
SBTFAH	Switch block for windows, driver’s side rear
SINE	Alarm Siren
SMBF	Seat Module, passenger

Key for LIN-Bus control units (F01/F02) cont.

Index	Explanation
SMBFH	Seat Module, passenger’s side rear
SMFA	Seat Module, driver
SMFAH	Seat Module, driver’s side rear
SORO	Roller sunblind
SRTBFH	Roller sunblind switch, passenger’s side rear
SRTFAH	Roller sunblind switch, driver’s side rear
SSH	Seat heating switch
SZL	Steering column switch cluster
TMSL	Headlight module, left
TMSR	Headlight module, right
TPMS	Tire Pressure Monitoring System
WM	Wiper Motor/module
ZGM	Central Gateway Module
ZWP	Auxiliary water pump

Table of Contents

F01 Voltage Supply

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Voltage Supply

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Locate voltage supply components
- Locate fuse boxes
- Understand overall voltage supply layout

Voltage Supply Overview

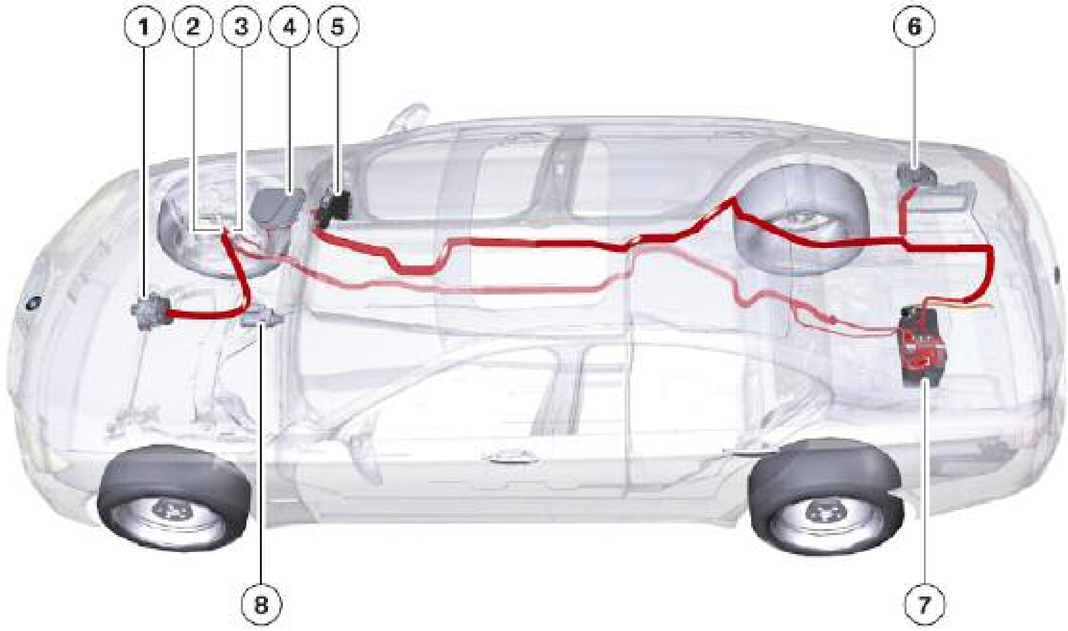
Introduction

Due to the steady increase of electrical functions for comfort, communication and safety in BMW vehicles, the voltage supply is becoming ever more important.

In the F01/F02, there are two separate fuse carriers. The front fuse carrier is located near to the glove compartment and the rear fuse carrier is located on the right-hand side of the luggage compartment.

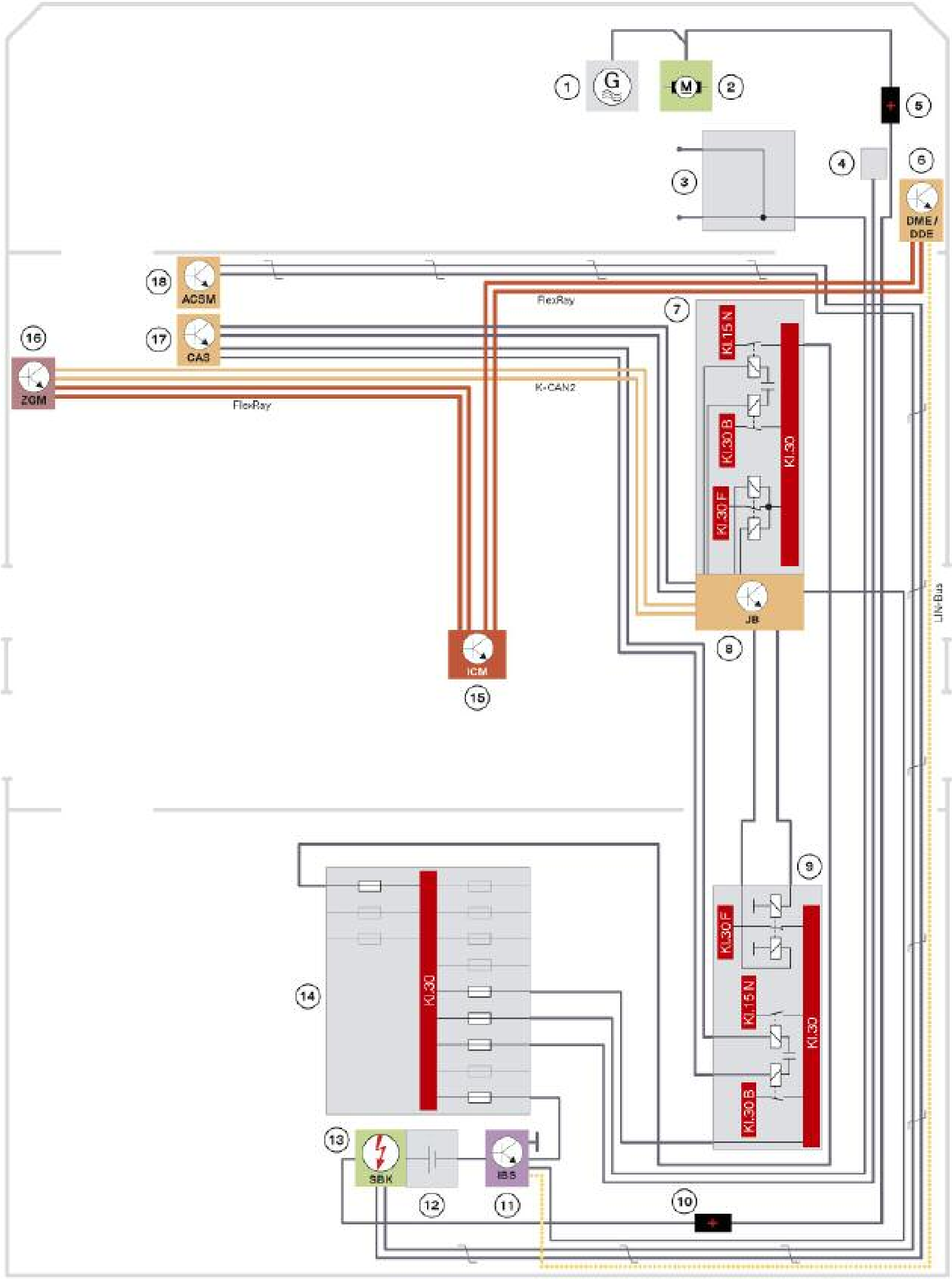
In the graphic below, you can see the layout of the most important components of the voltage supply in the F01/F02.

Overview of the F01/F02 voltage supply



Index	Explanation
1	Alternator
2	Positive battery terminal
3	Power distribution box in engine compartment
4	Electronics box in the engine compartment
5	Front fuse carrier behind the glove compartment
6	Rear fuse carrier on the right-hand side of the luggage compartment
7	Battery
8	Starter

System Circuit Diagram



Index	Explanation
1	Alternator
2	Starter
3	Power distribution box in engine compartment
4	Electronics box
5	Positive battery terminal
6	DME Digital Motor Electronics; DDE Digital Diesel Electronics
7	Front fuse carrier, behind the glove compartment
8	Junction box electronics
9	Rear fuse carrier, on the right-hand side of the luggage compartment
10	Transfer point on the luggage compartment floor
11	Intelligent battery sensor IBS
12	Vehicle battery
13	SBK safety battery terminal
14	Distribution box on the battery
15	ICM Integrated Chassis Management
16	ZGM central gateway module
17	Car Access System CAS
18	ACSM crash safety module
KL30	Continuous positive 30
KL30B	Terminal 30 basic operation
KL30F	Terminal 30 fault switched
KL 15N	Terminal 15 overrun
LIN-bus	Local Interconnect Network bus
K-CAN 2	Body controller area network 2

System Components

Overview of System Components

The most important new/modified features of the voltage supply in the F01/F02 are described below. The voltage supply in the F01/F02 consists of the following components:

- Vehicle battery
- Intelligent battery sensor IBS
- SBK safety battery terminal
- Distribution box on the battery
- Rear fuse carrier on the right-hand side of the luggage compartment
- Battery cables
- Front fuse carrier, behind the glove compartment
- Junction box electronics
- Power distribution box in engine compartment
- Electronics box in engine compartment
- Positive battery terminal
- Alternator

Vehicle Battery

The vehicle battery is fitted in the center at the rear of the luggage compartment floor. The vehicle battery is always an AGM battery (**A**bsorbant **G**lass **M**att). The AGM battery has a capacity of 90 Ah.

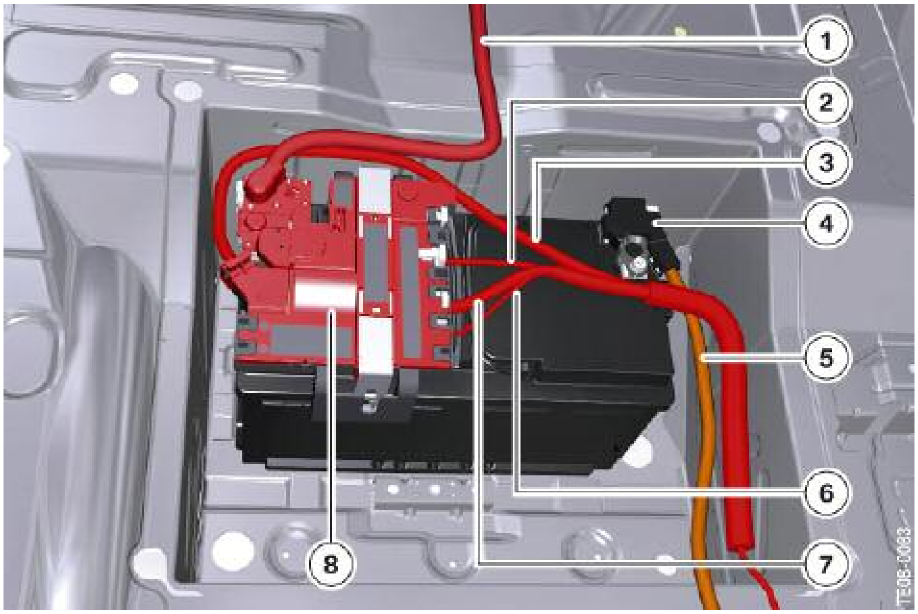
The main advantage of the AGM battery is its higher cycle strength.

AGM battery

Distribution Box on the Battery

In the F01/F02, the distribution box is located in the luggage compartment directly on top of the vehicle battery.

Installation location of the distribution box on the battery in the F01/F02



Index	Explanation	Index	Explanation
1	Battery cable to the starter and alternator 5	5	Negative battery cable
2	Cable to the rear fuse carrier on the right-hand side	6	Cable to the power distribution box in the engine compartment
3	Cable to the front fuse carrier	7	Cable to the electronics box in the engine compartment
4	Intelligent battery sensor IBS	8	Distribution box on the battery

The distribution box on the battery is secured on the vehicle battery by means of a metal tab. The metal tabs must be pressed downward and outward in order to release the distribution box.

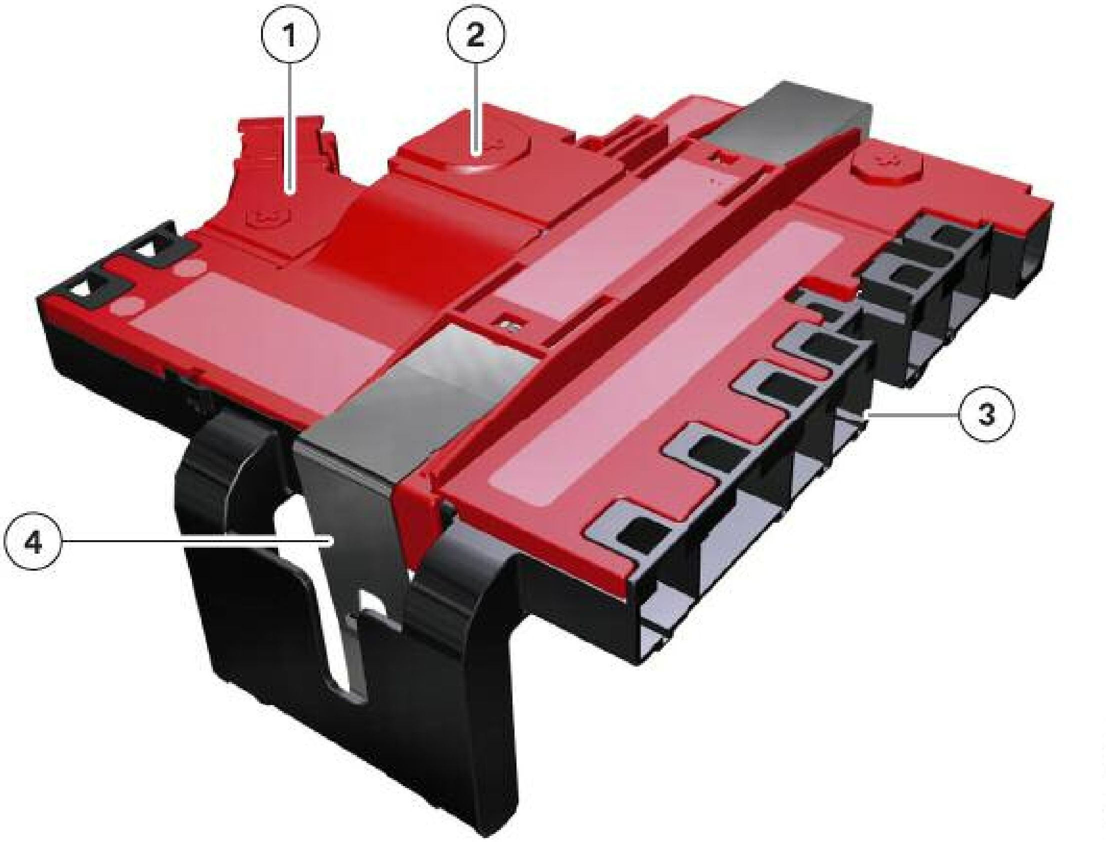
The distribution box on the battery is equipped with fuses for the following electric loads:

- Front fuse carrier (250 A)
- Rear fuse carrier (100 A)
- Engine compartment distribution box (100 A)
  - large electric fan (850 W or 1000 W)
- Electric coolant pump (100 A)
- Intelligent battery sensor IBS.

The distribution box on the battery must always be replaced as a complete unit.
The fuses are integrated as a complete unit in the housing of the distribution box on the battery. The fuses differ in terms of their power rating. The distribution box additionally contains the power supply for the intelligent battery sensor IBS.

The connectors are color-coded and mechanically coded to avoid confusion. These are high power connections, therefore always ensure correct contacting!

Distribution box on the battery in the F01/F02



Index	Explanation	Index	Explanation
1	Connection for the battery cable to the front fuse carrier	3	High current consumer connections
2	Connection to battery terminal	4	Retaining clip

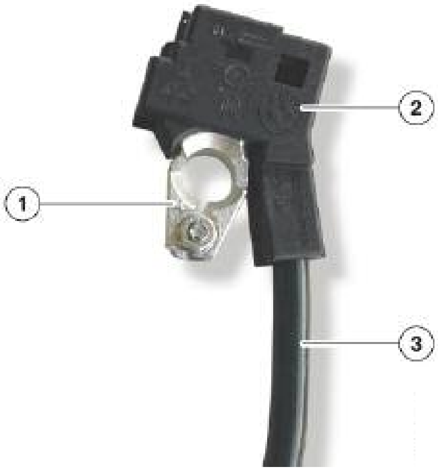
Note: When replacing or working on the distribution box, always make sure the plug connections and, above all, the screw connections are secured properly. Connection between battery terminal and distribution box 15 Nm.

Intelligent Battery Sensor (IBS)

The intelligent battery sensor (IBS) is a mechatronic component for monitoring the battery status. The following physical measurements are recorded for the battery:

- Current
- Voltage
- Terminal temperature

The term “intelligent” means that there is a microprocessor integrated in the IBS. This microprocessor calculates and analyses time-critical measured variables. The results are then forwarded to the higher-level control units (i.e. DME) via the LIN bus.



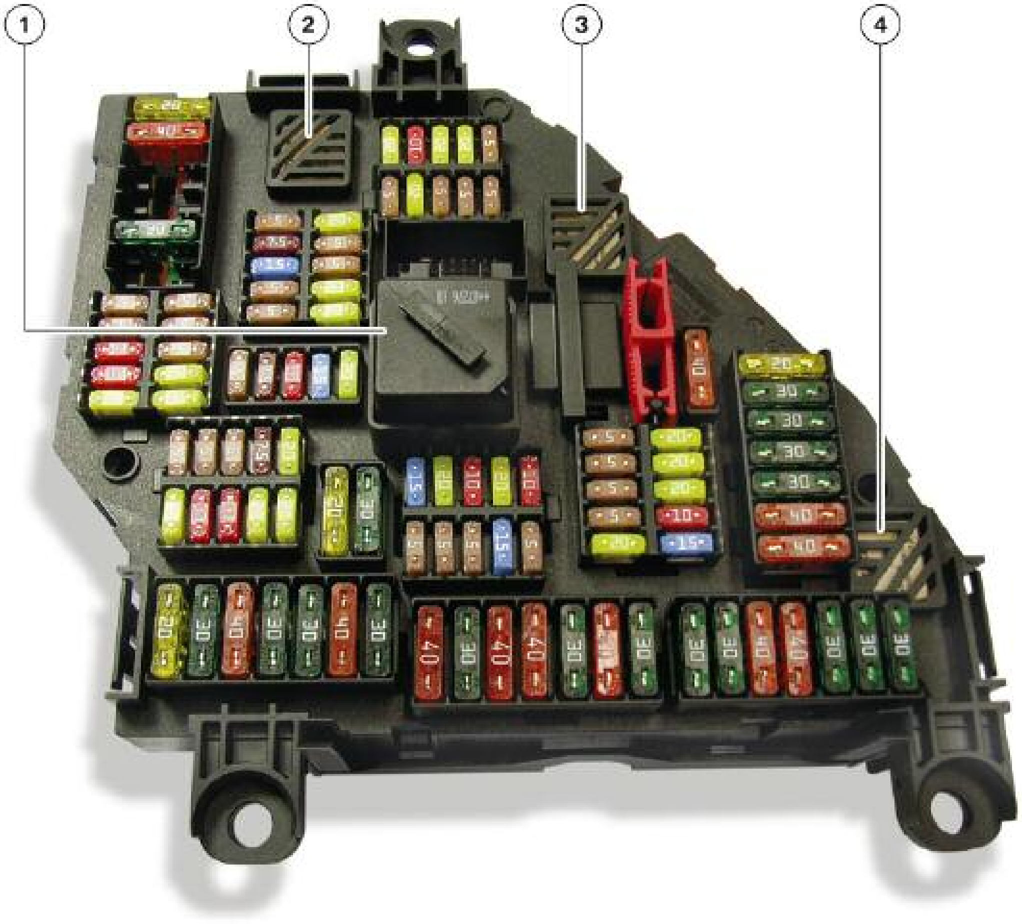
Index	Explanation
1	Negative battery terminal
2	Intelligent battery sensor
3	Negative battery cable

Rear Fuse Carrier in the Luggage Compartment

Due to the large number of consumers and control units in the F01/F02, an additional fuse carrier has been fitted in the luggage compartment.

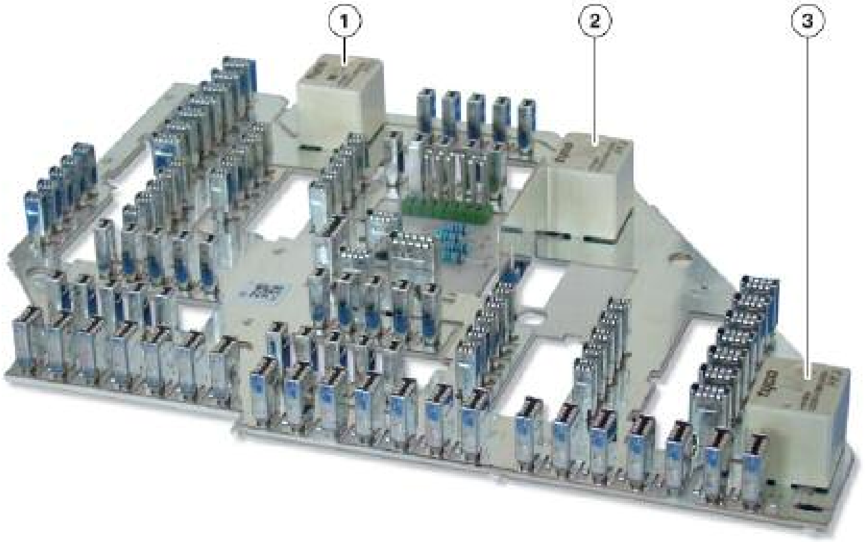
As well as the fuses, a few relays are plugged in here or soldered to the circuit board. If one of the soldered relays is faulty, the rear distribution box must be replaced as a whole unit. The connection port of the battery cable is located on the rear of the fuse carrier.

External view of the rear fuse carrier in the F01/F02



Index	Explanation	Index	Explanation
1	Relay terminal 30B (plugged in)	3	Relay terminal 15N (soldered)
2	Relay terminal 30F (soldered)	4	Relay for the heating element in the rear window (soldered)

Internal view of the rear fuse carrier in the F01/F02



Index	Explanation	Index	Explanation
1	Relay terminal 30F	3	Relay for the heating element in the rear window
2	Relay terminal 15N		

Battery Cables

In the F01/F02, three main power lines on the underbody run from the distribution box at the battery to the engine compartment. One of the main power lines runs via the positive battery terminal to the starter motor and to the alternator.

The second line powers the engine electronics (and electric coolant pump).

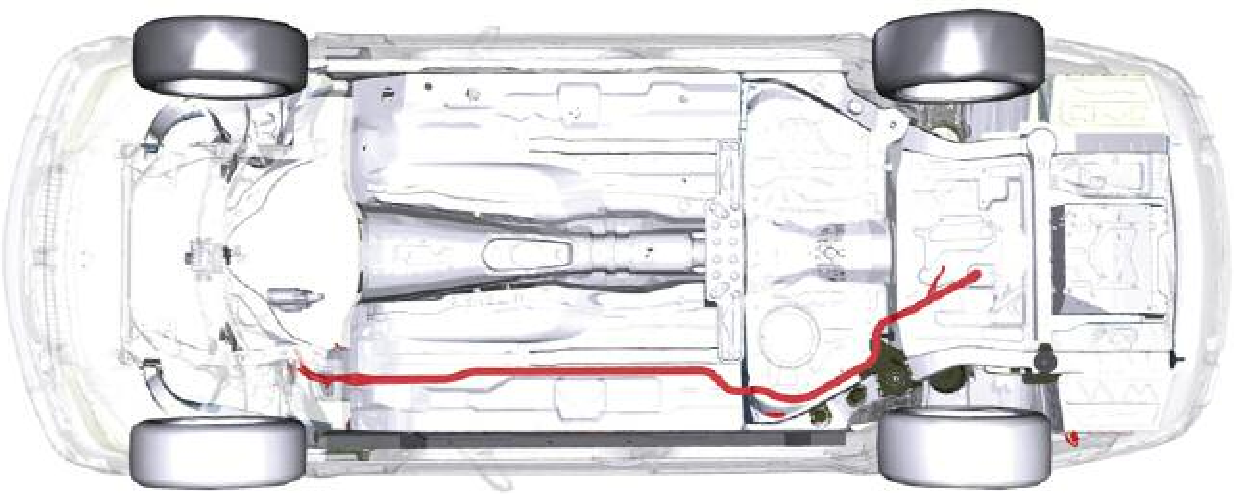
The third line runs to the distribution box in the engine compartment. This distribution box supplies the electric fan with power. This line is safeguarded by the high-current fuse (100 A) in the distribution box at the battery.

Cable	Cross section	Material
Cable to the starter motor and alternator	110 mm2	Aluminum
Cable to the front distribution box, behind the glove compartment	25 mm2	Copper
Cable to the rear fuse carrier	10 mm2	Copper
Cable to the power distribution box in the engine compartment	16 mm2	Copper

In addition, a battery cable is routed to the front fuse carrier through the vehicle interior.

The transfer points for the main power cables are located in the luggage compartment. The main power lines on the underbody are laid in a protected area to prevent damage.

Routing of battery cable on the underbody in the F01/F02

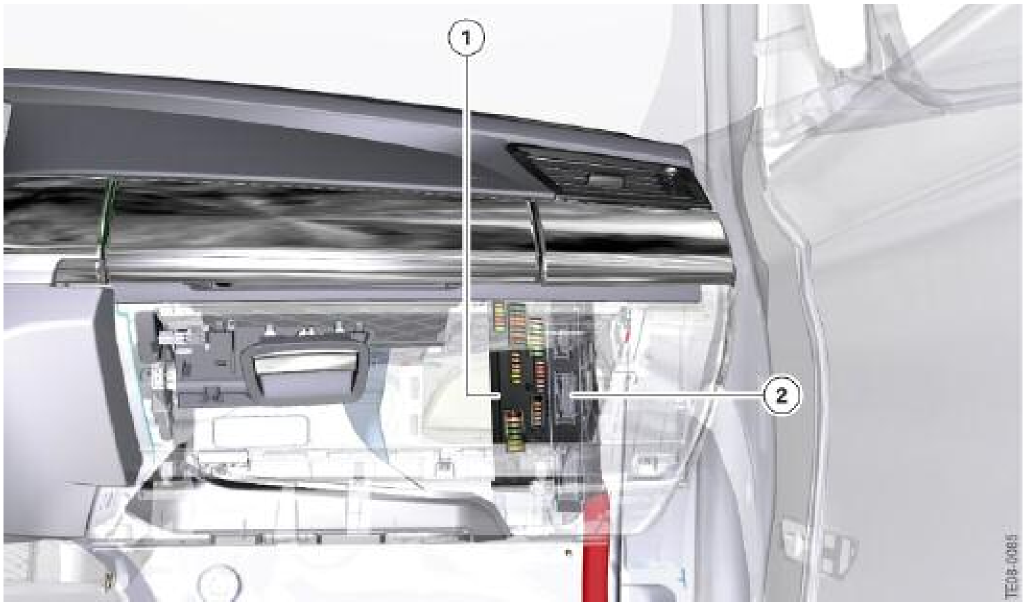


Front Fuse Carrier

This section describes the front fuse carrier(1). In the right-hand part of the front fuse carrier, there is an opening through which the junction box electronics (2) are connected to the front fuse carrier.

The front fuse carrier is located underneath the dashboard on the right-hand side. In order for a fuse to be replaced, the glove compartment must be opened.

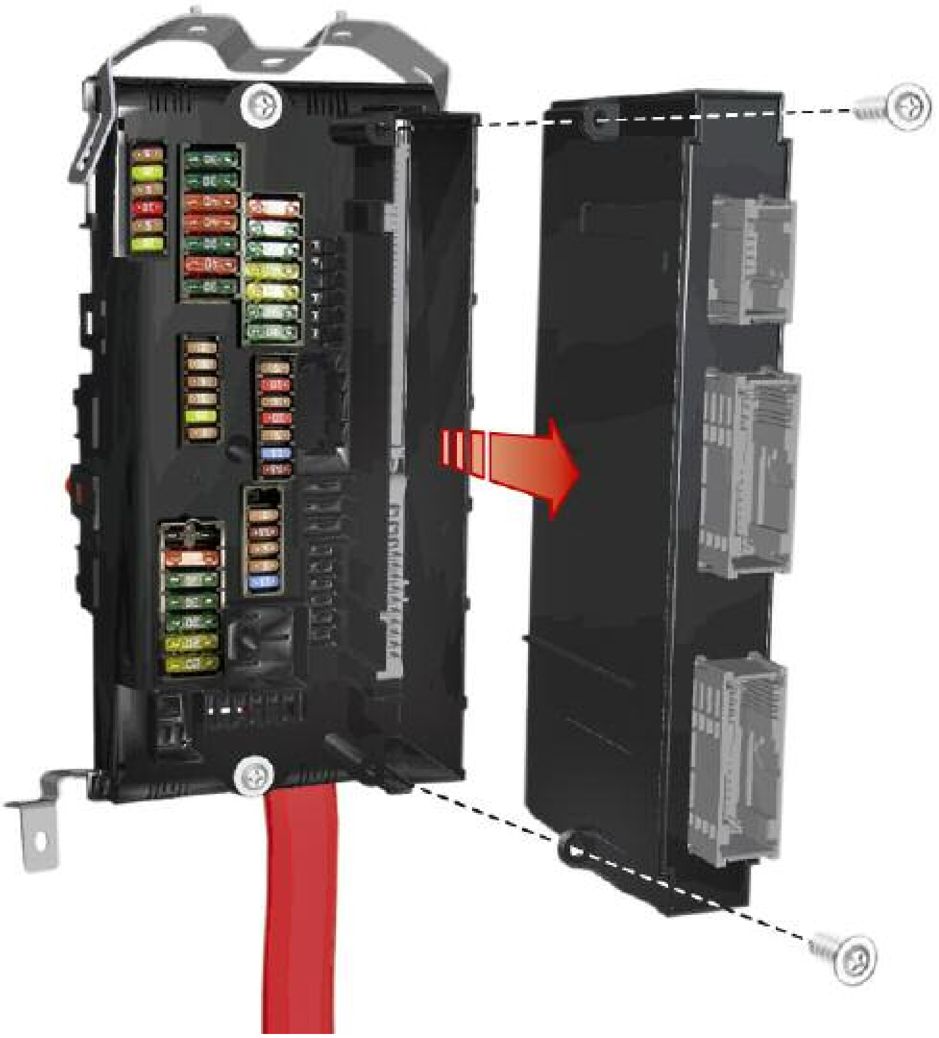
Installation location of the front fuse carrier in the F01/F02



Front Fuse Carrier and Junction Box Electronics

The connection between the front fuse carrier and the junction box electronics is established through the opening in the right-hand area of the fuse carrier. An internal plug connection provides the electrical connection between the two components.

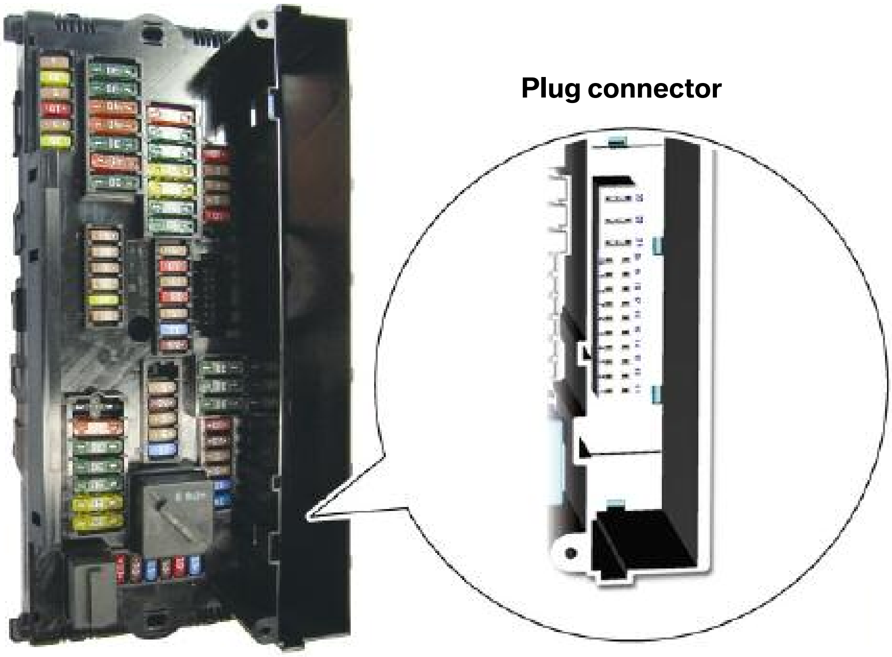
Junction box electronics and front fuse carrier in the F01/F02



When assembled, the two components form a single unit (junction box) consisting of the junction box electronics and the front fuse carrier.

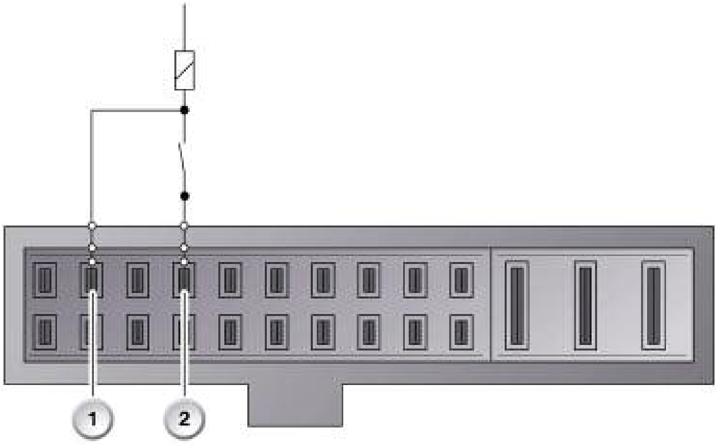
The fuse carrier and junction box electronics components must be replaced separately. In addition to the corresponding test modules in the diagnostics, diagnosis cables are also available with which electrical measurements can be made directly on the control-unit plugs and on the internal interface.

Internal Plug Connection



The internal plug connection is located on the right hand side, inside the opening for the junction box electronics.

Internal plug connection for the junction box electronics in the F01/F02



Index	Explanation	Index	Explanation
1	Monitoring connection	2	Actuation connection

The internal plug connection is responsible for Relays in the front fuse carrier activating the relays in the front fuse carrier. In addition, the correct functioning of these relays is monitored by the junction box electronics

There are a few relays in the front fuse carrier. One of these is plugged in, the others are soldered to the circuit board.

Connected Relay

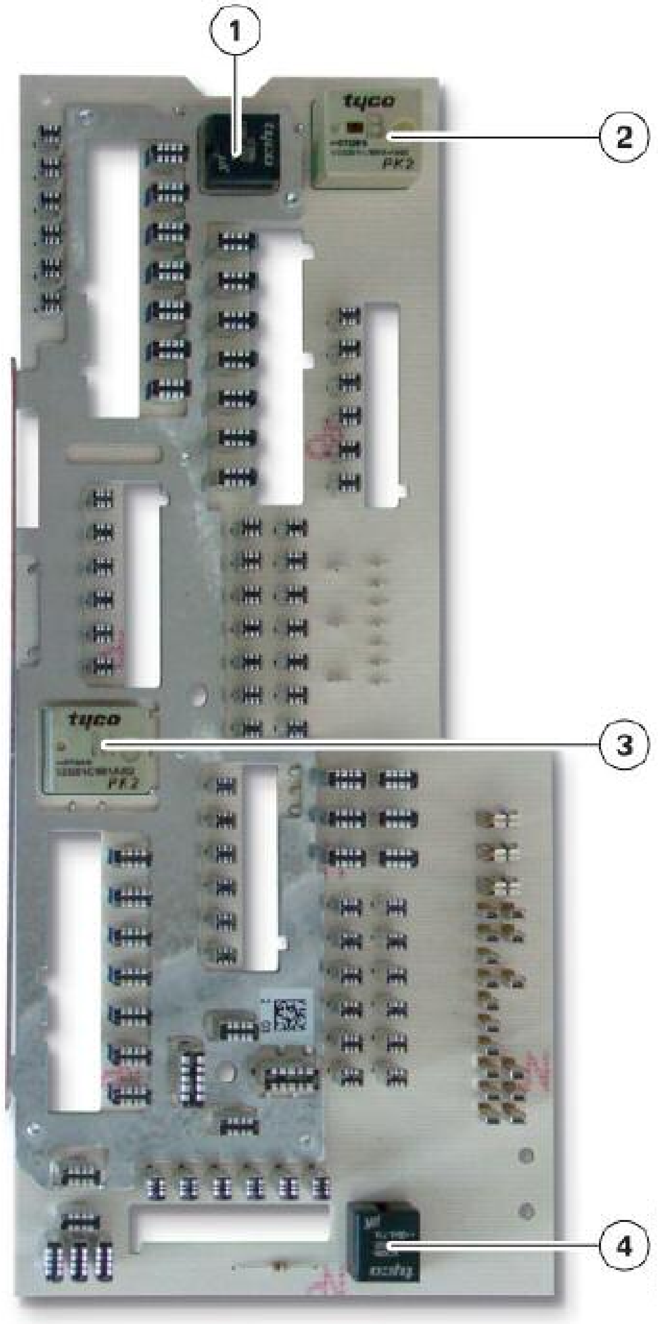
Front view of the front fuse carrier in the F01//F02

Index	Explanation
1	Relay terminal 30B

Soldered Relay

Various relays are soldered to the circuit board in the front fuse carrier. In the event of a fault, the fuse carrier must be replaced as a complete unit.

Internal view of the front fuse carrier, F01/F02



Index	Explanation	Index	Explanation
1	Relay, terminal 30F (bistable)	3	Relay, terminal 15N
2	Relay for the headlight cleaning system	4	Horn relay

Direct Contacting

On the distribution boxes, direct contacting to the fuses is carried out. The fuses are plugged into the plug connections on the circuit board with a connection. The other plug connections are directly connected to the connecting plugs on the wiring harness.

The advantages of this design modification are:

- Improved package space utilization
- Improved heat dissipation.

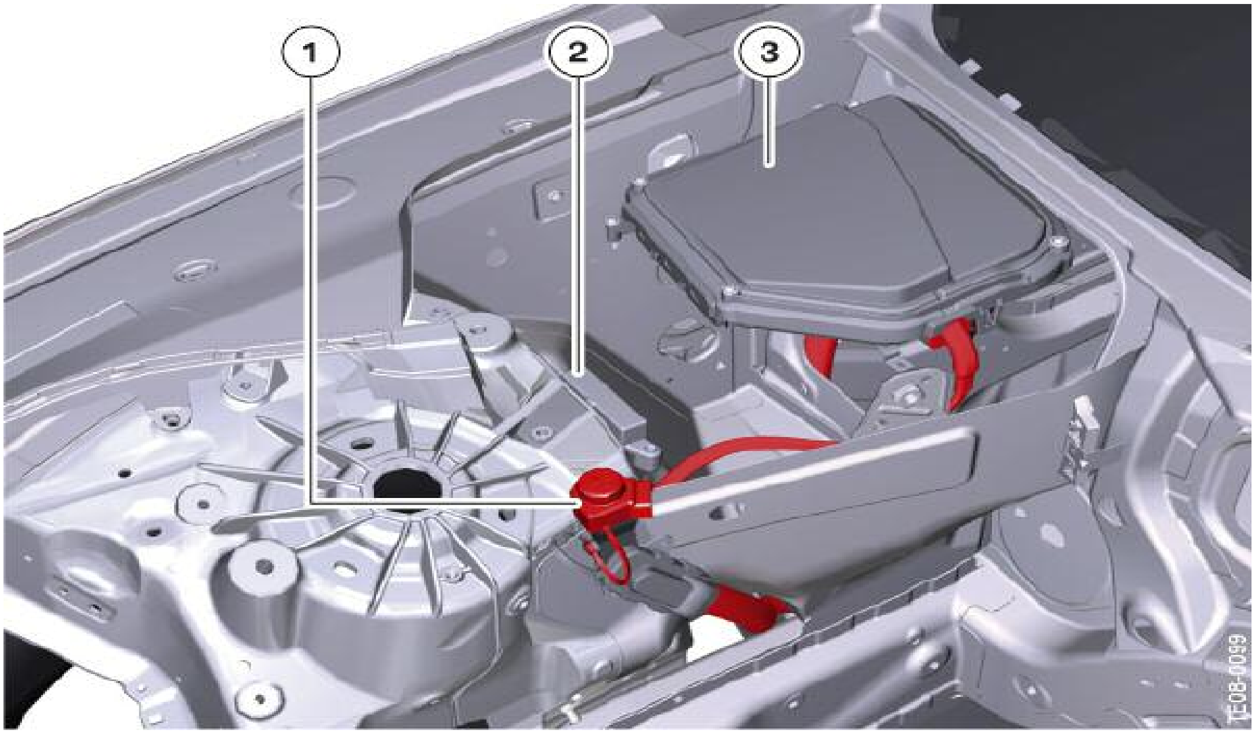
Direct contacting of fuses in the F01/F02

Index	Explanation	Index	Explanation
1	Front fuse carrier housing	3	Wiring harness connector
2	Fuse		

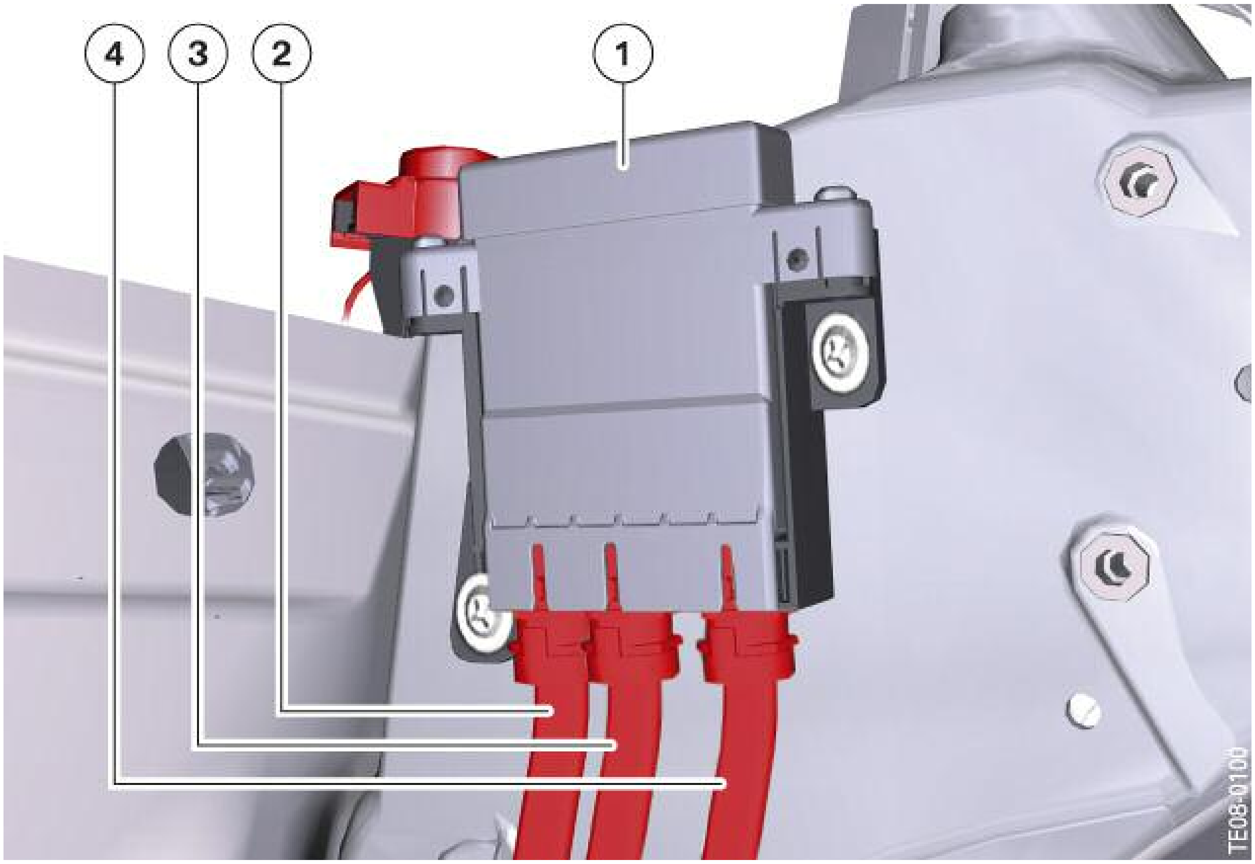
Particular care must be taken to ensure that the fuses are fitted firmly when unplugging and reconnecting the connectors for the wiring harness. The fuses must be braced when plugging in the wiring harness.

Power Distribution Box in Engine Compartment

There are no fuses in the engine compartment distribution box.



Index	Explanation	Index	Explanation
1	Positive battery terminal	3	Electronics Box
2	Power distribution box in engine compartment		



Index	Explanation	Index	Explanation
1	Power distribution box in engine compartment	3	Cable to electric fan
2	Cable from distribution box to battery	4	Not for US market

Table of Contents

F01 Energy Management

Subject **Page**

Energy Management

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand changes to the Energy Management

The Energy Circuit in the Vehicle

The vehicle's electrical energy system comprises all components for generating, storing, distributing and converting electrical energy.

The job of the vehicle's electrical energy system is to supply and distribute electrical energy in all vehicle operating situations. The aim is to provide all electrical components with the necessary electrical energy in all vehicle situations.

The highest-priority aims are maintaining the vehicle's ability to start and trouble-free operation of the vehicle when it is being driven. Another aim is to minimize wear (high battery energy throughput) and prevent damage to components (total battery discharge) of the vehicle's electrical system by networking, dimensioning and appropriate control of devices that consume, store and convert electrical energy.

Like the other current BMW Group models, the F01/F02 uses an energy management system to ensure balanced use of energy on the vehicle.

The energy management functions are integrated in the power management system that is implemented in the form of software on the engine management module.

Energy management encompasses a large number of functions such as:

- Power terminal shut-down
- Electric load shut-down
- Determining required battery charge voltage
- Enabling battery discharge
- Idle speed boost
- Detecting battery condition
- Vehicle programming.

The sections that follow describe only the most important changes to the energy management system.

Bus Overview and Terminal Status

The F01/F02 introduces new designations for some of the terminals. A distinction is also made between logical terminals and power supply terminals. The logical terminals are:

- Terminal R
- Terminal 15
- Terminal 50.

The power supply terminals are:

- Terminal 30
- Terminal 15N
- Terminal 30B
- Terminal 30F.

The logical terminals do not serve as power supply terminals; instead, they represent a status. They are activated/deactivated by pressing the START-STOP button.

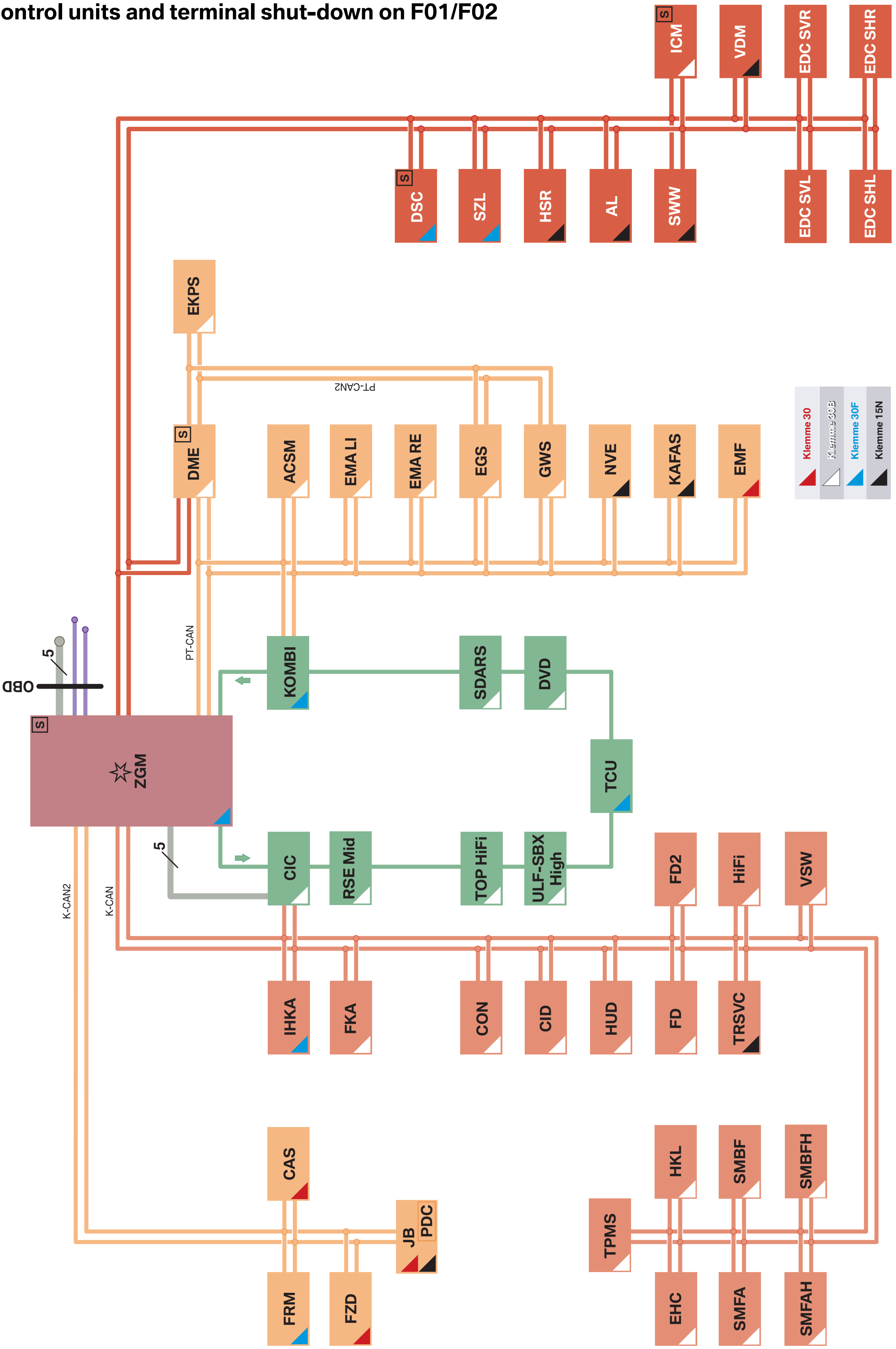
The table below details the previous and new terminal designations.

Previous	New
Terminal 15	Terminal 15N
Terminal 30g	Terminal 30B
Terminal 30g_f	Terminal 30F

For clearer illustration of terminal shut-down, the control units are identified by a colored triangle. Identification and allocation to the individual terminals are shown in the diagram below.

Color coding

Control units and terminal shut-down on F01/F02



Index	Explanation	Index	Explanation
AL	Active steering	HKL	Tailgate lift
CAS	Car Access System	HSR	Rear suspension slip angle control
CIC	Car Information Computer	HUD	Head-up display
CID	Central information display	ICM	Integrated Chassis Management
CON	Controller	IHKA	Automatic climate control
DME	Digital Motor Electronics	JBE	Junction Box electronics
DSC	Dynamic Stability Control	KAFAS	Camera-based driver assistance systems
DVD	DVD changer	Kombi	Instrument cluster
EDC SHL	Electronic Damper Control, rear left satellite unit	NVE	Night Vision module
EDC SHR	Electronic Damper Control, rear right satellite unit	PDC	Park Distance Control
EDC SVL	Electronic Damper Control, front left satellite unit	OBD	Diagnosis connector
EDC SVR	Electronic Damper Control, front right satellite unit	RSE-Mid	Rear seat entertainment
EGS	Electronic transmission control unit	SDARS	Satellite tuner
EHC	Electronic ride-height control	SMBF	Front passenger seat module
EKPS	Electric fuel pump control unit	SMBFH	Rear passenger-side seat module
EMA LI	Motorized reel, left	SMFA	Driver's seat module
EMA RE	Motorized reel, right	SMFAH	Rear driver's-side seat module
EMF	Electromechanical parking brake	SWW	Lane departure warning
FCON	Rear Controller	SZL	Steering column switch cluster
FD	Rear display	TCU	Telematics Control Unit
FD2	Rear display 2	TOP-HIFI	Top-HiFi system
FKA	Rear climate control	TPMS	Tire pressure monitoring system
FLA	Main beam assistant	TRSVC	Control unit for reversing camera and SideView
FRM	Footwell module	ULF-SBX	Interface box (ULF functionality)
FZD	Roof function center	VDM	Vertical dynamics management (central control unit for electronic damper control)
GWS	Gear selector switch	VSW	Video switch
HiFi	HiFi amplifier	ZGM	Central Gateway Module

Power Management

The power management system is a subsystem of the energy management system. The power management functions are carried out by the engine management module (DME).

The power management system regulates the power consumption of some of the most important electrical devices and the power output of the alternator while the vehicle is being driven.

Only advanced power management (APM) is used on the F01/F02.

In addition to the main functions of basic power management (idling speed and required battery charge voltage), APM also incorporates the following extended functions:

- Electric load reduction
- Electric load shut-down
- Vehicle systems diagnosis
- Battery diagnosis.

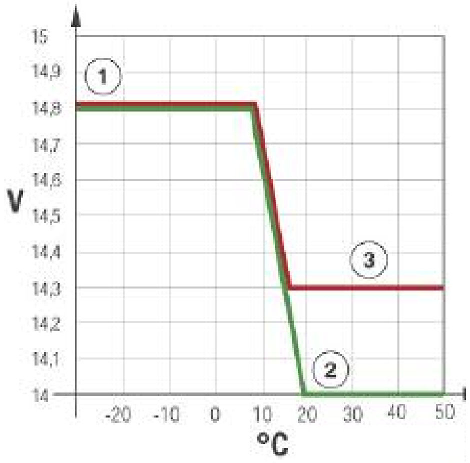
Idle Speed Boost

On vehicles with gasoline engines, the idling speed is raised by up to 200 rpm as soon as current starts to be drawn from the battery despite the alternator working at full capacity.

Charging Voltage Target Value

The required battery charge voltage is determined according to outside temperature and IGR function.

Voltage regulation on alternator on F01/F02



Index	Explanation
1	Model-based battery temperature of 8 °C
2	Model-based battery temperature of 19 °C
3	Emergency operation

Effect of Outside Temperature

The required battery charge voltage function ensures electrochemically optimum battery charging by adjusting the battery charge voltage according to temperature. Since the current absorbed by a cold battery is lower, the voltage for charging must be higher than for a warm battery.

Conversely, if that higher voltage were constantly used to charge a warm battery, there would be a risk of gas formation. Therefore, the charge voltage is regulated on the alternator according to temperature. The current battery temperature is measured by the intelligent battery sensor (IBS) attached directly to the battery negative terminal and signalled to the engine management module (DME) via the LIN bus.

The power management uses this value as the input variable for calculating the battery temperature. With the aid of a calculation model, the specified charging voltage is set based on the battery temperature. This information is sent to the alternator via the bit-temperature of serial data interface (BSD).

Battery Regeneration

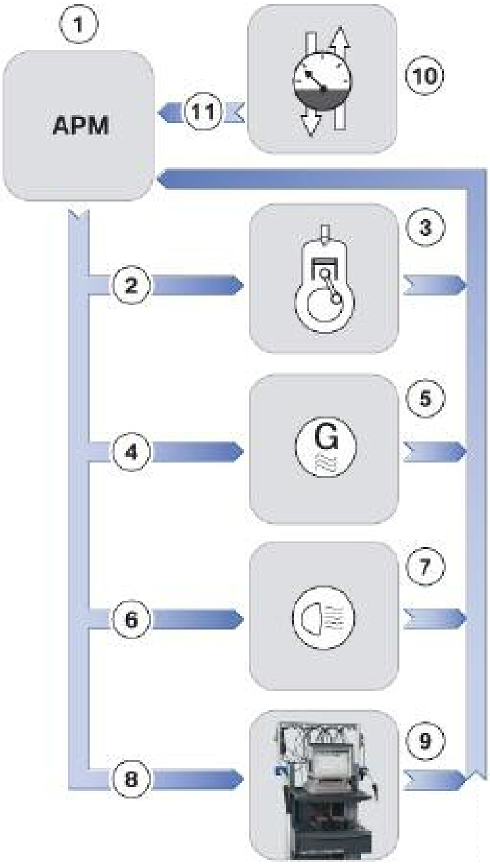
In order to ensure the availability of IGR Low, a certain level of unused capacity must always be retained in the battery. That is implemented by means of IGR High and IGR Medium. For the battery, that means that it is never fully charged. If a battery were not fully charged over a long period or were left fully discharged, sulphation could occur. Sulphation causes a battery to prematurely age, thereby reducing the usable proportion of its rated capacity. To prevent that occurring, the required battery charge voltage function performs a battery regeneration cycle in the course of which the battery is fully charged.

On vehicles with IGR function, regular battery regeneration phases are maintained in order to protect the battery against premature aging and loss of capacity due to cyclic discharge and sulphation. That involves the battery being fully charged using the maximum permissible charge voltage taking account of ambient conditions (temperature, charge level).

Emergency Operation

The APM makes use of emergency operation set to a constant 14.3 V. A fault code functions when there is a break in the LIN "Communication LIN" is entered in the fault interface. In this case, the alternator voltage is code memory of the engine management.

APM Control System



Index	Explanation
1	Advanced power management
2	Idle speed boost
3	Combustion engine
4	Charging voltage target value
5	Alternator
6	Electric load reduction
7	Electric loads
8	Electrical system and battery diagnosis
9	BMW diagnostic system
10	Intelligent battery sensor
11	Battery data

Electric Load Reduction

In order to reduce the power consumption in critical situations, not only can the idling speed be increased and the required charge voltage raised, the power of various non-essential electrical devices can be reduced or they can be switched off altogether. That prevents the battery being discharged.

The electrical devices (that consume power when the engine is running) are subdivided into two classes.

- **Class A**
  A reduction of the power consumption or shut-down of these devices is only noticeable to the driver to a limited degree or after a delay. Individual Class A devices are only switched off or have their power consumption reduced under the following 2 conditions:
  - Battery charge status in critical range
  - High load on alternator.
- **Class B**
  A reduction of the power consumption or shut-down of these functions is immediately noticeable to the driver. Individual Class B devices are only switched off or have their power consumption reduced under the following condition:
  - Battery charge status in critical range.

Class A Electrical Devices

The following measures are taken for Class A devices under the conditions specified above:

Sequence	Function	Operation	Control unit
1	Rear window defogger	Clocking	IHKA
2	Seat heating, rear Electric auxiliary heater, rear	Stage 2 75%	SM FAH SM BFH JB FKA
3	Seat heating, front Seat heating, rear	Stage 2 50%	SM FA SM BF JB SM FAH SM BFH JB
4	Electric auxiliary heater, rear	50%	FKA
5	Seat heating, front Seat heating, rear	50% Stage 1	SMFA SMBF JB SM FAH SM BFH JB
6	Electric auxiliary heater, rear Steering wheel heating	25% 50%	FKA SZL
7	Electric auxiliary heater, rear Mirror heating Washer-jet heating	OFF OFF OFF	FKA FRM/JB JB
8	Steering wheel heating	OFF	SZL
9	Seat heating, front Seat heating, rear	OFF OFF	SMFA SMBF JB SM FAH SM BFH JB

Sequence	Function	Operation	Control unit
10	Rear window defogger	OFF	IHKA
	Top-HiFi system or BMW individual high end audio system	Maximum 30 A power consumption after engine started	Top HiFi High End Audio

All measures are implemented in the specified order.

Class B Electrical Devices

The following measures are taken for Class B devices under the conditions specified above:

Sequence	Function	Operation	Control unit
1	Top-HiFi system or BMW individual high end audio system Heater fan, front and rear	Maximum 30 A power consumption in general 75%	Top HiFi High End Audio IHKA FKA HKA
2	Heater fan, front and rear	50	IHKA FKA HKA
3	Heater fan, front and rear	25%	IHKA FKA HKA

All measures are implemented in the specified order.

Once the battery charge level is outside the critical range, the functions are fully available again.

Note: While shut-down of individual devices or reduction of their power consumption is active, the displays remain active (LEDs remain on).

Note: If devices have their power consumption reduced or are switched off, a fault memory entry is registered and the history memory records the duration, odometer reading, and the function concerned.

Advanced Power Management

Vehicle in Stationary Mode

■ Electric loads in stationary mode

Certain electric loads may be active even when the closed-circuit current monitoring facility of the power management is already in operation. This is necessary for various reasons:

- Legally required electric loads, e.g. side lights, hazard warning system
- Convenience for the customer, e.g. radio function, telephone.

These electric loads must be excluded from the closed-circuit current monitoring system in order to avoid misinterpretation in the power management. For this purpose, these electric loads must log in with the power management.

In turn, the power management recognizes the activity and accepts the higher power consumption when the systems are deactivated, the corresponding control units log off from the power management.

■ Stationary load log-off

The power management in the engine control can send a request to switch off the active electric loads in stationary mode depending on the battery charge status and the start capability limit. The electrical devices operating when the vehicle is in stationary mode must then deactivate their functions irrespective of the terminal status and must have attained their closed-circuit current within 5 minutes. Legally required electric loads are excluded from this function.

Terminals

New Terminal Designation

The F01/F02 introduces new designations for some of the terminals. A distinction is also made between logical terminals and power supply terminals. The logical terminals are:

- Terminal R
- Terminal 15
- Terminal 50.

The logical terminals do not serve as power supply terminals; instead, they represent a status. They are activated/deactivated by pressing the START-STOP button. Their status is signalled to the control units by means of a bus message.

The power supply terminals are:

- Terminal 30
- Terminal 15N
- Terminal 30B
- Terminal 30F.

The table below details the previous and new terminal designations.

Previous	New
Terminal 15	Terminal 15N
Terminal 30g	Terminal 30B
Terminal 30g_f	Terminal 30F

Terminal	Description
Terminal 15	Terminal 15N
Terminal R	Radio setting
Terminal 30	Continuous positive
Terminal 30g	Continuous positive, time dependent
Terminal 30g_f	Continuous positive, fault dependent

Terminal 15N

Terminal 15N is used to supply power to control units and components that are only intended to be active when the vehicle is being driven, e.g. PDC.

The letter “N” stands for “Nachlauf”, meaning “overrun”. The power supply Terminal 15N is switched on and off by means of the logical Terminal 15. The overrun time after Terminal 15N is switched off is 5 seconds. That time is required so that the control units have enough time to save their data. While Terminal 15N is active, Terminal 30B and Terminal 30F are also active.

Terminal 30B

Terminal 30B supplies power to control units and electrical components that are required when the driver is present.

The letter B stands for “Basic mode”.

Terminal 30B is activated by:

- Pressing the buttons on the radio remote control
- Unlocking/locking/double-locking the vehicle
- Pressing the START-STOP button
- Change of door switch status, change of trunk switch status, change of side-window position
- Bus message.

Regular deactivation by:

- Vehicle double-locked and tailgate closed (one minute overrun)
- Vehicle not double-locked or tailgate open (30 minutes overrun).

Other possible deactivation triggers:

- Upper starting capacity limit reached (one minute overrun)
- “Powerdown”: diagnosis command for purposes of measuring closed-circuit (10 seconds overrun)
- Transport mode (one minute overrun).

While Terminal 30B is active, Terminal 30F is also active.

Terminal 30F

Terminal 30F supplies power to control units and electrical devices that are also required when the driver is not present but which can be switched off in the event of a fault.

Use: all control units that are not supplied by Terminal 15N or Terminal 30B, are not responsible for vehicle access and do not have to meet a legal requirement for permanent operation.

The letter “F” stands for “Fault”.

Terminal 30F is activated by:

- Pressing the buttons on the radio remote control
- Unlocking/locking/double-locking the vehicle
- Pressing the START-STOP button
- Change of door switch status, change of tailgate switch status, change of side-window position
- Bus message.

In the event of a fault (closed-circuit current too high, bus wake-up, sleep-mode inhibitor, start capacity limit reached) Terminal 30F is reset for 10 seconds.

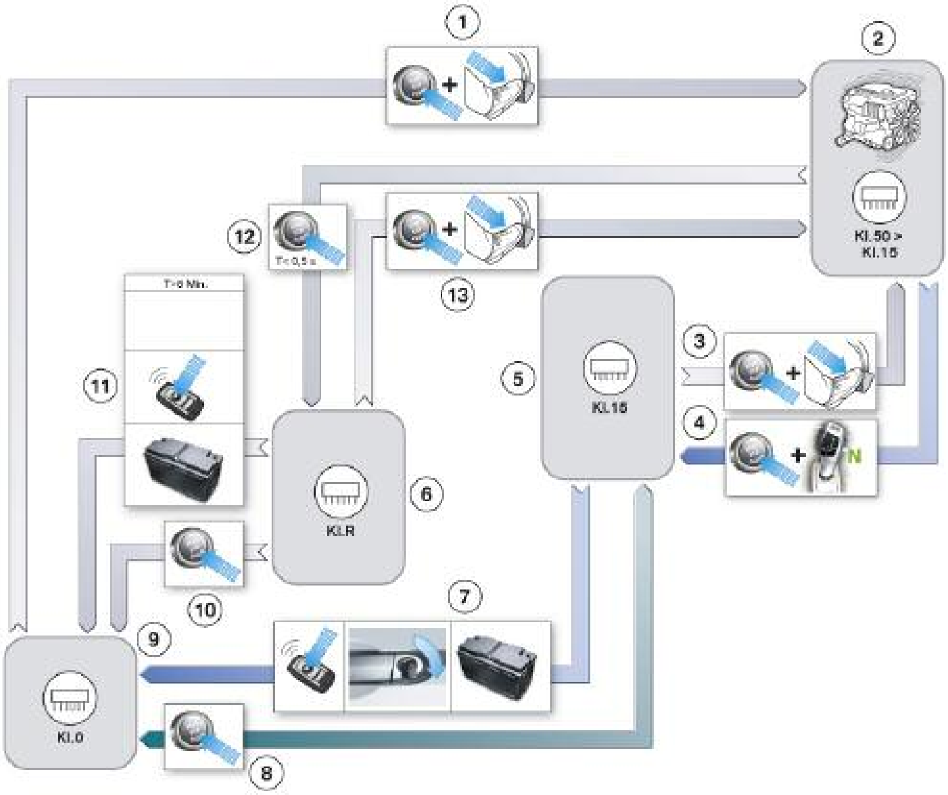
Terminal 30F is not reset or switched off if at least one of the following conditions is met:

- Terminal 30B active
- Parking lights switched on
- Side lights switched on
- Hazard warning lights switched on
- If an extended overrun time for Terminals 30B and 30F is demanded by a service message from any of a number of control units. Example: when the engine is warm, it can be necessary for the electric fan to run on for up to 11 minutes after the vehicle is parked and locked. In order for the electric fan to be operated, the engine management module must be supplied with power. Since the overrun time in that case is only three minutes (that is currently the short overrun time for Terminal 30B, not one minute), the DME requests the appropriate extension by way of a bus message when the engine is switched off.
- “Sticking relay” detected.

Terminal 30F is switched off if Terminal 30B is off and at least one of the following conditions is met:

- Starting capacity limit reached
- Another 10 bus wake-ups have occurred after Terminal 30F reset
- Unexplained bus activity after Terminal 30F reset
- Violation of closed-circuit current limit detected after Terminal 30F reset.

Terminal control



Index	Explanation	Index	Explanation
1	START-STOP button pressed and brake pedal operated --> Terminal 50 is activated and engine starts	8	Pressing the START-STOP button toggles terminal status between Terminal 15 and Terminal 0.
2	Engine running (Terminal 50 > Terminal 15)	9	Terminal 0
3	START-STOP button pressed and brake pedal operated —> Engine starts.	10	Pressing the START-STOP button changes the terminal status from Terminal R to Terminal 0.
4	If selector lever is in position “N” and the engine is stopped by pressing the START-STOP button, Terminal 15 remains on for 15 minutes.	11	Change from Terminal R to Terminal 0 if more than 8 minutes elapsed or vehicle is locked or starting capacity limit reached.
5	Terminal 15	12	START-STOP button briefly pressed -> Engine stops. Terminal R.
6	Terminal R	13	START-STOP button pressed and brake pedal operated —> Engine starts.
7	Terminal 15 OFF when vehicle is locked or starting capacity limit reached.		

Terminal Relays

The F01/F02 has various relays for switching off the power supply to most control units.

Location	Relay	Connection	Controlled by:
Front fuse box	KL 15N	Soldered	CAS
Front fuse box	KL 30B	Plugged in	CAS
Front fuse box	KL30F (bistable)	Soldered	ZGM/DME
Rear fuse box	KL 15N	Soldered	CAS
Rear fuse box	KL 30B	Plugged in	CAS
Rear fuse box	KL30F (bistable)	Soldered	ZGM/DME

The Junction box module controls the bistable relays for Terminal 30F but receives the request from the central gateway module (ZGM) or IBS.

- ZGM: If sleep mode inhibited or on occurrence of unauthorized wake-up.
  ZGM monitors the vehicle status and registers inhibited sleep mode or unauthorized wake-up after Terminal 30B is switched off.
- IBS: If closed-circuit current limit violated or starting capacity limit reached.

The computation for activating the Terminal 30F relay takes place on two control units. The ZGM monitors the following activities:

- Invalid wake-up procedures within the bus systems
- Sleep blockers (control units that constantly keep the bus systems active).

The ECM (DME) continuously reads and assesses the battery data. The relay is also switched off when the starting capability limit of the vehicle battery is reached.

The Terminal 30F relay is a bistable relay and is always in the ON state under normal conditions. It switches off the connected electric loads only in the case of fault. Once the Terminal 30F relay has been switched off, one of the switch-on conditions must be met before it can be switched on again.

Note: More information on this topic can be found in the Reference Information on the CAS.

General Measures

The terminals "load shut-down" and the terminal "interior lighting" are switched off as a general measure when the vehicle is in stationary mode. This occurs only when the vehicle is not locked and secured. These loads are shut down immediately when the vehicle is locked and secured. This measure affects the following electric loads:

Electric loads	Terminal
Interior lighting (front and rear	Load shut-down after 8 minutes (immediately if double locked)
Footwell lighting (front and rear)	Load shut-down after 8 minutes (immediately if double locked)
Reading light (front and rear)	Load shut-down after 8 minutes (immediately if double locked)
Vanity mirror light	Load shut-down after 8 minutes (immediately if double locked)

System Components

Components

The components of the energy management system are:

- Engine
- Alternator
- Vehicle battery
- Intelligent battery sensor
- Junction box module
- Engine management (power management)
- Loads.

The most important components of the energy management system are described in the following.

Intelligent Battery Sensor (IBS)

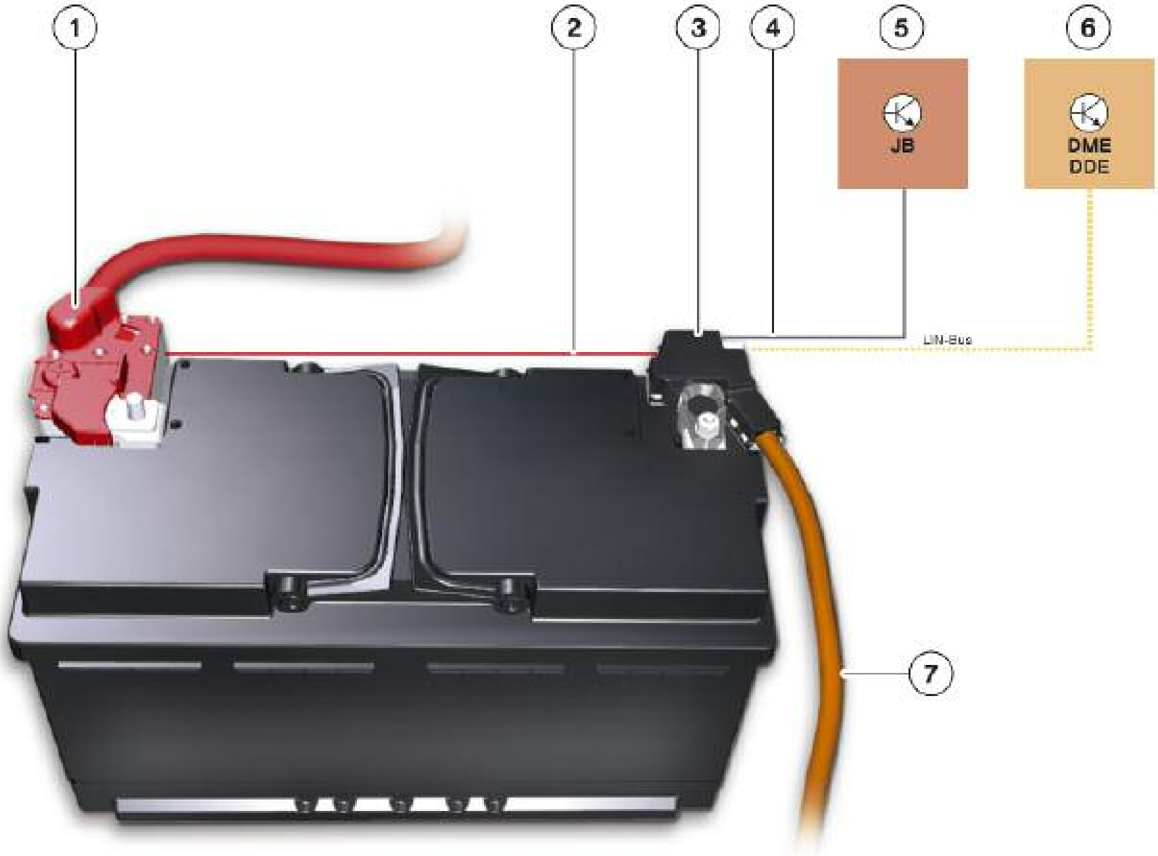
The intelligent battery sensor has a similar range of functions to the intelligent battery sensor on previous models. A new feature is data transmission between the IBS and the engine management module via LIN bus and the wake-up function of the IBS.

Index	Explanation
1	Battery negative terminal
2	IBS
3	Battery negative lead

The intelligent battery sensor (IBS) is a mechatronic component for monitoring the battery condition. The description “intelligent” indicates that the IBS has an integral microprocessor. That microprocessor performs the computation and assessment of time-critical measured variables.

The power supply for the IBS is provided by a separate lead from the power distribution box on the battery. The data from the IBS is passed to the higher-level control units (DME) via the LIN bus. If necessary, the IBS can wake up the Junction box module via a separate lead.

IBS in vehicle network



Index	Explanation	Index	Explanation
1	Battery positive lead	5	Junction box module
2	Power supply for IBS	6	ECM (DME)
3	IBS	7	Battery negative lead
4	Wake-up line	LIN	Local Interconnect Network bus

The following physical battery variables are registered by the IBS:

- Current
- Voltage
- Terminal temperature.

Among other things, the following main functions are integrated in the IBS:

- Continuous measurement of the battery current, voltage and temperature under all vehicle operating conditions.
- Calculation of the battery indicators as the basis for the charge and health status of the battery. The battery indicators are charge and discharge current, voltage and temperature of the vehicle battery. Alongside calculation of the battery indicators, preliminary computation of the battery charge level ("state of charge", SOC) is also carried out.
- Balancing of the charge/discharge current of the battery.
- Continuous monitoring of the battery charge status and making available the corresponding data in the event of insufficient battery power.
- Calculation of the current progression when starting the engine to determine the battery health status.
- Closed-circuit current monitoring of the vehicle.
- Self-diagnosis

Wake-up Function

When the vehicle is in idle mode, the IBS continuously records the data relevant to the battery indicators. The IBS is programmed to wake up every 14 seconds in order to update the measured data by taking new readings. The time required to take the readings is approximately 50 milliseconds. The measured data is stored on the IBS in the memory for recording the closed-circuit current.

The wake-up function applies only when the vehicle is in idle mode. If the IBS detects a wake-up trigger, the Junction box module is woken up by a PWM signal. The IBS is directly connected to the Junction box module via a separate lead.

The pulse duty factor indicates the reason for the wake-up:

Pulse duty factor	Reason for wake-up
20%	Starting capacity, limit 1
40%	Starting capacity, limit 2
60%	Raised closed-circuit current

A wake-up due to raised closed-circuit current can take place up to three times.

Depending on the vehicle status and reason for the wake-up, the Junction box module performs one of the following actions:

- Wakes up the vehicle so that the DME can send shut-down commands to electrical devices that are operating while the vehicle is in parked mode
- Resets Terminal 30F (without waking up the vehicle)
- Switches off Terminal 30F (without waking up the vehicle).

A fault memory entry is registered in each case.

Commissioning

The IBS is fully functional as soon as it has been fitted to the battery terminal (screwed to the grounding point and connected to the signal leads), i.e. it can immediately detect the basic variables, current, voltage and temperature.

However, the variables derived from those readings for the purposes of power management, i.e. battery condition, starting capacity, etc., must first be recalculated and, therefore, there is a time lag before they are available.

When the engine is restarted, the DME reads off the closed-circuit current progression. If it diverges from the defined closed-circuit current progression, a fault is registered in the DME fault memory.

In the period between “Engine OFF” and when the DME main relay is switched off, the IBS is informed by the DME as to the maximum charge that can be drawn from the battery on the basis of ensuring that the engine can be reliably restarted. After the DME main relay is switched off, the IBS continually checks the battery charge level (SOC) and the closed-circuit current.

Junction Box Module

The Junction box module (JBE) is responsible for switching the Terminal 30F relay and for storing information (history data and fault memory entries) related to energy management. As part of vehicle diagnostics, these data can be used to evaluate faults and to analyse the vehicle battery.

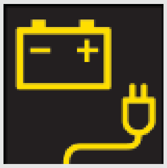
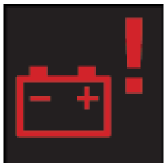
Engine Management (Power Management)
The (power management) software for controlling the energy balance is located in the engine management. On the basis of that control algorithm, various electrical devices in the vehicle's electrical system are switched off by the CAS control unit via the Terminal 30B relay or by the Central Gateway Module and engine management module via the Terminal 30F relay. The power management is additionally responsible for evaluating and storing the IBS data.

Transport Mode

Indication of Battery Condition

The batteries in vehicles coming off the production line are adequately charged so that SOC > 80% (SOC = “State of charge”). However, since several days or weeks can pass between the time the vehicle comes off the production line and when it is delivered to the customer, the battery will have discharged to a greater or lesser degree. Therefore, every battery must be charged according to the recharging calendar.

The F01/F02 is the first model on which it is possible to display the charge level of the battery when the new car is being transported. When production or transport mode is activated, a Check Control message is generated that provides a quick indication of the battery condition.

Battery condition	Display on instrument cluster	Audible signal	Action
Battery condition OK SOC 60% to 100%		No sound	No action necessary.
Battery is discharged. SOC 35% to 60%		No sound	Charge battery.
Battery charge level is very low. SOC less than 35%		Double gong	Replace battery.

Note: If the SOC has dropped to less than 35%, the indication continues to be displayed on the instrument cluster until the battery is replaced and a change of battery is registered.

Note: When transport mode is reset, there is no indication on the instrument cluster of the battery charge level.

Note: If the vehicle is delivered with the red Check Control message “Battery charge level very low” active, it is essential that the low battery charge is recorded as transport damage on the delivery note.

In such cases, the test module “Energy diagnosis” must be carried out to establish the cause. Replace the battery before handing over the vehicle to the customer and register the change of battery using the service function.

Note: If a vehicle is delivered with the yellow Check Control message “Charge battery”, this should also be recorded on the delivery note. The battery must then be charged once and an energy diagnosis carried out.

Functions switched off/modified in transport mode

On the F01/F02, the following functions are switched off/on in transport mode:

○ = Function is switched off

● = Function is switched on or changed.

Index	Function	Control unit	Transport mode
1	Mirror heating High (driver's/front passenger's door)	FRM	○
2	Home lighting	FRM	○
3	Welcome light	FRM	○
4	Daytime lights (bar can no longer be activated once vehicle has travelled more than 60 km)	FRM	○
5	Side lights in switch position “A” + “2” (at Terminal 15 OFF)	FRM	○
6	Parking light (at Terminal 0)	FRM	○
7	Turning lights	FRM	○
8	Adaptive headlights	FRM	○
9	Main beam assistant	FRM	○
10	Limitation of load shut-down time from 8 minutes to 1 minute (vanity mirrors, reading lights, interior lights are also switched off)	FRM	●
11	Pre-sleep mode, i.e. raised closed-circuit current when vehichle not locked for cyclic scanning of steering column and light selector switch; deactivated 1 minute after Terminal R OFF.	FRM	●
12	Power window (rear driver’s side)	JB	○
13	Power window (rear passenger’s side)	JB	○
14	Headlight washer system (SRA)	JB	○
15	Seat heating Low (driver/passenger, front and rear)	JB	○
16	Washer-jet heating	JB	○
17	Mirror heating Low (driver/passenger)	JB	○
18	Terminal 30F isolation after programmable period: Isolation generally occurs 1 minute after Terminal 30B OFF regardless of lock status.	JB	●
19	Electric sunblinds (middle, left/right)	JB	○
20	Output of Check Control message “TRAMODE” when transport mode set.	JB	●
21	Radio remote control (open/double-lock vehicle) Radio remote control only usable in transport mode when CAS active. To wake vehicle from sleep mode to use radio remote control, tailgate button must be pressed -> Bus awake -> Radio remote control active.	CAS	○

Index	Function	Control unit	Transport mode
22	Radio remote control, open tailgate Reason: transport damage to tailgate on train or truck due to inadvertent opening of tailgate by pressing radio remote control.	CAS	○
23	Limitation of Terminal 30B time from 30 min/60 min to 5 min	CAS	●
24	Reduction of Terminal R active time from 8 minutes to 1 minute regardless of whether door switch operated	CAS	●
25	Immediate switch from Engine Off to Terminal 0when Start/Stop button held pressed and when quickly pressed and released	CAS	●
26	Comfort Access, complete function	CAS	○
27	Slide/tilt sunroof FZD 8 28 DWA function	FZD	○
29	Read outside temperature sensor or cyclic query in vehicle idle mode	Kombi	○
30	Coolant temperature request from DME	Kombi	○
31	Clock function for aux. heating and aux. ventilation functions	Kombi	○
32	Set fault memory bar (excluding transport mode fault memory and high/low voltage fault memory	Kombi	●
33	Tailgate lift	HKL	○
34	Steering wheel heating	SZL	○
35	Seat heating (driver/passenger) SM 8		
36	Seat adjustment, passenger	ISM	○
37	Seat adjustment, rear	ISM	○
38	Lumbar support	ISM	○
39	Active seat ventilation	ISM	○
40	Active seat	ISM	○
41	Rear window defogger	IHKA	○
42	Blower; limitation to max. 50% Caution: if DEFROST button pressed > no limitation i.e. 100% blower output possible.	IHKA	●
43	Defrost function (100% fan power possible)	IHKA	●
44	Compressor coupling closed so disconnected from power	IHKA	○
45	Electric auxiliary heater (PTC)	IHKA	○
46	Residual heat function	IHKA	○
47	Auxiliary ventilation function	IHKA	○
48	Independent ventilation function	IHKA	○
49	PATT module	IHKA	○
50	Run-on of interior temp. sensor fan from Terminal R Off	IHKA	○

Index	Function	Control unit	Transport mode
51	Air vent positioning immediately after Terminal R OFF (due to Term. 30B + Term. 30F switching off)	IHKA	●
52	Aux. coolant pump and valve	IHKA	○
53	Rear fan; (total shut-down)	FKA	○
54	Rear PTC, left/right	FKA	○
55	Rear A/C control panel	FKA	○
56	Rear A/C fan; (total shut-down)	HKA	○
57	Flap setting	HKA	○
58	Head unit MOST active, unusable, no display, no entertainment system output; nevertheless, sound output from PDC; \ Diagnosis of MOST control units possible; MOST devices "not functioning": Top HiFi, CDC, DVD changer, ULF-SBX, SDARS/IBOC, RSE	CIC	●
59	HiFi amplifier, audio output	Top HiFi	○
60	Central information display, front	CID	○
61	Central information display, rear	FD	○
62	Video switch, video output and reception	VSW	○
63	Controller, rear Controller	CON/FCON	○
64	Bluetooth interface	ULF-SBX	○
65	Telematics function	TCU	○
66	Emergency call function	TCU	○
67	Telephone control, prevent wake-up of MOST bus	TCU	○
68	Night Vision	NVE	○
69	HUD (Head-up display)	HUD	○
70	All cameras	KAFAS	○
71	Ride height monitoring and levelling during overrun	EHC	○
72	Power supply to wheel satellites for VDC	VDM	○
73	ARS valves (5 in total)	VDM	○
74	ACC (heater, camera)	ICM	○
75	Power supply for RDC transmitter/function	RDC	○
76	Speed limitation to 4500 rpm	DME	●
77	Idle speed boost (upper idle speed value)	DME	●
78	Maximum charging voltage (+14.8 V to 40 °C)	DME	●
79	Deactivating IGR function	DME	○
80	Battery charge indication by CCM	DME	●

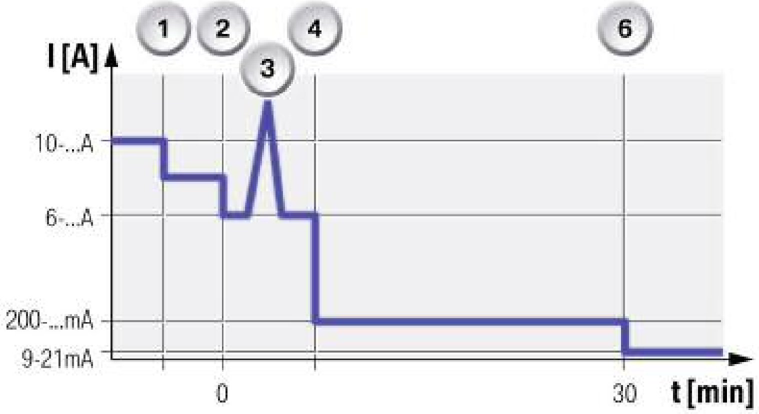
Closed-circuit Current

Upwards of a closed-circuit current level of 80 mA, a Check Control message is generated (raised battery discharge rate when parked).

Note: The closed-circuit current should always be measured if increased current consumption is suspected. Even power consumption levels only slightly above normal can cause relatively rapid battery discharge.

The graph below shows the typical closed-circuit current progression on the F01/F02 associated with the various electrical system statuses. The actual current values change depending on the vehicle equipment configuration.

Typical closed-circuit current progression for double-locked vehicle on F01/F02

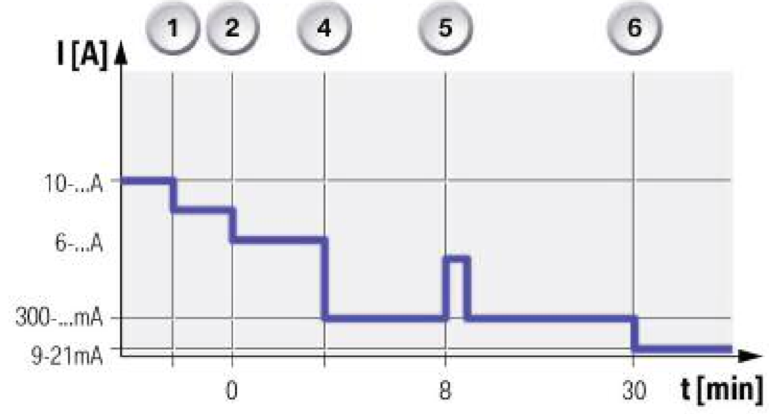


The terminal "load shut-down" (e.g. reading or 60 minutes with) light and vanity mirror light) is switched off corresponding to the terminal status.

Index	Explanation
1	Terminal 15N off
2	Terminal R off
3	Vehicle is secured (locked)
4	Start of bus rest phase
5	Electrical load shutdown after 8 minutes
6	KL30 B OFF (30 minutes w/o phone or 60 min with)

Load shut-down switches off immediately when the vehicle is secured. In all other terminal statuses, the load shut-down terminal is switched off after an overrun period of 8 minutes. It is activated by the footwell module.

Typical closed-circuit current progression for unlocked vehicle on F01/ F02



Electrical System and Battery Diagnosis

Over the past few years, the energy management of all BMW models has been continuously improved and standardized across the various model series. In terms of energy diagnosis, this also means standardization of testing schedules and displays in the BMW diagnostic system.

The aim of the diagnostic procedures is to show the causes of a discharged battery as unambiguously as possible. In view of the complexity, especially in the area of energy management, the specific cause of a fault can be shown only partially depending on its nature. The acquired energy diagnosis data are shown if the fault cannot be clearly assigned based on the acquired data.

Power management is retained in full while the expanded diagnostic options are now resident in the history memory.

ZGM monitors the vehicle status, registers inhibited sleep mode or unauthorized wake-up after Terminal 30B is switched off and requests a reset or shut-down of Terminal 30F by a bus message to the JBE.

The originator and reason for wake-up (unauthorized wake-up) are stored as additional information in the ZGM fault memory. The driving profile for the last 5 weeks is stored in the JBE energy history memory. The energy history memory is referred to for energy diagnosis purposes.

Table of Contents

F01 Chassis and Suspension

Subject **Page**

Chassis and Suspension

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the differences between the Integral IV and V rear axle.

- Understand the differences between chassis components and systems on the F01 as compared to the E65.

New Chassis Systems for F01/02

Through intelligent design layout and optimum package space utilization on the new F01/F02, the basis has been created for distinctly increasing the driving dynamics while improving comfort and vehicle handling.

At virtually identical wheel loads, a greater track width and a larger wheelbase have been realized compared to the predecessor, the E65.

The development of the new generation chassis and suspension systems in the new F01/F02 focused on revolution instead of evolution. The aim was to set a new benchmark.

The lightweight construction philosophy was consistently pursued in the design of the chassis and suspension systems. This is reflected in the widespread use of aluminum, representing an important contribution to increasing comfort and reducing CO2 emissions.

For the first time, a BMW Sedan is fitted with a double wishbone front axle made of aluminum, a steerable integral-V rear axle, BMW integral active steering (IAL) and the innovative damper system, the 2nd generation vertical dynamics control (VDC 2).

The integrated chassis management (ICM) intelligently links all chassis and suspension control systems, thus achieving a new level of functional quality. Further highlights include "Dynamic Drive" (ARS) and a fully variable power steering pump to improve fuel economy.

Explanation	E65	F01	E66	F02
Overall length	5039 mm	**5072 mm**	5179 mm	**5212 mm**
Wheelbase	2990 mm	**3070 mm**	3130 mm	**3210 mm**
Overhang, front	914 mm	864 mm	914 mm	864 mm
Overhang, rear	1135 mm	**1138 mm**	1135 mm	**1138 mm**
Vehicle Width	1902 mm	1902 mm	1902 mm	1902 mm
Front track width (basic wheel)	1578 mm	**1612 mm**	1578 mm	**1612 mm**
Rear track width (basic wheel)	1596 mm	**1646 mm**	1596 mm	**1646 mm**

Chassis and Suspension Comparison

Comparison	E65/E66	F01/F02
Front Axle	Doble pivot spring strut front axle	Double wishbone front axle
Suspension/damping, front	Steel spring/EDC	Steel spring/VDC 2
Stabilizer bar, front	Passive or Active (ARS)	Passive or Active (ARS)
Rear axle	Integral IV	Integral V
Suspension/damping, rear	Steel spring or Air spring/EDC	Steel spring or Air spring (VDC2)
Stabilizer bar, rear	Passive or Active (ARS)	Passive or Active (ARS)
Brake, front	Disc brake with rotor diameter of 348mm	Disc brake with rotor diameter of 373mm
Brake, rear	Disc brake with rotor diameter of 345mm	Disc brake with rotor diameter of 368mm
Parking brake	Drum brake with EMF	Drum brake with EMF
Wheels/tires	Standard tires	Runflat tires (as standard)
Steering	Power steering (w /Servotronic)	Power steering with Servotronic (optional IAL)

Track Width

The size of the track width at the front and rear has a decisive influence on the cornering characteristics of the vehicle and its tendency to roll.

- The track width should be as large as possible, however, it cannot exceed a defined value in relationship to the width of the vehicle.
- The fully deflected (spring compressed) wheel turned at full lock on the front axle must not scrape or snag in the wheel arch cutout.
- A certain degree of clearance for fitting snow chains is required on the drive axle (irrespective of whether this is the front, rear or both axles).
- The wheels must not make contact with any chassis or body parts when the suspension springs fully compress and rebound.

Wheelbase

The wheelbase -measured from the center of the front axle to the center of the rear axle has a decisive influence on the vehicle handling properties.

A large wheelbase compared to the length of the vehicle permits favorable accommodation of the vehicle occupants between the axles and reduces the influence of the vehicle load on the overall load distribution. Short body overhang at the front and rear reduces the pitching tendency.

A short wheelbase, on the other hand, provides favorable cornering characteristics, i.e. a smaller turning circle at the same steering lock angle.

The outstandingly balanced values on the E65 result in safe, superior and agile vehicle handling characteristics that represent the standard in the luxury class segment also for the future. These technical data are the prerequisite for achieving the top position in its class. In terms of driving dynamics, the F01/ F02 will assume a leading position without forfeiting driving and rolling comfort compared to the competition (with comparable equipment).

System Overview

Front Axle

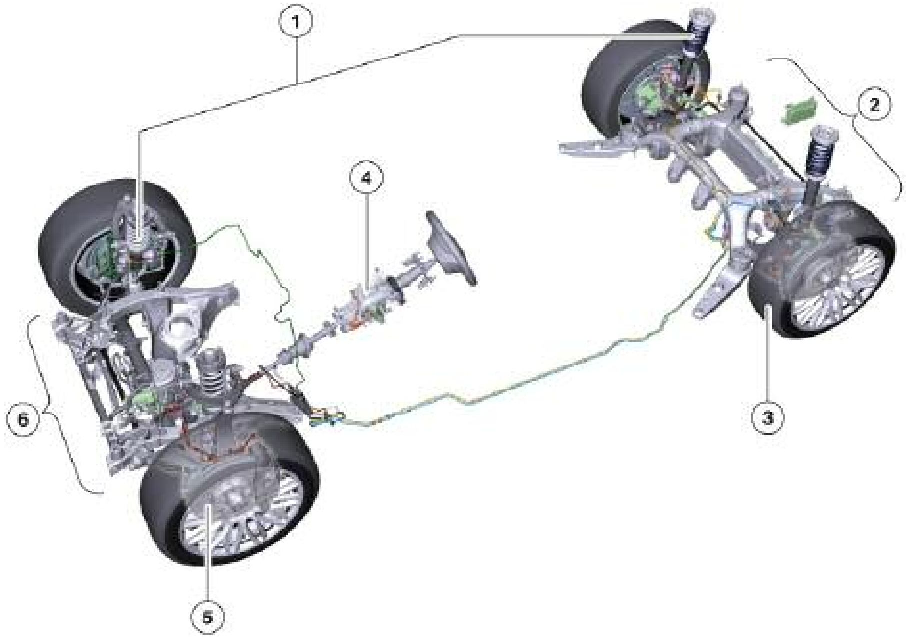
A double wishbone front axle as known from the E70 and E71 is now also fitted in the F01/ F02.

In comparison with the double pivot spring strut front axle on the E65, this front axle design offers the following advantages:

- Higher transverse acceleration is reflected in greater vehicle agility.
- Improved cornering/steering and transition characteristics which are particularly favourable in terms of rolling motion.
- Reduced interference means greater comfort.
- Shock absorbers that are subjected to virtually no transverse forces provide greater comfort.
- The design layout of the double wishbone front axle facilitates vertical dynamics control (VDC) and all-wheel drive (as on the E70/E71) without the need to adjust height and no spring travel loss.
- Double wishbone front axles improve directional stability.

The outstanding driving dynamics, the excellent driving comfort as well as the exceptional directional stability are factors of this double wishbone front axle design solution that contribute to a high degree of driving pleasure and safety while making the vehicle ideal for every day use and providing the most relaxing drive on long journeys.

F01/F02 Chassis and Suspension components



Index	Explanation	Index	Explanation
1	Spring/damper	4	Steering
2	Rear axle	5	Brakes
3	Wheels/tires	6	Front axle

Rear Axle

Compared to the integral IV rear axle, the further-developed integral-V rear axle in the F01/F02 is characterized by further improved driving dynamics without compromising comfort and driving safety.

Furthermore, a “distributed” integral-V rear axle was required in order to realize HSR (rear axle slip angle control) that is a fundamental part of the integral active steering system.

Dampers/suspension

In the F01/F02, the range of spring/damper units extends from the steel spring with standard vertical dynamics control (VDC) through to the electronically controlled dampers that can also be combined with the single axle air spring on the rear axle.

Brakes

The brake system on the F01/F02 is a furtherdeveloped high performance brake system with newly adapted dimensions for the F01/ F02 and is dependent on the national market specification. The service brake is based on the conventional design, however, the parking brake features an electromechanical parking brake system (EMF).

Steering

The F01/F02 is available with two steering system variants:

- Hydraulic servotronic
- Integral active steering (IAL).

Both steering systems are adapted to the varied application options of the F01/F02. The integral active steering is a new BMW development.

Wheels and Tires

In contrast to its predecessor the E65/E66, the F01/F02 is now equipped as standard with a runflat safety package.

System Components

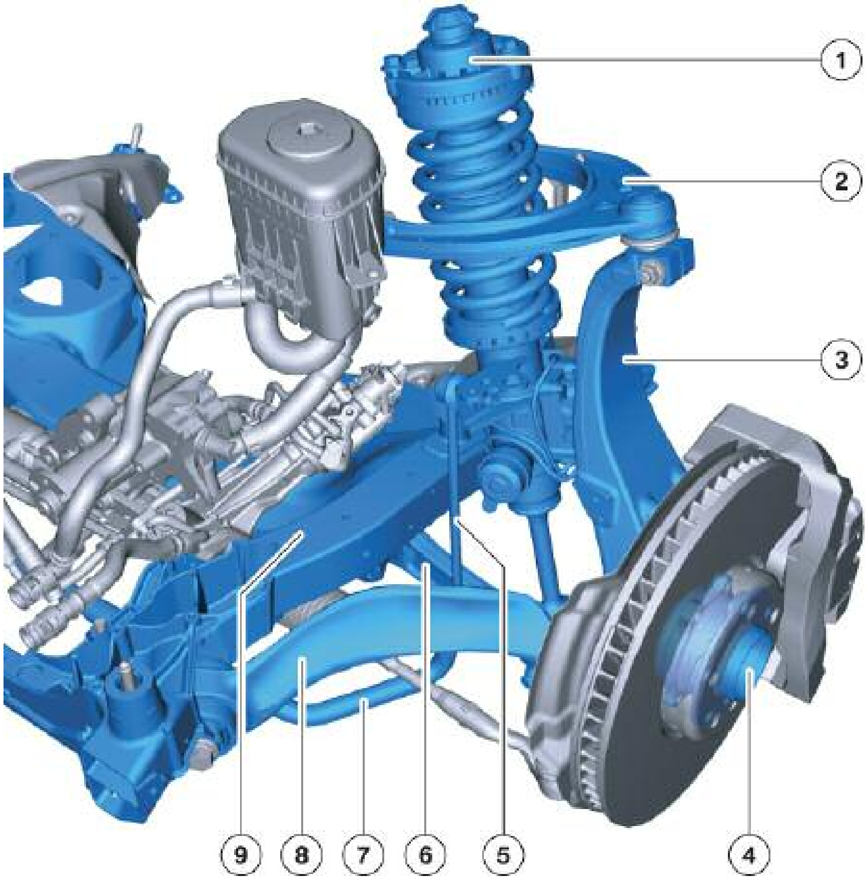
General

The chassis and suspension is subdivided into the main components that are described in more detail in the following:

- Front axle
- Rear axle
- Damping/suspension
- Brakes
- Steering
- Wheels/tires.

Front Axle

Design Layout



F01/F02 Front axle components

Index	Explanation	Index	Explanation
1	Spring strut	6	Transverse control arm, bottom
2	Transverse control arm, top	7	Stabilizer bar
3	Swivel bearing	8	Tension strut with hydraulic mount
4	Wheel bearing	9	Front suspension subframe
5	Stabilizer link		

The introduction of a second control arm level for wheel control, which is arranged above the wheel, results in additional degrees of freedom for the kinematics of the front axle as well as for the suspension/damping compared to other designs such as a spring strut front axle.

Components with special materials:

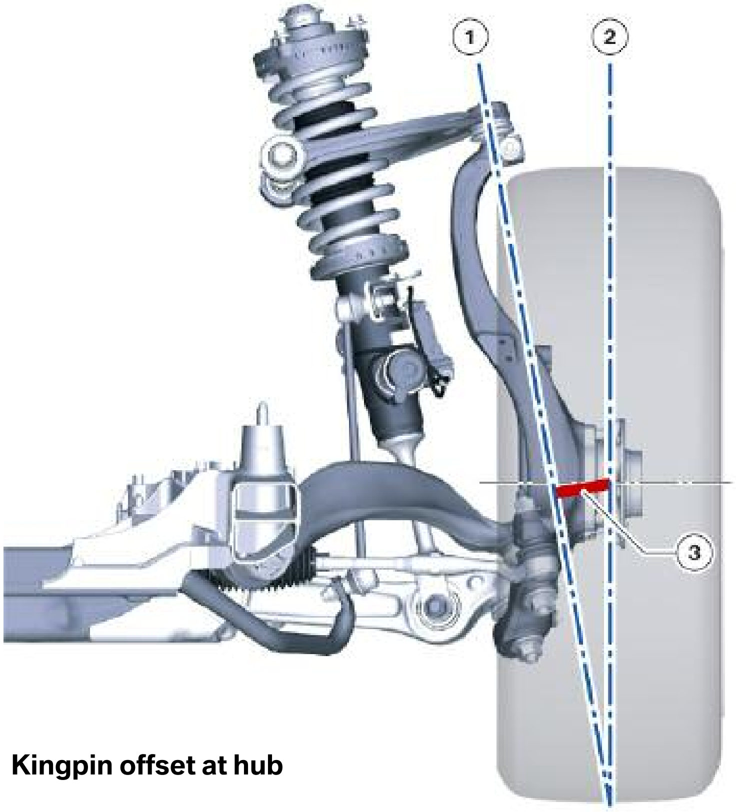
- The forged aluminum swivel bearing (3) with the 3rd generation wheel bearing (4).

Note: The arms and links are bolted by means of ball/disc connections to the swivel bearing and, similar to the track rod heads, no longer have tapered screw fittings.

- The transverse control arm at the top (2) is made from forged aluminum and the cylindrical joint pin is clamped in the swivel bearing (3).
- Tension strut with hydraulic mount (8) and lower transverse control arm (6) are forged aluminum components while the lower control arm bears the spring strut (1) by means of a forged steel mount.
- The new front axle subframe (9) is a welded aluminum structure which, as the standard axle, does not require the familiar aluminum thrust panel with service openings for increasing stiffness. This is made possible by the solid transverse section in the front axle subframe.

Note: The design layout of the front axle subframe makes it possible to lower the complete steering gear for service purposes.

Virtual pivot point or steering pivot axis



Kingpin offset at hub

Index	Explanation	Index	Explanation
1	Steering pivot axis	3	Kingpin offset at hub
2	Wheel center plane		

The steering pivot axis of the wheel suspension is now formed by a joint at the top A-arm and the virtual pivot point of the lower arm level as known from the spring strut or McPherson front axle.

The steering pivot axis is therefore freely selectable and can be positioned such as to produce a small kingpin offset at hub with sufficient weight recoil.

This kingpin offset at hub is decisive for transmitting the irregularities on the road surface to the steering wheel. The lower and upper arm levels now move simultaneously in response to wheel deflection. As a result, as the spring compresses, the wheel pivots in such a way that the negative camber to the road does not decrease as much as is the case with a spring strut front axle.

Since the two control arm levels undertake the wheel control, the damper is virtually no longer subjected to transverse forces and rotational motion.

This makes it possible to do without a roller bearing assembly (conventional strut mount) on the spring strut support. Instead of this conventional roller bearing a damping and support unit is installed that takes up all three load paths. The load paths are the damper piston rod, the inner auxiliary spring and the bearing spring. This damping and support unit is still referred to as the “strut mount”.

Due to the lack of transverse forces, the piston rod can be made thinner, resulting in a similar displacement volume in the push and pull direction of the damper. This serves to improve the design layout of the damper and is the prerequisite for the innovative damper control system - vertical dynamics control (VDC).

Due to the substantially lower friction at the circumference of the piston rod, the damper can respond more sensitively.

By connecting the stabilizer bar via the stabilizer link to the spring strut, the torsion in response to body roll motion is equivalent to the total wheel lift from the inside to the outside of the curve (in other suspension setups, the stabilizer bars are connected to a transverse control arm and therefore achieve only a fraction of the torsion angle). Despite being highly effective, this high degree of torsion allows for the stabilizer bar to be made relatively thin which has a favorable effect on driving comfort and dynamics as well as saving weight.

Comparison of front axle technical data

Description (Front axle data)	E65/E66	F01/F02
Kingpin offset at hub (mm)	**88.1**	**56.3**
Track width (mm)	1578	1611
Camber	-0° 20' ±20'	-0° 12' ±15'
Camber difference	0° ±30'	0° ±30'
Total toe-in	10' ±8'	16' ± 6'
Turning circle (**m**/ft)	**11.92**/39.10	**12.15**/39.86
Kingpin offset (mm)	0	0.5
Toe angle difference (toe out on turns)	1° 27' ±30'	12° 20'
Caster angle	7° 27' ± 30'	7° 0'

Cast aluminium spring support (body side)

On the E70, a cast aluminum spring support was used for the first time on the front end of the X Series. This assembly is now also used on the F01/F02. It offers the following advantages:

- Reduced weight through intelligent lightweight construction
- Improved driving dynamics thanks to higher degree of stiffness
- Less components therefore reduced manufacturing expenditure.

The cast aluminum spring support takes up the forces from the chassis and suspension and directs them into the car body. Both the spring strut as well as the upper transverse control arm are secured to the cast spring support. The component must exhibit a high degree of stiffness for this purpose. This is achieved by optimum material distribution by ensuring material is only accumulated where necessary. The spring support therefore represents an important contribution to controlling driving characteristics as it takes up both static and dynamic wheel forces. Since, with the cast construction, it is possible to integrate many individual functions and components in one single component, compared to the conventional shell construction, this setup is distinctly more compact while making a significant contribution to reducing weight.

- The cast aluminum lightweight construction reduces the weight by approx. 50 % compared to the conventional sheet steel construction
- More useful package space compared to conventional sheet steel construction -80 mm shorter front end
- Function-compliant design with specific local stiffening points adding to lightweight construction
- Integration of various brackets for mounting units etc. in the cast aluminum spring support with add-on parts.

The cast aluminum spring support is connected to the neighboring steel components (e.g. engine support) by means of a rivet-adhesion structure. The structure is of lower weight while making it possible to reduce the number of parts (no additional sheet metal brackets). Nevertheless, the vehicle body is more stable and torsionally rigid while increasing local stiffness. This design arrangement has a positive effect on improved driving dynamics.

Service

Note: The camber can also not be adjusted on the double wishbone front axle. As for the E70/ E71, two replacement upper transverse control arms are available for the F01/F02 should the camber need to be changed (e.g. after an accident). These replacement upper transverse control arms enable positive (+5 mm) and negative (-5 mm) correction.

Front axle wheel alignment is required during service when:

Component/screw Connection is Replaced		
Front axle subframe	YES	
Steering gear	YES	
Transverse control arm, bottom	YES	
Rubber mount for lower transverse control arm	YES	
Tension strut		NO
Rubber mount for tension strut		NO
Transverse control arm, top		NO
Rubber mount for upper transverse control arm		NO
Track rod	YES	
Swivel bearing	YES	
Wheel bearing		NO
Spring strut		NO
Coil spring		NO
Mount		NO

Screw Connections are Released		
Front axle subframe to body (lowering)		NO
Steering gear unit to front axle subframe	YES	
Lower transverse control arm to front axle subframe	YES	
Lower transverse control arm to swivel bearing		NO
Tension strut to front axle subframe		NO
Tension strut to swivel bearing		NO
Upper transverse control arm to body		NO
Upper transverse control arm to swivel bearing		NO
Track rod to steering gear		NO
Track rod head to track rod	YES	
Track rod head to swivel bearing		NO
Spring strut to lower transverse control arm		NO
Strut mount to body		NO
Lower steering shaft to steering gear		NO
Steering column to lower steering shaft		NO

Rear Axle

Highlight in F01/F02

The integral-V rear axle is a revolutionary further development of the integral IV rear axle now installed in many BMW models.

The integral IV rear axle fulfils the primary function of the running gear and wheel control in a unique way while making a significant contribution to driving dynamics characteristic of a BMW.

Safety functions are defined by the superior vehicle control characteristics. Effective decoupling of the road and drive train guarantees outstanding levels of acoustic and vibration comfort.

The further developed integral-V rear axle in the F01/F02 also provides these properties. In addition, the new rear axle has been specifically tuned to the new requirements of the F01/F02:

- Larger vehicle dimensions
- Greater total weight
- Greater drive output
- Higher drive torque
- Runflat tires.

In addition, the demanding objectives relating to driving dynamics and comfort have been correspondingly adapted while the new system integrates driving dynamics systems required for this purpose.

The integral-V rear axle primarily fulfils the driving dynamics functions of the mechanical chassis and suspension, i.e. define elastokinematic wheel control in all relevant driving situations.

The particularly innovative BMW development of the integral active steering (IAL), however, makes specific demands in terms of the **elastokinematics** of the integral-V rear axle: To a certain extent, the wheels on the rear axle must be able to execute steering movements.

Kinematics and elastokinematics

The spatial arrangement of the pivot points or pivot axes of the arms and links is known as kinematics. This term applies to components that are assumed to be non-deformable.

Elastokinematics takes into account the flexibility at least of the rubber-metal mounts, often of the ball joints and rarely of the components.

Various arms define the horizontal plane of the rear axle wheel suspension at the axle carrier and the wheel carrier. These arms are mounted such that they can rotate about an approximately horizontal axis of rotation and therefore allow vertical movement of the wheel carrier.

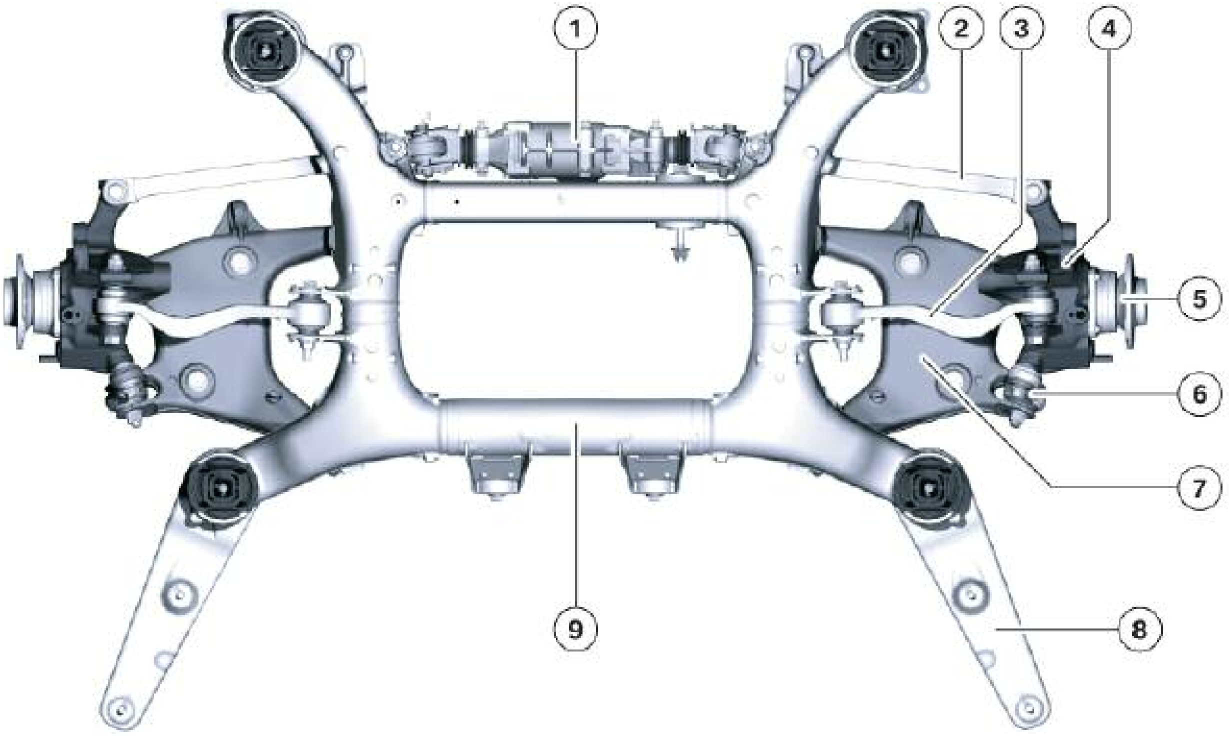
Kinematics is primarily of significance in terms of vehicle handling. The kinematics is arranged such that defined camber and toe-in angles are achieved between the wheel and road surface in response to the suspension and steering.

Kinematics is superimposed by elastokinematic effects. These elastokinematic effects occur as the movement points and movement axes are spatially displaced by the effect of the forces at the wheel.

■ New challenge for the integral rear axle

In terms of the F01/F02, the new integral active steering (IAL) as a BMW driving dynamics innovation, posed a completely new challenge to the engineers and the tried and tested integral IV rear axle.The integral active steering is made up of the active steering and the rear axle slip angle control (HSR).

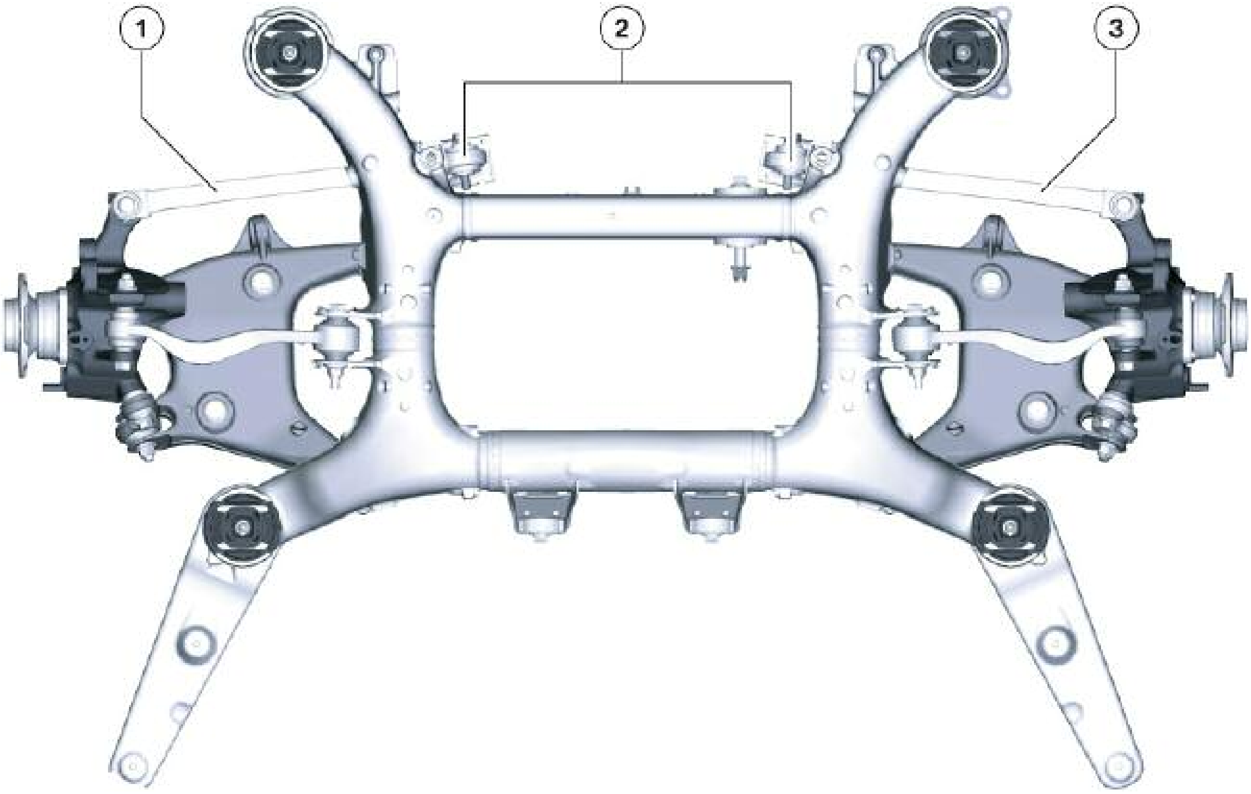
Components of the integral V rear axle with integral active steering



Index	Explanation	Index	Explanation
1	Actuator, rear axle slip angle control (HSR)	6	Integral link
2	Track rod, left	7	A-arm (swinging arm)
3	Transverse control arm, top	8	Thrust strut
4	Wheel carrier	9	Rear axle carrier
5	Wheel bearing		

The principle of the integral-V rear axle makes it possible to resolve the conflict between driving dynamics and comfort. The dynamic and drive forces applied through the wheel contact point into the wheel suspension are taken up by the wheel carrier, rear axle carrier, three links and an A-arm (swinging arm).

Integral V rear axle without integral active steering



Index	Explanation	Index	Explanation
1	Track rod, right	3	Track rod, left
2	Bearing assemblies, track rod		

The design layout reduces the flexible pulling action in the wheel carrier and therefore enables lengthways damping of the wheel control, which is important for rolling comfort, by means of axially soft front link mounts on the rear axle carrier.

Thanks to the position of the spring on the wheel carrier, it is no longer necessary to support the weight of the vehicle on the rubber mounts on the rear axle carrier.

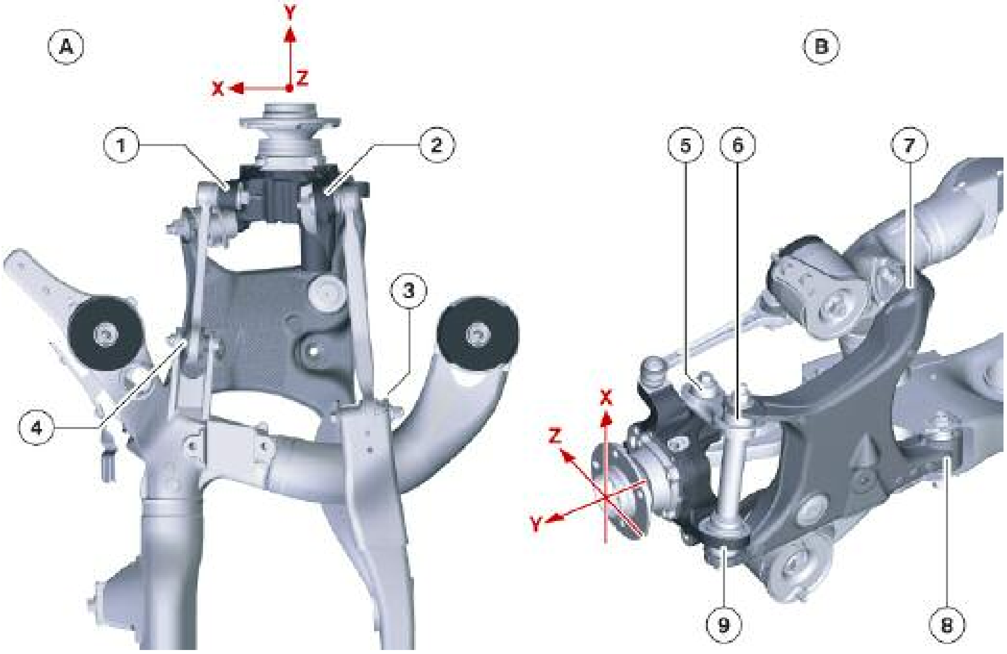
This optimum spring position in conjunction with specific lengthways control guarantees effective isolation of rolling and drive noise while significantly contributing to the refined smooth and quiet vehicle running characteristics.

The main criteria that governed the selection of materials included component weight, production process (cold forming, casting properties, welding properties), strength and deformation characteristics as well as corrosion resistance.

Two versions of the integral-V rear axle are available. Bearing assemblies are fitted on the two track rods if the vehicle is not equipped with integral active steering.

The revolutionary further development of the integral IV rear axle culminates in the BMW patented integral-V rear axle. The new arrangement of the arms and links as well as the use of ball joints facilitates a rear axle with steering capabilities.

Arm arrangement, E65 integral IV rear axle



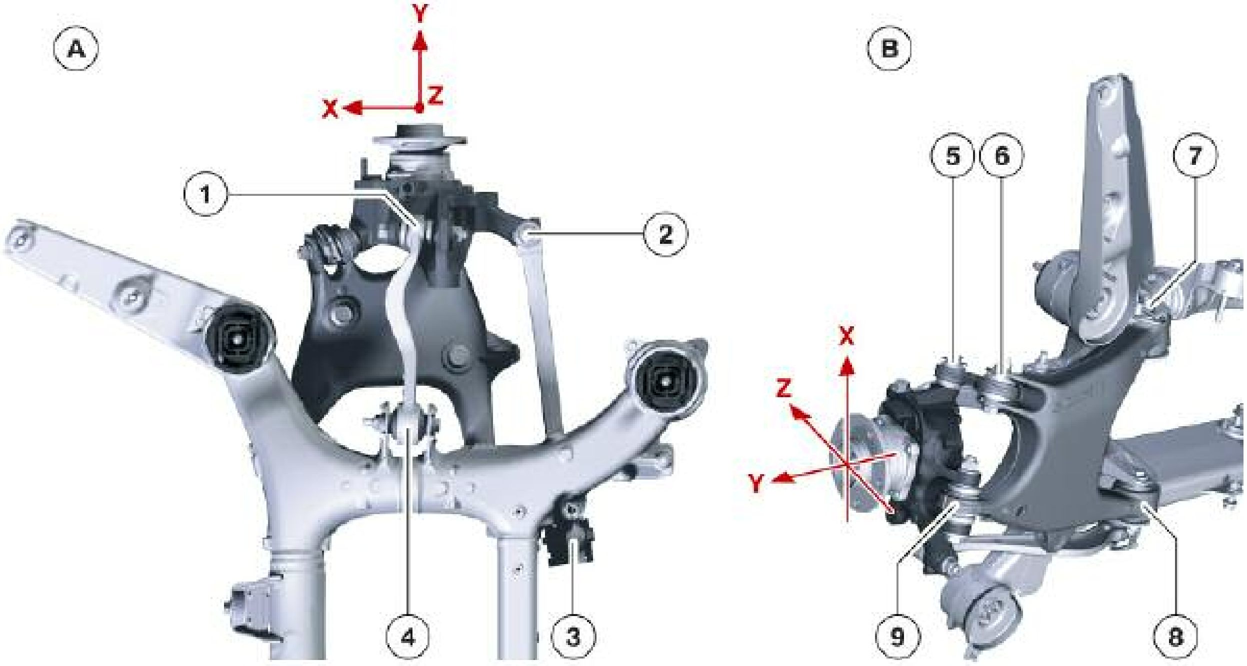
Index	Explanation	Index	Explanation
A	Top view (forward direction x)	5	Rubber mount
B	Bottom side view	6	Rubber mount
1	Angle joint	7	Rubber mount
2	Angle joint	8	Rubber mount
3	Rubber mount	9	Ball joint
4	Rubber mount		

Viewing the arrangement of the arms and links in the integral IV rear axle of the E65 it is difficult to imaging that defined steering movement of the rear wheels about the Z-axis could be realized.

Theoretically, i.e. kinematically, the design of the integral IV rear axle could facilitate steering capabilities, however a large actuator would be required that could not be accommodated in the package space available on the F01/F02. This would have to be designed considerably longer and would therefore be decisively heavier and more expensive.

Arm arrangement, integral-V rear axle in the F01/F02

Summary of the design layout:



Index	Explanation	Index	Explanation
A	Top view (forward direction x)	5	Rubber mount
B	Bottom side view	6	Rubber mount
1	Ball joint	7	Rubber mount
2	Ball joint	8	Rubber mount
3	Rubber mount	9	Ball joint
4	Ball joint		

The system consists of a wheel carrier that is controlled from below by a torsionally rigid A-arm (swinging arm).

At the bottom, the wheel carrier is connected directly by means of a first bearing mount and indirectly by means of a second bearing mount, in connection with an integral link arranged vertically with respect to the plane of the A-arm (swinging arm), to the wheel carrier.

The two rubber mounts on the inside of the vehicle are connected to the rear axle carrier such that they are torsionally soft and can be displaced axially.

The upper transverse control arm lies approximately in the vertical plane of the drive shaft and therefore also at the center point of the wheel.

The rear track rod arranged approximately at the center point of the wheel is either mounted on the rear axle carrier or connected to the actuator of the integral active steering.

■ Service

Note: The track and camber at the rear axle can still be adjusted by means of two eccentric screws, however, a new procedure must be observed!

Description (Rear axle data)	F01 (Standard)	F01 (optional HSR)
Whee base (mm)	3070	3070
Track width	1628	**1650**
Camber	-1° 50' ±15’	-1° 50' ±15’
Camber difference	0° ±30'	0° ±30'
Total toe-in	14' ±10’	16' ± 6'
Thrust angle	0° ±12'	0° ±12'

Damping/suspension

The standard chassis and suspension system of the F01 features steel springs on the front and rear axle. The standard chassis and suspension on the F02 has steel springs on the front axle with the single axle air suspension (EHC) fitted on the rear axle. The F01/F02 is equipped as standard with vertical dynamics control featuring electronically controlled damper systems. In addition, the following combinations are available:

- Standard suspension with single axle air spring
- Dynamic drive with steel springs and VDC dampers
- Dynamic drive with 2 steel springs and single axle air spring and VDC dampers.

BMW is the first car maker to offer as standard a continuously controlled adjusting damper system irrespective of tension/compression.

The outstanding properties of this new (VDC2) adjusting damper are:

- Advanced opening adjustment for improved body stabilization. Realized by adjustments even at low damper speeds.
- Difference between “soft” and “hard” in connection with driving dynamics control easily identifiable by the customer.
- Separately tuned identifier for rolling comfort through tension characteristics irrespective of compression.

Brakes

Function-optimized lightweight construction brakes are used on the F01/F02.

Lightweight brake rotors with riveted aluminum hubs are installed on the front axle, while cast iron rotor are used on the rear axle.

Floating brake calipers are fitted on the front and rear axle. The brake system in the F01/F02 features the known brake wear monitoring system for the CBS indicator.

Technical data, front axle:

Technical data, front brakes	Specification
Brake caliper, piston diameter (mm)	60
Brake disc, thickness (mm)	36
Brake disc diameter (mm)	373
Brake disc diameter (inches)	14.7
Brake disc construction	Aluminum (riveted)
Brake caliper construction	Aluminum

Technical data, rear axle:

Technical data, rear brakes	Specification
Brake caliper, piston diameter (mm)	44
Brake disc, thickness (mm)	24
Brake disc diameter (mm)	368
Brake disc diameter (inches)	14.5
Brake disc construction	Cast iron
Brake caliper construction	Cast iron

Brake caliper

Brake calipers with optimized function and efficiency are fitted on the F01/F02.
The frame structure of the floating caliper effectively uses the package space available in the wheel.

In connection with effective brake cooling, the brake system achieves a high degree of thermal efficiency. The aluminum housing of the floating caliper saves weight while ensuring maximum operating efficiency.

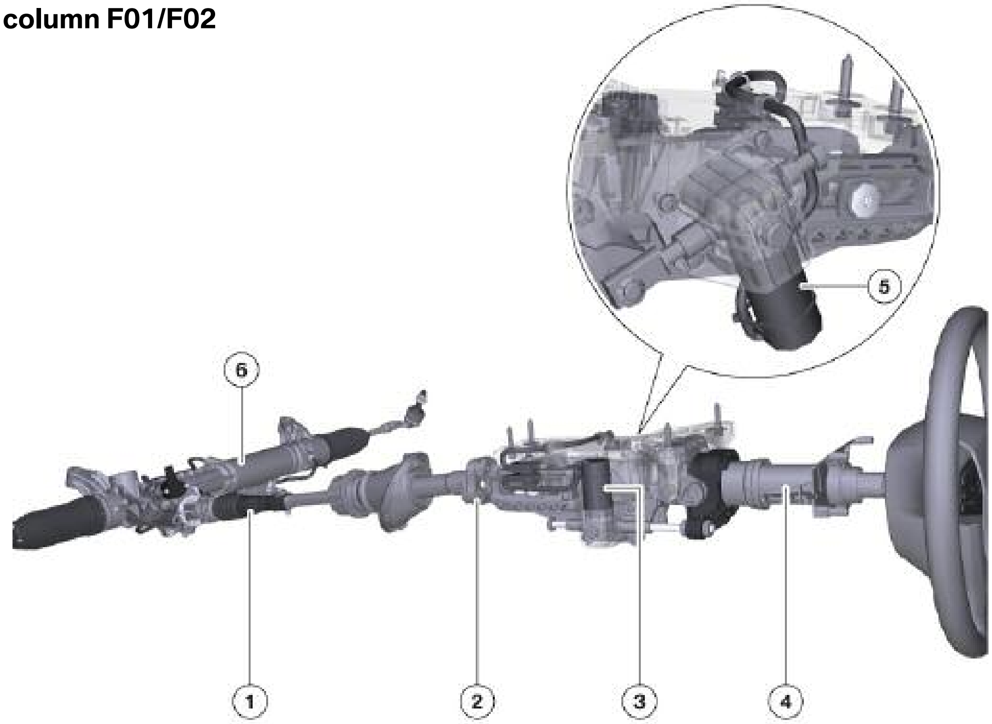
Brake disc

The familiar riveted aluminum hub also saves weight while drastically reducing the shielding effect that may occur under harsh braking conditions, i.e. deformation of the brake disc caused by thermal material expansion. Internally ventilated brake discs are fitted on the front and rear axle.

Steering

The steering column in the F01/F02 is ergonomics, comfort and passive occupant designed to conform with the most safety all coupled with characteristic BMW demanding requirements in terms of steering properties.

Steering column F01/F02



Index	Explanation	Index	Explanation
1	Splined tube	4	Crash tube
2	Flexible coupling	5	Actuator motor, right
3	Actuator motor, left	6	Steering gear

The F01/F02 is equipped with an electrically operated steering column with infinitely variable horizontal and vertical adjustment as standard.

- Outstanding ergonomics ensured by an optimum adjustment range for the steering wheel position:
  - Horizontal ± 30 mm
  - Vertical ± 20 mm
- Additional comfort function provided by easy entry and exit:
  - When getting in and out of the vehicle, the steering wheel temporarily moves into the topmost position thus providing maximum freedom of movement.
- Outstanding crash safety provided by the familiar, innovative BMW crash system, specifically tuned and featuring force-dependent energy absorbers.

The steering column has a motor for in/out adjustment and a motor for up/down adjustment with a specially developed gear mechanism.

Each of these low-noise drive units is mounted acoustically decoupled executes the adjustment with the aid of motor/driven flexible spindles.

The components of the steering column are optimized in terms of rigidity in the comfort-relevant frequency range to reduce vibration and avoid disturbing steering wheel vibration and have been developed in line with a magnesium and aluminium lightweight construction concept.

The flexible coupling fitted in the steering column represents the perfect means of finely tuning the steering characteristics and driving comfort. Vehicle-specific loop packages are vulcanized in elastomer in this flexible coupling, allowing extremely high torque to be transmitter reliably and precisely. The steering column is thus successfully decoupled from disturbing influences caused by excitation from the road surface (axial impact or radial torque peaks).

Example: Crash sleeve on steering column

Index	Explanation	Index	Explanation
1	Normal position (travel range 0 mm)	2	Crash position (travel range 80 mm)

The innovative crash system essentially consists of a crash adapter and crash tube. In the event of a crash, the impact energy is progressively reduced for the driver by the crash tube breaking open and deforming, thus providing the advantage of reduced stress on the occupants in the event of a crash (integral part of the 5-star philosophy at BMW).

In addition, the lower and center steering shaft collapses during the crash thus preventing penetration of the steering column into the passenger compartment. The system design also prevents the back displacement of all components in the engine compartment and possible damage to the bulkhead.

Wheels and Tires

Unlike the E65 predecessor, the F01/F02 is fitted with the RunFlat System Component RSC package on board as standard.

Highlights of the safety tires:

The BMW Group has put together a safety package with the aim of avoiding such accidents as well as the risk involved with changing a tire at the side of the road, at night or in wet conditions, in tunnels or at road construction.

The BMW runflat safety system:

- Warns the driver in good time of imminent tire pressure loss so that countermeasures can be taken
- Allows the journey to be continued for a defined distance even in the event of complete loss of tire pressure
- Keeps the tire safely on the rim even in the event of sudden tire pressure loss at high speed.

The system consisting of the RSC tires, rims with EH2+ contour and the electronic tire pressure monitoring system (TPMS), renders a spare wheel or space-saver wheel, breakdown kit or vehicle jack unnecessary and this creates more storage space in the luggage compartment while also saving weight.

■ Extended Hump rims (EH2+)

The specially shaped rim humps ensure that the RSC tire cannot detach from the rim even in the case of sudden tire pressure loss. This means substantially greater safety particularly when driving at high speed and on winding roads.

■ TPMS

The Tire Pressure Monitoring Systemmonitors the tire pressure via wheel mounted pressure sensors. A warning lamp informs the driver of any irregularities that occur due to the loss of tire pressure.

Note: The TPMS system does not exempt the driver from regularly checking the tire pressure.

After changing the tire pressure or after changing a tire, the TPMS systemmust be reinitialized in order to restore the target values with the correct tire pressure.

The entire safety package consists of three components:

- Runflat tires
- Extended hump rims (EH2+)
- Tire Pressure Monitoring System (TPMS)

RSC tires with emergency running properties

With its reinforced side walls, additional strip inserts and heat-resistant rubber mixtures, even when completely depressurized, the “self-supporting tire” makes it possible to continue the journey for a limited distance at a maximum speed of 50 mph. This means each tire is also its own spare wheel.

The maximum range after complete tire pressure loss is:

- approximately 250 miles at low vehicle load
- approximately 150 miles at medium vehicle load
- approximately 50 miles at high vehicle load.

ABS, ASC and DSC remain fully operational even in the event of complete tire pressure loss.

When driving with a run flat tire with no pressure, the standard VDC automatically distributes the vehicle weight over the remaining wheels so as to relieve the load on the depressurized tire with the aim of achieving the highest possible range for continued operation.

F01/F02 Wheel sizes

For the benefit of creating a sports appearance and to improve the overall design, compared to the E65/E66 the track width on the F01/F02 has been increased while the wheel arch overhang has been reduced to a minimum.

In addition, the entire range of wheels for the F01/F02 has been aligned flush by correspondingly matching the outer rim offset so that, with the exception of the different rim dimensions, there are no longer any differences between the tire sizes.

The following table lists the standard wheels on the F01/F02.

Explanation	750i	750Li
Front tire	245/50 R 18 Y 100 Y RSC	245/50 R 18 Y 100 Y RSC
Rear tire	245/50 R 18 Y 100 Y RSC	245/50 R 18 Y 100 Y RSC
Front rim	8J x 18 EH2+LM - IS30	8J x 18 EH2+LM - IS30
Rear rim	8J x 18 EH2+LM - IS30	8J x 18 EH2+LM - IS30

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Dynamic Driving Systems

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand Integrated Chassis Management on the new 7-series
- Understand “Higher Level” driving dynamics control
- Understand the interaction between various chassis dynamics systems

Introduction

Integrated Chassis Management (ICM)

History

A central, higher-level driving dynamics control system was first introduced in BMW vehicles several years ago.

The introduction of the longitudinal dynamics management system in the BMW 3 Series (E9x) was the first step in this direction. The longitudinal dynamics control functions, Dynamic Cruise Control and Active Cruise Control, were integrated into one control unit, the LDM control unit. These integrated functions considerably enhanced the harmony and coordination of drive and brake actuation.

The Vertical Dynamics Management made its debut in the BMW X5 (E70) with the VDM control unit: the integrated Vertical Dynamics Control (VDC) function controls the adjustable dampers. In contrast to the earlier system, not only ride-level heights and vertical acceleration are used as the input signals. Instead, the higher-level control strategy of the Vertical Dynamics Control takes all signals relevant to driving dynamics into account, including, for example, road speed, and longitudinal and lateral acceleration.

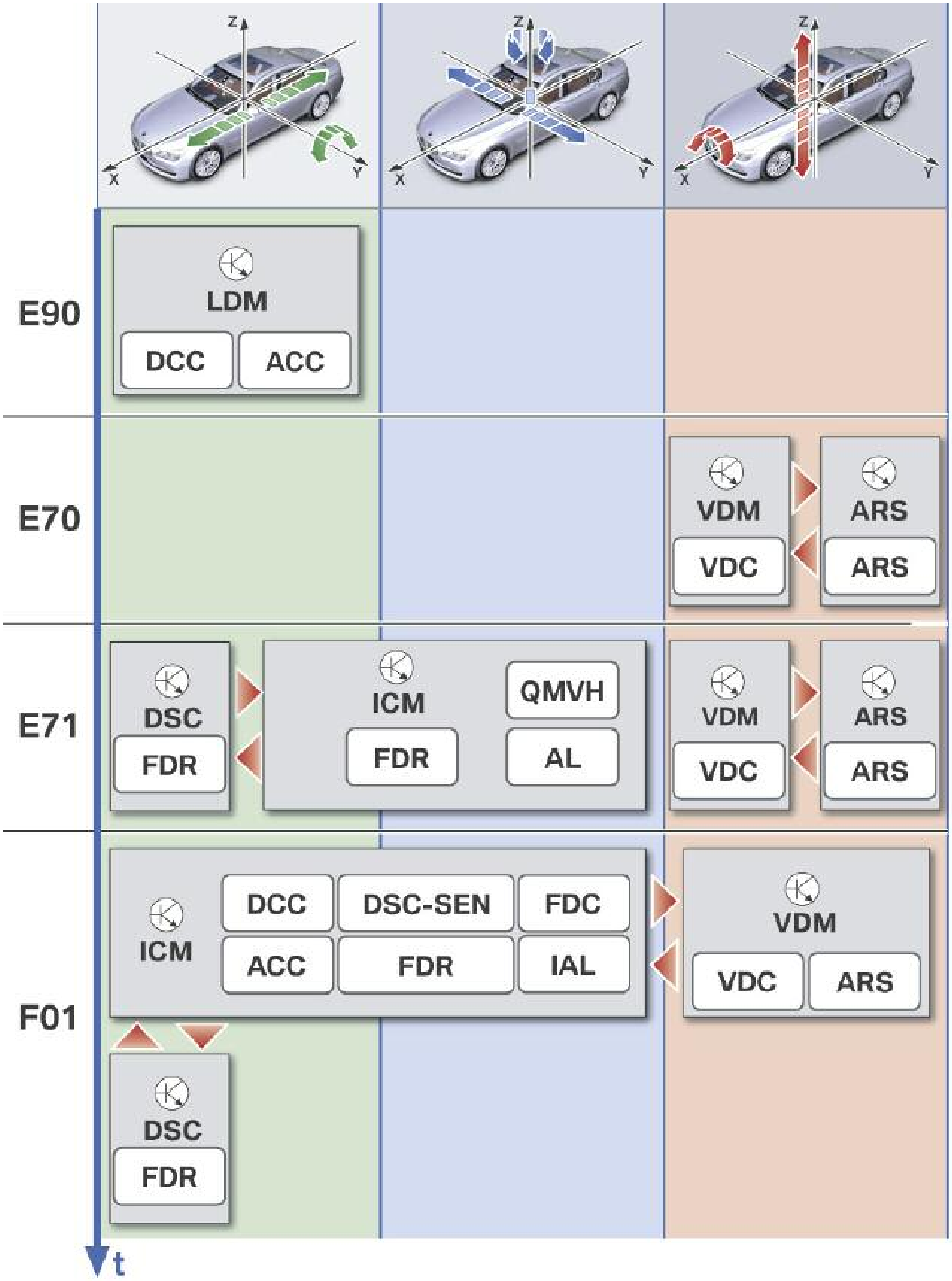
The VDM control unit also coordinates the Vertical Dynamic Control and Active Roll Stabilization (ARS) functions. Overall, this meant that wheel contact with the road surface was improved and the vertical movement of the body reduced for a wider variety of road situations.

In addition to the VDM control unit, the BMW X6 (E71) was also equipped with an ICM control unit that for the first time incorporates both the longitudinal and lateral dynamics control functions. The longitudinal and lateral motion of the vehicle is evaluated centrally in the ICM control unit.

Following on from this development, the dynamic driving systems Active Steering and Dynamic Performance Control are now used and their interaction is of course also coordinated by the ICM control unit.

Significant at this stage is the definition of the ICM as the main control unit for the control functions. The actuators on the other hand are activated by control units specially intended for this purpose.

Evolution stages of Integrated Chassis Management



Index	Explanation
LDM	Control unit, Longitudinal Dynamics Management
DCC	Dynamic Cruise Control function (cruise control with braking function)
ACC	Active Cruise Control function
VDM	Control unit, Vertical Dynamics Management
VDC	Vertical Dynamics Control function
ARS	Control unit or function, Active Roll Stabilization (Dynamic Drive)
DSC	Control unit, Dynamic Stability Control
FDR	Driving dynamics control function
ICM	Control unit, Integrated Chassis Management
QMVH	Lateral torque distribution at rear axle (Dynamic Performance Control)
AL	Active Steering function
DSC-SEN	DSC sensor in the ICM control unit
FDC	Driving dynamics control switch
IAL	Integral Active Steering function

The red triangles denote interaction between the control units and functions. This is not always purely be an exchange of sensor signals. Control signals and reference values may be also used (for example) to influence the driving dynamics control in the ICM control unit or the Active Roll Stabilization in the VDM control unit.

New Control Units

Two newly developed control units for dynamic driving systems will also be used in the F01/F02:

- Integrated Chassis Management (ICM) and
- Vertical Dynamics Management (VDM).

Although their names are already familiar from the E70/E71, they differ considerably in their functional range and design.

A multitude of driving dynamics functions is concentrated in these control units.

In addition to central signal provision, the essential functions of the ICM control unit are concerned with longitudinal and lateral dynamics. These include the control function for the new Integral Active Steering, for example.

The vertical dynamics functions on the other hand are incorporated in the VDM control unit: Vertical Dynamics Control in the 2nd generation and Active Roll Stabilization (also: Dynamic Drive).

Although both control units are standard equipment, two expansion stages are available in each case, depending on the options fitted to the vehicle.

■ ICM control unit expansion stages

The basic version of the ICM control unit is fitted as standard in the F01/F02. In this case, the vehicle is provided with the Servotronic steering system and cruise control driver assistance function with braking function.

The high-performance version of the ICM control unit is used if one or both of the following options are ordered by the customer:

- Integral Active Steering
- Active Cruise Control with Stop & Go function

■ Expansion stages of VDM control unit

The basic version of the VDM control unit contains the Vertical Dynamics Control function. This is included in the standard equipment of the F01/F02.

The high-performance version of the VDM control unit is fitted if the customer also orders the option Active Roll Stabilization (ARS). The high-performance version also incorporates the output stages required for activation of the hydraulic valves in the ARS.

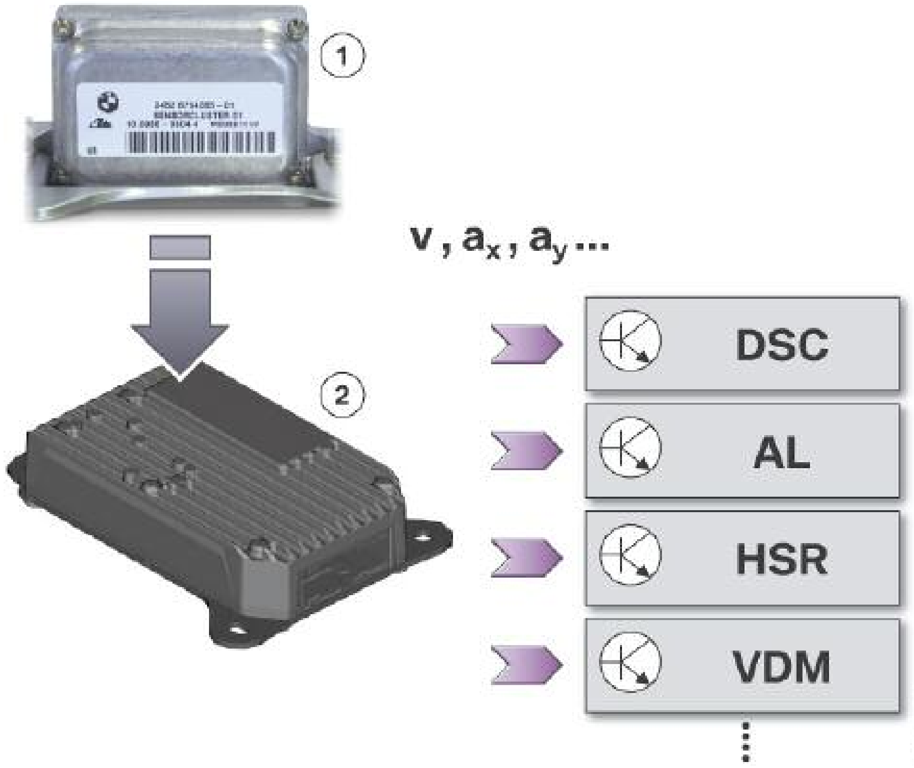
New Evolution Stage in Driving Dynamics Control

The notion of “Integrated Chassis Management” is significantly developed further in the F01/F02. The two main objectives were to improve the performance and interaction of the individual dynamic driving systems. In order to achieve the desired dynamic effect in each road situation, the most suitable actuator can now be selected and activated. It may of course be useful to operate several actuators in tandem. Examples of this are activating the brakes for individual wheels or superimposing a steering angle using Integral Active Steering.

A further task of the ICM control unit is to make the driving dynamics condition available throughout the entire vehicle through in the form of signals. This is why the DSC sensor in the F01/F02, which was previously fitted separately, has now been integrated into the ICM control unit.

This means that all systems have access to the same information provided by the ICM control unit. As a consequence, the potential for errors, particularly in networked systems, is reduced and the system reliability of systems is increased. Further, this simplifies the diagnosis of the interconnected system as the fault code memory entries for the driving dynamics signals are now stored centrally in the ICM control unit and are no longer distributed between many control units.

Driving dynamics signals provided by the ICM control unit



Index	Explanation	Index	Explanation
1	DSC sensor integrated into the ICM control unit	DSC	Dynamic Stability Control
2	ICM control unit	AL	Active Steering
v	Road speed	HSR	Rear axle slip angle control
ax	Longitudinal acceleration	VDM	Vertical Dynamics Management
ay	Lateral acceleration		

The result for the customer is perfect harmony in terms of vehicle handling - irrespective of the equipment specification and road situation. This uses the possibilities for maximizing convenience, agility and stability to the full.

The customer's experience of this harmony in terms of vehicle handling is especially enhanced by the new **Driving Dynamics Control** function. This offers several particularly distinctive vehicle characteristics that determine how the vehicle handling as a whole is perceived by the driver and passengers. The driver can use the driving dynamics switch to select a characteristic that perfectly matches the specific driving requirement or section of road.

Standard Equipment and Options

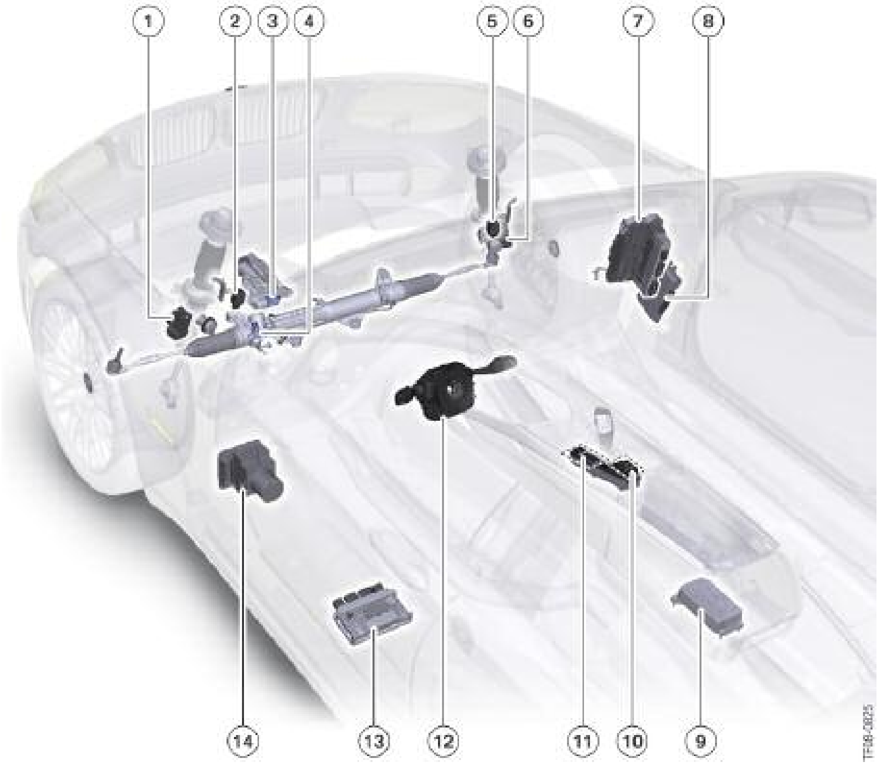
The following table shows the standard equipment and options available for dynamic driving systems. A specific model (750i) has been selected in order to compare the functions and equipment levels of the E65 and F01.

Dynamic Driving System	E65/E66		F01/F02	
	Standard	**Optional**	**Standard**	**Optional**
Higher Level Driving Dynamics Systems				
Integrated Chassis Management			●	
Driving Dynamics Control			●	
Longitudinal Dynamics				
Dynamic Stability Control	●		●	
Electro-Mechanical Parking Brake (EMF)	●		●	
Lateral Dynamics				
Servotronic	●		●	
Integrated Active Steering (IAL)				●
Vertical Dynamics				
Electronic Damping Control (continuous) EDC-K		●		
Vertical Dynamics Control 2 (VDC 2)			●	
Active Roll Stabilization	●			●
Electronic Height Control		● (E65/66)	● (F02)	
Driver Assistance				
Cruise Control (FGR)	●			
Cruise Control with braking function (DCC)			●	
Active Cruise Control (ACC)		●		
Active Cruise Control with Stop and Go (ACC Stop and Go)				●

System Overview

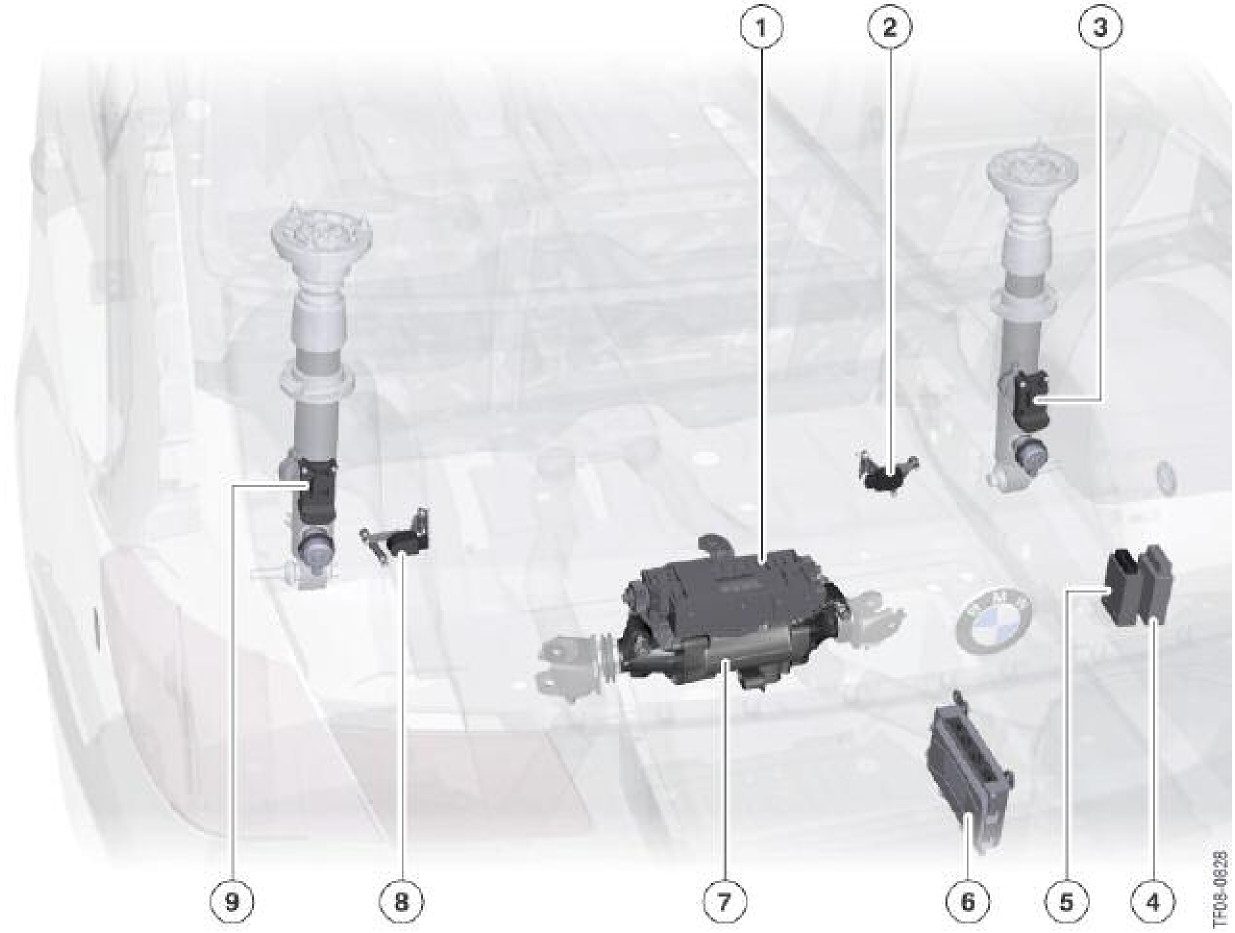
Installation Locations in the Vehicle

Control units, sensors and actuators of the dynamic driving systems in the F01/F02



Index	Explanation
1	Electronic Damping Control satellite, front left
2	Ride-height sensor, front left
3	Valve for electronic flow rate adjustment of power steering pump (EVV)
4	Servotronic valve
5	Ride-height sensor, front right
6	Electronic Damping Control satellite, front right
7	Junction box electronics and fuse carrier, front
8	Control unit for Vertical Dynamics Management
9	Control unit for Integrated Chassis Management
10	Buttons for electromechanical parking brake and Automatic Hold
11	Driving dynamics switch and DTC button
12	Steering column switch cluster with steering angle sensor
13	Control unit for Active Steering
14	Control unit and hydraulic unit for Dynamic Stability Control

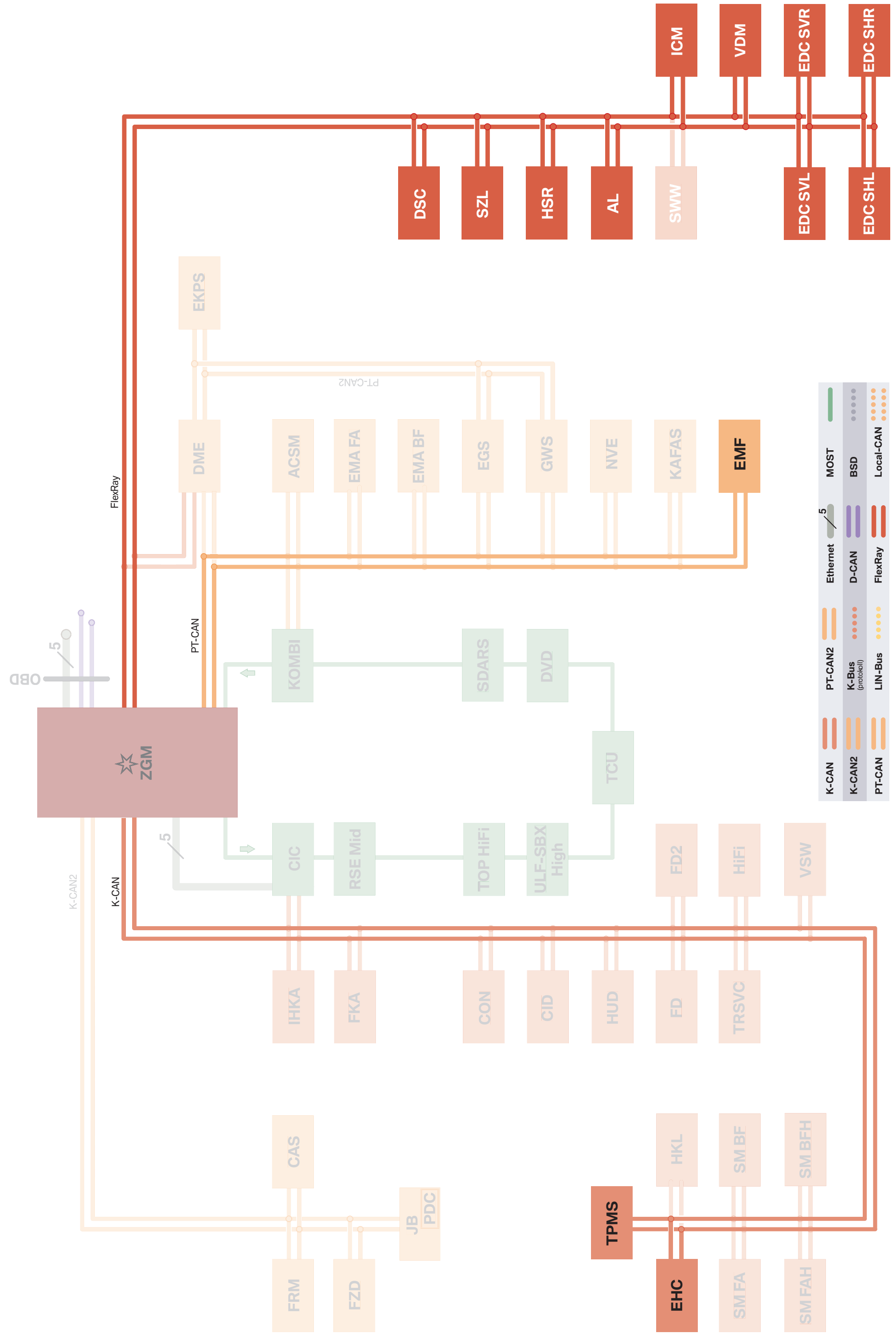
Control units, sensors and actuators of the dynamic driving systems in the F01/F02 (2)



Index	Explanation
1	Control unit and actuating unit for electromechanical parking brake
2	Ride-height sensor, rear right
3	Electronic Damping Control satellite, rear right
4	Control unit for TPMS
5	Control unit for electronic ride-height control
6	Control unit for rear axle slip angle control
7	Actuating unit for rear axle slip angle control
8	Ride-height sensor, rear left
9	Electronic Damping Control satellite, rear left

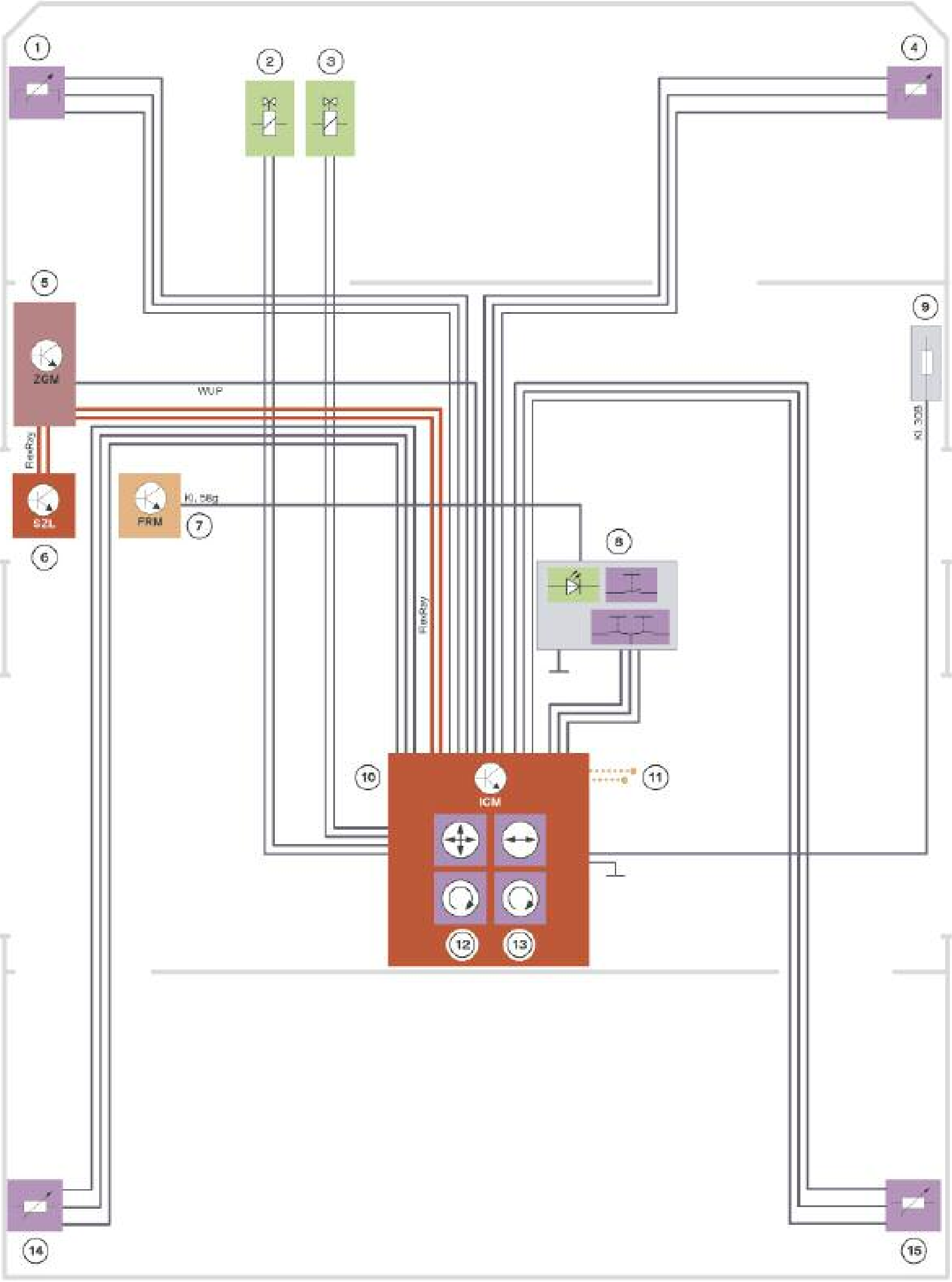
Both graphics show the installation locations of the most important control units, sensors and actuators of the dynamic driving systems in the F01/F02. These have been split into two graphics to maintain clarity of overview and not for functional reasons.

Bus System Overview for Dynamic Driving Systems



Index	Explanation
AL	Active Steering
DSC	Dynamic Stability Control
EHC	Electronic ride-height control
EDC SHL	Electronic Damping Control satellite, rear left
EDC SHR	Electronic Damping Control satellite, rear right
EDC SVL	Electronic Damping Control satellite, front left
EDC SVR	Electronic Damping Control satellite, front right
EMF	Electromechanical parking brake
ICM	Integrated Chassis Management
HSR	Rear axle slip angle control
TPMS	Tire Pressure Monitoring System
SZL	Steering column switch cluster with steering angle sensor
VDM	Vertical Dynamics Management
ZGM	Central gateway module

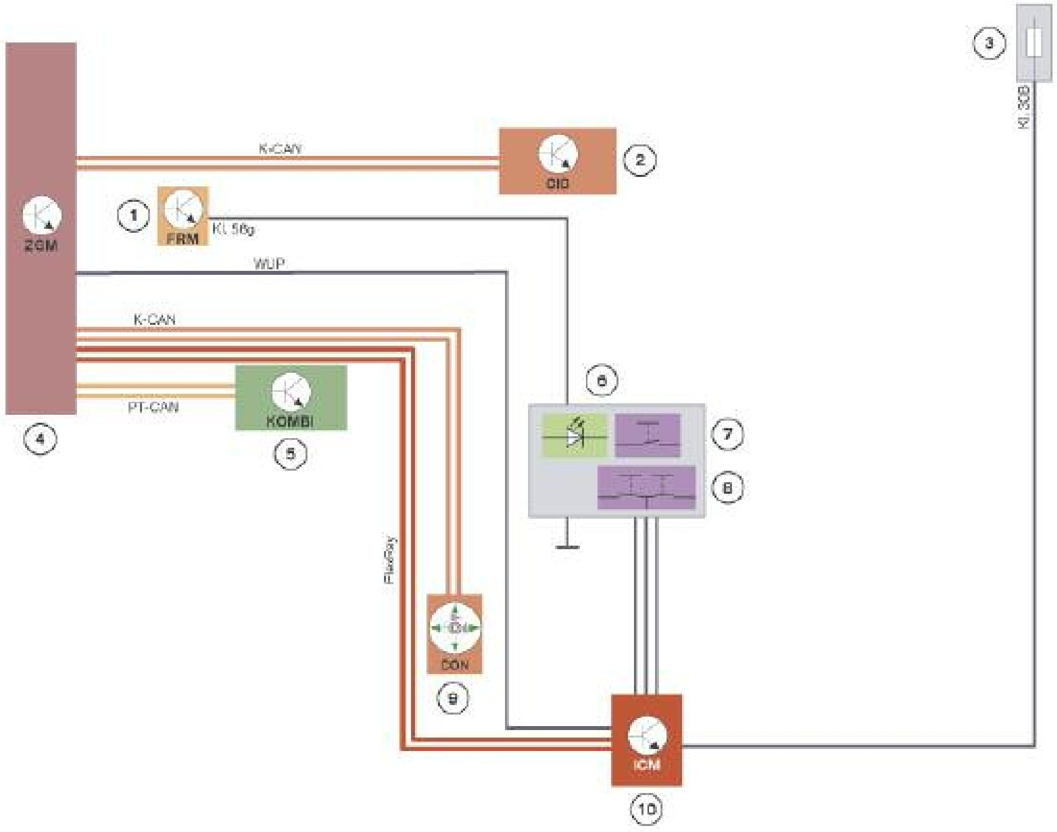
Integrated Chassis Management System Circuit Diagram



Index	Explanation
1	Ride-height sensor, front left
2	Servotronic valve
3	EVV valve
4	Ride-height sensor, front right
5	Central gateway module
6	Steering column switch cluster with steering angle sensor
7	Footwell module
8	Driving dynamics switch and DTC button
9	Fuse for ICM control unit (fuse carrier at front, junction box electronics)
10	Integrated Chassis Management
11	Local CAN
12	DSC sensor in the ICM control unit (longitudinal acceleration, lateral acceleration, yaw rate)
13	Redundant DSC sensor in the ICM control unit (lateral acceleration, yaw rate)
14	Ride-height sensor, rear left
15	Ride-height sensor, rear right

The purpose of the local CAN is to connect the ICM control unit to the radar sensors for the Active Cruise Control with Stop & Go function.

Driving Dynamics Control System Circuit Diagram



Index	Explanation
1	Footwell module
2	Central Information Display
3	Fuse for ICM control unit (fuse carrier at front, junction box electronics)
4	Central gateway module
5	Instrument cluster
6	Operating unit for center console with locating lamp
7	DTC button
8	Driving dynamics switch
9	Controller
10	Integrated Chassis Management

This system circuit diagram shows the operator control and display elements for the driving dynamics control function. For clarity of overview, the drive and dynamic driving systems upon which the driving dynamics control acts have been omitted. These are described in the Functions section instead.

Functions

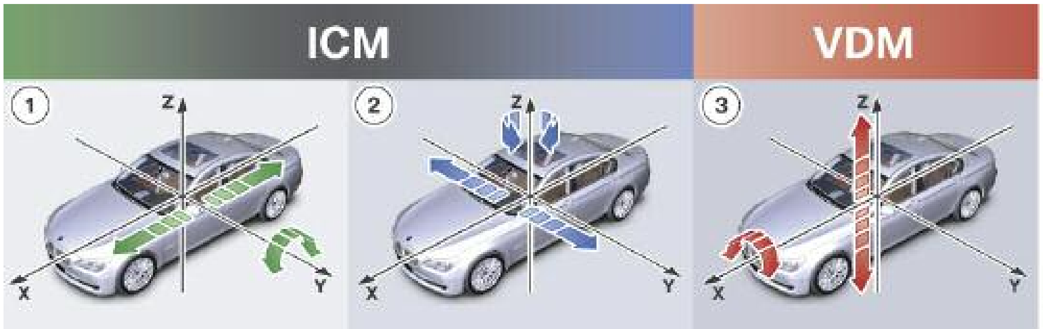
Integrated Chassis Management

Overview

With the E71, the notion of a higher-level driving dynamics control system was implemented for the first time in a standard model. This central function is also referred to as "Integrated Chassis Management" ("ICM" for short) and is integrated in the control unit of the same name in the E71.

The previous strategy was to use one control unit to perform the control tasks for each main movement direction. This approach was not employed in the E71 or the F01/F02.

Control units and main movement directions of vehicle



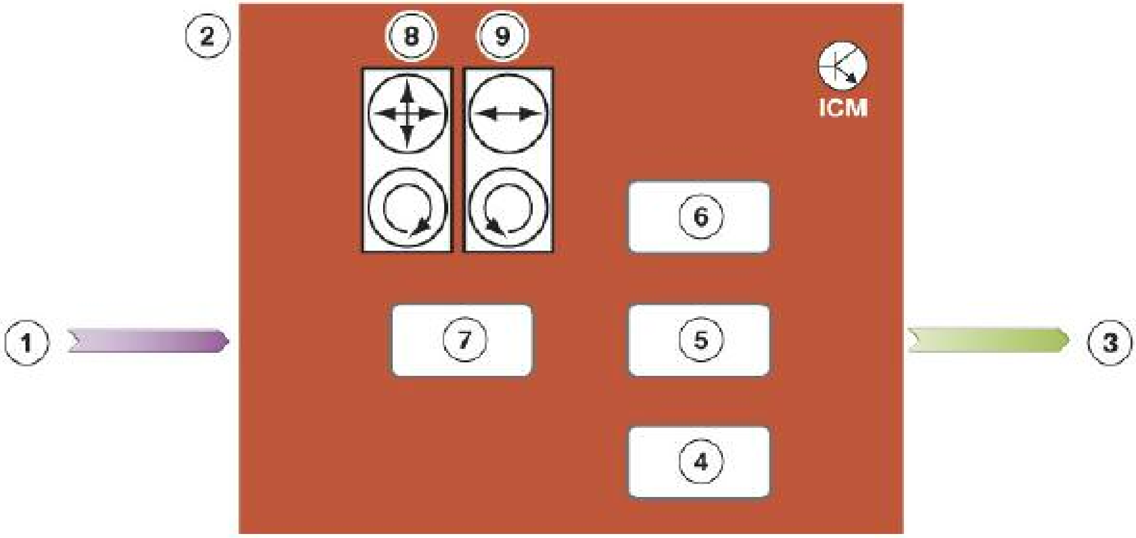
Index	Explanation	Index	Explanation
1	Longitudinal dynamics	ICM	Integrated Chassis Management
2	Lateral dynamics	VDM	Vertical Dynamics Management
3	Vertical dynamics		

As is the case in the E71, the new ICM control unit in the F01/F02 essentially performs the calculations for the control functions that influence the longitudinal and lateral dynamics. The actuators are activated by separate control units (e.g. AS control unit). The functional range of the ICM control unit in the F01/F02 has grown considerably when compared to the E71.

The Vertical Dynamics Management (VDM) is still responsible for controlling the vertical dynamics. The vertical dynamic control and dynamic drive functions are therefore accommodated in the VDM control unit. Signals that provide information on the current driving situation are obviously exchanged between the ICM and VDM.

The main focus of this section is to describe the functions of the ICM control unit. An introductory overview of these functions is provided in the following illustration and explanation. The functions are dealt with in more depth in the following chapters.

Functions in the ICM control unit



Index	Explanation
1	Input signals from external sensors
2	Integrated Chassis Management
3	Output signals (target values at actuators and actuator control units)
4	Driver assistance functions
5	"Central driving dynamics and steering control" function
6	"Sensor signal processing and signal provision" function
7	"Driving dynamics control" function
8	DSC sensor in the ICM control unit (longitudinal acceleration, lateral acceleration, yaw rate)
9	Redundant DSC sensor in the ICM control unit (lateral acceleration, yaw rate)

Signal Provision

The ICM control unit reads signals from external and also internal sensors. These sensor signals are processed and converted into physical signals that describe the driving dynamics of the vehicle, and are subsequently made available to a large number of systems in the vehicle. Examples of these signals are road speed and lateral acceleration.

The central driving dynamics control system in the ICM firstly evaluates the current driving condition and driver's command, also taking the dynamic driving systems installed in the vehicle into account.

On the basis of this information, the system decides whether or not to intervene in the driving dynamics, and also the extent the intervention. The highly intelligent dynamic driving systems permit slight and barely noticeable interventions as soon as e.g. a tendency towards understeering is detected.

A coordinator ensures that the most suitable actuator is activated in each case. Where several actuators are used simultaneously, a great deal of importance has been placed on ensuring that these interventions are in perfect harmony.

The driving dynamics control provides the driver with the choice of one of four driving dynamics settings (Normal, Comfort, Sport and Sport+). By making this choice, the driver influences the central driving dynamics control system and therefore all dynamic driving systems and drive train systems. All systems are matched appropriately to every setting and, most importantly, their interaction with each other within one specific setting is also perfectly coordinated. The status of the Dynamic Stability Control is also taken into account thus ensuring that two additional driving dynamics specifications are possible.

The ICM control unit is also responsible for the Servotronic function including valve actuation. This steering control function is also influenced by the driving dynamics control.

Driver Assistance Functions

The ICM control unit incorporates the “Cruise control with braking” and “Active Cruise Control with Stop & Go” control functions. In addition, the ICM coordinates activation of the vibration actuator in the steering wheel for the “Lane Departure Warning” and “Active Blind Spot Detection” driver assistance functions.

Signal Provision

Signals from integrated sensor system

The sensors that were previously accommodated separately in the DSC sensor are now installed in the ICM control unit. The following variables can be recorded with these sensors.

- Longitudinal acceleration and pitch of the road or vehicle in the longitudinal direction
- Lateral acceleration and pitch of road or vehicle in lateral direction
- Rotational speed around vertical axis (yaw rate)

The sensor signals are initially referenced to the sensor housing. However, to be useful to the dynamic driving systems, these variables must be referenced to the vehicle coordinate system. The ICM control unit performs the necessary conversion. A synchronization process is carried out when the ICM control unit is started up during which appropriate correction values are determined and saved.

Note: Calibration of the sensors integrated into the ICM control unit is necessary in the following cases:

- **the ICM control unit has been replaced or**
- **if requested by the test schedule in the diagnostic system due to a fault code memory entry.**

The calibration must be performed with the vehicle standing on a level surface in the longitudinal and lateral direction. Terminal 15 must be switched on.

Signals from External Sensors

The ICM control unit imports the following signals that are important for dynamic driving systems from external sources:

- Wheel speeds, four signals transmitted via FlexRay from DSC.
- Ride-level heights, four signals, wired directly to ICM control unit.
- Steering wheel angle, transmitted via FlexRay from steering column switch cluster.
- Position of actuators for Active Steering and rear axle slip angle control, transmitted via FlexRay.

The ICM calculates the actual **speed** at which the vehicle moves along the driving axis on the road based on the four **wheel-speed signals**. If dynamic driving systems intervene and affect the wheel speeds, this is taken into account in the calculation. The status of the ABS control (for example) is also imported in this instance.

The road speed thus determined for the first time in the F01/F02 is now used as the reference for practically all systems in the vehicle. This means that a multiple calculation no longer needs to be performed in many other control units.

The ICM control unit also derives the following information from the wheel-speed signals:

- **Distance** travelled
- **Wheel tolerance check:** The marginal differences in wheel speeds (e.g. due to differences in tire diameter) are identified and adjusted by the ICM.
- **Snow chain detection:** If snow chains are fitted, the driver can enter this information manually via the Central Information Display. The wheel speeds are also used by the HSR control unit to automatically determine whether snow chains are mounted on the rear wheels. The result of this identification is transmitted to the ICM control unit via the FlexRay.

Although, from a theoretical standpoint, it may be more appropriate to assign the **ride-height sensors** to the Vertical Dynamics Management, the four ride-height sensors are directly connected to the ICM control unit.

The ICM control unit imports the analog voltage signals of the ride-height sensors. These are converted into the actual ride-level heights in millimeters. To perform this conversion, the ICM control unit must be able to map the voltage signals it receives to reference values as otherwise it will not be able to determine the actual ride-level heights. These reference values are determined by means of a synchronization procedure.

The harmonized ride-level heights are made available by the ICM control unit as bus signals. They are imported from:

- the Vertical Dynamics Management system for the Vertical Dynamics Control and Active Roll Stabilization and also from the
- footwell module for the headlight-range adjustment function.

The ride-level heights are not transmitted as bus signals for the purposes of electronic ride-height control (EHC). Instead, an additional direct line connection exists between the ride-height sensors of the rear axle and the EHC control unit.

The ICM control unit determines the resulting steering lock angle of the front wheels based on the steering wheel angle and location of the Active Steering actuator motor.

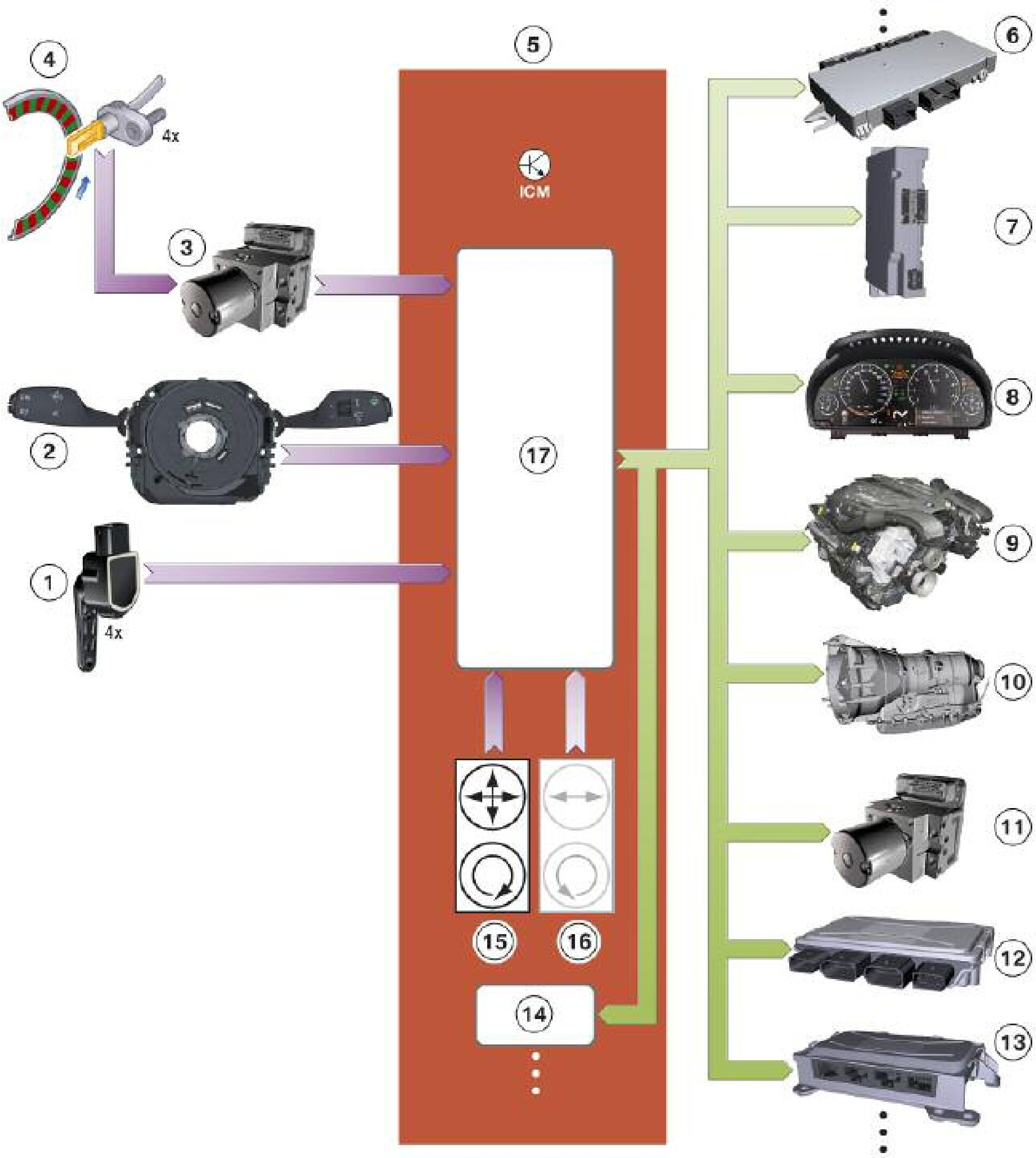
As the rear axle can also be steered, a reliable conclusion regarding the driving dynamics cannot be obtained purely on the basis of the steering angle of the front wheels. This is why the ICM control unit also takes the steering angle of the rear wheels into account. The **effective steering angle** (of the front and rear wheels) is then determined using both steering angles.

This is a purely theoretical computing value that indicates the steering lock of the vehicle's front wheels that would be required to achieve the same vehicle motion if the rear axle could not be steered. The easiest way for all systems in the vehicle to evaluate the data on the steering wheel movement is to use this effective steering angle.

NOTES PAGE

Processing and distribution of signals

Signal provision by ICM



Index	Explanation	Index	Explanation
1	Ride-height sensors	10	Electronic transmission control unit
2	Steering column switch cluster with steering angle sensor	11	Dynamic Stability Control
3	Dynamic Stability Control	12	AS control unit
4	Wheel-speed sensors	13	HSR control unit
5	Integrated Chassis Management	14	Driving dynamics functions in the ICM control unit
6	Footwell module	15	DSC sensor in the ICM control unit (longitudinal acceleration, lateral acceleration, yaw rate)
7	KAFAS control unit	16	Redundant DSC sensor in the ICM control unit (lateral acceleration, yaw rate)
8	Instrument cluster	17	"Signal processing" function in the ICM control unit
9	Engine control system		

The signals from the sensors are processed before being made available in the vehicle via the FlexRay bus system. Specific examples of this have already been referred to above. To formulate this in more general terms, the ICM control unit uses all available sensor signals and several computing models to improve the quality of the signals provided. This means that they contain fewer errors and therefore allow the signal “users” (e.g. the dynamic driving systems) to operate with a greater degree of precision.

A new aspect of the F01/F02 is that the signals are not available to just a few systems in the vehicle.

In the F01/F02, the signals provided by the ICM are not used exclusively by the dynamic driving systems. The drive control units, driver assistance systems, information systems and body electrical system share the signals, instead of recording or preparing these separately.

Note: This has a distinct advantage when it comes to the diagnosis of signal faults: Faults in all signals described here are stored centrally in the fault memory of the ICM control unit.

In previous vehicles, it was possible for one signal fault to produce a large number of branches in the test schedule trees. The ICM architecture in the F01/F02 means that the test schedule can quickly pinpoint the ICM control unit in the event of a signal fault.
The test schedule then shows the effective repair measure in each case.

Higher-level Driving Dynamics Control

Observation of the Driving Condition

The Integrated Chassis Management (ICM) control unit calculates the current driving situation from the signals listed below. This essentially means the longitudinal and lateral dynamic driving condition.

- Wheel speed signals from all four wheels
- Longitudinal acceleration
- Lateral acceleration
- Yaw rate

The ICM control unit therefore knows how the vehicle is actually moving at this point.

To be able to optimize the vehicle behavior, the dynamic driving systems require information about how the driver wishes the vehicle to move. The driver's command is determined from the following signals:

- Accelerator pedal angle and current engine torque and gear ratio
- Application of the brake pedal and current brake pressure
- Effective steering angle and steering-angle speed.

The driving condition and driver's command are provided both internally and externally by the ICM control unit. The central driving dynamics control acts as a receiver internally in the ICM control unit. The control units of the dynamic driving systems (e.g. DSC) are the external receivers. They receive the driving condition and the driver's command from the ICM control unit via the FlexRay bus system.

Central Driving Dynamics Control

The aim of the interventions by the dynamic driving system is to improve agility and traction. If required, they can of course also restore the stability of the vehicle. In previous vehicles, separate systems existed that were designed to do this and although they in fact communicated with each other, they tended to have a more restricted range of tasks. The interaction of all systems that ultimately determines the overall driving characteristics was therefore difficult to coordinate.

The Integrated Chassis Management of the F01/F02 incorporates the central driving dynamics control. This compares the command given by the driver with the actual movement of the vehicle at that point and therefore determines whether intervention of the dynamic driving system is required, and also the extent of the intervention.

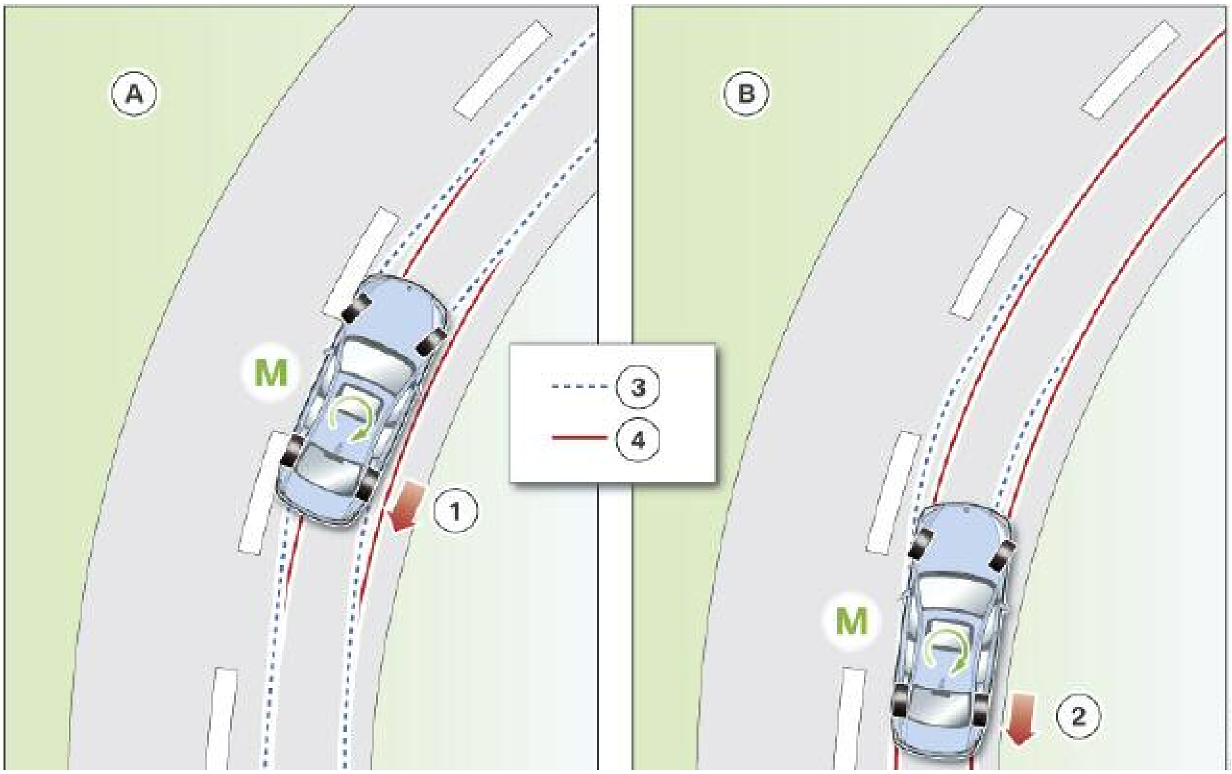
The yawing force is an output variable of the central driving dynamics control system. This produces a rotation of the vehicle that is superimposed on the existing movement of the vehicle.

This can be used to “readjust” the driving characteristics if the result identified does not match the driver’s command. Classic examples of this are understeering or oversteering driving characteristics.

A new feature of the ICM installed in the F01/ F02, however, is that the dynamic driving systems are already deliberately activated before a deviation of this nature is identified. The interventions of the dynamic driving systems therefore take place long before the driving characteristics become unstable.

This produces a far more harmonious effect in the vehicle than would be possible from a conventional chassis design. The vehicle reacts neutrally in many more situations and does not even begin to understeer or oversteer. This new function is possible through the use of extremely precise computing models and new control strategies that can be used to evaluate and influence the driving characteristics.

Influencing the driving characteristics using the driving dynamics control system



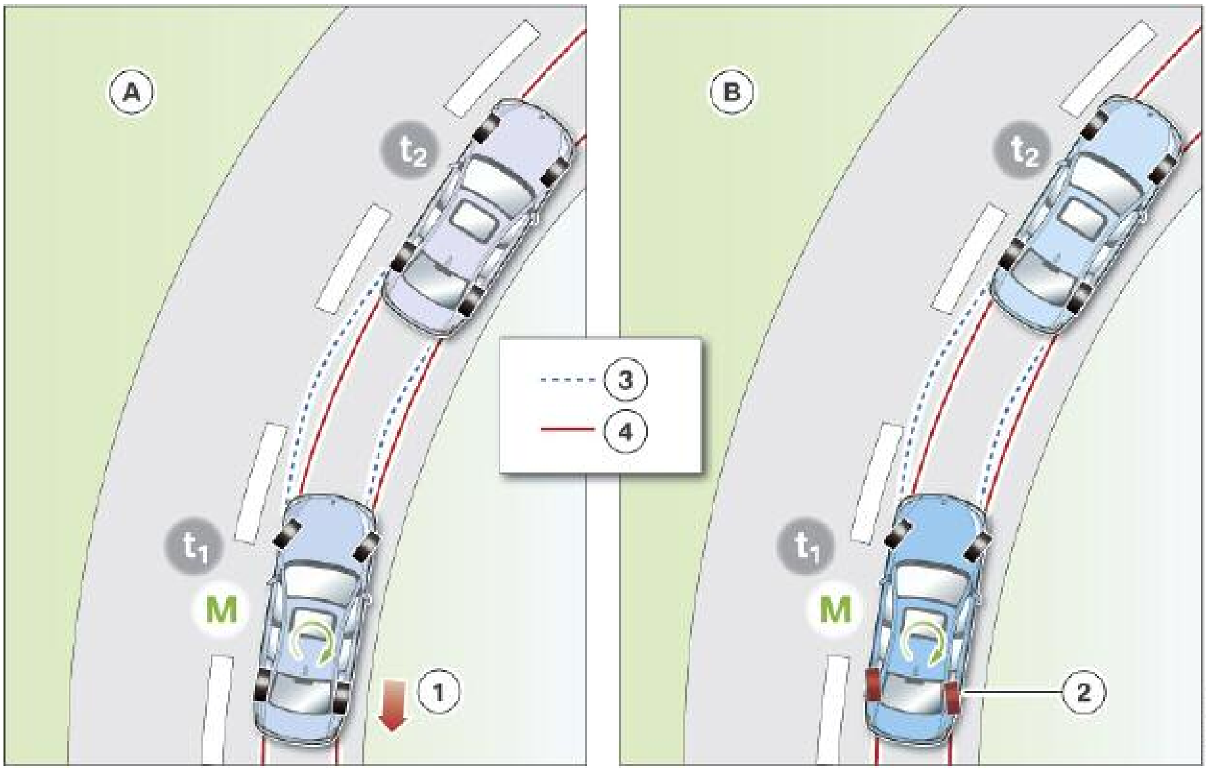
Index	Explanation
A	Correction of unstable driving characteristics
B	Intervention at an early stage to achieve neutral driving characteristics
1	Braking intervention at individual wheels in order to correct understeering
2	Braking intervention at individual wheels in order to prevent understeering
3	Course of an understeered vehicle
4	Course of a vehicle with neutral driving characteristics
M	Yawing force that acts on the vehicle due to braking intervention (at individual wheels)

Coordinated Intervention by the Dynamic Driving Systems

The following intervention options for producing the yawing force calculated by the central driving dynamics control system have been available up till now (and will of course remain available) -the corresponding dynamic driving systems are shown in brackets:

- Individual activation of the wheel brake (DSC)
- Adjustment of the current engine torque (ASC+T, DSC, MSR)
- Adjustment of the steering angle of the front wheels, regardless of the driver’s input (Active Steering).

Possible driving dynamics interventions during understeering



Index	Explanation
A	Prevention of understeering by means of braking at individual wheels
B	Prevention of understeering by means of steering intervention at rear axle
1	Braking intervention at individual wheels
2	Steering intervention at the rear axle
3	Course of an understeered vehicle
4	Course of a vehicle with neutral driving characteristics
M	Yawing force that acts on the vehicle due to braking intervention (at individual wheels)

The option of influencing the lateral dynamics of the vehicle - the rear axle slip angle control (HSR) - was available for the first time in the F01/F02. The customer only receives this innovative dynamic driving system in combination with the established Active Steering feature. This option is referred to as “Integral Active Steering”.

A function referred to as “Actuator coordination” follows the central driving dynamics control. This decides which dynamic driving system should be used to produce the yawing force in the specific road situation.

For example, if the vehicle has a tendency to sharply understeer this can be counteracted by means of selective braking intervention at the back wheel on the inside of the curve. If the vehicle is equipped with Integral Active Steering, the same objective can be achieved more harmoniously by applying an appropriate steering angle at the rear axle.

As both actuating options are limited, it may also be beneficial to apply both at once. If understeering is avoided the driver becomes aware of this due to the considerable increase in agility.

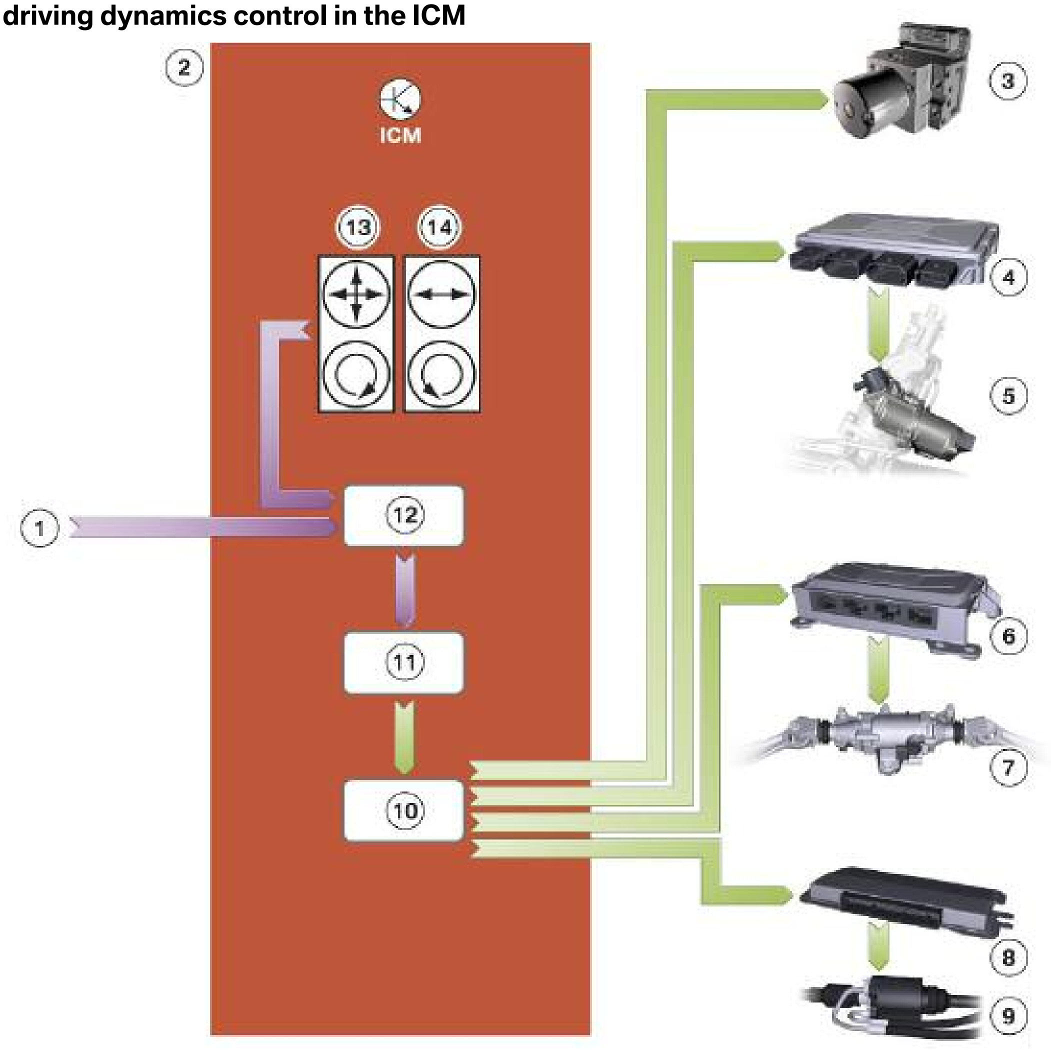
The F01/F02 is the first instance where genuine functional networking between the integrated chassis management and Vertical Dynamics Management functions also takes place. This does not simply mean that the ICM records and processes ride-height information and then delivers it to the VDM.

The ICM also actively controls the Active Roll Stabilization as an integral part of central driving dynamics control in order to influence the self-steering characteristics. As the conventional chassis design already demonstrates, a more rigid anti-roll bar on one axle means that the overall achievable cornering stability on the same axle is lower. The effects of more or less rigid anti-roll bars can be emulated with the aid of the hydraulic motors in the anti-roll bars of the Dynamic Drive. This means that the central driving dynamics control of the ICM can selectively influence the degree of available lateral force on one axle via the active anti-roll bars of Dynamic Drive.

If the vehicle is currently oversteering, the cornering force at the rear axle is insufficient. The roll stabilizing torque at the rear axle tends to reduce in this case. This loss of torque is compensated for by additional cornering stability at the rear axle which helps stabilize the vehicle.

The activity of the central driving dynamics control in the ICM control unit is summarized in the input/output graphic on the following page.

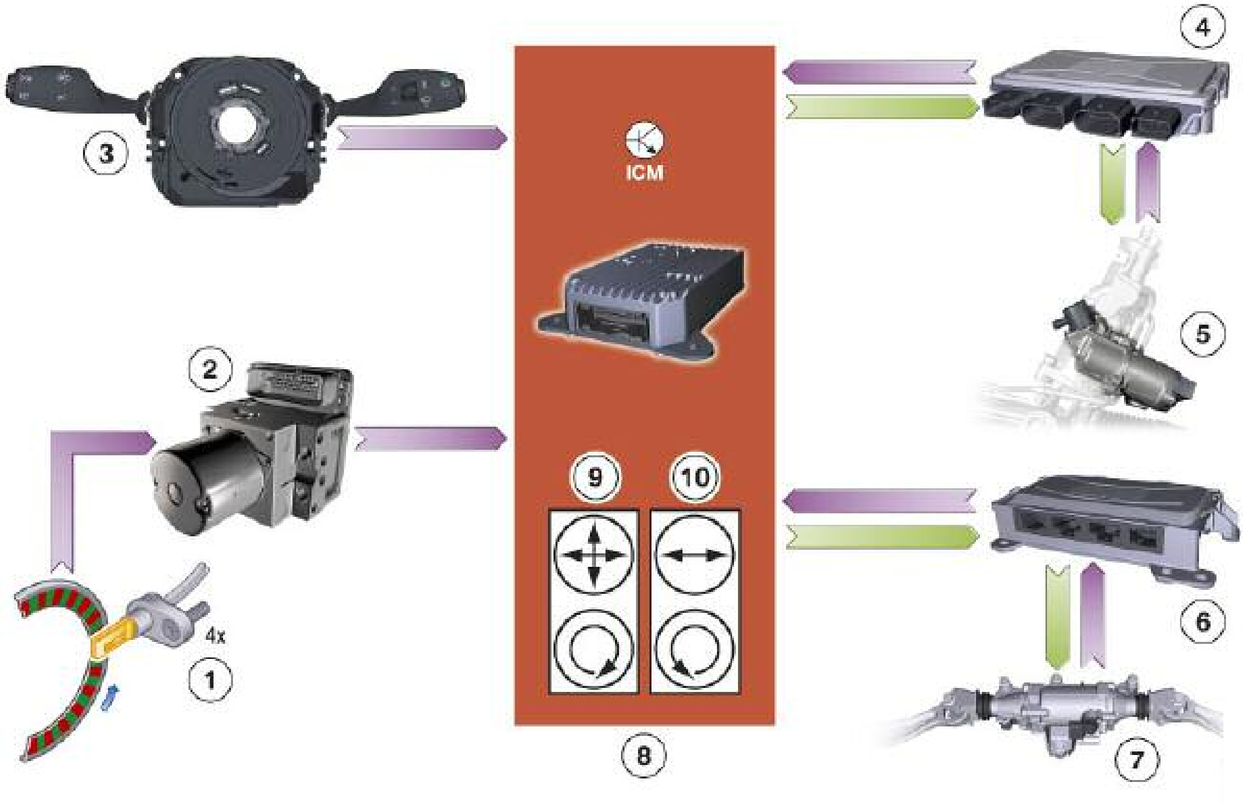
Central driving dynamics control in the ICM



Index	Explanation	Index	Explanation
1	Input signals from external sensors	8	VDM control unit
2	Integrated Chassis Management	9	Active anti-roll bar
3	Dynamic Stability Control	10	"Actuator coordination" function
4	AS control unit	11	"Central driving dynamics control" function
5	AS actuating unit	12	"Sensor signal preparation" function
6	HSR control unit	13	DSC sensor in the ICM control unit (longitudinal acceleration, lateral acceleration, yaw rate)
7	HSR actuating unit	14	Redundant DSC sensor in the ICM control unit (lateral acceleration, yaw rate)

Distributed functions: ICM and actuator control units
A description of the distribution of tasks between the ICM and the other driving dynamics control units follows using Integral Active Steering as an example.

ICM and actuator control units AS and HSR



Index	Explanation	Index	Explanation
1	Wheel-speed sensors	6	HSR control unit
2	Dynamic Stability Control	7	HSR actuating unit
3	Steering column switch cluster with steering angle sensor	8	Integrated Chassis Management
4	AS control unit	9	DSC sensor in the ICM control unit (longitudinal acceleration, lateral acceleration, yaw rate)
5	AS actuating unit	10	Redundant DSC sensor in the ICM control unit (lateral acceleration, yaw rate)

The Integrated Chassis Management (ICM) is the control unit that performs the calculations for higher-level driving dynamics functions of the Integral Active Steering.

The Integrated Chassis Management uses the current driving situation and the driver's directional input to calculate the individual setpoint values for the variable steering-transmission ratio and the Yaw-Rate Control Plus. Once these have been prioritized, the ICM produces a reference value for the AS and HSR control unit respectively. This is a reference angle that should be set at the front or rear wheels.

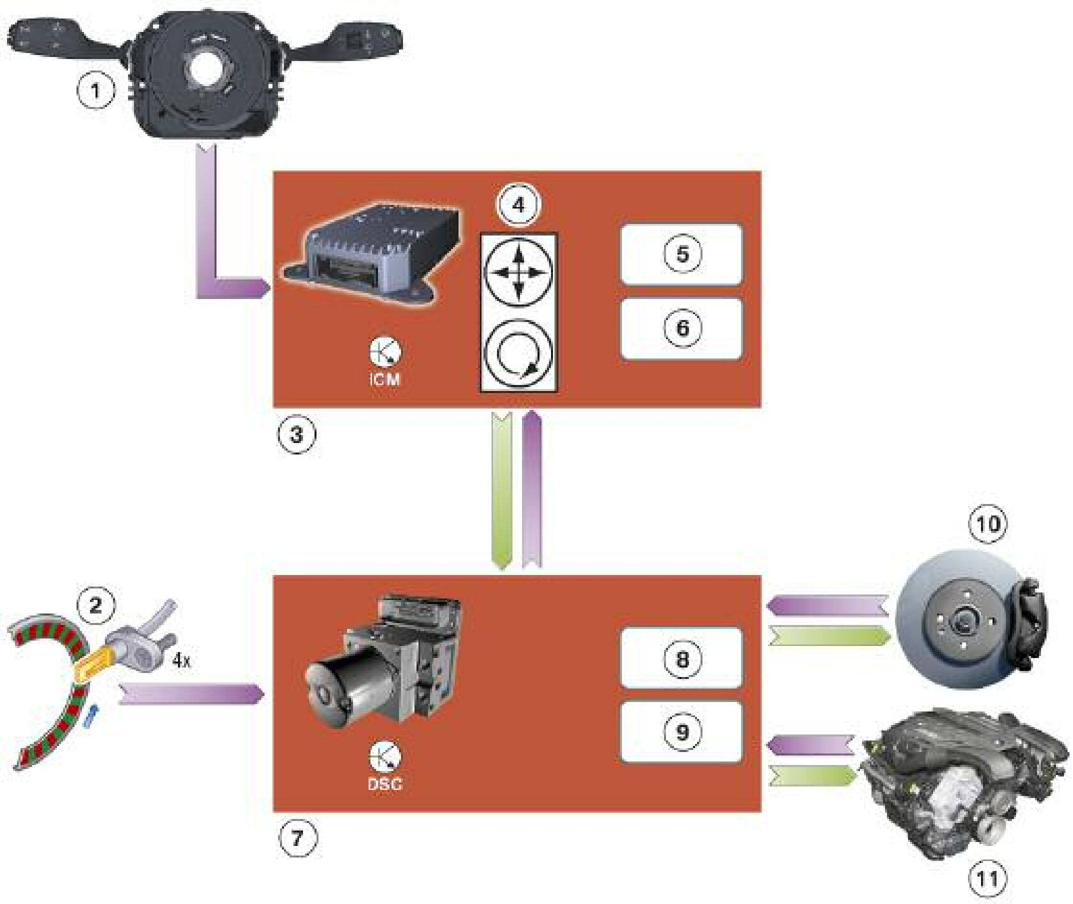
The AS control unit receives this reference value and has the principal task of controlling the actuating elements in order to achieve the reference value. The AS control unit is therefore purely an actuator control unit. The same applies for the HSR control unit: this is also an actuator control unit. As with the AS control unit, this control unit is purely responsible for implementing the reference steering angle requested by the ICM.

This type of task distribution was implemented for the first time with the introduction of the ICM in the E71. The expansions in the F01/F02 mean that

- the ICM now controls all longitudinal and lateral dynamics systems centrally (AS, HSR and also DSC) and that
- ICM is the master control unit both in the linear range and also in unstable driving conditions.

However, the interface between the Integrated Chassis Management and Dynamic Stability Control is a special case.

Input/Output: interaction of ICM and DSC



Index	Explanation	Index	Explanation
1	Steering column switch cluster with steering angle sensor	7	Dynamic Stability Control
2	Wheel-speed sensors	8	"Driving dynamics control" function in DSC control unit
3	Integrated Chassis Management	9	"Actuator control" function
4	DSC sensor in the ICM control unit (longitudinal acceleration, lateral acceleration, yaw rate)	10	Wheel brake
5	"Driving dynamics control" function in the ICM control unit	11	Drive
6	"Actuator coordination" function		

The Dynamic Stability Control also has its own internal driving dynamics controller that normally implements the reference value (reference yawing force) sent from the ICM control unit in the F01/F02. This is achieved through braking intervention at individual wheels and also by influencing the input torque.

The DSC driving dynamics controller is also able to detect an unstable road situation itself using corresponding signals on the driving condition provided by the ICM in which case the stabilizing braking or engine interventions are implemented automatically by DSC. Corresponding feedback is of course also sent to the ICM. In this case, the interventions of the driving dynamics control in the ICM are cancelled.

Control and Adjustment of Steering

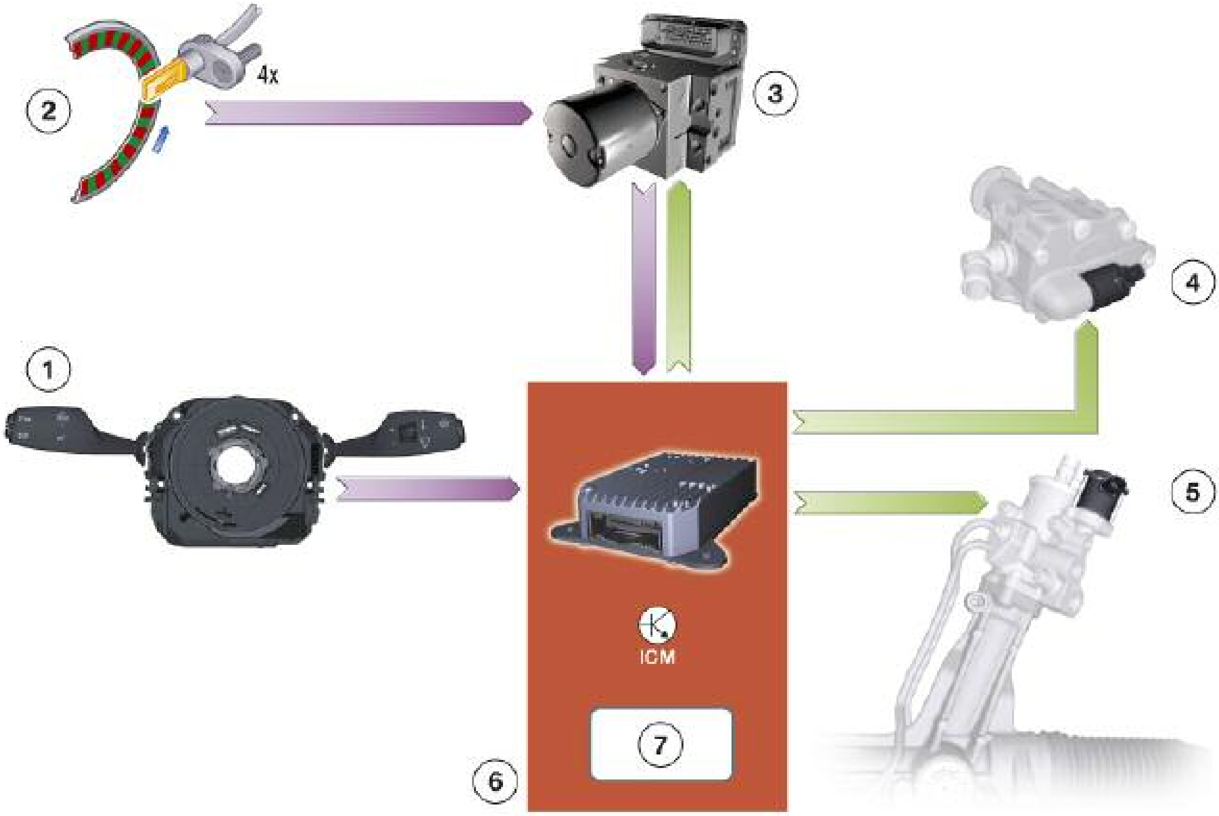
The **Servotronic** function in the F01/F02 is included in the basic steering and Integral Active Steering (option). This speed-dependent power steering assistance function is implemented by the Servotronic valve at the steering gear.

The Servotronic valve is always activated from the ICM control unit irrespective of the equipment specification. It follows that the ICM control unit also incorporates the logic of the Servotronic function.

Again, regardless of the options fitted, the steering system also contains a proportional valve that is also controlled by the ICM control unit. The volumetric flow in the steering hydraulic circuit can be adjusted electronically assisted by this valve which is why it is also referred to as an “electronic volumetric flow adjustment” valve, or EVV valve for short.

This valve is also controlled by the ICM control unit. The volumetric flow generated by the power steering pump is distributed between a circuit to the steering valve and a bypass circuit according to the level of power steering assistance required. This distribution is infinitely variable. The less power steering assistance is required, the more hydraulic oil is diverted to the bypass circuit. Because the hydraulic oil in the bypass circuit has no task to perform, this means that the power steering pump consumes less power. In this way, the EVV valve contributes to **reducing** fuel consumption and **CO_2 emissions**.

Input/Output: control of steering by ICM



Index	Explanation	Index	Explanation
1	Steering column switch cluster	5	Servotronic valve
2	Wheel speed sensor	6	Integrated Chassis Management
3	Dynamic Stability Control	7	"Steering control" function
4	EVV valve		

Driver Assistance Functions

Depending on the equipment specification, two driver assistance functions that act on the longitudinal dynamics of the vehicle can be integrated in the ICM control unit:

- **Cruise control with braking function** (Dynamic Cruise Control, DCC) and
- **Active cruise control with stop & go function** (ACC Stop&Go).

The Adaptive Brake Assistant function is included in the same equipment package as ACC Stop&Go.

The ACC Stop&Go function has been integrated into the ICM control unit in the F01/F02. This dispenses with the need for a separate LDM control unit. The DCC function that is calculated in the Dynamic Stability Control in the E70, for example, has been accommodated in the ICM control unit of the F01/F02.

Input/Output, driver assistance systems - longitudinal dynamics

Index	Explanation	Index	Explanation
1	Short range radar sensors (SRR)	7	Integrated Chassis Management
2	Long range radar sensors (LRR)	8	Drive
3	Footwell module	9	Dynamic Stability Control
4	Control panel for driver assistance functions	10	Instrument cluster
5	Steering column switch cluster	11	"DCC" function
6	Control panel for DCC or ACC Stop & Go on multi-function steering wheel	12	"ACC Stop & Go and Adaptive Brake Assistant" functions

The ICM control unit performs an additional important function for the **Lane Departure Warning** and **Active Blind Spot Detection** driver assistance systems. As both systems warn the driver via a vibration in the steering wheel, a coordinator function is required. This is integrated in the ICM control unit.

The ICM control unit generates a reference value for the vibration based on the warning requirements for the lane departure warning (KAFAS control unit) and the lane change warning (SWW sensor). The amplitude of the vibration varies depending on what triggered the warning.

The reference value is transmitted to the steering column switching cluster via the FlexRay bus system then put into effect via the steering wheel module (LRE) or the vibration actuator in the steering wheel.

The Input/Output graphic below is intended as an overview only.

Input/Output, coordination of steering wheel vibration

Index	Explanation	Index	Explanation
1	Radar sensor, lane change warning	7	Steering column switch cluster
2	KAFAS control unit	8	Steering wheel electronics (LRE) and vibration actuator in steering wheel
3	Camera for lane departure warning	9	Lane change warning display in door mirror
4	Footwell module	10	Instrument cluster
5	Control panel for driver assistance functions	11	Coordination function for steering wheel vibration
6	Integrated Chassis Management		

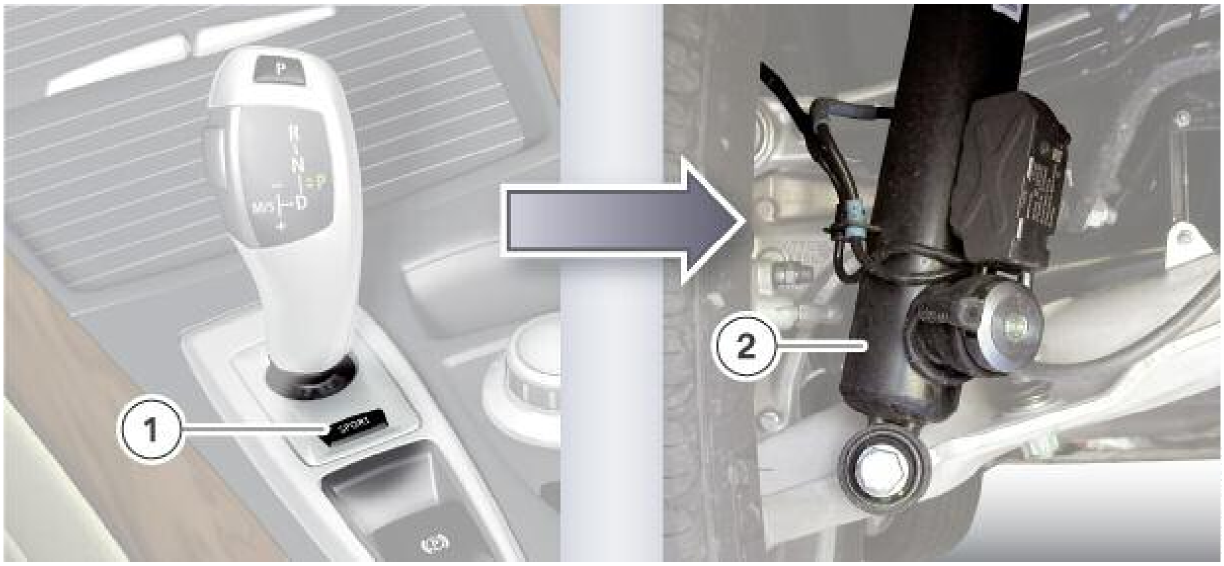
Driving Dynamics Control

History

Control elements are already installed in a number of BMW vehicles that the driver can use to switch individual systems to a sporting mode. This includes the sports setting of the automatic selector lever. In this case, only the shift characteristics of the automatic gearbox are influenced.

The system behaves in a similar manner when the SPORT button for the Electronic Damping Control or Vertical Dynamics Control (shown below) is used. This only changes the characteristic (hardness) of the shock absorber.

SPORT button in E70/ E71

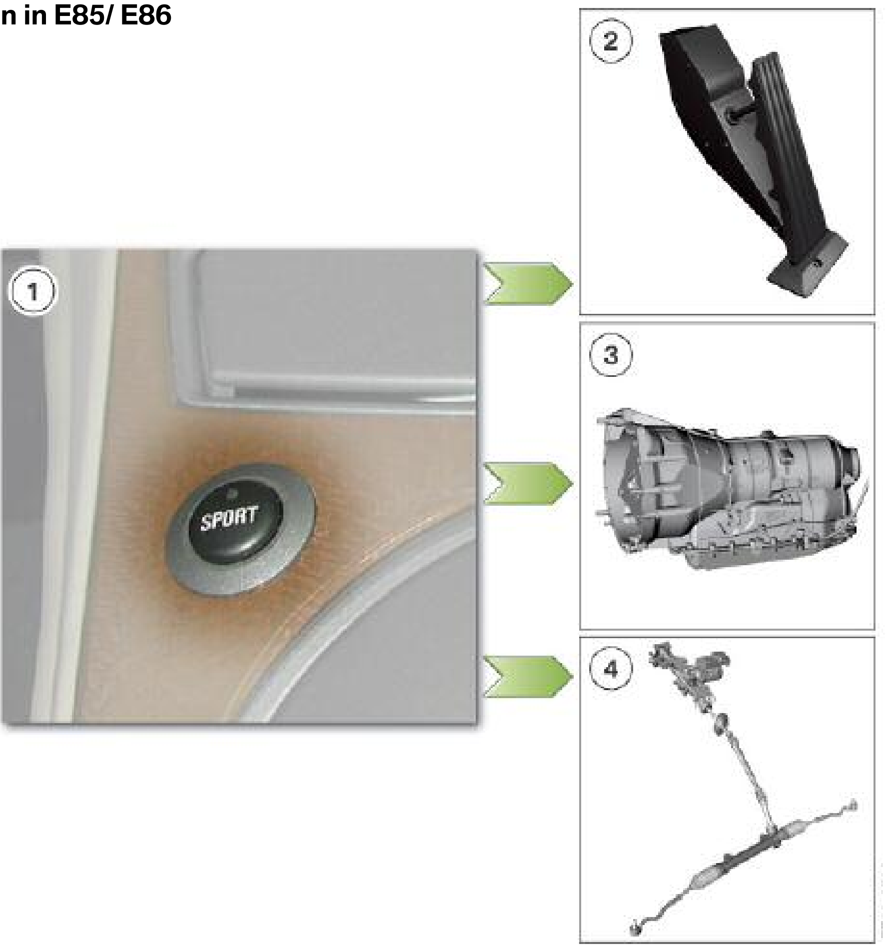


Index	Explanation	Index	Explanation
1	SPORT button	2	Vertical Dynamics Control with electronically adjustable shock absorbers

All other drive and dynamic driving systems therefore be found as it would need to remain in their basic setting. A suitable harmonize the damping action in both sporting compromise for this basic setting must mode and standard mode.

A SPORT button that influences several systems was introduced for the first time in the E85/E86. The corresponding “driving dynamics control” function effects a changeover between a standard mode and a sporting mode in the steering, automatic gearbox and accelerator pedal. This meant it was now possible to coordinate these three systems far more effectively in both modes with the result that the customer now experiences a car that is uncompromisingly tailored to “Sport” in every sense.

SPORT button in E85/ E86



Index	Explanation	Index	Explanation
1	SPORT button	3	Automatic transmission
2	Accelerator pedal	4	Steering

The new driving dynamics control in the F01/ F02 contains two groundbreaking new features when compared to the E85/E86:

1. All drive and dynamic driving systems installed in the vehicle are comprehensively switched over.
2. Four settings are available. The status of the Dynamic Stability Control is also taken into account thus ensuring that two additional settings are possible.

The driving dynamics control is operated via a new driving dynamics switch and the DTC button positioned directly in front of it.

The changeover operations for many drive and driving dynamics functions are therefore bundled in the driving dynamics control of the F01/F02. The vehicle as a whole then behaves as the driver would expect in accordance with his/her chosen setting.
This bundling can make the handling characteristics of the vehicle considerably more distinctive and less compromising.

Conversely, many individual, and also sometimes meaningless, combinations are avoided (example: sports steering combined with comfort-oriented damping).

DTC button and driving dynamics switch

Index	Explanation	Index	Explanation
1	DTC button	2	Driving dynamics switch

Mode of Action of Driving Dynamics Control in F01/F02

Networking of Systems

The systems involved in the “driving dynamics control” function are shown in the following Input/Output illustration.

Input/Output, driving dynamics control

Index	Explanation	Index	Explanation
1	Controller	7	Vertical Dynamics Control with electronically adjustable shock absorbers
2	Driving dynamics switch and DTC button	8	Active anti-roll bar
3	Integrated Chassis Management	9	Dynamic Stability Control
4	Accelerator pedal	10	Instrument cluster
5	Automatic transmission	11	Central information display
6	Steering		

The driver operates the driving dynamics control using the driving dynamics switch and the DTC button. The ICM control unit imports the control signals then determines on the basis of this which new mode the driving dynamics control should adopt. The mode thus determined is transmitted to the relevant drive and dynamic driving systems for implementation. These are:

- The engine control system for the accelerator pedal characteristic.
- The electronic gearbox control for driving programs and shift speed.
- The Vertical Dynamics Management system for the Vertical Dynamics Control and Active Roll Stabilization.
- The Dynamic Stability Control .
- The ICM control unit itself that controls the power steering assistance (Servotronic) and the steering-transmission ratio (Active Steering).

The ICM control unit also prompts the display of the relevant mode in the instrument cluster and also in the Central Information Display. In addition to selecting a mode, the driver can use the controller to make further settings.

Operation and display

The driver can select the four main modes using the driving dynamics switch. These main modes are designated as follows:

- Comfort
- Normal
- Sport
- Sport+

After the vehicle is started, the driving dynamics control is always in “Normal” mode. When the driving dynamics switch is moved to the “Sport” position, the driving dynamics control initially changes to “Sport” mode and then to “Sport+” mode if this button is pressed again. If the driver moves the driving dynamics switch to the “Comfort” position, the mode changes in the opposite direction, i.e. from “Sport” to “Normal” mode.

The DTC button provides the driver with two additional modes:

- Traction
- DSC off

The “Traction” mode can be activated by briefly pressing the DTC button. This works irrespective of which driving dynamics control mode was previously active. “DSC off” is activated by holding the DTC button pressed for longer. The “Traction” and “DSC off” modes can be switched off by pressing the DTC button again. The driving dynamics control subsequently returns to “Normal” mode. If the driver instead presses one of the two rocker switches at the driving dynamics switch to deactivate the “Traction” or “DSC off” modes, the driving dynamics control subsequently enters “Sport” or “Comfort” mode (depending on which rocker switch is pressed).

Each time the driving dynamics switch or DTC button is pressed this immediately prompts a reaction in the instrument cluster display. The changeover to “Sport” mode is shown below.

Display of "Sport" mode directly following operation

After some time, unless the driving dynamics switch is pressed, a more compact version of the display for the driving dynamics control appears.

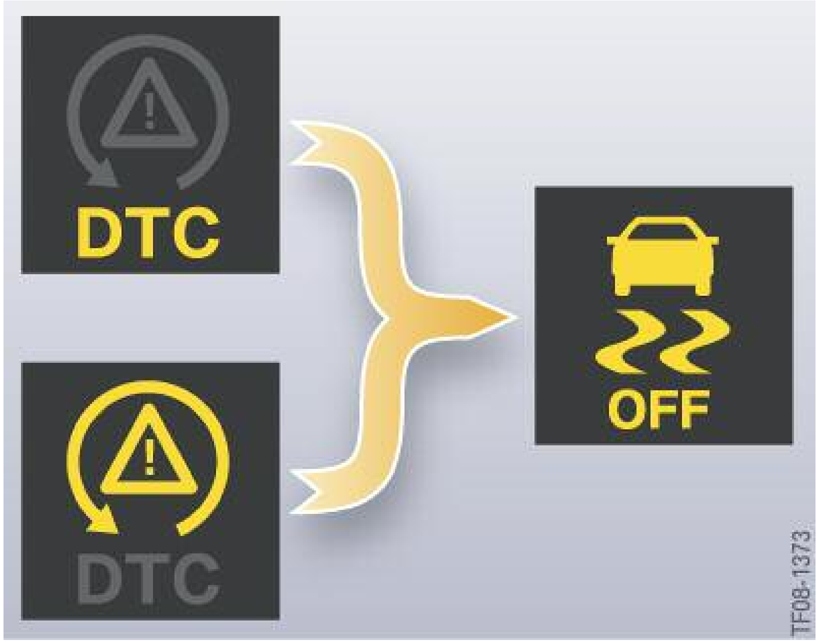
"Sport" display mode

"Traction" display mode

The two modes “Traction” and “DSC off” present a special case in terms of their display requirements. In addition to the text entry, the yellow DSC indicator and warning lamps must be activated.

”DSC off” display mode

Note: New symbols are now used for the yellow DSC indicator and warning lamp and the DTC button. The new DSC symbols used for the first time in the F01/F02 replace the symbols previously used.



DSC and DTC symbolic representation

Two different symbols were formerly used for the two states "DTC mode" and "DSC off" and were displayed in the instrument cluster. Since the launch of the F01/F02, only one symbol has been used for both states.

The new symbols are being gradually introduced in all newly developed vehicles. The reason for this are changes to legislation that require automobile manufacturers to produce a uniform display format.

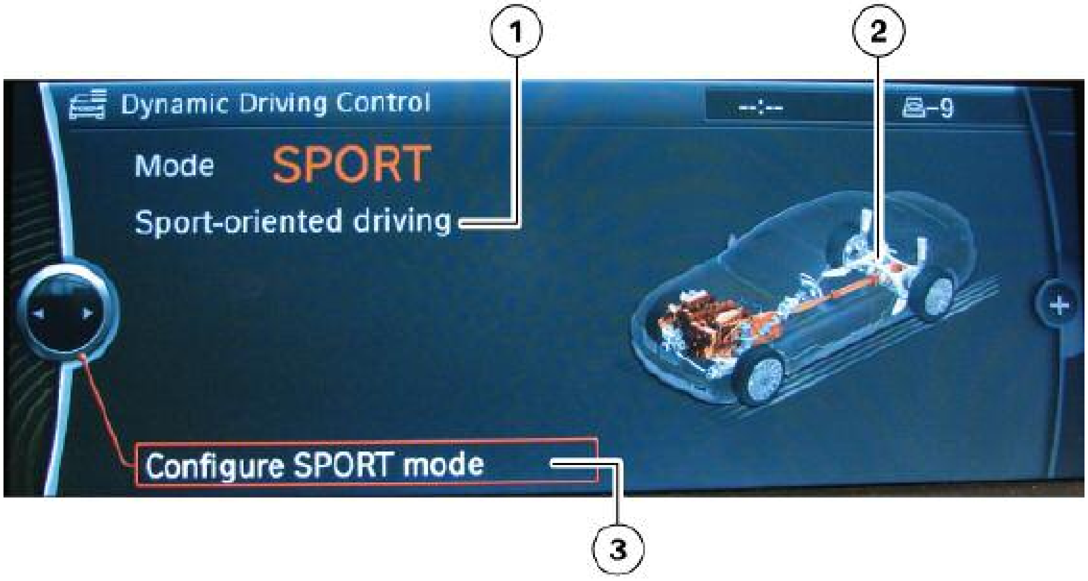
This legislation also specifies that the text message "off" must be displayed as soon as the DSC function is restricted, as is the case in the "Traction" and "Sport+" modes.

When the DTC button or the driving dynamics switch is pressed, an assistance window appears at the same time as the instrument cluster display in the Central Information Display. The name of the newly selected mode appears there together with an explanatory text.

In the “Sport” mode the driver also has the option of configuring this. Assisted by the controller, the driver can choose whether to apply the “Sport” mode to the drive systems, or the dynamic driving systems or both.

Configuration of the "Sport" mode	Drive systems	Chassis and dynamic driving systems
Drive and chassis (factory setting)	Sports	Sports
Drive only	Sports	Normal
Chassis only	Normal	Sports

Assistance window, “Sport” mode



Mode SPORT

Sport-oriented driving

Index	Explanation
1	Text description of the area(s) in which "Sport" mode is applied (shown here: chassis only and/or dynamic driving systems)
2	Visual description of the area(s) in which "Sport" mode is applied
3	Menu for configuration of "Sport" mode

Modes and their effects

This chapter describes the effects of the individual modes in the drive and dynamic driving systems. As the individual systems are switched over together in a coordinated manner, this lends coherence to the overall behavior of the vehicle. This of course also means that meaningless combinations, such as a sports accelerator pedal characteristic combined with a highly comfort-oriented automatic gearbox shift program, are avoided and meaningful combinations for the mode are integrated instead.

This is why when compared to earlier vehicles, the configuration of individual systems can to a great extent now be uncompromisingly tailored to one mode. The driver therefore not only experiences coherent vehicle response characteristics in all modes, he/she will also sense the differences between the individual modes far more acutely.

The table below demonstrates this, particularly through the comparison between the "Normal" and "Sport" modes.

	Comfort	**Normal**	**Sport**	**Sport+**
Drive systems				
Accelerator pedal characteristic	Normal	Normal	Sports	Sports
Shift program, automatic gearbox	Normal	Normal	Sports	Sports
Shift speed, automatic gearbox	Normal	Normal	Sports	Sports
Chassis and dynamic driving systems				
Power steering assistance	Normal	Normal	Sports	Sports
Integral Active Steering	Normal	Normal	Sports	Sports
Dynamic Stability Control	DSC on	DSC on	DSC on	DTC (sports)
Vertical Dynamics Control	Comfortable	Normal	Sports	Sports
Active anti-roll bar	Normal	Normal	Sports	Sports
The configuration shown here in "Sport" mode applies for both drive and dynamic driving systems.				

If the "Comfort" and "Normal" modes are compared instead, it is evident that the configuration differs in one dynamic driving system only: the Vertical Dynamics Control. This characteristic of the "Comfort" mode does not happen by chance and takes several peripheral factors into account:

- Most drive and dynamic driving systems ensure that driving is sufficiently comfortable in the "Normal" configuration; this is something that BMW 7 Series customers would expect. The Servotronic already offers requirement-based power steering assistance with maximum comfort, for example.

- The “Normal” configuration does not necessarily mean adherence to a single, defined system characteristic. The shift program of the automatic gearbox is only one example of how the current driving condition and driver’s command are taken into account in order to bring the behavior of the relevant system into line with these requirements.
- Most drivers relate a desire for greater comfort with the suspension and damping characteristics. This requirement is particularly relevant when driving on poor or uneven roads.

This means that the “Comfort” mode also embraces the philosophy of driving dynamics control which is to achieve a coherent vehicle response characteristic that meets the expectations of the driver.

The “Sport” and “Sport+” modes also differ in terms of the coordination of one specific dynamic driving system: the Dynamic Stability Control. In the “Sport” mode, a decidedly sports-oriented overall vehicle behavior is available to the driver.

Although it is assumed that many drivers would like to use this “Sport” mode, the DSC remains in normal operating mode and stabilizes the vehicle in a timely manner as required. The familiar intervention thresholds (slip, sideslip angle) that the driver has become accustomed to in the “Comfort” and “Normal” modes remain unchanged. This ensures that less proficient drivers are not taken by surprise when the DTC subsequently intervenes in the sportier DTC mode.

Only once a proficient driver deliberately selects the second sports mode “Sport+” will gentle drifts also become available due to the higher wheel slip and sideslip angle.

The two additional modes that the driver can select using the DTC button produce the effects on the drive and dynamic driving systems shown below.

	Normal	**Traction**	**DSC off**
Drive systems			
Accelerator pedal characteristic	Normal	Normal	Normal
Shift program, automatic gearbox	Normal	Normal	Sports
Shift speed, automatic gearbox	Normal	Normal	Sports
Chassis and dynamic driving systems			
Power steering assistance	Normal	Normal	Sports
Integral Active Steering	Normal	Normal	Sports
Dynamic Stability Control	DSC on	DTC	DSC off
Vertical Dynamics Control	Normal	Normal	Sports
Active anti-roll bar	Normal	Normal	Sports

The "Traction" mode is similar to the familiar DTC mode of the DSC in former BMW vehicles. All other drive and dynamic driving systems remain in their normal configuration which makes its main application clear: the purpose of "Traction" mode is to improve traction, e.g. when driving off on a loose subsurface. Sports driving takes a background role instead as the "Sport+" and "Sport" modes are available for this.

The stabilizing DSC interventions are switched off in the "DSC off" mode. Only the braking interventions that support traction are performed i.e. Electronic Differential Lock Control.

In this case, most other drive and dynamic driving systems are in the sports configuration. This means that the aim of "DSC off" mode is to support pure driving; a direct bond between the driver, vehicle and road.

Although initially it may seem astonishing that the accelerator pedal characteristic remains in the normal configuration in both "Traction" and "DSC off" modes, this setting is deliberate. When driving off on a loose subsurface and also when driving in a highly sports-oriented manner with the DSC switched off, it is especially important that the driver can apply engine torque extremely sensitively. This is much easier to do using a normal rather than a more sports-oriented accelerator pedal characteristic.

The sports-oriented accelerator pedal characteristic translates the accelerator pedal angle into a higher torque requirement at the engine. This torque requirement is then also put into effect more quickly by the engine control system.

As a result, the driver perceives the response characteristics of the drive, and therefore the vehicle, as more sports-oriented. However, the driver cannot use this to apply engine torque sensitively.

System Components

ICM Control Unit

Only the system components that are linked to the new architecture of the dynamic driving systems in the F01/F02 are described in this Product Information. In essence, this is the new ICM control unit and the periphery equipment directly connected to this control unit.

Three other Product Information packages are available in which descriptions of the system components for the individual dynamic driving systems are provided:

- Longitudinal dynamics systems
- Lateral dynamics systems
- Vertical dynamics systems

Design of the Two Control Unit Versions

An ICM control unit is installed in every F01/ F02. Each ICM control unit contains the following, irrespective of the equipment installed in the vehicle:

- Two microprocessors
- A FlexRay controller
- Output stages for activating valves in the steering system
- Integrated sensor system for driving dynamics variables (previously: DSC sensor)

The essential tasks of one of the microprocessors are the calculation of control functions, communication processing and activation of the output stages. The main task of the second processor is to monitor safety-relevant functions and bring about a system shut down in the event of a fault.

The other components of the ICM control unit listed above are described in the following chapters.

Two versions of the ICM control unit exist. The version installed in the vehicle depends on the equipment.

If the vehicle is equipped with one or both of the following options

- Integral Active Steering (IAL, SA 2VH) or
- Active Cruise Control with Stop & Go function,

the high-performance version of the ICM control unit is installed.

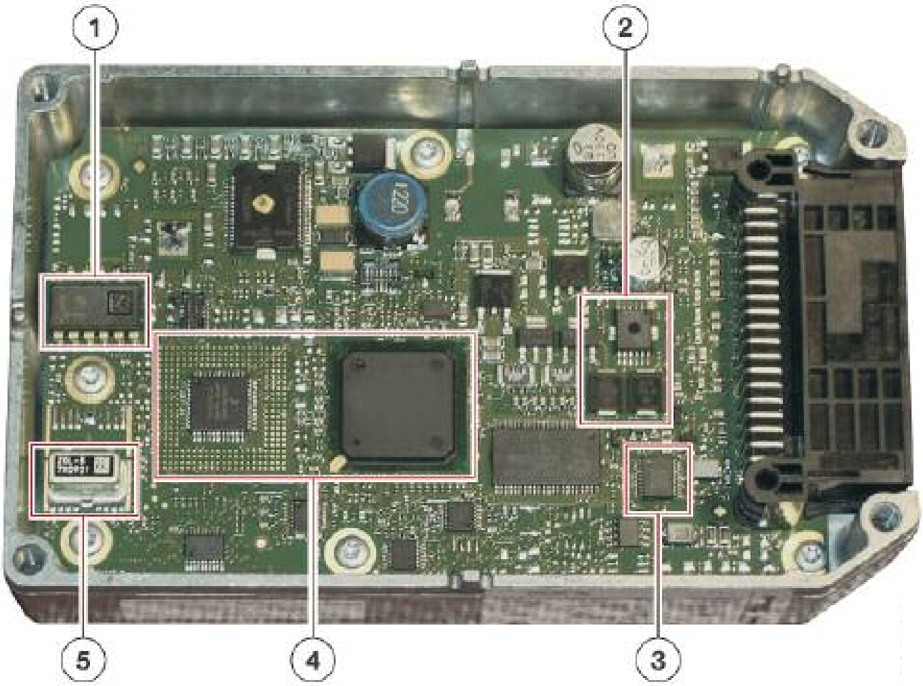
If neither of these options are installed in the vehicle, the basic version of the ICM control unit is used. The two versions of the ICM control unit are differentiated externally by their part numbers.

The internal layout of the high-performance version differs from the internal layout of the basic version in the following ways:

- Larger microprocessor (required to calculate the Integral Active Steering control and active speed control)
- Redundant sensor system for lateral acceleration and yaw rate (safety requirement for Integral Active Steering).

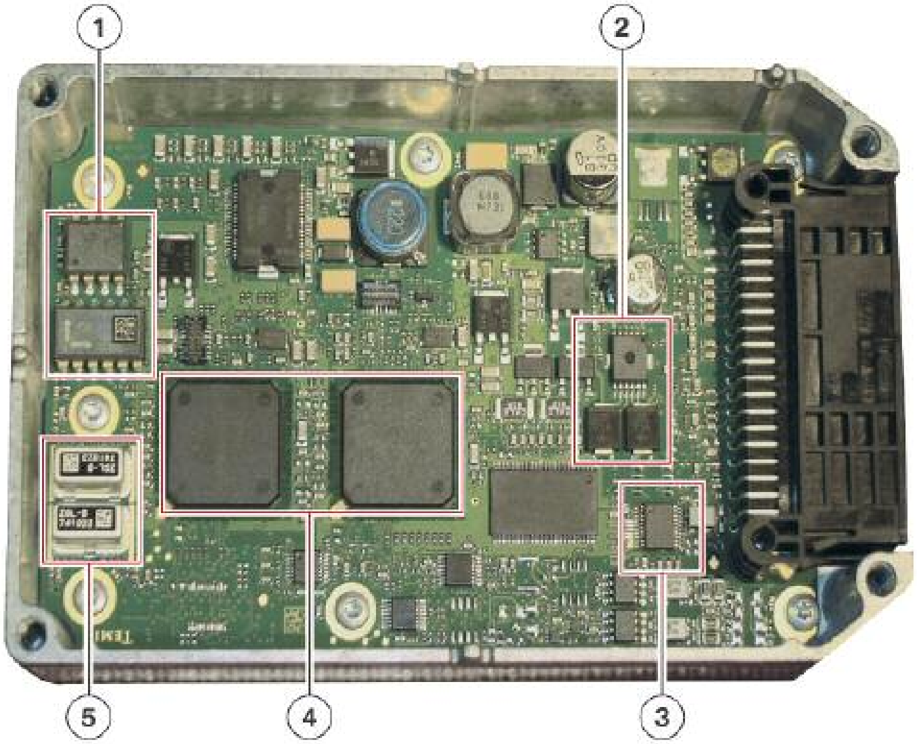
The following graphics make these differences clear.

ICM control unit, basic version



Index	Explanation
1	Acceleration sensor (longitudinal and lateral acceleration)
2	Output stages for Servotronic and EVV valves
3	Controller for FlexRay connection
4	Two microprocessors (basic version)
5	Yaw rate sensor

ICM control unit, high-performance version



Index	Explanation
1	Acceleration sensors (1 for longitudinal acceleration, 2 for lateral acceleration)
2	Output stages for Servotronic and EVV valves
3	Controller for FlexRay connection
4	Two microprocessors (high-performance version)
5	Yaw rate sensors (2x)

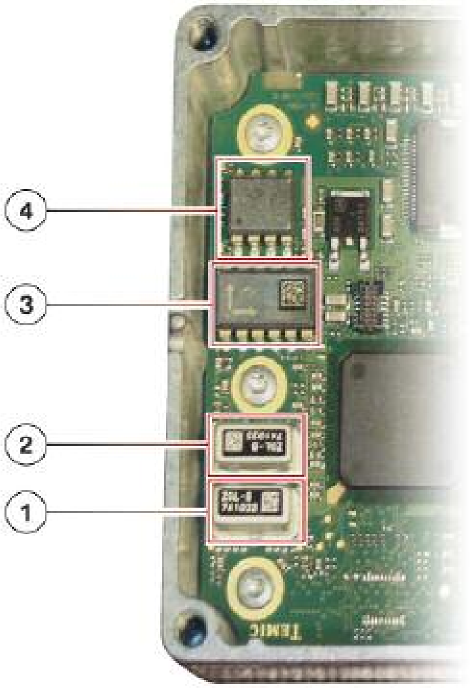
Integrated sensor system

The sensors that were previously accommodated separately in the DSC sensor are now installed in the ICM control unit.

The ICM control unit uses these sensors to calculate variables that provide key information on the vehicle's dynamic state:

- Longitudinal acceleration and pitch of the vehicle in the longitudinal direction
- Lateral acceleration and pitch of the vehicle in the lateral direction
- Yaw rate.

DSC sensor integrated into the ICM control unit



Index	Explanation
1	Yaw rate sensor
2	Second redundant yaw rate sensor
3	Longitudinal and lateral acceleration sensor
4	Second redundant lateral acceleration sensor

All sensors integrated into the ICM control unit are known as micromechanical sensors. By applying this principle, the dimensions of these sensors can be reduced to the extent that they can be accommodated in housings that are similar in size to microprocessor housings. The sensors are of course designed on the basis of prevailing stresses in the vehicle (thermal, mechanical). However, when servicing the vehicle, the ICM control unit must be handled with the same degree of care as the familiar DSC sensor.

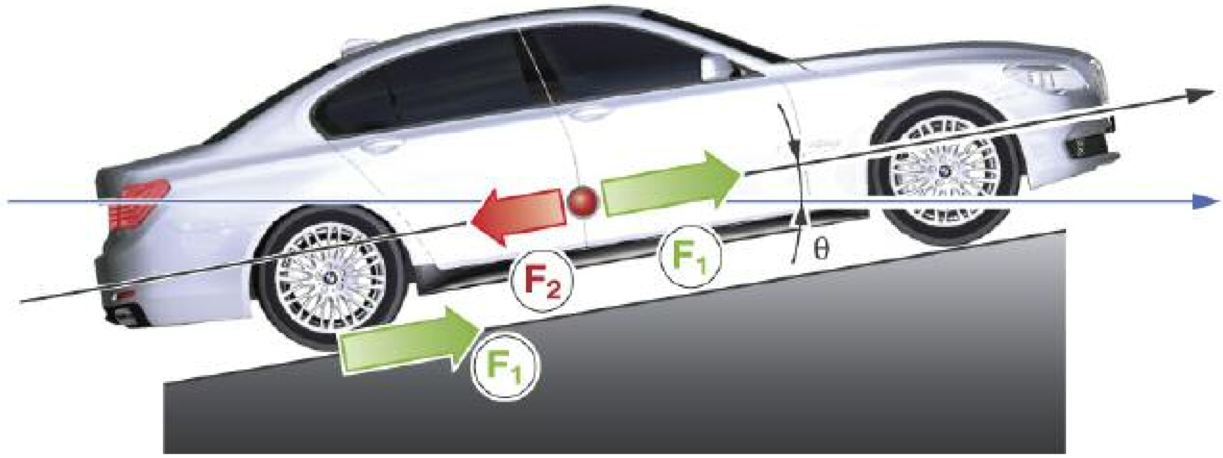
Note: The ICM control unit must not be exposed to strong vibrations. The integrated sensor system will be destroyed if the housing is struck by hard objects, or if the control unit is dropped. The control unit must not be installed in the vehicle in this case.

The **longitudinal and lateral acceleration** sensors operate according to the capacitive principle. They consist of two electrodes, that mesh in a comb-like form. One of the electrodes has a unidirectional moving bearing which means that if a force acts on the sensor, the electrode is displaced. This changes the gap between the two electrodes and in turn changes the capacitance which is calculated back to the size of the force applied by means of evaluating circuits.

Instead of recording the acceleration directly, the sensors record it indirectly by **measuring the force** on the sensor element. The force applied may have several causes and the sensor cannot differentiate between these:

- Inclination of the vehicle or road (e.g. gradient accelerating force)
- Change in speed (drive or braking force)
- Cornering (centrifugal force).

Longitudinal forces acting on the vehicle



Index	Explanation	Index	Explanation
F_1	Motive force	θ	Inclination of road
F_2	Gradient accelerating force		

In the graphic two longitudinal forces are shown acting on the vehicle: a motive force and a gradient accelerating force. These forces are produced due to the inclination of the road. As a result, a force acts on the vehicle and can be calculated as follows:

$$F_{resulting} = F_1 - F_2$$

Only the resulting force can be measured by the sensor. The measured force is processed in the control unit. The change in road speed is taken into account.
The actual acceleration of the vehicle and the gradient of the road are the only calculation results provided.

A similar calculating process is used for the lateral direction. The calculation results produced in this case are the lateral tilt and lateral acceleration of the vehicle.

The sensor that determines the **yaw rate** also employs the principle of force measurement, a principle also used by the acceleration sensors. The yaw rate sensor measures the force that acts on a sensor element oscillating across the direction of rotation.

The sensor signals are initially referenced to the sensor housing. However, in order to be useful to the dynamic driving systems, these variables must be referenced to the vehicle coordinate system. The ICM control unit performs the necessary conversion.
A synchronization process is carried out when the ICM control unit is started up during which corresponding correction values are determined and saved.

Note: Calibration of the sensors integrated into the ICM control unit is necessary in the following cases

- **the ICM control unit has been replaced or**
- **if requested by the test schedule in the diagnostic system due to a fault code memory entry.**

The calibration must be performed with the vehicle standing on a level surface in the longitudinal and lateral direction. Terminal 15 must also be switched on.

■ **Connector**
The control unit has a 54-pin plug via which the power supply, sensors, actuators and bus systems are connected.

As is the case with the controller housing, the plug does not have a watertight design. This is The control unit has a 54-pin plug via which not necessary as it is installed on the inside of the vehicle.

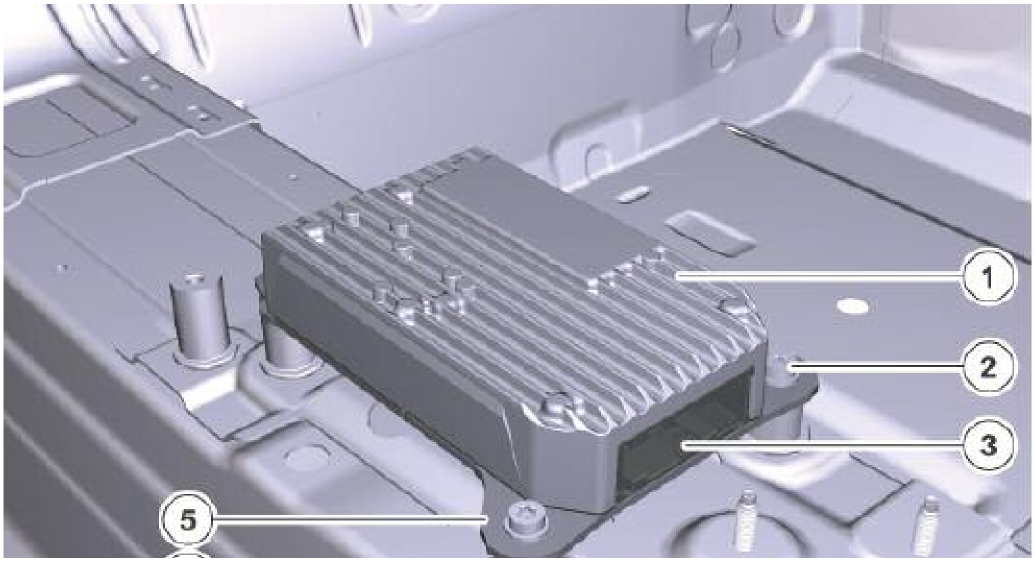
Installation location of the ICM control unit overview

Installation Location

The ICM control unit is installed in the center console behind the sensor for the crash safety module. This means that the position of the control unit and its integrated sensor system in the vehicle, near to its center of gravity, is ideal from the point of view of driving dynamics. The mounting points on the body are precisely determined and are measured when the vehicle is manufactured and must not be replaced with any other mounting points.

The housing of the control unit is connected to the metal body of the transmission tunnel with four screws and spacer sleeves made of aluminum. The control unit must be mounted on the vehicle body free of play as otherwise vibrations may be induced in the control unit housing which would severely impair the operation of the integrated sensor system. A secondary task of this mounting is to conduct heat away from the control unit to the body.

Installation location of the ICM control unit - detail



Index	Explanation	Index	Explanation
1	Upper section of housing	4	Spacer sleeve
2	Mounting bolt	5	Lower section of housing
3	Connector		

For the mounting to be able to perform these tasks, the following points must be observed when mounting and replacing the ICM control unit:

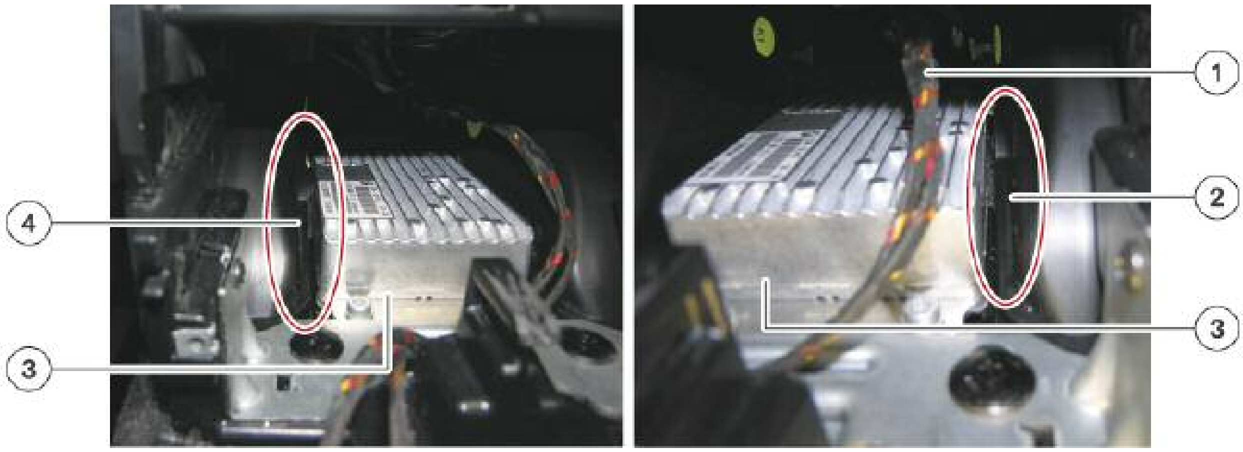
Note: Only screws and spacer sleeves that are in perfect condition may be used. Deformed or damaged fixing elements must not be used.

The mounting screws in the reamed holes must be tightened first, followed by the other two screws. The tightening torque specified in the repair instructions must be observed without fail.

A check must then be carried out to make sure the control unit is mounted securely and free of play.

To ensure sufficient heat dissipation and to avoid vibrations, the sides and top of the control unit housing must not come into contact with other vehicle components. Instead, the spaces provided around the control unit as part of the engineering design must always remain free of other components.

Installation situation of the ICM control unit - detail



Index	Explanation
1	Wiring harness, e.g. for rear display
2	The compartment on the right next to the ICM control unit must remain unoccupied
3	ICM control unit
4	The compartment on the left next to the ICM control unit must remain unoccupied

The wiring harness that runs in the center console in particular must never be routed in, or even pushed into, the spaces on either side of the ICM control unit.

Replacement and Start-up

Removing and installing the ICM control unit

The ICM control unit performs tasks that are important for many vehicle functions, e.g. provision of sensor signals. If the vehicle were operated without the ICM control unit installed, a large number of vehicle functions would not be available. In the area of dynamic driving systems, for example, the Servotronic and stabilization functions would no longer be available. In addition, fault code memory entries would inevitably also be generated in many control units.

Note: If the ICM control unit needs to be replaced, the repair instructions must be observed without fail.

For example, the vehicle battery must be disconnected before removing the control unit and reconnected following the installation. This is the only way to ensure synchronized restarting of the control unit assembly.

Note: Once the new ICM control unit has been installed, it must be started up with the assistance of the diagnostic system. To do this, the following steps must be carried out (depending on the equipment specification):

- **Calibration of the sensors integrated into the ICM**
- **Calibration of the ride-height sensors**
- **Initialization of the Integral Active Steering.**

Calibration of the sensors integrated into the ICM

The signals from the acceleration and yaw rate sensors integrated into the ICM are referenced to their housing. However, in order to be useful to the dynamic driving systems, these variables must be referenced to the vehicle coordinate system. In order for the ICM control unit to be able to carry out the necessary conversion, it requires corresponding correction values. These are determined during the one-off calibration procedure and stored in the ICM control unit.

Note: The instructions of the diagnostic system must be followed precisely during calibration of the sensors integrated into the ICM. It is particularly important for the vehicle to be standing on a surface that is level in both the longitudinal and lateral directions. If this is not the case, incorrect correction values will be determined that may cause the dynamic driving system to malfunction.

Calibration of the ride-height sensors

The measurement signals from the ride-height sensors are evaluated by means of voltage measurement in the ICM control unit. The ICM control unit cannot calculate the actual ride-level heights in millimeters on the basis of this information alone. To perform this calculation, the ICM control unit must be able to map the voltage signals it receives to reference values. This is the only way to establish a relationship between the measurement signals and the actual ride-level heights at the wheels. These reference values are determined during a synchronization procedure.

Note: The ride-height signals in the ICM must be synchronized in the following cases

- **following replacement of the ICM control unit,**
- **following replacement of a ride-height sensor or**
- **if prompted to do so by the test schedule of the diagnostic system (due to a fault code memory entry in the ICM).**

The synchronization does not have to be carried out if a wheel has been changed.

Note: The following points must be observed in order to perform the synchronization using the diagnostic system

- **the air suspension control operations must be blocked (remove fuse for EHC control unit)**
- **the ride-level heights must be measured using a tape measure and**
- **the rim size must be determined.**

The diagnostic system also refers to the ride-level height reference values (design position). These values are used by the diagnostic system and ICM to calculate the reference values for the conversion that are ultimately saved in the ICM control unit.

The ride-height signals in the EHC control unit (if installed) and the ride-height signals in the ICM control unit must be synchronized together.

Initialization of the Integral Active Steering

The ICM control unit calculates the higher-level control functions for the Integral Active Steering. The output signals of this control function are the reference steering angles, that should be set at the front and rear axle.

This is performed by the AS and HSR actuator control units together with the actuators. The actual angle set at the front and rear axle is sent to the ICM control unit as acknowledgement. The control circuit of the driving dynamics control system closes once this information has been received.

To determine this information correctly, the Integral Active Steering must be initialized. During this initialization procedure, the center of the steering gear at the front axle is determined and the corresponding signal values are stored (for example).

Note: The Integral Active Steering must be initialized under the following circumstances:

- **the ICM, AS or steering column switch cluster control unit has been replaced or**
- **the steering angle sensor in the steering column switch cluster has been calibrated or**
- **the steering gear has been replaced or**
- **if requested by the diagnostic system due to a fault code memory entry in the test schedule.**

During the calibration the diagnostic system issues several prompts to steer from one limit position to the other. The internal combustion engine should be running and the vehicle should be standing on the ground of the workshop when calibration is in progress. These marginal conditions most closely resemble the conditions under which the customer operates the vehicle and deliver the best initialization results. If the front wheels are resting on revolving and sliding supports, or are suspended in mid air if the vehicle is raised, this may lead to unsatisfactory results.

Calibration of the steering angle sensor in the steering column switch cluster

In addition to the signals from the motor-position sensors of the Integral Active Steering, the ICM control unit also imports the signal from the steering angle sensor in the steering column switch cluster. This is used by the ICM to determine the effective steering angle (see “Functions” section).

This is why it is important that the ICM receives a correctly mapped value from the steering angle sensor.

Note: The steering angle sensor must be calibrated if the steering column switch cluster is replaced or reprogrammed. A calibration must also be performed if this is requested in the test schedule of the diagnostic system as the result of a fault code memory entry.

The steering angle sensor must be calibrated before the ICM can calculate a correct effective steering angle and make this available via the bus system.

Note: Once the steering angle sensor has been calibrated, the instructions of the diagnostic system must be precisely followed.

The vehicle must be standing on even ground during calibration. The steering wheel must be in the straight-ahead position (visually).

Start-up, short range radar sensors

If the option “Active speed control with stop & go function” is installed in the vehicle, this will include the necessary radar sensors.

Although short range radar sensors are intelligent sensors that perform the functions of a control unit they cannot be accessed directly via the diagnostic system. The ICM control unit acts as a “go-between” between the short range radar sensors and the diagnostic system which is why the ICM also controls the start-up process for the short range radar sensors.

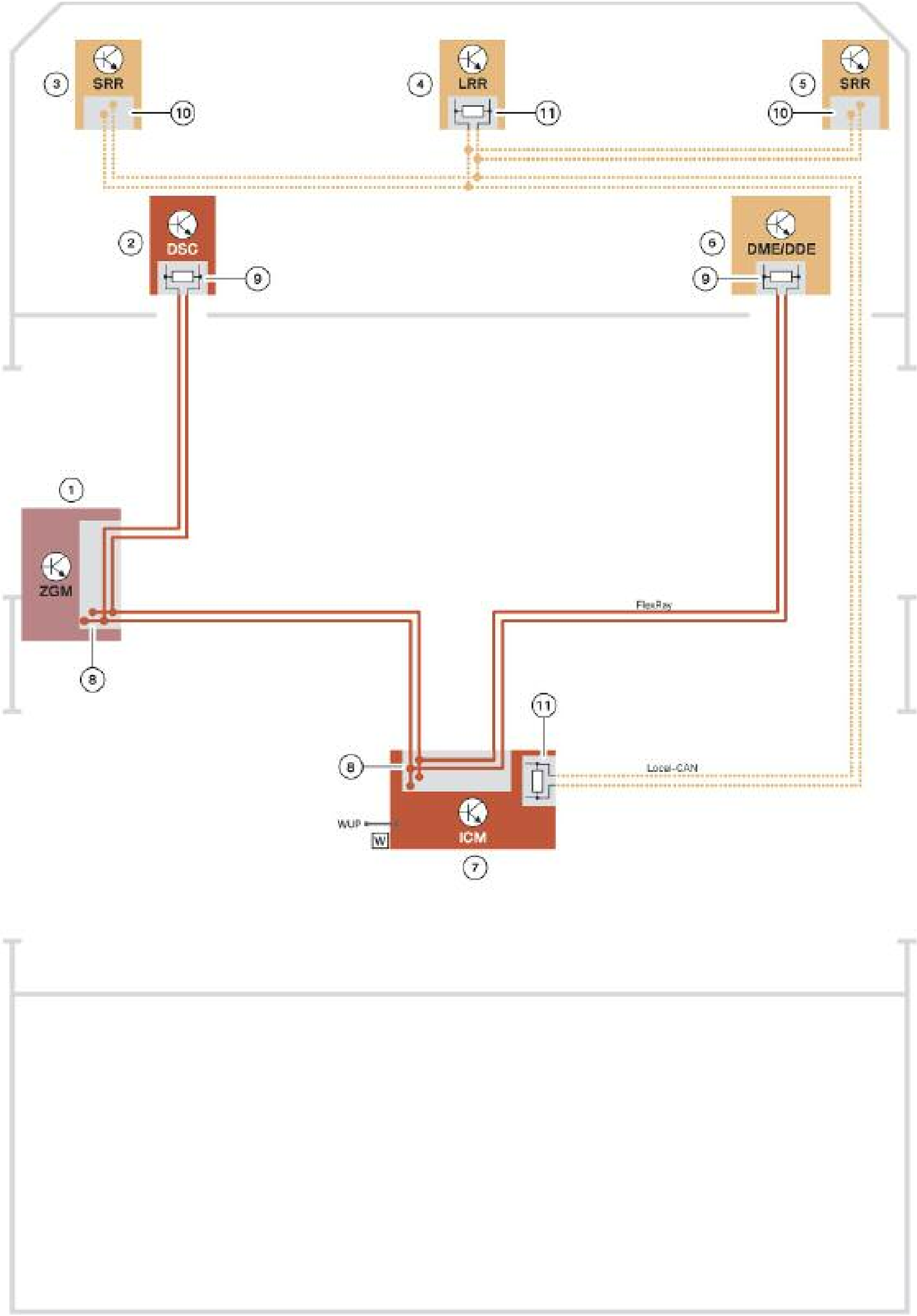
Note: The short range radar sensors for ACC Stop & Go must be started up if one (or both) short range radar sensor(s) is/are replaced. In this instance, the diagnostic system communicates with the ICM control unit. The ICM in turn controls the corresponding functions in the short range radar sensors.

The installation position and, most importantly, the angle at which they are installed relative to the vehicle’s longitudinal axis, are entered in the newly installed short range radar sensors during start-up. A measurement does not need to be carried out in this case. The angle entered is the angle predetermined by the construction and the form of the bumper support.

Periphery of ICM Control Unit

Bus Systems

ICM control unit with FlexRay, local CAN and wake-up line



Index	Explanation	Index	Explanation
1	Central gateway module	8	FlexRay routing and continuation without terminating resistor
2	Dynamic Stability Control	9	Routing of FlexRay with terminating resistor
3	Short range radar sensor (SRR), left	10	Routing of local CAN without terminating resistor
4	Long range radar sensor (LRR)	11	Routing of local CAN with terminating resistor
5	Short range radar sensor (SRR), right	W	ICM control unit can be woken up
6	DME/DDE control unit	WUP	Wake-up line
7	ICM control unit		

FlexRay

The ICM control unit is connected to the FlexRay controller via the FlexRay bus system. The communication with virtually all partner control units is handled by the microprocessors in the ICM.

The FlexRay is routed to the ICM control unit (from the central gateway module) and continues from there (to the DME/DDE). The ICM control unit is related to the FlexRay, i.e. not an end node. This is why it does not have a terminating resistor for the FlexRay.

Local CAN

A further bus system, a local CAN, is connected to the ICM control unit in addition to the FlexRay. This serves the ICM exclusively for the purposes of communication with the active speed control radar sensors. This local CAN therefore performs the same tasks as the sensor CAN in the E6x LCI that connects the LDM control unit to the radar sensors. It transmits information on road users that has been recorded by the radar sensors.

The local CAN operates in the same way as the PT-CAN with a data transfer rate of 500 kBit/s. There are two terminating resistors for the local CAN, each with 120 .. One of these is in the ICM control unit, the second is integrated in the long range radar sensor (LRR). The close range sensors (SRR) are routed to the local CAN via short lines.

The pins for the local CAN are only connected at the plug of the ICM control unit if it is a high-performance version.

Wake-up line

The ICM control unit is also connected to the wake-up line. The ICM control unit can be woken up via the wake-up line.

Power Supply

The only external power supply to the ICM control unit is with terminal 30B. This is made available by the junction box electrical system and the fuse carrier at the front.

The electronics and integrated sensor system are therefore supplied inside the ICM control unit. Additionally, the ride-height sensors connected to the ICM control unit and the output stages for activation of the valves for the steering unit are also supplied.

Ride-height Sensors

Index	Explanation
1	Connector
2	Housing
3	Arm (pivoting)

Design and principle of operation

The angle of a pivoting arm is converted to a voltage signal via the ride-height sensors. The greater the angle (with reference to a defined starting position), the greater the output voltage generated by a Hall sensor element.

Versions

Four ride-height sensors are installed in every F01/F02 as standard equipment.

However, the ride-height sensors installed in the vehicle are available in different versions. Different ride-height sensors are used on the left and right of the front axle.
Different ride-height sensors are also used on the rear axle. The reasons for this in both cases are the available installation space and the starting position.

Double or single-type ride-height sensors are used at the rear axle, depending on whether the vehicle is equipped with electronic ride-height control (EHC). Single-type ride-height sensors are always used at the front axle.

Type of ride-height sensors at the ...	Front axle	Rear axle
Without electronic ride-height control	single	single
With electronic ride-height control	single	double

Interface with ICM control unit

As shown in the system circuit diagram, each ride-height sensor (irrespective of the version) is connected to the ICM control unit by three lines. The double-type ride-height sensors at the rear axle are also connected to the EHC control unit according to the same principle via three additional lines.

Power is supplied by the ICM control unit to the ride-height sensor via one of the lines. The sensor uses the second line to deliver its measurement signal (0-5 V DC voltage). The third line is connected to a common ground inside the ICM control unit.

The measurement signal is evaluated by means of voltage measurement in the ICM control unit. The ICM control unit cannot calculate the actual ride-level heights in millimeters on the basis of this information alone. To perform this calculation, the ICM control unit must be able to map the voltage signals it receives to reference values. This is the only way to establish a relationship between the measurement signals and the actual ride-level heights. These reference values are determined during a synchronization procedure.

Note: The ride-height signals in the ICM must be synchronized in the following cases

- **following replacement of the ICM control unit,**
- **following replacement of a ride-height sensor or**
- **if prompted to do so by the test schedule of the diagnostic system (due to a fault code memory entry in the ICM).**

The synchronization does not have to be carried out if a wheel has been changed.

Driving Dynamics Switch

The driving dynamics switch and DTC button are integral components of the center console operator control unit.

Installation location of the driving dynamics switch and DTC button

Index	Explanation
1	DTC button
2	Driving dynamics switch, "SPORT" rocker switch
3	Driving dynamics switch, "COMFORT" rocker switch

The new driving dynamics switch consists of two buttons labeled “COMFORT” and “SPORT”. This is a rocker switch that returns automatically to the center position after it is pressed. The center position corresponds to the “no button pressed” status.

Both buttons of the driving dynamics driving switch are connected directly to the ICM control unit via two lines. The ICM control unit applies a voltage at these lines. Both buttons are connected to the ground via a resistance network. The ICM control unit can determine the following by back-scanning the voltage obtained:

- whether a button has been pressed and, if so, which of the two buttons,
- whether breaks in the wiring exist and
- whether a short to ground has occurred.

In previous vehicles, the familiar DTC button is connected electrically, e.g. to the IHKA control unit (E70/E71). In the F01/F02 on the other hand, the DTC button is connected to the ICM control unit via an electrical wire. A voltage is applied to this wire by the ICM control unit. The DTC button connects to the ground. The ICM control unit can determine by means of voltage measurement whether the DTC button is operated.

The “Driving dynamics control” function in the ICM control unit evaluates the operation of the driving dynamics switch and DTC button and uses this as the basis for determining the corresponding mode (see “Functions” section). The ICM control unit sends signals via the bus system to inform the driver at the instrument cluster which mode has been set.

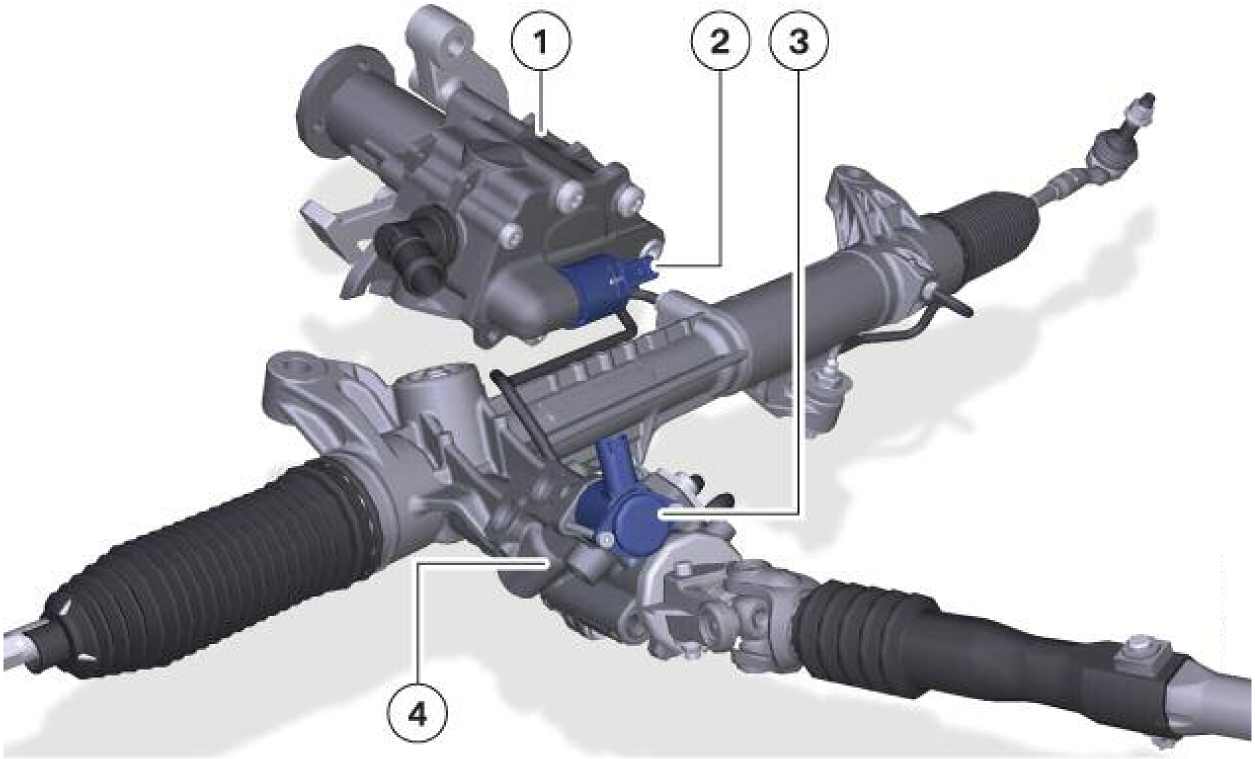
The footwell module supplies power to the center console operator control unit via terminal 58g for the locating lamp.

Valves of Steering Unit

The proportional valve that adjusts the electronic flow (EVV valve) and the Servotronic valve is activated directly from the ICM control unit. The ICM control unit contains the necessary output stages that are built up using power semiconductors.

Each valve is connected by two lines to the ICM control unit. The ICM control unit calculates the reference values for the aperture of both valves based on the road speed, steering angle and steering-angle speed input signals. These reference values are converted to a pulse-width-modulated signal that is applied at the lines leading to the valves. This means that the ICM control unit can change the aperture of the valves at any time.

Valves of the steering unit



Index	Explanation
1	Power steering pump
2	Valve for electronic flow rate adjustment (EVV valve)
3	Servotronic valve
4	Housing of control valve for hydraulic power steering

Service Information

What Points must be Observed During Servicing

ICM Control Unit

Note: If the ICM control unit needs to be replaced, the repair instructions must be observed without fail.

For example, the vehicle battery must be disconnected before removing the control unit and reconnected following the installation. This is the only way to ensure synchronized restarting of the control unit assembly.

Note: The ICM control unit must not be exposed to strong vibrations. The integrated sensor system will be destroyed if the housing is struck by hard objects, or if the control unit is dropped. The control unit must not be installed in the vehicle in this case.

Note: Only screws and spacer sleeves that are in perfect condition may be used to mount the ICM control unit. Deformed or damaged fixing elements must not be used.

The mounting screws in the reamed holes must be tightened first, followed by the other two screws. The tightening torque specified in the repair instructions must be observed without fail.

A check must then be carried out to make sure the control unit is mounted securely and free of play.

Note: Once the new ICM control unit has been installed, it must be started up with the assistance of the diagnostic system. To do this, the following steps must be carried out (depending on the equipment specification):

- **Calibration of the sensors integrated into the ICM**
- **Calibration of the ride-height sensors**
- **Initialization of the Integral Active Steering.**

Diagnosis in the Event of Signal Faults

Note: The ICM control unit itself contains sensors that provide the following signals:

- longitudinal acceleration
- lateral acceleration
- yaw rate.

The wheel-speed signals are recorded and made available by the DSC control unit. The steering wheel angle is determined by the steering angle sensor in the steering column switch cluster.

The ICM control unit processes all the sensor signals and makes these available in the form of bus signals to other systems in the vehicle.

If fault code memory entries for these signals exist, the following procedure is recommended when working through the test schedules:

Start with the test schedule for the control unit that is providing the signals. The most important signal sources for dynamic driving systems are the ICM, DSC and steering column switch cluster. You will be able to get to the root of the fault and eliminate it more quickly using this procedure.

Instead, the test schedules for the control units that receive these signals only contain references to the transmitter control units which means they do not lead directly to the ultimate cause/solution of the fault.

Sensors in the ICM

Note: Calibration of the sensors integrated into the ICM control unit is necessary in the following cases

- the ICM control unit has been replaced or
- if requested by the test schedule in the diagnostic system due to a fault code memory entry.

The calibration must be performed with the vehicle standing on a level surface in the longitudinal and lateral direction. Terminal 15 must also be switched on.

Note: The instructions of the diagnostic system must be followed precisely during calibration of the sensors integrated into the ICM. It is particularly important for the vehicle to be standing on a surface that is level in both the longitudinal and lateral directions.

If this is not the case, incorrect correction values will be determined that may cause the dynamic driving system to malfunction.

Ride-height Sensors

Note: The ride-height signals in the ICM must be synchronized in the following cases:

- **following replacement of the ICM control unit,**
- **following replacement of a ride-height sensor or**
- **if prompted to do so by the test schedule of the diagnostic system (due to a fault code memory entry in the ICM).**

The synchronization does not have to be carried out if a wheel has been changed.

Note: The following points must be observed in order to perform the synchronization using the diagnostic system

- **the air suspension control operations must be blocked (remove fuse for EHC control unit)**
- **the ride-level heights must be measured using a tape measure and**
- **the rim size must be determined.**

The diagnostic system also refers to the ride-level height reference values (design position).

These values are used by the diagnostic system and ICM to calculate the reference values for the conversion that are ultimately saved in the ICM control unit.

The ride-height signals in the EHC control unit (if installed) and the ride-height signals in the ICM control unit must be synchronized together.

Steering Column Switch Cluster with Ssteering Angle Sensor

Note: The steering angle sensor must be calibrated if the steering column switch cluster is replaced or reprogrammed. A calibration must also be performed if this is requested in the test schedule of the diagnostic system as the result of a fault code memory entry.

The steering angle sensor must be calibrated before the ICM can calculate a correct effective steering angle and make this available via the bus system.

Note: Once the steering angle sensor has been calibrated, the instructions of the diagnostic system must be precisely followed. The vehicle must be standing on even ground during calibration. The steering wheel must be in the straight-ahead position (visually).

Integral Active Steering

Note: The Integral Active Steering must be initialized under the following circumstances

- **the ICM, AS or steering column switch cluster control unit has been replaced or**
- **the steering angle sensor in the steering 1 column switch cluster has been calibrated or**
- **the steering gear has been replaced or**
- **if requested by the diagnostic system due to a fault code memory entry in the test schedule.**

Displays and Operation

Note: New symbols are now used for the yellow DSC indicator and warning lamp and the DTC button. The new DSC symbols used for the first time in the F01/F02 replace the symbols previously used.

Table of Contents

F01 Longitudinal Dynamics Systems

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Longitudinal Dynamics Systems

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the systems related to Longitudinal Dynamics
- Locate and Identify components of the DSC and EMF systems
- Understand the new DSC functions on the F01/F02
- Understand the changes to the EMF system pertaining to the F01/F02

Introduction

Refinements in Detail

The longitudinal dynamics systems described in this document comprise the following:

- Dynamic stability control (DSC) and
- Electromechanical parking brake (EMF)

Both DSC and EMF are standard equipment on all F01/F02 models. Thus BMW has consistently continued the standards set by the E65/E66 and the E70/E71. Both systems are based on the technology used on the E70/ E71.

However, many specific details have had to be changed. Those changes were essential to ensure that DSC and EMF could be seamlessly integrated in the new dynamic handling system complex on the F01/F02.

As far as the Dynamic Stability Control was concerned, co-ordination with the central dynamic handling controller on the Integrated Chassis Management (ICM) master control unit had to be taken into consideration. And the new “dynamic handling control” function also affects the way the DSC operates. The thresholds and the nature of the DSC interventions have to be adapted to suit the setting selected.

Thus the DSC doesn’t simply contain a setting that suits a luxury-class vehicle such as the F01/F02. Instead, several different settings have been developed which correspond to the characteristics of the various dynamic handling control settings.

In addition to adaptation to handling characteristics, there are numerous other changes to the Dynamic Stability Control on the F01/F02 which relate to location, display features, fault diagnosis and repair.

Starting from the basis of the system on the E70/E71, the electromechanical parking brake has been adapted to the requirements of the F01/F02. That includes such things as location and attachment to the vehicle. In addition, design enhancements have been introduced to make the EMF actuator quieter in operation.

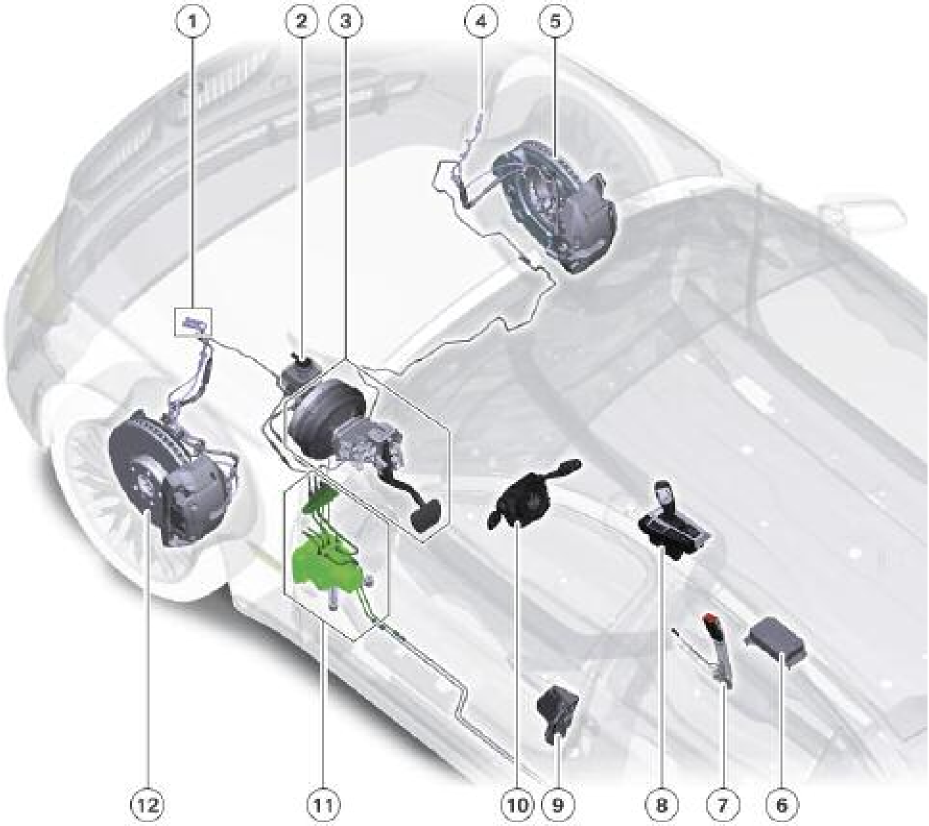
This reference document sets out in detail all the changes to the Dynamic Stability Control and electromechanical parking brake that are specific to the F01/F02.

However, features of the two systems that are familiar from the E70/ E71 are not repeated in this document. Those details can be found in the respective training manuals.

System Overview

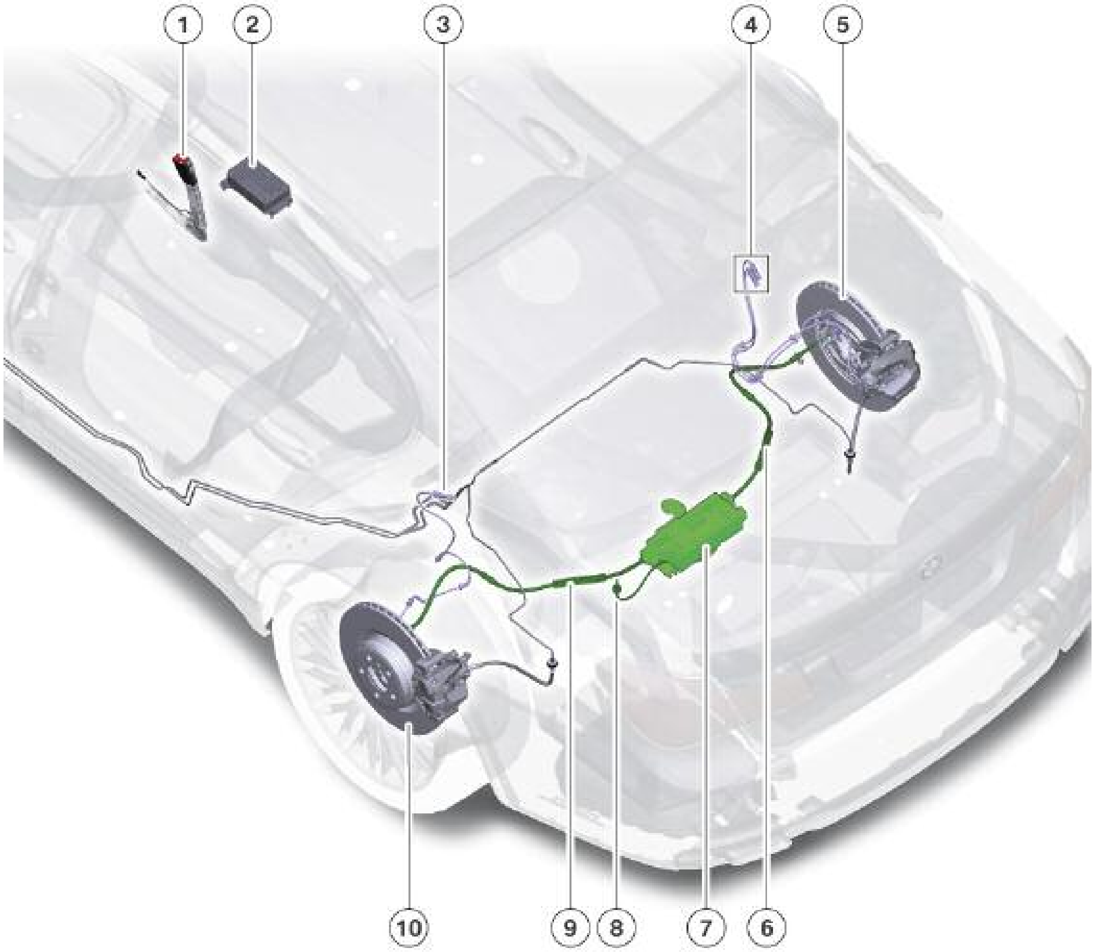
Components on the Vehicle

Components of Dynamic Stability Control and electromechanical parking brake on F01/F02 (front half of vehicle)



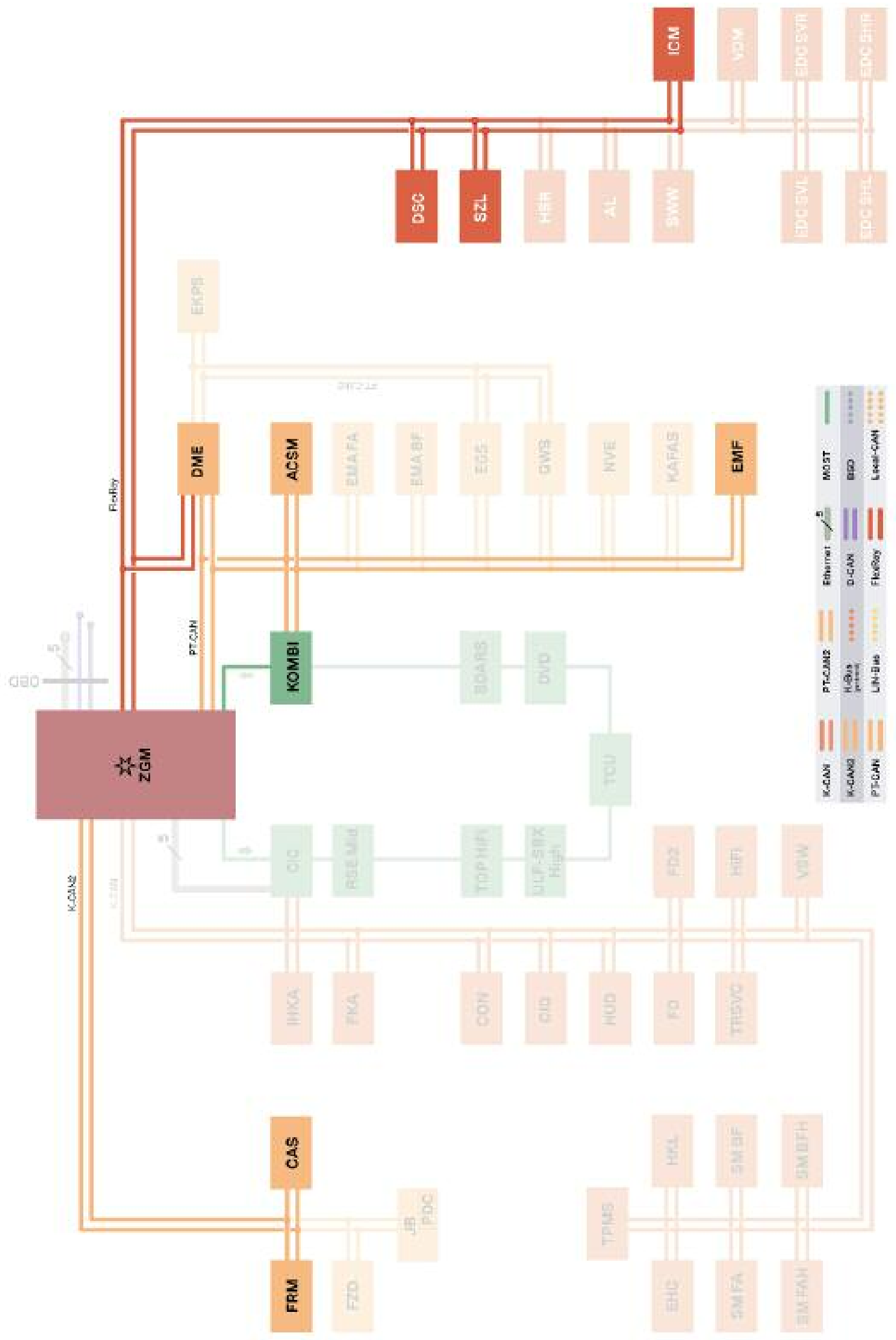
Index	Explanation
1	Connection for front left wheel-speed sensor and brake-pad wear sensor
2	Brake fluid reservoir with brake fluid level switch
3	Brake pedal cluster (brake pedal, brake servo unit, tandem master cylinder)
4	Connection for front right wheel-speed sensor
5	Wheel brake, front right
6	Integrated Chassis Management control unit
7	Seat belt buckle contact, driver's seat
8	Center console control panel (DTC button, handling setting switch, parking brake button, automatic hold button)
9	Door switch, driver's door
10	Steering column switch cluster with steering-angle sensor
11	DSC control unit and hydraulic modulator
12	Wheel brake, front left

Components of Dynamic Stability Control and electromechanical parking brake on F01/F02 (rear half of vehicle)



Index	Explanation
1	Seat belt buckle contact, driver's seat
2	Integrated Chassis Management control unit
3	Connection for rear left wheel-speed sensor
4	Connection for rear right wheel-speed sensor and brake-pad wear sensor
5	Wheel brake, rear right
6	Right EMF brake cable
7	Electromechanical parking brake control unit and actuator unit
8	Emergency release EMF
9	Left EMF brake cable
10	Wheel brake, rear left

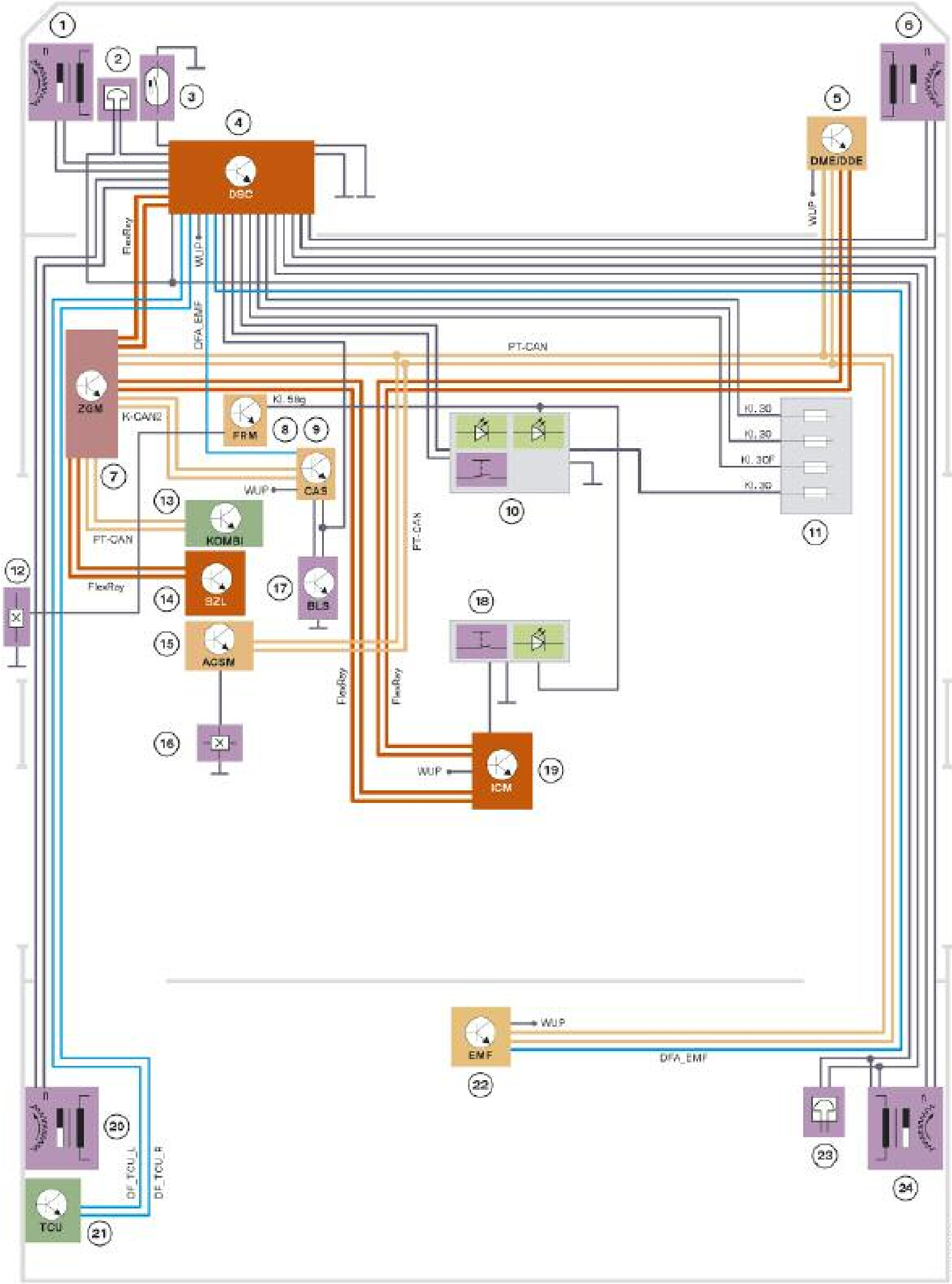
Bus System Overview for DSC and EMF



Index	Explanation
ACSM	Advanced Crash Safety Module
CAS	Car Access System
DME	Digital Motor Electronics
DSC	Dynamic Stability Control
EMF	Electromechanical Parking Brake
FRM	Footwell Module
ICM	Integrated Chassis Management
KOMBI	Instrument Cluster
SZL	Steering column switch cluster with steering-angle sensor
ZGM	Central Gateway Module

System Circuit Diagrams

Dynamic Stability Control



Index	Explanation
1	Wheel-speed sensor, front left
2	Brake pad wear sensor, front left
3	Brake fluid level switch
4	Dynamic stability control (DSC)
5	Digital Motor Electronics/Digital Diesel Electronics
6	Wheel-speed sensor, front right
7	Central Gateway Module
8	Footwell module
9	Car Access System
10	Auto-H button with function indicator and illumination
11	Fuses for DSC electronics, valves, pump motor and Auto-H button (front fuse board, junction box electronics)
12	Door switch, driver's door
13	Instrument cluster
14	Steering column switch cluster with steering-angle sensor
15	Crash Safety Module
16	Seat belt buckle contact, driver's seat
17	Brake light switch
18	DTC button with illumination
19	Integrated Chassis Management
20	Wheel speed sensor, rear left
21	Telematics Control Unit
22	Electromechanical parking brake
23	Brake pad wear sensor, rear right
24	Wheel-speed sensor, rear right

Functions

DSC Functions

Overview

The Dynamic Stability Control on the F01/F02 (DSC F0x) essentially incorporates the same functions as on the E70/E71 (DSC E7x).

As the DSC F0x is based on the same highly advanced technology as the DSC E7x, all DSC functions on the F01/F02 achieve outstanding performance in terms of:

- dynamic response (brake pressure can be generated extremely quickly).
- control precision (brake pressure can be adjusted extremely precisely and without significant fluctuation).
- noise emission (operation of the valves and the hydraulic pump is quieter than the previous generations).
- tactile response (unpleasant feedback from the brake pedal has been substantially reduced, e.g. pedal vibration during brake modulation).

Differences between the DSC functions on the E70/E71 and F01/F02 arise from the different drivetrain configurations (4-wheel drive/rear-wheel drive). Therefore, the DSC F0x does not include the “Hill Descent Control (HDC)” function specific to 4-wheel drive vehicles.

Instead of the 4-wheel-drive version of the automatic differential brake (ADB-X), the DSC F0x uses the version for vehicles with rear-wheel drive (ADB).

A new subfunction of the ADB is that traction-control brake modulation is available even when the DSC is switched off. This subfunction is called “Electronic Differential Lock Control” and is described in one of the subsections below.

Function	DSC ON	Traction	DSC OFF
Anti-lock braking system (ABS)	●	●	●
Electronic brake force distribution (EBV)	●	●	●
Cornering Brake Control (CBC)	●	●	●
Engine drag torque control (MSR)	●	●	●
Automatic Stability Control (ASC)	●	X	
Automatic Differential Brake (ADB)	●	X	X
Dynamic handling control (FDR) ⊕	●	X	
Brake modulation for increased agility	●	●	
Dry braking	●	●	●
Start assist	●	●	●
Brake readiness	●	●	●
Fading assistance	●	●	●
Dynamic Brake Control (DBC)	●	●	●
Automatic Hold combined with electromechanical parking brake (EMF) ⊕	●	●	●
Run Flat Indicator (RPA)	●	●	●
Condition Based Service (CBS)	●	●	●

Symbols:

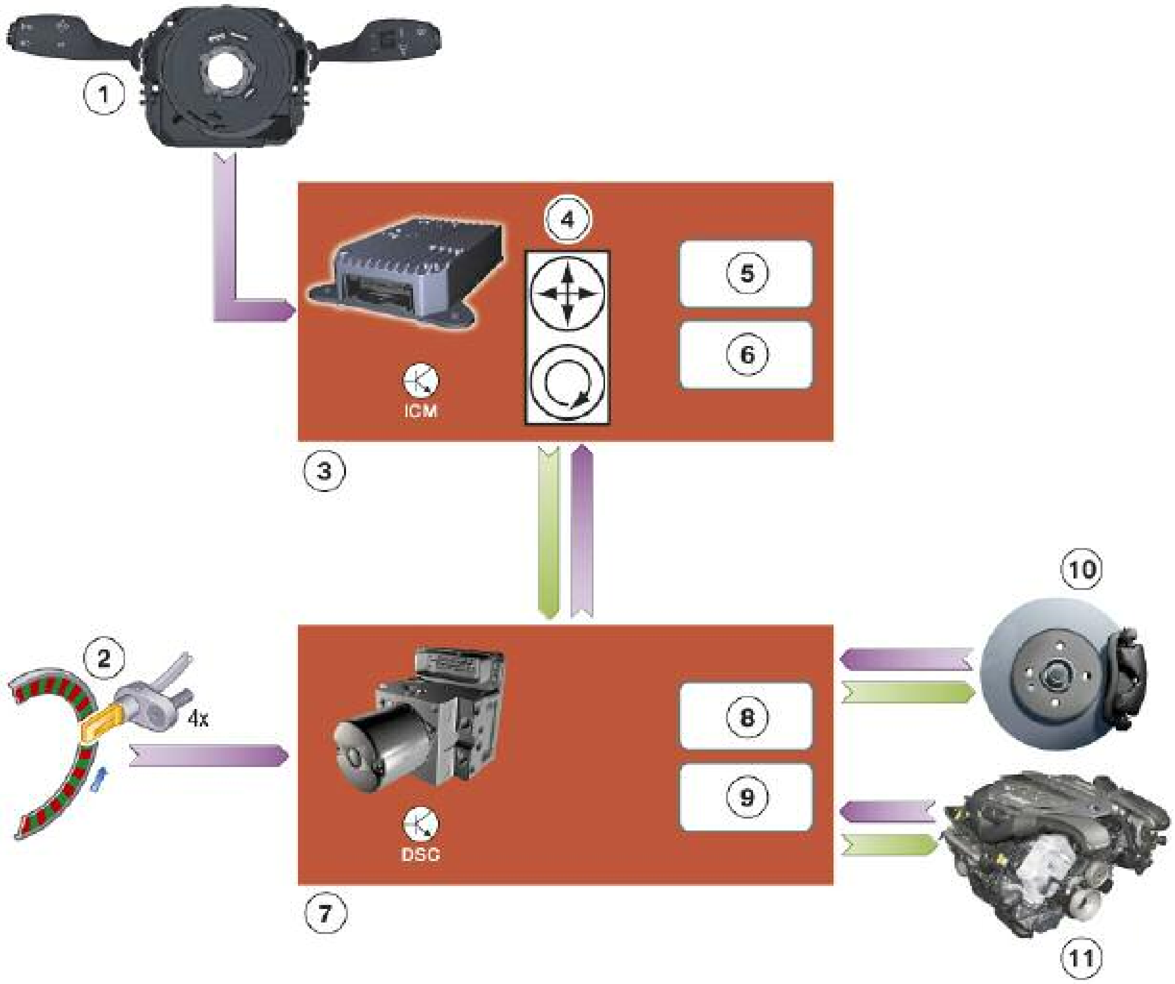
● = Function active

X = Function has adapted control thresholds

⊕ = Can be switched on/off by driver

DSC and Integrated Chassis Management

Input/output diagram: interaction of ICM and DSC



Index	Explanation	Index	Explanation
1	Steering column switch cluster with steering-angle sensor	7	Dynamic Stability Control
2	Wheel speed sensors	8	"Dynamic handling control" function on DSC
3	Integrated Chassis Management	9	"Actuator control" function on DSC
4	Integral DSC sensor (linear acceleration, lateral acceleration and yaw rate)	10	Brake
5	"Dynamic handling control" function on ICM	11	Drivetrain
6	"Actuator co-ordination" function on ICM		

On previous vehicles, the DSC control unit contained the central dynamic handling control functions. A dynamic handling control complex remains part of the DSC F0x. However, it is controlled by the central dynamic handling controller on the ICM (as are the other dynamic handling systems).

The ICM calculates the current handling status and the vehicle response desired by the driver. To do so, it makes use not only of the signals from the DSC sensor integrated in the ICM but also of those from external sensors such as the steering angle sensor and the wheel-speed sensors. If a difference between the response desired by the driver and the reaction of the vehicle is detected, the central dynamic handling controller on the ICM calculates a required compensatory yaw force.

The purpose of that yaw force is to bring about a yawing motion on the part of the vehicle that is superimposed over the existing movement of the vehicle. In that way, the vehicle handling can be corrected retrospectively, so to speak, when it threatens to become unstable. The highly advanced DSC technology and the central dynamic handling controller on the ICM even make is possible to optimize handling characteristics in advance. One example of that is brake modulation for the purposes of improved agility, which is described in one of the subsections further on.

Subordinate to the central dynamic handling controller on the ICM is an “actuator coordination” function. It decides whether and to what degree the DSC dynamic handling system is to contribute to producing the required yaw force.

The required force is signalled to the DSC’s dynamic handling controller, which puts it into action by operating the actuators represented by the brakes and drivetrain.

Simple implementation of the settings specified by the ICM is, however, not the only task of the DSC’s dynamic handling controller on the F01/F02. It also continues to independently perform the following original DSC functions:

- Anti-lock braking system (ABS)
- Cornering Brake Control (CBC)
- Automatic Stability Control (ASC)
- Engine drag torque control (MSR)
- Automatic Differential Brake (ADB)

The numerous additional functions over and above pure handling dynamics control are also carried out largely independently by the DSC and without intervention by the ICM.

- Functions which help to reduce stopping distance: they include brake drying, brake standby, brake fade prevention and dynamic brake control. The efficiency of the brake standby and dynamic brake control functions is further improved in combination with the “ACC Stop & Go” optional extra.
- Convenience functions which make driving easier, e.g. Automatic Hold, which is performed by the DSC and EMF in combination.
- The stresses on and wear of brake components are monitored with the aid of computation models. Based on information such as brake pressure and brake temperature and the signals from the brake-pad wear sensors, a remaining service life expressed as a mileage is calculated. The owner can view that information as a subfunction of Condition Based Service and use it as an aid to planning servicing appointments.

DSC Displays and Controls

New DSC symbols

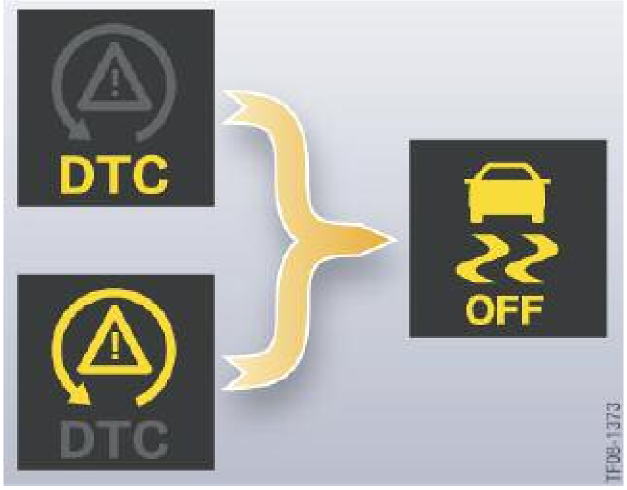
There is a new set of symbols for Dynamic Stability Control displays and controls. Starting on the F01/F02, this new DSC symbol set replaces the symbols previously used.

Previously there were two different symbols displayed on the instrument cluster for the statuses “DTC mode” and “DTC off”.

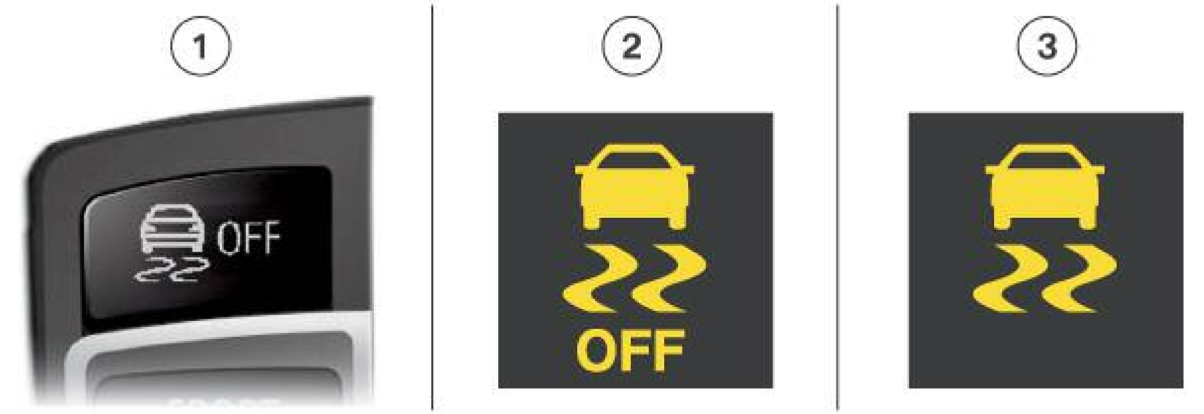
As of launch of the F01/F02, there is now only one symbol for both statuses. However, the drive can distinguish between the two statuses by means of additional information in text form.

The new DSC symbol set relates not only to the display but also the labeling of the DTC button.

DSC indicator and warning lamp on the instrument cluster:



DSC symbols



Index	Explanation
1	DTC button
2	DSC indicator and warning lamp on the instrument cluster: – DSC switched off or – DSC in DTC mode
3	DSC indicator and warning lamp on the instrument cluster: – DSC control sequence active (flashing) – DSC failure (permanently lit)

The new symbols will gradually be introduced on all new vehicles as they are phased in. The reason for the change of symbols are the new legal requirements which oblige all car manufacturers to use standardized display symbols. That will enable motorists to immediately recognize the controls and displays of a DSC system as such regardless of the brand of car they are driving.

The regulations also require that even merely limited DSC function must result in display of the word “off”. That is the case in “DTC mode”, in which the stabilizing interventions take place at a later stage.

■ DSC modes

As familiar from previous vehicles, the Dynamic Stability Control on F01/F02 incorporates the following function modes:

- DSC on
- DTC (Dynamic Traction Control)
- DSC off

In the “DSC on” mode, all DSC functions are fully active. The stabilizing interventions in brake and engine function take place at an early stage. That makes it easier for less expert drivers to regain control of a vehicle that is becoming unstable.

In “DTC mode” the stabilizing interventions take place at a slightly later stage. The Automatic Stability Control and Automatic Differential Brake functions allow a greater degree of wheelspin. That improves traction when pulling away on loose surfaces such as uncompacted snow. The dynamic handling control function does not come into action until a larger sideslip angle is reached than in “DSC on” mode.

In “DSC off” mode, the stabilizing interventions by:

- the dynamic handling controller,
- the Automatic Stability Control and

are switched off.

Especially safety-critical DSC functions such as ABS remain fully active in all DSC modes, however.

The mode “DSC off” is aimed at the undiluted driving experience, the direct connection between the driver, vehicle and the road.

■ Integration in dynamic handling control

A new feature of the DSC modes on the F01/ F02 is that they are integrated in the dynamic handling control function. Dynamic handling control is activated by means of the handling setting switch and the DTC button.

Dynamic handling control enables the driver to choose one of six possible vehicle handing modes. The dynamic handling controller then controls all drivetrain and dynamic handling systems simultaneously and in co-ordination with one another. The result is totally harmonious handling in all modes.

DTC button and handling setting switch

The vehicle handling modes are called:

- Comfort
- Normal
- Sport
- Sport+
- Traction
- DSC off

When the vehicle is first started, the dynamic handling controller is always in “Normal” mode.

The table below shows what mode the Dynamic Stability Control is in for each of the vehicle handling modes.

The other dynamic handling systems and drivetrain control systems are switched in and out as appropriate to the vehicle handling mode selected.

Index	Explanation
1	DTC button
2	Handling setting switch

Vehicle handling mode	DSC mode
Comfort	DSC on
Normal	DSC on
Sport	DSC on
Sport +	DTC
Traction	DTC
DSC OFF	DSC off

DSC Functions in Detail

ADB Active Even When DSC is Off

The DSC function ADB has been around for a long while on a wide variety of BMW vehicles and especially in the form of the ADB-X version on the xDrive models.

If one of the wheels of a driven axle is spinning, it cannot transmit any driving force (torque) to the road. And because the differential distributes the torque equally between the two wheels, the other wheel on the axle can not transmit any driving force either.

ADB brakes the spinning wheel so that the driving torque and braking force are in equilibrium on that wheel. Then, by virtue of the differential, an equal amount of driving torque is applied to the wheel that is not spinning. And because that wheel is offered grip by the road surface, a driving force can be transmitted that results in forward motion of the vehicle.

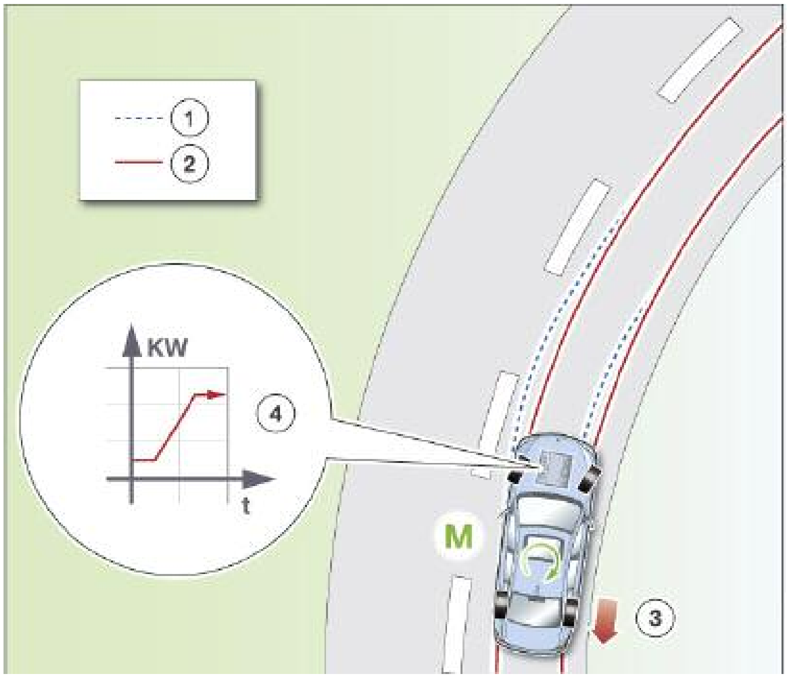
Thus ADB increases traction on slippery surfaces and has a similar effect to a differential lock.

- On the **xDrive** models, ADB-X remains active even when the DSC is switch off in order to achieve improved traction, especially when driving off road.
- On vehicles with **rear-wheel drive**, that individual braking of the driving wheels was previously only active when the DSC was active or in “DTC” mode.
- On the new F01/F02 (and the top 1 Series and 3 Series models) that ADB subfunction remains active even when the DSC is switched off.

That function is called **“Electronic Differential Lock Control”** and uses the DSC to emulate the effect of a differential lock on the driving wheels. In contrast with previous arrangements, such brake modulation for the purposes of increasing drive transmission takes places even if the driver has switched off the DSC.

Brake Modulation for Increasing Agility

The highly advanced hardware of the DSC F0x enables brake modulation to be carried out without unpleasant feedback for the driver. On the F01/F02, that capability is utilized to influence the vehicle's self-steering characteristics is a specifically targeted way.



Index	Explanation
1	Course of an understeering vehicle
2	Course of a vehicle with neutral handling
3	Individual modulation of brakes to prevent understeer
4	Increased engine torque to compensate for braking force
M	Yaw force acting on the vehicle as a result of individual modulation of brakes

If the vehicle begins to understeer, e.g. when cornering quickly, the central dynamic handling controller on the ICM detects the very first indications that it is starting to happen. A required setting is transmitted to the DSC requiring it to apply the brake on the rear wheel on the inside of the bend. The DSC sensitively applies the required setting and without generating a level of noise perceptible by the driver. The uneven braking effect thus produced, creates a yaw force acting around the vehicle's center of gravity. As a result, the vehicle turns towards the inside of the bend, doesn't understeer and corners with absolutely neutral handling.

This type of brake modulation increases road safety because it prevents the vehicle drifting towards the outside of the bend. The disadvantage, however, is that the vehicle is slowed slightly by the application of the brake and thus a degree of momentum is lost.

Therefore, in typical BMW fashion, the solution is taken a step further. Whenever handling stability considerations allow, the engine torque is increased simultaneously with brake application. The higher engine torque is transmitted to the road by the wheel on the outside of the bend that is not being braked. The control strategy ensures that the increase exactly matches the retardation by the brake application.

While that DSC function is active, there is no display of any kind on the instrument cluster.

In that way, highly advanced components (DSC) and intelligent control strategies are combined to produce an overall effect that substantially improves agility without impairing the handling stability of the vehicle.

Automatic Hold

This function has been around since the E65, on which it was called “Auto-P”. The Automatic Hold function was also used on the E70/E71.

Although the Automatic Hold function is computed on the DSC control unit, it can not be put into effect without an electromechanical parking brake (EMF). The EMF is always required whenever the DSC hydraulic modulator is unable to permanently hold the vehicle stationary. In particular, that is the case when the engine is switched off.

When the Automatic Hold function is active, the driver first of all brakes the vehicle to a standstill. It is then held stationary by the DSC hydraulic modulator. That is achieved by maintaining the final brake pressure applied by the driver. If the vehicle starts to roll on an incline, the DSC hydraulic modulator actively generates brake pressure.

Pressing the accelerator causes the brake pressure to be released and the vehicle starts to move again. Automatic holding and releasing of the brakes in that way makes driving in easier in conditions such as urban traffic and stopping at traffic lights or stop-and-go driving in traffic tailbacks.

After the engine is started, the function can be activated until the next time the engine is switched off. To do so, the driver’s door must be closed and the driver’s seatbelt fastened. The function can, of course, also be manually deactivated before the engine is switched.

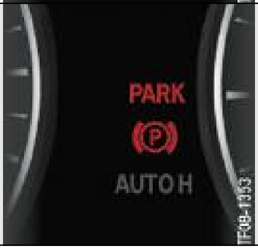
The footwell module reads the signal from the door switch. The ACSM control unit analyses the signal from the seat belt buckle contact. The two signals are transmitted to the DSC control unit via the bus systems. One signal that is not analysed for the Automatic Hold function on the F01/F02 is the driver’s seat occupancy signal.

Conversely, the Automatic Hold function is automatically deactivated if the driver’s door is opened and the driver’s seatbelt unfastened. To prevent the vehicle rolling away in that situation, the EMF parking mode is activated. As long as the engine is running, the parking mode is effected by means of the DSC hydraulic modulator. If the driver switches the engine off, the function is taken over by the EMF actuator unit.

Note: Before the vehicle is driven into a car wash, the Automatic Hold function has to be deactivated as otherwise the brakes are applied when the vehicle is stationary and it can not be rolled.

The Automatic Hold function is activated and deactivated by means of the button marked "AUTO H" on the center console. Activation of the function is acknowledged by the function indicator lamp (green LED in the button). Whenever the green LED is lit, the Automatic Hold function is active. The status of the Automatic Hold function is also indicated on the instrument cluster.

The various function statuses and how they are indicated are summarized below.

Status of Automatic Hold function	Function indicator lamps in buttons	Display on instrument cluster
Switched off		
Switched on and on standby (e.g. when vehicle is moving)		
Switched on and active (vehicle is being held stationary)		
Deactivated by driver getting out of vehicle or switching engine off		

When Automatic Hold is holding the vehicle stationary, two additional internal DSC sub-functions are activated: roll-away monitoring and slide detection.

The roll-away monitoring function is described in the section "EMF functions".

The slide detection function is designed to intervene if the vehicle starts to slide after stopping, i.e. if all four stationary wheels start to slip. That can happen on a steep slope when the road is slippery, for instance. If the driver were holding the vehicle stationary and became aware of such a situation, he/she would release the brake. In that way the vehicle can at least be steered as it rolls down the slope.

The slide detection function is based on exactly the same principle. When the vehicle is being held stationary by Automatic Hold, the slide detection function monitors the signals from the wheel-speed sensors. The DSC releases the pressure on one of the brakes in alternation while keeping the others under pressure. If the wheel-speed sensor registers a movement from the wheel on which the brake is released, then obviously the entire vehicle must be moving. That means that the other wheels, on which the brakes are applied, must be sliding while locked. Under those circumstances, the condition "sliding" would be detected.

The response to detection of sliding is progressive release of brake pressure so that the vehicle becomes steerable. The driver is made aware of the critical situation by a Check Control message and an audible warning signal.

■ Interface for Adaptive Braking Assistance

The function "Adaptive Braking Assistance" implemented as a co-ordinated strategy by the DSC and Adaptive Cruise Control with Stop & Go function is also available on the F01/F02. It is a function that was previously introduced on the E60/E61 LCI.

The interface relates to two functions on the Dynamic Stability Control:

- brake standby and
- dynamic braking control.

"Brake standby" can be activated by a request signal transmitted by the ICM control unit. That happens when a potential collision situation has been detected with the aid of the radar sensors. And, of course, "brake standby" is also activated if the internal DSC criteria familiar from previous models are met (minimum speed, rapid release of accelerator pedal).

The threshold for triggering dynamic braking control can be influenced by ACC Stop & Go. If a potential collision situation is detected, the ICM control unit sends out a signal requesting lowering of the activation threshold. To be precise, the activation threshold is the rate of increase of brake pressure applied by the driver that has to be exceeded in order to dynamic braking control (braking assistance). That makes it easier for the driver to trigger dynamic braking control. This function is the only means by which a driver braking hesitantly can activate dynamic braking control.

System Components

DSC Components

DSC Unit

The DSC unit on the F01/F02 essentially uses the same technology as on the E70/E71.

Versions

The DSC unit comprises the DSC control unit and the hydraulic modulator. The two are attached to one another in such a way as to form a waterproof unit.

The repair kits available are either

- the complete DSC unit with pre-filled hydraulic modulator or
- the DSC control unit on its own.

There is a seal integrated in the casing of the DSC control unit at precisely the point where it joins the hydraulic modulator. That is the reason why the DSC control unit can be replaced separately (seal is replaced at the same time). The hydraulic modulator, by contrast, can not be replaced separately because the seal would be damaged when the two parts were separated. The required degree of waterproofing would then no longer be provided.

There are two versions of the DSC unit which differ by virtue of the number of pressure sensors fitted.

Optional extra ACC / ACC Stop & Go	Number of pressure sensors	Brake pressures measured
No	1	Pressure applied by driver
Yes	3	Pressure applied by driver Pressure in front-wheel brake circuit Pressure in rear-wheel brake circuit

The DSC unit with only one pressure sensor uses a computation model to determine the pressures in the front and rear brake circuits. The degree of accuracy obtained is sufficient for the functions of the dynamic handling systems and the cruise control with braking function. The optional extras ACC and ACC Stop & Go require a higher degree of accuracy for determining the brake pressure generated and modulated by the Dynamic Stability Control. Therefore, the two additional brake sensors are fitted in the front and rear brake circuits.

Hydraulic modulator

With its highly advanced pump design, the hydraulic modulator also offers an enhanced degree of control accuracy. There are 2 groups of 3 pump elements with a diameter of 6.5mm and intake-optimized units. This pump design produces, firstly, substantially improved pressure generation dynamics. And secondly, the pressure increments during pressure generation are smaller. Together with the improved design of the valves, the overall effect is less pedal feedback during brake modulation.

For the driver this is noticeable in as far as the pedal pulsation can now only be felt very slightly during ABS braking. There is a pressure sensor for detecting the pressure applied by the driver in the hydraulic modulator.

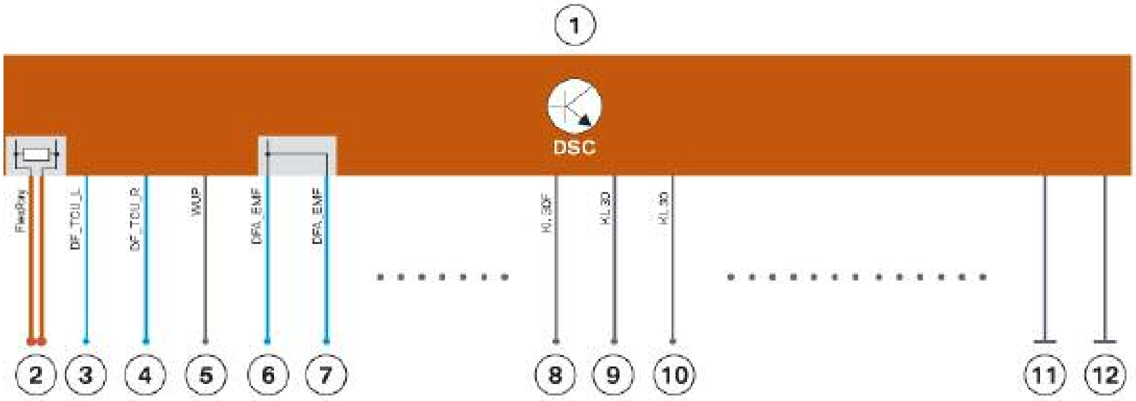
DSC control unit

Like the hydraulic modulator, the DSC control unit on the F01/F02 is also based on the one used on the E70/E71.

Specifically, the following special features and differences should be noted:

- FlexRay connection
- Wiring of the new DTC button
- Wheel-speed signals for electromechanical parking brake, Car Access System and Telematic Control Unit

Overview of important connections on DSC control unit



Index	Explanation
1	DSC control unit
2	FlexRay input with terminal resistor
3	DF_TCU_L, front left wheel-speed signal for Telematic Control Unit (TCU)
4	DF_TCU_R, front right wheel-speed signal for TCU
5	WUP, wake-up line
6	DFA_EMF, wheel-speed signal for Car Access System (CAS)
7	DFA_EMF, wheel-speed signal for electromechanical parking brake (EMF)
8	Power supply for DSC module (Terminal 30F)
9	Power supply for valves (Terminal 30)
10	Power supply for pump motor (Terminal 30)
11	Ground for DSC module
12	Ground for valves and pump motor

The DSC control unit on the F01/F02 is connected to the FlexRay and not, as on previous vehicles, to the PT-CAN and F-CAN.

The FlexRay is brought to the DSC control unit (from the ZGM) and ends there. The DSC control unit is thus the terminal node of the FlexRay. Accordingly, it contains a terminal resistor for the FlexRay.

On previous vehicles, the DTC button was electrically analysed by the IHKA control unit, for instance (E70/E71). On those vehicles, the button operation signal is transmitted via bus systems to the DSC control unit.

The new DTC button on the F01/F02 is connected to the ICM control unit instead. The DTC button and the associated function is part of the “dynamic handling control” function on the F01/F02. As that, in turn, is computed on the ICM control unit, the DTC button has been connected to the ICM control unit. The ICM control unit then signals the appropriate vehicle handling mode via the FlexRay. The DSC control unit analyses the signalled mode and adapts its function accordingly.

For the EMF and CAS control units, the information about vehicle standstill is of particular importance. For those two systems, the DSC control unit provides the DFA_EMF signal. It is a calculated signal computed from the speeds of the two rear wheels. It is transmitted as a pulse-width modulated signal on a dedicated line to the EMF and CAS control units.

If there is a Telematic Control Unit (TCU) fitted on the vehicle but no navigation system, the TCU control unit has to take on the task of determining vehicle location. That is necessary for the manual and automatic emergency call functions. The signals from the GPS aerial are insufficient for that purpose as it has to be possible to determine the vehicle’s location even if the GPS signals are temporarily unavailable. In that case, the TCU control unit uses the speed signals from the two front wheels to calculate the road speed and changes of direction when cornering. The wheel-speed signals are provided by the DSC control unit and transmitted to the TCU control unit by a directly wired connection (DF_TCU_L and DF_TCU_R).

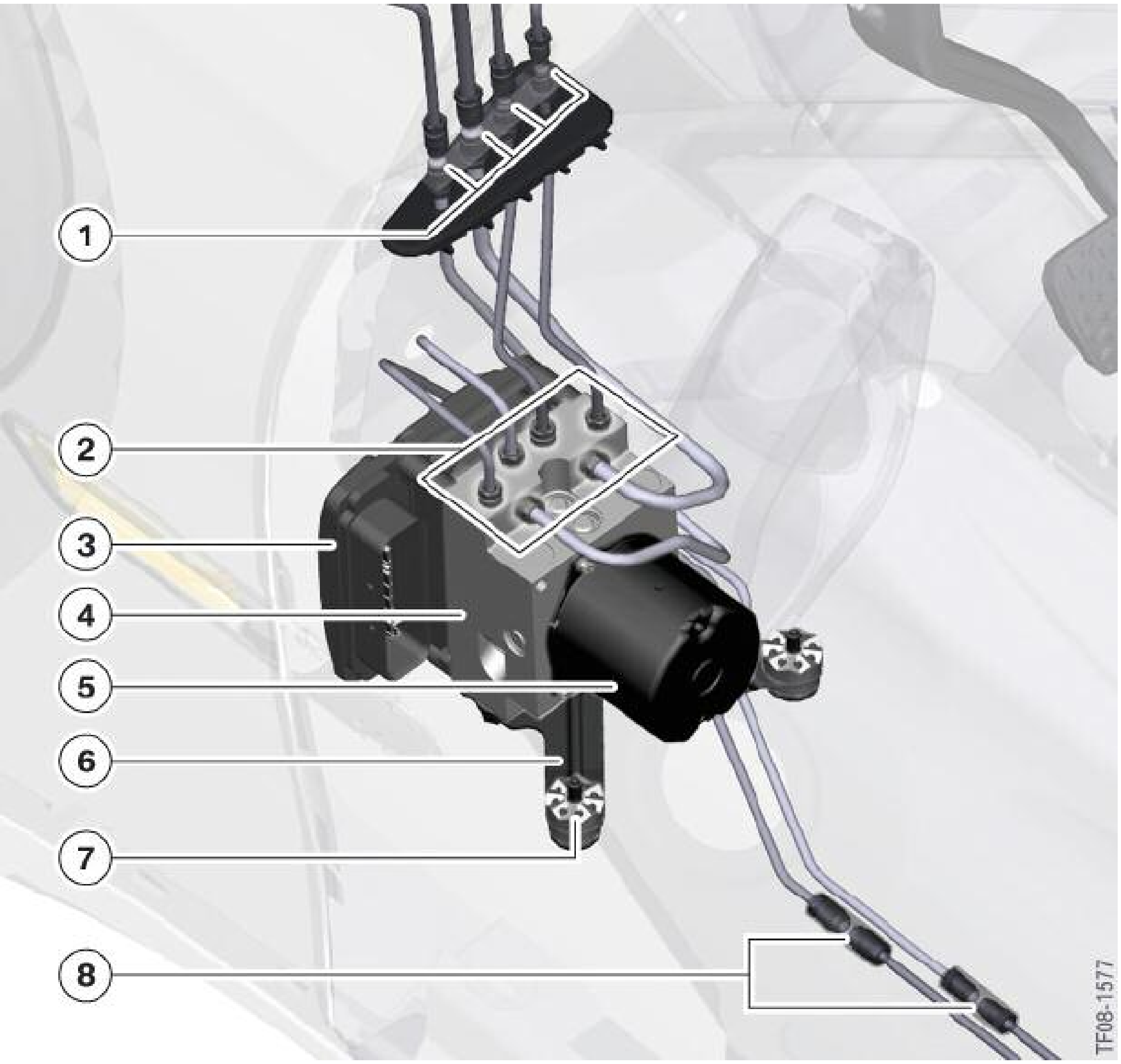
The power supply for the DSC unit is split into three: control unit, valves and pump motor are supplied by separate leads. That prevents interference from the load circuits (inductive loads) being transferred to the electronic circuitry.

The DSC control unit is also connected to the wake-up line. The wake-up line is used to wake up the DSC control unit.

Location and repair

The DSC unit is located in the vehicle underbody, set back somewhat from the wheel arch. That location applies to both left and right-hand-drive vehicles.

Location of DSC unit on F01/F02



Index	Explanation	Index	Explanation
1	Quick-release hydraulic pipe unions, 4 off	5	DSC pump motor
2	Screw-fit hydraulic pipe unions, 6 off	6	DSC unit mounting bracket
3	DSC control unit	7	Bolt fixing with vibration damper for DSC unit
4	DSC valve manifold	8	Screw-fit hydraulic pipe unions, 2 off

Six short lengths of hydraulic pipe are connected to the DSC unit by screw-fit unions.

Four of those hydraulic pipes run upwards from the hydraulic modulator and terminate at a block with quick-release unions. They are connected by those quick-release unions to the pipes running off to other parts of the vehicle. Specifically, that is the two pipes to the left and right front brakes and the two pipes to the tandem master cylinder.

The two remaining hydraulic pipes run to the rear. They are connected by quick-fit unions to the pipes running off to other parts of the vehicle. In this case, they lead to the left and right rear brakes.

If the DSC unit has to be replaced, first of all the vehicle underbody trim has to be removed in the appropriate places. When the DSC unit is removed, the six short lengths of hydraulic pipe referred to above are removed with it. Therefore, before removal, the four quick-release unions (4) and the two screw-fit unions (8) have to be disconnected. The short lengths of hydraulic pipe subsequently have to be removed and fitted to the new DSC unit.

Only after the DSC unit has been removed can the DSC control unit be separated from the hydraulic modulator, if necessary, and new one fitted.

The braking system must always be bled whenever the DSC unit has been removed and refitted/replaced.

The precise procedures for the individual repair operations in connection with the DSC unit are described in the Repair Instructions.

Sensors for DSC

Wheel speed sensors

The same type of wheel-speed sensor is used on the F01/F02 as on the E70/E71 (DF11i made by Robert Bosch GmbH).

They are four active wheel-speed sensors, all four of which are connected by dedicated two-core leads directly to the DSC control unit. The wheel-speed data is transmitted to the DSC control unit as a pulse-width-modulated signal.

The active wheel speed sensors enable detection of direction of rotation and clearance gap.

Detection of direction of rotation is required for the hill-start assistance and Automatic Hold functions, among others. The clearance-gap sensing function allows sensor positioning faults to be detected. If there is too much play in the wheel bearings, the wheel-speed signal can also become unreliable. That situation is also detectable by the clearance-gap sensing capability of the wheel-speed sensors.

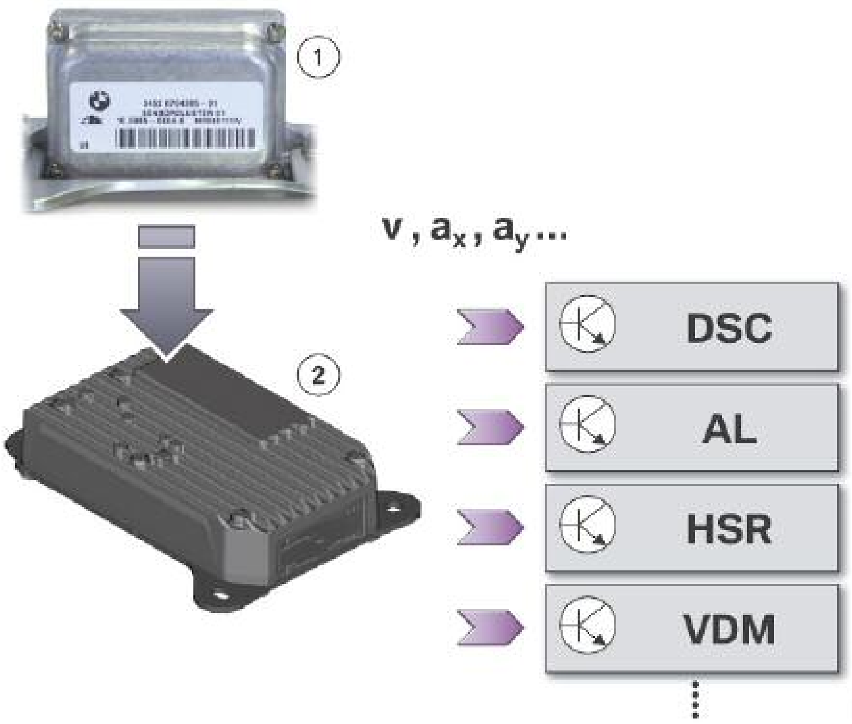
It can therefore be guaranteed that the DSC control unit only operates on the basis of correctly detected wheel-speed signals.

Index	Explanation	Index	Explanation
1	Sensor ring/ferromagnetic wheel bearing seal carrier	3	Sensor housing
2	IC sensor with Hall sensor		

The DSC control unit broadcasts the wheel-DSC sensor in ICM speed sensor signals via the FlexRay network and directly wired links to the other systems on the vehicle.

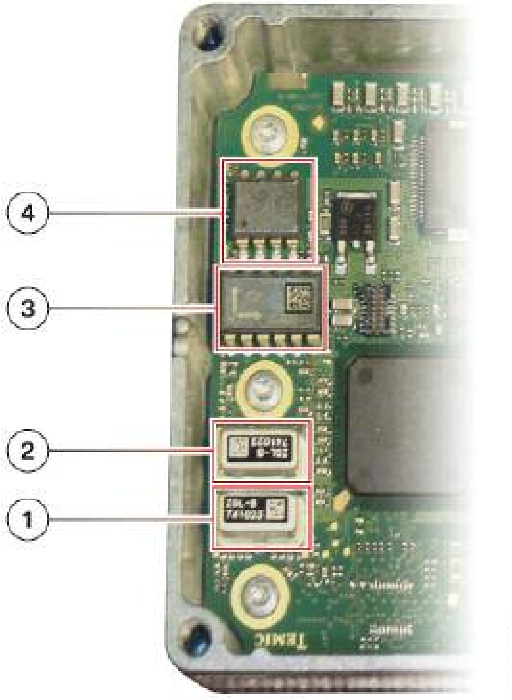
The DSC sensor, which was previously a separate component, has been integrated in the ICM control unit on the F01/F02.

Dynamic handling signals provided by ICM control unit



Index	Explanation	Index	Explanation
1	DSC sensor integrated in ICM control unit	DSC	Dynamic Stability Control
2	ICM control unit	AL	Active steering
v	Road speed	HSR	Rear suspension slip angle control
ax	Linear acceleration	VDM	Vertical Dynamics Management
ay	Transverse acceleration		

DSC sensor integrated in ICM control unit



Index	Explanation
1	Yaw rate sensor
2	Second, back-up yaw rate sensor
3	Linear and lateral acceleration sensor
4	Second, back-up lateral acceleration sensor

With the aid of the signals from those integrated sensors and the wheel-speed signals provided by the DSC control unit, the ICM control unit calculates the following variables that are of significance for the vehicle's dynamic handling status:

- Road speed
- Linear acceleration and pitch
- Lateral acceleration and roll
- Yaw rate

Steering-angle sensor in SZL

With the aid of the steering-angle sensor, the SZL is able to provide the following signals via the FlexRay bus system:

- Steering angle
- Steering rate

Those variables are used as input signals by the dynamic handling systems to determine the driver's intention when cornering. On the F01/F02 it is important to note that the steering-angle sensor signals are first analysed by the ICM control unit and then provided to control units of the other dynamic handling systems as the "effective steering-angle signal".

Detection of the steering angle and the steering rate is performed by an optical proximity sensor, the optical steering angle sensor.

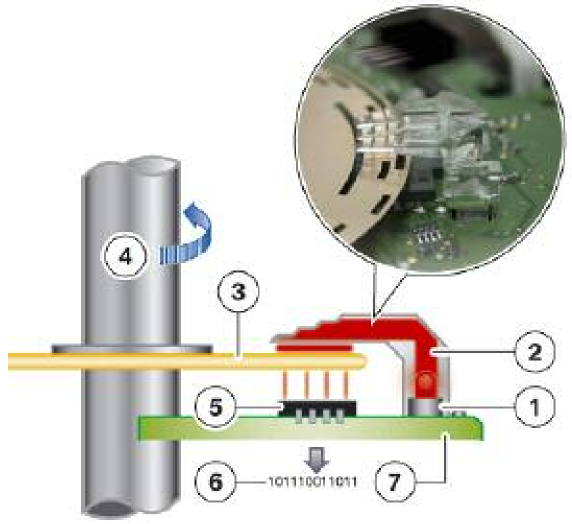
Information such as the absolute steering angle or the steering wheel rotation is calculated. The optical steering-angle sensor detects steering angles from -640° to +640°.

If the SZL suffers a power loss, e.g. if the battery terminals are disconnected, the steering wheel rotation data is lost. The SZL is then initially unable to determine the absolute steering angle and can only identify the relative steering angle.

This temporary fault status can be remedied by turning the steering wheel from lock to lock. Alternatively, the SZL can detect the straight-ahead position from the wheel-speed signals from the front wheels when driving in a straight line.

In either case, the absolute steering angle is then known again.

Schematic diagram of optical steering-angle sensor on F01/F02



Index	Explanation
1	Light-emitting diode
2	Fiber optics unit
3	Code disc
4	Steering column
5	Photo-transistors
6	Output: Conversion to electrical signals
7	PCB

Note: If at least one of the following conditions exists, the steering column switch cluster has to perform steering-angle sensor calibration:

- **Wheel alignment carried out**
- **SZL replaced or re-programmed**
- **Diagnosis system test procedure specifies calibration.**

Note: When calibrating the steering angle sensor, the instructions given by the diagnosis system must be followed precisely.

The vehicle must be standing on a level surface during calibration. The steering wheel must be aligned visually in the straight-ahead position.

Service Information

Important Points for Servicing and Repairs

Dynamic Stability Control (DSC)

General details

Note: The modes “Dynamic Traction Control” (DTC) and “DSC off” are still used on the F01/ F02. However, on the F01/F02, the DSC modes are integrated in the “dynamic handling control” function, which rather than controlling individual systems, controls the system complex of all drivetrain and dynamic handling systems.

Note: There is a new set of symbols for DSC displays and controls on the F01/F02.

DSC symbols

Automatic hold function

The Automatic Hold function is activated/ deactivated by means of a button on the center console control panel. The Automatic Hold status is indicated by the function indicator lamp on the button and an indicator lamp on the instrument cluster.

For Automatic Hold to be activated, the driver's seatbelt must be fastened and the driver's door closed.

Note: Before the vehicle is driven into a car wash, the Automatic Hold function has to be deactivated as otherwise the brakes are applied when the vehicle is stationary and it can not be rolled.

■ DSC unit

There are two versions of the DSC unit which have either one or three pressure sensor(s) (vehicles without/with “Active Cruise Control” optional extra)

Note: The repair kits available are either

- **the complete DSC unit with pre-filled hydraulic modulator or**
- **the DSC control unit on its own.**

The hydraulic modulator can not be replaced separately.

Note: The DSC unit is located in the vehicle underbody, set back somewhat from the wheel arch.

Note: If the DSC unit has to be replaced, first of all the vehicle underbody trim has to be removed.

When the DSC unit is removed, the six short lengths of hydraulic pipe are removed with it. Therefore, before removal, the four quick-release unions at the top and the two screw-fit unions at the bottom have to be disconnected from the hydraulic pipes.

The short lengths of hydraulic pipe subsequently have to be removed and fitted to the new DSC unit.

Signals and sensors

Note: The wheel speed sensors are connected to the DSC control unit. The DSC control unit processes the wheel-speed sensor signals and broadcasts them via the FlexRay network to other systems, in particular the Integrated Chassis Management.

Note: The DSC control unit does not only provide the wheel-speed signals in the form of bus signals. They are transmitted to the EMF, CAS and TCU control units by direct wired links.

Note: The DSC sensor, which was a separate component on previous vehicles, has been integrated in the ICM control unit. The ICM control unit processes the important sensor signals for the Dynamic Stability Control and supplies them in the form of bus signals. Those signals are:

- **Yaw rate**
- **Transverse acceleration**
- **Linear acceleration**
- **Steering angle**
- **Vehicle speed.**

Note: The DSC sensor in the ICM control unit has to be calibrated if

- **the ICM control unit has been replaced or**
- **the testing sequence on the diagnosis system demands it on the basis of a fault memory entry.**

Calibration must be performed with the vehicle on a surface that is level both lengthways and side to side. Terminal 15 must also be switched on.

Note: If at least one of the following conditions exists, the steering column switch cluster has to perform steering-angle sensor calibration:

- **Wheel alignment carried out**
- **SZL replaced or re-programmed**
- **Diagnosis system test procedure specifies calibration.**

Note: When calibrating the steering angle sensor, the instructions given by the diagnosis system must be followed precisely.

The vehicle must be standing on a level surface during calibration. The steering wheel must be aligned visually in the straight-ahead position.

Overview of EMF Functions

Normal Operation

■ Parking brake application

The driver can activate the EMF parking brake function by pulling on the parking brake button. Thus the way in which the parking brake button is operated emulates the action of a handbrake lever.

The signal from the parking brake button is read by the EMF control unit and transmitted to the DSC control unit as a bus signal. The DSC control unit then decides whether to use the DSC hydraulic modulator or the EMF actuator unit to implement the parking brake function. If the engine is running, the vehicle is held stationary by using the DSC hydraulic modulator; otherwise the EMF actuator unit is used.

The parking brake function is possible at any logical terminal status, i.e. at:

- Terminal 0
- Terminal R
- Terminal 15 (and Terminal 50)

Parking brake application at Terminal 0 is specifically made possible by the fact that the EMF control unit is supplied by Terminal 30 and the parking brake button is connected directly to the EMF control unit. If the driver operates the parking brake button at Terminal 0, the EMF control unit is woken up. The EMF control unit in turn wakes up the other control units on the vehicle. Only then can the EMF control unit receive the important signals relating to vehicle standstill. In addition, the changed status of the parking brake can be displayed after the system has been woken up.

The status “parking brake on” is indicated by a red LED on the parking brake button and an indicator lamp on the instrument cluster.

The driver does not have to operate any other controls to apply the parking brake. Once the parking brake is on, pulling the parking brake button again has no effect.

Indication of "parking brake on"

Index	Explanation
1	Function indicator lamp on parking brake button
2	Indicator lamp on instrument cluster

Roll-away monitoring

The roll-away monitoring function is computed on the DSC control unit. It is active while the vehicle is being held stationary by:

- the DSC hydraulic modulator or
- the EMF actuator unit.

The condition for activation of roll-away monitoring is thus that either the EMF parking brake function or the Automatic Hold function is active.

Roll-away monitoring observes the signals from the wheel-speed sensors. If any of the wheel-speed sensors signals movement of the wheel, that indicates that the vehicle is rolling. Since, however, the vehicle is supposed to be stationary by virtue of the brake pressure applied by the hydraulic system or the EMF actuator, the roll-away monitoring function has to intervene. The hydraulic brake pressure is increased by control signals to the DSC hydraulic modulator or EMF electric motor in order to increase the braking force. In that way the rolling is counteracted.

Release

In similar fashion to the operation of a handbrake lever, the EMF is released by pushing the parking brake button in.

But in order that the parking brake function is actually cancelled, Terminal 15 must also be on and one of the following conditions must be met:

- Brake pedal depressed or
- Automatic transmission parking lock engaged.

That prevents the vehicle rolling away if another occupant of the vehicle apart from the driver presses in the parking brake button (child safety feature).

Once the parking brake is released, the function indicator lamp on the parking brake button and the indicator lamp on the instrument cluster go out.

Indication of "parking brake released"

Index	Explanation	Index	Explanation
1	Function indicator lamp on parking brake button	2	Indicator lamp on instrument cluster

■ Dynamic braking

The law requires that vehicles have two means of applying the brakes. On the F01/F02, the second means (the brake pedal being the first) is the parking brake button on the center console.

If the parking brake button is pulled out while the vehicle is in motion, a defined degree of braking is applied by the DSC system. That function is intended for emergency situations in which the driver is unable to apply the brakes by pressing the brake pedal. Other occupants of the vehicle can also bring the vehicle to a standstill in that way if, for example, the driver suddenly loses consciousness.

Dynamic braking hydraulically applies brake pressure at all four brakes. The stabilization functions of Dynamic Stability Control remain fully functional and the brake lights are switched on. That represents a major advantage over a manual parking brake.

Braking takes place only while the parking brake button is pulled out. The degree of deceleration set by the DSC is increased progressively from initially 3 m/s2 to 5 m/s2.

During dynamic braking, the parking brake indicator light on the instrument cluster comes on. In addition, a Check Control message and an audible warning signal are issued to make the driver aware of the critical situation.

If the driver uses the brake pedal and the parking brake button at the same time to slow down, the DSC control unit prioritizes. The greater braking requirement is put into effect.

If dynamic braking is continued to the point of standstill, the vehicle continues to be held stationary after the parking brake button is released. The indicator lamp on the instrument cluster remains on. The driver can then release the parking brake (as described above).

■ Emergency release

A mechanical emergency release facility is provided in order to be able to release the parking brake in the event of the electromechanical actuator unit failing or insufficient power supply.

Note: Caution: secure vehicle to prevent it rolling before operating the emergency release!

Note: After a power supply failure, it may still not be possible to move the vehicle even after releasing the brake with the emergency release facility. The automatic transmission parking lock may still be engaged.

In that case, the parking brake must first be released with the emergency release facility. Then the automatic transmission parking lock must be released using the emergency release facility. To do so, the appropriate tool must remain engaged in the parking lock emergency release.

The parking brake emergency release status is indicated on the instrument cluster. The parking brake indicator lamp shows yellow.

Indication of "parking brake emergency release/fault"

The driver is shown the same indication (together with a check control message) if the parking brake has a fault.

When the parking brake is to be used again after an emergency release, that can not be done mechanically but only electrically. It requires pushing in the parking brake button once as if to release the parking brake. The familiar conditions for releasing the parking brake must also be met.

Service Function

Installation Mode

EMF installation mode is required for the purposes of replacing the EMF actuator unit or the brake cables. The EMF can be set to installation mode with the aid of the BMW diagnosis system. This mode is comprized of two subfunctions:

- Setting the EMF actuator unit to the installation position
- Preventing the EMF parking brake function.

To set the unit to the installation position, the brake cables are extended to the maximum length. That is the essential requirement for being able to remove and refit the cables.

While work is being carried out on the actuator unit, the brake cables or the duo-servo parking brake, the EMF must not be inadvertently or deliberately applied. Doing so would risk causing injury. Installation mode prevents the EMF parking brake function.
That means that pulling out the parking brake button as if to apply the parking brake has no effect.

Installation mode is indicated on the instrument cluster by the parking brake indicator lamp flashing yellow.

Indication of parking-brake installation mode

Installation mode can be cancelled in two ways:

- By the performing the service function “Reset installation mode” using the BMW diagnosis system
- By driving the vehicle; when doing so, a minimum speed must be exceeded.

Once installation mode has been successfully cancelled, the parking-brake indicator lamp on the instrument panel goes out.

Running-in the Brakes

The function for running-in the parking brakes only has to be carried out if

- the linings of the duo-servo parking brakes have been replaced or
- the rear brake discs have been replaced.

In either case, a material/surface pairing then initially exists which does not yet have the optimum frictional properties. That means that the required braking forces could not be achieved.

The brake running-in function removes play between the two surfaces forming the frictional pairing, i.e. the brake linings and the inside of the brake disc recess. It also wears-in the surfaces. Both operations are essential to achieving the required frictional coefficient between the two surfaces.

The brake running-in function is prepared with the aid of the BMW diagnosis system. It is started by pulling out the parking brake button once. The parking brake indicator lamp flashes red throughout the entire sequence.

While running-in the parking brakes, the EMF applies a defined force to the duo-servo parking brakes. That force is substantially lower than the brake force required to hold the vehicle stationary. The rear wheels are then rotated either on a brake dynamometer or by driving the vehicle on the road.

Note: The precise procedure for running-in the parking brakes is described in the Repair Instructions under the heading “Adjusting the parking brake”. The instructions given there must be followed exactly.

EMF Components

This section deals only with the special features of the actuator unit and the controls for the electromechanical parking brake. On the F01/F02, as on numerous other BMW models, the braking force for the parking brake is produced by the familiar duo-servo parking brakes on the two rear wheels.

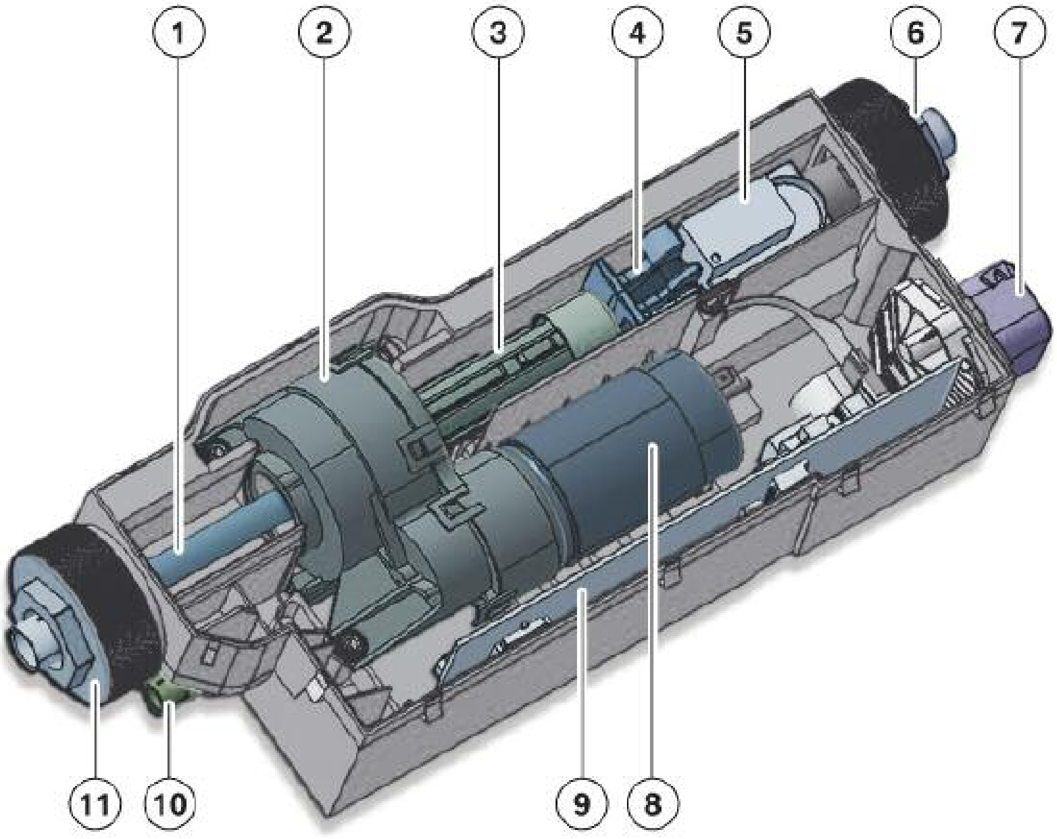
EMF Actuator Unit

The complete EMF actuator unit and especially the electric motor and gearing have been optimized for use on the F01/F02. That is noticeable in particular by quieter operation during actuation.

The EMF actuator unit is made up of the following main components:

- EMF control unit
- Electric motor
- Gearbox
- Force sensor

Those components are housed in a plastic casing that can not be opened. In the event of a fault, the EMF actuator unit can only be replaced as a complete unit.



Index	Explanation	Index	Explanation
1	Spindle	7	Connector
2	Gearbox	8	Electric motor
3	Splined shaft	9	Control unit circuit board
4	Emergency release mechanism	10	Entry/exit for emergency release cable
5	Force sensor	11	Sleeve nut for left brake cable
6	Sleeve nut for right brake cable		

EMF control unit

As on the E70, the EMF control unit on the F01/F02 is integrated in the actuator unit casing and is also identical in design to the one on the E70. It is the actuation controller for the EMF functions. It therefore controls the electric motor and reads the signals from the force sensor.

The most important control signal from outside is that from the parking brake button. The parking brake button is directly wired to the EMF control unit.

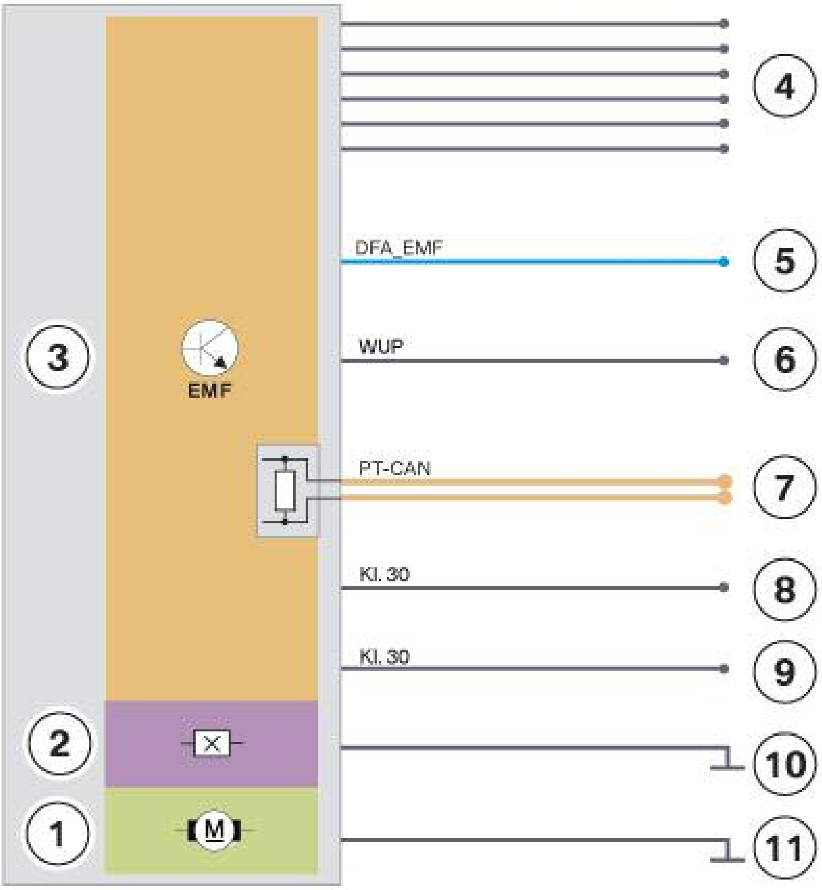
The EMF control unit is connected to the PTCAN. Integrated in the EMF control unit is one of the two terminal resistors for the PT-CAN. The EMF control unit communicates via the PT-CAN with its most important partner, the DSC control unit. As the DSC control unit is only connected to the FlexRay, the central gateway module is required to transfer the signals between the PT-CAN and the FlexRay.

A special place among the input signals is occupied by the information relating to vehicle standstill. The EMF actuator unit must not be activated while the vehicle is moving but rather only when it is stationary. Otherwise, the vehicle handling would become unstable due to the rear wheels locking up. The EMF control unit detects vehicle standstill on the basis of the following three input signals:

- Road speed (provided by Integrated Chassis Management via bus systems)
- Rear axle speed (provided by engine management via PT-CAN)
- Wheel-speed signal “DFA_EMF” (calculated by Dynamic Stability Control and transmitted via direct wired link to EMF control unit).

Only when those three signals definitively indicate vehicle standstill does the EMF control unit allow operation of the actuator unit.

Overview of important connections on EMF actuator unit



Index	Explanation
1	Electric motor
2	Force sensor
3	EMF control unit
4	Signal leads for parking brake button and function indicator lamp
5	DFA_EMF, wheel-speed signal from DSC
6	WUP, wake-up line
7	PT-CAN input with terminal resistor
8	Power supply for EMF control unit (Terminal 30)
9	Power supply for electric motor (Terminal 30)
10	Earth for EMF control unit
11	Earth for electric motor

Force sensor

Technically speaking, the force sensor is a travel sensor that operates according to the Hall effect. Between the two brake cables there is a spring with a defined strength. That strength is stored on the EMF control unit. Therefore, it can determine the force acting on the cables from the change in the length of the spring.

The force acting on the brake cables is an important input variable for the control algorithm on the EMF control unit. When the parking brake is applied, the EMF control unit has to ensure that a specific required force is applied to the brake cables. The EMF control unit calculates that required force on the brake cables directly from the legally required holding force on the wheels. The latter has to be great enough to safely keep the vehicle stationary on an uphill or downhill gradient of up to 20 %.

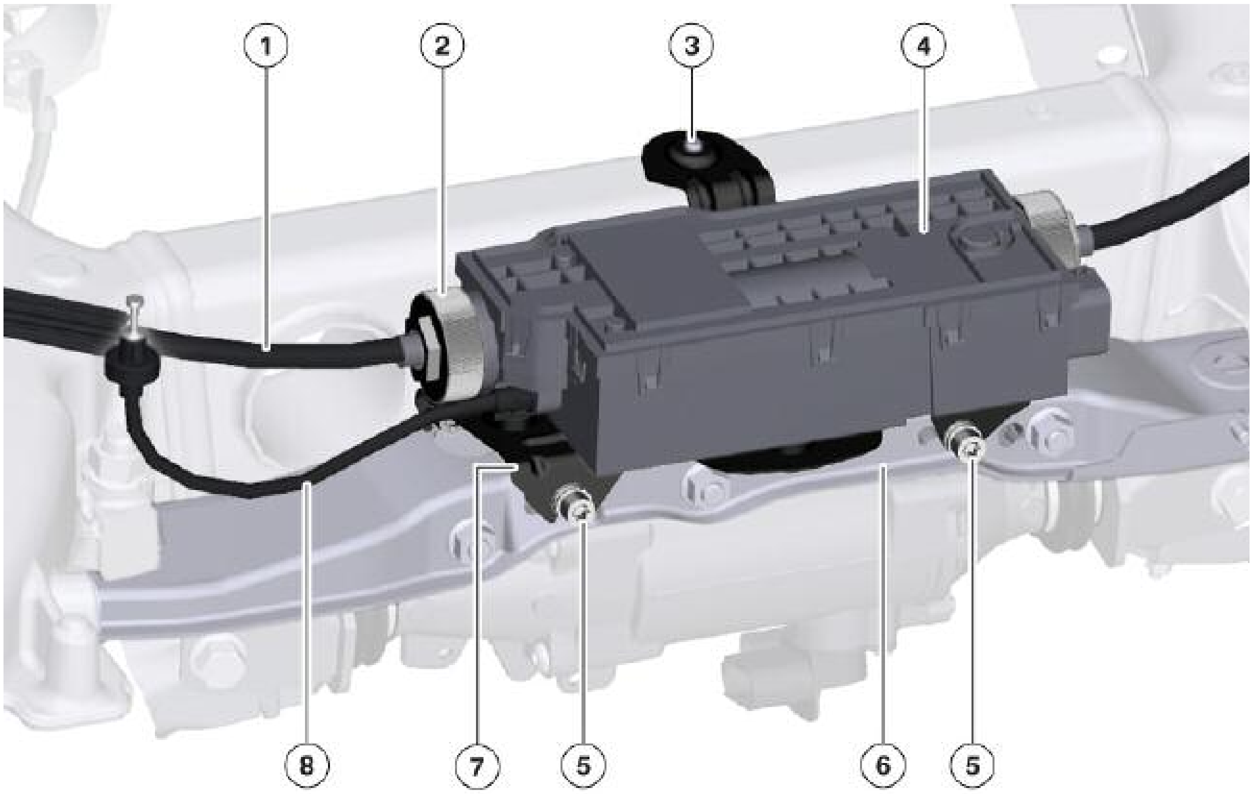
Over the life of the cables, a slight degree of stretching can occur. However, that does not corrupt the force-sensor signal. The spring does not, of course, start to compress until a force is acting on the cables. If, due to stretching, the cables are initially loose when in the released position, then no force is acting on the spring. Only when a force is applied to the cables, and, therefore, to the spring by operation of the electric motor does the spring compress. Then the force sensor sends the appropriate signal to the EMF control unit.

■ Bracket

To attach the EMF actuator unit to the vehicle's structural components, a multi-angled bracket is used. That design allows the EMF actuator unit itself to remain virtually identical in dimensions (to the one on the E70/ E71). Adaptation to the geometry of the surrounding components on the different vehicles is achieved by the specific design of the mounting bracket.

The bracket for the EMF actuator unit locates at the top on a boss on the rear suspension subframe. Fixing of the bracket at the bottom differs according to whether the vehicle is fitted with Integrated Active Steering or not. Vehicles with Integrated Active Steering have an actuator for the rear-wheel steering on the rear suspension. The bracket for the EMF actuator then rests on the rear-wheel steering actuator bracket. The two brackets are joined by two bolts.

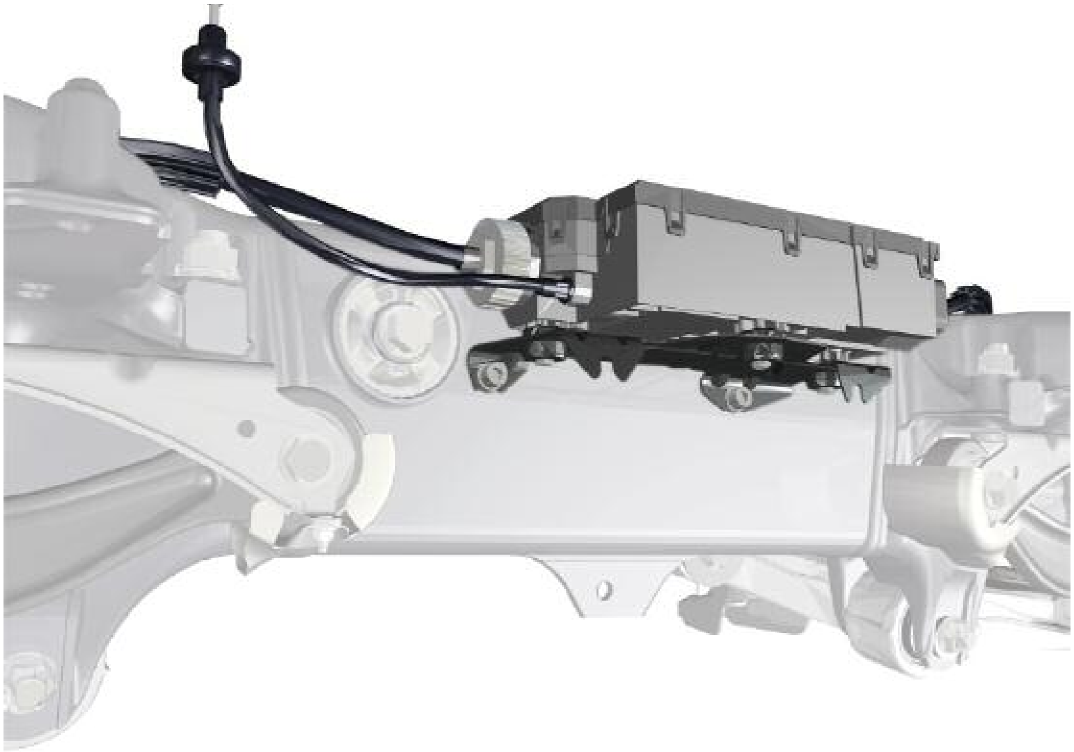
EMF actuator unit bracket and HSR actuator



Index	Explanation	Index	Explanation
1	Left brake cable	5	Bolt joining EMF actuator and HSR actuator brackets
2	Sleeve nut for left brake cable	6	HSR actuator bracket
3	Boss on rear suspension subframe	7	EMF actuator unit bracket
4	EMF actuator unit	8	Emergency release cable

On vehicles without Integrated Active Steering, the bracket for the EMF actuator unit is attached to the rear suspension subframe by the same two bolts.

EMF actuator unit bracket without HSR actuator



Index	Explanation	Index	Explanation
1	Bowden cable, emergency release	6	Bolt fixing EMF actuator to rear suspension subframe
2	Left brake cable	7	EMF actuator unit bracket
3	Sleeve nut for left brake cable	8	Rear suspension subframe
4	EMF actuating unit	9	Track rod
5	Bolt fixing EMF actuator to mounting bracket		

The bracket and the EMF actuator unit itself are also attached to one another by bolts. If replacement is necessary, both the bracket and the EMF actuator unit itself can be ordered as separate parts.

Controls

Parking Brake Button

The parking brake button supplies the EMF control unit with the button operation signal. The signal is duplicated on the parking brake button and transmitted to the EMF control unit via double direct wired connections. It not only enables the EMF control unit to distinguish between the resting position and the two directions of operation (release/apply). Faults can also be detected (e.g. broken circuit, short circuit). If such a fault is detected, the function of the parking brake can still be maintained in most cases.

Parking brake button with function indicator lamp

In contrast with the button on the E70/E71, the parking brake button on the F01/F02 has a function indicator lamp. It is an LED that tells the driver when the parking brake is on. The EMF control unit directly controls that LED.

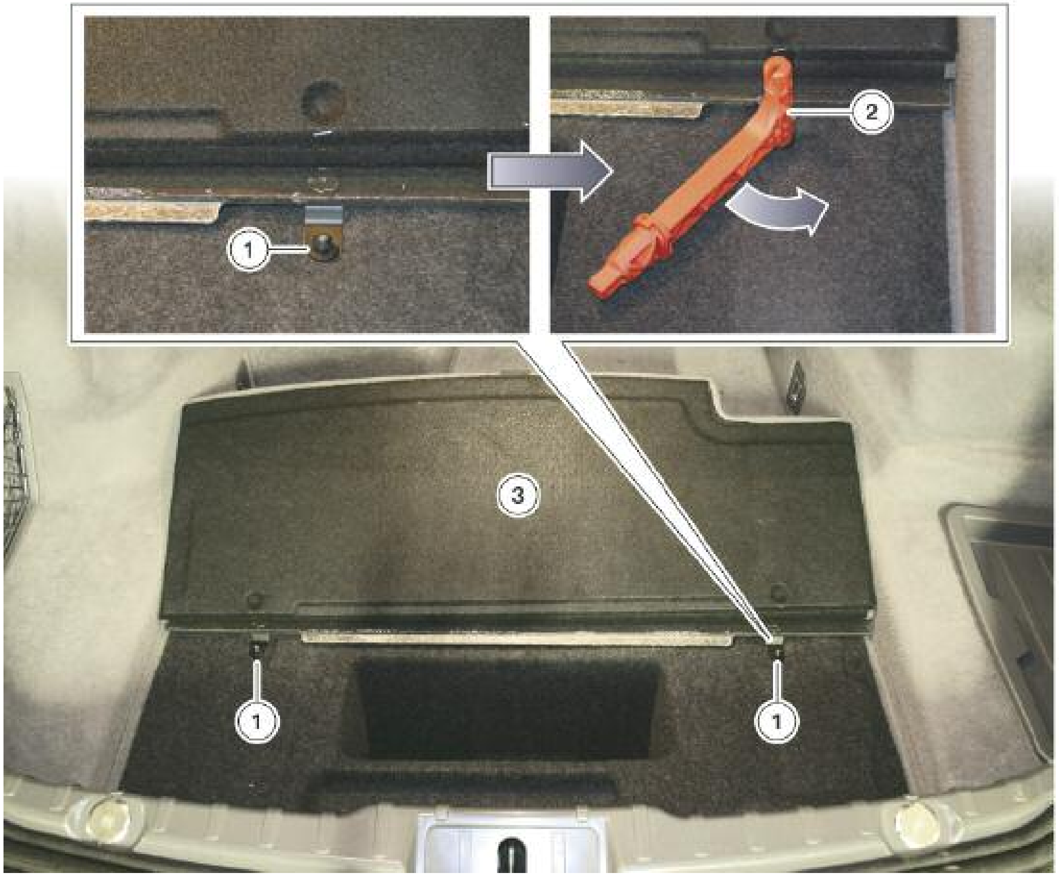
It is important to note that the button directly behind it for the Automatic Hold function is not wired to the EMF control unit but to the DSC control unit.

Emergency release

The cable for emergency release of the parking brake is accessible via the trunk.

However, the cable is located underneath the trunk floor trim, which on the F01/F02 can not be simply taken out.

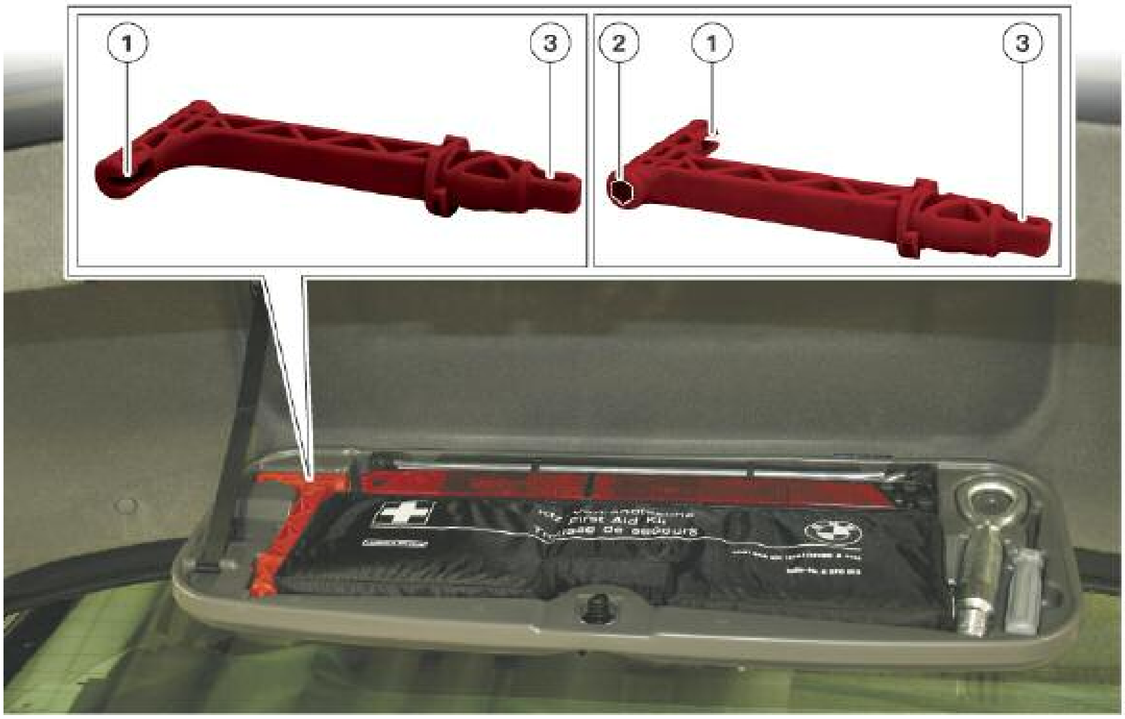
Removing trunk floor trim on F01/F02



Index	Explanation
1	Plastic nut (size 10mm)
2	Emergency release tool
3	Trunk floor trim

Under a flap there are two plastic nuts which fix be removed. The emergency release tool (red the trunk floor trim in place. Those nuts must T-shaped handle) incorporates a plastic first be undone before the trunk floor trim can socket for unscrewing the nuts.

Emergency release tool on F01/F02

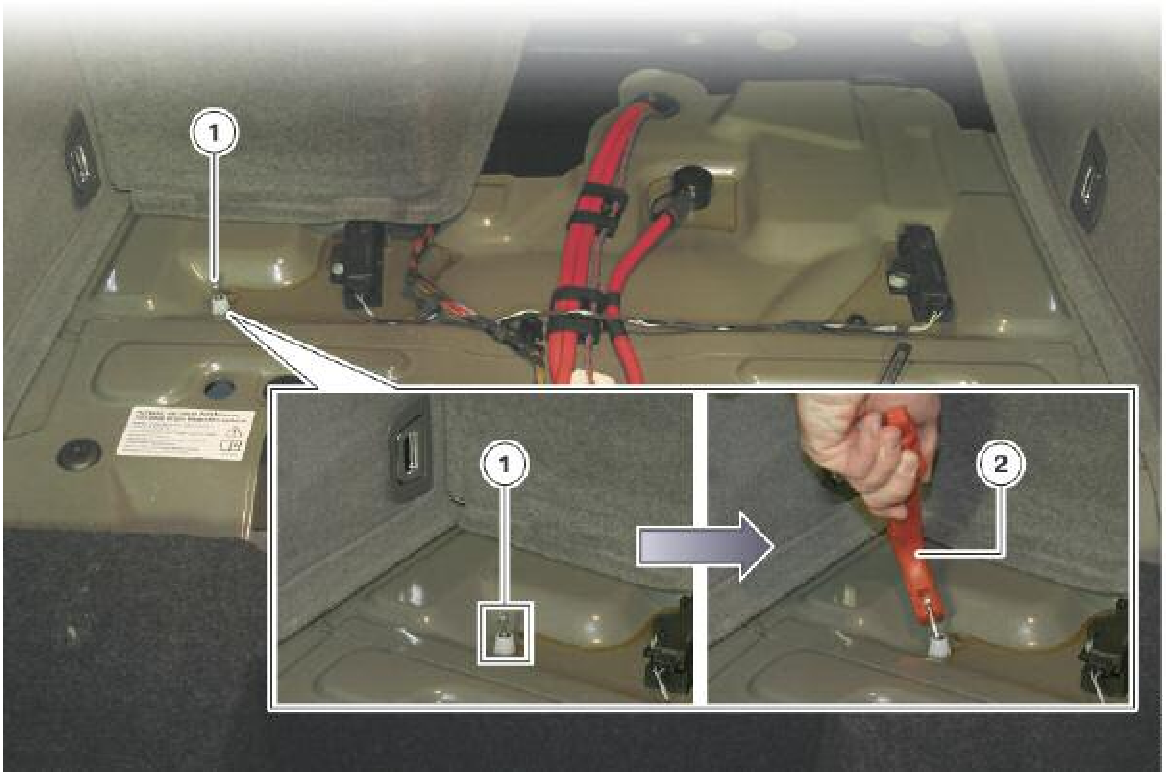


Index	Explanation
1	Slot for accepting the EMF emergency release cable
2	Socket (size 10mm) for unscrewing the plastic nuts on the trunk floor trim
3	Square key for releasing the automatic transmission parking lock

Once the trunk floor trim has been removed, the emergency release cable is directly accessible. The handle of the release tool is hooked onto the end of the emergency release cable by means of the slot provided.

Pulling the cable up operates the emergency release mechanism in the EMF actuator unit. There is a noticeable jolt when it releases. The cables to the two duo-servo parking brakes are then released from the force acting on them. The parking brake is thus released.

Emergency release of electromechanical parking brake on F01/F02



Index	Explanation
1	Bowden cable, emergency release (EMF)
2	Emergency release tool

Electromechanical Parking Brake (EMF)

■ General details

The electromechanical parking brake (EMF) is applied/released by means of the parking brake button on the center console control panel. The parking brake status is indicated by the function indicator lamp on the button and an indicator lamp on the instrument cluster.

Indication of "parking brake on"

The EMF can be applied in all logical terminal statuses (Terminal 0, Terminal R, Terminal 15, Terminal 50). The conditions for release of the EMF are: Terminal 15 active and brake pedal depressed or automatic transmission parking lock engaged.

■ Emergency release

The EMF can be released in an emergency by means of a cable. That cable is accessible through the trunk and is under the trunk floor trim. To effect emergency release of the EMF, the red T-shaped handle from the vehicle toolkit is required.

Note: Caution: Secure vehicle to prevent it rolling before operating the emergency release!

Note: After a power supply failure, it may still not be possible to move the vehicle even after releasing the brake with the emergency release facility. The automatic transmission parking lock may still be engaged.

In that case, the parking brake must first be released with the emergency release facility. Then the automatic transmission parking lock must be released using the emergency release facility. The appropriate tool must remain engaged in the parking lock emergency release for that purpose.

Note: When the parking brake is to be used again after an emergency release, it can only be done by pushing in the parking brake button. The familiar conditions for releasing the parking brake must also be met.

■ Installation mode

Note: Installation mode sets the EMF actuator unit to the installation position (brake cables extended to maximum). It also prevents the EMF being accidentally applied, e.g. when carrying out repairs.

Note: Installation mode can be cancelled either by means of a service function or by driving the car.

Running-in the brakes

While running-in the parking brakes, the EMF applies a defined force to the duo-servo parking brakes.

Note: The function for running-in the parking brakes only has t be carried out if:

- **the linings of the duo-servo parking brakes have been replaced or**
- **the rear brake discs have been replaced.**

Note: The precise procedure for running-in the parking brakes is described in the Repair Instructions under the heading "Adjusting the parking brake". The instructions given there must be followed exactly.

EMF actuating unit

The EMF actuator unit is made up of the following main components:

- EMF control unit
- Electric motor
- Gearbox
- Force sensor.

Note: In the event of a fault, the EMF actuator unit can only be replaced as a complete unit.

Note: The following are available as separate parts:

- **the EMF actuator unit itself**
- **the bracket for the EMF actuator unit and**
- **the cables.**

Note: The EMF control unit detects vehicle standstill on the basis of the following signals:

- **Road speed (from ICM)**
- **Rear axle speed (from DME)**
- **Wheel-speed signal "DFA_EMF" (from DSC).**

Only when those three signals definitively indicate vehicle standstill does the EMF control unit allow operation of the actuator unit.

Note: The EMF control unit is connected to the PT-CAN. Integrated in the EMF control unit is a terminal resistor for the PT-CAN.

Note: The EMF control unit is connected to the wake-up line.

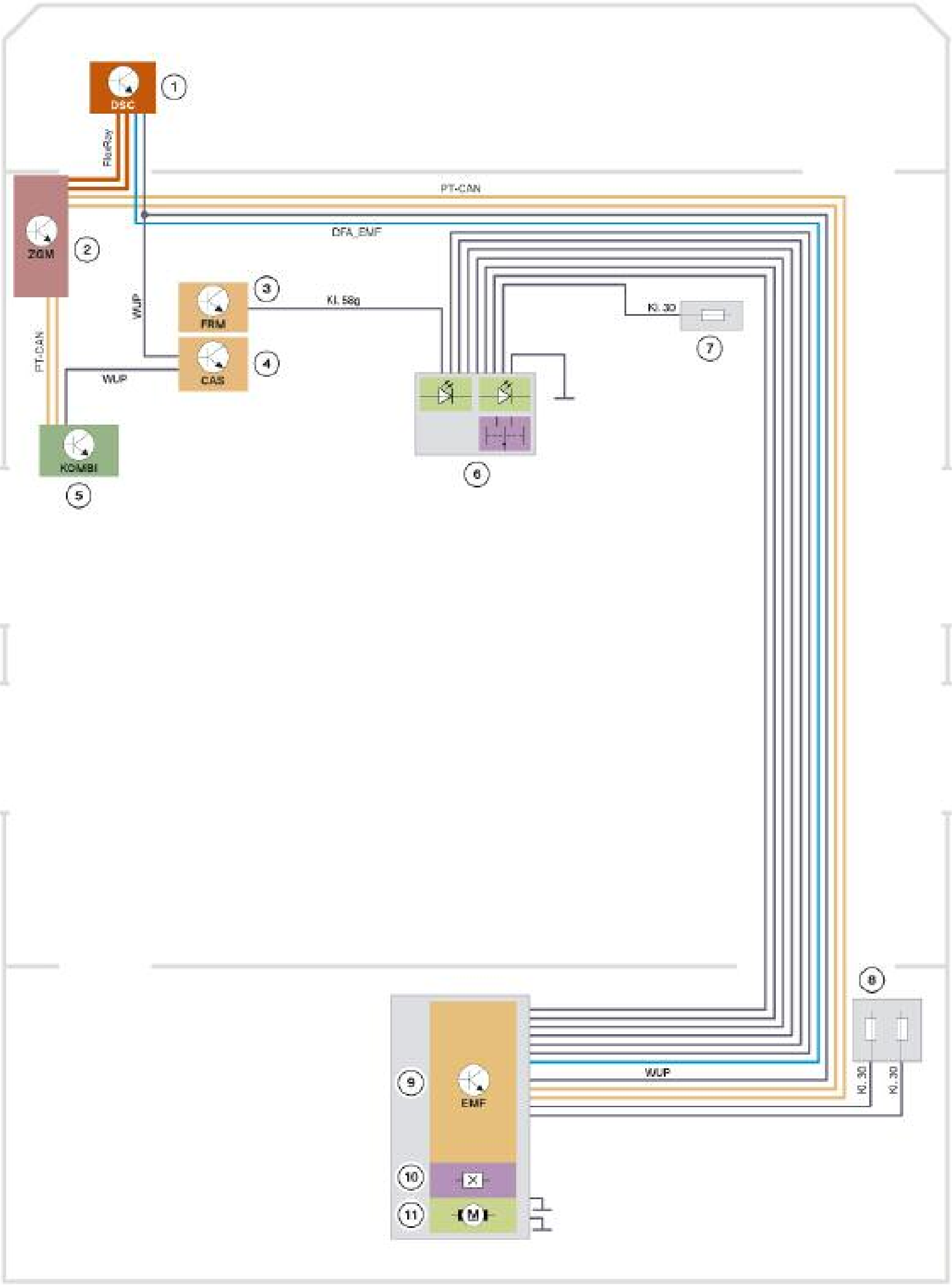
If the driver operates the parking brake button at Terminal 0, the EMF control unit is woken up. The EMF control unit in turn wakes up the other control units on the vehicle via the wake-up line.

Note: On vehicles with the Integrated Active Steering optional extra, the bracket for the EMF actuator unit is bolted to the bracket for the HSR actuator.

On vehicles without Integrated Active Steering, the bracket for the EMF actuator unit is bolted to the rear suspension subframe.

System Circuit Diagram

Electromechanical Parking Brake



Index	Explanation
1	Dynamic Stability Control
2	Central Gateway Module
3	Footwell module
4	Car Access System
5	Instrument cluster
6	Parking brake button with function indicator and illumination
7	Fuse for parking brake button (front fuse board, junction box electronics)
8	Fuses for EMF electronics and electric motor (rear fuse board in trunk)
9	EMF control unit
10	EMF force sensor
11	EMF electric motor

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Lateral Dynamics Systems

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the operation new Integrated Active Steering
- Locate and identify components of the Integrated Active Steering
- Understand the interaction of IAL with Integrated Chassis Management

Introduction

BMW Steering Systems - Innovative and technically always something special!

Since the introduction of the first EPS electric power steering system on the E85 in 2002, the variety of technical innovations on steering systems has rapidly expanded. Before then the following systems were used:

- Hydraulic power steering
- Speed-sensitive power steering (Servotronic)

The next major step with steering systems then came with the E60 and the revolutionary Active Steering system, which not only had the Servotronic function but also incorporated speed-sensitive modulation of the steering angle.

BMW also improved the electric power steering (EPS) system and used it in a variety of forms.

The main difference between hydraulic and electric power steering is in the method of generating the power assistance force that reduces the amount of force that the driver has to apply to the steering wheel.

In order to further inventively optimize the advantages of Active Steering on the new 7 Series, **Integrated Active Steering** has now been developed and is described in this document.

Current BMW Steering Systems

Model Series	Standard steering systems	Optional steering systems
1-Series (E8X)	Hydraulic power steering	Active Steering
3-Series (E9X)	Servotronic	Active Steering
5-Series (E60)	Servotronic	Active Steering
6-Series (E63/E64)	Servotronic	Active Steering
7-Series (E65/E66)	Servotronic	N/A
X3 (E83)	Hydraulic power steering	Servotronic
X5/X6 (E70/E71)	Hydraulic power steering	Active Steering
Z4 (E85/E86)	C-EPS	N/A
Z4M (E85/E86)	Hydraulic power steering	N/A

EPS = Electric Power Steering
C-EPS = Column mounted EPS

System Overview

Integrated Active Steering

General Details

Integrated Active Steering is an innovative and logical development of the Active Steering system developed by BMW.

With Active Steering, a steering angle amplification factor reduces the steering effort on the part of the driver and combines the capabilities of “steer by wire” systems with authentic steering feedback.

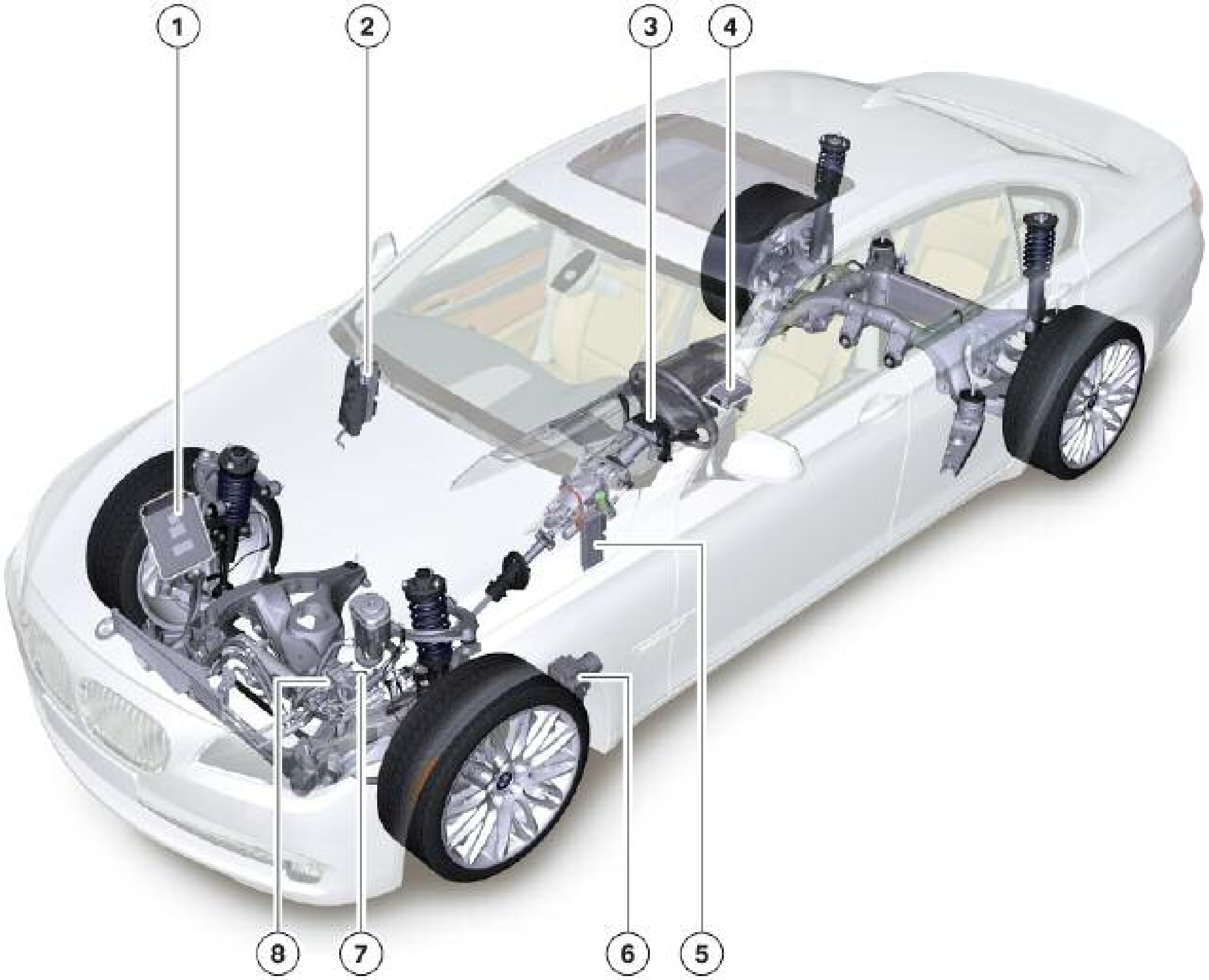
By intervening in the steering independently of the driver’s actions, it is also able to perform a stabilizing function in terms of vehicle handling.

In order to move further ahead in terms of handling dynamics, the familiar Active Steering has now been logically extended by the addition of active rear-wheel steering on the new BMW 7 Series.

Active Steering of the rear wheels is a logical extension of Active Steering and the two are now combined as an all-in one system referred to as Integrated Active Steering.

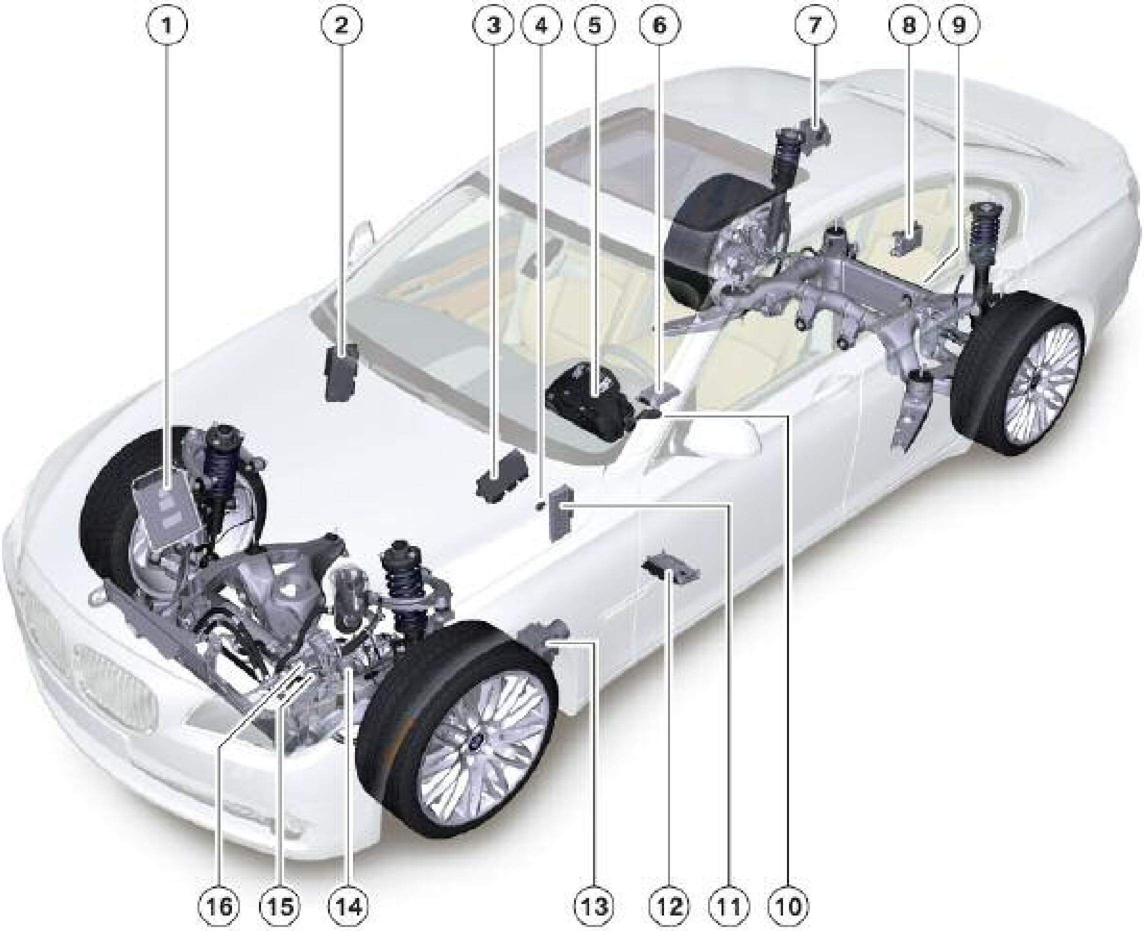
Integrated Active Steering is available as an option on the F01/F02 because the standard steering system is the Servotronic.

Components of Servotronic Steering (standard)



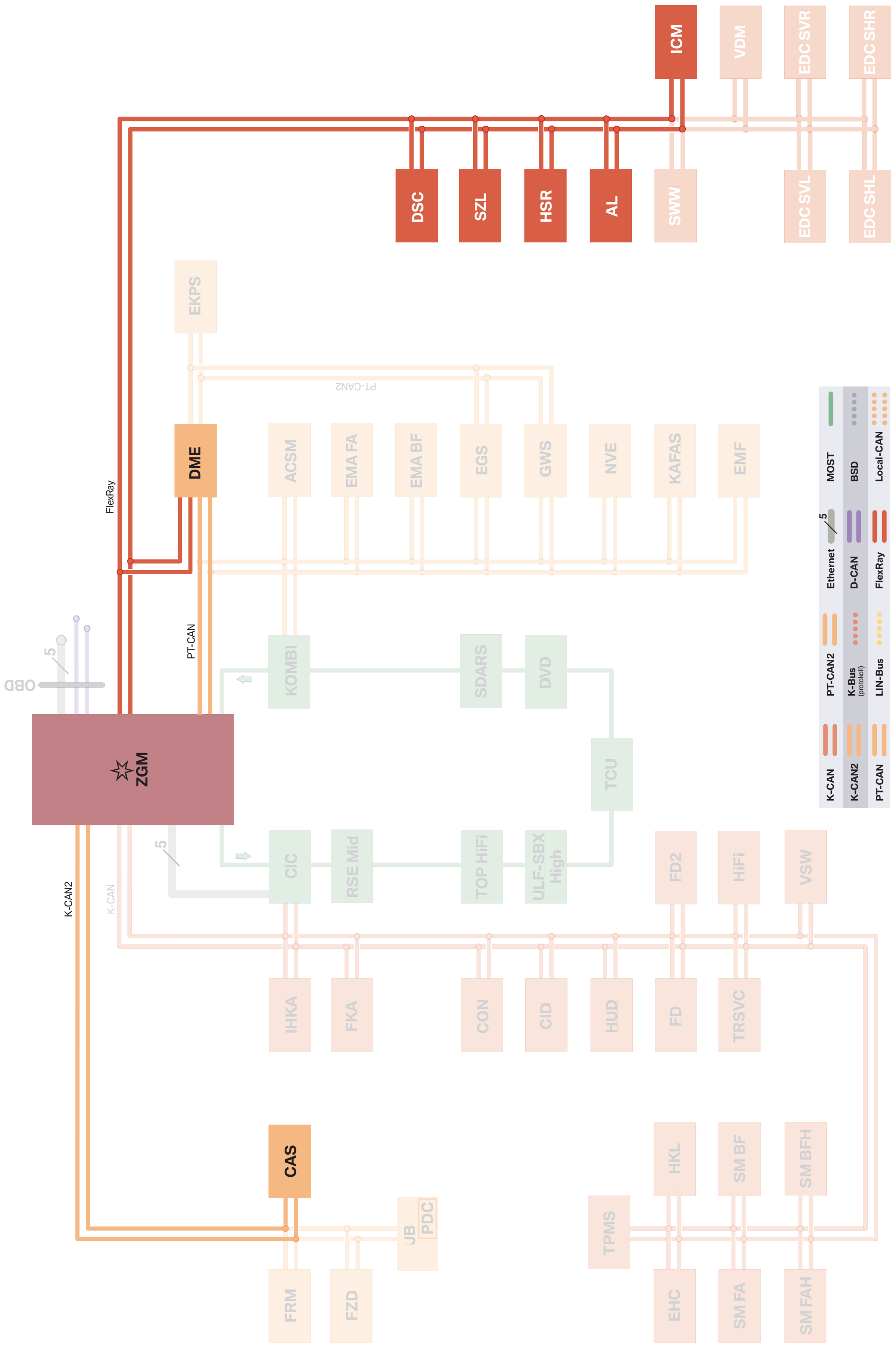
Index	Explanation	Index	Explanation
1	DME	5	ZGM
2	Front power distribution box	6	DSC
3	SZL	7	Servotronic valve
4	ICM	8	Electronic volumetric flow control (EVV) valve

Components of Integrated Active Steering



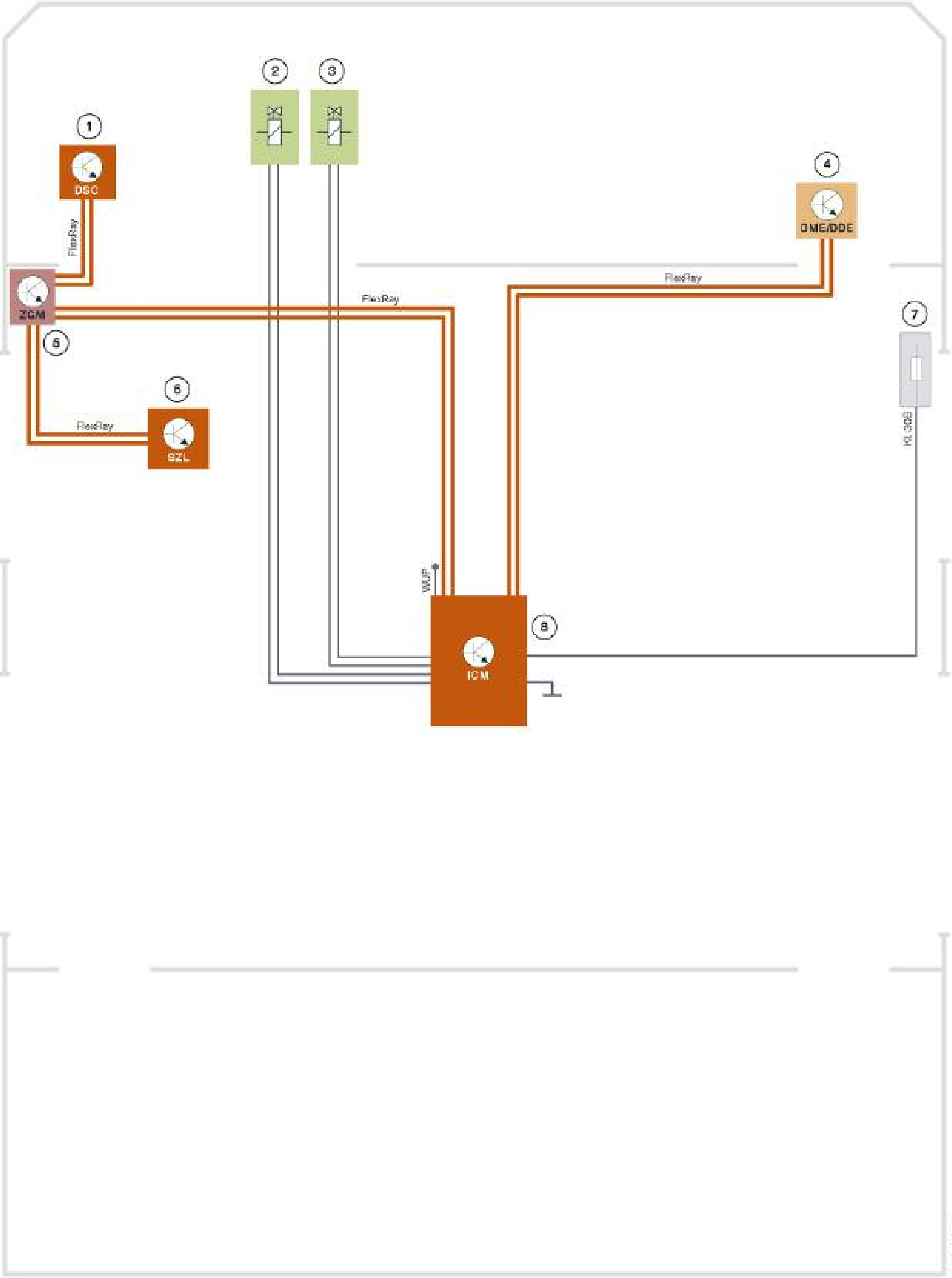
Index	Explanation	Index	Explanation
1	DME	9	Rear-wheel steering actuator (HSR)
2	Front power distribution box	10	SZL
3	CAS	11	ZGM
4	Brake light switch	12	Active Steering actuator control unit
5	Instrument cluster	13	DSC
6	Integrated Chassis Management (ICM)	14	Active Steering actuator motor with motor angular position sensor and lock
7	Rear power distribution box	15	Electronic volumetric flow control (EVV) valve
8	HSR control unit	16	Servotronic valve

Bus Diagram for Lateral Dynamics Systems



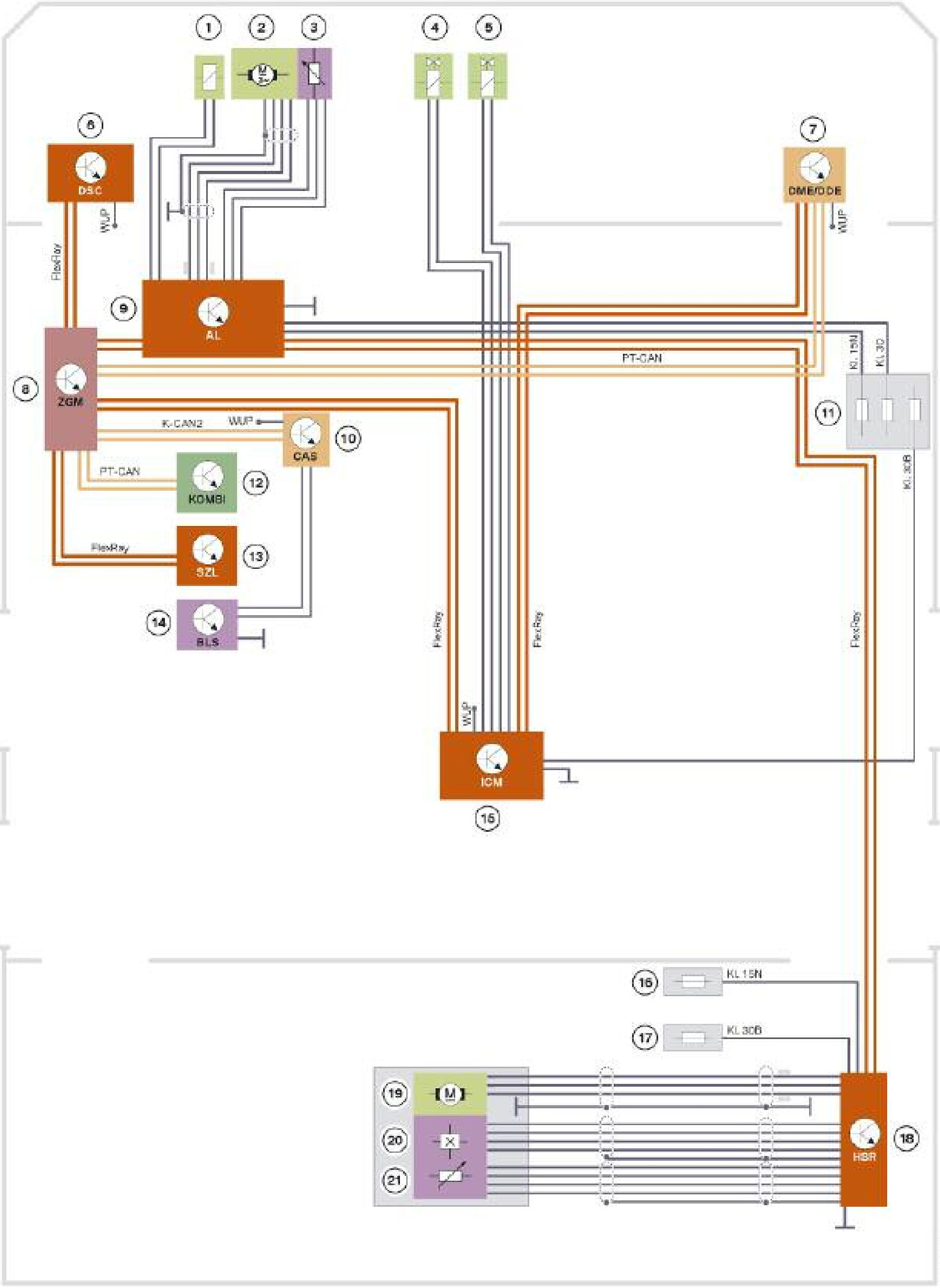
Index	Explanation	Index	Explanation
CAS	Car Access System	SZL	Steering column switch cluster
ZGM	Central Gateway Module	HSR	Rear-wheel steering control unit
DME	Digital Motor Electronics	AL	Active Steering
DSC	Dynamic stability control	ICM	Integrated Chassis Management

System Circuit Diagram for Servotronic System



Index	Explanation	Index	Explanation
1	Dynamic stability control	5	Central Gateway Module
2	Electronic volumetric flow control (EVV) valve	6	Steering column switch cluster
3	Servotronic valve	7	Front power distribution box
4	Digital Motor Electronics	8	Integrated Chassis Management

System Circuit Diagram for Integrated Active Steering



Index	Explanation	Index	Explanation
1	Active Steering lock	12	Instrument cluster
2	Active Steering electric motor	13	Steering column switch cluster
3	Active Steering motor angular position sensor	14	Brake light switch
4	Electronic volumetric flow control (EVV) valve	15	Integrated Chassis Management
5	Servotronic valve	16	Right rear power distribution box
6	Dynamic stability control	17	Battery power distribution box
7	Digital Motor Electronics	18	Rear suspension slip angle control
8	Central Gateway Module	19	HSR electric motor
9	Active Steering	20	Hall-effect sensor
10	Car Access System	21	Track-rod position sensor
11	Front power distribution box		

Functions

Steering Systems

Implementation of the Integrated Active Steering function has essentially been made possible by the new ICM system complex on the F01/F02.

The Servotronic function including valve control is also taken over by the ICM control unit. That steering control function is also influenced by the Driving Dynamics Control function.

Advantages of Integrated Active Steering:

- Extension of Active Steering (AL) by the addition of rear-wheel steering (HSR)
- Variable steering-gear ratio (steering angle amplification factor)
- Independent control of rear-wheel steering angle (steer by wire)
- Servotronic
- Handling stabilization functions
- Reduction of braking distance under split surface braking conditions.

Supply of Signals

■ Signals from external sensors

The ICM control unit reads the following signals that are essential to the Integrated Active Steering from external sensors:

- Four wheel-speed signals sent via Flexray by the DSC
- Steering angle sent via Flexray by steering column switch cluster
- Status of AL and HSR actuators transmitted via Flexray.

However, because the rear-wheels are steerable, the steering angle of the front wheels alone is not definitive for dynamic handling control purposes. Therefore, the ICM control unit also takes the steering angle of the rear wheels into account. Ultimately, the effective steering angle is calculated from the two steering angles (front and rear wheels). The effective steering angle indicates the angle to which the front wheels would have to be turned to bring about the same vehicle response without steerable rear wheels. That variable is the easiest for all vehicle systems to use to analyse the steering action.

Control and Modulation of Steering

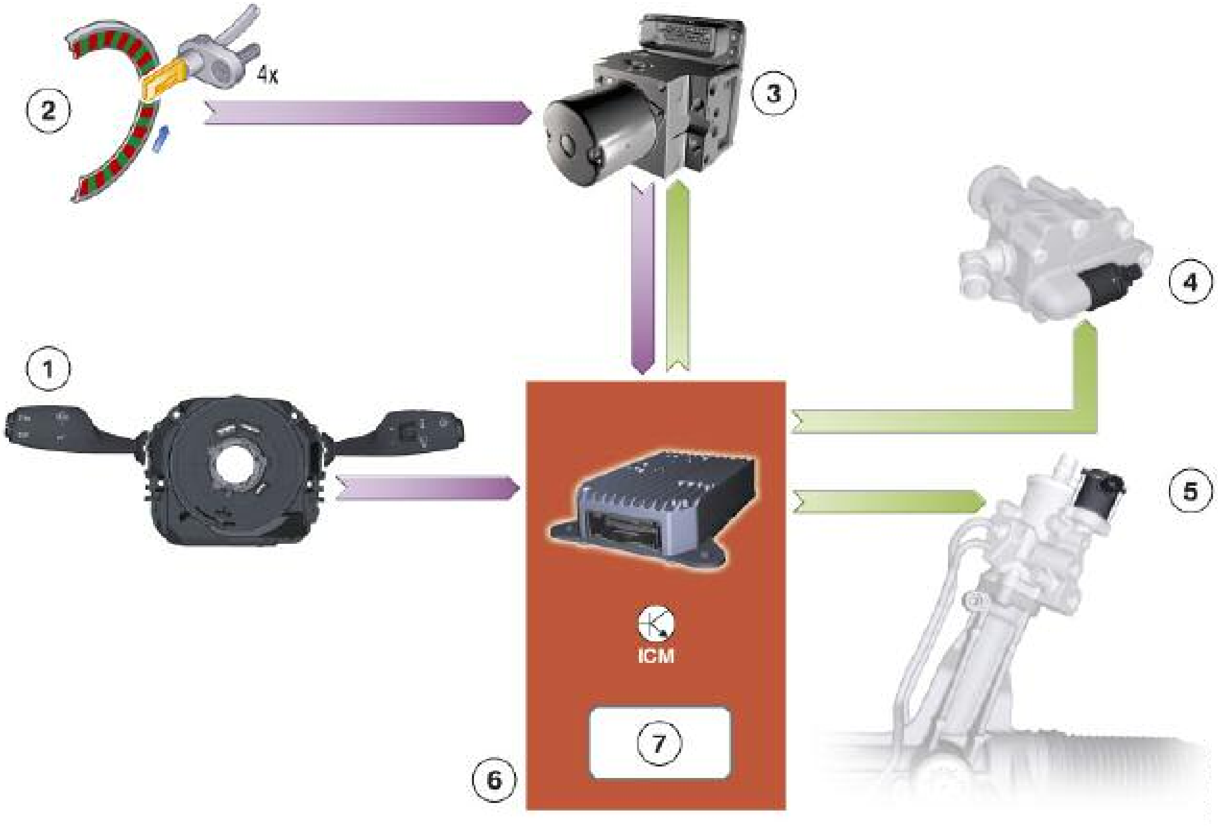
Both the basic steering system and the optional Integrated Active Steering on the F01/F02 incorporate the **Servotronic** function. That speed-sensitive power assistance function is effected by way of the Servotronic valve on the steering gear.

The Servotronic valve is always controlled by the ICM control unit regardless of the equipment options fitted. Accordingly, the Servotronic function algorithm is stored on the ICM control unit.

Similarly regardless of equipment options, the steering system also always incorporates a proportional control valve which is controlled by the ICM control unit. With the aid of that valve, the power steering pump's volumetric flow rate can be electronically adjusted. For that reason it is also referred to as the **"electronic volumetric flow control"** valve (EVV valve).

That valve too is controlled by the ICM control unit. Depending on the degree of power assistance demanded at the time, the volumetric flow rate delivered by the power steering pump is split between the steering valve and a bypass circuit. The ratio of that split can be infinitely varied. The less power assistance is required, the more hydraulic fluid is diverted into the bypass circuit. As the hydraulic fluid does not have to do any work in the bypass circuit, less power is required to drive the power steering pump. Consequently, the proportional control valve helps to **reduce** fuel consumption and **CO_2 emissions**.

Inputs/outputs: control of steering by ICM



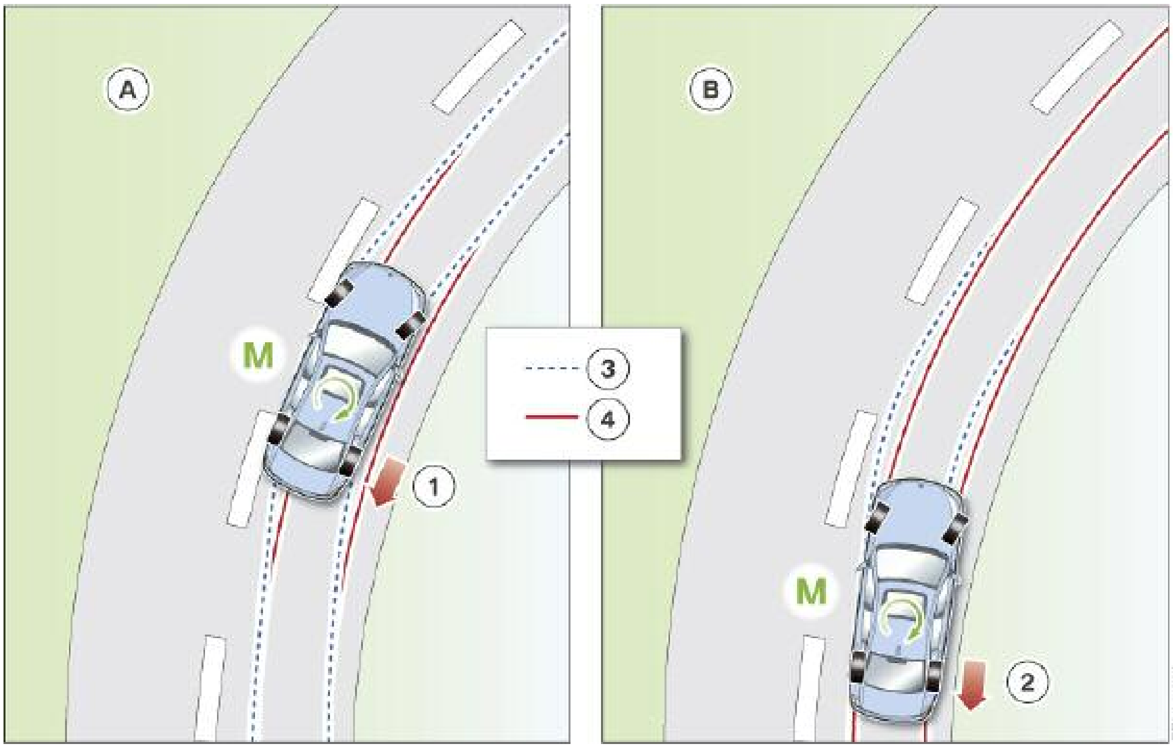
Index	Explanation	Index	Explanation
1	Steering column switch cluster	5	Servotronic valve
2	Wheel speed sensor	6	Integrated Chassis Management
3	Dynamic stability control	7	"Steering control" function on ICM
4	Electronic volumetric flow control (EVV) valve		

Higher-level Dynamic Handling Control

Centralized Dynamic Handling Control

The interventions by the dynamic handling control systems are performed with the aim of improving agility and traction. Quite obviously, they also re-stabilize the vehicle when required. On previous vehicles the various functions were performed by a number of discrete systems which, although they communicated with one another, nevertheless had strictly defined limits to their spheres of operation. Accordingly, the interaction of all systems which ultimately determines the overall handling response, was difficult to harmonize.

Influence on handling characteristics by dynamic handling control system



Index	Explanation
A	Correction of unstable handling
B	Early intervention to bring about neutral handling
1	Individual modulation of brakes to correct understeer
2	Individual modulation of brakes to prevent understeer
3	Course of an understeering vehicle
4	Course of a vehicle with neutral handling
M	Yaw force acting on the vehicle as a result of individual modulation of brakes

The Integrated Chassis Management system on the F01/F02 employs centralized dynamic handling control. It compares the vehicle response desired by the driver with the actual motion of the vehicle at that moment. By so doing, it is able to determine whether and in what way intervention in the dynamic handling systems is required.

The output variable of the centralized dynamic handling control system is a yaw force. It brings about a yawing motion on the part of the vehicle that is superimposed over the existing movement of the vehicle. In that way, the behavior of the vehicle can be “corrected” if a difference from what is desired by the driver is detected. The classic examples of that are vehicle understeer or oversteer.

A new feature of the ICM on the F01/F02, however, is that the dynamic handling systems are brought into action even before such a discrepancy is detected. Thus, the interventions by the dynamic handling systems take place long before the vehicle becomes unstable. As a result, the vehicle feels much better balanced than would be achievable with a conventional suspension and steering set-up. The vehicle displays neutral handling characteristics in many more situations and does not even begin to under or oversteer. This new function is made possible by very precise computation models and new control strategies by which the handling characteristics can be assessed and influenced.

Co-ordinated Intervention by the Dynamic Handling Systems

The possibilities for intervention available in the past (and, of course, still available now) in order to generate the required yaw force calculated by the central dynamic handling controller are listed below. In brackets in each case are the dynamic handling systems concerned.

- Modulation of individual brakes (DSC)
- Adjustment of engine torque (ASC+T, DSC, MSR)
- Adjustment of front-wheel steering angle independently of driver input (Active Steering).

Subordinate to the centralized dynamic handling control system is an "actuator coordination" function. It decides which dynamic handling system can be used to produce the yaw force in the particular situation concerned.

For example, if the vehicle is exhibiting significant understeer, it can be counteracted by controlled braking of the rear wheel on the inside of the bend. If the vehicle has Integrated Active Steering, the same effect can be brought about even more harmoniously by steering the rear wheels to an appropriate degree.

As both means of intervention are limited in their degree, it can also be useful to use them both simultaneously. Avoidance of understeer is noticeable to the driver in the shape of a significant gain in agility.

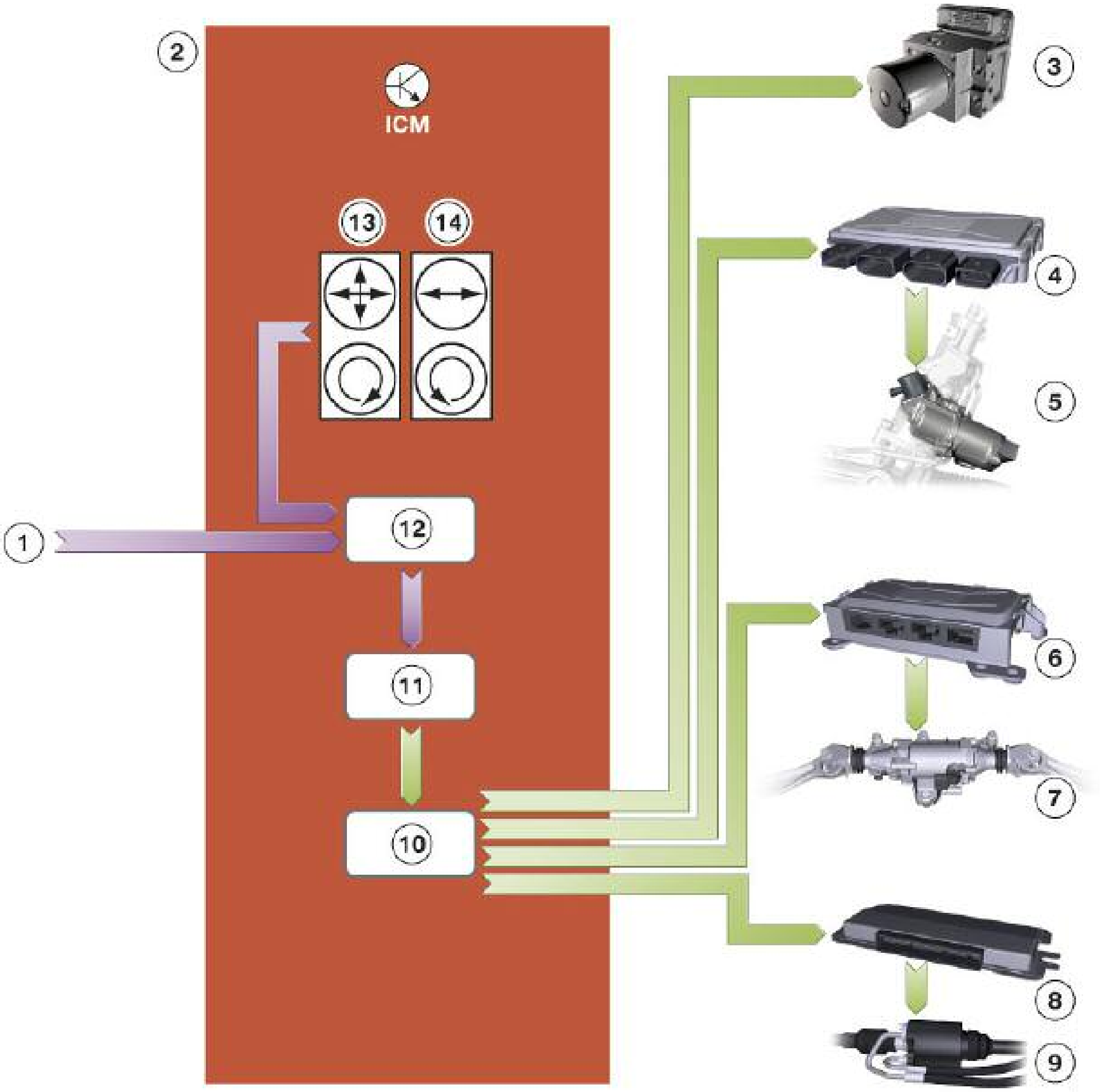
The F01/F02 is also the first model on which there is true functional networking between the Integrated Chassis Management and vertical dynamics management functions. But that doesn't simply mean that the ICM registers the ride height data, processes it and passes to the VDM.

An integral component of the dynamic handling control system is that the ICM also actively initiates the Dynamic Drive function in order to affect the self-steering characteristics. As is familiar from conventional suspension and steering designs, a stiffer anti-roll bar results in a lower achievable overall lateral friction force at the pair of wheels concerned. The actuator motors in the Dynamic Drive anti-roll bars can be used to simulate the effect of stiffer and more flexible anti-roll bars.

Thus the ICM centralized dynamic handling control system can use the Dynamic Drive's active anti-roll bars to selectively control the available lateral friction force at a pair of wheels. If the vehicle is oversteering, that means there is too little lateral friction force on the rear wheels. In that case, it is better to reduce the roll limiting force on the rear suspension. In return, there is a gain in lateral friction force on the rear wheels which helps to stabilize the vehicle.

The input/output diagram on the following page summarizes the effect of the centralized dynamic handling control functions on the ICM control unit.

Centralized dynamic handling control on ICM

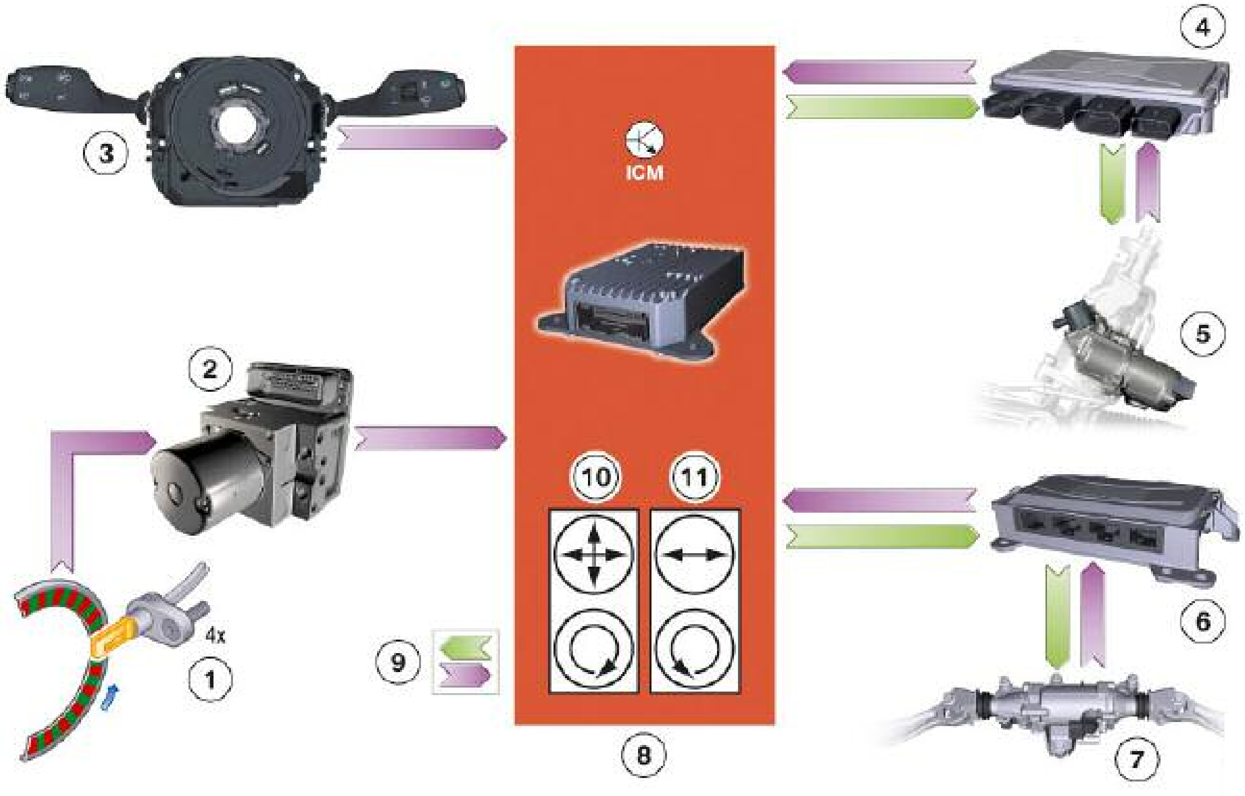


Index	Explanation	Index	Explanation
1	Input signals from external sensors	8	VDM control unit
2	Integrated Chassis Management (ICM)	9	Active stabilizer bar
3	Dynamic stability control	10	"Actuator co-ordination" function on ICM
4	Active Steering control unit	11	"Centralized dynamic handling control" function
5	AS actuating unit	12	"Sensor signal processing" function
6	HSR control unit	13	Integrated DSC sensor (combined linear acceleration, lateral acceleration and yaw rate sensor)
7	HSR actuator unit	14	Integrated DSC sensor (additional combined lateral acceleration and yaw rate sensor)

Distributed Functions: ICM and Actuator Control Units

The distribution of functions between the ICM and the other dynamic handling control units in the case of Integrated Active Steering is described below.

ICM and actuator control units AL and HSR



Index	Explanation	Index	Explanation
1	Wheel speed sensors	7	HSR actuator unit
2	Dynamic stability control	8	Integrated Chassis Management (ICM)
3	Steering column switch cluster with steering-angle sensor	9	Other input and output signals*
4	Active Steering control unit	10	Integrated DSC sensor (combined linear acceleration, lateral acceleration and yaw rate sensor)
5	AS actuating unit	11	Integrated DSC sensor (additional combined lateral acceleration and yaw rate sensor)
6	HSR control unit		

* Instrument cluster failure BLS-CAS braking DME engine torque increase.

The Integrated Chassis Management is the control unit which computes the higher-level dynamic handling control functions for the Integrated Active Steering.

From the current vehicle handling status and the desired course indicated by the driver, the Integrated Chassis Management calculates individual settings for the variable steering-gear ratio and the superimposed yaw rate. Once they have been prioritized, the ICM provides a required setting in each case for the AL and HSR control units. The setting specified is a required steering angle to be applied to the front and rear wheels respectively.

The AL control unit receives the required setting and has the main job of controlling the actuators so as to correctly apply the specified setting. Thus the AL Active Steering control unit is purely an actuator control unit. The same applies to the HSR control unit. It too is an actuator control unit. Like the AL control unit, it is responsible only for implementing the required steering angle specified by the ICM.

With the introduction of the ICM on the E71, this type of function distribution was used for the first time. On the F01/F02, it has been expanded to the extent that

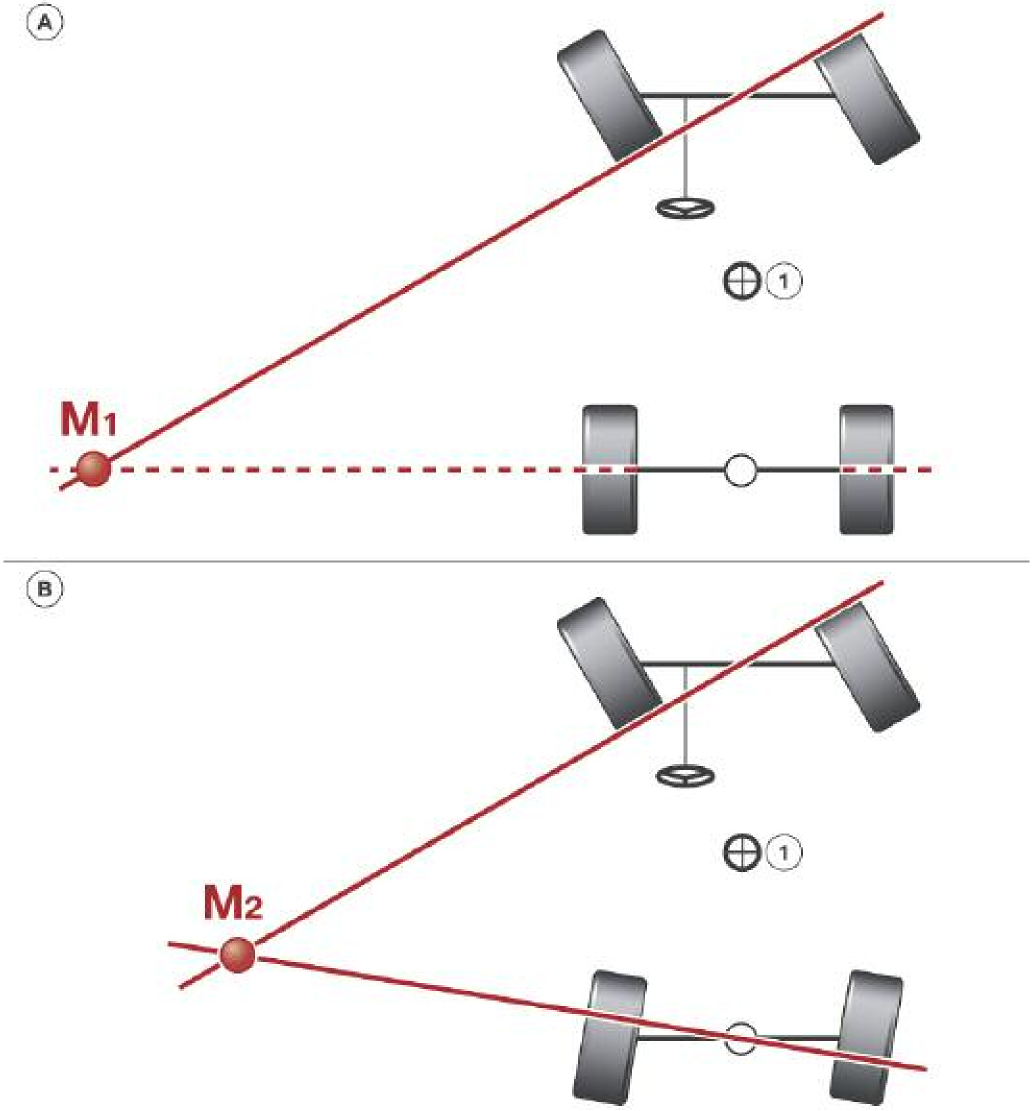
- the ICM now controls all linear and lateral dynamics systems (AL, HSR and also DSC) and
- the ICM is the master control unit both for linear dynamics and unstable handling situations.

The interface between the Integrated Chassis Management and the Dynamic Stability Control (DSC) represents a special case.

Functional Areas of Integrated Active Steering

Low Speed Range

The variable steering-gear ratio of the Active Steering component reduces steering effort to approximately 2 turns of the steering wheel from lock to lock. In the low speed range up to approximately 37 mph, the variable steering-gear ratio for the front wheels is combined with a degree of opposite rear-wheel steer. The effect is to increase vehicle agility.

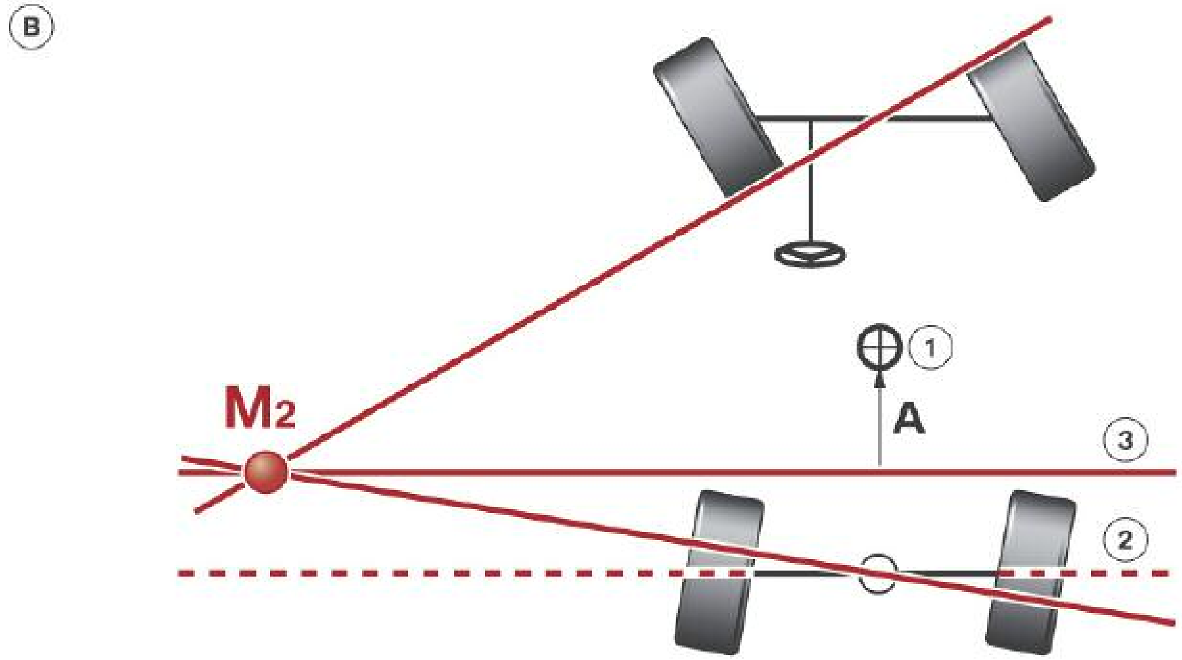


Index	Explanation	Index	Explanation
A	Conventional steering system	M2	Momentary axis 2
B	Integrated Active Steering	1	Center of vehicle
M1	Momentary axis 1		

When the steering wheels of a vehicle are turned, it follows a curved path around what is called the momentary axis “M”.

In the case of conventional vehicles, that momentary axis is positioned at a point along the extension of a line passing through the center of the rear wheels.

Active Steering intervention turns the rear wheels in the opposite direction at speeds up approximately 37 mph.



Index	Explanation	Index	Explanation
A	Effective wheelbase reduction	1	Center of vehicle
B	Integrated Active Steering	2	Straight line through Center of rear wheels
M2	Momentary axis 2	3	Axis of rotation closer to center of vehicle

The consequence of the rear-wheel steering intervention is that the axis of rotation moves closer to the center of the vehicle with the same amount of steering effort.

In terms of agility and dynamic handling, that is equivalent to a vehicle with a shorter wheelbase.

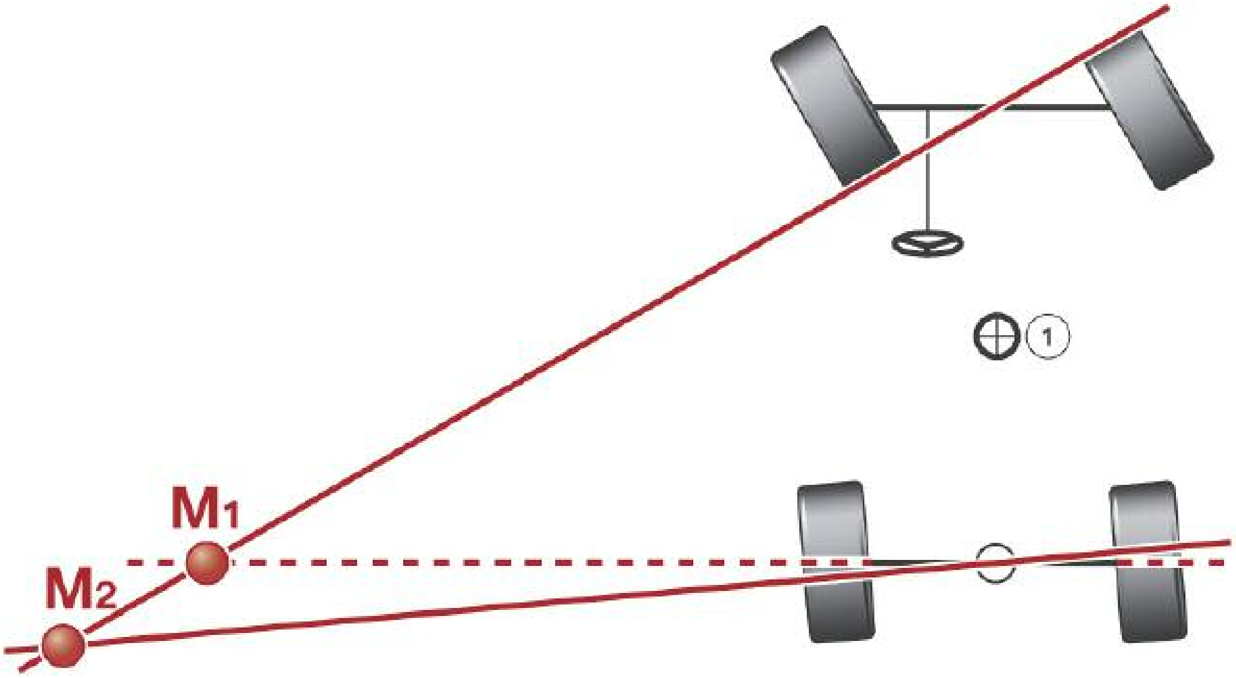
High Speed Range

As the vehicle speed increases, the degree of steering angle amplification by the Active Steering component is reduced. The steering-gear ratio becomes less direct.

At the same time, the steering strategy adopted by the Integrated Active Steering changes. Whereas, at low speeds, the rear wheels are steered in the opposite direction to the front wheels, at higher speeds the rear wheels are steered in the same direction as the front.

The momentary axis moves further back, equivalent to a vehicle with a longer wheelbase, producing more stable straight-line handling. The radius of the curve becomes longer.

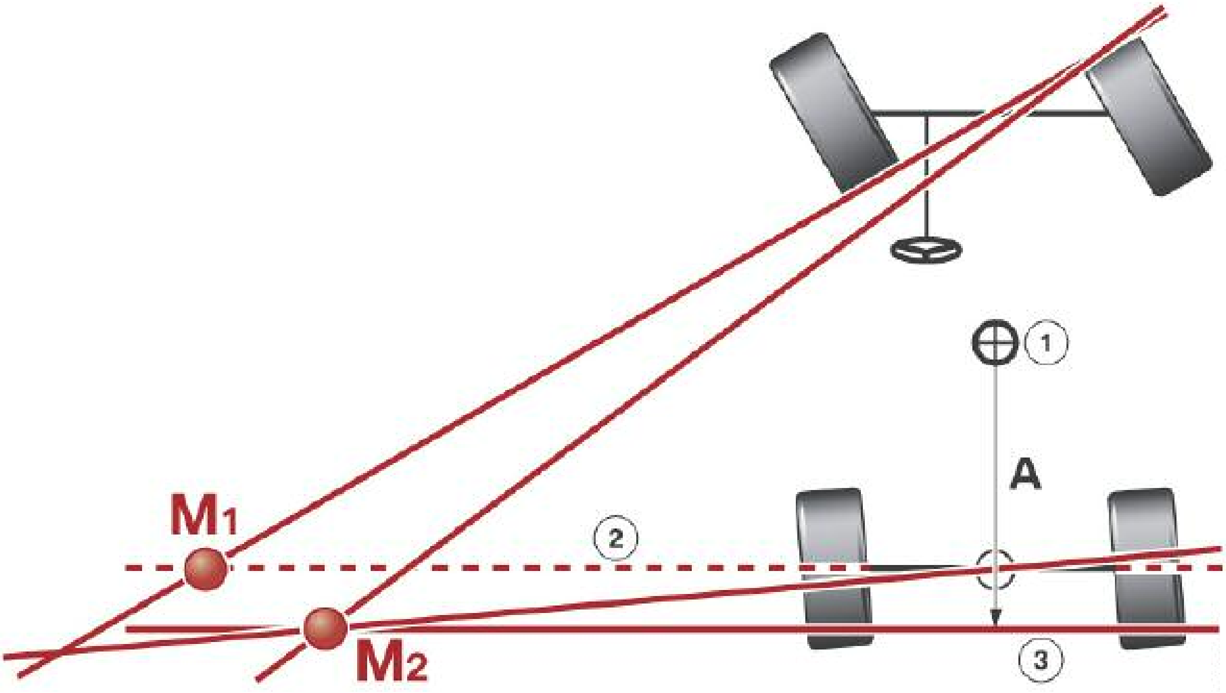
By the combination with the Active Steering, an additional amount is added to the steering angle of the front wheels so that the radius of the curve and the required amount of steering lock remain at the familiar level.



Index	Explanation	Index	Explanation
M1	Momentary axis 1	1	Center of vehicle
M2	Momentary axis 2		

All in all, co-ordination of the steering interventions at front and rear makes lane changes and steering maneuvers considerably easier to negotiate without sacrificing agility or balance.

Combination of the Active Steering with the new rear-wheel steering system offers benefits for the driver at all speeds.



Index	Explanation	Index	Explanation
M1	Momentary axis 1	1	Center of vehicle
M2	Momentary axis 2	2	Straight line through center of rear wheels
A	Effective wheelbase increase	3	Axis of rotation further from center of vehicle

Handling Stabilization by Integrated Active Steering When Understeering

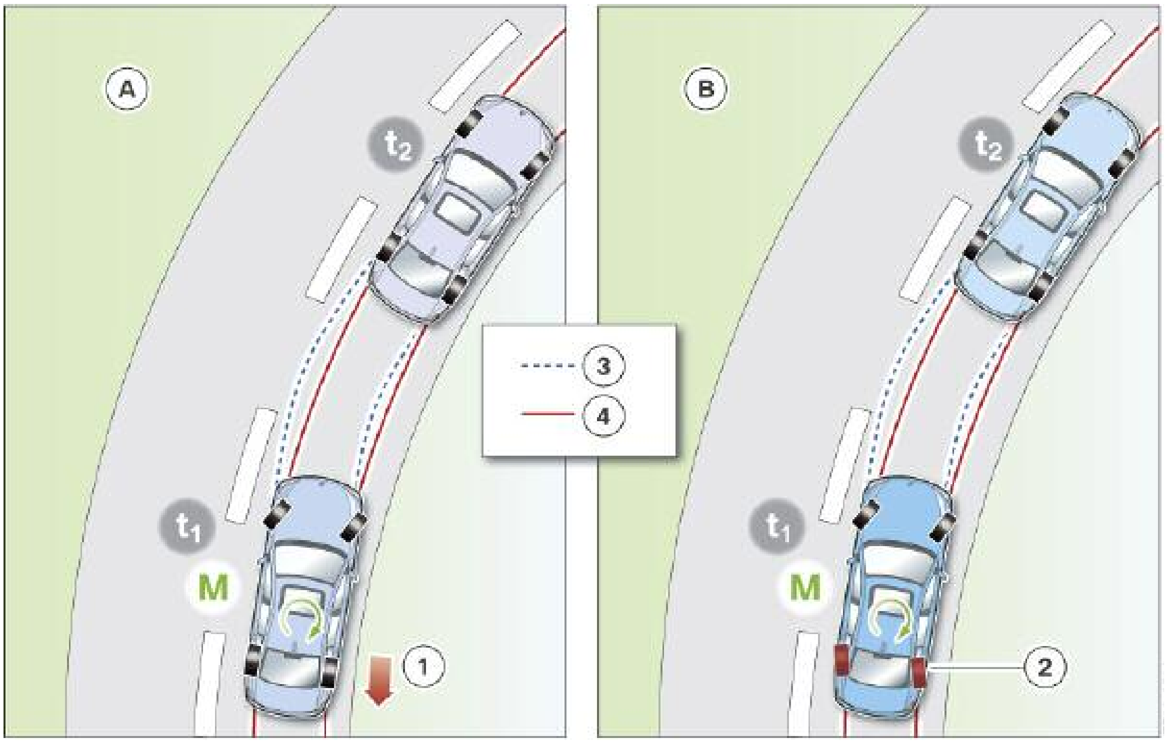
When changing lanes quickly, all vehicles have a tendency to produce a significant yaw response and can sometimes start to oversteer.

If the ICM dynamic handling controller detects a difference between the response desired by the driver and the reaction of the vehicle, it initiates co-ordinated steering interventions on the front and rear wheels. The speed of the stabilizing intervention is such that it is hardly discernible by the driver.

Braking interventions by the DSC, which have a decelerating effect, can be largely dispensed with.

The end result is that the vehicle is more stable and more effectively damped.

Possible dynamic handling interventions when understeering



Index	Explanation
A	Prevention of understeer by individual brake modulation (DSC)
B	Prevention of understeer by rear-wheel steering intervention (IAL)
1	Individual brake modulation (DSC)
2	Rear-wheel steering intervention (IAL)
3	Course of an understeering vehicle
4	Course of a vehicle with neutral handling
M	Yaw force acting on the vehicle as a result of dynamic handling system intervention

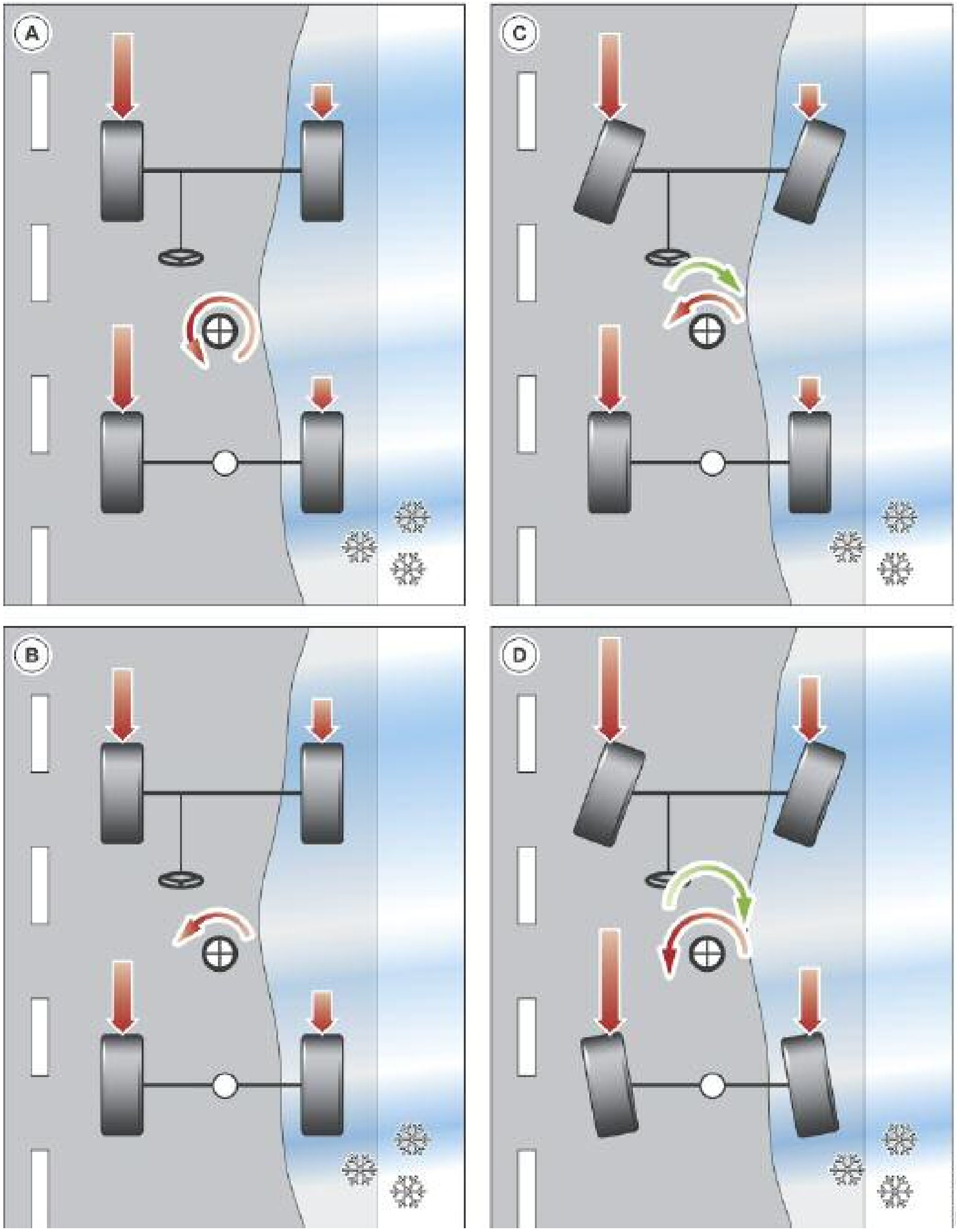
If the driver underestimates how sharp a bend is when driving quickly on a country road, he/ she can be caught out by sudden understeer.

By virtue of its inherent features, Active Steering was only able to react to vehicle oversteer.

Integrated Active Steering incorporating active rear-wheel steering is now also able to make corrective interventions when the vehicle is oversteering and thus further increases active safety.

Handling Stabilization by Integrated Active Steering Under Split Surface Braking Conditions

Hard braking on road surfaces which provide less grip for the wheels on one side of the vehicle than on the other causes the vehicle to yaw towards the side with more grip.



Index	Explanation	Index	Explanation
A	Vehicle without DSC	C	Vehicle with DSC and AL (yaw force compensation on E90)
B	Vehicle with DSC	D	Vehicle with DSC and Integrated Active Steering

Under emergency braking, the driver of a conventional vehicle then has to correct the vehicle's course.

Under such split surface braking conditions, the dynamic handling controller generates a stabilizing yaw force by opposite steering interventions on the front and rear wheels.

A) Without DSC
In the case of a vehicle without DSC, maximum braking effect is achieved by the wheels on the dry side of the road, while those on the wet or icy side produce very little retardation.

As a result, a very substantial yaw force acting in an counterclockwise direction is produced, causing the vehicle to swerve to the right.

B) With DSC
A vehicle equipped with DSC brakes the individual wheels more sensitively in order to keep the yaw force within manageable limits for the driver, which however, slightly increases the braking distance.

C) With DSC and AL
The additional "yaw force compensation" function represents a significant safety feature.

When braking on road surfaces with differences in frictional coefficient between one side of the vehicle and the other (tarmac, ice or snow), a turning force is generated around the vehicle's vertical axis (yaw force) rendering the vehicle unstable. In such cases, the DSC calculates the required steering angle for the front wheels and the Active Steering implements it by actively applying opposite lock.

As a result, an opposing yaw force around the vertical axis is generated, "compensating" for the original yaw force (cancelling it out, i.e. the vehicle is stabilized by intelligent coordination of DSC brake modulation and AL steering, constituting a safety feature unique in this class of vehicle).

D) With DSC, dynamic handling controller and Integrated Active Steering
Under such split surface braking conditions, the dynamic handling controller generates a stabilizing yaw force by opposite steering interventions on the front and rear wheels.

That counteracts the slewing of the vehicle caused by the uneven braking forces.

At the same time, maximum braking force can be applied in order to achieve a short braking distance.

Integrated Active Steering is a logical development from the Active Steering systems. The functions of the systems complement each other perfectly, taking the driving experience to a new dimension.

Integrated Active Steering Special Function

Quite obviously, Active Steering systems must not be capable of being switched on or off by the driver.

In the case of Integrated Active Steering, there is a special feature in that regard because if snow chains are fitted to the rear wheels, Active Steering of the rear wheels must be disabled.

When snow chains are fitted, the rear-wheel steering is deactivated in order to ensure that the wheels are always free to rotate.

Automatic snow-chain detection assists the driver and indicates the detected status on the Control Display. This does not remove the responsibility for manually changing the setting.

Control display message

☑ Tire chains installed

Rear wheel steering is deactivated when tire chains are installed. Observe maximum permitted speed of 30 mph (50 km/h) when tire chains are installed.

When show chains are used, the setting on the iDrive Settings menu must be changed to “Show chains fitted”.

If the maximum speed of 50 kph (31mph) for driving with snow chains is exceeded, the rear-wheel steering is reactivated regardless of the “Snow chains fitted” setting.

Automatic snow chain detection

It is possible to detect from the wheel-speed sensor signals a characteristic pattern produced by the motion of the wheel when show chains are fitted (only with BMW-approved show chains). From that characteristics signal pattern, the control unit is able to detect whether show chains are fitted on each individual wheel.

System Components

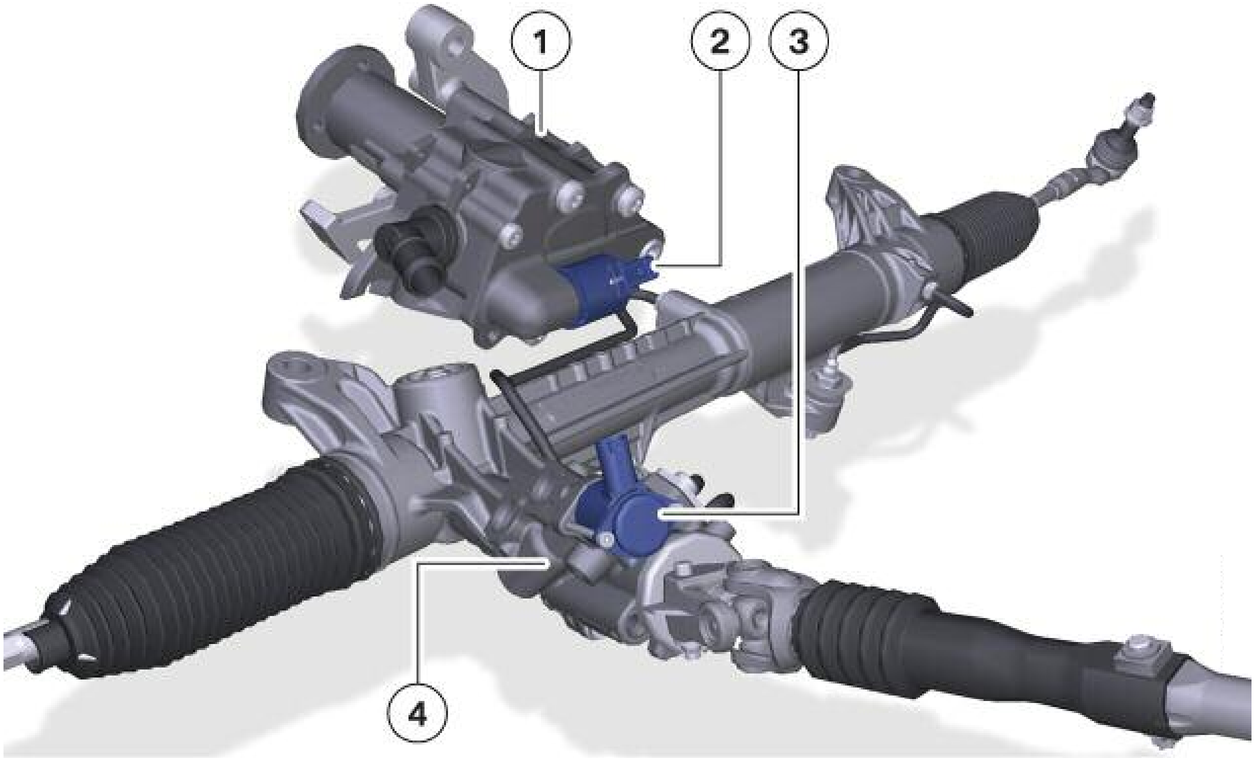
Steering Systems

There are two lateral dynamics systems available on the F01/F02:

- Servotronic
- Integrated Active Steering

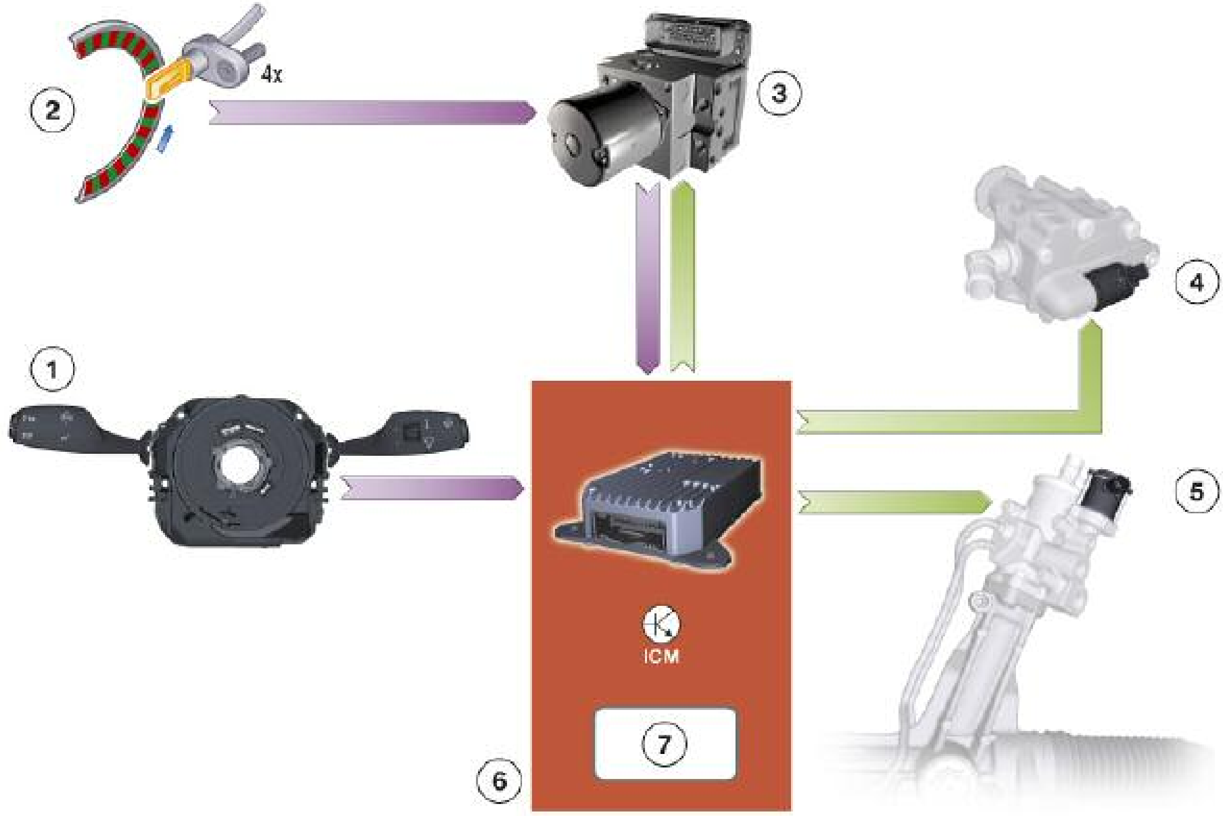
Servotronic Components

The proportional valve for electronic volumetric flow control (EVV valve) and the Servotronic valve are directly controlled by the ICM regardless of whether the Servotronic or Integrated Active Steering is fitted.



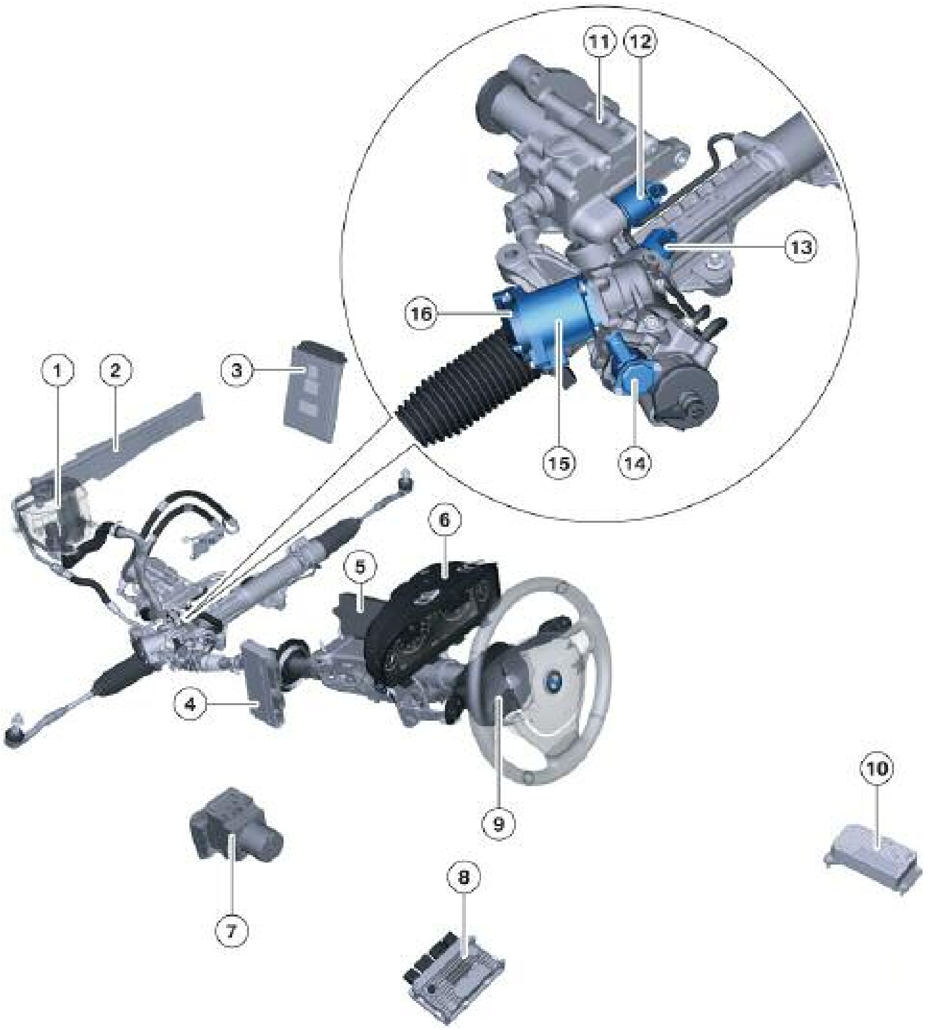
Index	Explanation	Index	Explanation
1	Hydraulic pump	3	Servotronic valve
2	Electronic volumetric flow control valve (EVV valve)	4	Hydraulic power steering control valve body

Inputs/outputs: control of steering by ICM



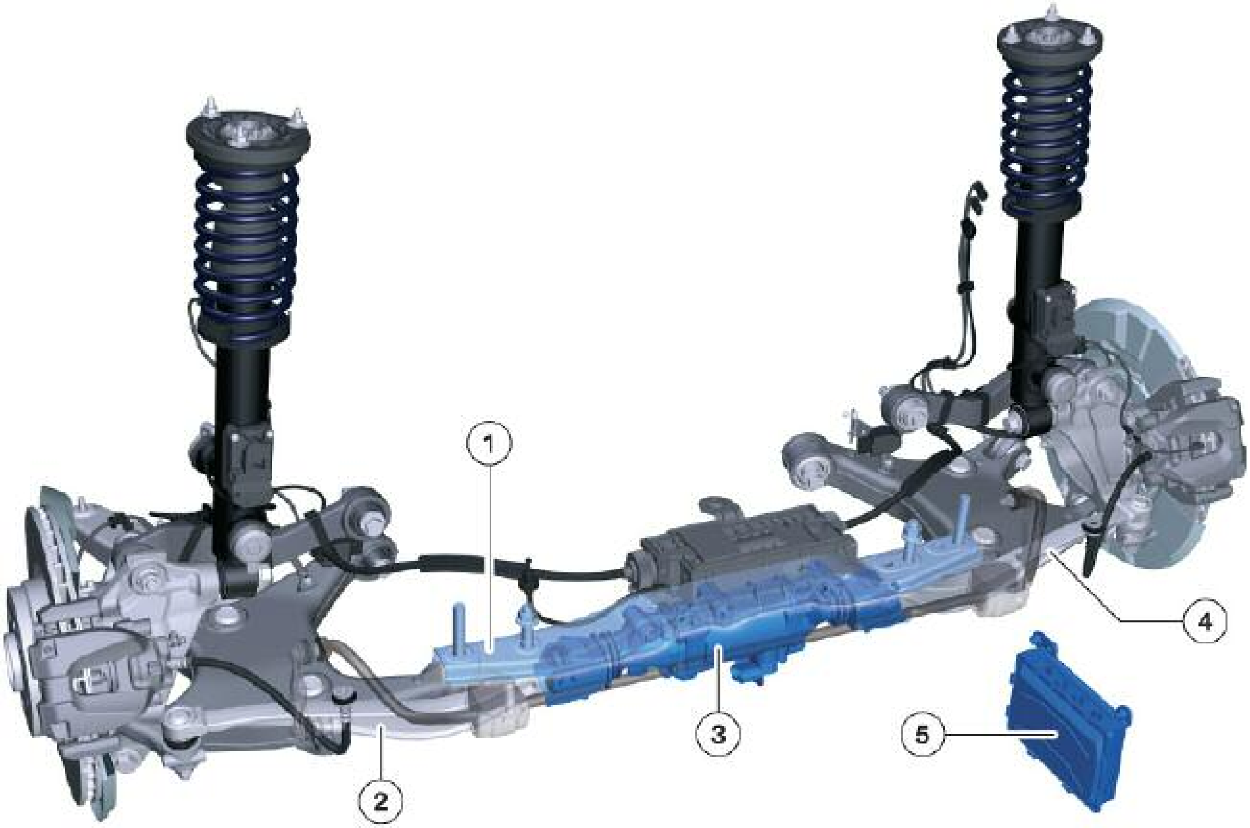
Index	Explanation	Index	Explanation
1	Steering column switch cluster (SZL)	5	Servotronic valve
2	Wheel speed sensor	6	Integrated Chassis Management (ICM)
3	Dynamic stability control (DSC)	7	"Steering control" function
4	Electronic volumetric flow control (EVV) valve		

Components of Integrated Active Steering



Index	Explanation	Index	Explanation
1	Hydraulic fluid reservoir	9	SZL
2	Power steering cooler	10	ICM
3	DME	11	Hydraulic pump
4	ZGM	12	Electronic volumetric flow control (EVV) valve
5	CAS	13	Lock
6	Instrument cluster	14	Servotronic valve
7	DSC	15	Actuator unit electric motor
8	AL	16	Motor angular position sensor

Location of HSR actuator on rear suspension



Index	Explanation	Index	Explanation
1	Mounting plate	4	Right track rod
2	Left track rod	5	HSR control unit
3	HSR actuator		

The special actuator on the rear suspension is fixed underneath a mounting plate on the rear suspension subframe.

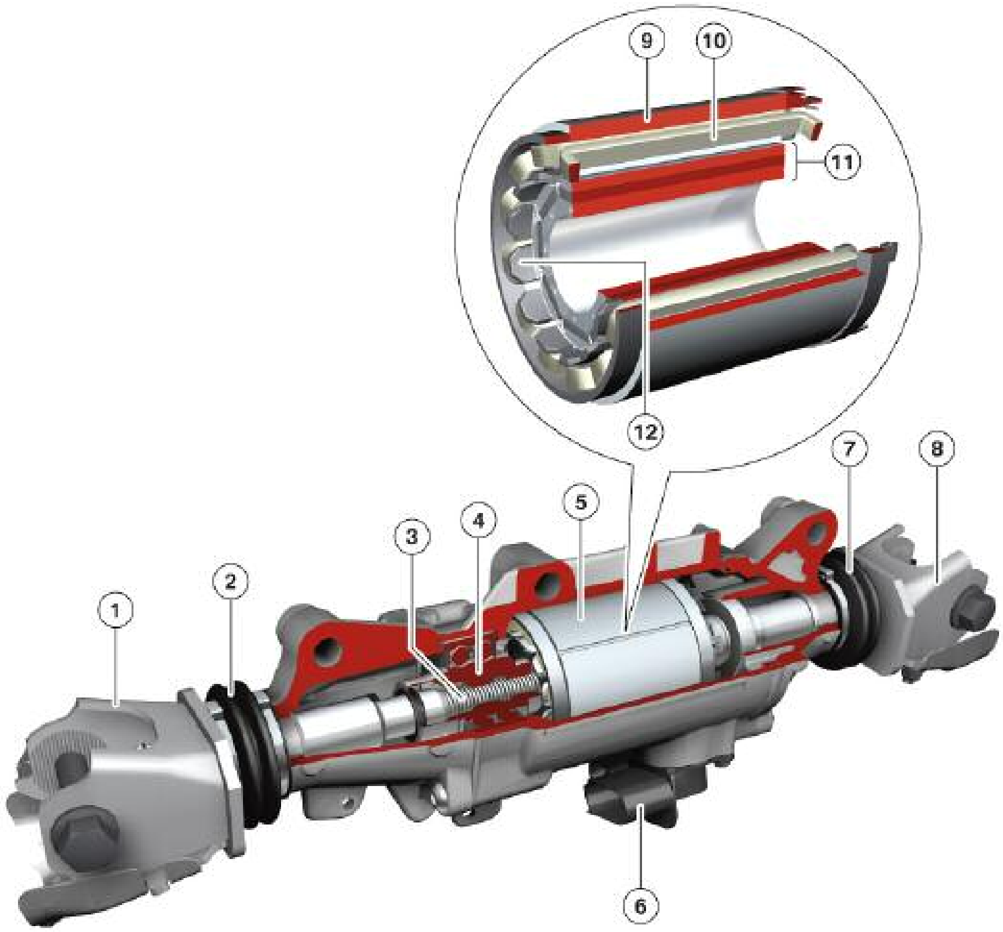
The electromechanical actuator is positioned between the two new track rods of the Integral V rear suspension. The rear-wheel steering system has its own actuator control unit which is responsible for controlling and monitoring the actuator.

It was previously the state of the art that control systems were largely independent of one another.

On the F01/F02, the Integrated Chassis Management (ICM) system brings the separate systems together.

A central ICM control unit in the ICM architecture replaces the previous dynamic handling sensors and forms a central dynamic handling controller.

HSR actuator



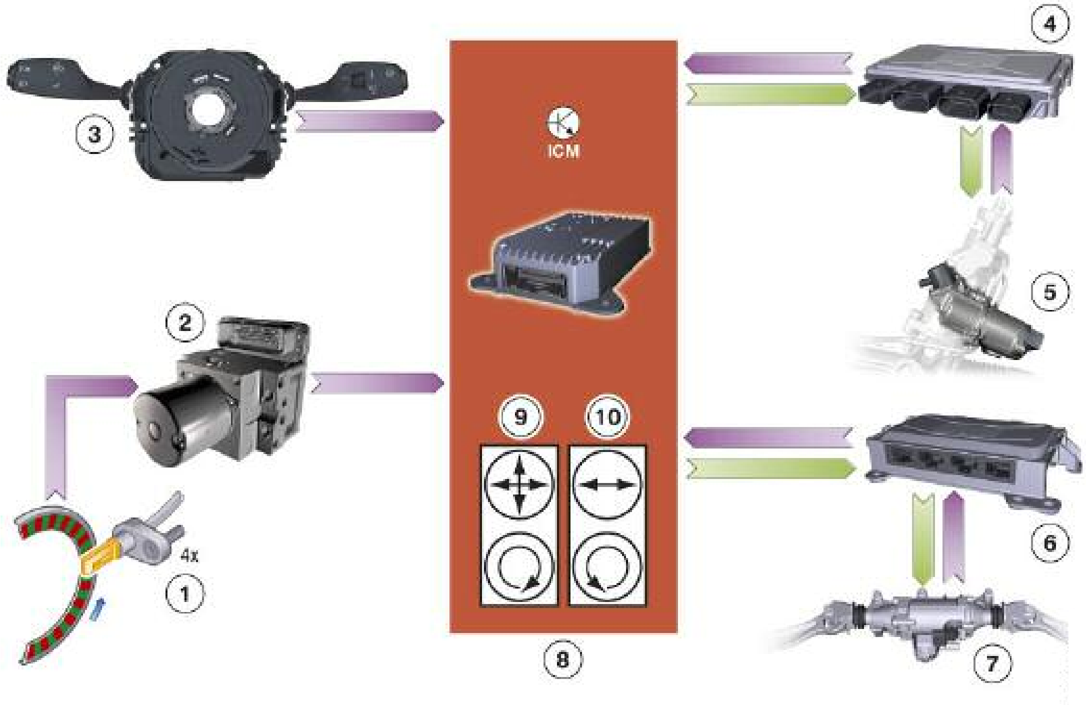
Index	Explanation	Index	Explanation
1	Left track rod joint	7	Right shaft gaiter
2	Left shaft gaiter	8	Right track rod joint
3	Worm shaft	9	Iron jacket
4	Worm nut	10	Winding stator
5	Electric motor	11	Permanent magnet
6	Electrical connector	12	Carrier/armature winding iron core

The electromechanical actuator essentially consists of an electric motor which moves the two track rods by means of a worm-and-nut steering gear.

The actuator is designed for a maximum travel of ±8 mm, which brings about a maximum steering angle of ±3 ° at the roadwheel.

The worm-and-nut rear-wheel steering gear is self-inhibiting. That means that if the system fails, the vehicle adopts exactly the same handling characteristics as a vehicle without rear-wheel steering.

Components and system complex for Integrated Active Steering



Index	Explanation	Index	Explanation
1	Wheel speed sensors	6	HSR control unit
2	DSC	7	HSR actuator unit
3	SZL with steering-angle sensor	8	ICM
4	Active Steering control unit	9	DSC sensor in ICM (linear acceleration, lateral acceleration and yaw rate sensor)
5	AS actuating unit	10	Back-up DSC sensor in ICM (lateral acceleration and yaw rate sensor)

Table of Contents

F01 Vertical Dynamics Systems

Initial Print Date: 01/09 Revision Date:

Vertical Dynamics Systems

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Locate and identify components of the various Vertical Dynamics Systems
- Understand the operation of Vertical Dynamics Control
- Understand the operation of Active Roll Stabilization
- Understand the operation of Electronic Height Control

Introduction

New Generation of Familiar Systems

General

Nowadays, the dynamic handling systems are subdivided into three groups according to the co-ordinate axis that their function relates to.

Development continued over the years with the EDC II (E24) and EDC III (E31, E38 and E39) and ultimately the EDC-K ("K" stands for continuous) in the E65.

The E65 then became the first model to feature a new vertical dynamics system called **ARS** Active Roll Stabilization, which was marketed as "Dynamic Drive".

The existing vertical dynamics systems are also complemented by the **EHC** electronic ride-height control system which made its BMW debut on the E39 (air springs on 2 wheels) and E53 (air springs on all 4 wheels).

With the arrival of the E70 came an increasing level of system integration in the area of dynamic handling and for the first time a central control unit was used for the vertical dynamics systems which was called the **VDM** Vertical Dynamics Management unit.

With the new **VDC** Vertical Dynamics Control function, independent electronic damper control for each wheel was realized for the first time.

On the E70, and subsequently also on the E71, VDC was combined with ARS under the name of Adaptive Drive.

On the F01/F02, that constant development of the vertical dynamics systems has continued and the new generation of vertical dynamics management is referred to internally as **VDC II**.

System Overview

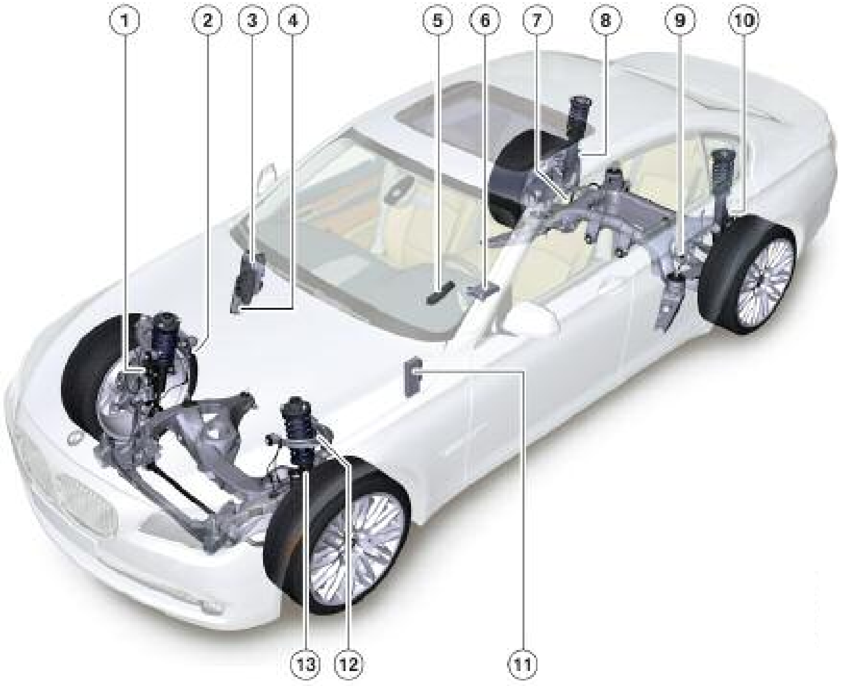
General

The following systems are available on the F01/F02:

- Electronic ride-height control (EHC)
- Active Roll Stabilization (ARS)
- Electronic ride-height control (EHC)

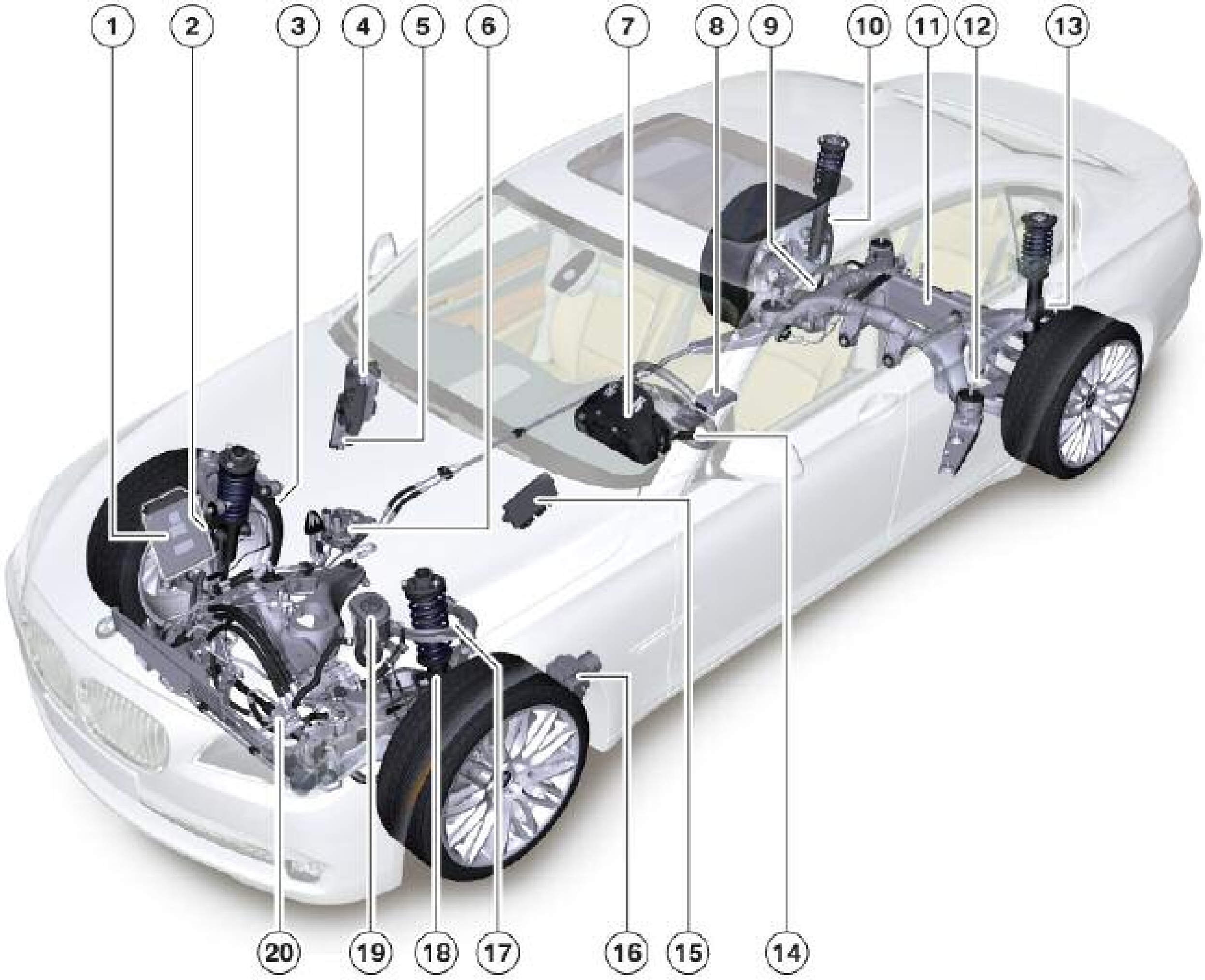
VDC (also called VDC II) is fitted as standard on the F01/F02. ARS and EHC are offered as optional extras on the F01, whereas EHC is standard on the F02.

Components of Vertical Dynamics Control (standard equipment)



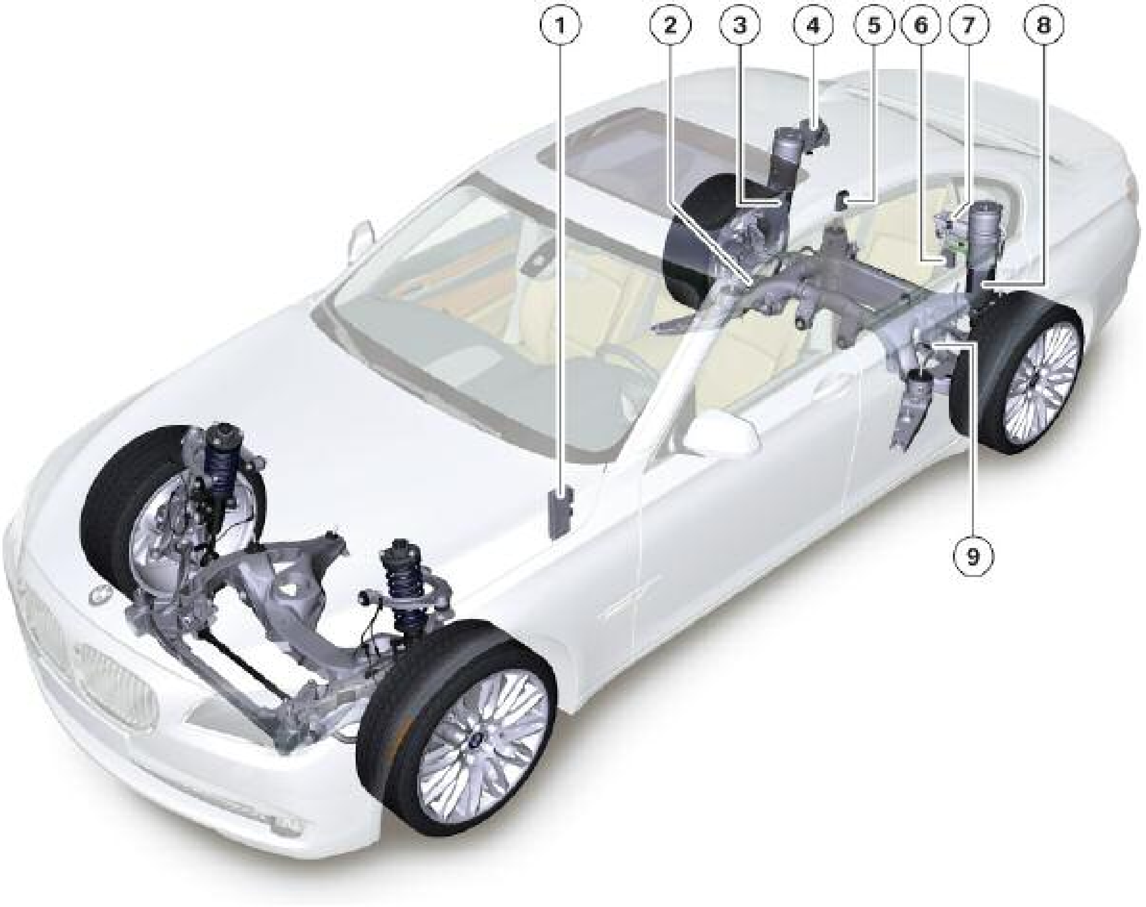
Index	Explanation	Index	Explanation
1	EDC_SVR	8	EDC_SHR
2	Ride-height sensor, front right	9	Ride-height sensor, rear left
3	Front power distribution box	10	EDC_SHL
4	VDM	11	ZGW
5	Handling setting switch	12	Ride-height sensor, front left
6	ICM	13	EDC_SVL
7	Ride-height sensor, rear right		

Components of Active Roll Stabilization with VDC



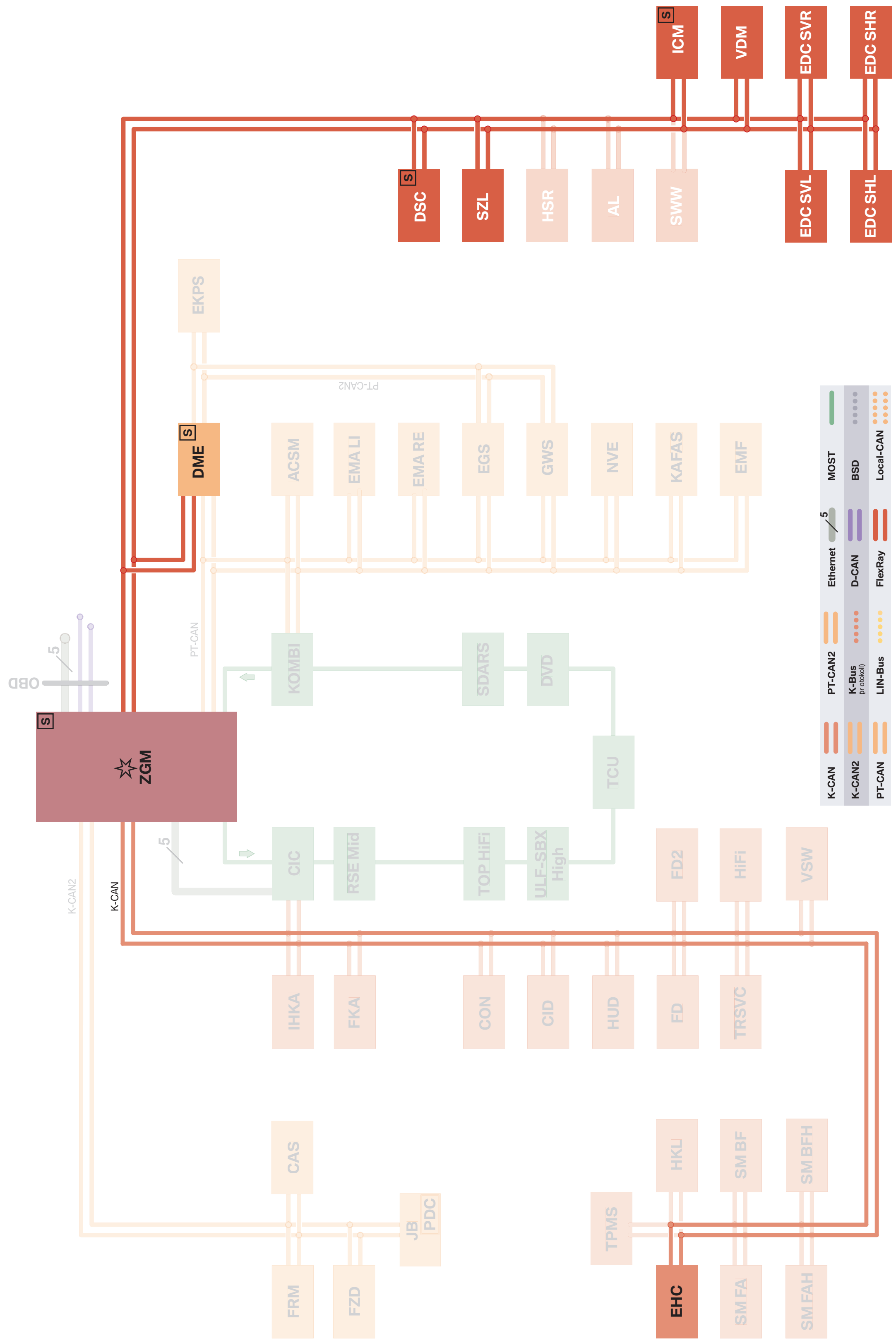
Index	Explanation	Index	Explanation
1	DME	11	Rear-suspension hydraulic motor
2	EDC_SVR	12	Ride-height sensor, rear left
3	Ride-height sensor, front right	13	EDC_SHL
4	Front power distribution box	14	SZL
5	VDM	15	ZGM
6	ARS valve manifold	16	DSC
7	Instrument cluster	17	Ride-height sensor, front left
8	ICM	18	EDC_SVL
9	Ride-height sensor, rear right	19	Hydraulic fluid reservoir
10	EDC_SHR	20	Front-suspension hydraulic motor

Components of electronic ride-height control



Index	Explanation	Index	Explanation
1	ZGM	6	Air supply relay
2	Ride-height sensor, rear right	7	LVA, air supply unit
3	EDC_SHR	8	EDC_SHL
4	Rear power distribution box	9	Ride-height sensor, rear left
5	EHC		

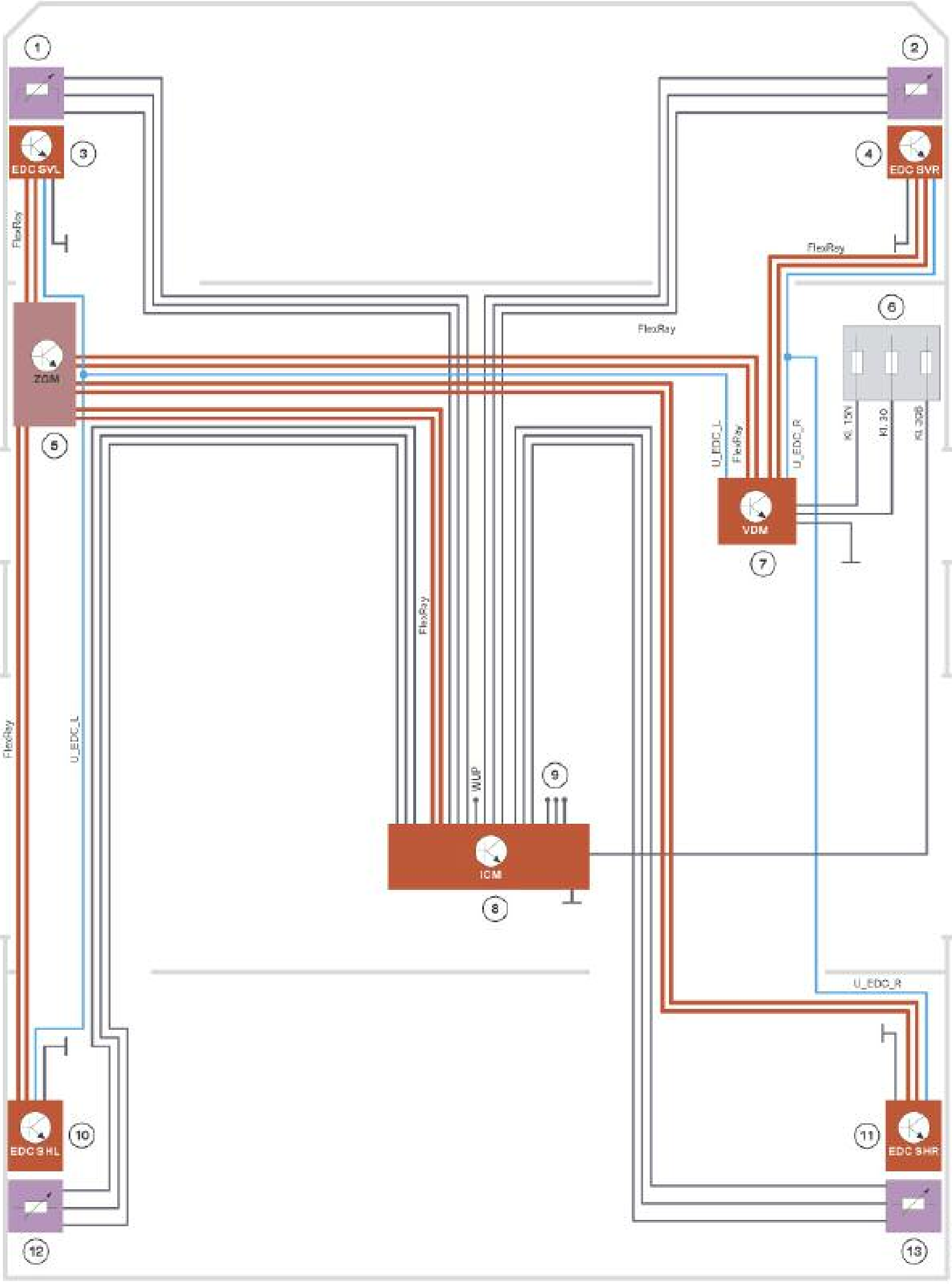
Bus System Overview for Vertical Dynamics Systems



Index	Explanation	Index	Explanation
EHC	Electronic ride-height control	VDM	Vertical Dynamics Management
ZGM	Central Gateway Module	EDC SVL	Electronic Damper Control satellite, front left
DME	Digital Motor Electronics	EDC SHL	Electronic Damper Control satellite, rear left
DSC	Dynamic stability control	EDC SVR	Electronic Damper Control satellite, front right
SZL	Steering column switch cluster	EDC SHR	Electronic Damper Control satellite, rear right
ICM	Integrated Chassis Management		

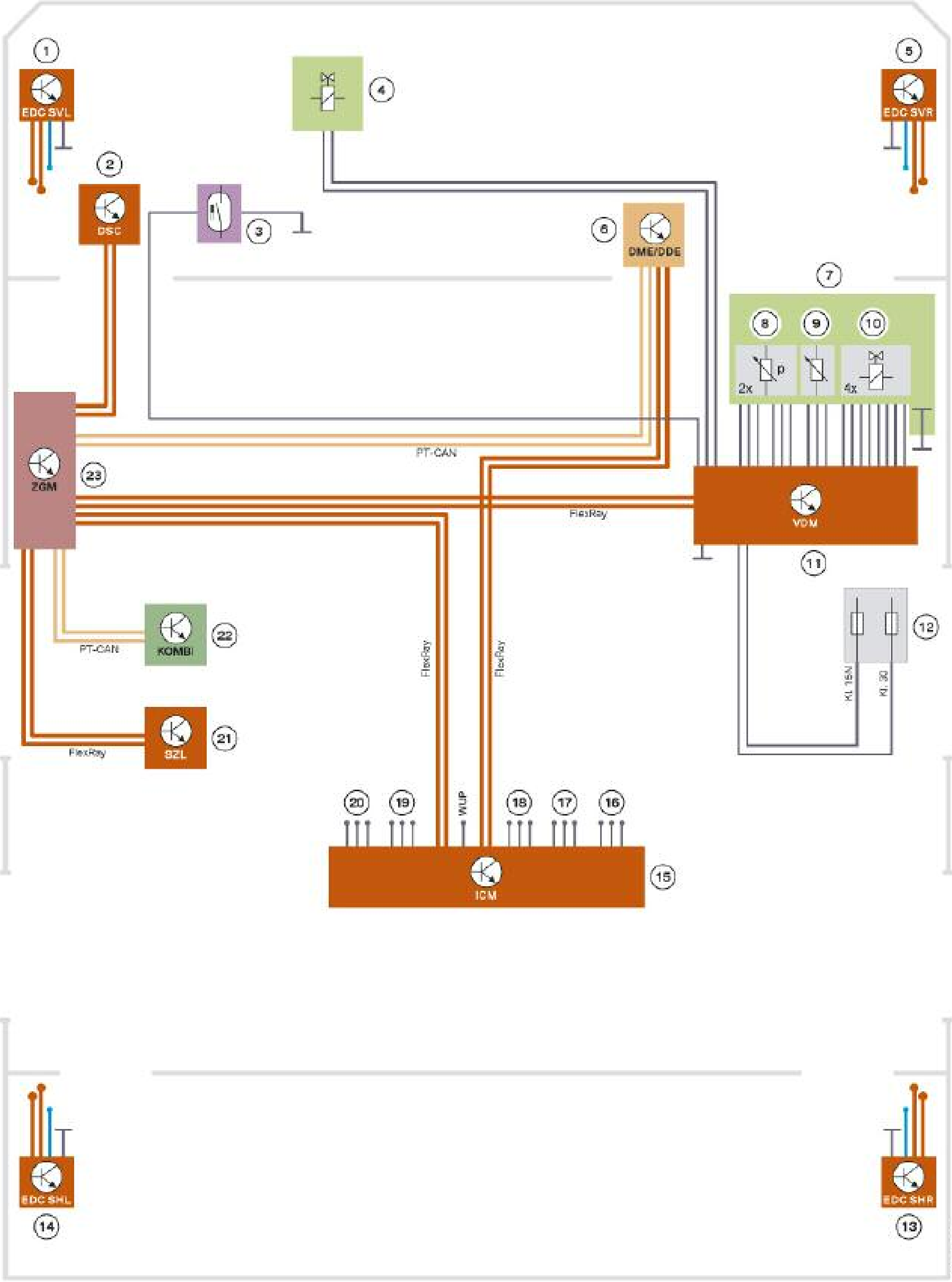
System Circuit Diagrams

VDC System Circuit Diagram



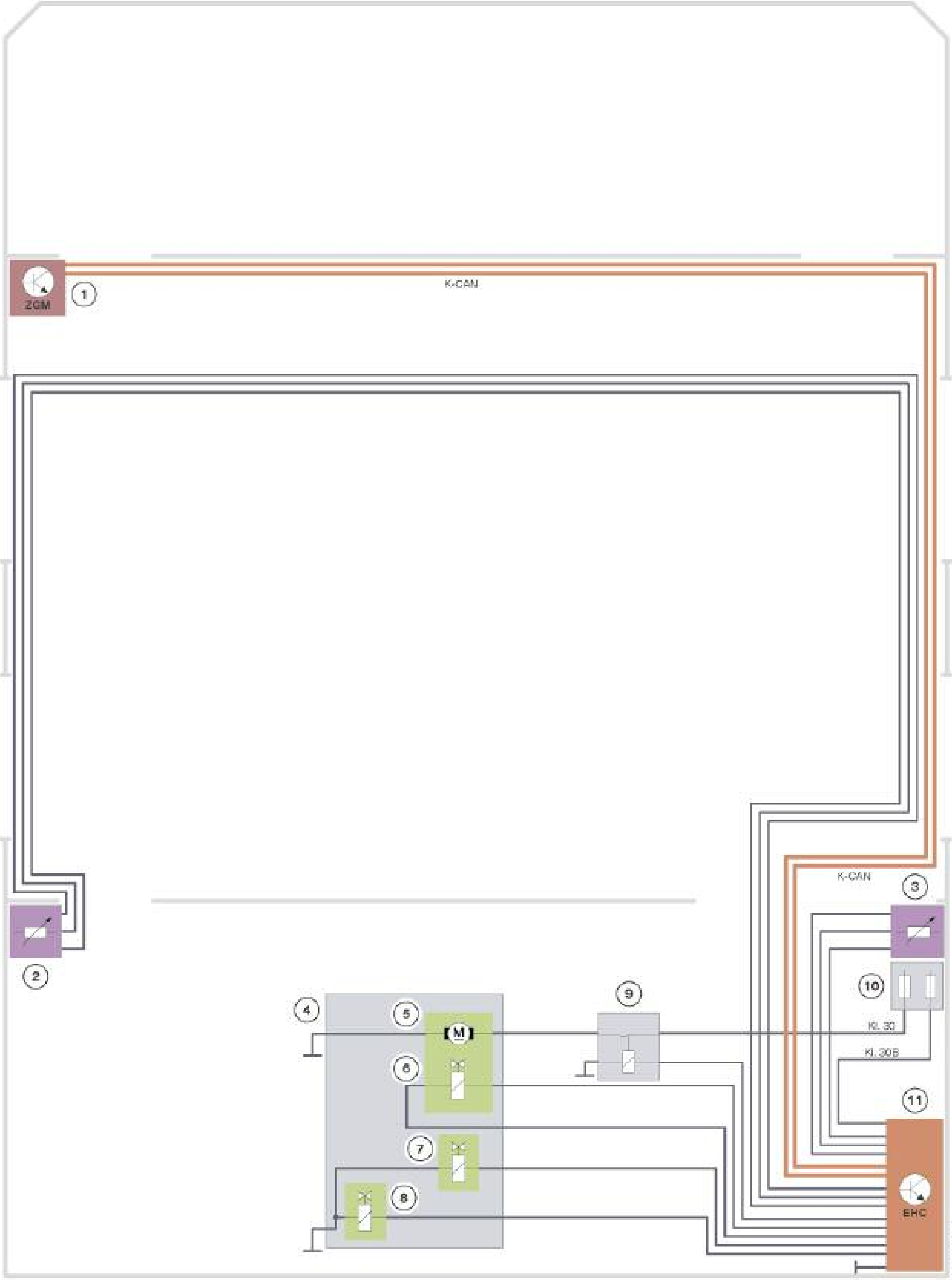
Index	Explanation	Index	Explanation
1	Ride-height sensor, front left	8	Integrated Chassis Management
2	Ride-height sensor, front right	9	Connection for handling setting switch
3	Electronic Damper Control satellite, front left	10	Electronic Damper Control satellite, rear left
4	Electronic Damper Control satellite, front right	11	Electronic Damper Control satellite, rear right
5	Central Gateway Module	12	Ride-height sensor, rear left
6	Front power distribution box	13	Ride-height sensor, rear right
7	Vertical Dynamics Management		

VDC and ARS System Diagram



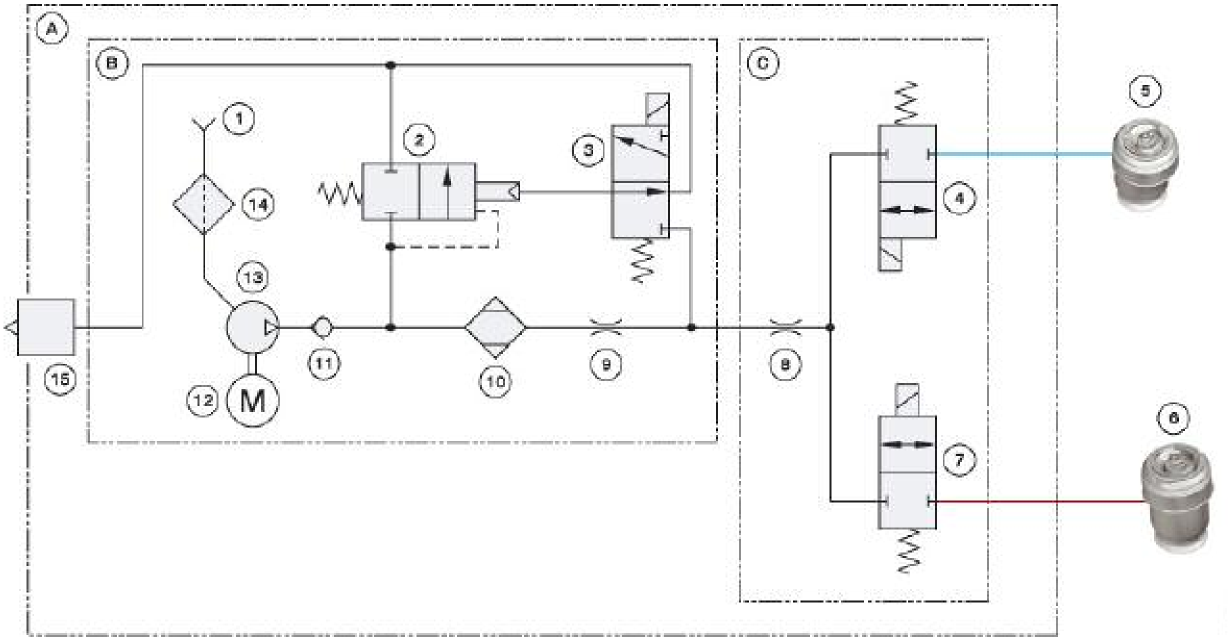
Index	Explanation	Index	Explanation
1	Electronic Damper Control satellite, front left	13	Electronic Damper Control satellite, rear right
2	Dynamic Stability Control	14	Electronic Damper Control satellite, rear left
3	Hydraulic fluid level sensor	15	Integrated Chassis Management
4	Intake restrictor valve	16	Ride-height sensor, rear left
5	Electronic Damper Control satellite, front right	17	Ride-height sensor, front left
6	Digital Motor Electronics/Digital Diesel Electronics	18	Ride-height sensor, front right
7	ARS valve manifold	19	Ride-height sensor, rear right
8	Front suspension pressure sensor/ rear suspension pressure sensor	20	Connection for handling setting switch
9	Switch-position detector	21	Steering column switch cluster
10	Failsafe, directional control and pressure valves	22	Instrument cluster
11	Vertical Dynamics Management	23	Central Gateway Module
12	Front power distribution box		

EHC System Diagram



Index	Explanation	Index	Explanation
1	Central Gateway Module	7	Solenoid valve, right side
2	Ride-height sensor, rear left	8	Air exhaust valve
3	Ride-height sensor, rear right	9	Air supply relay
4	Air supply unit	10	Rear power distribution box
5	Compressor unit	11	Electronic ride-height control
6	Solenoid valve, left side		

EHC Pneumatics Diagram



Index	Explanation	Index	Explanation
A	LVA, air supply unit	7	Solenoid valve, left side
B	Compressor unit	8	Restrictor
C	Solenoid valve block	9	Restrictor
1	Air intake (by left rear light unit)	10	Air drier
2	Pressure limiting/holding valve	11	Non-return valve
3	Air exhaust valve	12	Electric motor
4	Solenoid valve, right side	13	Compressor
5	Air spring, rear right	14	Air cleaner
6	Air spring, rear left	15	Air exhaust silencer

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Active Roll Stabilization (ARS)

General Information

Active Roll Stabilization was first fitted on the 7 Series predecessor, the E65/E66, and has been used in similar form since on the E6x and E7x models.

This section only describes the essential details and modifications of the ARS on the F01/F02.

As Vertical Dynamics Control (VDC) is fitted as standard on the F01/F02, the ARS optional extra (now also available in the US markets) is always offered as a combination.

In customer communications, ARS continues to be marketed under the name “Dynamic Drive” on the F01/F02.

System Dynamics

VDC and ARS have to respond with the appropriate speed in the event of rapid lane changes, rapid cornering or rapid changes of direction on winding country roads.

The ARS systems on previous model series had a separate control unit with the appropriate output stages for controlling the ARS valve manifold. The system architecture on the F01/F02 now features two different vertical dynamics management (VDM) control units:

- If ARS is not fitted, the VDM has no output stages for ARS valve manifold control
- If ARS is fitted, the VDM has output stages for ARS valve manifold control

The system dynamics of ARS and VDC are determined by the duration of the following stages:

Process	Time
Signal detection by sensors, processing of sensor signals in the control unit, valve control	approximately 10 ms
Change of direction, reversal of force direction, directional control valve	approximately 30 ms
Pressure increase (force per wheel) 0 -> 30 bar (0 -> 350 N) 0 -> 180 bar (0 -> 2100 N)	 approximately 120 ms approximately 400 ms

Operating States

■ **Straight-ahead travel**

When the engine is started, the pump delivers hydraulic fluid to the system and a back pressure builds up. The pressure difference of approximately 1 bar which exists between the chambers of the control motor is very small and has no effect on the anti-roll bar.

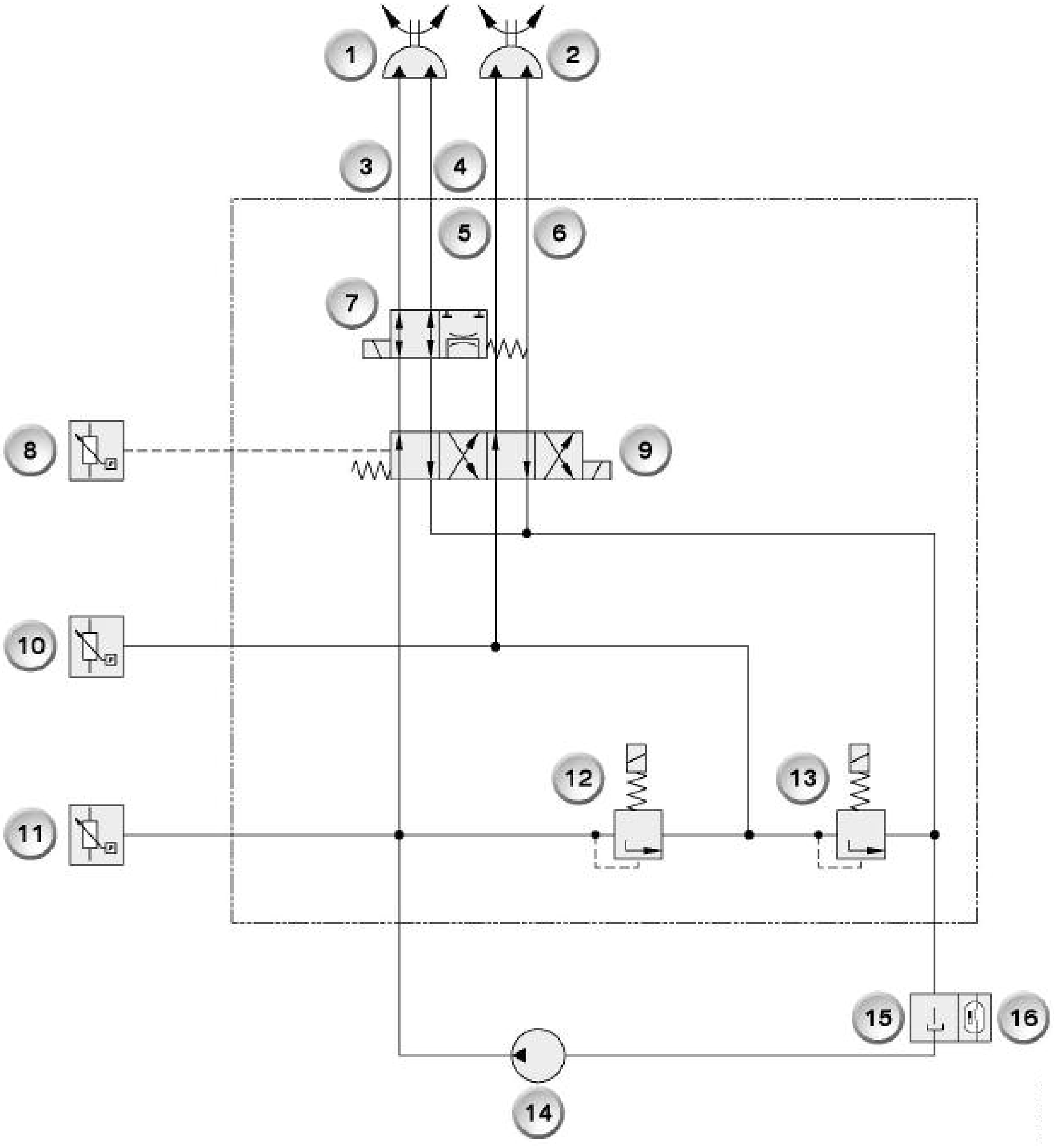
The pressure valves for the front-axle anti-roll bar (PVV) and rear-axle anti-roll bar (PVH) are not supplied with current and are therefore open. The hydraulic fluid can flow back into the fluid reservoir directly. The pump's new intake restrictor valve is energized so that the circulation pressure can be substantially lowered when driving in a straight line in order to reduce CO2 emission. This condition remains unchanged as long as the vehicle is travelling straight ahead. The system function is displayed continuously up to 10 mph. The full stabilization capacity is available from 10 mph upwards.

■ **Cornering**

As the vehicle enters a bend, the signals from the lateral acceleration sensor in the ICM are sent to the VDM control unit. The control unit then sends a pulse-width modulated (PWM) signal to the pressure valves for the front and rear-suspension hydraulic motors and simultaneously stops restriction of pump intake by switching off the power to the intake restrictor valve. The greater the lateral acceleration, the higher is the PWM signal current for the pressure valves. The stronger the current supplied to the valve, the more the valve closes and the higher the pressure which builds up in the anti-roll bars.

The pressures at the anti-roll bars are detected by pressure sensors (10, 11) and signalled to the control unit. The direction valve (9) is activated by the control unit to create a pressure build-up which corresponds to the progression of the bend (left or right-hand bend). A sensor (8) detects the switching position of the direction valve.

Hydraulic circuit diagram, normal function - failsafe valve supplied with current



Index	Explanation	Index	Explanation
1	Front hydraulic motor (SMV)	9	Directional control valve (RV)
2	Rear hydraulic motor (SMH)	10	Rear-suspension pressure sensor (DSH)
3	Front-suspension hydraulic circuit 1 (V1)	11	Front-suspension pressure sensor (DSV)
4	Front-suspension hydraulic circuit 2 (V2)	12	Front-suspension pressure valve (PVV)
5	Rear-suspension hydraulic circuit 1 (V1)	13	Rear-suspension pressure valve (PVH)
6	Rear-suspension hydraulic circuit 1 (V1)	14	Tandem pump (P)
7	Failsafe valve (FS)	15	Fluid reservoir (HB)
8	Switch-position detector (SSE)	16	Fluid level sensor

Safety Concept

General information

The safety concept prevents malfunctioning of the system by monitoring signals and responds in a defined manner to faults caused by external problems on interfacing units or systems. System monitoring essentially comprizes of the following monitoring functions:

- Monitoring of the power supply voltage
- Monitoring of the electrical circuits for the valves and sensors within the system
- Monitoring of FlexRay bus communication and checking signal plausibility
- Monitoring hydraulic function when the vehicle is in motion and predrive test

If a fault is detected, a defined response is initiated according to the significance of the fault (function impairment). The VDM control unit records the fault in the fault memory and displays the response on the instrument cluster.

Limited function (fall-back level)

If a system fault has been detected which allows continued operation of the system with limited functionality, this is indicated together with a warning message

ARS indicator lamp (yellow)

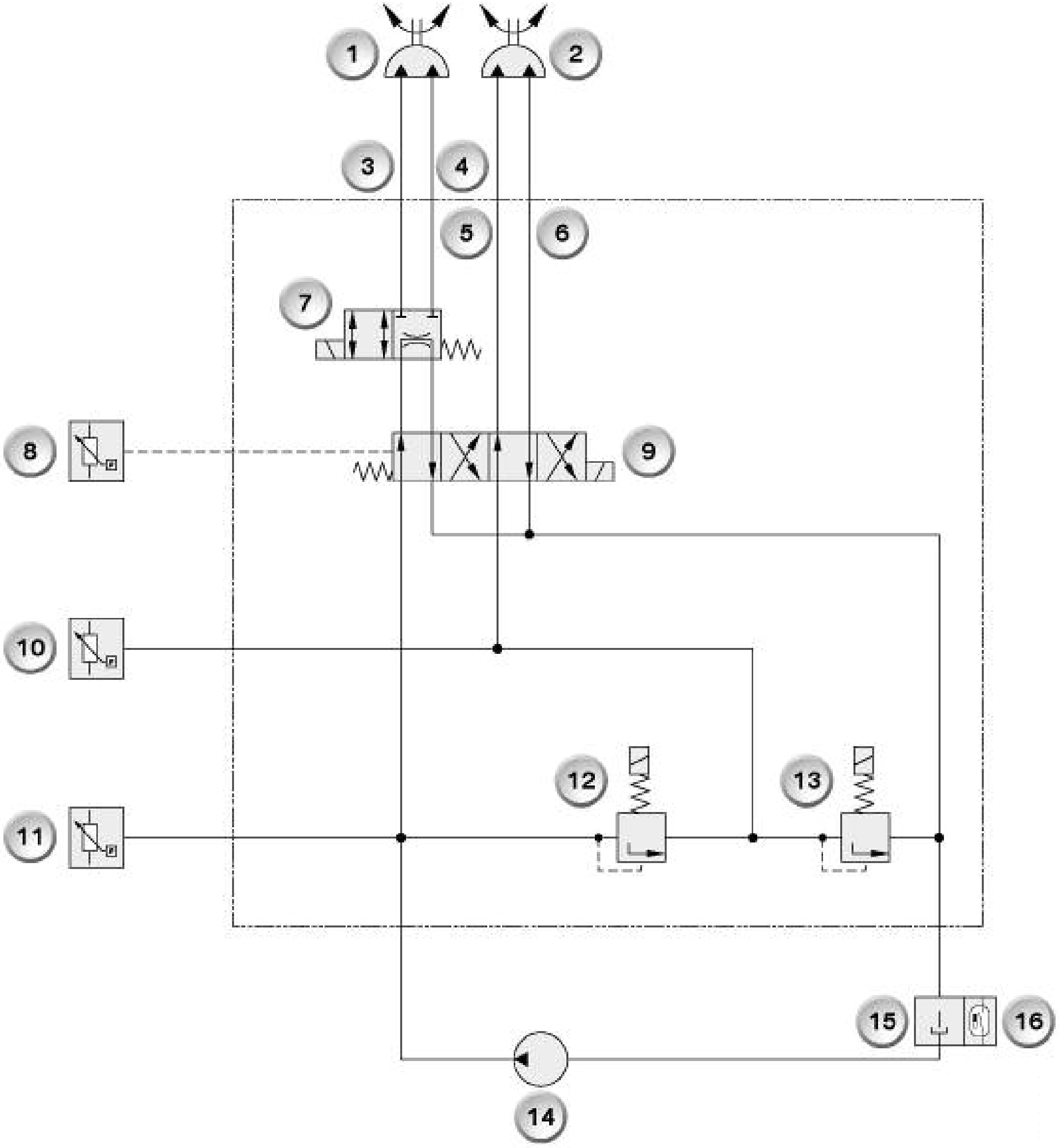
Serious fault (fall-back level)

If a serious fault is detected, the ARS system is set to “failsafe mode” and this is indicated on the instrument cluster. A CC message advises the driver to take corners more slowly.

ARS indicator lamp (yellow)

If the failsafe condition is activated, the failsafe valve is closed by means of a spring. The hydraulic fluid in the front anti-roll bar is sealed in, thereby ensuring an adequate anti-roll effect and an understeer effect equivalent to that of a conventional suspension and steering system. The failsafe situation is shown by the hydraulic circuit diagram below.

Failsafe function or neutral position hydraulic circuit diagram



Index	Explanation	Index	Explanation
1	Front hydraulic motor (SMV)	9	Directional control valve (RV)
2	Rear hydraulic motor (SMH)	10	Rear-suspension pressure sensor (DSH)
3	Front-suspension hydraulic circuit 1 (V1)	11	Front-suspension pressure sensor (DSV)
4	Front-suspension hydraulic circuit 2 (V2)	12	Front-suspension pressure valve (PVV)
5	Rear-suspension hydraulic circuit 1 (V1)	13	Rear-suspension pressure valve (PVH)
6	Rear-suspension hydraulic circuit 1 (V1)	14	Tandem pump (P)
7	Failsafe valve (FS)	15	Fluid reservoir (HB)
8	Switch-position detector (SSE)	16	Fluid level sensor

Fluid loss due to external leakage

The hydraulic circuits of the ARS system and the steering system are linked to one another by virtue of a shared fluid reservoir. The VDM control unit monitors the fluid level in the reservoir by means of a fluid level sensor. Loss of fluid due to external leakage in the hydraulic circuits of the ARS or steering systems leads to a drop in the fluid level in the shared fluid reservoir. Fluid loss can result in total failure of the ARS system and impairment of the steering system. If the fluid level sensor trips, the ARS system is set to failsafe mode and a fault is registered on the VDM control unit.

ARS indicator lamp (red)

Simultaneously, a CC message is issued warning of impairment of ARS system and steering system function. The driver is instructed to carefully bring the vehicle to a halt and switch off the engine.

Initialization/reset performance

When the VDM control unit is booted up, various checks and initialization routines are executed. They include checks of the electrical circuits for the valves and the sensors within the system, an authentication check involving querying the VIN number on the CAS and testing FlexRay communication. The system is not enabled until the tests have been successfully completed. Occurring faults are stored and displayed.

Predrive test

Every time the engine is started or the vehicle is stopped, an automatic quick test of the hydraulic function of the failsafe valve and front-suspension pressure regulating valve is carried out which lasts only 450 ms and is imperceptible to the driver. That test is only started when the engine is running and the vehicle is stationary, provided no other fault is present. If the predrive test identifies a fault, the appropriate fault response is initiated.

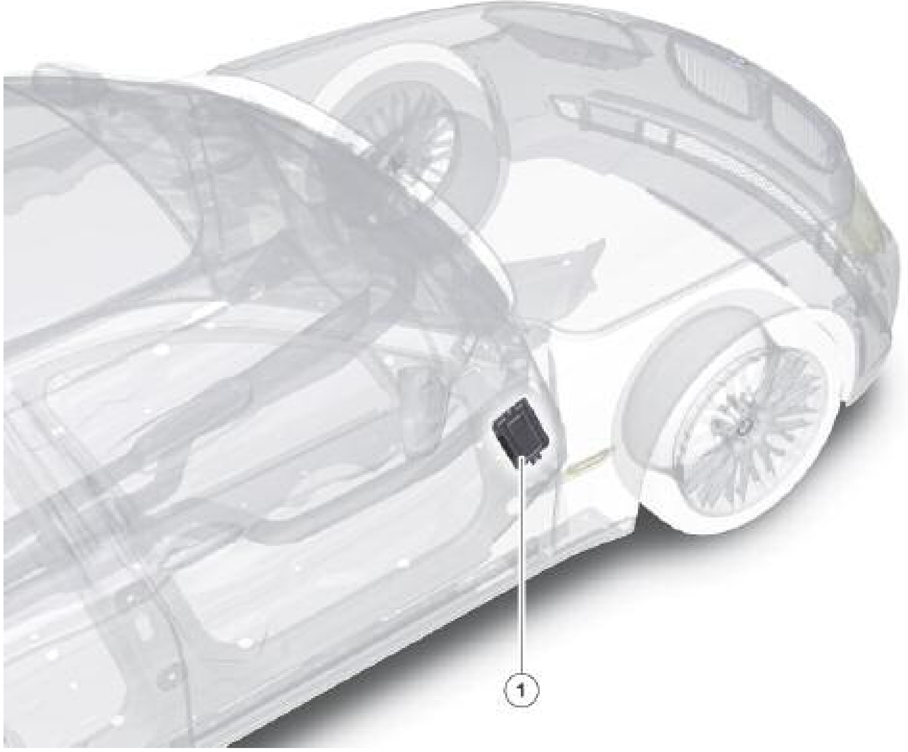
Components

Active Roll Stabilization (ARS)

Control Unit

The VDM control unit is located in the passenger compartment near the right-hand A-pillar. The VDM control unit receives its power supply via Terminal 15N and is protected by a 5A fuse. The VDM control unit is activated exclusively by the Car Access System (CAS) via a Terminal 15N lead as of status “Ignition ON”.

Location of VDM control unit



Index	Explanation
1	VDM control unit

A vehicle authentication process takes place when the system is started. This compares the vehicle identification number from the CAS with the vehicle identification number which is encoded on the VDM control unit.

That is followed by a check of the VDM control unit’s hardware and software. All outputs (valve solenoids and sensors) are subjected to a comprehensive check for short circuits and circuit breaks. If there is a fault, the system switches the actuators to a safe-driving mode.

The VDM control unit switches off if the voltage is too low/too high.

VDM control unit inputs

From the input signals, the VDM control unit calculates the control signals to the actuators. The input signals are also checked for plausibility and used for system monitoring.

The VDM control unit receives the following input signals:

- FlexRay bus
- Front-suspension circuit pressure (analog)
- Rear-suspension circuit pressure (analog)
- Switch position detector reading (analog)
- Fluid level sensor signal (analog)

The most important control signal for the ARS function is the lateral acceleration measured by the ICM control unit, which is sent to the VDM via the FlexRay bus. Additional lateral dynamics information from the FlexRay bus which is also provided by the ICM comprizes the road speed signal and the steering angle. From that, the stabilization requirement is calculated and the relevant active forces are applied. The road speed and steering angle information is also used to improve the reaction time of the system.

VDM control unit outputs

All outputs are compatible with diagnostics and protected against short-circuit. The outputs include controls for:

- Pressure regulating valves for front and rear axle
- Failsafe valve
- Directional valve
- Intake restrictor valve
- 5 V power supply for the sensors:
  - Pressure sensors at the front and rear axle
  - Switch-position detector (SSE)

The valves are controlled by the supply of current regulated by pulse-width modulation (PWM). The current measurements of the individual coil currents are designed with redundancy. The valve currents are mutually checked for plausibility on a continuous basis.

Thanks to the current measurement, the pressure can be set more precisely and the switch valves can be monitored electronically. Fault symptoms of the output signals are:

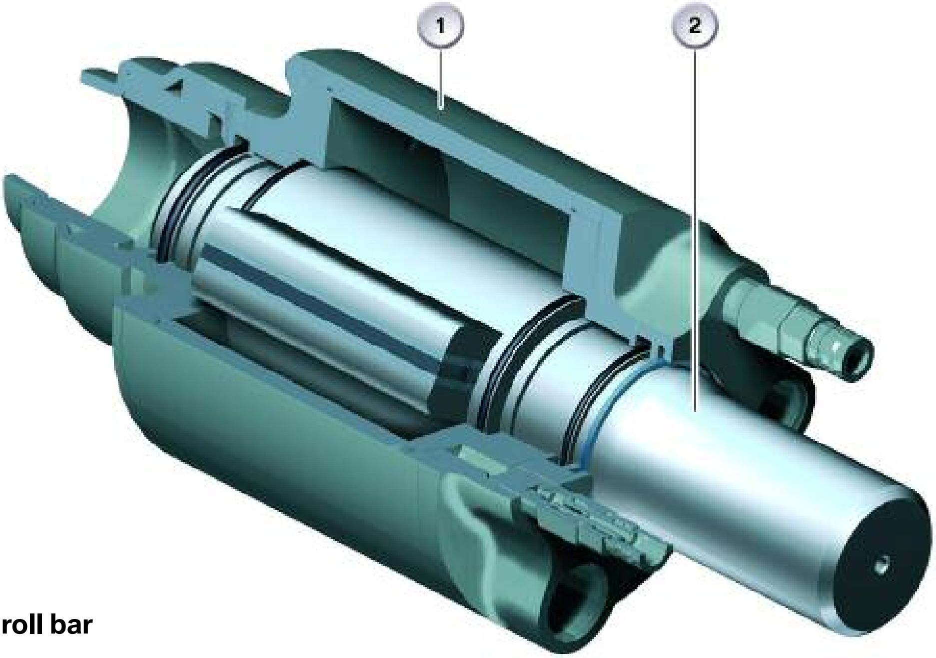
- Short circuit to Terminal 30 and Terminal 31
- Open circuit and
- Valve short circuits
- Sensor power supply faults

A message is sent to the DME via the FlexRay bus from the central dynamic handling controller on the ICM. The message contains information on how much power the tandem pump currently requires to supply the active anti-roll bars. In this way, output at the engine can be increased to satisfy the additional power requirement. A regular data signal (alive signal) is broadcast and read by other VDM control units to identify whether the system is still active. In addition, a function status signal is broadcast which communicates the status of the ARS function. The VDM control unit transmits an additional status message via the FlexRay to the instrument cluster in order to actively initiate display messages.

That status message is assigned a priority among all suspension/steering messages by the message co-ordinator on the ICM control unit and passed to the instrument cluster. All signal faults are recorded and permanently stored in the fault memory. If the alive signal fails, the ICM control unit automatically sends a message to the instrument cluster to activate the ARS warning lamp.

ARS indicator lamp (red)

Oscillating Motor



Active anti-roll bar

Index	Explanation	Index	Explanation
1	Oscillating motor housing	2	Oscillating motor shaft

The hydraulic motor and the hydraulic motor body are each attached to one half of the anti-roll bar. The active anti-roll bar consists of the oscillating motor and the anti-roll bar halves fitted to the oscillating motor, with press-fitted roller bearings for their connection to the axle carriers. The use of roller bearings ensures optimum comfort thanks to better response and reduced control forces. A thin coating of grease on the roller bearing does not impair the function of the active anti-roll bar.

Operating principle of oscillating motors

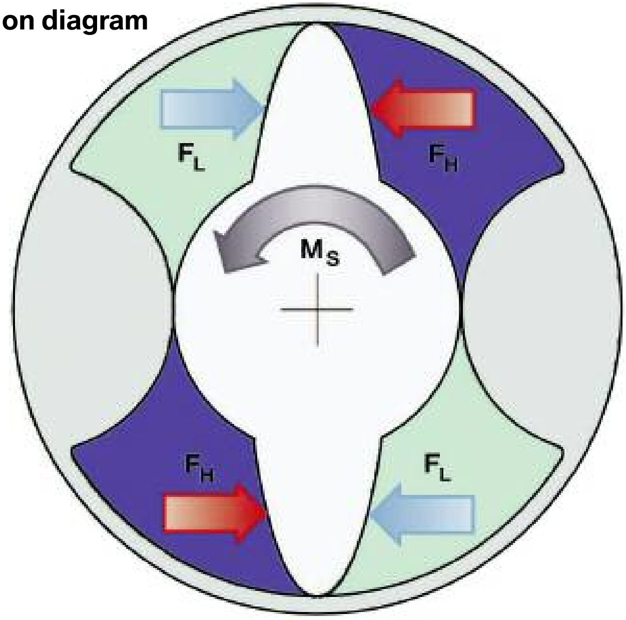
The oscillating motor has three functions to perform:

- The oscillating motor transfers the torque into the anti-roll bars.
- The hydraulic motor isolates the two halves of the anti-roll bar
- In the event of system failure (failsafe mode), the front axle anti-roll bar creates sufficient damping via the oscillating motor hydraulic fluid (hydraulic locking). The front suspension anti-roll bar then works like a conventional anti-roll bar.

Exception: if the hydraulic motor chambers no longer contain any fluid as a result of a leak, the front suspension anti-roll bar cannot provide a damping force. The opposing chambers in the oscillating motor are connected to one another. The same pressure exists in both chambers. Two chambers are supplied with high-pressure fluid using one connection. The two other chambers are connected to the tank via the return line.

The forces F_H (High) or F_L (Low) are created as a result of the differences in pressure. Since F_H is greater than F_L, a torque M_S is produced, which causes the shaft to turn in relation to the housing.

Oscillating motor section diagram



Since one half of the stabilizer bar is connected to the shaft, and the other with the housing, the two halves turn in opposite directions. This torque M_S generates the active moment M_A around the vehicle longitudinal axis via the anti-roll bar connections which counteracts the rolling moment M during cornering.

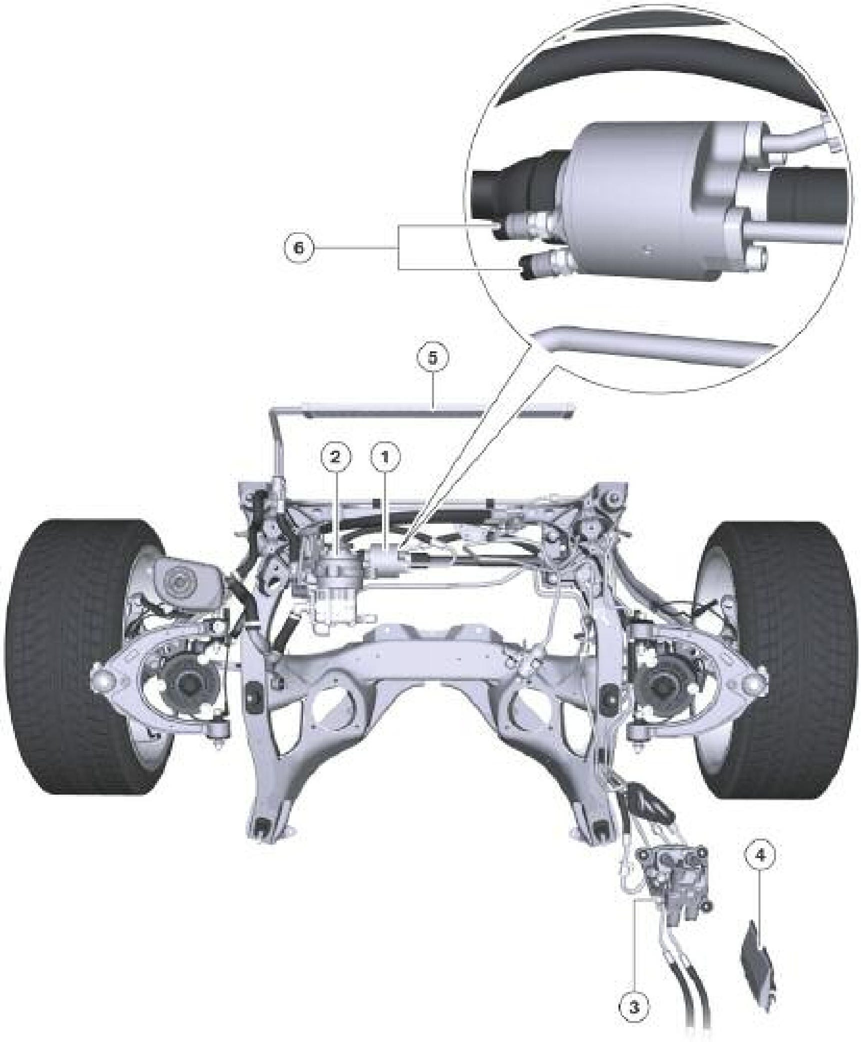
The shell is forced upwards on the outside of a curve, and dragged down on the inside of a curve. The maximum level of body torque on the front and rear suspension occurs when there is a high rate of lateral acceleration. The system pressure is then 180 bar on the front suspension and also 180 bar on the rear suspension. If the oscillating motor twists as a consequence of external forces (road excitation, e.g. bumps or potholes), the oscillating motor then acts as a torsional-vibration damper.

As a result of the twisting action, fluid is forced out of the two chambers. The displaced fluid flows through the pipes and the hydraulic valve manifold, the hydraulic resistance of which produces a damping effect. In the event of failsafe locking (hydraulic locking), the oscillating motor can only twist with a very high damping effect as a consequence of the hydraulic jamming in the oscillating motor.

■ Function of pressure relief valves

When the vehicle is driven on poor road surfaces, the movements of the anti-roll bar produce transient low pressures (cavitation) and pressure peaks in the hydraulic motors which can cause rattling noises. To prevent those noises, pressure relief valves and internal pulsation dampers have been fitted on the front hydraulic motor. The pressure relief valves allow filtered air to flow into the hydraulic motor to prevent cavitation. That small quantity of air is absorbed by the hydraulic fluid (Pentosin) to form an emulsion which is discharged in the course of subsequent operation of the hydraulic motor. The surplus air is separated out in the expansion tank.

Front Suspension Active Anti-roll Bar

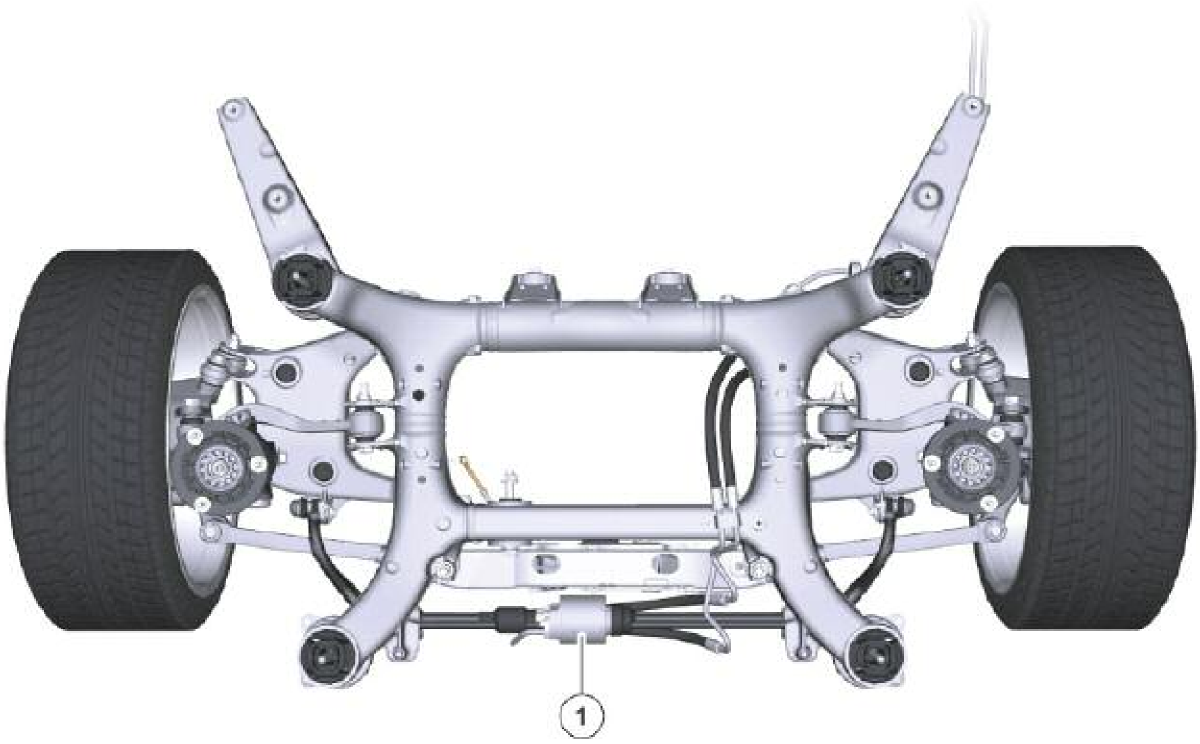


Index	Explanation	Index	Explanation
1	Front-suspension hydraulic motor	4	VDM
2	Tandem pump	5	Hydraulic cooler
3	ARS hydraulic valve manifold	6	Air filter element

The anti-roll bar is mounted on the front suspension subframe. The anti-roll bar links are attached to the pivot bearing. There are two pressure relief valves on the hydraulic motor of the front suspension anti-roll bar.

On the pressure relief valves there are air filter elements (black plastic caps) attached. Those black air filter caps with Goretex inserts must not be removed.

Rear Suspension Active Anti-roll Bar

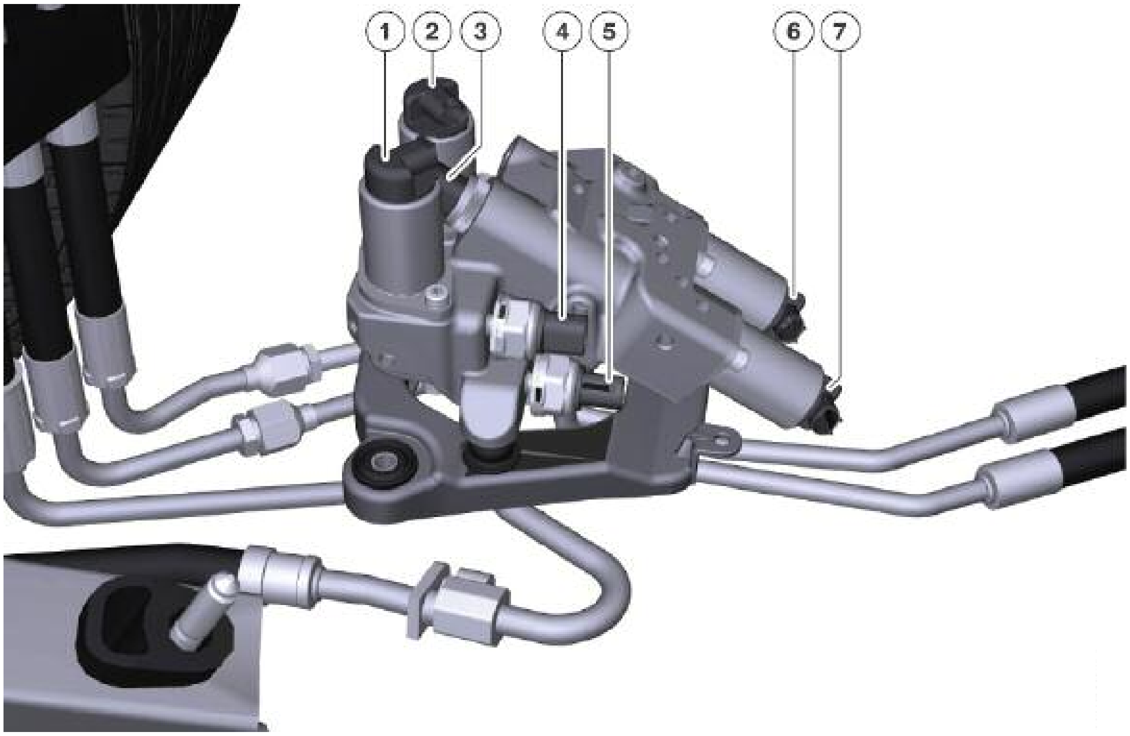


Index	Explanation
1	Rear suspension hydraulic motor

The anti-roll bar is mounted behind the rear suspension subframe. The anti-roll bar links are attached to the rear suspension swing arms.

On the hydraulic motor for the rear suspension anti-roll bar, blanking plugs are fitted in place of the pressure relief valves.

ARS Hydraulic Valve Manifold

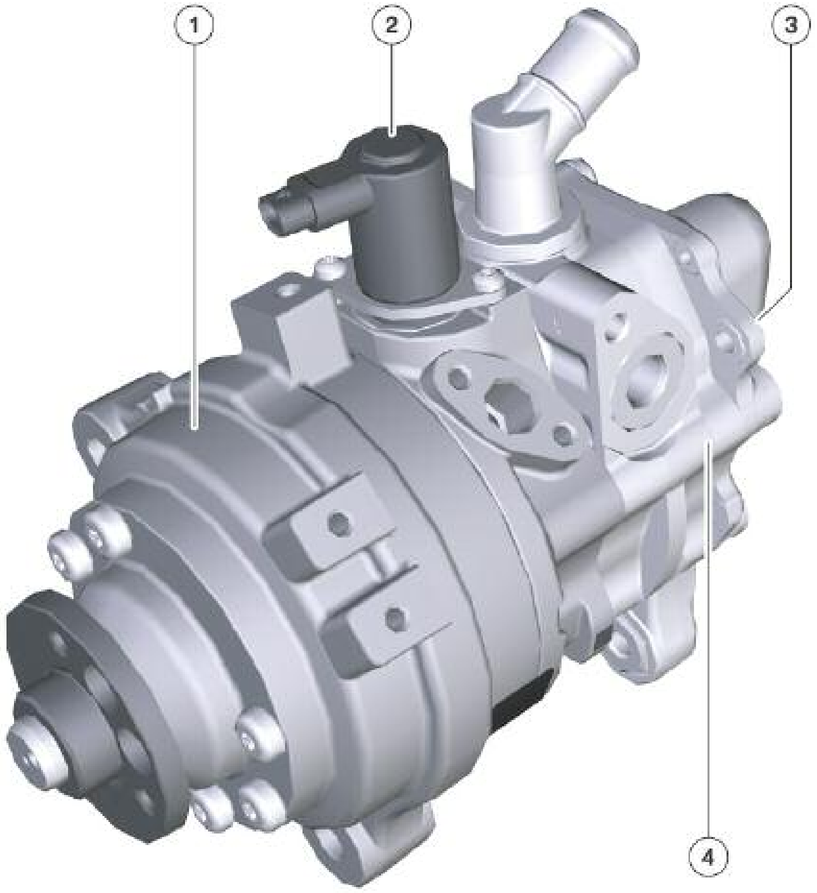


Index	Explanation	Index	Explanation
1	Front-axle pressure valve [PVV]	5	Rear-axle pressure sensor [DSH]
2	Rear-axle pressure valve [PVH]	6	Failsafe valve [FS]
3	Switch-position detector [SSE]	7	Direction valve [RV]
4	Front-axle pressure sensor [DSV]		

The hydraulic valve block is located on the floor plate of the vehicle behind the front right-hand wheel housing level with the front right- hand door. The hydraulic valve block is connected to a carrier plate bolted to the body. The hydraulic valve block houses the following valves and sensors:

- 2 pressure valves; 1 for the front suspension and 1 for the rear suspension [these are proportional pressure limiting valves]
- 1 directional control valve
- 1 failsafe valve
- 2 pressure sensors; 1 sensor for the front suspension, 1 sensor for the rear suspension
- Switch-position detector

Tandem Pump



Index	Explanation	Index	Explanation
1	Radial piston pump (ARS)	3	Electronic volumetric flow control (EVV) valve
2	Intake restrictor valve	4	Vane pump (power steering)

The hydraulic pumps fitted in this model series were based on a modular design principle. Depending on the engine and equipment specification, a suitably dimensioned hydraulic pump is flange-mounted to the engine in the same installation space. Decisive equipment features for these tandem pumps:

- Basic steering
- Integrated Active Steering (IAL)
- CO2 reduction measures
- Dynamic Drive (ARS)
- Dynamic Drive (ARS) and Integrated Active Steering (IAL)
- Intake restrictor valve

The hydraulic pump driven by the engine’s poly-V belt is, on vehicles with Dynamic Drive, invariably a tandem pump, which consists of a radial-piston pump section for ARS and a vane pump section for the power steering.

■ **Radial-piston pump section of the tandem pump**

This radial piston pump has 8 pistons in a single row and is designed for a maximum pressure of 210 bar.

When the engine is idling, the pump speed is approximately 750 rpm. At that speed, the radial piston pump section delivers a minimum fluid flow rate of approximately 5.5 l/min at a pressure of approximately 3 bar. Consequently an adequate fluid flow rate is guaranteed even at idling speed.

At a pump speed of 1450 rpm, the maximum fluid flow rate is limited to approximately 9 l/min.

■ **New feature**

As a CO2 reduction measure when driving in a straight line, the fluid flow rate of the radial piston pump is restricted by a restrictor valve on the intake side, thereby substantially reducing the circulation pressure and, therefore, the engine power used to drive the pump. As a result, active control of the intake restrictor valve makes a positive contribution to the CO2 equation.

The Dynamic Drive and hydraulic power steering share a common fluid reservoir and fluid cooler.

Vertical Dynamics Control

General Information

When driven vigorously or on an uneven road surface, a vehicle tends to respond with undesirable body movements. BMW first developed Vertical Dynamics Control for the E70 and was able to effectively reduce such body motion as a result.

VDC improves the following driver-perception related vehicle characteristics according to road surface conditions:

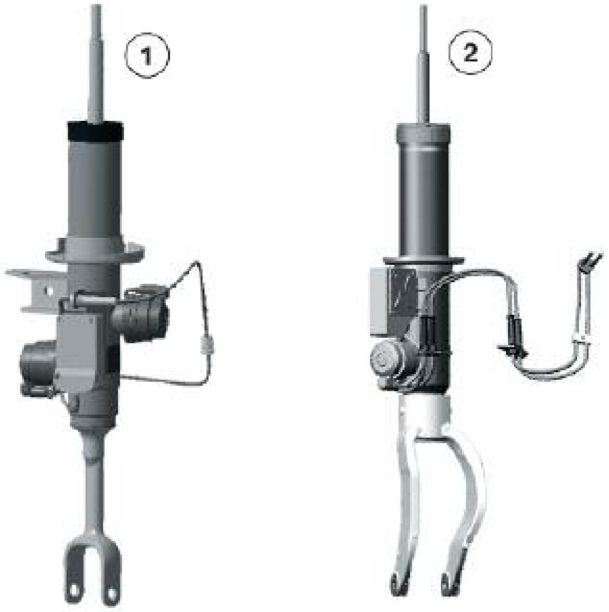
- Body-related ride comfort (primary ride comfort)
- Roadwheel-related ride comfort (secondary ride comfort)
- Dynamic handling (transitional response, agility) even with more comfortable suspension setting.

BMW is the first manufacturer to offer a damper adjustment system that is continuously controllable independently of damper compression/extension as is the case with the VDC (2) on the F01/F02.

The essential improvements compared with VDC (1) are:

- 1 EDC control valve for damper extension control
- 1 EDC control valve for damper compression control
- “Pre-opening adjustment” for improved body stabilization (has adjustment effect even at low damper rates)
- Driver-perceptible broad spread in conjunction with the handling setting switch (difference between soft and hard characteristics)
- Separately adjustable characteristic for roadwheel-related ride comfort (extension characteristic independent of compression characteristic)

VDC dampers



Index	Explanation	Index	Explanation
1	Front damper, VDC 2	2	Front damper, VDC 1

	VDC 1	VDC 2
Model	On E70/E71 included in Adaptive Drive Equipment package	Standard equipment in F01/F02
Program selection	Sport button next to gear selector	Handling setting switch next to gear selector
Program type	Sport/Comfort	Coordinated integration in all dynamic handling control functions
Control unit	VDM control module, right rear of luggage compartment 4 EDC satellite control modules directly on damper units	VDM control module, front right A-pillar 4 EDC satellite control modules directly on damper units
Damper	Twin tube, gas filled shock absorbers	Twin tube, gas filled shock absorbers
Fault diagnosis	VDM and EDC satellite control modules fully diagnosable	VDM and EDC satellite control modules fully diagnosable
Programming	VDM and EDC satellite control modules flash-programmable	VDM and EDC satellite control modules flash-programmable
Coding	VDM and EDC satellite control modules codable	VDM and EDC satellite control modules codable
Malfunction display	Messages in the Control Display or instrument cluster	Messages in the Control Display or instrument cluster
Testing	BMW diagnostic systems	BMW diagnostic systems

Signal Processing

- The vertical movement of the wheels is detected by the wheel-acceleration sensors integrated in the EDC satellite control units
- From the wheel acceleration rates and the ride height signals (FlexRay bus) the vehicle body motion is calculated
- In addition, signals such as the vehicle road speed are read from the FlexRay bus for the purpose of determining required damping forces.

■ **Signal processing/VDC (2) controller**
Individual damping forces are calculated for each individual wheel according to the vehicle body motion, the wheel motion and the additional signals read from the FlexRay bus, and are sent every 2.5 ms to the EDC satellite control units.

Damping Force Adjustment

- Stored on each EDC satellite control module is the actual individual damper characteristic, making it possible to minimize differences from the specified characteristic arising from manufacturing tolerances
- From the specified damping force and the damper characteristic data map, the EDC satellite control units calculate the required current to be applied to the damper extension valve and compression valve

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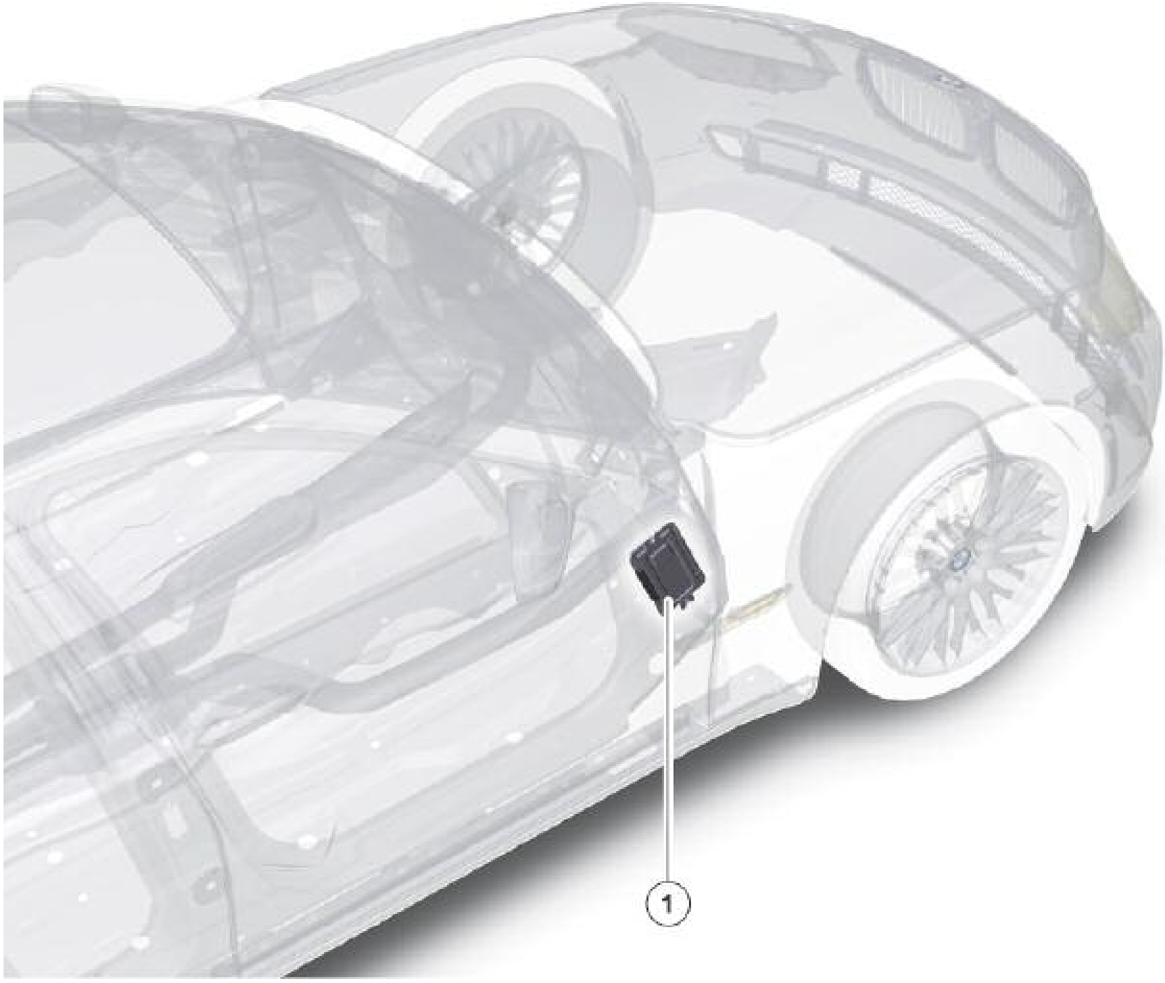
Vertical Dynamics Control (VDC)

Control Unit



Location of VDM

Index	Explanation
1	VDM

The location of the VDM control unit is dependent on the country in which the vehicle is sold.

- On left-hand drive vehicles the control unit is fitted inside the passenger compartment near the right A-pillar (as illustrated)
- On right-hand drive vehicles the control unit is fitted inside the passenger compartment near the left A-pillar

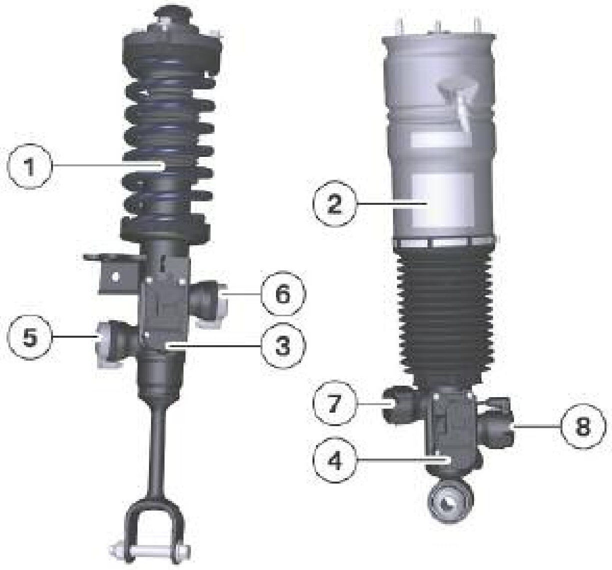
There are two different versions of the VDM control unit according to the equipment options fitted on the vehicle.

- The basic version of the VDM control unit is used if the vehicle has only the standard VDC equipment
- The high-spec version of the VDM control unit is used if, as well as the standard VDC system, the vehicle also has ARS Active Roll Stabilization (Dynamic Drive). In that case, the output stages for controlling the ARS valve manifold are also integrated in the VDM control unit.

EDC Satellite Control Unit with Damper

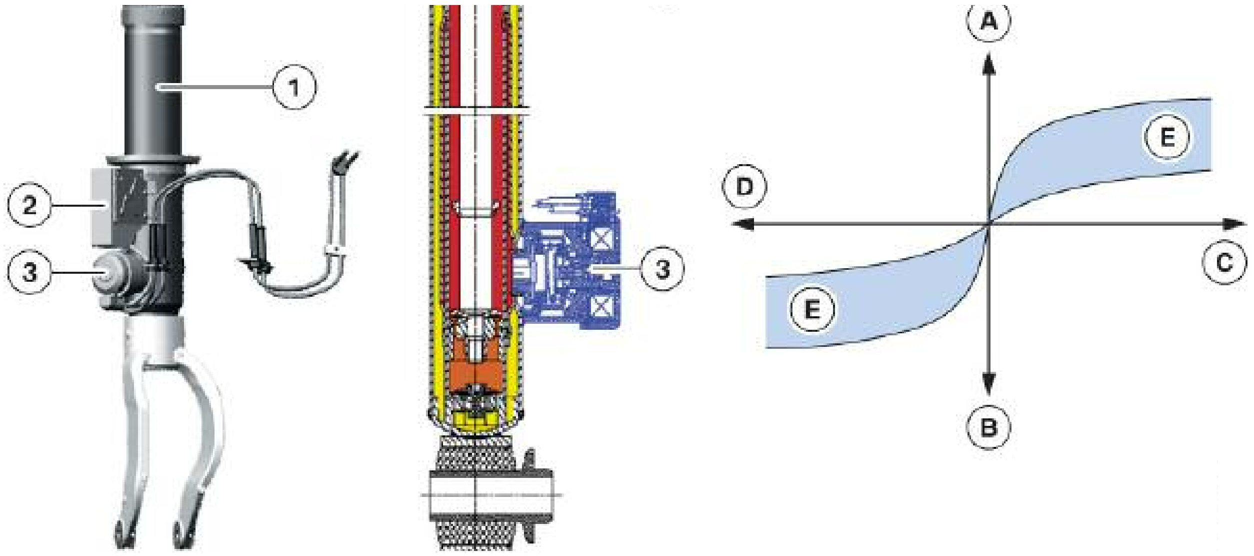
The VDC dampers on the rear suspension are either steel-spring or air-spring versions depending on the optional equipment fitted.

VDC damper versions



Index	Explanation
1	VDC damper with steel spring
2	VDC damper with air spring
3	Front EDC satellite control module
4	Rear EDC satellite control module
5	EDC data-map valve for compression control
6	EDC data-map valve for extension control
7	EDC data-map valve for extension control
8	EDC data-map valve for compression control

VDC (1) damper with one EDC data-map valve 12 -VDC (2) damper with two EDC data-map valves



Index	Explanation	Index	Explanation
1	Damper tube	B	FC = Compression force
2	EDC satellite control unit	C	VE = Extension velocity
3	EDC data-map valve for extension and compression control	D	VC = Compression velocity
A	FE = Extension force	E	Extension and compression characteristic data map

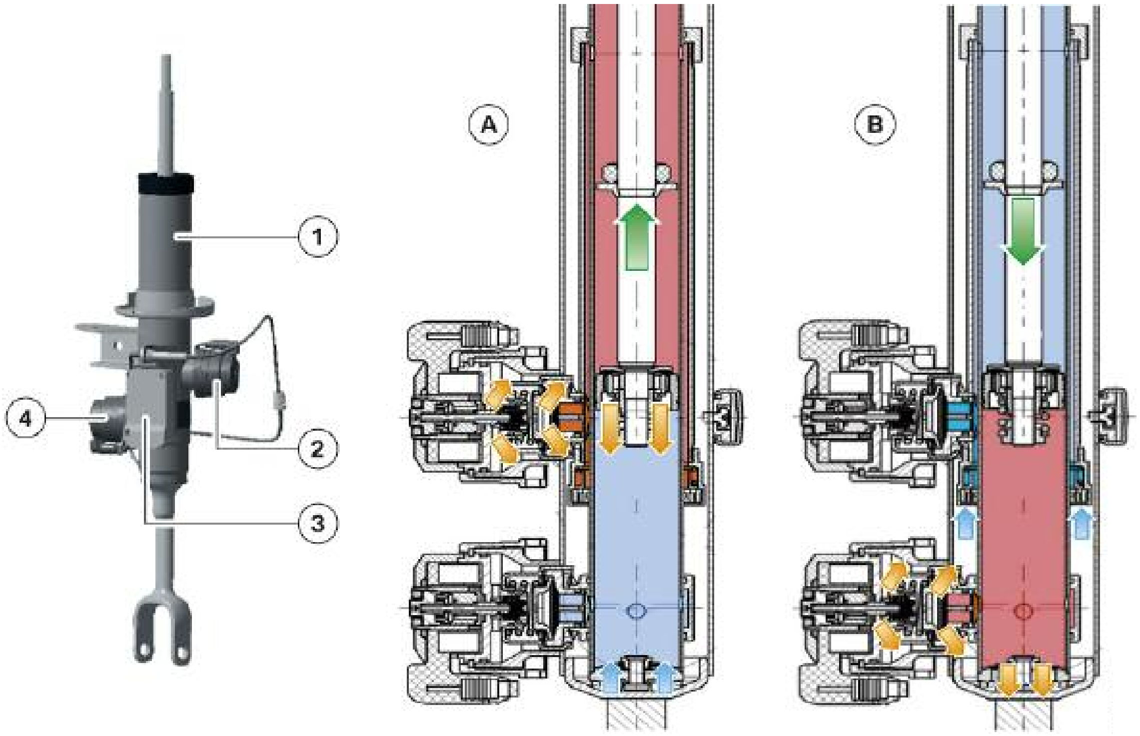
Difference between a VDC (1) and a VDC (2) damper:

A VDC (1) damper with only one EDC data map valve uses combined extension/compression adjustment which has to be cycled extremely rapidly.

With this type of control, the damper adjustment is based on wheel frequency.

The wheel frequency is the frequency at which the wheel oscillates along the z-axis.

VDC (2) damper with two EDC data-map valves



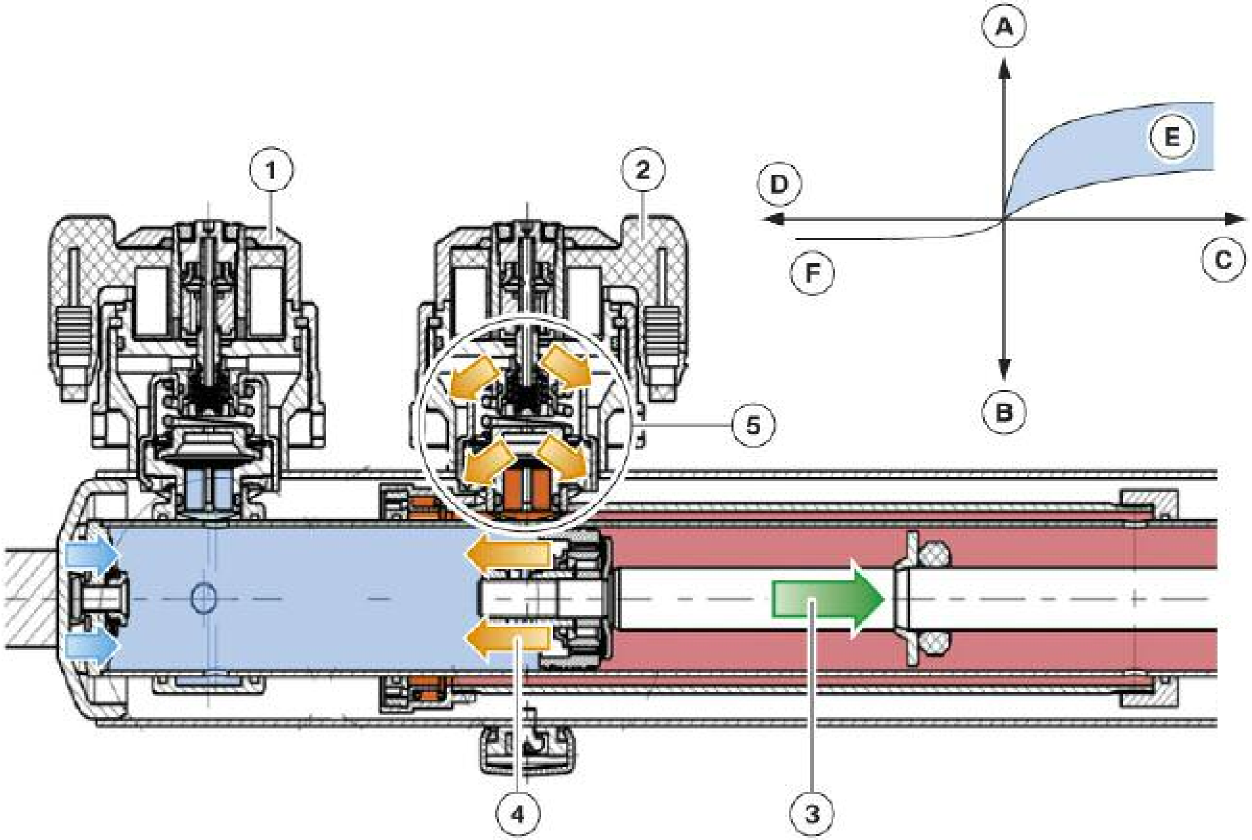
Index	Explanation	Index	Explanation
A	Extension progression	2	EDC data-map valve for extension
B	Compression progression	3	EDC satellite control unit
1	Damper tube	4	EDC data-map valve for compression

A VDC (2) damper with two EDC data-map valves uses independent extension/ compression adjustment which does not demand such a high cycling rate.

With this type of control, the damper adjustment can be based on body frequency.

The body frequency is the frequency at which the body oscillates along the z-axis.

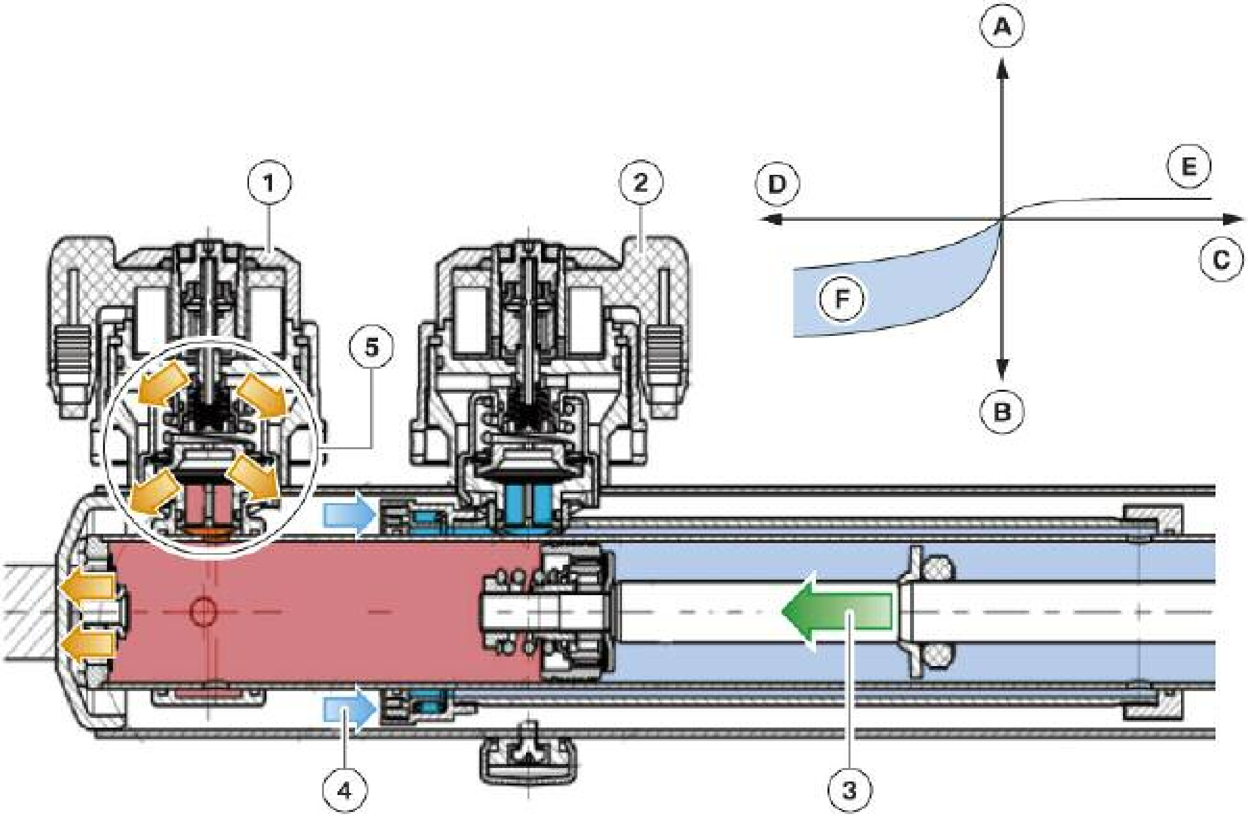
Fluid flow during extension



Index	Explanation	Index	Explanation
1	EDC data-map valve for compression	B	FC = Compression force
2	EDC data-map valve for extension	C	VE = Extension velocity
3	Force/direction of piston rod movement	D	VC = Compression velocity
4	Fluid medium	E	Extension data map
5	Data-map control	F	Compression data map
A	FE = Extension force		

The two EDC data-map valves firstly enable independent extension control and, therefore, data-map compatible design, and secondly independent compression control and, therefore, data-map compatible design.

Fluid flow during compression



Control strategy

The fundamental control principle is known as the “Skyhook system”, the name of which reveals the primary control objective of holding the vehicle stationary in a vertical direction regardless of driving situation as if suspended from a “hook in the sky”.

To achieve this highest of all comfort objectives, the movements of the entire body have to be evaluated. Thus an overall analysis is performed of the ride height data and z-axis acceleration rates.

Furthermore, VDC regulation takes into consideration steering inputs (e.g. transition from straight-ahead travel to cornering) based on the steering angle curve. If VDC detects a rapid increase in the steering angle, the controller infers that the vehicle is entering a bend and can preventively adjust the dampers on the outside of the bend to a harder setting in advance. Thus VDC assists the ARS system, if fitted, and contributes to reducing vehicle roll (roll tendency).

Moreover, VDC is able to detect the braking operations by the driver based on the brake pressure information supplied by DSC. A high brake pressure normally results in pitching of the vehicle body; VDC counteracts that effect by setting the front dampers to higher damping forces. This also results in an improvement in the front/rear brake force distribution, which in turn reduces the braking distance (by comparison with a vehicle without VDC).

On the E70/E71 with VDC (1), the “Sport” button for switching between comfort and sports setting only affected the VDC characteristics.

With the introduction of the handling setting switch, the VDC setting is incorporated in a number of modes which bring about a coordinated overall setting across all systems.

Ride-height Sensor

Index	Explanation
1	Electrical connector
2	Sensor housing
3	Lever

The angle of a pivoting lever is converted into a voltage signal by the ride height sensor. The greater the angle (relative to a defined starting or zero position), the greater is the output voltage. It is generated by a Hall-effect sensor element.

Designs

There are always four ride-height sensors fitted on all F01/F02 models.

The ride-height sensors fitted all operate according to the same principle but there are different designs (different part numbers). The reason for the differences are the available space and the starting position (zero position) of the individual ride-height sensors.

Depending on whether or not the vehicle is fitted with Electronic Height Control (EHC), double or single ride-height sensors are fitted on the rear suspension.

On the front suspension, single ride-height sensors are always used.

	Front suspension	**Rear suspension**
EHC, not fitted	Single RHS	Single
EHC, fitted	Single RHS	Double

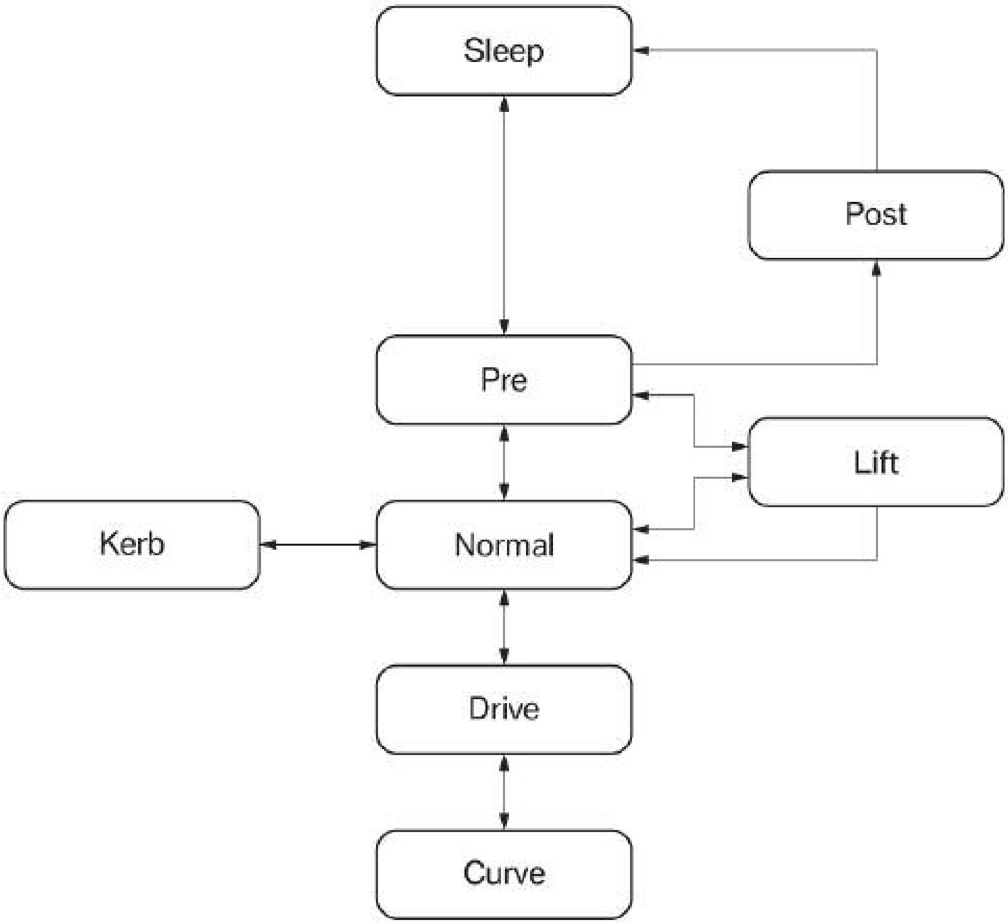
RHS = Ride-height sensor

Electronic Ride-height Control

Function of Air Springs

The various control modes on the F01/F02 are similar to those on other model series such as the E70:

EHC control mode flowchart for F01/F02



Control Modes with Single-axle Air Suspension
Ongoing control operations are not affected by transitions from one mode to another. However, in the case of load cutout OFF (VA_AUS), control operations are always concluded in order to safeguard system deactivation. The EHC control unit then sets Sleep mode.

Important: All technical data quoted are code-specified as at SOP.

Sleep Mode

The vehicle is in Sleep mode at the latest by the time it has been parked for longer than a few minutes without a door or hood/trunk lid being operated or the terminal status changing. This is the initial state of the control system. No control function is performed in Sleep mode. The control system goes into Pre-mode when a wake-up signal is received by the EHC control unit.

Post-mode

Post-mode is activated in order to compensate for any inclination or to adjust the ride height after driving and between the Pre-mode and Sleep mode.

Duration of Post-mode is limited to approximately 1 minute. This mode is only executed if the engine has been running before the system switches into this mode. If the engine has not been running, the system switches directly from Pre-mode to Sleep mode.

Control adjustments are made within a tight tolerance band using the following coding parameters:

Coding parameter	Value
niv_post_up_e	- 59 mm
niv_post_up_d	- 07 mm
niv_post_down_e	+ 06 mm
niv_post_down	+ 04 mm

The fast signal filter is used.

In the event of an inclination (Kerb mode), the control operation takes place for the nominal heights applicable in this situation.

Pre-mode

Pre-mode is activated by the “Load cutout OFF” signal (e.g. in response to opening of the door or unlocking with the radio remote control). The Pre-mode then stays set for 16 minutes and is restarted with a change in status.

The ride height of the vehicle is monitored and evaluated with a wide tolerance band.

In Pre-mode, the vehicle is only controlled up to the nominal height if the level is significantly below the nominal height. This control tolerance ensures that the vehicle is only controlled up in the case of large loads in order to increase the ground clearance prior to departure. Small loads give rise to small compression travel and this is compensated only when the engine is started. This control setting helps to reduce the battery load.

Coding parameter	Value
niv_pre_up_e	- 09 mm
niv_pre_up_d	- 07 mm
niv_pre_down_e	+ 09 mm
niv_pre_down_d	+ 07 mm
niv_pre_mw_up	- 59 mm*
niv_pre_mw_down	0 mm
pre_delay_counter	20 min

* Average figure

With single-axle air suspension, the vehicle is controlled down when the mean value of both ride height signals is > 0 mm and one side is in excess of + 10 mm.

In this mode, only the mean value of the two ride height signals (fast filter) is considered when deciding whether there is a need for a control operation.

There is no inclination detection in Pre-mode.

Normal Mode

Normal mode is the starting point for the vehicle's normal operating state. It is obtained by way of the "Engine running" signal.

Levelling is possible. The compressor starts up as required.

Coding parameter	Value
niv_normal_up_e	- 09 mm
niv_normal_up_d	- 07 mm
niv_normal_down_e	+ 09 mm
niv_normal_down_d	+ 07 mm

A narrower tolerance band than that in Pre-mode can be used because the battery capacity does not have to be protected. The fast filter is used with a narrow tolerance band of ± 10 mm. In this way, ride level compensation takes place outside a narrow tolerance band of ± 10 mm. The faster filter allows the system to respond immediately to changes in ride level. Evaluation and control are performed separately for each wheel.

When a speed signal is detected, the EHC control unit switches into Drive mode. When the vehicle is stopped, the EHC control unit remains in Drive mode. The system switches back into Normal mode only when a door or the luggage compartment lid is also opened. If none of the doors or the luggage compartment lid is opened, the vehicle logically cannot be loaded or unloaded.

This prevents a control operation happening when the vehicle is, for example, stopped at traffic lights and the ride height is above the mean value due to a possible pitching motion at the rear axle.

Drive Mode

Drive mode for the single-axle air suspension is activated when a speed of > 1 km/h is detected.

Coding parameter	Value
niv_drive_up_e	- 07 mm
niv_drive_up_d	- 05 mm
niv_drive_down_e	+ 09 mm
niv_drive_down_d	+ 07 mm

Low-pass filters are used. In this way, only changes in ride height over a prolonged period of time (1000 seconds) are corrected. These are merely the changes in ride height, caused by vehicle compression and a reduction in vehicle mass due to fuel consumption. The high-pass filter (fast filter) is used during the control operation. The slow filters are reinitialized at the end of the control operation. The markedly dynamic height signals caused by uneven road surfaces are filtered out.

Kerb (curb)

Coding parameter	Value
niv_delta_kerb_e	28 mm
niv_delta_kerb_d	24 mm
kerb_delay	<1s

The Kerb mode prevents the inclination caused by the vehicle mounting an obstacle with only one wheel from being compensated. Compensation would cause a renewed inclination of the vehicle and result in a renewed control operation after the wheel came off the obstacle.

Kerb mode is activated if the difference in height between the left and right-hand side of the vehicle is > 24 mm and is present for longer than 0.9 seconds. No speed signal may be present for this mode to be set. The system switches from single-wheel control to axle control.

Kerb mode is quit if the difference between the left and right-hand side of the vehicle is < 28 mm and this difference remains for longer than 0.9 seconds or if the speed is > 1 km/h.

If the system switches from Kerb mode to Sleep mode, this status is stored in the EEP-ROM.

If the vehicle is being loaded or unloaded in Kerb mode, the EHC control unit calculates the mean value for the axle from the changes in ride height determined from the spring travel on the right and left-hand side.

A change in ride level is initiated if the mean value of compression or rebound at the axle is outside the tolerance band of ± 10 mm. The left and right sides of the vehicle are raised or lowered in parallel. The height difference between the two sides is maintained.

Curve

Since rolling motions have a direct impact on the measured ride levels, an unwanted control operation would be initiated during longer instances of cornering with an appropriate roll angle in spite of the slow filtering of the Drive mode. The control operations during cornering would cause displacement of the air volume from the outer side to the inner side of the curve. Once the curve is completed, this would produce an inclination which would result in a further control operation. Curve mode prevents that adjustment by stopping slow filtering when cornering is detected and cancelling any adjustment that may have been started.

Curve mode is activated upwards a lateral acceleration of > 2 m/s2 and deactivated at <

1.0 m/s2. The lateral acceleration is recorded by the DSC sensor.

Substitute conditions:

Coding parameter	Value
time_curve_exit	252 s
niv_delta_curve_e	20 mm
niv_delta_curve_d	16 mm
speed_curve	50 km/h (31 mph)

Lift

The Lift mode is used to prevent control operations when a wheel is changed or during work on the vehicle while it is on a lifting platform.

Coding parameter	Value
niv_lift_up	60 mm
niv_lift_down	Unlimited
kerb_delay	<1s
time_ex_liftdetect	approximately 40 s
speed_lift_exit2	3 km/h

This mode is detected when the permitted rebound travel at one or more wheels is exceeded > 55 mm. A jacking situation is also detected and the ride height stored if the lowering speed drops below the level of 2 mm/ s for 1 second.

If the vehicle is raised only slightly and the permitted rebound travel has not yet been reached, the control operation attempts to readjust the ride height. If the vehicle is not lowered, a car jack situation is recognized after a specific period of time and this ride height is stored.

A reset is performed if the vehicle is again 10 mm below this stored ride height.

Special Modes (Transport, Belt)

Transport mode is set and cancelled by means of diagnostics control. It serves to increase the ground clearance in order to ensure safe transportation of vehicles on transporter trucks. The nominal height of the vehicle is raised in this mode by 30 mm.

When Transport mode is activated, the air suspension symbol is lit on the variable indicator lamp on the instrument cluster and a message is shown on the Check Control display to alert the driver to this special mode.

Control operations do not take place in this mode because the vehicle mass does not change during transportation.

Belt mode is set during assembly in the works to prevent control operations.

When Belt mode is activated, the air suspension symbol is lit in the variable indicator lamp in the instrument cluster and a message is output in the Check Control display to alert the driver to this special mode.

Production-line mode is cleared by means of diagnostics control only. The Belt mode can no longer be set.

New EHC control units (spare part) are supplied with Belt mode set.

Control operations are not performed, the safety concept only operates with limited effect.

Control modes	Single-axle air suspension
Sleep	No control, load cutout on
Post	Approximately 1 minute fast filter 2 s, very narrow tolerance band -59 mm/ -07 mm, control ends at +06/+04 mm
Pre	Approximately 16 minutes fast filter 2 s, wide tolerance band adjusted up at -09 mm, adjusted down at mean value (-59 mm) +09 mm and one side > 10 mm
Normal	Engine running: fast filter 2 s, narrow tolerance band -09 mm/+09 mm
Drive	v > 1 km/h, slow filter 1000 s, narrow tolerance band -07 mm/+07 mm
Kerb	**ON when:** difference between left and right-hand sides of vehicle > 24 mm, longer than 0.9 s changeover from single-wheel control to two-wheel control **OFF when:** difference between left and right-hand sides of vehicle < 28 mm, t = 0.9 s or v > 1 km/h
Curve	**ON when:** lateral acceleration > 2 m/s2 **OFF when:** lateral acceleration < 1.0 m/s2
Lift	**ON when:** rebound travel > 60 mm at one or more wheels **Jack on at:** lowering speed drops below 2 mm/s for 1 s, ride height stored **OFF when:** level change < -10 mm, ride height drops below stored setting by more than 10 mm

Method of Operation

■ Initialization/reset behavior

Different checks and initializations are carried out when the EHC control unit is powered up after a reset (triggered by an undervoltage or also by load cutout off VA_AUS).

The system is only enabled after the tests have been successfully completed and starts to execute the control programs on a cyclical basis. Occurring faults are stored and displayed.

■ Control sequence

In an ongoing control operation, the high-pass filter (fast filter) is always used to prevent the controlled height from overshooting the specified setting.

If a low-pass filter (slow filter) were used to calculate the ride height, brief changes of ride height would be “absorbed”.

The low-pass filter is used when the vehicle is in motion (see Normal mode) to filter out vibrations induced by prevailing road conditions on this basis of this method of filtering.

The high-pass filter is used to respond quickly to ride level deviations from setpoint. These take place while the vehicle is stationary in the event of large load changes (see Pre-mode).

Both sides of the vehicle are controlled individually, i.e. even the setpoint/actual-value comparison for both sides is carried out individually.

Exception: check for falling below the minimum height in Pre-mode and Kerb mode. The left/right mean values are taken into consideration here. The following stipulations are applicable here:

- Raising or lowering
- All valves controlled with control in the same direction
- Individual wheel deactivation

To ensure reliable closing of the non-return valve in the air drier, the exhaust valve is operated briefly for 200 ms by the EHC control unit after each control sequence.

The permissible ON period is monitored while performing upward adjustment operations.

■ Safety concept

The safety concept is intended to inhibit any system malfunction, particularly unintentional control operations, through the monitoring of signals and function-relevant parameters.

If faults are detected, the system is switched over or shut down depending on the components concerned. The driver is informed of any faults by the display, and detected faults are stored for diagnostic purposes.

In order to ensure high system availability, existing faults, as far as possible, are cleared with terminal 15 ON.

This is done by resetting the logistics counter to zero. However, the fault memory content in the EEPROM is retained and can be read out for diagnostic purposes. The system is then operational again. Fast fault detection means that existing faults are detected before control operations can take place.

Only lowering is permitted if:

- the power supply voltage drops below the permissible minimum of 9 volts.
- the permissible compressor duty periods, and therefore compressor temperatures, based on a temperature duty period algorithm* are exceeded.

A reset is carried out if the voltage is within the required range of 9 to 16 volts or after expiry of the compressor pause period of approximately 100 seconds.

Only raising is permitted if:

- The permissible control down period of 40 seconds is exceeded.
- The reset takes place the next time the vehicle is driven or after the next control-up procedure.

No control if:

- The permissible supply voltage of 16 volts is exceeded.

The reset takes place as soon as the voltage is within the required range.

*** Temperature duty period algorithm:**
In order to prevent overheating problems when the compressor is running or when outside temperatures are very high, a temperature duty period algorithm has been implemented.

T_{Start} (starting temperature) is assumed from the coil resistance of the exhaust valve and the theoretical temperature change is calculated on the basis of the change in coil resistance.

Electronic Ride-height Control (EHC)

Control Unit

The EHC control unit is located in a module carrier in the rear of the luggage compartment on the right-hand side.

Rear right module carrier

Index	Explanation	Index	Explanation
1	Air supply (LVA)	2	EHC control module on mounting bracket

The EHC control unit is fully compatible with diagnostics.
The EHC control unit receives the following signals:

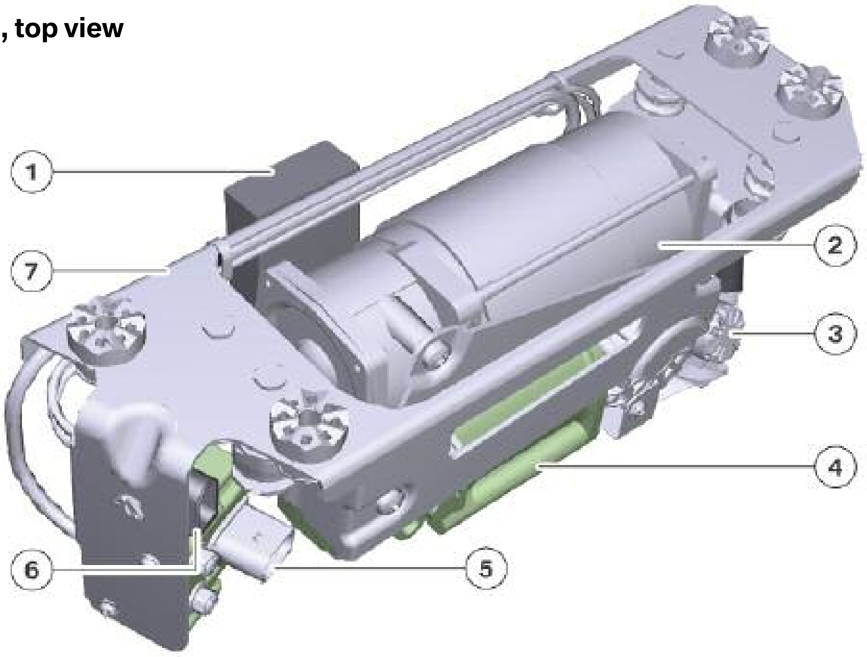
- Vehicle ride height
- Load cutout signals
- Terminal 15 ON/OFF
- Vehicle speed
- Lateral acceleration
- “Engine running” signal
- Hatch status.

The EHC control unit decides on a case-by case basis whether a control operation is required in order to compensate for changes in load.

It is thus possible to optimally adapt the frequency, specified heights, tolerance thresholds and battery load to the relevant situation by means of the control operation.

Air Supply Unit (LVA)

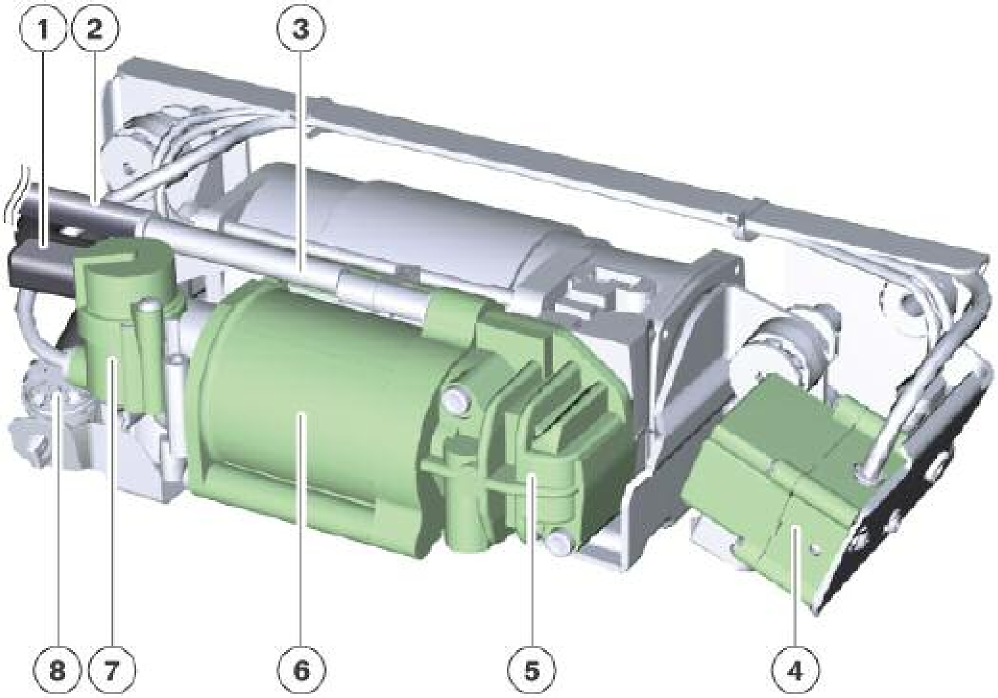
Air supply unit, top view



Index	Explanation	Index	Explanation
1	Compressor relay	5	Electrical connector, 3-pin, for valve manifold
2	Electric motor	6	Electrical connector, 2-pin, for electric motor
3	Air exhaust silencer	7	Component carrier
4	Air drier		

The air supply unit is mounted at the rear of the vehicle on the trunk floor.

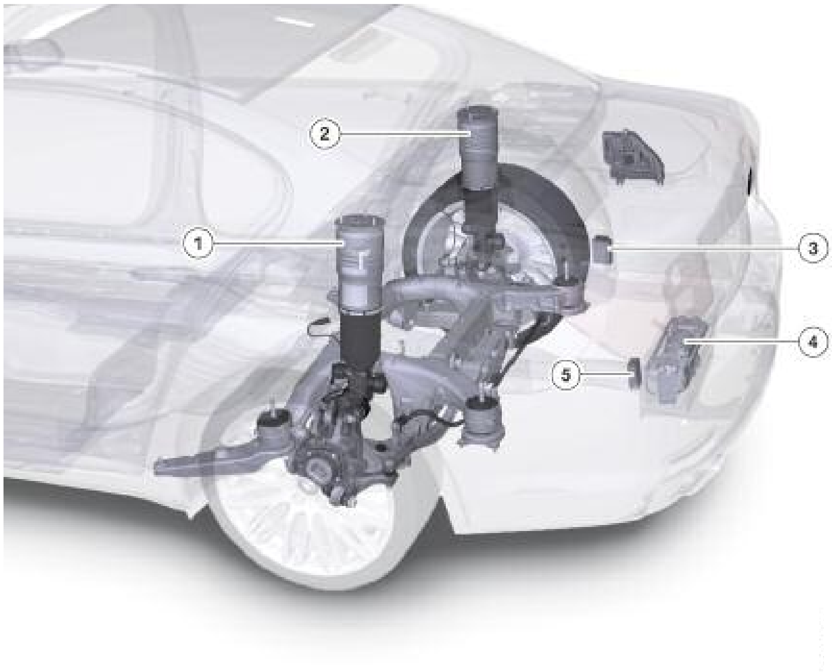
Air supply unit, bottom view



Index	Explanation	Index	Explanation
1	Electrical connector, 2-pin, for exhaust valve	5	Compressor
2	Air intake line to left rear light unit	6	Air drier
3	Air intake	7	Air exhaust valve
4	Valve block	8	Air exhaust silencer

Air Suspension

Components in the vehicle



Index	Explanation	Index	Explanation
1	Left air spring strut	4	Air supply unit
2	Right air spring strut	5	Compressor relay
3	EHC control unit		

Ride-height Sensor

Index	Explanation
1	Electrical connector
2	Sensor housing
3	Lever

The angle of a pivoting lever is converted into a voltage signal by the ride height sensor. The greater the angle (relative to a defined starting or zero position), the greater is the output voltage. It is generated by a Hall-effect sensor element.

■ Designs

There are always four ride-height sensors fitted on all F01/F02 models.

The ride-height sensors fitted all operate according to the same principle but there are different designs (different part numbers). The reason for the differences are the available space and the starting position (zero position) of the individual ride-height sensors.

Depending on whether or not the vehicle is fitted with Electronic Height Control (EHC), double or single ride-height sensors are fitted on the rear suspension.

On the front suspension, single ride-height sensors are always used.

	Front suspension	Rear suspension
EHC, not fitted	Single RHS	Single
EHC, fitted	Single RHS	Double

Table of Contents

F01 Cruise Control Systems

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Cruise Control Systems

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the new functions of DCC and ACC Stop and Go
- Locate DCC and ACC components

Introduction

Trusted Driver Assistance Systems

BMW has long since offered a comprehensive range of driver assistance systems. These make it easier for the driver to control the vehicle, by

- providing the driver with information,
- prompting the driver how to act or
- actively intervening in the way the vehicle is driven.

The systems presented have, for the most part, already been tried and tested in BMW vehicles for many years. These include:

- Cruise control with braking function
- Active Cruise Control with Stop & Go function
- Adaptive Brake Assistant with warning function.

The F01/F02 will see refinements and enhancements to improve customer benefits further still.

Standard and Optional Equipment

The following table is a comparison of standard equipment and options available for driver assistance systems. This comparison is between the E65 and F01:

System	**E65**		**F01**	
	Std.	Optional	Std.	Optional
Higher level Integrated Chassis Management			●	
Driver Assistance Systems				
Cruise control (FGR)	●			
Cruise control with braking function (Dynamic Cruise Control - DCC)			●	
Active Cruise Control		●		
Active Cruise Control with Stop and Go				●
Adaptive Brake Assistant with warning function				●
Active Blind Spot Detection (Lane Change Warning)				●

In the F01/F02, “Dynamic Cruise Control” (DCC) supersedes the cruise control (FGR) function available as standard in the E65.

The optional extra “Active Cruise Control with Stop & Go function” (ACC Stop & Go) provides optimum assistance to the driver not only in smoothly flowing traffic but also in traffic jam situations. Both systems are based on the new architecture of the Integrated Chassis Management (ICM).

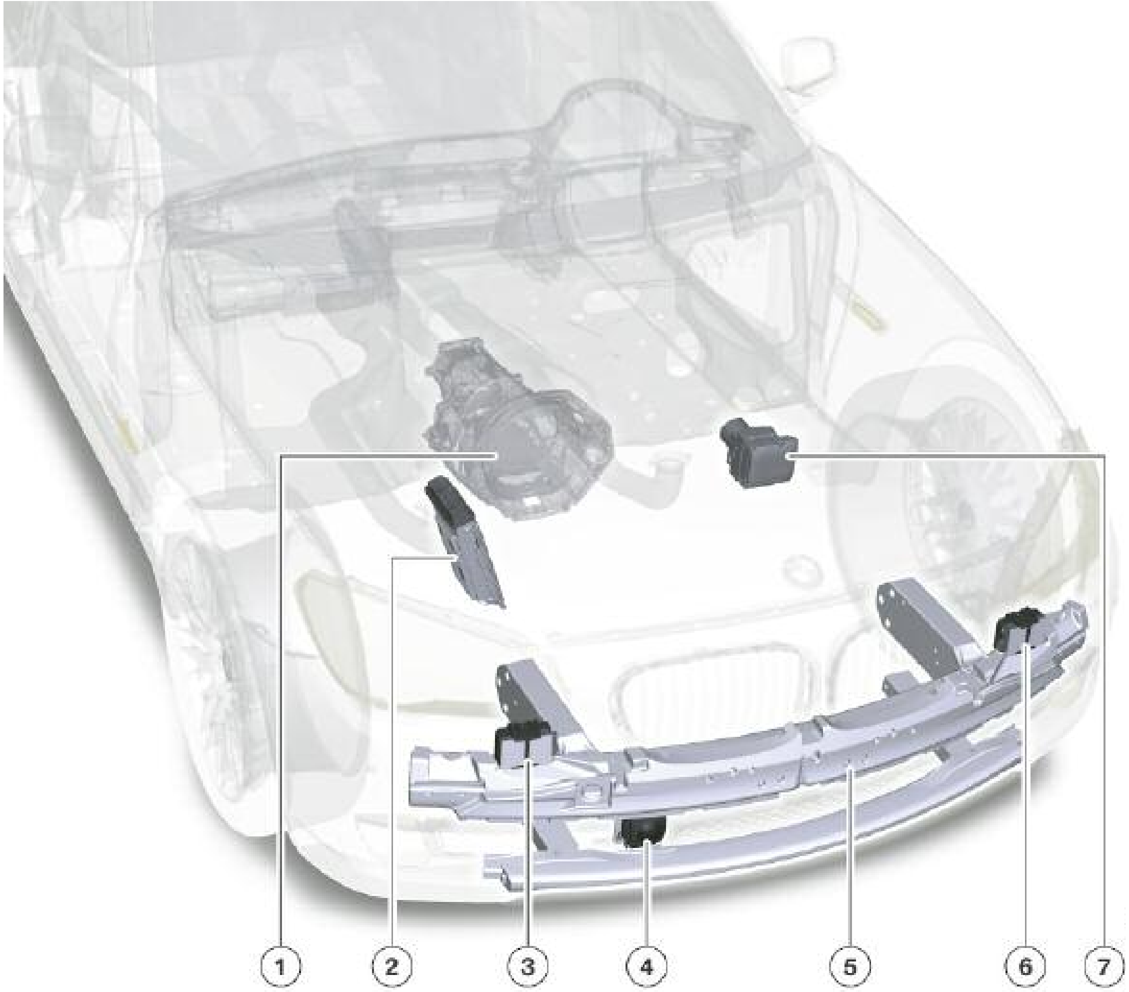
The primary aim of both items of optional equipment, ACC and ACC Stop & Go, is to relax the driver and, therefore, to make an improvement to the comfort/convenience area of the vehicle.

To assist the driver in panic braking situations as well, each of these items of optional equipment has been enhanced by the Adaptive Brake Assistant function. This safety function, which was first available in the E6x LCI, has been supplemented by a new warning function in the F01/F02. It alerts the driver to a risk of collision detected by the long-range radar sensor. This enables the driver to intervene even faster and, potentially, to avoid an accident.

System Overview

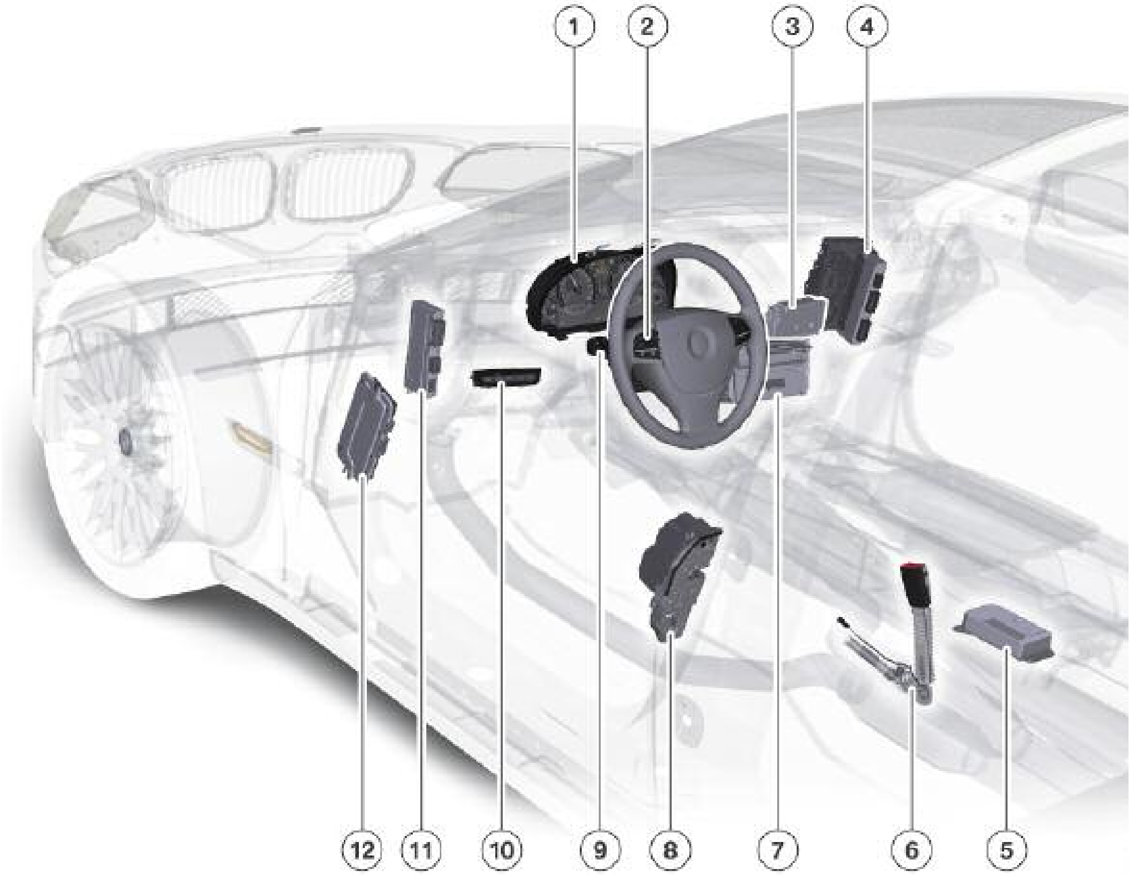
Components in the Vehicle

Components of DCC, ACC Stop & Go in the F01/F02 (view from front)



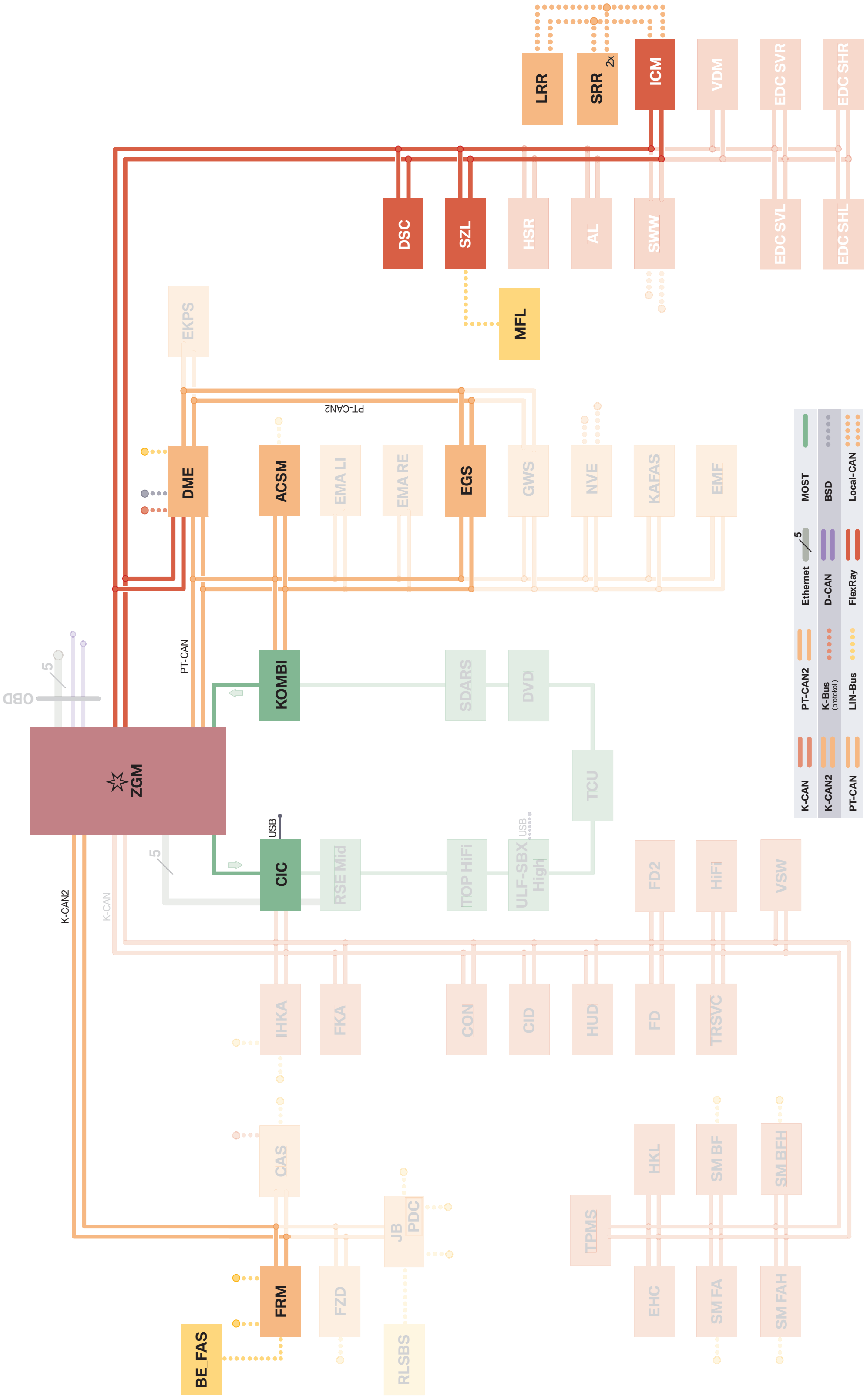
Index	Explanation
1	Electronic transmission control module
2	Engine control system
3	Short-range radar sensor (SRR), right
4	Long-range radar sensor (LRR)
5	Bumper cross-member
6	Short-range radar sensor (SRR), left
7	Dynamic Stability Control

Components of DCC, ACC Stop & Go in the F01/F02 (side view)



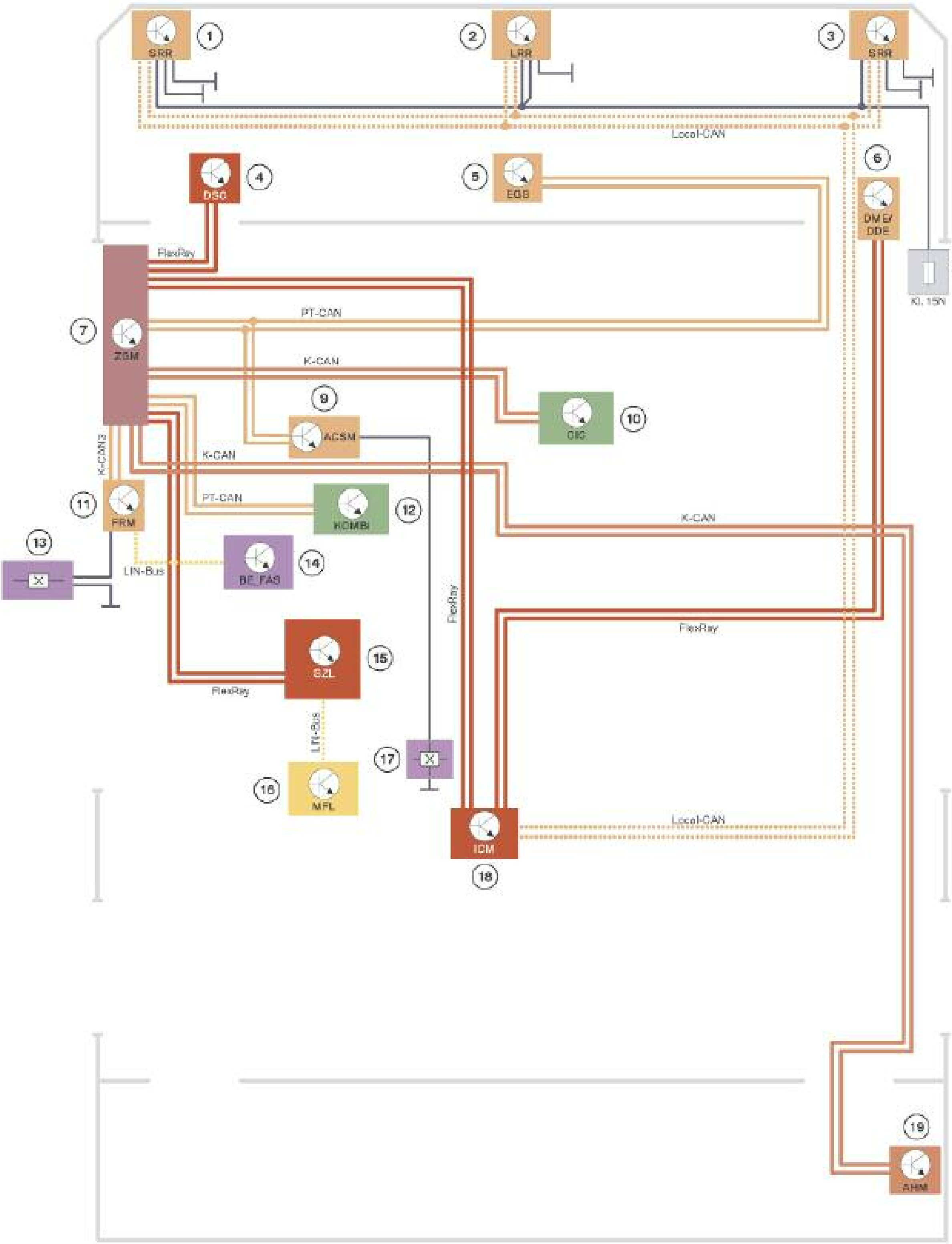
Index	Explanation
1	Instrument cluster
2	Multifunction steering wheel button pad
3	Crash safety module
4	Front fuse carrier, junction box electronics
5	Control unit for Integrated Chassis Management
6	Seat belt buckle contact, driver's seat
7	Car Information Computer
8	Door switch, driver's door
9	Steering column switch cluster with steering angle sensor
10	Driver assistance systems operating unit
11	Central gateway module
12	Footwell module

Bus System Overview



Index	Explanation
ACSM	Crash safety module
BE_FAS	Driver assistance systems operating unit
CIC	Car Information Computer
DME	Digital Motor Electronics
DSC	Dynamic Stability Control
EGS	Electronic transmission control unit
FRM	Footwell module
KOMBI	Instrument cluster
ICM	Integrated Chassis Management
JB	Junction box electronics
LRR	Long-range radar sensor (LRR)
MFL	Multifunction steering wheel button pad
SRR	Short-range radar sensor (SRR)
SZL	Steering column switch cluster with steering angle sensor
ZGM	Central gateway module

System Circuit Diagram

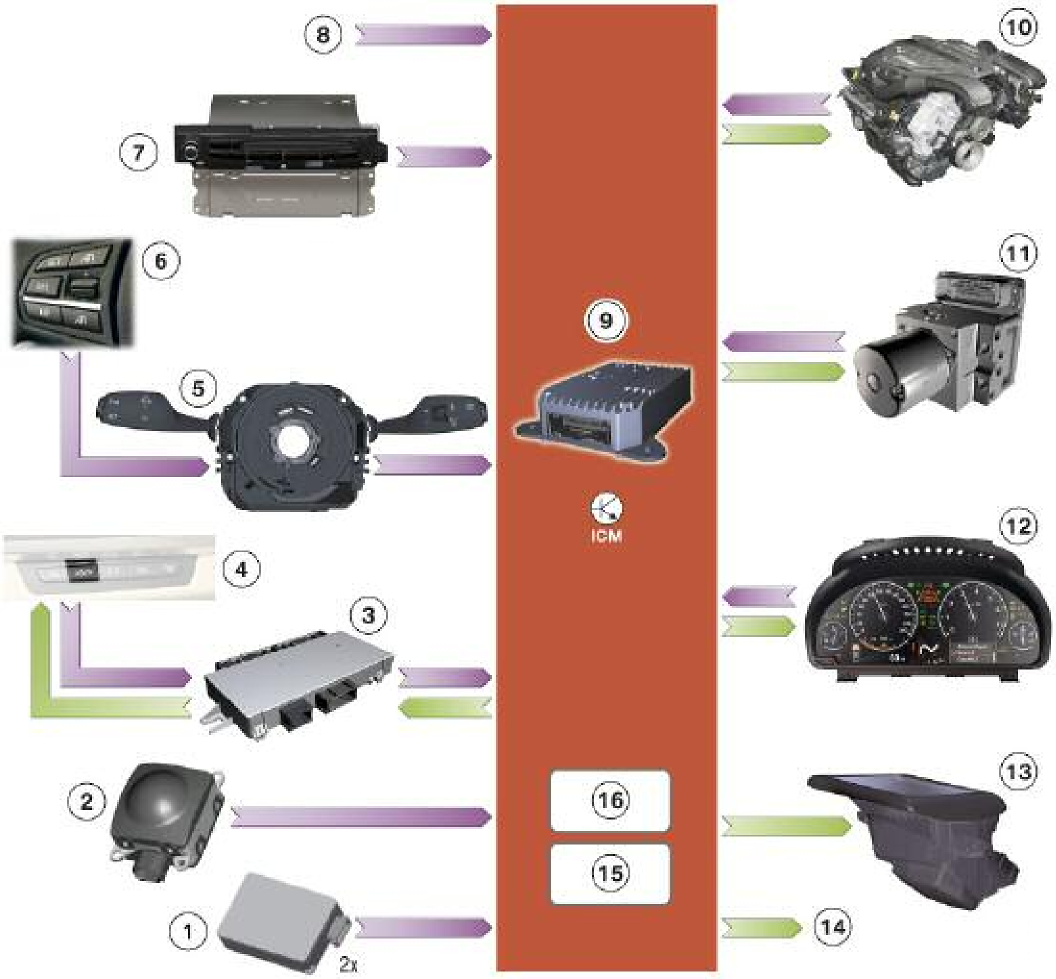


Index	Explanation
1	Short-range radar sensor, left
2	Long-range radar sensor
3	Short-range radar sensor, right
4	Dynamic Stability Control
5	Electronic transmission control unit
6	Digital Motor Electronics
7	Central gateway module
8	Fuse for long-range radar sensor and short-range radar sensors (front fuse carrier, junction box electronics)
9	Crash safety module
10	Car Information Computer
11	Footwell module
12	Instrument cluster
13	Door switch, driver's door
14	Driver assistance systems operating unit
15	Steering column switch cluster with steering angle sensor
16	Multifunction steering wheel button pad
17	Seat belt buckle contact, driver's seat
18	Integrated Chassis Management

Functions

Technical Networking Overview

ACC Stop & Go input/output diagram

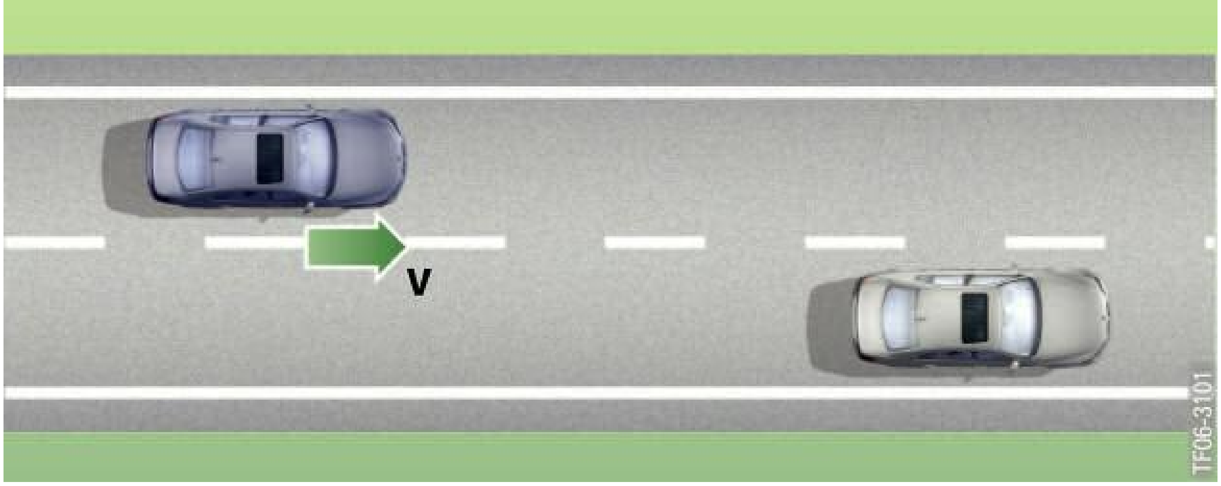


Index	Explanation	Explanation
1	Short-range radar sensors	• Detecting near objects • Pre-processing object data • Transmitting a list of object data to the ICM control unit on the local CAN
2	Long-range radar sensor	• Detecting distant objects, pre-processing object data and transmitting a list of object data for ACC Stop & Go to the ICM control unit on the local CAN • Detecting distant objects, pre-processing object data, establishing trigger criteria for the functions of the Adaptive Brake Assistant and transmitting them to the ICM control unit on the local CAN

Index	Explanation	Explanation
3	Footwell module	• Forwarding button-stroke signals from the driver assistance systems operating unit to the ICM control unit • Forwarding the request of the ICM control unit to activate/ deactivate the function illumination to the driver assistance systems operating unit • Generating the door contact signal (for recognition of driver's intention to get out)
4	Driver assistance systems operating unit	• Evaluating button strokes and transmitting the result to the footwell module • Activating/deactivating the function illumination at the request of the footwell module
5	Steering column switch cluster	• Forwarding the operating signals from the MFL button pad to the ICM control unit (for DCC/ACC Stop & Go) • Generating a number of other signals (e.g. steering wheel angle, turn signal operation)
6	MFL button pad	• Generation of driver control signals (for DCC/ACC Stop & Go)
7	Car Information Computer	• Generating the GPS position (deactivation of the short-range radar sensors of ACC Stop & Go in the vicinity of radio astronomy stations) • Generating road type and course of road segments to permit adaptation of controller parameters by ACC Stop & Go • Setting selected by the driver for collision warning of the Adaptive Brake Assistant
8	Other input signals	• Terminal status, engine running (from CAS) • Drive position of the automatic transmission (from EGS) • State of driver's seat belt buckle contact (from ACSM) • State of all actuators (e.g. drive, DSC, EMF, Kombi) necessary to the operation of DCC/ACC Stop & Go
9	Integrated Chassis Management (ICM)	• Analysis of objects and selection of relevant object (for ACC Stop & Go) • Interpretation of operating signals and generation of display signals (for DCC/ACC Stop & Go) • Regulation of straight-line speed and cornering speed (for DCC/ ACC Stop & Go) • Distance regulation (for ACC Stop & Go) • Control of drive train and brake actuators by outputting nominal values to the FlexRay (for ACC Stop & Go) • Gateway between local CAN and FlexRay (for diagnostics and programming of the long-range radar sensor) • Gateway between local CAN and FlexRay (for the functions of the Adaptive Brake Assistant)

Index	Explanation	Explanation
10	Drive train, comprising engine and transmission (DME and EGS)	• Implementation of the nominal values of the ICM control unit (for DCC/ACC Stop & Go) • Generation of signals from drive forces (for DCC/ACC Stop & Go)
11	Dynamic Stability Control (DSC)	• Implementation of the nominal values of the ICM control unit (for DCC/ACC Stop & Go) • Monitoring of stationary vehicle with ACC Stop & Go active • Implementation of the functions of the Adaptive Brake Assistant at the request of the ICM control unit (precharging of the brake system and reduction in the threshold of the hydraulic Brake Assistant) • Supply of signals relating to motion status of the car and brake pressure
12	Instrument cluster	• Implementation of the displays requested by the ICM control unit (for DCC/ACC Stop & Go and for the collision warning of the Adaptive Brake Assistant) • Generation of the signal for displayed speed (for DCC/ACC Stop & Go)
13	Head-up display	• Implementation of the displays requested by the ICM control unit (for DCC/ACC Stop & Go and for the collision warning of the Adaptive Brake Assistant)
14	Other output signals	• Calling up the Assistant window for setting the collision warning time (on CIC)
15	Control functions	• The control functions for both DCC and ACC Stop & Go are integrated into the ICM control unit
16	Status control	• ICM controls the status of DCC and ACC Stop & Go in accordance with received operating signals (and other signals). The status is needed outside the ICM control unit specifically for display information in the instrument cluster and in the head-up display • The activation and deactivation of the collision warning is also controlled by the ICM.

Cruise Control with Braking Function



Cruise control

The cruise control with braking function has already featured in the BMW 3 Series (E9x). It is also referred to as “Dynamic Cruise Control” (DCC).

It relieves the burden on the driver on quiet roads by maintaining a constant speed regardless of the resistance to vehicle motion (gradient, payload).

It also offers the driver the opportunity to adjust the set speed in small or large increments, which is then set and maintained by the system by controlling power output and braking. The brakes are also controlled during steep downhill driving if sufficient deceleration is not achieved by engine drag-torque alone.

Dynamic Cruise Control in the F01/F02 is not computed in the DSC control unit as it is in other vehicles. Instead, it has been integrated into the ICM control unit.

The function has, of course, been newly configured for optimum compatibility with the F01/F02. Due to the new vehicle interior, there are differences in how the function is operated and how information is displayed by comparison with the function implemented in other vehicles. These are described here.

Operation and display

In the F01/F02, Dynamic Cruise Control is no longer operated by means of an operating lever. Instead, the driver can operate the function conveniently using a button pad on the multifunction steering wheel.

Index	Explanation
1	SET button to activate
2	Rocker switch to change the set speed
3	I/0 button to switch on and off
4	RES button to resume a stored set speed

To prevent accidental activation, the function remains inoperable until the I/0 button has been pressed after the vehicle has started. This switches the function to standby. This state is acknowledged in the instrument cluster by a green indicator light lighting up.

With the function in standby, the driver is now able to activate cruise control. To do this, the driver can press the SET button used to store the vehicle’s current road speed as the set speed. An active state is indicated by a green indicator light in the circumference of the speedometer dial lighting up.

There is an alternative way to activate the function if a set speed has already been stored. This is indicated by an orange indicator light in the circumference of the speedometer dial. If the driver wants to use this speed value as the set speed, he simply has to press the RES button. Dynamic Cruise Control then accelerates or decelerates the vehicle to this speed value automatically.

While the function is active, the driver is able to increase or decrease the set speed at any time. There are two adjustment increments available. The rocker switch offers two different increments in either direction. First, the set speed is altered in increments of 1 km/h each time the rocker switch is pressed; second, it is altered in increments of 10 km/h.

Note: In the F01/F02, the adjustment range for the set speed is 30 km/h (18 mph) to 230 km/h (142mph).

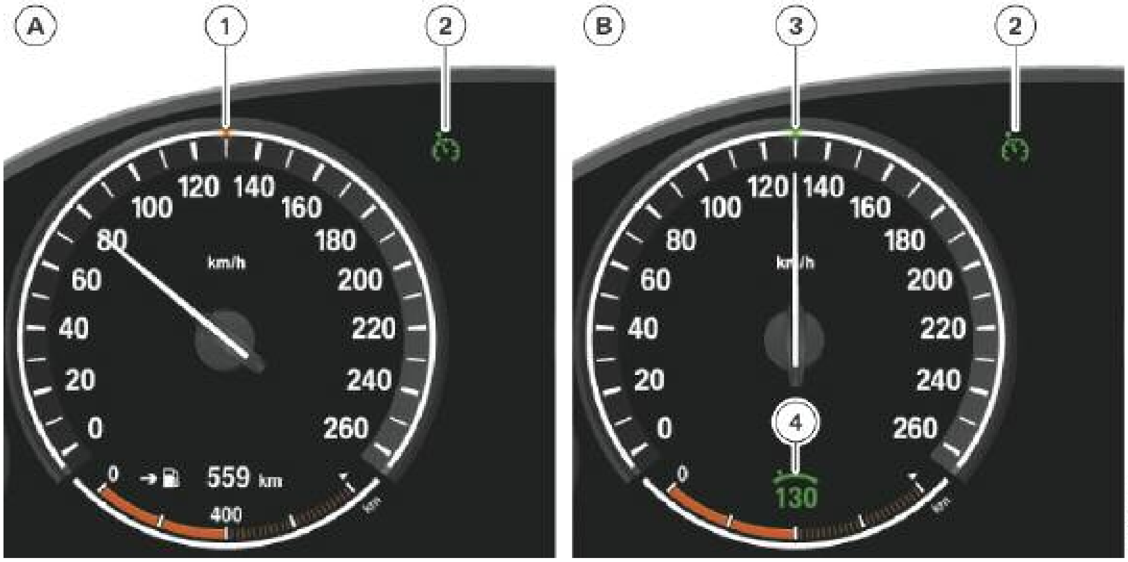
If the rocker switch is pressed and held, the system will accelerate/decelerate the vehicle until the rocker switch is released. This is known as a “comfort dynamics” function as featured in the E9x and E6x LCI.

To deactivate the system, the driver can simply operate the brake pedal like before.
Or, the driver can deactivate the system by pressing the I/0 button. The system is then returned to standby and keeps the set speed last used stored in its memory.

If the driver then presses the I/0 button once more, the system is completely switched off and the green indicator light in the instrument cluster goes out.

There follows a summary of the most important displays for Dynamic Cruise Control.

Dynamic Cruise Control displays in the F01/F02

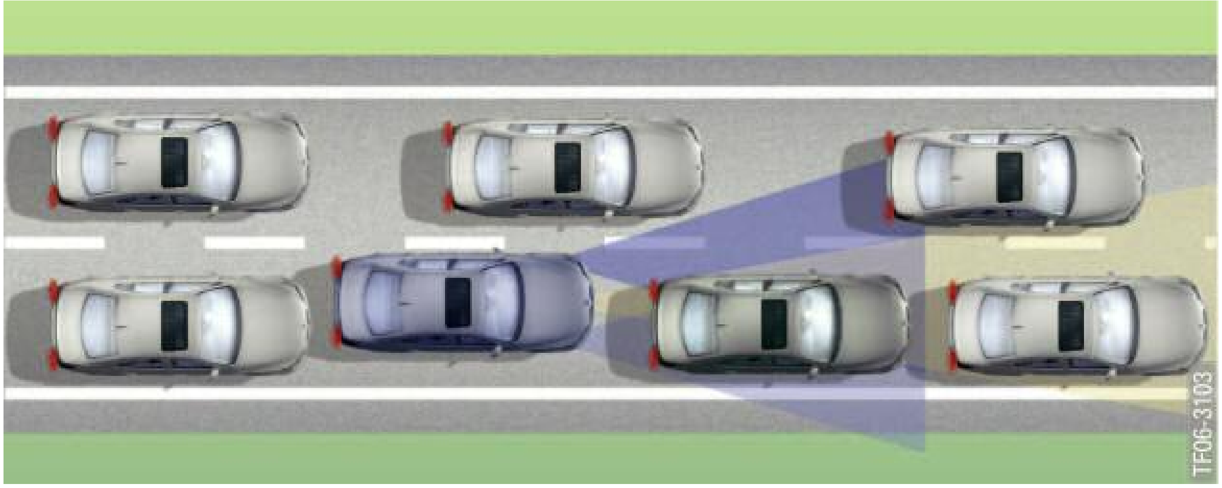


Index	Explanation
A	"Standby" state
B	"Active" state
1	Orange LED: set speed of 130 km/h (81 mph) stored
2	Indicator light for Dynamic Cruise Control
3	Green LED: actively maintaining a set speed of 130 km/h (81 mph)
4	Set speed displayed numerically: briefly displayed at the time of function activation or whenever the set speed is changed

In the event of particular operating states, the displays shown here are supplemented by information messages displayed below the speedometer. This is the case, for instance, if the driver attempts to activate the system even though not all the activation criteria have been fulfilled (e.g. speed less than 18 mph).

In the F01/F02, a difference in the way Dynamic Stability Control interacts with Dynamic Cruise Control has been introduced. This is explained by the following example: Using the “Dynamic Performance Control”, the driver has selected a mode in which DSC is inactive (e.g. “Sport+” mode). If the driver now activates cruise control, DSC will be activated automatically. This is accompanied by an automatic changeover from “Dynamic Performance Control” to “Normal” mode. In previous vehicles, the driver was unable to activate cruise control without activating DSC manually first.

Active Cruise Control with Stop & Go Function



Traffic jam situation

The ACC Stop & Go function in the F01/F02 is largely identical to that in the E6x LCI.

ACC Stop & Go extends the operating range of the former ACC system to include low speeds down to a standstill. In other words, speed and distance from the vehicle in front are automatically controlled at those speeds as well.

ACC Stop & Go will automatically stop the car if necessary and then indicate to the driver as soon as it detects that it is possible to start moving again. To pull away again, the driver has to acknowledge this message. The pulling-away process is controlled fully automatically by ACC Stop & Go only if the duration of the standstill is very short.

Thus, ACC Stop & Go provides optimum assistance for the driver not only in moving traffic but also in traffic jams such as are more and more frequently encountered on highways. However, this system (in common with ACC) is not intended for use in urban areas for negotiating junctions or traffic lights.

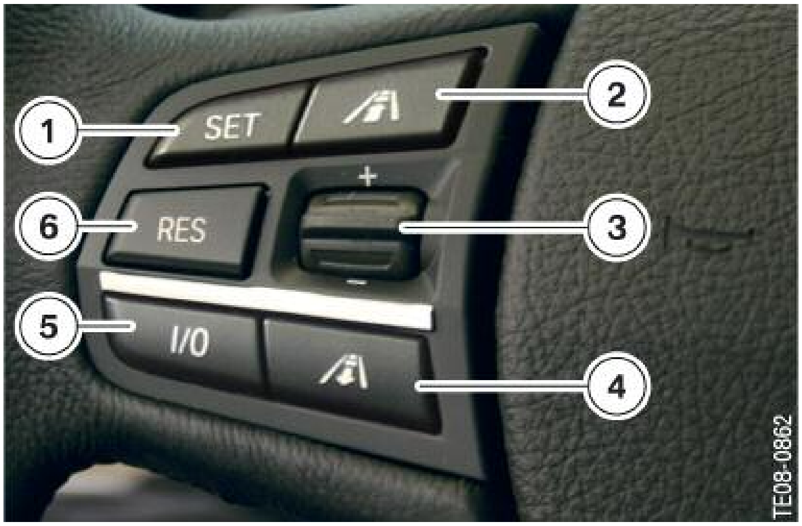
The functions of ACC Stop & Go in the F01/ F02 differ from those in the E6x LCI in the following areas:

- Operation and display
- Behavior in response to driver’s intention to get out.

Operation and display

ACC Stop & Go and DCC are activated/ deactivated in a very similar way. The driver is able to activate ACC Stop & Go not only while the vehicle is in motion, but also when the vehicle is stationary, provided the system has detected another vehicle in front. To activate ACC Stop & Go at a standstill, the driver has to depress the brake pedal and press the SET or RES button at the same time. The activation conditions that applied to the E6x LCI similarly apply here:

- Brake pedal must not be depressed
- Automatic transmission must be in Drive
- Parking brake must not be activated
- Radar sensors must be operational and not dirty
- There must be no system fault present.



Index	Explanation
1	SET button to activate
2	Button for reducing the distance
3	Rocker switch to change the set speed
4	Button for increasing the distance
5	I/0 button to switch on and off
6	RES button to resume a stored set speed

If Dynamic Stability Control was inactive before, in the F01/F02 it is activated as soon as ACC Stop & Go is activated. At the same time, the “Dynamic Performance Control” automatically changes to “Normal” mode (same behavior as for DCC).

Similarly, ACC Stop & Go cannot be deactivated by means of the I/0 button while the vehicle is stationary unless the brake pedal is depressed at the same time.

Note: In the F01/F02, the adjustment range for the set speed is 30 km/h (18 mph) to 230 km/h (142mph).

By comparison with DCC, a vehicle with ACC Stop & Go has an MFL button pad that additionally features two buttons for making distance adjustments.

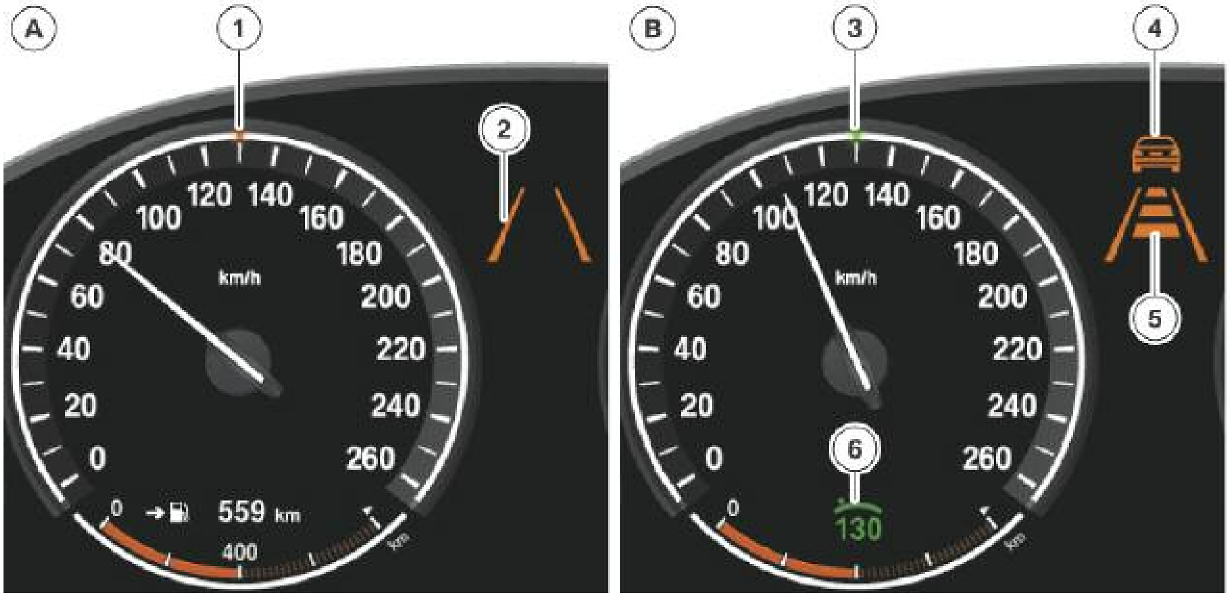
Each (short) button stroke to change the distance increases the desired distance used by ACC Stop & Go for its control process by one increment at a time. A total of four increments are available to the driver.

The most important display functions of ACC Stop & Go in the F01/F02 are illustrated below.

As with DCC, the display symbols for ACC Stop & Go are supplemented by messages displayed below the speedometer as and when necessary.

If the vehicle is equipped with the head-up display option, the ACC displays also appear there, provided the driver has configured them to do so.

ACC Stop & Go displays in the F01/F02

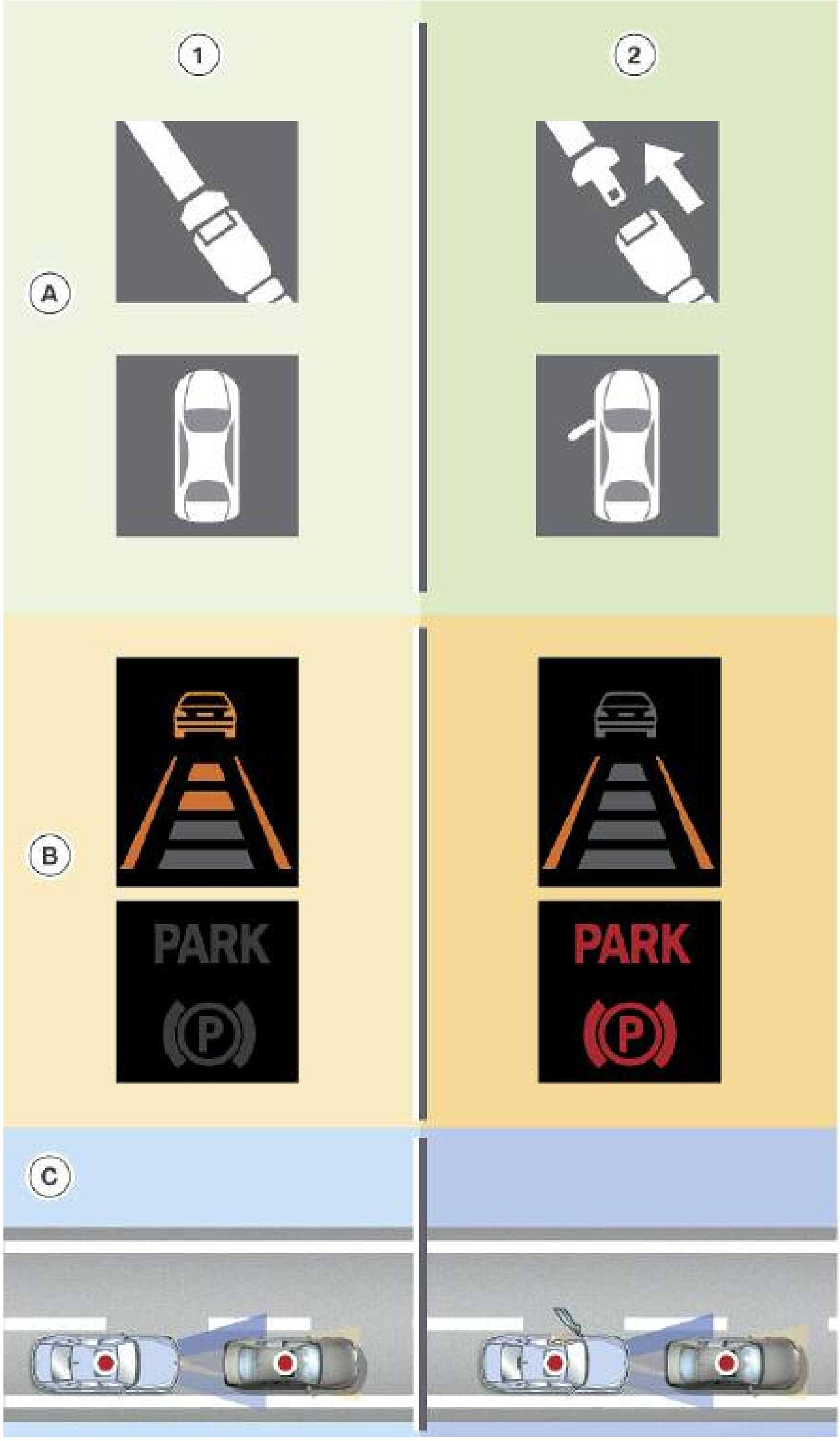


Index	Explanation
A	"Standby" state
B	"Active" state
1	Orange LED: set speed of 130 km/h (81 mph) stored
2	Lines that indicate "standby" mode
3	Green LED: set speed of 130 km/h (81 mph) selected by the driver (the speedometer needle is not pointing at the LED here because the vehicle in front is travelling slower than the set speed)
4	Car symbol: vehicle ahead detected by ACC Stop & Go
5	Bars: represent the distance increment selected by the driver
6	Set speed displayed numerically: briefly displayed at the time of function activation or whenever the set speed is changed

Behavior in response to the driver's intention to get out

ACC Stop & Go uses the DSC hydraulics to reliably slow the vehicle to a halt and keep it stationary.

Without a supply of electricity, the DSC hydraulics are, however, unable to indefinitely maintain the braking force necessary to keep the vehicle stationary.



Index	Explanation
A	State of driver's seat belt and driver's door
B	Displays of ACC Stop & Go and parking brake in the instrument cluster
C	Road traffic situation or perceptible response of vehicle with ACC Stop & Go
1	ACC Stop & Go is active and has automatically braked the vehicle to a halt behind a vehicle in front. The DSC hydraulics hold the vehicle stationary (and are monitored by the DSC control unit).
2	The driver has undone the seatbelt and opened the driver's door. This is evaluated as an unequivocal signal for the driver's intention to get out. DSC detects this state and activates the parking brake function. As a result, the vehicle can be held stationary for any length of time, even if the driver gets out. The parking brake indicator light indicates that the parking brake has been applied. ACC Stop & Go detects that the parking brake has been applied and switches off automatically.

By contrast with the E6x LCI, the F01/F02 is equipped with an electromechanical parking brake (EMF). This is able to assume the function of holding the vehicle stationary if

- DSC is no longer able to maintain the hold function due to a fault or overload,
- the driver gets out or
- the engine is switched off.

Thanks to the EMF, therefore, ACC Stop & Go also benefits from improvements designed to enhance comfort while the vehicle is stationary. Drivers of an E6x LCI had to be issued with a warning if they were about to get out with ACC Stop & Go still active. They were reminded to secure the vehicle against rolling away. They had to apply the parking brake manually.

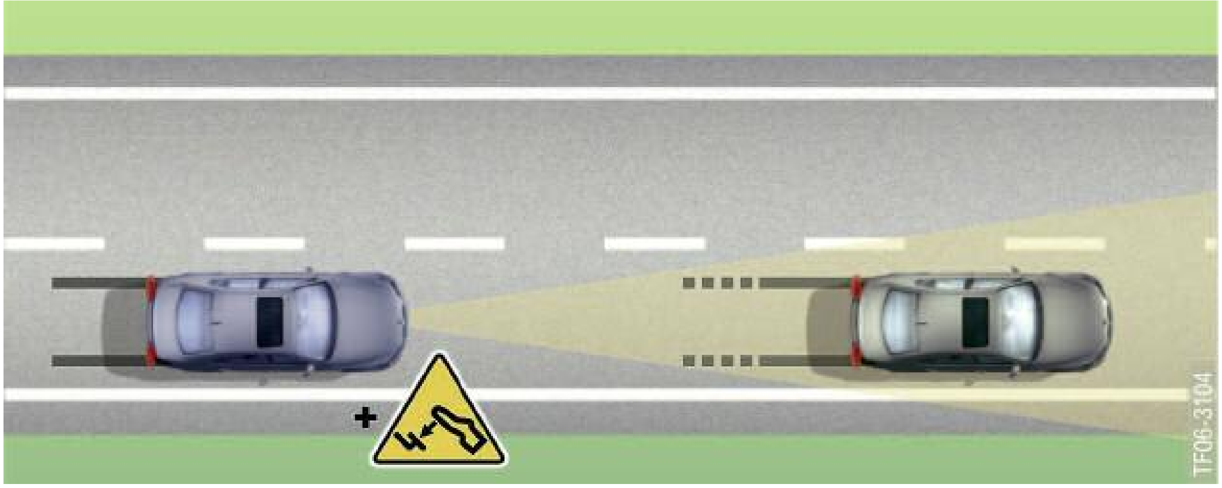
In the F01/F02, however, the parking brake function of the EMF is activated automatically whenever the driver is about to get out of the vehicle with ACC Stop & Go still active.

The driver’s intention to get out of the F01/ F02 is detected by the signals of the seat belt buckle contact (driver’s) and door contact (driver’s door). A signal from the seat occupancy detection (driver’s seat) is not used in the F01/F02.

While the vehicle is being held stationary by ACC Stop & Go, the DSC unit takes over all monitoring and control processes. The DSC also controls the system’s behavior in response to the driver’s intention to get out of the vehicle. For ACC Stop & Go, this is absolutely identical to that implemented for the DSC-internal Automatic Hold function (see the “F01/F02 longitudinal dynamics systems” Product Information).

ACC Stop & Go is deactivated automatically if, from the bus signals it receives, it detects that the parking brake function has been activated. Now the vehicle is still held stationary but by the parking brake function instead.

Adaptive Brake Assistant with Warning Function



Panic braking situation

As Featured in the E6x LCI

The Adaptive Brake Assistant has been carried over from the E6x LCI. This function is included automatically if the customer orders the ACC Stop & Go option, or in some countries, the ACC option.

Adaptive Braking Assistance offers the greatest benefit in situations where the vehicle is following another vehicle. If the vehicle in front brakes hard, it is detected by the long-range radar sensor. The two subfunctions of

- precharging the brake system (also known as the “brake readiness” function) and
- lowering the threshold for the hydraulic Brake Assistant

assist the driver to perform the braking operation to best effect and thus in the best case to avoid a rear-end collision with the vehicle in front.

In the F01/F02, this function is no different from the function implemented in the E6x LCI. The long-range radar sensor gathers data on the road users ahead of the vehicle. The data are supplemented by data relating to the driving status of the customer’s vehicle, and both types of data are used as a basis for calculating a collision avoidance rate of deceleration. This is the rate of deceleration at which the driver would have to brake in order to avoid a collision with the vehicle in front. If the calculated collision avoidance deceleration is above a stored threshold value, the brake system begins to precharge and the activation threshold for the hydraulic Brake Assistant is reduced.

All sensor-related and processing functions of Adaptive Braking Assistance are computed in the long-range radar sensor. However, the computed output variables have to be transmitted to the DSC control unit because that is where they are put into action. To make this possible, the ICM control unit acts as a gateway between the local CAN and the FlexRay.

In the DSC control unit, there are still more conditions that need to be fulfilled before these two subfunctions can be carried out. (Example: road speed must be higher than a defined minimum speed.)

However, the Adaptive Braking Assistance technology also has limits and cannot react fast enough in situations such as other road users cutting in right in front of the vehicle. Driving with care and anticipation remains the fundamental imperative even with Adaptive Braking Assistance!

Note: The Adaptive Brake Assistant and its subfunctions ,precharging the brake system and lowering the threshold for the hydraulic Brake Assistant are always active and does not have to be switched on separately by the driver.

New warning function

In the F01/F02, the Adaptive Brake Assistant is supplemented by a warning function. This useful “collision warning” is designed to draw the driver’s attention to hazardous situations in good time. The driver is then assisted by the subfunctions of the Adaptive Brake Assistant, which provide optimum deceleration in this kind of emergency situation.

The driver is able to switch the collision warning on and off. Its state (on/off) remains stored for the duration of the current driving cycle (key-specific).

The field of application in which the collision warning offers the greatest benefit to the customer is as follows: The customer is driving behind a vehicle that brakes suddenly and hard.

If the customer has activated the collision warning, he is given notification in two stages that a hazardous situation has been detected and the customer is thereby prompted to intervene:

- Advance warning
- Acute warning.

The time at which the warning has to be issued is, again, calculated by the long-range radar sensor based on the collision avoidance deceleration. Each warning stage has its own threshold values.

Setting the warning time

Collision warning

Pre-warning time

✓ Early

Late

Off

Setting the advance warning

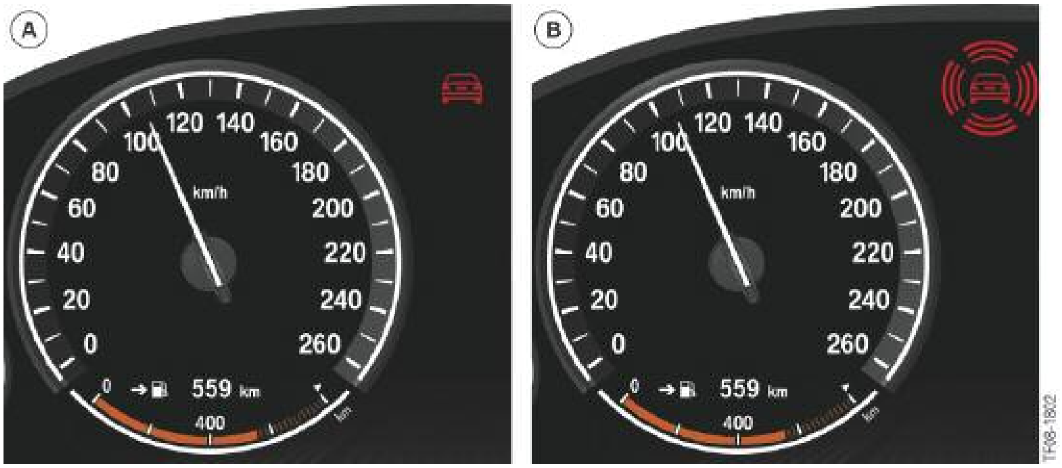
In the event of an advance warning, powerful braking by the driver is sufficient to allay the situation. If the acute warning is issued, the driver must brake immediately and with maximum force to avoid a collision.

The driver has some control over the threshold value for the activation of the first stage, the advance warning. From an Assistant window in the Central Information Display, the driver is able to select one of three warning times for the advance warning:

- Early
- Late
- Off (no advance warning given).

For the collision warning, the ICM control unit is responsible for the following control tasks. The switching on and off, the activation conditions, the fault monitoring and the adjustment of the warning time are all computed by the ICM. In addition, the ICM control unit forwards the warning request from the long-range radar sensor to the instrument cluster and (if fitted) the head-up display, where the warning is issued.

Issuing of the warning

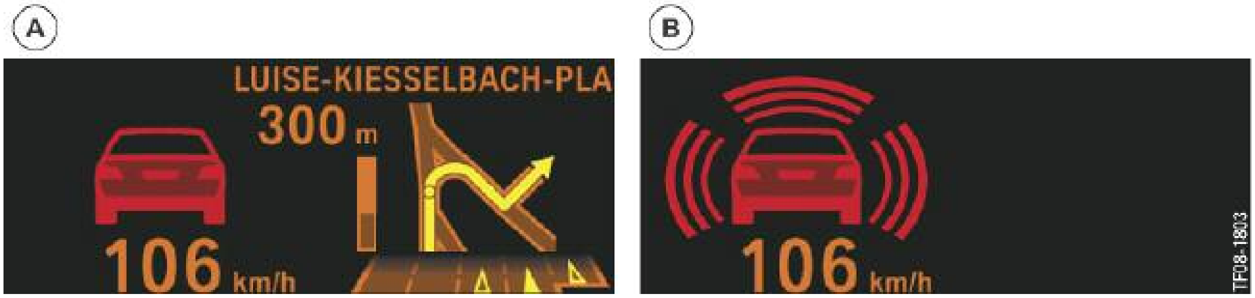


Collision warning in the instrument cluster

Index	Explanation	Index	Explanation
A	Stage 1: Advance warning	B	Stage 2: Acute warning

The advance warning is represented by the red car symbol in the instrument cluster. In the event of an advance warning, it lights up constantly. As there is no audible signal, this visual warning signal is the only signal for the advance warning.

In the event of an acute warning, the car symbol in the instrument cluster begins to flash. Since an immediate intervention by the driver is required, this visual signal is supplemented by an audible tone.



Collision warning in the head-up display

Index	Explanation	Index	Explanation
A	Stage 1: Advance warning	B	Stage 2: Acute warning

This particular high-frequency tone is used only for the acute warning and differs distinctly from other tones that are issued, e.g. with Check Control messages.

If the vehicle is equipped with the head-up display, the visual displays of the collision warning are seen by the driver even more directly and therefore even sooner.

In the head-up display, the advance warning is represented by a significantly enlarged red car symbol. As with the instrument cluster display, the advance warning is indicated by the symbol lighting up constantly.

In the event of an acute warning, the car symbol in the head-up display begins to flash. At the same time, the parts of the display that are irrelevant to this emergency situation are hidden so as not to distract the driver unnecessarily. These displays include those of the navigation system, for example. As soon as the acute warning is over, all the displays in the head-up display re-appear. The same distinctive tone for the acute warning is used in vehicles with head-up display.

Note: The collision warning is active only if the driver has switched it on at the driver assistance systems operating unit.

As the advance warning is the first warning stage, its timing is configurable but it can also be switched off.

Fault states

The functions of the Adaptive Brake Assistant depend on the faultless operation of the long-range radar sensor in particular, but also of the ICM control unit and the DSC unit. If one of these essential system components is limited in its availability in any way, these functions may no longer work correctly and would need to be deactivated.

The driver is given notification of this condition. If, for example, a fault is present at the time the system is switched on, the function illumination of the collision warning will not be activated. From this, the driver can infer that the collision warning is not available.

If a fault were to occur some time after the system was switched on, the driver could fail to see the function illumination go out. For this reason, a Check Control message is issued as an additional warning measure. There are two different symbols, and each one is supplemented by a relevant instruction.

	
Collision warning deactivated (due to unfavorable operating conditions, e.g. dirty long-range radar sensor)	Collision warning failure (due to genuine faults or defective components)

Vehicle-specific Modifications in Detail

Long-range Radar Sensor

In terms of physical design, the long-range radar sensor (LRR) for ACC Stop & Go in the F01/F02 is largely identical to the one fitted in the E6x LCI.

Functionally, however, it differs from the sensor in the E6x LCI in that it also calculates the new collision warning of the Adaptive Brake Assistant.

In the F01/F02, the long-range radar sensor no longer has a connection to the wake-up line. Instead, it is supplied with power by terminal 15N and is thus hard switched. Terminal 15N is tapped off at the front fuse carrier. The long-range radar sensor contains a terminating resistor (for the local CAN) as it does in the E6x LCI.

The installation location of the long-range radar sensor and the way it is mounted have been adapted to the structural conditions specific to the F01/F02.

Installation location of the long-range radar sensor in the F01/F02

Index	Explanation	Index	Explanation
1	Fixed bearing	4	Housing/radome
2	Connector	5	Screw for vertical adjustment
3	Screw for horizontal adjustment	6	Bracket

Note: In the F01/F02, the long-range radar sensor is fitted with the connector at the top. It should therefore be noted that the adjustment screws have had to be relocated.

Note: Adjusting the long-range radar sensor on vehicles with Integral Active Steering: Before the adjustment device is set up and the actual adjustment work can begin, it is necessary to bring the actuator for the rear-wheel steering to the straight-ahead position. It is essential that the instructions of the diagnostic system and Repair Instructions be observed.

■ Short-range radar sensors

The short-range radar sensors (SRR) used for ACC Stop & Go in the E6x LCI have undergone a hardware revision. New, integrated switch circuits have been implemented. The principle of operation, however, is much the same. The table below compares the sensors' properties with those of the Lane Change Warning.

Characteristic	Radar sensors for Lane Change Warning	Short-range radar sensors for ACC Stop & Go
Modulation method	LF MSK (Linear Frequency Modulation Shift Keying)	PD (pulse doubler)
Mid-range transmission frequency 24 GHz	24 GHz	24 GHz
Bandwidth	100 MHz	> 1 GHz
Distance measurement	Based on the propagation time of one chirp[1]	Based on pulse propagation time
Measurement of 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 measured object)	At least 50 m, up to 70 m	At least 10 m, up to 20 m
Horizontal angular width of beam	Approximately -70° to +80°	+/-40°
Vertical angular width of beam	Approximately +/-6.5°	Approximately 20°

[1] Characteristic signal segment with changing frequency

Note: As in the E6x LCI, the short-range radar sensors cannot be programmed. While they do have a self-diagnostics function, accessing the ICM control unit is the only means by which it is possible to read their fault code memory entries.

The short-range radar sensors on the left and right are identical, as they are in the E6x LCI. Each of the short-range radar sensors detects its respective installation position from the pin that is assigned to ground in the wiring harness.

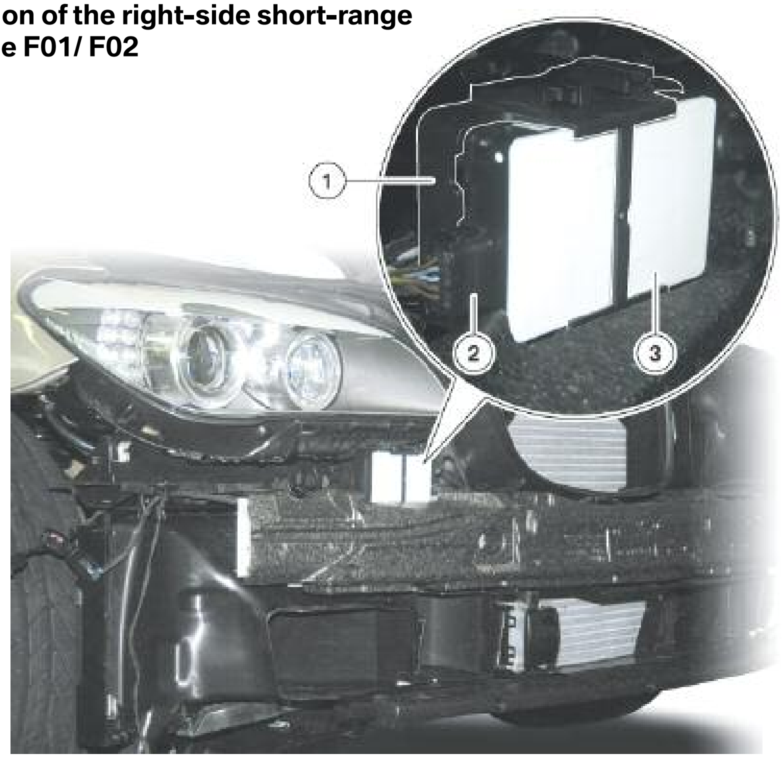
In the F01/F02, the short-range radar sensors -like the long-range radar sensor - are supplied with power by terminal 15N, which is supplied in turn by the front fuse carrier. There is no connection to the wake-up line.

The local CAN is connected to the short-range radar sensors by two short stub lines, which begin at the long-range radar sensor.

The short-range radar sensors have no terminating resistor for the local CAN.

The F01/F02 and the E6x LCI differ greatly in the installation location of the short-range radar sensors and in the way they are mounted. The key differences are illustrated here using as an example a short-range radar sensor fitted on the right-hand side when viewed in the direction of travel.

Installation location of the right-side short-range radar sensor in the F01/ F02



Index	Explanation	Index	Explanation
1	Bracket	3	Housing/antenna cover
2	Connector		

In the F01/F02, the short-range radar sensors are fitted on top of the bumper carrier (and no longer on its front). For this reason, the bracket had to be completely redesigned. It now grips the housing of the short-range radar sensor from behind. To guarantee the necessary level of stability and reliability, the bracket now also has a reinforcement rib. This runs vertically to the front of the antenna cover. The rib was positioned here in order to minimize its interference with the propagation of radar waves.

Note: The material for the bracket (and thus for the rib) was also selected specifically for this particular application. Emergency repairs that use other plastic parts are not permitted. Otherwise, there is a risk that the short-range radar sensors may not work correctly.

For the short-range radar sensors, a distinction is made between the following types of fault:

- **Sensors dirty:** The short-range radar sensors can no longer function reliably if their antenna is covered by snow, slush or ice. If this condition is detected, a corresponding signal is sent to the ICM control unit. The ACC Stop & Go function is deactivated as a result. A separate Check Control message informs the driver about this special case. There is no fault code memory entry.
- **External interference with radar signal processing:** Radar sensors used by other vehicle manufacturers may interfere with the signal evaluation of the short-range radar sensors. If such a problem is detected, the ACC Stop & Go is deactivated. It can be switched on again by the driver as soon as the vehicle is far enough away from the vehicle causing the interference. This malfunction is logged in the fault code memory of the ICM control unit. However, there is no repair action that can be taken. Instead, the customer should be informed of the cause of the fault (external interference).
- **Temporary fault:** The causes of this type of fault include communication faults, overvoltage, undervoltage and thermal overloads in the short-range radar sensors. In these cases, it is necessary to proceed as instructed by the test plan in the diagnostic system. The short-range radar sensors must not be replaced unless the test plan prompts you to do so.
- **Control unit fault:** If one of the short-range radar sensors is affected by a control unit fault, the only way to rectify the fault is to replace the defective sensor.
- **Sensors maladjusted:** As with the long-range radar sensor, the short-range radar sensors in interaction with the ICM control unit are also able to detect a maladjustment caused by an accident. If the calculated degree of maladjustment exceeds a certain limit, the ACC Stop & Go function is shut down. An entry in the fault memory indicates the cause of the fault. To correct the fault, observe the instructions in the diagnostic system and Repair Instructions.

In the F01/F02, too, as with the long-range radar sensor, there is no means of adjusting the short-range radar sensors.

Note: If a short-range radar sensor has been replaced with a new one, it is necessary to commission the sensor using the diagnostic system. While commissioning is in progress, new short-range radar sensors are taught their respective installation position and, importantly, their angle relative to the vehicle longitudinal axis. A measurement does not need to be carried out in this case. The angle entered is the angle predetermined by the construction and the form of the bumper support.

Note: Great care must taken during repair work carried out at the front end. If the bumper carrier is deformed or if the bumper trim is scratched or dented, the short-range radar sensors may no longer work correctly. The specified structural clearances between the short-range radar sensors and the bumper trim must also be maintained. The Repair Instructions must be observed without fail.

New Components

Integrated Chassis Management

The new ICM control unit in the F01/F02 essentially performs the calculations for the control functions that influence the longitudinal and lateral dynamics. The ICM control unit also contains the control functions of “Dynamic Cruise Control” and “Active Cruise Control with Stop & Go function”.

In addition, the ICM coordinates the control of the vibration actuator in the steering wheel for the “Lane Departure Warning” and “Lane Change Warning” driver assistance functions. Also integrated into the ICM control unit are micromechanical sensors that supply the driving dynamics signals (in previous vehicles, these were generated by the separate DSC sensor).

■ Two versions

An ICM control unit is installed in every F01/ F02. Which of the two available versions of the ICM control unit is fitted depends on the vehicle’s equipment level.

If the vehicle is equipped with one or both of the following options

- Integral Active Steering (IAL) or
- Active Cruise Control with Stop & Go function (ACC Stop & Go),

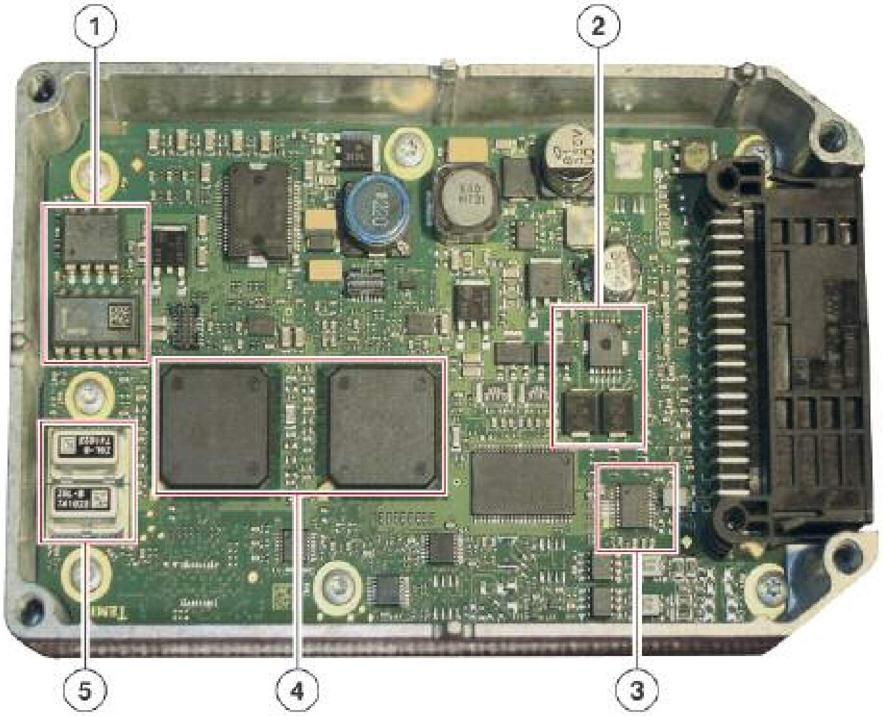
the high-performance version of the ICM control unit is installed.

If neither of these options are installed in the vehicle, the basic version of the ICM control unit is used.

The internal layout of the high-end version differs from the internal layout of the basic version in the following ways:

- Larger microprocessor (required to calculate the Integral Active Steering control and active speed control)
- Redundant sensor system for lateral acceleration and yaw rate (safety requirement for Integral Active Steering).

ICM control unit, high-end version



Index	Explanation
1	Acceleration sensors (1 for longitudinal acceleration, 2 for lateral acceleration)
2	Output stages for Servotronic and EVV valves
3	Controller for FlexRay connection
4	Two microprocessors (high-performance version)
5	Yaw rate sensors (2x)

Electrical interfaces

The control unit has a 54-pin plug via which the power supply, sensors, actuators and bus systems are connected.

As is the case with the controller housing, the plug does not have a watertight design. This is not necessary as it is installed on the inside of the vehicle.

The ICM control unit is connected to the integrated FlexRay controller via the **FlexRay** bus system. A detailed description of the new features of the FlexRay network is provided in the Product Information for the F01/F02 bus systems. The communication with most partner control units is handled by the microprocessors in the ICM via the FlexRay.

The FlexRay is routed to the ICM control unit (from the central gateway module) and continues from there (to the DME). The ICM control unit is related to the FlexRay, i.e. not an end node. This is why it does not have a terminating resistor for the FlexRay.

A further bus system, a **local CAN**, is connected to the ICM control unit in addition to the FlexRay. Its sole purpose is to enable the ICM to communicate with the long-range radar sensor and the short-range radar sensors. This local CAN therefore performs the same tasks as the sensor CAN in the E6x LCI that connects the LDM control unit to the sensors. It transmits information on road users that has been recorded by the sensors.

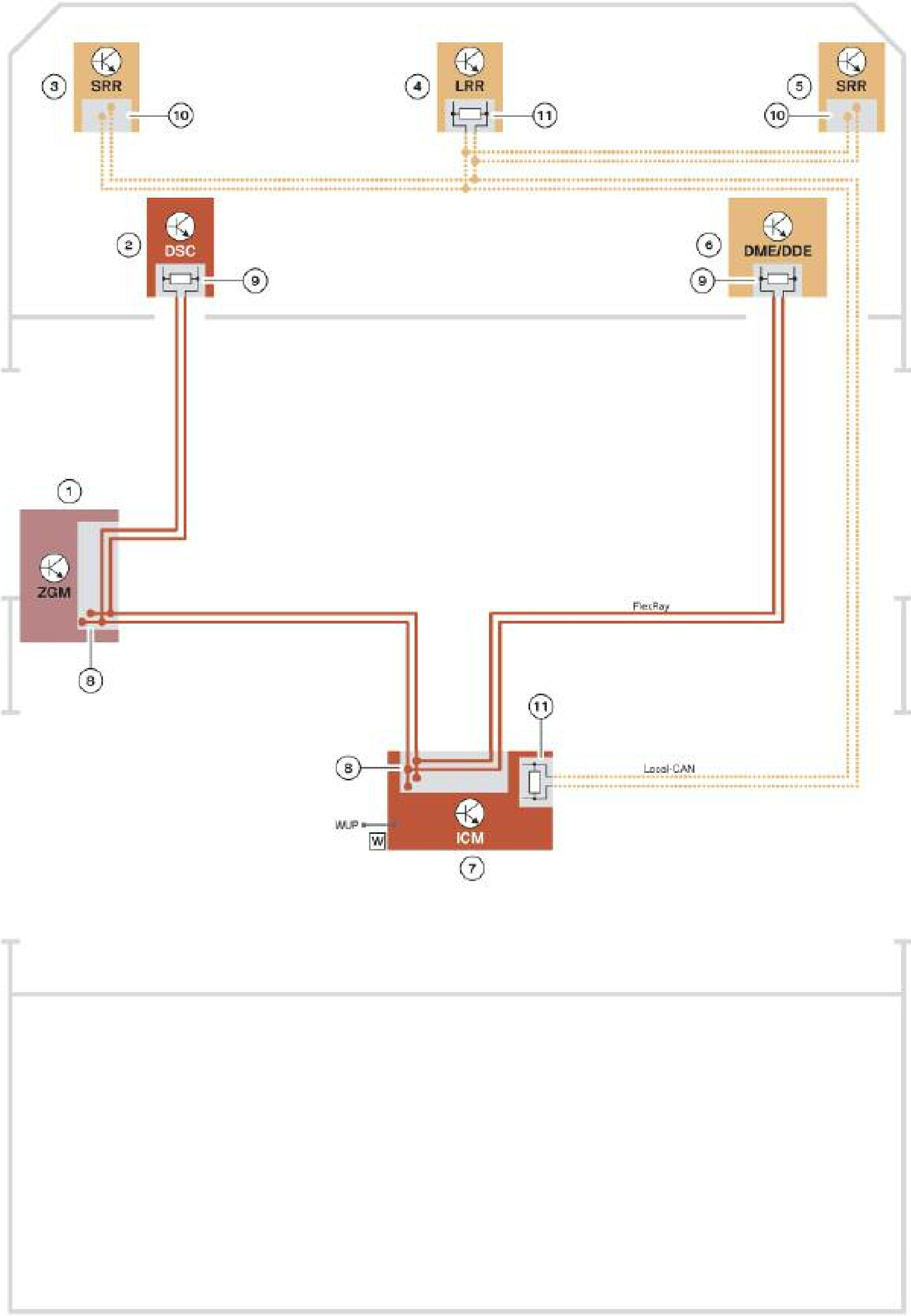
The local CAN operates in the same way as the PT-CAN with a data transfer rate of 500 kBit/s. There are two terminating resistors for the local CAN, each with 120 .. One of these is in the ICM control unit, the second terminating resistor is integrated in the long-range radar sensor. The local CAN is routed to the short-range radar sensors by short stub lines.

The pins for the local CAN are only connected at the plug of the ICM control unit if it is a high-end version.

The ICM control unit is also connected to the **wake-up line**. The ICM control unit can be woken up via the wake-up line.

Power is supplied from the front fuse carrier by terminal 30B.

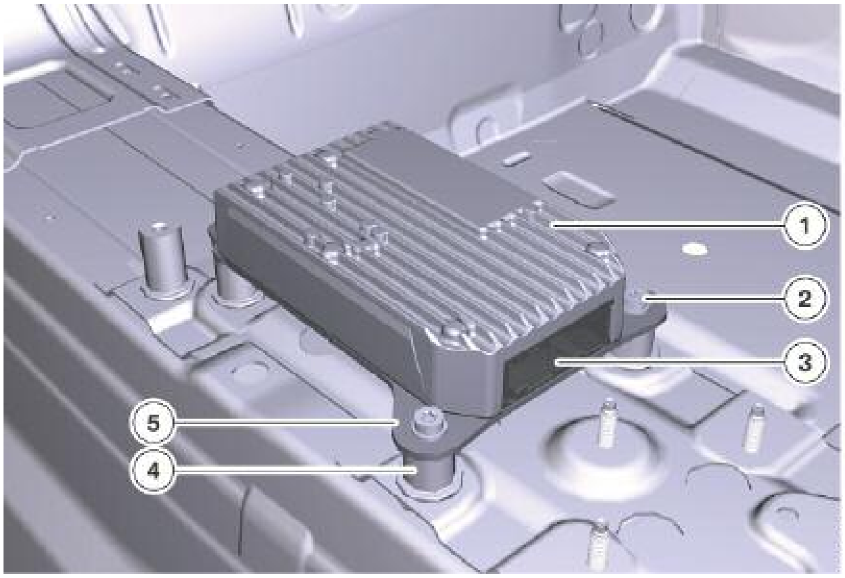
Electrical interfaces of the ICM control unit



Index	Explanation	Index	Explanation
1	Central gateway module	8	FlexRay routing and continuation without terminating resistor
2	Dynamic Stability Control	9	Routing of FlexRay with terminating resistor
3	Short-range radar (SRR) sensor, left	10	Routing of local CAN without terminating resistor
4	Long-range radar sensor (LRR)	11	Routing of local CAN with terminating resistor
5	Short-range radar sensor (SRR), right	W	ICM control unit can be woken up
6	DME control unit	WUP	Wake-up line
7	ICM control unit		

Installation location

The ICM control unit is installed in the center console behind the sensor for the crash safety module. This means that the position of the control unit and its integrated sensor system in the vehicle -near to its center of gravity -is ideal from the point of view of driving dynamics. The mounting points on the body are precisely determined and are measured when the vehicle is manufactured and must not be replaced with any other mounting points.



Index	Explanation	Index	Explanation
1	Upper section of housing	4	Spacer sleeve
2	Mounting bolt	5	Lower section of housing
3	Connector		

The housing of the control unit is connected to the metal body of the transmission tunnel with four screws and spacer sleeves made of aluminum. The control unit must be mounted on the vehicle body free of play as otherwise vibrations may be induced in the control unit housing which would severely impair the operation of the integrated sensor system. A secondary task of this mounting is to conduct heat away from the control unit to the body.

For the mounting to be able to perform these tasks, the following points must be observed when mounting and replacing the ICM control unit:

Note: Only screws and spacer sleeves that are in perfect condition may be used. Deformed or damaged fixing elements must not be used.

The mounting screws in the reamed holes must be tightened first, followed by the other two screws. The tightening torque specified in the repair instructions must be observed without fail.

A check must then be carried out to make sure the control unit is mounted securely and free of play.

To ensure sufficient heat dissipation and to avoid vibrations, the sides and top of the control unit housing must not come into contact with other vehicle components. Instead, the spaces provided around the control unit as part of the engineering design must always remain free of other components.

Removing and installing the ICM control unit

The ICM control unit performs tasks that are important for many vehicle functions, e.g. provision of sensor signals. If the vehicle were operated without the ICM control unit installed, a large number of vehicle functions would not be available. In the area of dynamic driving systems, for example, the Servotronic and stabilization functions would no longer be available. In addition, fault code memory entries would inevitably also be generated in many control units.

Note: **If the ICM control unit needs to be replaced, the repair instructions must be observed without fail.**

For example, the vehicle battery must be disconnected before removing the control unit and reconnected following the installation. This is the only way to ensure synchronized restarting of the control unit assembly.

Note: **Once the new ICM control unit has been installed, it must be started up with the assistance of the diagnostic system. To do this, the following steps must be carried out (depending on the equipment specification):**

- **Calibration of the sensors integrated into the ICM**
- **Calibration of the ride-height sensors**
- **Initialization of the Integral Active Steering.**

Commissioning the short-range radar sensors

In vehicles with the ACC Stop & Go option, the ICM control unit also plays an important role in the interaction with the short-range radar sensors.

Although short range radar sensors are intelligent sensors that perform the functions of a control unit they cannot be accessed directly via the diagnostic system. The ICM control unit acts as a “go-between” between the short range radar sensors and the diagnostic system which is why the ICM also controls the start-up process for the short range radar sensors.

Note: **The short range radar sensors for ACC Stop & Go must be started up if one (or both) short range radar sensor(s) is/are replaced. In this instance, the diagnostic system communicates with the ICM control unit. The ICM in turn controls the corresponding functions in the short range radar sensors.**

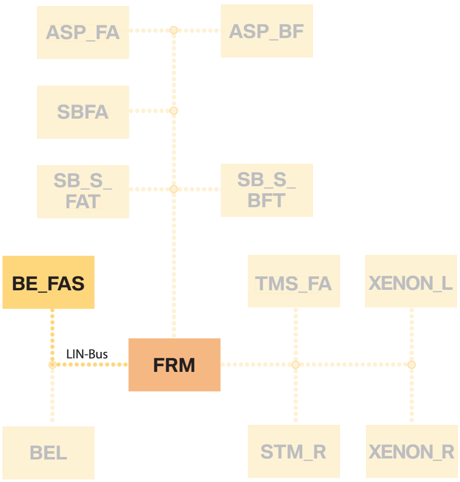
Display and Operating Controls

Driver assistance systems operating unit

Index	Explanation
1	Function illumination
2	Button for the warning function of the Adaptive Brake Assistant

The driver assistance systems operating unit contains a button for switching the collision warning on and off. The operating unit is connected to the footwell module (FRM) on the LIN bus. A bus signal from the FRM notifies the ICM control unit when the button has been pressed.

LIN bus subscribers at the footwell module



Index	Explanation
BE_FAS	Driver assistance systems operating unit
FRM	Footwell module

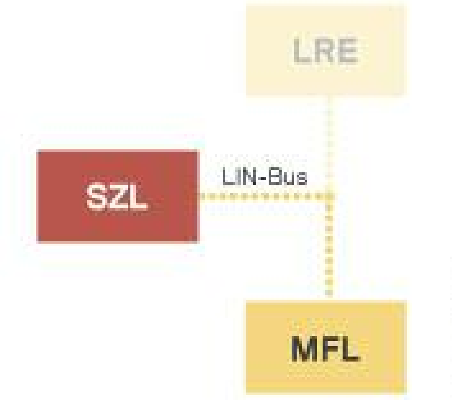
The ICM does not allow the collision warning to switch on unless the entire system is working faultlessly. It is only then that a bus signal providing positive feedback is sent to the FRM in order to have the function illumination in the button light up. If, however, a fault is present in any part of the entire system, the function illumination remains off even if the button is pressed. From this, the driver can infer that the collision warning is not available.

Multifunction steering wheel button pad

Which version of the MFL button pad on the left-hand spoke of the multifunction steering wheel is fitted depends on which option, DCC or ACC Stop & Go, is fitted in the vehicle. This does not apply to the MFL button pad on the right-hand spoke, which is the same regardless of whether the vehicle is equipped with DCC or ACC Stop & Go.

The operation and function of the buttons were described in the “functions” section.

LIN bus subscribers at the steering column switch cluster



Index	Explanation
MFL	Multifunction steering wheel
SZL	Steering column switch cluster

The electronics of the multifunction steering wheel evaluate the button strokes on both MFL button pads. On the LIN bus, the signals are transmitted to the steering column switch cluster (SZL). The SZL forwards the button stroke signals to the ICM control unit on the FlexRay. This is where the signals for controlling the DCC and ACC Stop & Go function are evaluated.

There is no function illumination on the MFL button pad. For this reason, no feedback is sent by the ICM control unit to the MFL button pad as it is to the driver assistance systems operating unit.

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F01 Comfort Access

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Initial Print Date: 01/09 Revision Date:

Subject **Page**

Comfort Access

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the functions of Comfort Access on the F01/F02
- Understand the “Passive Go” functions on the F01/F02

Introduction

Keyless Vehicle Access

Using Comfort Access, the customer can unlock and open the vehicle without active use of the ID transmitter. Access to the vehicle can be gained from any point. It is important that the ID transmitter be located in the vehicle's immediate vicinity (approximately 5 feet). It is sufficient to have the ID transmitter somewhere on your person.

Comfort Access was first introduced on the E65 (03/2002). The system was then gradually introduced on different BMW models. There were the 1 Series, 3 Series, 5 Series, 6 Series, X5 and X6.

The F01/F02 will have Comfort Access from the start of series production in 09/2008. Comfort Access can be ordered as an option.

The benefits of Comfort Access are:

- High level of convenience when unlocking and locking the vehicle
- Convenient and fast access to the vehicle
- Simple engine start/stop procedure
- Maximum comfort for the driver
- No more annoying hunting for keys.

The Comfort Access in the F01/F02 is based on predecessor systems and is adapted to the F01/F02. However, the entire function is now located in the Car Access System 4. For this reason, there is no separate control unit for Comfort Access in the F01/F02, in contrast to previous systems.

The vehicle is unlocked when you place your hand into the handle recess on the outside of the door and opened when you pull the door handle.

You can lock the vehicle again by subsequently pressing on the sensitive surface of the outside door handle.

For vehicles fitted with Soft Close Automatic, the Soft Close Automatic drive fully closes the vehicle door. You can then lock the vehicle again by subsequently pressing on the sensitive surface of the outside door handle.

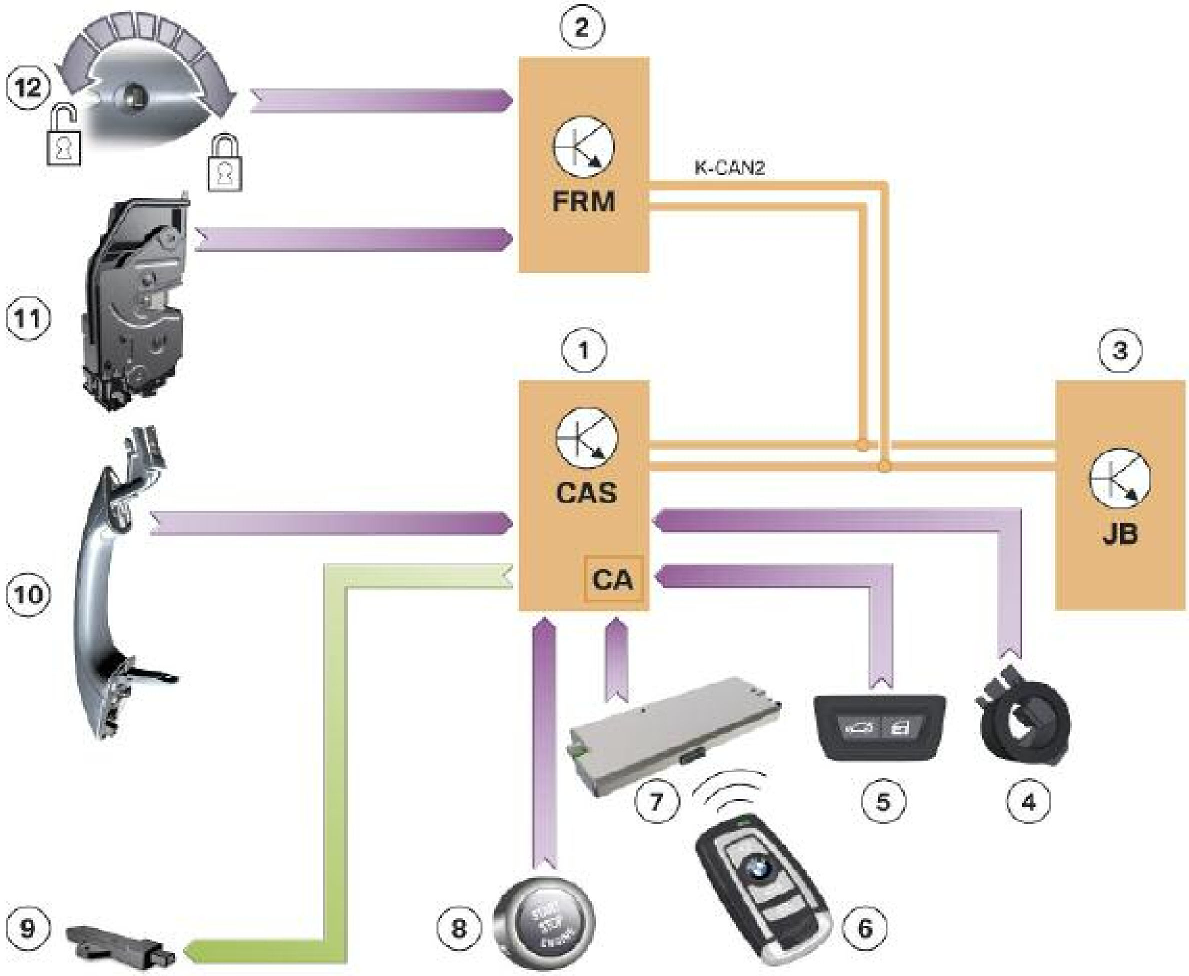
The ID transmitter must be located in the vehicle interior in order for the engine to be started. The engine can now be started by pressing the START-STOP button and the vehicle is ready to be driven.

Note: In vehicles with automatic transmission, the brake pedal must be depressed in order for the engine to be started.

In vehicles with manual transmission, the clutch pedal must be depressed in order for the engine to be started.

System Overview

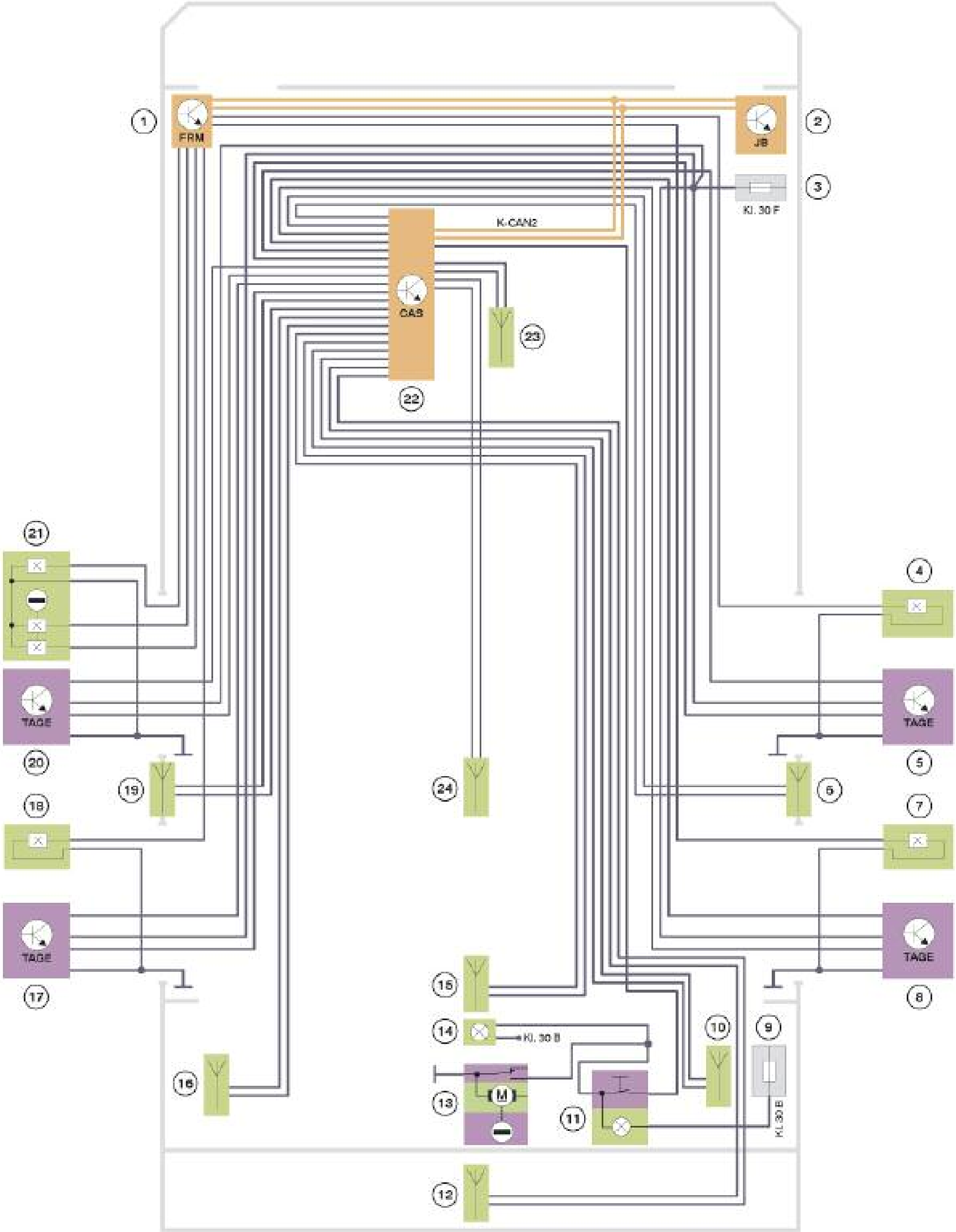
Input/Output - Comfort Access



Index	Explanation	Index	Explanation
1	CAS 4 Car Access System 4	8	START-STOP button
2	Footwell module (FRM)	9	Antenna for Comfort Access
3	Junction box electronics (JB)	10	Outside door handle electronics module
4	Emergency start coil (transponder coil)	11	Lock with door contact
5	Central locking button	12	Driver's door lock cylinder
6	ID transmitter	CA	Comfort Access (function)
7	Diversity module	K-CAN2	Body CAN2

NOTES PAGE

System Circuit Diagram - Comfort Access



Index	Explanation	Index	Explanation
1	Footwell module (FRM)	14	Luggage compartment lighting
2	Junction box electronics (JB)	15	Interior antenna for Comfort Access, parcel shelf
3	Front distribution box	16	Luggage-compartment antenna, driver's side
4	Lock door contact, front-passenger side, front	17	Rear driver's side outside door handle electronics
5	Outside door handle electronics, front-passenger side, front	18	Lock door contact, driver's side, rear
6	Antenna for Comfort Access, door sill, front-passenger side	19	Antenna for Comfort Access, door sill, driver's side
7	Lock door contact, front-passenger side, rear	20	Outside door handle electronics, driver's side, front
8	Outside door handle electronics, front-passenger side, rear	21	Lock door contact, driver's side, front and locking cylinder in driver's door
9	Luggage-compartment distribution box	22	Car Access System 4 (CAS 4) with Comfort Access (CA) function
10	Luggage-compartment antenna, front-passenger side	23	Antenna for Comfort Access, interior, front
11	Central locking button	24	Antenna for Comfort Access, interior, rear
12	Antenna for Comfort Access, bumper	K-CAN2	Body CAN2
13	Trunk lock		

Functions

Function Overview

Comfort Access is divided into the following functions:

- Passive Entry
- Passive Go
- Passive Exit.

ID transmitters are required for Comfort Access to function.

An ID transmitter comprizes, among other things:

- A battery
- Remote control function
- Transponder coil for emergency start function
- Mechanical key
- Receiver unit.

Remote Control Function for Comfort Access

When the unlocking or locking button on the ID transmitter is pressed, it emits an encrypted remote control signal. The antenna in the rear window forwards the remote control signal to the diversity module. The diversity-module remote control receiver demodulates, processes and then sends the signal to the Car Access System on the LIN bus.

If the vehicle is in sleep mode, the remote control receiver wakes the Car Access System to reduced consumption mode via the LIN bus. The Car Access System thus receives the request that was sent using the ID transmitter. The ID transmitter is checked by the remote control receiver at this stage. If the result of the check is positive, the remote control receiver forwards the request via the LIN bus. If the request is authenticated, the Car Access System wakes the vehicle and initiates the unlocking or locking of the vehicle. To do so, the Car Access System issues the release signal for the junction box electronics to actuate the central-locking drive.

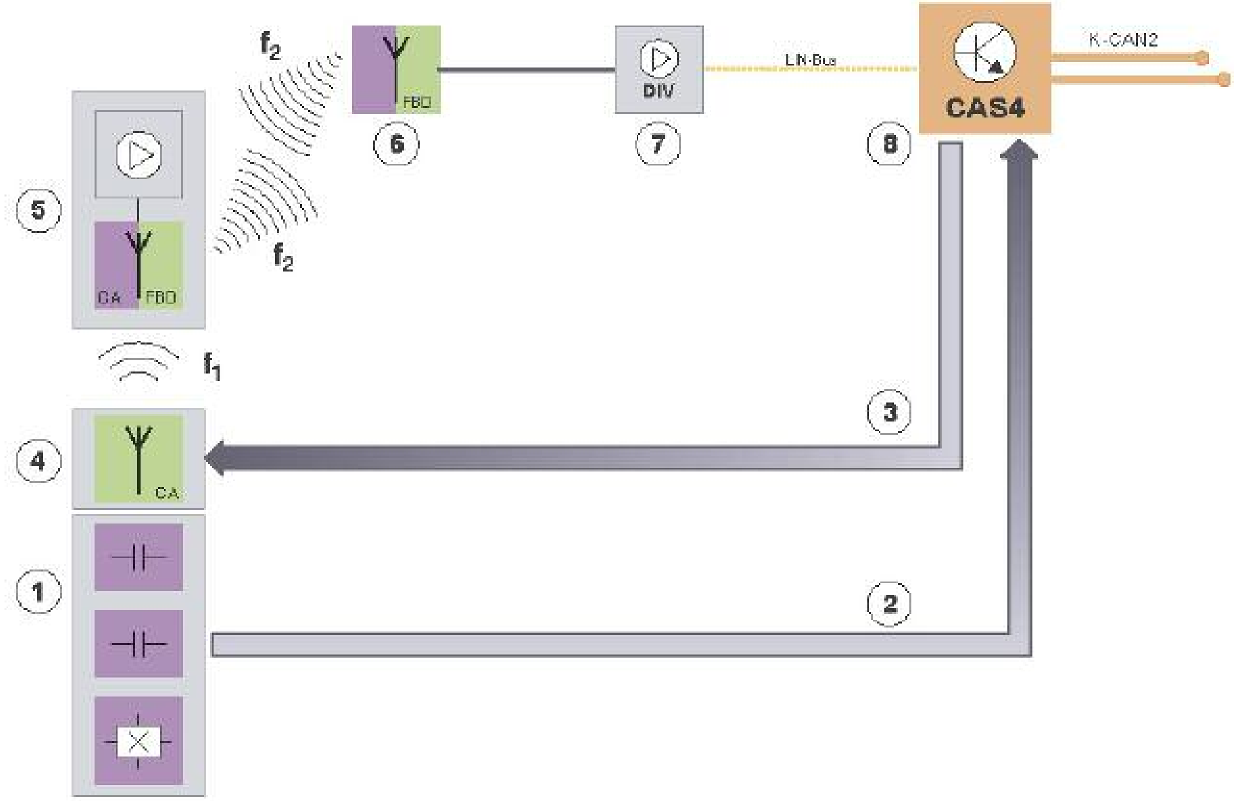
The ID transmitter can also be used to open the trunk separately. For this, only the button with the open trunk symbol need be pressed.

The Car Access System is responsible for communication via the LIN bus. The diversity module therefore only forwards the LIN bus signal if prompted to do so by the Car Access System 4. This applies to a vehicle that is not in sleep mode.

Passive Entry

The graphic below shows the functional principle of “Passive Entry”.

Signal path for Comfort Access in the F01/F02 Passive Entry System



Index	Explanation	Index	Explanation
1	Outside door handle electronics module (TAGE)	8	Car Access System 4 (CAS 4)
2	TAGE request to the CAS	LIN-Bus	Local Interconnect Network bus
3	Prompt about Comfort Access antenna	f_1	Low frequency in the kHz range
4	Comfort Access antenna	f_2	High frequency in the MHz range
5	ID transmitter	K-CAN2	Body CAN2
6	Rear window antenna	CA/FBD	Comfort Access/remote control services
7	Remote control receiver in the diversity module		

Passive Entry enables access to the vehicle without the ID transmitter being actively operated.

For example, if the outside door handle is pulled, this triggers a pulse in the sensor. The outside door handle electronics analyze the sensor and inform the Car Access System that vehicle access is requested.

The Car Access System prompts the ID transmitter to identify report to the vehicle. For this, a low-frequency signal is emitted by Comfort Access via the antennas. Transmission is via the 125 kHz antennas.

The 125-kHz signal serves only to wake the ID transmitter. The ID transmitter responds with its transmission frequency. Subsequent communication is now bi-directional, i.e. in two directions. The Car Access System sends or receives all further information via the LIN bus.

The remote control receiver is equipped with both a receiver unit and a transmitter unit. It establishes the connection with the ID transmitter via the rear-window antenna. For that reason, only the high frequency range is now used.

Bi-directional communication has the advantage that data can be requested from or sent to the ID transmitter. The Car Access System has sole responsibility for this communication.

If the ID transmitter is able to be authenticated, the Car Access System initiate the request, e.g. unlocking the vehicle. The junction box electronics execute the unlocking.

The transmission frequency of the ID transmitter varies for the US is 315MHz.

Note: When it is not required, the ID transmitter is in sleep mode. This reduces its energy consumption. For sleep mode to be ended, the ID transmitter requires a wake-up signal. The wake-up signal can be sent by the Car Access System via the Comfort Access antennas. Pressing one of the buttons on the ID transmitter also wakes it.

Passive Entry at the Trunk

An authentication check also takes place before the trunk is opened.

If the outside trunk button in the trunk handle strip is operated, it changes its status. The junction box electronics analyze the status and send it via the K-CAN2.

The Car Access System 4 therefore knows that the outside trunk button has been operated.

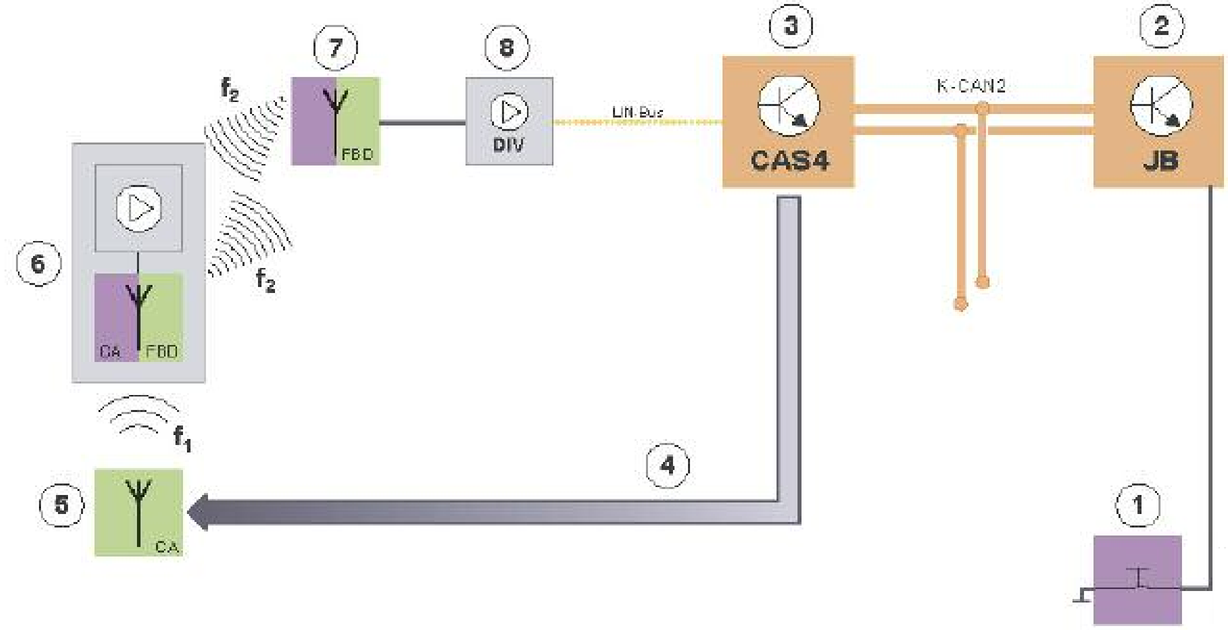
The Car Access System initiates the emission of the 125 kHz signal, so that the ID transmitter can report to the vehicle.

At the same time, the Car Access System initiates communication to the ID transmitter.

The Car Access System sends the requests for this via the LIN bus to the remote control receiver. The latter sends the requests from the Car Access System via the rear-window antenna.

If the ID transmitter is recognized as belonging to the vehicle, the Car Access System prompts the junction box electronics to unlock the trunk.

Principle of Comfort Access at the trunk



Index	Explanation	Index	Explanation
1	Outside trunk button in the handle strip of the luggage compartment lid	8	Remote control receiver in the diversity module
2	Junction box electronics (JB)	LIN-Bus	Local Interconnect Network bus
3	Car Access System 4 (CAS 4)	K-CAN2	Body CAN2
4	CAS request to the CA antenna	f_1	Low frequency in the kHz range
5	Bumper antenna for Comfort Access	f_2	High frequency in the MHz range
6	ID transmitter	CA/FBD	Comfort Access/remote control services
7	Rear window antenna		

Passive Go

The “Passive Go” function makes it possible to start the vehicle when the ID transmitter is in the passenger compartment.

Issuing Start Enable

Authorization to start the engine is only given when there is an ID transmitter in the vehicle. Once the last door is closed, the Car Access System begins its search for a valid ID transmitter.

The Car Access System 4 requests a signal to be sent out to identify a valid ID transmitter. The interior antennas are used for this.

The ID transmitter responds using a high-frequency range (315 MHz). If the ID transmitter is authenticated, the Car Access System 4 grants permission for the engine to be started.

Note: The electronic immobilizer gives its own approval for the engine to be started.

The search for an ID transmitter in the passenger compartment can also be triggered by pressing the START-STOP button. This will take place if the START-STOP button is pressed before the last door is closed, for instance.

Or if the vehicle is stationary too long and therefore loses communication with the ID transmitter. Pressing the START-STOP button triggers the search for the ID transmitter in the vehicle interior.

Passive Exit

The Passive Exit function makes it possible to lock the vehicle without actively using the ID transmitter.

Locking Procedure

After the vehicle door has been closed, the locking procedure is started by pressing the sensitive area on the outside door handle. The outside door handle electronics module sends the request to unlock the vehicle to the Car Access System 4.

The Car Access System 4 checks whether a valid ID transmitter is in the vicinity of the outside door handle using the outside antennas.

The ID transmitter is instructed to send an authentication signal.

In turn, the identification sensor sends encrypted data via the high-frequency link to the remote control receiver.

The remote control receiver processes the data and sends it via the LIN bus to the Car Access System. The Car Access System causes the communication with the ID transmitter to be established.

If the ID transmitter is recognized as belonging to the vehicle, the Car Access System 4 issues authorization for the vehicle to be unlocked.

The junction box electronics activate the central-locking drives.

Special Comfort Access Functions

The Comfort Access additionally features the special functions described in the following that are determined by the actions of the vehicle user.

Second ID Transmitter Remains in the Vehicle Interior

By checking via the interior antennas, the Car Access System 4 recognizes whether there is a valid ID transmitter in the vehicle interior. If the Car Access System 4 detects a valid ID transmitter in the vehicle interior and the vehicle is locked by means of another valid ID transmitter (located outside), the ID transmitter located in the vehicle interior is set to "blocked".

This ID transmitter will not be recognized as belonging to the vehicle for Comfort Access until the vehicle is unlocked again.

Note: The "blocked" status only applies to the functions of Comfort Access.

The remote control functions are still available.

Identification Transmitter in Luggage Compartment

If an ID transmitter is located in the luggage compartment when the vehicle is locked and the trunk open and the trunk is then closed, the trunk will immediately be automatically opened again. Audible and visual signals draw the customer's attention to the fact that the ID transmitter is located in the luggage compartment.

The Car Access System 4 starts the request via the luggage-compartment antennas.

If a valid ID transmitter is detected in the luggage compartment, the Car Access System 4 will not issue authorization for the trunk to be locked.

The trunk cannot be closed before the ID transmitter has been removed and is located outside the luggage compartment.

Note: This behavior only occurs if the Comfort Access does not find a valid ID transmitter in the vicinity of the vehicle when it searches the outside of the vehicle.

Starting the Engine without an ID Transmitter

This function makes it possible to start the vehicle within 10 seconds after “engine OFF” without detecting the ID transmitter. This function is intended for cases where, for example, the ID transmitter is not detected due to high-frequency interference.

Unintentional Wake-up Function

The vehicle cannot be woken simply by someone gripping the outside door handle. A valid ID transmitter must be detected in the vicinity of the vehicle.

Locking with Engine Running

The vehicle can also be unlocked with the engine running if the engine was started with Passive Go. When leaving the vehicle, the ID transmitter should also be taken and the vehicle locked from the outside.

Emergency Start Coil

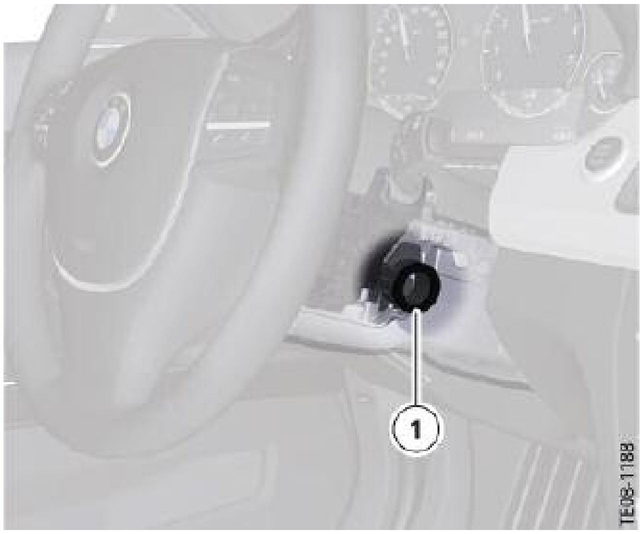
In unfavorable situations, the ID transmitter cannot be found in the passenger compartment. The Car Access System therefore causes a message to be output to the instrument cluster. The message tells the customer that the ID transmitter could not be found.

Because there is no slot for the ID transmitter in the F01/F02, there is an emergency start coil on the steering column. Communication via the emergency start coil allows the engine to be started and the vehicle is then ready to be driven.

The emergency start coil has the same function as the transponder coil. Communication via the transponder coil makes it possible for the Car Access System 4 to identify the ID transmitter. The Car Access System 4 can issue the start authorization following successful identification.

The remote control or ID transmitter cannot be found in the following situations:

- Fault in the remote control/ID transmitter
- Interference in the transmission to the remote control/ID transmitter
- Flat battery in the remote control/ID transmitter.



Emergency start coil

System Components

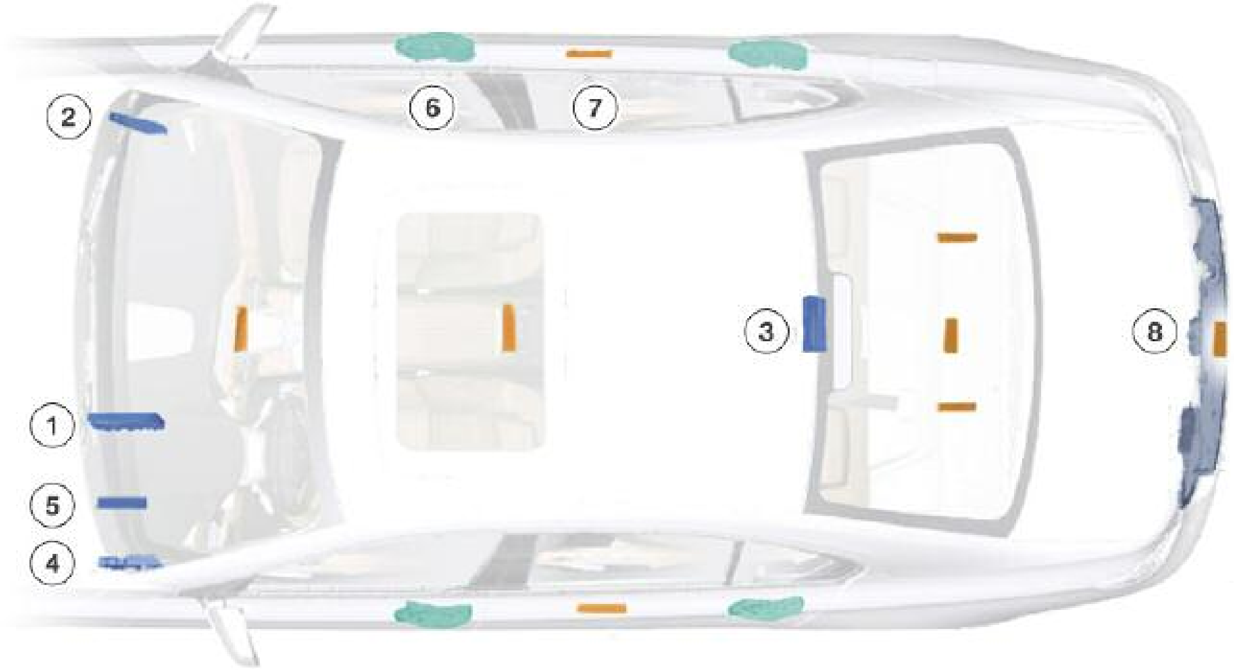
Control Unit

The Car Access System is located above the steering column on the right-hand side.

For the Comfort Access function, the Car Access System controls the transmitting antennas for the vehicle exterior and interior.

The outside door handle electronics are read by the Car Access System.

Installation location of the Car Access System 4 with Comfort Access



Index	Explanation	Index	Explanation
1	Car Access System 4 with Comfort Access	5	Central gateway module
2	Junction box electronics	6	Outside door handle electronics
3	Remote control receiver in the diversity module	7	Antennas for Comfort Access
4	Footwell module	8	Central locking components in the trunk

Control Elements

ID Transmitter

The ID transmitter for Comfort Access must be actuated by means of a radio signal. The ID transmitter is therefore equipped with a receiver for the coded 125 kHz radio signal that is transmitted by the Comfort Access antennas. The radio signal wakes the ID transmitter. The ID transmitter registers with the vehicle automatically (authentication).

For this purpose, the ID transmitter emits a coded 315 MHz high-frequency signal to enable identification of the ID transmitter as being valid and belonging to the vehicle.

The ID transmitter is exclusively responsible for use of the Comfort Access system. The ID transmitter has a battery, the service life of the battery in the ID transmitter is about 4 years.

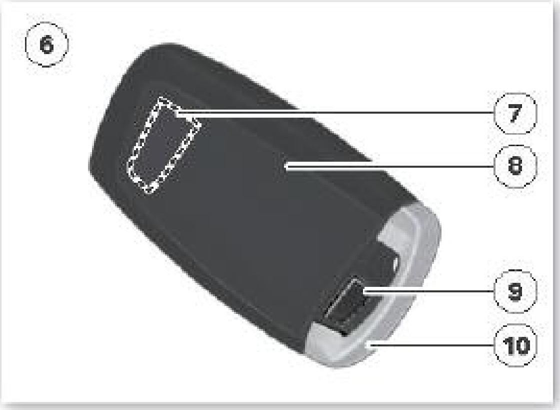
Voltage Monitoring

The ID transmitter monitors its own battery voltage. The battery voltage is monitored in 2 stages.

The first stage signals to the Car Access System 4 that the battery is flat. In response, the Car Access System 4 generates a check control message. The check control message informs the customer that the battery needs to be changed.

If the battery is not changed, the voltage monitoring facility switches to the second stage. This means that the data in the ID transmitter is saved. The ID transmitter is then set to “inoperative”.

F01/F02 ID transmitter



Index	Explanation	Index	Explanation
1	Top view of ID transmitter	6	Rear view of ID transmitter
2	Vehicle unlock button	7	Transponder coil
3	Vehicle lock button	8	Battery compartment
4	Trunk unlock button	9	Mechanical key button
5	Follow-me-home lights button	10	Mechanical key

Data for Conditioned Based Service

From terminal status “terminal 15 ON”, data for the Conditioned Based Service is transferred to the ID transmitter in the high-frequency range. The ID transmitter then confirms that the transmission was received.

Antennas for Comfort Access

Eight antennas are installed for the Comfort Access system. Five antennas are for the vehicle interior and three are for the vehicle exterior.

The antennas for the exterior and interior are inductive antennas and have a ferrite core.

The antenna transmission frequency is 125 kHz .   All messages that are sent via the antennas are encrypted.

Antenna Installation Locations

■ Exterior antennas

The exterior antennas are installed in the following locations on the F01/F02:

- Door sill on the driver’s side, in the center of the vehicle
- Door sill on the front-passenger side, in the center of the vehicle
- Rear bumper in the center

Passenger-compartment antenna in the door sills in the F01/F02

The antennas are designed to give about 5 feet (1.5 m) of coverage around the vehicle.

The exterior antennas are equipped with a splash-proof plug connection.

■ Interior antennas

The interior antennas are installed in the following locations in the F01/F02:

- Passenger compartment, front center console
- Passenger compartment, middle center console
- Luggage compartment, left and right
- Parcel shelf

The antenna characteristic is spherical. The entire vehicle interior is covered by the front and middle antennas.

Front passenger-compartment antenna in the F01/F02

■ Luggage compartment antenna

The luggage-compartment antennas are of the same design as the interior antennas. They are integrated in the left- and right-hand sides of the luggage compartment.

The luggage-compartment antennas are configured so that they cover the entire luggage compartment.

Outside Door Handle Electronics Module

The outside door handle electronics are connected to terminal 30F and work within a voltage range of 9 V to 16 V. The Car Access System is directly connected to the data line of the outside door handle electronics. This provides the Car Access System with information about the capacitive sensors and the piezo sensors. The status of the “pull” Hall sensor is monitored directly by the Car Access System.

The outside door handle electronics detect the status of the outside door handle using the sensors.

Each change in the status of the outside door handle module triggers the corresponding function.

These functions are:

- Trigger pulse by inserting a hand into the handle recess of the outside door handle; Capacitive sensor 1
- Unlock request by pulling the outside door handle; Hall sensor
- Lock request by pressing the sensitive area on the outside door handle; capacitive sensor 2 plus piezo sensor.

Sensors

■ **Capacitive sensor 1**
If a hand is placed into the handle recess of the outside door handle, for example, this is detected by the outside door handle electronics. On detecting this, the outside door handle electronics send the request to the Car Access System. The request initially contains the information to wake up the Car Access System. The Car Access System is woken and reads the request. Then, the Car Access System establishes communication with the ID transmitter.

The Car Access System switches the remote control receiver on permanently and therefore ensures that the data sent by the ID transmitter can be received.

Note: The remote control receiver is integrated in the diversity module.

■ **Capacitive sensor 2/piezo sensor**
Touching the sensitive surface generates the capacitive sensor 2 signal. Together with the piezo sensor, a press on the sensitive surface is detected. A lock signal is only triggered if the capacitive sensor and piezo sensor are both actuated.

The outside door handle electronics analyze the two sensors and send the request to the Car Access System.

■ Outside door handle Hall sensor

The Hall sensor is redundant to the capacitive sensor 1. The Hall sensor is analyzed directly by the Car Access System. The Car Access System monitors the Hall sensor using a clocked voltage supply.

If the vehicle has already been woken by someone reaching into the handle recess, pulling on the outside door handle triggers the unlocking on the vehicle.

In unfavorable situations, it may be necessary to pull on the outside door handle twice to trigger the vehicle unlocking. This is caused if the signal from the capacitive sensor 1 is not present or is implausible.

Door Locks

The vehicle has rapid opening locks in the doors as standard. A spring exerts pretension on the central locking drive for the unlocking procedure. The door is already unlocked before an attempt is made to open it with the outside door handle.

Note: However, if the outside door handle is pulled very fast, the vehicle door may not yet be unlocked. In this case, it is necessary to pull the outside door handle a second time in order to open the door.

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F01 Central Locking System

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Subject **Page**

Central Locking System

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Locate and identify components of the central locking system
- Understand the operation of the central locking system

Introduction

Unlocking and Locking the Vehicle

The central locking system makes it possible to unlock or lock the vehicle. It is fitted as standard equipment and relates to all vehicle doors, the fuel filler flap and the trunk.

The central locking can be operated via the following components:

- ID transmitter
- Driver's-door lock barrel (door lock)
- Central-lock button
- Trunk lock barrel
- Exterior trunk button
- Interior trunk button in the A-pillar
- Outside door handle * (outside door handle electronics/Car Access System)
- Central locking button in the trunk lid *.

* Component of the Comfort Access option.

The central locking system in the F01/F02 is based on the central locking system as it is already known in, for instance, the E90 or E70. The function of the central locking system is basically divided between three control units.

The Car Access System has overall control. The Car Access System is aware of the statuses of the central locking system. Therefore it is the Car Access System which causes the unlocking, locking and central locking of the vehicle.

The junction box electronics module executes the request to unlock or lock the vehicle.

Note: The Car Access System is now entering its fourth control-unit generation and contains the functions of its predecessor.

With Car Access System 4, Comfort Access functionality is now also integrated into this control unit. This means that, on the F01/F02 there is no separate control unit for Comfort Access.

It is possible to unlock and lock the vehicle actively or passively.

- Active means that the vehicle can be opened after it has been unlocked by a press of the button on the ID transmitter. The vehicle can be locked by pressing the Lock button after the doors have been closed.

Note: The vehicle can only be locked with the driver's door closed.

Passive locking and unlocking requires the option Comfort Access.

- Passive means the vehicle is unlocked when the outer door handle is grasped, provided the ID transmitter is located within a radius of no more than approxiamately 1.5 meters from the vehicle. The locking function is triggered by pressing on the sensitive area on the outer door handle.

The trunk is fitted with the automatic soft-close function as standard. With the automatic soft-close function, it is sufficient to gently press the trunk into the trunk lock. As soon as the locking pawl reaches the pre-locking position, automatic soft-close fully closes the trunk. The locking pawl is then located in the main locking position.

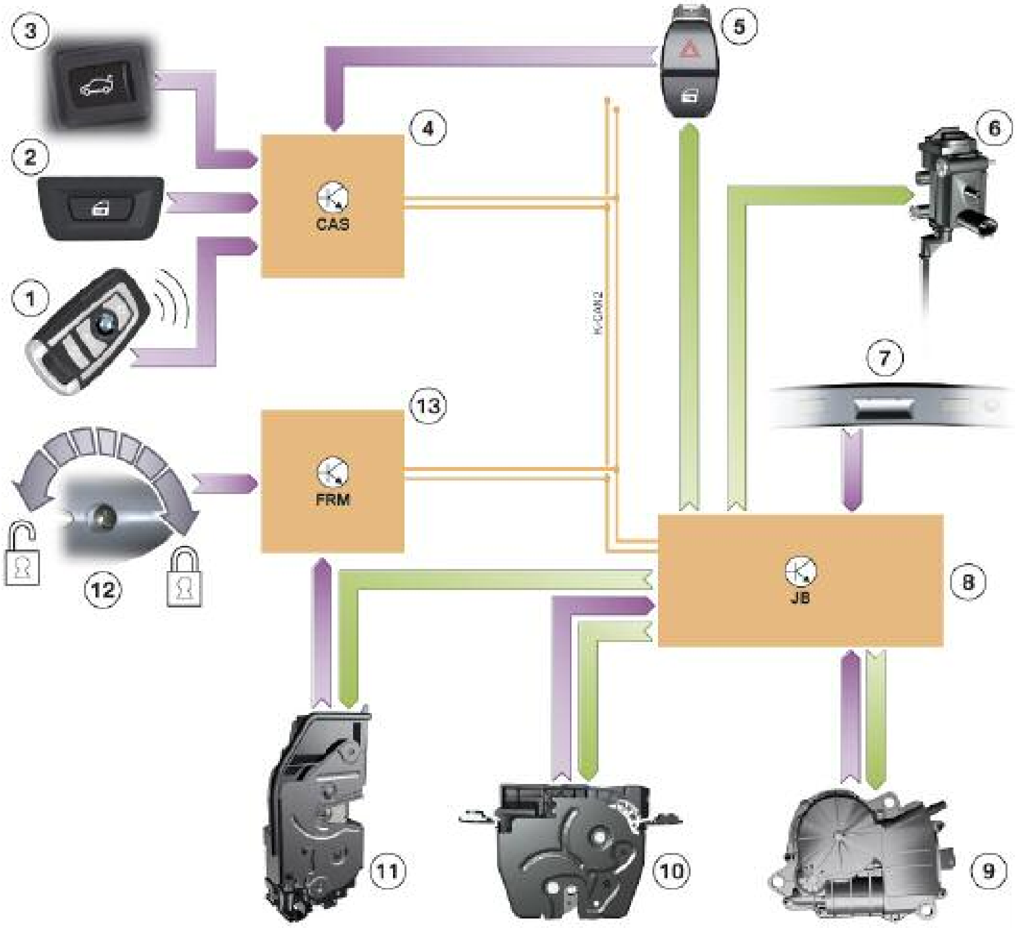
An alternative is automatic soft-close, the automatic soft-close function is available for all vehicle doors. When equipped with the automatic soft-close function, the vehicle door needs only to be gently pulled or pushed into the lock. The automatic soft-close function then completely closes the door.

The Car Access System (4) evaluates the signal from the ID transmitter (1) and requests the unlocking or locking of the vehicle. The junction box electronics module (8) executes the requests.

The lock barrel (12) in the driver's door is used for mechanically unlocking or locking the door. The footwell module (10) evaluates the movement (status of Hall sensors) of the lock barrel and the status of the door contacts.

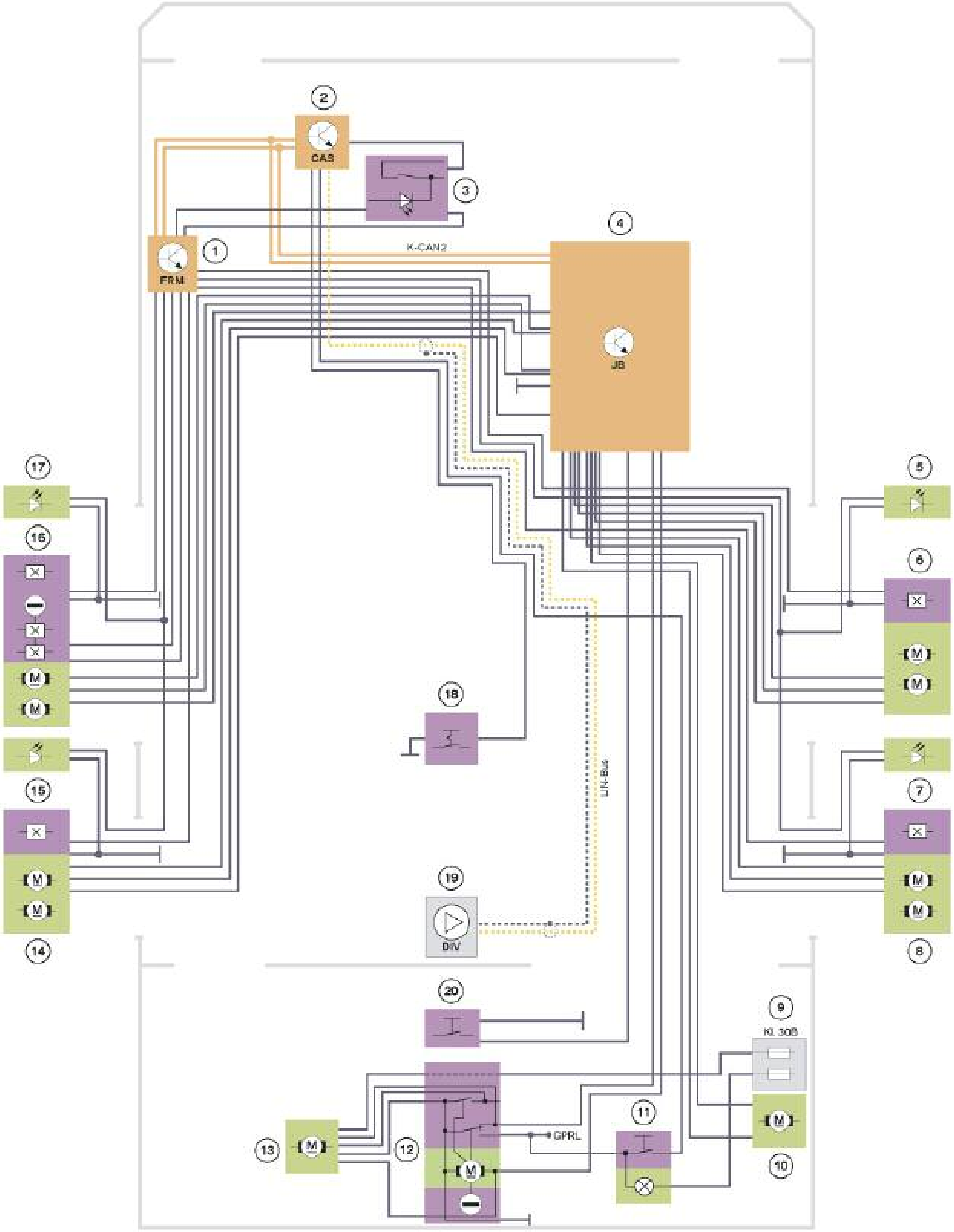
System Overview

Input/output Central Locking



Index	Explanation	Index	Explanation
1	ID transmitter	8	Junction box electronics module (JB)
2	Central locking button	9	Automatic soft-close drive in the trunk lock
3	Interior trunk button in the A-pillar	10	Trunk central locking system
4	Car Access System 4 (CAS 4)	11	Lock (4x) in vehicle doors
5	Center-lock button	12	Driver's-door lock barrel
6	Central locking, fuel filler flap	13	Footwell module (FRM)
7	Exterior trunk button	K-CAN2	Bodyshell CAN

Central Locking System Circuit Diagram



Index	Explanation	Index	Explanation
1	Footwell module (FRM)	13	Automatic soft-close drive in the trunk lock
2	Car Access System (CAS)	14	Rear, driver’s side central locking system
3	Center-lock button	15	Rear, driver’s side illuminated entry system
4	Junction box electronics module (JB)	16	Hall sensors for lock barrel, door contact, driver’s-door central locking system
5	Front-passenger-door illuminated entry system	17	Driver’s-door illuminated entry system
6	Door contact, central locking, front passenger door	18	Valet switch
7	Rear, passenger-side illuminated entry system	19	Remote control receiver in diversity module
8	Door contact, central locking, rear passenger side	20	Exterior trunk button
9	Fuse in the luggage compartment power distribution box	K-CAN2	Bodyshell CAN2
10	Central locking, fuel filler flap	Kl. 30B	Terminal 30, basic operation
11	Central locking button	LIN-Bus	Local Interconnect Network bus
12	Trunk lock central locking system	GPRL	Luggage compartment light

K-CAN signals at Car Access System 4

In/out	Information	Source/sink	Function
In	Crash signal	Crash sensor > Advanced Crash Safety Management	Unlock central locking in the event of a crash
In	Driving speed	Wheel-speed sensor > Integrated Chassis Management	Lock central locking from a defined driving speed
Out	Hall sensor status, driver's-door lock barrel	Driver's-door lock barrel > Footwell module	Comfort opening of vehicle
Out	Hall sensor status, driver's-door lock barrel	Driver's-door lock barrel >	Comfort closing of vehicle Footwell module

The radio signal from the ID transmitter is received by the rear window antenna. The remote control receiver integrated in the diversity module (19) forwards the signal to the Car Access System (2). After the signal has been successfully checked, the Car Access System issues a request for control of the central locking system. The Car Access System is the master control unit for the central locking system.

The junction box electronics module (4) executes the unlocking or locking of the vehicle.

The footwell module (1) evaluates the status of all door contacts (6, 8, 14 and 16).
It communicates the current status on the KCAN2. This means, for example, that the Car Access System is able to prevent locking when the driver's door is open.

The status of the center-lock button (3) is evaluated by the Car Access System and communicated over the K-CAN2. Depending on the status, the junction box electronics module activates central locking. The junction box electronics modules is also responsible for registering the status and activating central locking in the trunk.

The junction box electronics module is also responsible for controlling the fuel filler flap (10).

The footwell module evaluates the signals from the Hall sensors for the lock barrel (16) and makes this information available on the K-CAN2.

With this information, the Car Access System knows the status of the door lock in the driver's door. This is important if a request is issued to unlock or lock the vehicle using the ID transmitter, for example.

The central locking button is integrated in the underside of the trunk and is part of the Comfort Access option.

Functions

Unlocking/locking the Vehicle

The vehicle unlocking/locking procedure is initiated by the following system components:

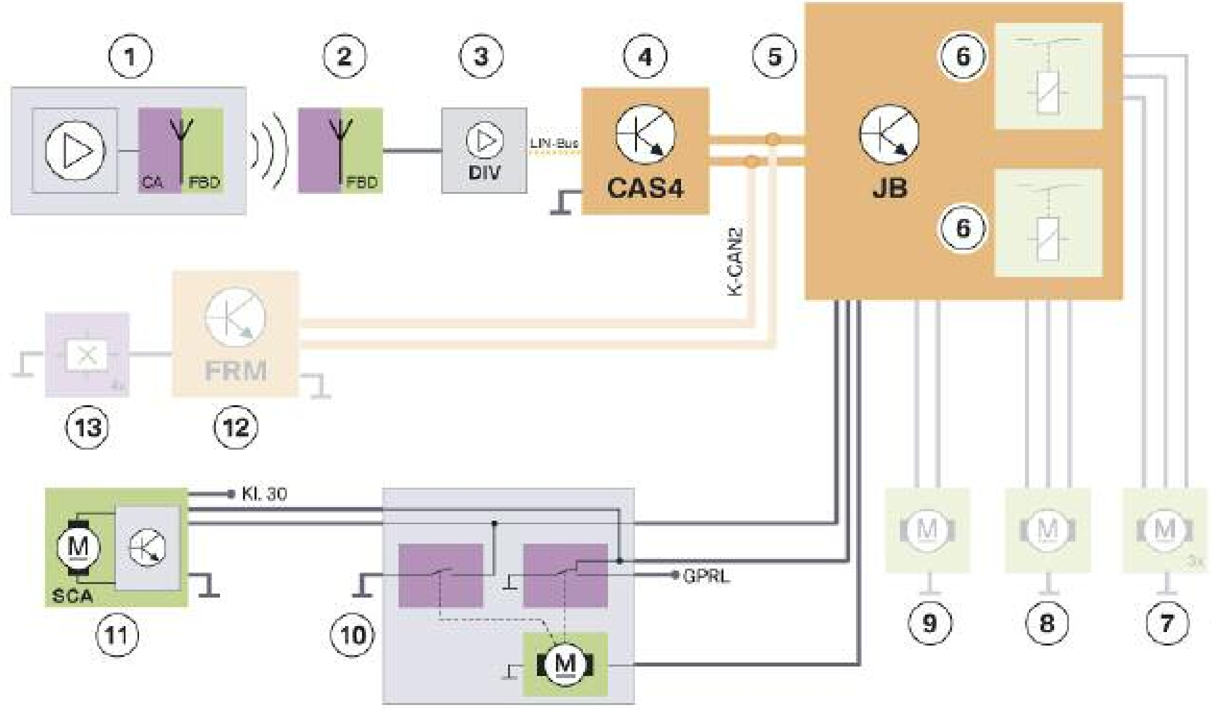
- ID transmitter
- Mechanical key/spare key
- Exterior trunk button (only unlocks the trunk)
- Central-lock button
- Interior trunk button on the A-pillar (only unlocks the trunk)
- Outside door handle *
- Central locking button * trunk.

* Vehicle equipment for Comfort Access.

The central locking system activates the following system components:

- Central locking, driver's and front passenger door
- Central locking, rear doors
- Central locking, fuel tank
- Trunk central locking system (with automatic soft-close drive).

The following example shows the signal path when the trunk is unlocked.



Index	Explanation	Index	Explanation
1	ID transmitter	8	Central locking, driver's door
2	Rear window antenna	9	Central locking, fuel filler flap
3	Remote control receiver in diversity module	10	Trunk central locking system
4	Car Access System 4 (CAS 4)	11	Trunk automatic soft-close
5	Junction box electronics module (JB)	12	Footwell module
6	Relay for central locking	13	Door contacts
7	Central locking, front passenger door and rear doors		

Functional Procedure

■ Unlocking

Pressing the Unlock button on the ID transmitter causes an encrypted remote control signal to be transmitted. The antenna in the rear window forwards the remote control signal to the diversity module. The diversity module remote control receiver demodulates, processes and then sends the signal to the Car Access System on the LIN bus.

If the vehicle is in sleep mode, the remote control receiver wakes up the Car Access System via the LIN bus for reduced-consumption operation. This allows the Car Access System to receive the request which was sent out by the ID transmitter. The ID transmitter has already been checked in the remote control receiver. If the result of the check is positive, the remote control receiver forwards the request via the LIN bus. If the request is authorized, the Car Access System wakes up the vehicle and causes the vehicle to unlock. The Car Access System thereby gives the junction box electronics module permission to unlock the central-locking drive.

The junction box electronics module then activates the relay and power output stages and triggers the unlocking of the vehicle.

Note: The Car Access System is responsible for communication over the LIN bus. This means that the diversity module only passes on a LIN bus signal when instructed to do so by the Car Access System 4. This applies to vehicles not currently in sleep mode.

■ Locking

The vehicle can only be locked once the footwell module has evaluated the door contacts and the Car Access System 4 has reported that the driver's door is closed.

The further signal progression for locking the vehicle corresponds analogously to the signal progression of the unlocking procedure.

During the vehicle locking process, all central locking drives are moved into the "Lock" position. The central-locking drives in the doors are additionally moved into the "centrally-locked" position. Following the central arrest procedure, the locking buttons in the doors are mechanically separated from the central locking drive system.

The vehicle can now no longer be unlocked using the locking buttons in the doors.

Note: The trunk can either be locked manually or using automatic trunk actuation.

■ Central locking button

The central locking button can be used to lock and centrally lock all vehicle doors.

The central locking button is located on the underside of the trunk and can therefore only be used with the trunk open.

Additional information is presented under the Central locking button section, which follows.

Center-lock Button

The vehicle can be locked/unlocked with the center-lock button.

If the center-lock button is not being pressed, the junction box electronics module receives a high signal (battery voltage approxiamately 12 V). The high signal changes to a low signal (approximately 0 V) as soon as the center-lock button is pressed.

The junction box electronics module evaluates the change from the high signal to the low signal and locks/unlocks the vehicle.

In order for locking or unlocking to take place, the driver's door and front passenger door must be closed.

Mechanical Key/Spare Key

The mechanical key/spare key is used to unlock/lock the driver's door. Should the ID transmitter fail, e.g. if the battery is flat, it is still possible to access or lock the vehicle.

■ Driver's-door lock barrel

The footwell module evaluates the Hall sensors for the lock barrel in the driver's door. The Car Access System 4 is informed of the change in status via the K-CAN2.

The Car Access System 4 enables the vehicle unlocking/locking procedure. The junction box electronics module triggers the unlocking/ locking of the vehicle.

The normal procedure for unlocking or locking using the mechanical key occurs within a period of approxiamately 20 ms to 1 second. Evaluation of the lock barrel Hall sensors occurs within this period of time.

Note: Turning the mechanical key in the driver's-door lock barrel too quickly or slowly, means that only the driver's door will be mechanically unlocked or locked. In such situations, the central locking system does not operate.

■ Trunk lock

The trunk lock can be unlocked by using the mechanical key in the lock barrel, and then opened.

Note: If the anti-theft alarm system is fitted, unlocking the trunk may trigger an alarm.

To close the trunk, the trunk must be pushed into the trunk lock. As soon as the locking pawl reaches the pre-locking position, automatic soft-close begins and closes the trunk.

Note: In the F01, the trunk lock is pulled closed via an automatic soft-close drive. Slamming the trunk closes the trunk so quickly that automatic soft-close is not activated.

Locking Button on Vehicle Doors

All four doors can be mechanically locked separately with the locking button.

The inside door handle of the door to be unlocked must be pulled twice before the door will unlock.

However, the junction box electronics module does not activate central locking.

If the vehicle is centrally locked, the locking knobs are mechanically disconnected from the lock. It is thus no longer possible to unlock the vehicle either via the locking knobs or by pulling twice on the door handle. On vehicles with an anti-theft alarm system, this also activates the system.

Car Access System 4

As soon as the Car Access System 4 receives the signal from the remote control receiver, it checks whether the ID transmitter is valid and belongs to the vehicle. Only if the check is successful will the Car Access System 4 forward the request to the central locking.

The check, also referred to as authentication, takes a few milliseconds. As the master control unit of the central locking system, the Car Access System 4 grants authorization for control of the central locking system.

The junction box electronics module receives the enable via the K-CAN2.

Junction Box Electronics Module

The junction box electronics module is the The trunk central locking system is activated slave control unit which unlocks/locks the directly via a power output stage. entire vehicle. The unlocking/locking relays are located in the junction box electronics module. The following relays are activated:

- Relay for unlocking/locking central locking
  - Driver’s door.
- Relay for unlocking/locking central locking
  - Rear doors
  - Front passenger door
  - Fuel filler flap.

Footwell Module

The footwell module monitors the Hall The request to lock the vehicle, for example, is sensors of the door contacts. Opening or not executed while the driver’s door is open. closing a door causes a change in status of the door contact in question to occur.

The junction box electronics module receives the current status of the door contacts from the footwell module via the K-CAN2. The junction box electronics module passes the status of the door contacts on to the Car Access System 4.

Unlocking the Trunk

The trunk can be unlocked via the ID transmitter and the exterior or interior trunk button, and then opened.

■ ID transmitter

The ID transmitter is used to trigger the unlocking of the trunk by means of a brief (approximately 500 ms) press on the trunk symbol button.

The junction box electronics module executes the unlocking of the trunk.

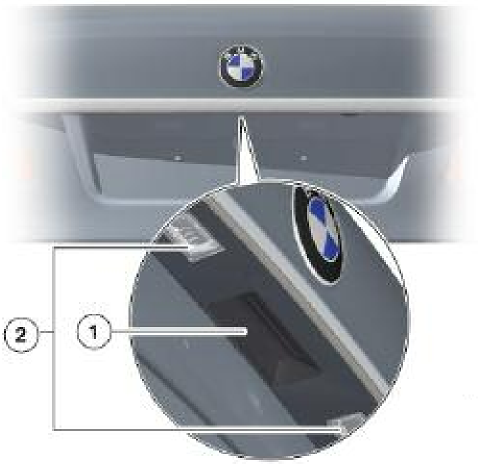
The motor in the trunk lock is activated via the power output stage in the junction box electronics module.

Note: If the vehicle is fitted with the automatic trunk actuation option, the trunk symbol button must be pressed and held for longer than 1.2 seconds.

■ Exterior trunk button

As soon as the vehicle is unlocked, the trunk can be opened with the exterior trunk button in the trunk. The button switches to ground when the exterior trunk button is pressed.

The button is monitored by the junction box electronics. When the signal of the button changes to low, the trunk is unlocked and can be opened.



Index	Explanation	Index	Explanation
1	Exterior trunk button	2	Liscense plate light

■ Interior trunk button in the A-pillar

As soon as the vehicle is unlocked, the trunk can be unlocked and opened by pressing the interior trunk button.

The button is integrated into the A-pillar and switches to ground.

The Car Access System evaluates the button and sends the signal for the junction box electronics module over the K-CAN2. The junction box electronics module evaluates the message and triggers the trunk to unlock.

■ Closing the trunk

Gently pressing the trunk into the trunk lock triggers the automatic soft-close drive.

A microswitch in the trunk lock is activated by the locking pawl being located in the pre-locking position. The drive electronics for automatic soft-close assess the change in status as a starting signal.

The drive then pulls the rotary striker closed via a Bowden cable. As soon as the locking pawl engages in the main locking position, the automatic soft-close drive is stopped.

Note: The automatic soft-close drive serves to ensure that the trunk closes both safely and securely.

Special Functions

■ Automatic locking (personal profiles)

At speeds in excess of 16 km/h (10 mph), the vehicle locks automatically. The speed signal is supplied by the Integrated Chassis Management.

The vehicle is unlocked in connection with Comfort Access as soon as terminal 15 is switched off.

Note: Various functions of the central locking system can be individually customized using “personal profiles”. Refer to the Owner’s Handbook for further information.

■ Unlocking after a crash

A locked central locking system is unlocked as soon as the Car Access System 4 receives a crash message from the advanced crash safety management.

After this crash message is received, the central locking controls are blocked.

The controls are only enabled again after Advanced Safety Crash Management (ASCM) stops sending the crash message or if, after 10 seconds, the crash message is no longer received.

■ Selective unlocking

With corresponding coding, the vehicle can also be unlocked selectively. In this case, initially the driver’s door is unlocked. The rest of the vehicle is unlocked in response to a renewed unlock request.

Central Locking Button

A new function for the central locking system is the ability to activate central locking from the trunk.

The central locking button is located on the underside of the trunk. Whether or not the button is present depends on which equipment is installed on the vehicle.

Pressing the central locking button locks and centrally locks all vehicle doors.

Note: The central locking button is only accessible with the trunk open.

The button status is evaluated by the Car Access System. If the vehicle is in sleep mode, it must first be woken up.

The Car Access System recognizes that the central locking button has been pressed and locks and centrally locks the car as appropriate.

Option	Central locking button	
Comfort Access (CA)	Central locking button	
Automatic Trunk Actuation (HKL)	Button for HKL actuation is located next to central locking button	

System Components

Components of the Central Locking System

Footwell Module

The footwell module is installed at the left-hand A-pillar. It evaluates the status of the door contacts and reads in the Hall sensor signals of the lock barrel in the driver's door and transfers the information via the K-CAN2 to the junction box electronics module or Car Access System 4.

Car Access System 4

The Car Access System 4 is installed on the right, above the steering column. It assumes the master function for the central locking system. The Car Access System 4 has the exclusive system authorization and is simply supported by the other control units.

The Car Access System 4 also registers the status of the center lock button. The Car Access System 4 activates central locking, depending on the status of the central locking system. Briefly pressing the center lock button triggers the vehicle to lock or unlock.

The Car Access System evaluates the status of the interior trunk button on the A-pillar and the central locking button on the trunk.

Junction Box Electronics Module

The junction box electronics module is plugged into the front power distribution box.

Note: The power distribution box and the junction box electronics module are two separate components. This must be borne in mind when performing service work.

The junction box electronics module contains the relays for activating the central locking drive units.

The trunk central locking is activated via a power output stage in the junction box electronics module.

The status of the exterior trunk button is read by the junction box electronics module and this information is passed on to the Car Access System 4.

The automatic soft-close drive and the remote control receiver are supplied with power by the rear power distribution box.

Controls

The central locking can be operated from the following controls (among others):

- ID transmitter
- Driver's-door/trunk lock barrel

- Central locking button
- Interior trunk button in the A-pillar
- Central locking button.

ID transmitter

Each vehicle is supplied with a purse key/ spare key and two ID transmitters.
The adapter for the spare key is located in the glove compartment.

Note: Up to eight ID transmitters can be used in conjunction with the Comfort Access function. Four ID transmitters can be used for personal profiles.

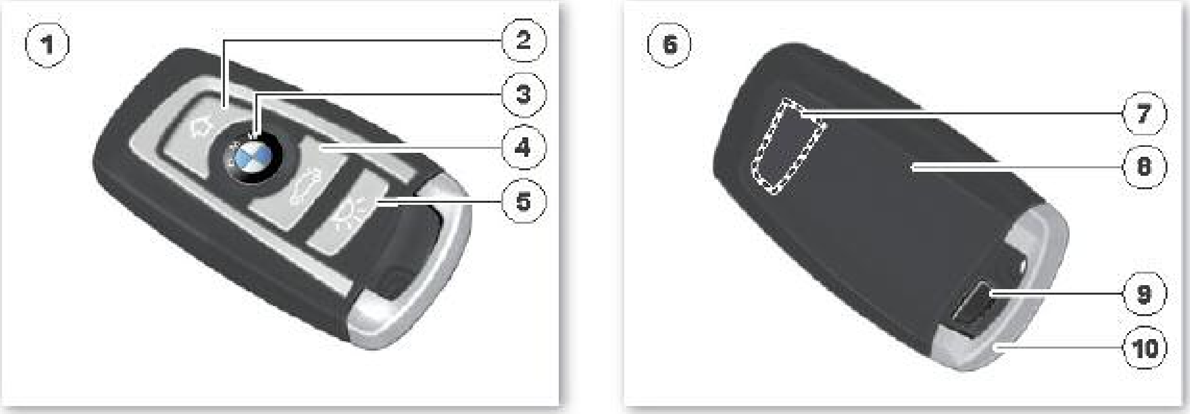
The ID transmitter has one button for locking and one for unlocking the vehicle. There is a separate button for unlocking the trunk. Pressing the trunk symbol button triggers automatic closing/opening of the trunk. Automatic closing requires the automatic trunk actuation option.

The ID transmitter contains a battery which lasts up to four years.

The mechanical key is located in the ID transmitter.

Note: The passenger airbag can also be deactivated/activated with the mechanical key.

F01/F02 ID transmitter



Index	Explanation	Index	Explanation
1	ID transmitter top view	6	ID transmitter rear view
2	Unlock/comfort open	7	Transponder coil area
3	Lock/comfort close	8	Battery compartment
4	Button for OPEN trunk	9	Button for mechanical key
5	Button for vehicle search function	10	Mechanical key

The ID transmitter has a 512 MB data memory. The following data can be stored in the ID transmitter:

Data	Explanation
km reading (mileage)	Current km reading of vehicle
VIN	
Key number	Number of the ID transmitter
Fault code memory entries	Which displays fault code memory entries and associates them with possible PuMAs
NAVI-DVD version	Data status of navigation DVD
Engine oil	Information on topping up or draining the engine oil, e.g. in the case of overfilling
Battery condition	Battery charge status
Integration stages	Integration stage that left the factory, integration stage last programmed or currently available integration stage.

Note: The remote control receiver is integrated in the antenna diversity facility and passes the remote control signal to the Car Access System 4 via the LIN bus.

■ Driver's-door lock barrel

The lock barrel is connected mechanically via a linkage to the door lock. Hall sensors for the lock barrel are integrated in the door lock.

The footwell module evaluates the signals from the Hall sensors for locking/unlocking purposes.

■ Trunk locking barrel

The lock barrel is connected mechanically via a Bowden cable to the trunk lock. Turning the spare key in the lock barrel opens the trunk lock.

Note: If the vehicle is fitted with an anti-theft alarm system, this causes an alarm to be triggered. 1 Center lock button 2 Center lock button

■ Center-lock button

The center-lock button is installed between the center of the outlets in the dashboard. The center-lock button forms one unit together with the hazard warning lights button.

F01/F02 button unit

Index	Explanation	Index	Explanation
1	Hazard warning flasher button	2	Central locking button

Note: The center lock button can also be operated when the vehicle is locked. However, opening the vehicle door will trigger an alarm from the anti-theft alarm system.

Central Locking Drive Units

A central locking drive unit consists of an electric drive unit and the unlocking/locking mechanism.

■ Central locking drive units in the doors

The central locking drive units in the doors are equipped with two motors to facilitate the unlocking/locking and central arrest functions of the vehicle.

Central arrest means that the locking button in the doors is separated mechanically from the central locking drive unit.

As a result, the vehicle cannot be opened by pulling the locking button.

The Hall sensor for the door contact is additionally integrated in the central locking drive unit.

■ Trunk central locking drive (trunk lock)

The central locking drive for the trunk is equipped with a motor for unlocking.

The central locking drive contains two microswitches which are actuated by the locking pawl. If the locking pawl is in the pre-locking position, the status of the microswitch changes from a high signal to a low signal. The electronics in the automatic soft-close drive register the status and activate the drive. As soon as the locking pawl engages in the main locking position, the drive stops.

Note: The junction box electronics module evaluates the status of the microswitch. The junction box electronics module sends the status via the K-CAN2. This applies to vehicles with automatic trunk actuation. The trunk lift requires this information so that it can start at the right time, and not cause damage to the trunk lock.

The second microswitch is used to switch on the luggage compartment lighting. The change in the status of the microswitch which occurs when the trunk is opened or closed is also used to monitor the trunk for the purposes of the anti-theft alarm system.

■ Automatic soft-close drive for the trunk

The automatic soft-close drive is connected to the trunk lock with a Bowden cable. This has the benefit that the drive can be fitted regardless of the available installation space. The drive is connected to terminal 30B. The fuse is located in the rear power distribution box. An electronics module is integrated into the automatic soft-close drive which is used to monitor its proper functioning.

Closing the trunk places the rotary striker in the trunk lock in the pre-locking position. To this end, a microswitch is located in the trunk lock which changes status when the lock is actuated.

The electronics module in the automatic soft-close drive evaluates this change in status and triggers the drive to switch on. The automatic soft-close drive is actuated until the rotary striker is located in the main locking position. Once this has occurred, the microswitch changes status again and the drive is switched off.

Note: The drive and the trunk lock can be replaced individually.

■ Fuel filler flap central locking drive

The central locking drive is equipped with a motor for unlocking/locking.

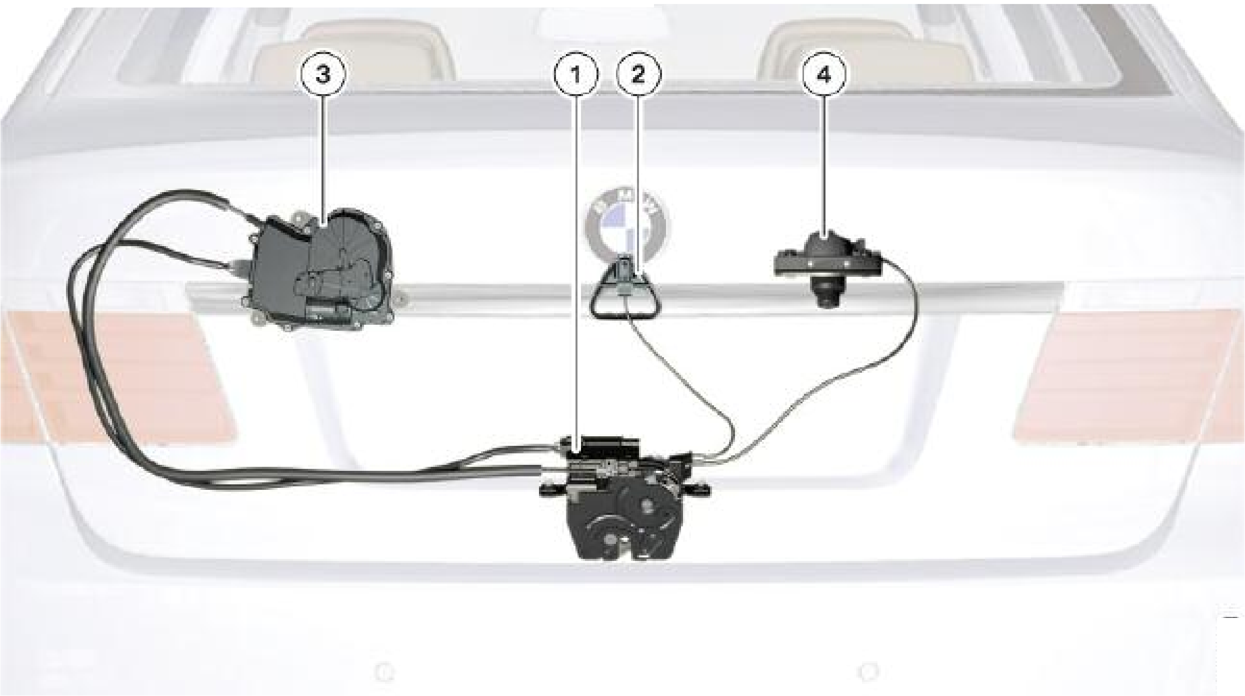
■ Manually releasing the fuel filler flap

The fuel filler flap can be released manually in the event of an electrical defect. The release mechanism is located in the luggage compartment, on the right-hand side.

Manually Unlocking the Ttrunk

The US variant of the F01/F02 has an emergency trunk release mechanism. This makes it possible to open the trunk manually from inside the luggage compartment.

F01/F02 emergency trunk release mechanism



Index	Explanation	Index	Explanation
1	Trunk lock	3	Automatic soft-close drive
2	Handle for the emergency release	4	Trunk lock barrel mechanism

Pulling on the handle (item no. 2) unlocks the trunk lock. The pulling motion on the handle is transferred to the trunk lock by a Bowden cable, causing the trunk lock to unlock.

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F01 Automatic Soft Close

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Automatic Soft Close (SCA)

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the operation of SCA on the F01/F02

Introduction

F01/F02 Available with Automatic Soft Close Function

The Automatic Soft Close function (SCA) is available and can be ordered as of volume production launch.

The Automatic Soft Close function requires the installation of suitable door locks with drives for Automatic Soft Close (SCA drives).

The particular feature of this Automatic Soft Close function is that the door lock and the Automatic Soft Close drive unit are no longer a single unit. The Automatic Soft Close drive unit is separate and controls the door lock by way of a cable.

This means that the lock and the drive can be fitted separately and the installation space available can be used to the best effect.

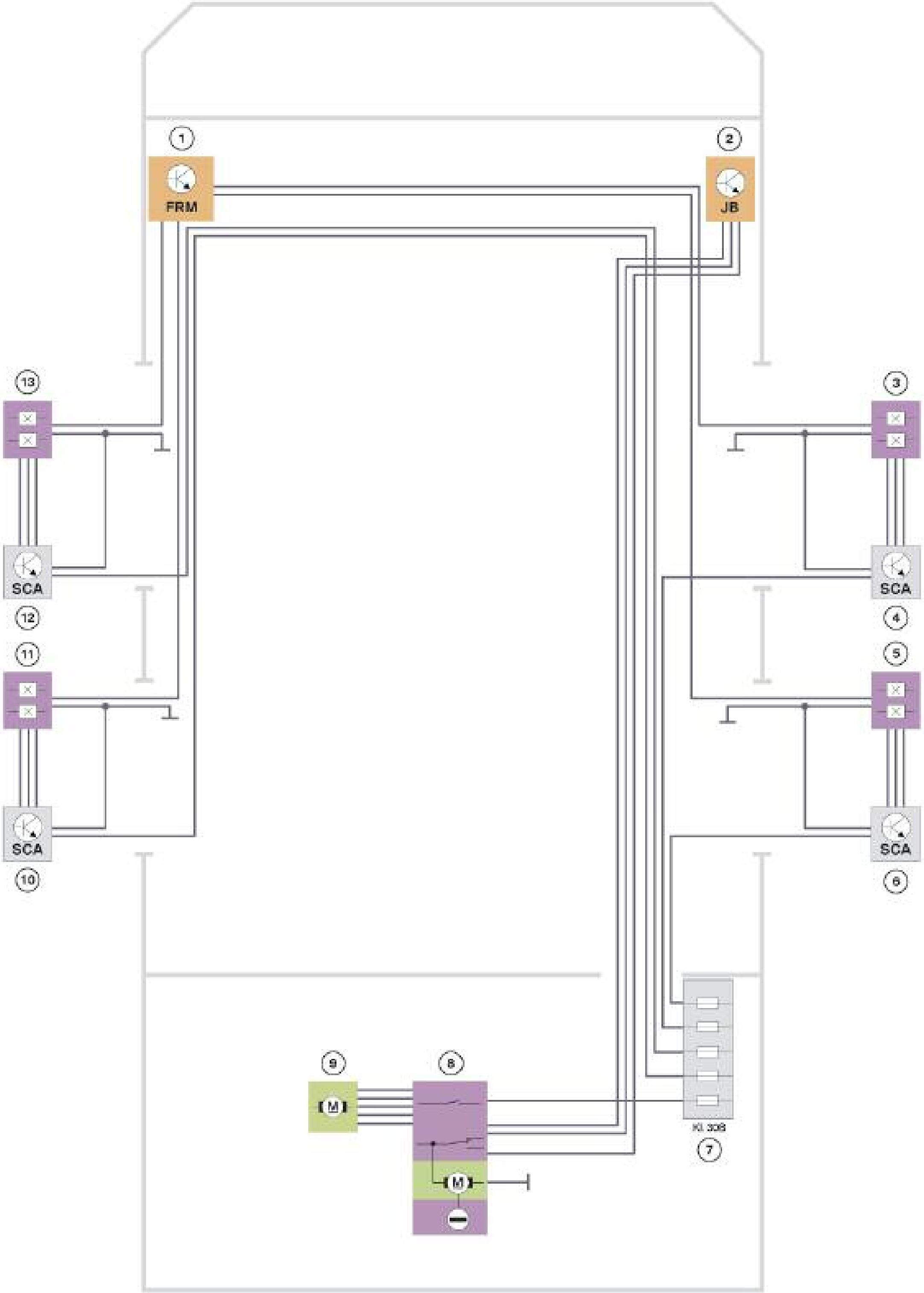
The Automatic Soft Close option is only available for all doors on the vehicle.

The benefit of the Automatic Soft Close function is that the doors only have to be pushed or pulled lightly into the lock. This action starts the Automatic Soft Close function which closes the doors fully.

Note: The Automatic Soft Close function for the trunk is standard equipment and thus is not part of this option.

System Overview

System Circuit Diagram for Automatic Soft Close Function



Index	Explanation	Index	Explanation
1	Footwell module (FRM)	8	Trunk central locking unit
2	Junction box module (JB)	9	Trunk Automatic Soft Close unit
3	Door switch, central locking, Hall-effect sensor for front passenger door Automatic Soft Close function	10	Off-side rear Automatic Soft Close unit
4	Front passenger door Automatic Soft Close unit (SCA)	11	Door switch, central locking, Hall-effect sensor for off-side rear door Automatic Soft Close function
5	Door switch, central locking, Hall-effect sensor for near-side rear door	12	Driver's door Automatic Soft Close unit (SCA) Automatic Soft Close function
6	Near-side rear door Automatic Soft Close unit (SCA)	13	Door switch, central locking, Hall-effect sensor for driver's door Automatic Soft Close function
7	Luggage compartment power distribution box	Kl. 30B	Terminal 30 basic mode

Functions

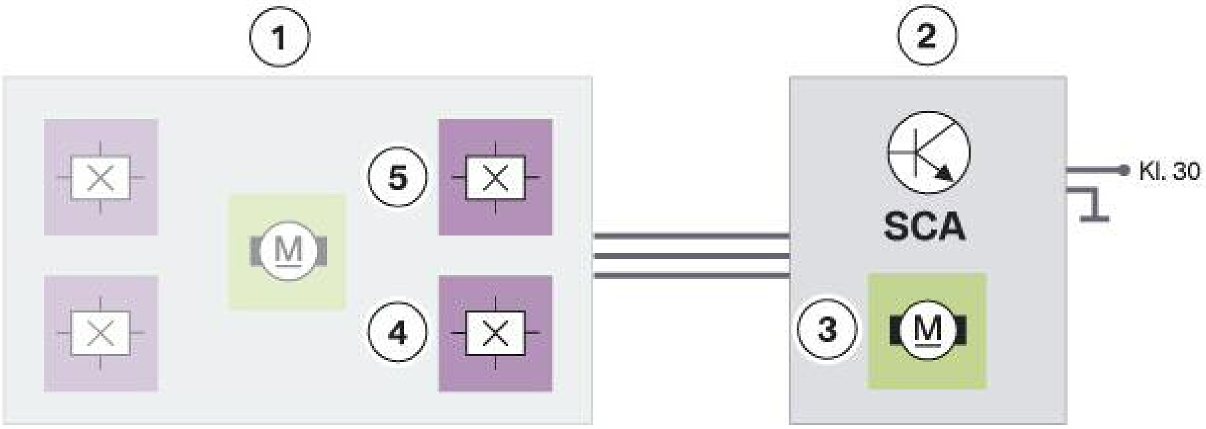
Automatic Soft Close

The Automatic Soft Close function is an autonomous function. The only connection to the car's electrical system is Terminal 30 basic mode (Terminal 30B) and the ground connection. The Automatic Soft Close function is operational as of "Terminal 30B ON".

Circuit Diagram for an Automatic Soft Close System

The electronics for controlling and monitoring the function are located in the Automatic Soft Close function drive.

The sensors for the Automatic Soft Close function are Hall-effect sensors and are located in the locks. The Hall sensors are built into the lock of each vehicle door. One Hall sensor is for the locking pawl, the other for the rotary striker.



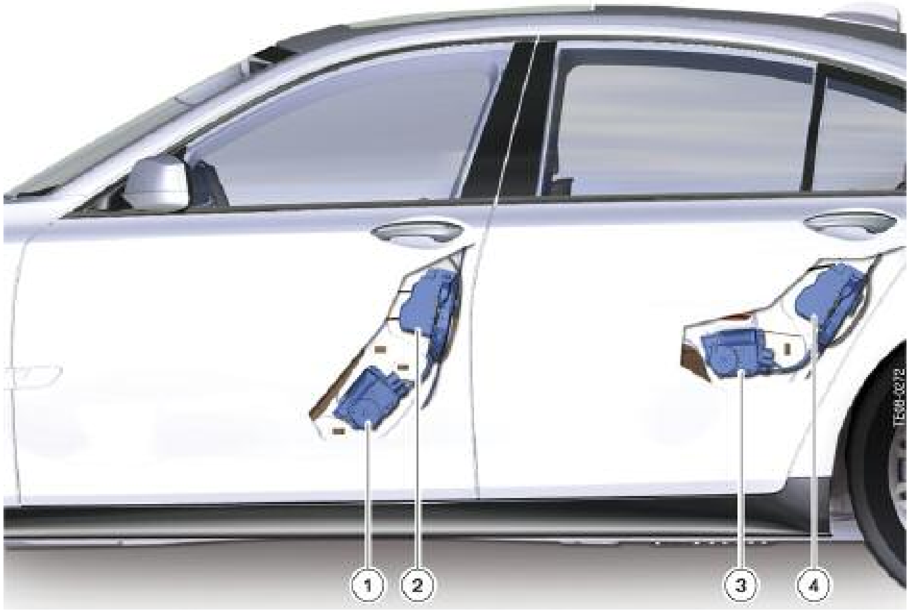
Index	Explanation	Index	Explanation
1	Lock in the vehicle door	4	Locking pawl Hall sensor
2	Automatic Soft Close function drive	5	Rotary striker Hall sensor
3	Automatic Soft Close function drive motor		

The Automatic Soft Close function analyzes the status of the Hall sensors. The Automatic Soft Close drive units are operated or moved back to their starting position according to status.

The Automatic Soft Close function drive is connected to lock by way of a Bowden cable and a 3 wire cable.

The following illustration shows where the Automatic Soft Close function drives are fitted.

Location of F01/F02 Automatic Soft Close system



Index	Explanation	Index	Explanation
1	Drive for Automatic Soft Close function in driver's side door	3	Drive for Automatic Soft Close function in driver's side rear door
2	Lock for driver's side door	4	Lock for driver's side rear door

Locking Procedure when Door is Pushed into the Lock

Starting position: Door open, the Automatic Soft Close function is in the standby position.

When the door is closed normally, first the locking pawl (lock) Hall sensor changes its status. The electronics in the Automatic Soft Close function drive start the door closing operation after a delay of 200 ms. This prevents the Automatic Soft Close drive unit starting before the lock bolt is located in the rotary striker. The drive operates the rotary striker by way of the Bowden cable until the Hall sensor for the rotary striker changes its status. The locking pawl is then engaged and secured in the rotary striker. Operation of the Automatic Soft Close drive unit is then stopped and the Automatic Soft Close drive unit returns to its parked position.

When the door is opened using the outside door handle (bow handle) or inside door handle, the system runs back to its original position. This is also known as the standby position.

Note: Only when the rotary striker sensor has changed its status is the rotary striker mechanically locked by the locking pawl. This is particularly important, as only then is it guaranteed that the door is truly closed.

Closing the Door by Slamming

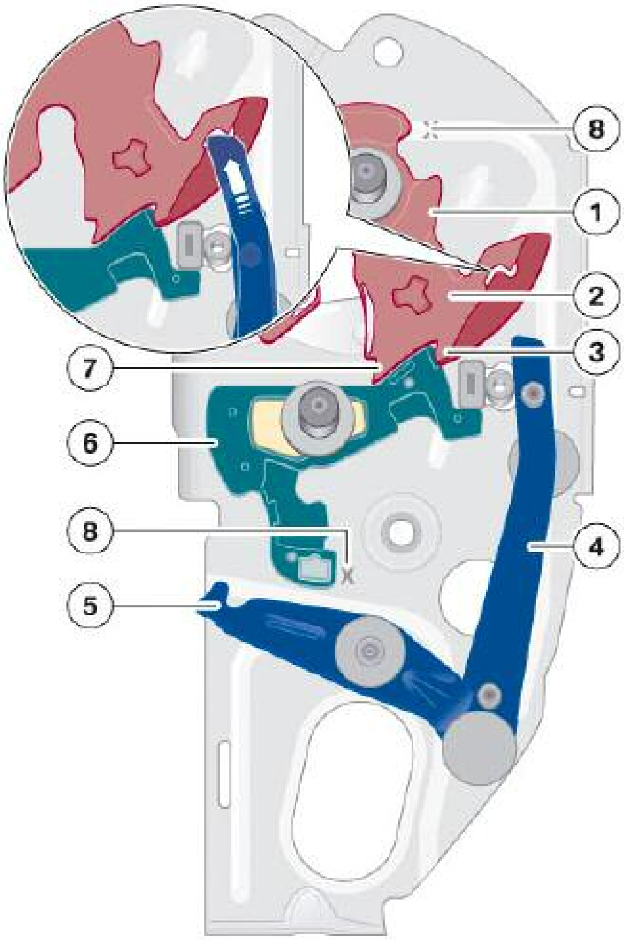
Slamming the door would make closing with the Automatic Soft Close function drive unnecessary. However, since it is essential to ensure that the door is definitely closed, the Automatic Soft Close drive unit is nevertheless still operated for safety reasons.

The electronic circuitry in the Automatic Soft Close drive unit detects the slamming of the door by the fact that the locking pawl and rotary striker Hall-effect sensors have changed their status within a short time.

Anti-repeat Circuit

Every Automatic Soft Close function drive has an anti-repeat circuit to prevent overheating of the Automatic Soft Close function drive. It permits 15 operations (counter incremented up to 15 times) of the control for the Automatic Soft Close function drive. The Automatic Soft Close function drive is then locked electrically for approximately 2 minutes.

Design of the Lock and Drive

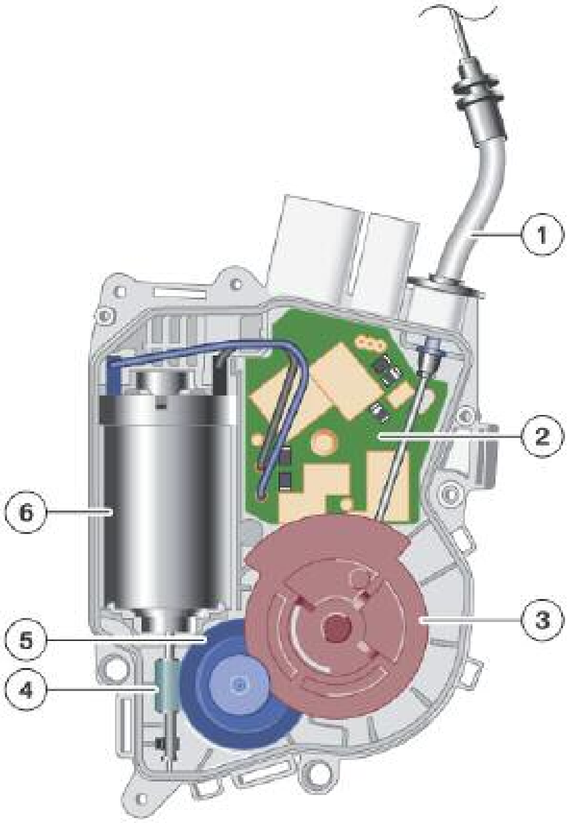


Basic principle of Automatic Soft Close lock as illustrated by E70

Index	Explanation	Index	Explanation
1	Rotary striker	5	Automatic Soft Close function drive actuating lever
2	Rotary striker pull pawl	6	Locking pawl
3	Advance detent tooth for rotary striker	7	Rotary striker main detent tooth
4	Drive pawl	8	Hall sensor installation locations

Light closing causes the advance detent tooth (3) of the rotary striker (1) to engage on the locking pawl (6). The Automatic Soft Close function drive pulls on the actuating lever (5). The actuating lever rotates the rotary striker by means of the pull latch (4) until it is rotated over the main detent tooth (7). The locking pawl can now engage in the main detent tooth of the rotary striker. The rotary striker is thus secured and the lock can no longer open by itself.

Basic principle of Automatic Soft Close drive unit as illustrated by E70



Index	Explanation	Index	Explanation
1	Bowden cable	4	Drive worm
2	Control electronics	5	Idler gear
3	Bowden cable drive wheel	6	Drive motor

The Automatic Soft Close function drive motor (6) has a two-start worm (4) on its shaft. This permits drive in the CLOSE direction for the Automatic Soft Close function. The rotary motion of the drive worm is transferred to the driven wheel (3) by the idler gear (5). The drive gear transfers the rotary motion to the Bowden cable (1). This means that the actuating lever in the lock is pulled by the Bowden cable and thus the vehicle door is fully closed.

Service Information

Lock and Drive

The lock and the Automatic Soft Close function drive are a closed unit (modular). This means that a faulty lock or Automatic Soft Close function drive cannot be replaced individually. Opening the drive, for instance, destroys it, and perfect operation is no longer guaranteed. The Automatic Soft Close function drive is inseparably fastened to the lock. The lock and the Automatic Soft Close drive unit can only be ordered together as spare parts.

Note: There is no diagnostic function for the Automatic Soft Close function drive in the diagnostics system. Retrofitting the Automatic Soft Close system would be very complicated and is therefore not envisaged.

There is no diagnostic function for the Automatic Soft Close function drive in the diagnostics system.

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F01 Power Windows

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Subject **Page**

Power Windows

Model: F01/F02

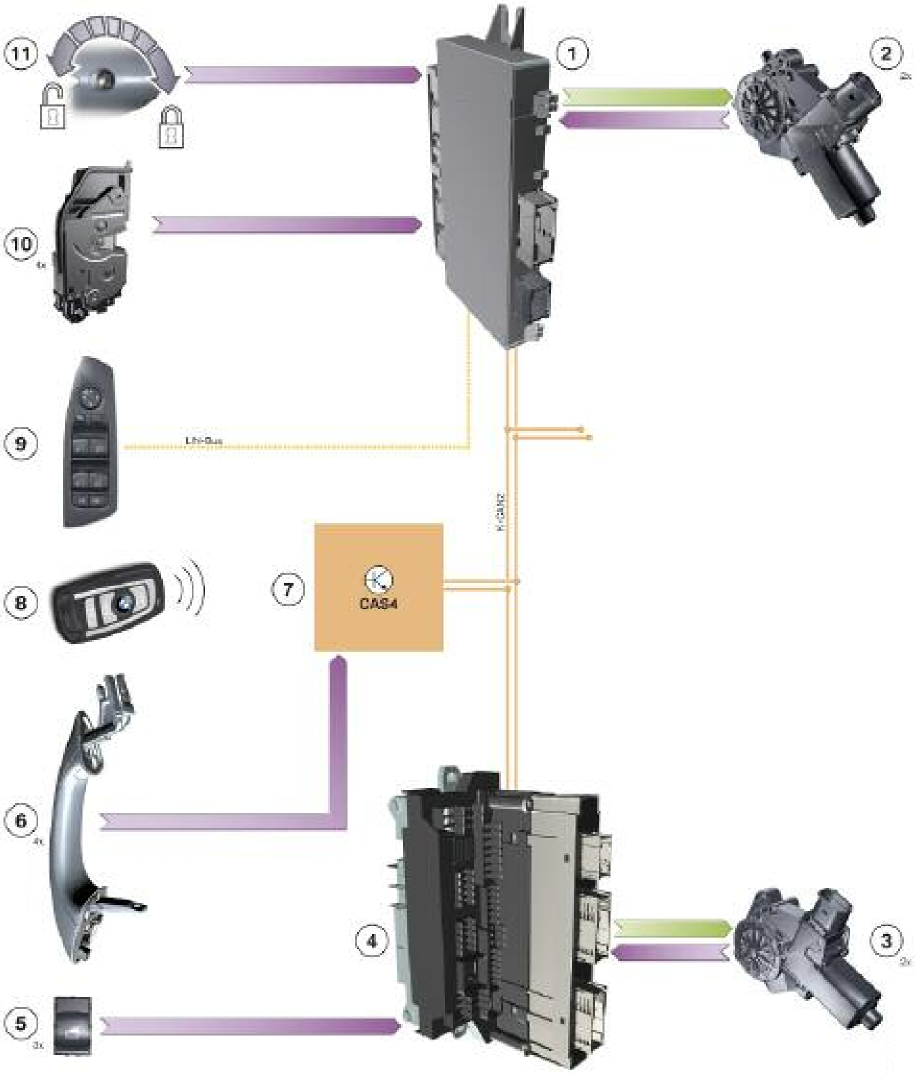
Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

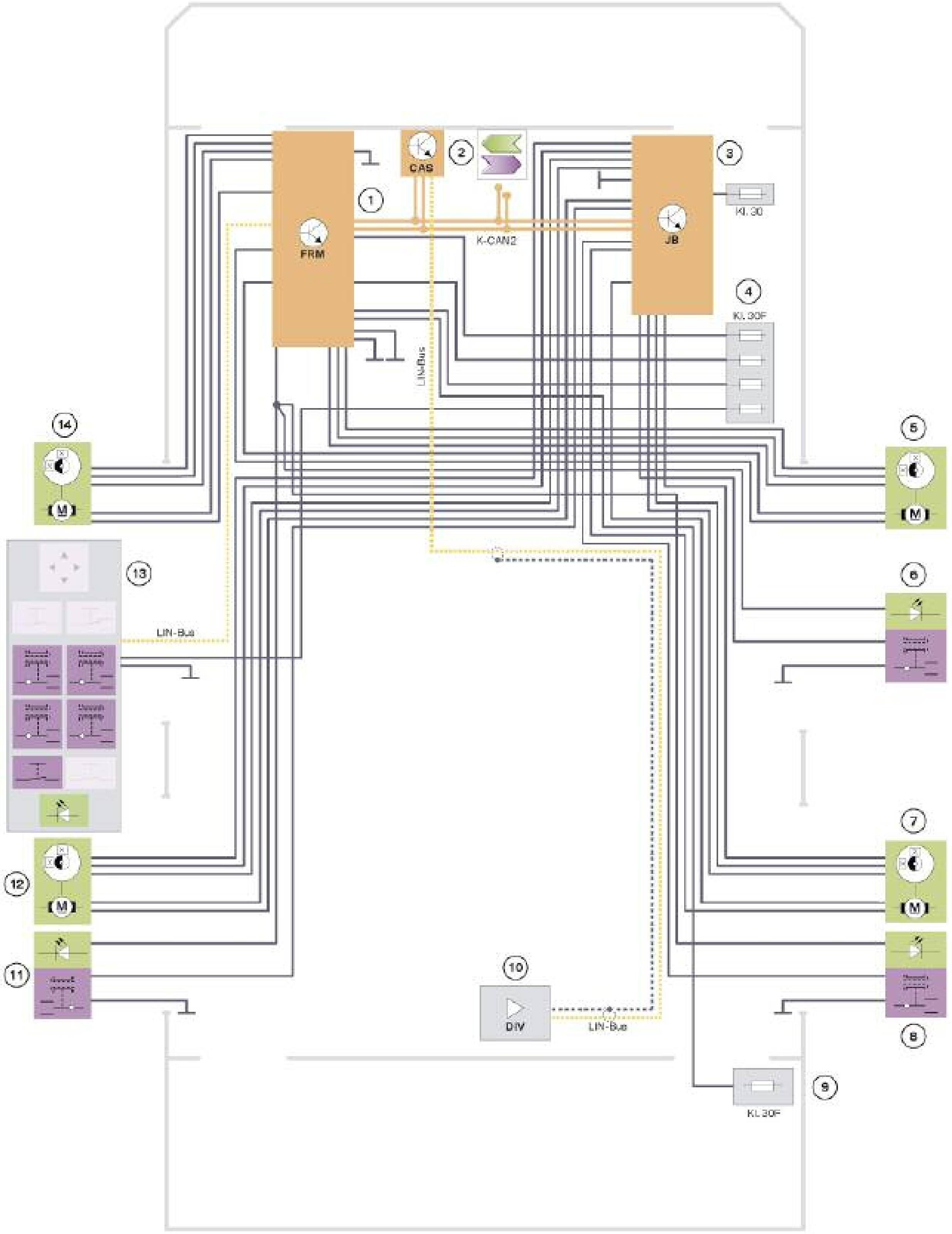
- Understand the operation of the power windows on the F01/F02
- Locate and identify power system components

System Overview



Index	Explanation	Index	Explanation
1	Footwell module	8	Identification transmitter
2	Power window motor, front	9	Driver’s door switch cluster
3	Power window motor, rear	10	Lock with door contact
4	Junction box electronics	11	Lock cylinder, driver’s door
5	Power window switch, driver’s side rear passenger side front and rear	K-CAN	Body CAN
6	Outside door handle for Comfort Access	LIN	Local Interconnect Network bus
7	Car Access System 4		

System Circuit Diagram - Power Windows



Index	Explanation	Index	Explanation
1	Footwell module (FRM)	10	Remote control receiver in diversity module
2	Car Access System 4 (CAS 4)	11	Power window switch, driver's side rear
3	Junction box electronics (JB)	12	Power window motor with indirect pressure-sensitive finger guard on rear driver's side
4	Front power distribution box	13	Driver's door switch cluster
5	Power window motor with indirect pressure-sensitive finger guard on front passenger's side	14	Power window with indirect pressure-sensitive finger guard on driver's door
6	Power window switch, passenger side front	K-CAN2	Body-CAN2
7	Power window motor with indirect pressure-sensitive finger guard on rear passenger's side	LIN-Bus	Local Interconnect Network bus
8	Power window switch, passenger side rear	Kl. 30	Terminal 30
9	Rear power distribution box	Kl. 30F	Terminal 30, fault switched

The Car Access System (2) issues the enable to actuate the power window motors (5, 7, 12 and 14). If a power window switch is then activated, the footwell module (1) (front power window motor) or the junction box electronics (3) (rear power window motor) executes the request.

Examples of the Signal Path

The following examples of a signal path show the path taken by the signal before the power window motor opens or closes the window. A requirement is that the Car Access System 4 has issued the enable to operate the power windows.

Driver's Door Switch Cluster

When the power window switch for the window in the driver's door or front passenger 's door is operated, the signal is routed via the LIN bus to the footwell module. The footwell module drives the corresponding power window motor.

The signal is routed from the driver's door switch cluster via the LIN bus to the footwell module when the power window switches for the windows in the rear doors are operated. The footwell module sends the signal via the K-CAN2 to the junction box electronics. The junction box electronics receives the signal and activates the corresponding power window motor.

Power Window Switch, Front Passenger's Door

The signal is routed to the junction box electronics when the power window switch in the front passenger's door is operated.

The junction box electronics sends the signal via the K-CAN2 to the footwell module. The footwell module drives the power window motor.

Power Window Switch, Rear Doors

When the power window switches in the rear doors are operated, the signal is routed to the JBE. The JBE drives the power window motor.

Overview

All four windows on the F01/F02 are electrically operated. The power windows are equipped with an indirect pressure-sensitive finger guard. The electric power windows have the following functions:

- Opening and closing
- Opening and closing with toll function
- Auto-remote opening and closing
- Indirect pressure-sensitive finger guard
- Panic mode
- Load shut-down at terminal 50
- Overheating protection of power window motors.

Opening and Closing

The Car Access System 4 has the central control function for electric opening and closing of the power windows.

This means that the Car Access System 4 issues the enable to open and close the power windows. The footwell module and the junction box electronics actuate the power window motors and monitor the motor speed of the respective power window motor. This means the footwell module or the junction box electronics can respond to the following operating situations:

- Trapping
- Overheating of the power window motor
- Blocking of power window motors.

The corresponding power window motor is activated in OPEN or CLOSE direction by pressing or pulling the power window switches to the first notch position. The power window motor remains active until the corresponding power window switch is released.

To ensure the power window is closed reliably, the power window motor is briefly driven to block status at the upper stop.

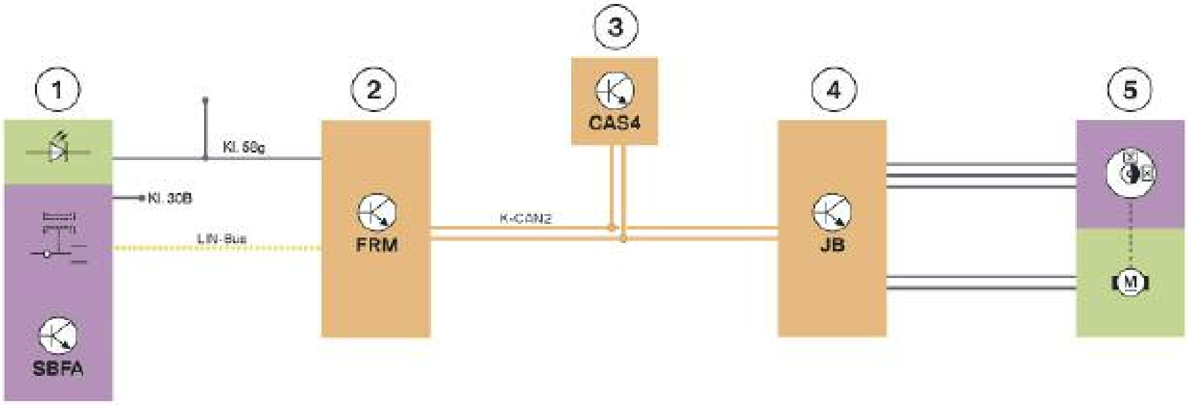
Opening and Closing with Toll Function

The toll function is implemented for all power windows. The corresponding power window motor is driven in the OPEN or CLOSE direction by pressing or pulling a power window switch beyond the limit stop.

The power window motor moves the window automatically until it is completely open or closed. Power window operation is stopped when the power window switch is pressed or pulled again.

By way of example, the opening and closing procedure for one of the rear windows is illustrated by the signal path in the following graphic. The opening or closing function is initiated from the driver's door switch cluster.

Example - Opening or closing the rear window in the F01/F02



Index	Explanation	Index	Explanation
1	SBFA power window switch in driver's door switch cluster	LIN-Bus	LIN-bus
2	Footwell module (FRM)	K-CAN2	Body-CAN2
3	Car Access System 4 (CAS 4)	Kl. 30B	Terminal 30, basic operation
4	Junction box electronics (JB)	KL. 58g	Terminal 58g
5	Power window motor		

Auto-remote Opening and Closing

Auto-remote opening or closing can be performed with the identification transmitter via the door lock in the driver's door or the outside driver's/passenger's door handle.

■ Auto-remote opening with identification transmitter

The auto-remote opening function is initiated by unlocking the vehicle with the identification transmitter and keeping the button pressed for longer than 5 seconds.

Initially, the front windows are opened, followed after a short time delay by the rear windows and the panorama glass roof.

Note: If the fold-in/out exterior mirrors option is installed and the mirrors are folded in, the mirrors will be folded out at the same time as the rear windows are opened.

Only the version sold in Japan offers auto-remote closing or auto-remote opening for folding the exterior mirrors in or out.

The signal from the identification transmitter is picked up by the Car Access System 4 via the remote control receiver.

The Car Access System 4 issues the enable to operate the power windows and initiates the auto-remote opening function. The footwell module and the junction box electronics correspondingly activate the power window motors.

■ Auto-remote closing with identification transmitter

The auto-remote closing function is initiated after locking the vehicle with the identification transmitter and keeping the button pressed for longer than 5 seconds. Initially, the panorama glass roof is closed followed after a short time delay by the rear/front windows.

If the folding exterior mirrors option is installed, the mirrors are folded in simultaneously as the rear windows are closed.

■ Auto-remote opening and closing via the driver's door lock barrel

There are two Hall sensors installed in the door lock for the purpose of opening and closing the vehicle. The Hall sensors enable the footwell module to detect the position of the mechanical key or of the spare key in the lock barrel.

The key must be turned to the open or close position to initiate the auto-remote opening and closing function. The auto-remote opening or closing function is initiated when the key is held in this position.

The footwell module sends the request via the K-CAN. On conclusion of the corresponding check, the Car Access System 4 initiates the auto-remote opening or closing procedure.

■ Auto-remote closing with Comfort Access

In connection with Comfort Access, the auto-remote closing function is triggered via the driver's/passenger's outside door handle.

It is sufficient to touch the sensitive area of the outside door handle in order to trigger the auto-remote closing function via the door handle. Auto-remote closing is triggered if the sensitive area is touched for longer than 5 seconds. The ID transmitter must be within an approximate 2 m radius of the vehicle.

Note: Touching the outside door handle corresponds to pressing the lock button on the ID transmitter.

Indirect Pressure-sensitive Finger Guard

Essentially, the indirect pressure-sensitive finger guard does not prevent an object being trapped but rather it limits the trapping force to maximum 80 N. The power window motor is reversed on exceeding this trapping force.

The footwell module and the junction box electronics monitor the activated power window motors. The indirect pressure-sensitive finger guard for the front windows is activated by the footwell module. The indirect pressure-sensitive finger guard for the rear windows is activated by the junction box electronics.

The indirect pressure-sensitive finger guard in the E90 is based on the evaluation of the Hall pulses from the power window motors. The speed is derived from the Hall pulses of the power window motors. Speed fluctuations within certain ranges trigger the indirect pressure-sensitive finger guard so that the windows are opened. Operation of the power window switches is ineffective while the windows are in the process of opening.

If no operable pressure-sensitive finger guard is detected as the result of defective Hall sensors, the window can only be operated in jolts. The power window is in emergency mode and must be reinitialized.

Note: The initialization procedure is described in the Service Information.

The customer is shown a Check Control message.

Check Control message	Meaning	Information on the central information display
	Power window pressure-sensitive finger guard!	Power window pressure-sensitive finger guard deactivated.
	Power window pressure-sensitive finger guard!	Power window pressure-sensitive finger guard failed. Ask your nearest BMW Service to check this.

Panic Mode

Panic mode is triggered by overpulling releasing-overpulling (overpulling = pulling beyond limit stop) the power window switches.

It is necessary to release and overpull the switch again as the pressure-sensitive finger guard is still active the first time the switch is overpulled. Overpulling the power window switch the second time within 4 seconds closes the window with maximum force.

Note: The indirect pressure-sensitive finger guard is no longer active in this case. The window closes at the maximum closing force and does not reverse.

Load shut-down, Terminal 50

Car Access System 4 sends the “terminal 50 ON” status. The signal is received by the footwell module and junction box electronics via K-CAN.

The junction box electronics and the footwell module prevent operation of the power windows during the start procedure or interrupt current operation of the power windows. This protects the battery during the starting procedure.

The power window switches must be pressed again following an interruption in operation.

Operation of the power windows is not possible until the start procedure has been completed.

Overheating Protection of Power Window Motors

The footwell module and the junction box electronics monitor the motor temperature. The motor temperature is determined based on the outside temperature, motor running time and the time the motor is stationary (not operative). Each motor can be switched off individually to prevent the power window motors overheating during operation of the power windows. The motor is then deactivated for a defined period of time.

The overheating protection facility does not prevent the windows being opened in the case of trapping. Once started, a power window function is not interrupted by the overheating protection facility. In panic mode the window can still be closed even when the overheating protection function is active.

Roller Sun Blind

Roller sun blinds are available as an option for the rear window and rear side windows. The roller sun blinds can be raised and lowered electrically.

The switch for the roller sun blind on the rear window is located in the driver's door switch cluster. The footwell module detects the switch status via the LIN-bus. When the button is pressed, the footwell module issues the operational request via the K-CAN2. The complete control and function monitoring facility is integrated in the junction box electronics. The junction box electronics therefore executes the operational request.

Every time the roller sun blinds are operated, their positions are stored in the junction box electronics.

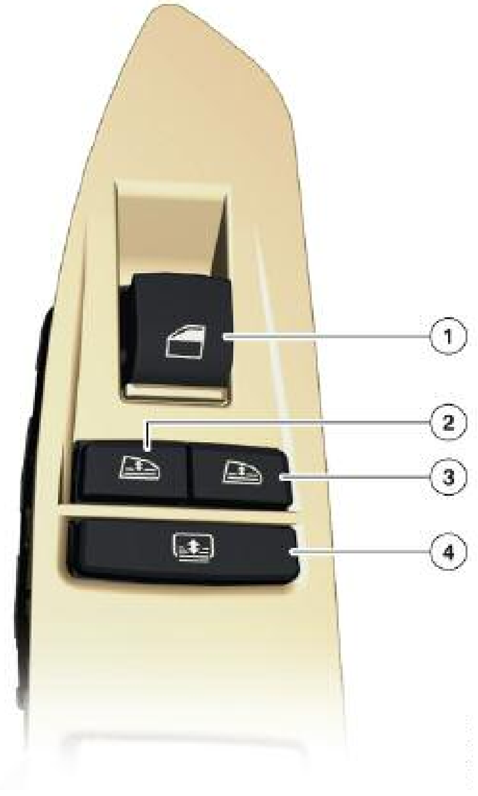
Other operating points are located in the armrests on the rear doors. The switches are located next to the switches for the power windows.

Three switches are provided in each armrest. The switches are:

- Switch for roller sun blind on rear window
- Switch for roller sun blind on left side window
- Switch for roller sun blind on right side window.

The roller sun blinds can be raised and lowered separately with the switches.

Switch cluster in driver's side armrest



Index	Explanation
1	Power window switch
2	Switch for roller sun blind on left side window
3	Switch for roller sun blind on right side window
4	Switch for roller sun blind on rear window

Each rear door has two roller sun blinds, one for the side window and one for the quarter light.

Both roller sun blinds are raised or lowered by means of an electric motor.

Note: The roller sun blinds are raised and lowered completely. They cannot be raised or lowered to an intermediate position.

If a new operational request is sent to the roller sun blinds during their actuation, they will reverse their direction of movement immediately.

The enable for operating the roller sun blinds on the rear doors is linked to the closed window position.

The Car Access System issues the enable for operating the roller sun blinds.

The roller sun blind of the corresponding side window is automatically lowered in response to an operational request to open the side window.

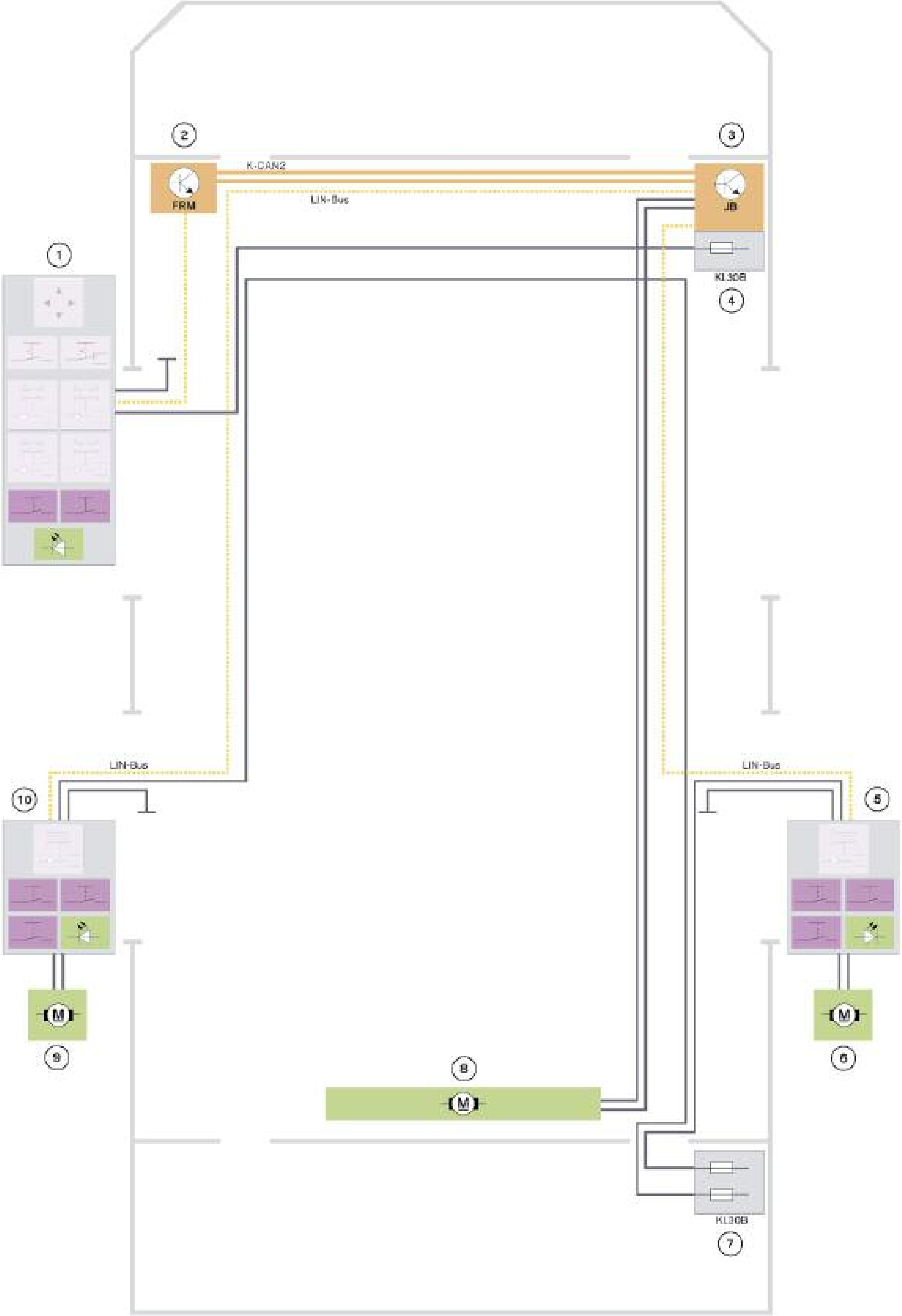
Operation of the roller sun blinds is restricted in the event of undervoltage.

By monitoring the outside temperature and interior temperature, the function “lower” roller sun blind is executed at an interior temperature > 11°C and outside temperature < -16°C.

The roller sun blinds can be operated as from terminal 15N ON.

Note: Operation of the roller sun blinds is disabled when the child safety lock is activated.

System Circuit Diagram - Roller Sun Blind



Index	Explanation	Index	Explanation
1	Driver's door switch cluster	8	Motor for roller sun blind, rear window
2	Footwell module (FRM)	9	Switch cluster in rear driver's side door
3	Junction box electronics (JB)	10	Motor for roller sun blind, rear driver's side
4	Front power distribution box	K-CAN2	Body-CAN2
5	Switch cluster in rear passenger's side door	LIN-Bus	Local Interconnect Network bus
6	Motor for roller sun blind, rear passenger's side	Kl. 30B	Terminal 30, basic operation
7	Rear power distribution box		

Overview of Functional Principle

The functional principle of the electrically operated roller sun blinds is described in the following.

Pressure-sensitive Finger Guard for Side Window

The roller sun blind has no electronic pressure-sensitive finger guard! The mechanism and drive units are designed such as to rule out any danger for the occupants posed by excessively high forces.

Nevertheless, to prevent trapping, the roller sun blinds can only be extended when the corresponding side window is closed. However should a trapping situation occur, movement of the roller sun blind will be stopped. The roller sun blind is then moved in the opposite direction in response to the next operational request. It is always possible to retract the roller sun blinds at the side windows.

The direction of roller sun blind movement that has already started can only be reversed

1.5 seconds after the button is pressed again.

Further button operation is ignored during the initial 1.5 seconds of roller sun blind movement. This function is intended to protect the operating mechanism of the roller sun blind.

Roller Sun Blind on Rear Window

The roller sun blind on the rear window can be operated by means of the roller sun blind switches. There are three operating points:

- Driver's door switch cluster

  The junction box electronics receives the switch status via the K-CAN2.
- Switch cluster in rear driver's side armrest*
- Switch cluster in rear passenger's side armrest*.

*The junction box electronics cyclically evaluates the switches at the rear doors via the LIN-bus.

The roller sun blind for the rear window is raised or lowered by briefly pressing the switch.

A special function is activated when the switch for the rear window roller sun blind is pressed longer. This special function allows all three roller sun blinds to extend or retract to assume the same position.

In this function, the roller sun blind for the rear window is actuated and, if necessary, also the roller sun blinds for the side windows.

Every time the roller sun blinds are operated, their positions are stored in the junction box electronics.

The end stops are detected by the motors blocking, thus cancelling activation.

A repeat inhibit function is integrated in the system to prevent the motor overheating due to continuous operational requests initiated by children playing with the switch. The repeat inhibit blocks operation of the roller sun blind in the down position. Once started, movement of the roller sun blind is not interrupted by the repeat inhibit.

The renewed enable to raise the roller sun blind depends on the number of times the roller sun blind is operated and the intervals between operation.

Rear window roller sun blind F01/F02

■ Position of roller sun blinds unknown

The raised or lowered positions of the roller sun blinds are stored in the junction box electronics. An unknown position of the roller sun blind may occur, for example, as a result of a voltage reset. If the position is not known, the junction box electronics interprets the roller sun blind as being in the raised position. The roller sun blind is then initially lowered in response to the next operational request. The direction is reversed if the junction box electronics detects blocking directly after actuation. Blocking signals that the roller sun blind is at the lower end stop position.

■ Blocking detection

The junction box electronics is equipped with a blocking detection facility to protect the motor. This function serves the purpose of immediately switching off the motor on reaching the upper or lower end position.

Motor actuation is additionally subject to a time monitoring function. Consequently, actuation of the motors is terminated after a defined maximum period of time.

The roller sun blinds on the side windows also feature a blocking detection function. This function is integrated in the electronic circuitry of the switch cluster in the rear door armrest.

This blocking detection function serves the purpose of switching off the motor on reaching the upper or lower end position.

The end positions are detected by evaluating the current consumption of the motors, thus cancelling activation. After detecting a significant increase in current consumption, the motor is short-circuit braked in blocked position and the drive is briefly reversed to relief the strain on the mechanical system.

The actuation time of the motor for the roller sun blind is additionally monitored. The actuation time is limited to 15 seconds. Actuation is then terminated after this period of time has elapsed.

■ Child safety lock

The child safety lock function is switched on or off by means of the child safety lock switch in the switch cluster on the driver's side.

The roller sun blinds can no longer be operated with the rear switches when the child safety lock is switched on.

No request to raise or lower the roller sun blind is triggered when the child safety lock button is pressed. Current movement of the roller sun blind is not interrupted when the child safety lock is engaged.

■ Roller sun blind switches

All switches have a LIN-bus connection. The switches are connected to terminal 30B and a ground connection.

The motors for the roller sun blinds in the side windows are connected directly to the respective switch cluster. The motor for the roller sun blind on the rear window is connected to the junction box electronics.

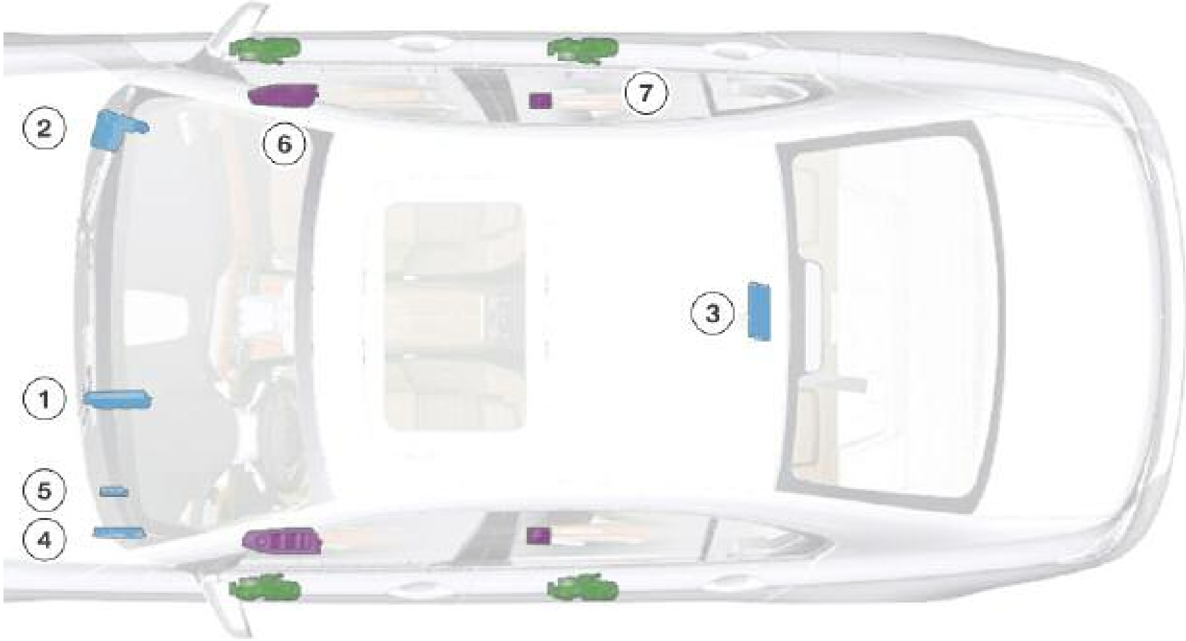
The electronic circuitry for the LIN-bus and the power electronics for actuation of the motors are integrated in the switch cluster. The electronic circuitry monitors actuation and detects the end positions of the roller sun blind.

The junction box electronics receives information on the end positions from the LIN-bus.

System Components

Components Involved

The following graphic shows all the components of the power window system together with the respective control units and control elements.



Index	Explanation	Index	Explanation
1	Car Access System 4	5	Central gateway module
2	Junction box electronics	6	Power window switch
3	Remote control receiver in diversity module	7	Power window motors
4	Footwell module		

The following components are described:

- Controls
- Control units
  - Car Access System 4
  - Footwell module
  - Junction box electronics
- Power window motor

Controls

Driver’s door switch cluster

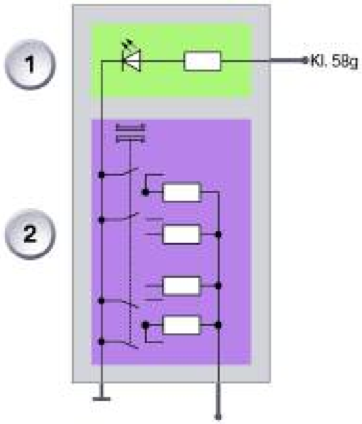
The driver’s door switch cluster is connected via the LIN bus to the footwell module.

Index	Explanation
1	Outside mirror adjustment switch
2	Selector switch, outside mirror left/ right
3	Power window button, passenger's door
4	Power window button, rear right
5	Roller sun blind button
6	Child safety lock button
7	Power window button, rear left
8	Power window button, driver's door
9	Outside mirror fold-in button

For opening or closing, the power window switch has two notch positions. The first notch position is used for the manual power window function. The second notch position (press) is used for the toll function of the power windows.

The power window switches are resistance-coded and switched to ground. The following graphic shows the principle of a resistance-coded switch.

Resistance-coded switch F01/F02



Index	Explanation
1	Illumination of power window switch
2	Resistance-coded switch

■ Signal evaluation of the power window switches

The signals of the power window switch in the driver's door switch console are evaluated directly by the driver's door switch cluster and transferred to the footwell module via the LIN bus.

The signals from the power window switches in the front passenger's door as well as the power window switches of both rear doors are evaluated by the junction box electronics.

Control Units

■ Car Access System 4

The Car Access System 4 is the central control unit for opening and closing the windows. Therefore, it issues the enable to operate the power windows.

"Terminal 50 ON" status is sent while starting the engine. The junction box electronics and the footwell module prevent operation of the power windows during the start procedure or interrupt current operation of the power windows. This means more energy from the battery is available for the starter during engine start-up.

■ Footwell module

The relays for the power window motors for the front doors are installed in the footwell module.

The footwell module provides information on the status of the door contacts and the driver's door lock cylinder.

The footwell module also provides the power window switch and the driver's door switch console with information on the "Terminal 58g ON" status.

■ Junction box electronics

The relays for the power window motors for the rear doors are installed in the junction box electronics.

Identification Transmitter

The identification transmitter can initiate auto-remote opening/closing of the power windows.

The operating procedure is defined in the Owner's Handbook.

Power Window Motors

The power window motors are equipped with Hall sensors that generate signals during motor operation. These signals serve the purpose of monitoring motor operation and are evaluated for the pressure-sensitive finger guard.

The signals are evaluated in the footwell module and the junction box electronics.

Initialization

Initialization of Power Windows

The front and rear power windows can be initialized via the power window switches or the BMW diagnosis system.

Note: The power windows can only be moved in jolts if not initialized.

■ Initialization via the power window switches

The following procedure must be performed to initialize the system:

- Completely close window by pulling the power window switch beyond the limit stop.
- Briefly interrupt pulling the power window switch and then pull the switch upwards again for approximately 1 second.

■ Initialization via the BMW diagnosis system

The power windows can be initialized as part of an initialization job using the diagnosis system. A detailed description of the initialization procedure is provided in the BMW diagnosis system.

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F01 Sliding Tilting Sunroof

Subject **Page**

Subject **Page**

Sliding Tilting Sunroof

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the operation of the sunroof on the F01/F02

Introduction

The F01/F02 with Slide/tilt Sunroof

The slide/tilt sunroof is an option on the F01/F02. Several control units are involved in the operation of the slide/tilt sunroof.

The roof control module controls and monitors the motors of the slide/tilt sunroof.

The roof control module (FZD) is linked with the Car Access System CAS which enables or disables operation of the slide/tilt sunroof.

The footwell module FRM supplies the signal from the door contacts. The Junction Box electronics provide the power supply for the motors via terminal 30.

The dynamic stability control acquires the signals from the wheel speed sensors while the integrated chassis management makes available the speed signal to the vehicle electrical system.

Slide/tilt Sunroof Operating Concept

The button for operating the slide/tilt sunroof has three directions of movement. In addition to the manual and overpress functions, the button has a double-click function in the three movement directions.

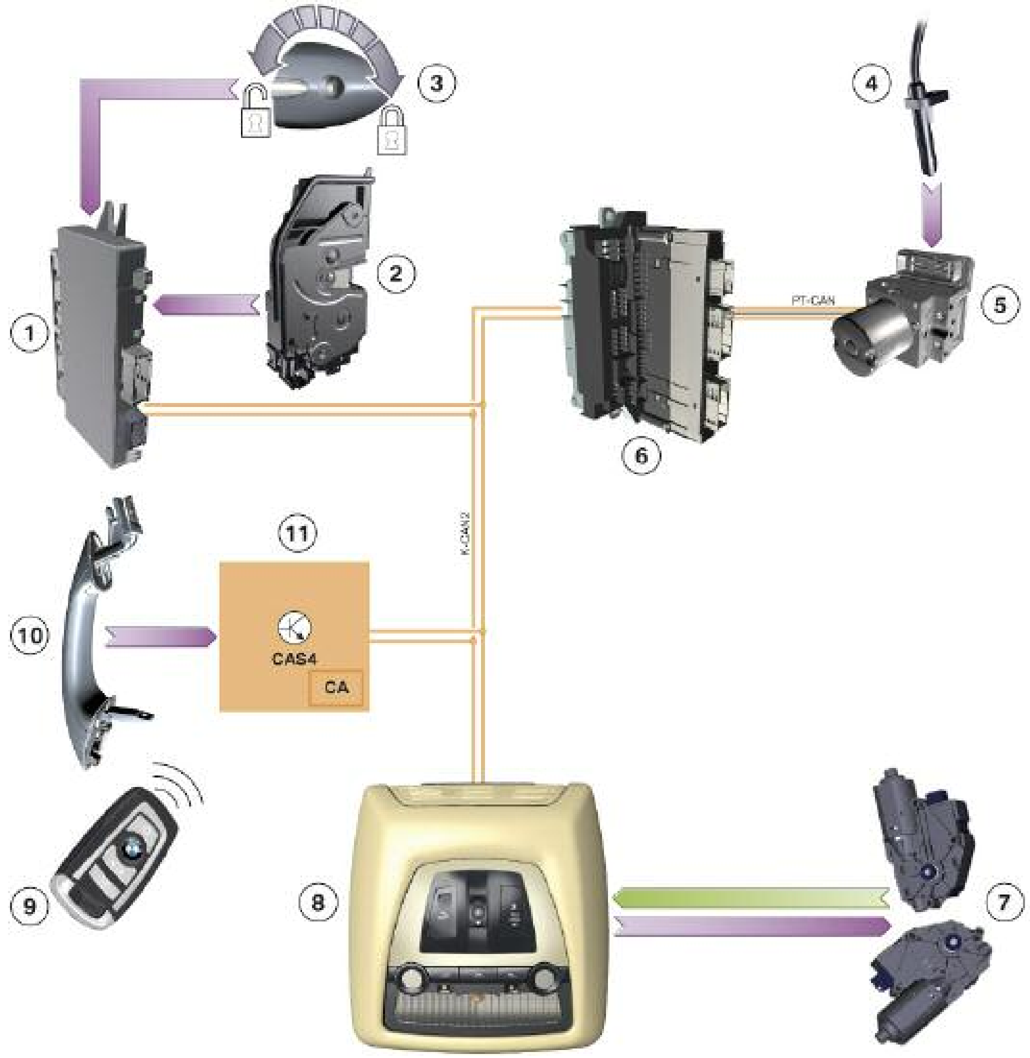
With the double-click function the button is actuated twice within a short time into the overpress position or tilt position.

This allows the customer to have the slide/tilt sunroof opened and closed automatically from any position of the slide/tilt sunroof and sunroof shade.

While moving, the slide/tilt sunroof can be stopped by pressing the button again.

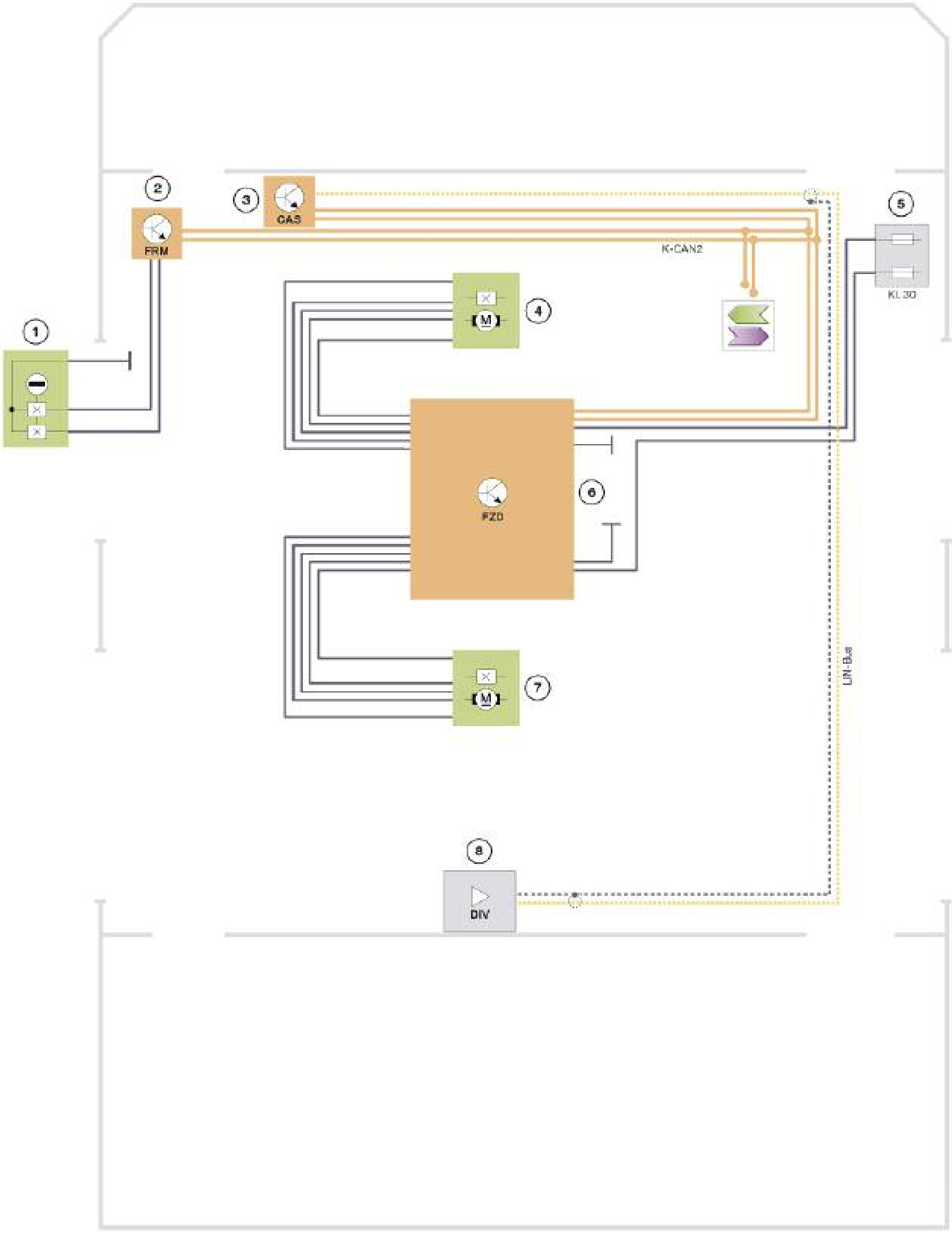
System Overview

Input/output slide/tilt sunroof



Index	Explanation	Index	Explanation
1	Footwell module FRM	8	Roof control module
2	Door contacts (4x) in the vehicle doors	9	Identification transmitter
3	Driver's door lock barrel	10	Outer door handles, driver's side and passenger side
4	Wheel speed sensor	11	Car Access System 4 CAS 4
5	Dynamic stability control	K-CAN2	Body-CAN2
6	Junction Box electronics JB	PT-CAN	Powertrain CAN
7	Slide/tilt sunroof motors		

System Circuit Diagram - Slide/tilt Sunroof



Index	Explanation	Index	Explanation
1	Hall sensors, driver's door lock barrel	7	Slide/tilt sunroof motor
2	Footwell module (FRM)	8	Remote control receiver in Diversity module
3	Car Access System (CAS)	K-CAN2	Body-CAN2
4	Slide/tilt sunroof motor	LIN-Bus	Local Interconnect Network bus
5	Front power distribution box	Kl. 30	Terminal 30
6	Roof control module FZD with button for slide/tilt sunroof		

K-CAN2 signals at roof control module

In/out	Information	Source/sink	Function
In	Vehicle speed	Wheel speed sensor > Dynamic stability control >	Release wind deflector Integrated chassis management
In	Outside temperature	Outside temperature sensor > instrument cluster	Value used in determining overheating protection for the slide/tilt sunroof motors
In	Slide/tilt sunroof enable	Car Access System 4 > roof control module	Enable for slide/tilt sunroof operation
In	Terminal 50 status	Car Access System 4 > roof control module	Interruption in sunroof slide/tilt sunroof actuation
In	Auto-remote opening	Identification transmitter > Car Access System 4	Slide/tilt sunroof auto-remote opening
In	Auto-remote opening	Driver’s door lock barrel > footwell module	Slide/tilt sunroof auto-remote opening
In	Auto-remote closing	Identification transmitter > Car Access System 4	Slide/tilt sunroof auto-remote closing
In	Auto-remote closing	Driver’s door lock barrel > footwell module	Slide/tilt sunroof auto-remote closing
In	Auto-remote closing	Outer door handle > Comfort Access	Slide/tilt sunroof auto-remote closing
Out	Anti-trapping protection function deactivated	Roof control module > instrument cluster	Anti-trapping protection function indicator deactivated

Auto-remote opening and auto-remote closing can be operated from the identification transmitter/remote control or via the lock barrel in the driver's door. This is done by holding down the lock/unlock button until the slide/tilt sunroof is closed/opened.

The lock barrel operates in a similar fashion. The mechanical key must be held in the lock/ unlock position until the slide/tilt sunroof is closed/opened.

With comfort access, the slide/tilt sunroof can be closed by touching the touch-sensitive area on the outer door handle. The touch-sensitive area must be touched until the slide/ tilt sunroof is closed.

Functions

Overview

The roof control module receives signals from the other control units for the functions of the slide/tilt sunroof.

The executing control unit is the roof control module. It controls the slide/tilt sunroof motors while also monitoring motor rotation.

The slide/tilt sunroof is equipped with two motors. One motor is for the glass panel and the other for the sunroof shade.

The following functions of the slide/tilt sunroof are integrated in the roof control module:

- Reading operation requests
- Controlling slide/tilt sunroof motors
- Opening/closing the slide/tilt sunroof and sunroof shade
- Anti-trapping protection function
- Blocking protection
- Panic mode
- Load cut-out during start procedure
- Terminal 58g
- Initialization

Reading Operation Requests

Slide/tilt sunroof operation may be requested through the following controls:

- Slide/tilt sunroof button
- Identification transmitter
- Driver’s door lock barrel
- Outer door handle in Comfort Access

■ Slide/tilt sunroof button

The button for the slide/tilt sunroof is located in the roof control module.

When operated, the button sends a low signal to the electronic module that drives the slide/ tilt sunroof motor corresponding to the button selection.

The power to the LED (locator lamp) of the button in the roof control module is supplied from “Terminal 58g ON”.

Identification transmitter

The auto-remote opening/closing function is initiated by pressing the button on the identification transmitter.

Driver’s door lock barrel

The convenient opening/closing function is triggered by turning and holding the mechanical key or the spare key in the open/ close position in the driver’s door lock barrel.

Outer door handle

Auto-remote closing can only be triggered using the outer door handle with Comfort Access. The touch-sensitive area must be touched for a longer time to start auto-remote closing.

Only then will the roof control module execute auto-remote closing. Releasing the touch-sensitive area interrupts auto-remote closing.

Controlling Slide/tilt Sunroof Motors

The roof control module actuates the integrated relay when it receives a corresponding request for the slide/tilt sunroof. The slide/tilt sunroof motor is supplied with power through the relay.

The relay contacts are monitored by the roof control module to ensure trouble-free operation of the motor and the slide/tilt sunroof. In addition, the motor speed is calculated and the direction of the motor's rotation is detected from the pulses of the Hall sensors.

The distance the slide/tilt sunroof must cover during the opening or closing procedure is defined in the roof control module. The slide/ tilt sunroof motor generates a certain number of pulses within this distance and therefore recognizes the end positions of the slide/tilt sunroof.

Anti-trapping Protection Function

Both the glass panel and the sunroof shade are equipped with an indirect anti-trapping protection function. The indirect anti-trapping protection function operates on the basis of the power consumption of the slide/tilt sunroof motor.

If the roof control module detects a trapping situation, the corresponding motor is stopped and controlled in the opposite direction. This opens the glass panel or sunroof shade again (approximately 20 cm) and releases the obstruction.

Blocking Protection

If the pulses from the Hall sensors drop out for more than 500 ms during an opening or closing operation, the roof control module detects a blockage.

The power supply to the motor is switched off.

Overheating Protection

The overheating protection for the slide/tilt sunroof motor is calculated in the roof control module. To this end, a temperature sensor is mounted on the board in the roof control module to measure the ambient temperature.

The roof control module calculates the current temperature of the motor based on the running time of the slide/tilt sunroof motor.

The warm-up and cool-down periods are stored in a temperature model in the roof control module.

The current temperature is stored in the memory before the roof control module passes into sleep mode. The motor temperature is made equal to the ambient temperature when the vehicle is started again.

Panic Mode

The slide/tilt sunroof is closed with maximum closing force in panic mode. Panic mode is triggered by pressing and holding, reversing, releasing and again pressing and holding the slide/tilt sunroof button.

A valid enable signal from Car Access System is the precondition for executing the emergency closing function.

It is necessary to release and press the button again as the first time the button is pressed the anti-trapping protection function is still active. The slide/tilt sunroof closes with maximum force after pressing the button again within a short period of time.

It is possible to activate panic mode up to a vehicle speed of 16 km/h (10 mph). Panic mode can be activated from both the tilt position (approximately 100 ms) and from the open position (approximately 1 s).

Load Deactivation

Operation of the slide/tilt sunroof is stopped/ interrupted during the vehicle start procedure.

The Car Access System sends “Terminal 50 ON” status. The signal is received by the footwell module and Junction Box electronics via K-CAN2.

The Junction Box electronics and the footwell module prevent operation of the slide/tilt sunroof during the starting procedure or interrupt current operation.

This protects the battery during the starting procedure.

Operation of the slide/tilt sunroof can resume on completion of the starting procedure.

Terminal 58g

When the exterior lighting is switched on, the footwell module sends this information via KCAN2.

The roof control module receives this information and adopts the set value for the instrument lighting.

The LED in the button for the slide/tilt sunroof is controlled by a pulse-width modulated signal from the roof control module. This achieves a constant brightness of the LED even under fluctuating system voltage conditions.

Opening/closing the Slide/tilt Sunroof

The button can be moved to two engaged positions in the opening and closing directions. In the first engaged position, a movement is initiated which is only executed for as long as the button is being pressed.

Control functions

- Opening sunroof shade only
- Opening sunroof shade and glass panel (to comfort position)
- Glass panel tilt position and sunroof shade ventilation position
- Closing glass panel only
- Closing glass panel and sunroof shade
- Closing sunroof shade only with glass panels already closed.

All control functions are also available as one-touch control functions (comfort functions). The one-touch control function is reached by pressing the button again to the second engaged position in the direction required for the slide/tilt sunroof.

The one-touch control function automatically opens or closes of the slide/tilt sunroofs.

Directions of movement

Initial state:

The glass panel and sunroof shade are closed.

Opening sunroof shade

Press “OPEN” 1 x

- Signal from switch to roof control module
- Roof control module controls the rear motor for as long as the button is pressed or until the sunroof shade is fully opened.
- Rear motor opens the sunroof shade
- Glass panel remains closed.

Opening sunroof shade (one-touch control function)

Press “OPEN” 1 x

- Signal from switch to roof control module
- Roof control module activates rear motor
- Rear motor opens the sunroof shade
- Glass panels remains closed

■ Opening sunroof shade and glass panel

Press “OPEN” 2 x (double-click function)

- Signal from switch to roof control module
- Roof control module first activates the rear motor
- Rear motor opens the sunroof shade
- Roof control module controls the front motor after a time, from a short distance from the sunroof shade.
- Front motor opens the glass panel
- Rear motor raises wind deflector.

■ Tilt position

Press “TILT” 1 x

- Signal from switch to control unit
- Roof control module activates both motors
- Front motor tilts the glass panel
- Rear motor moves the sunroof shade into the gap position (front ventilation position).

■ Closing glass panel

Press “CLOSE” 1 x

- Signal from switch to roof control module
- Roof control module controls the front motor for as long as the button is pressed or until the glass panel is fully closed.
- Front motor closes the glass panel.

■ Closing the glass panel (one-touch control function)

Press “CLOSE” 1 x past the first stop

- Signal from switch to roof control module
- Roof control module activates front motor
- Front motor closes the glass panel.

■ Closing glass panel and sunroof shade

Press “CLOSE” 2 x (double-click function)

- Signal from switch to roof control module
- Roof control module first activates the front motor
- Front motor closes the glass panel
- Roof control module controls the rear motor after a time, from a short distance from the glass panel.
- Rear motor closes the sunroof shade and releases the wind deflector so that the glass panel can press it down.

■ Closing the sunroof shade

(only possible if glass panel is already closed) Press “CLOSE” 1 x

- Signal from switch to roof control module
- Roof control module activates rear motor
- Rear motor closes the sunroof shade.

■ Wind deflector with roof open

The roof control module receives the speed signal from the integrated chassis management. The dynamic stability control DSC evaluates the wheel speed sensors.

The roof control module controls the rear motor to release the wind deflector from a road speed of 180 km/h (112 mph). Consequently, the wind deflector is depressed into a lower position.

Note: The motor only runs lightly, the sunroof shade does not move.

■ Auto-remote opening

The slide/tilt sunroof can be opened by extended actuation of the unlock button with the identification sensor by turning the mechanical key in Open direction.

Note: Movement of the power windows must be completed before auto-remote opening of the slide/tilt sunroof can be started.

■ Auto-remote closing

The slide/tilt sunroof can be closed by extended actuation of the lock button with the identification sensor by turning the mechanical key in Close direction.

If the vehicle is equipped with Comfort Access, auto-remote closing can be started by touching the touch-sensitive outer surface.

Spare Parts of Slide/tilt Sunroof

The slide/tilt sunroof in the F01/F02 consists The following table lists the most important of mechanical and electrical components.

Mechanical components	Electrical components
Glass panel	Button
Sunroof shade	Control unit (CAS 4, FRM, FZD)
Slide/tilt sunroof module	Sunroof motors
Wind deflector	

Electrical Components

The following graphic shows all the electrical components of the slide/tilt sunroof system together with the appropriate control units.

(Refer to the "Body/Complete Vehicle section for a description of the Mechanical components of the sunroof.)

Index	Explanation	Index	Explanation
1	Car Access System	6	Dynamic stability control
2	Junction Box electronics	7	Roof control module
3	Remote control receiver in Diversity module	8	Door lock with door contact *Hall sensors, lock barrel, only driver's door
4	Footwell module	9	Slide/tilt sunroof motor
5	Central gateway module		

Control Units

■ Car Access System 4

The Car Access System 4 issues the enable signal for the slide/tilt sunroof.

“Terminal 50 ON” status is sent via K-CAN2 while starting the engine. The roof control module prevents activation of the motors for the slide/tilt sunroof or interrupts current operation. This means that there is more energy available from the battery for the starter to start the engine.

■ Footwell module

The footwell module makes available the status of the door contacts and the driver’s door lock barrel.

The footwell module also supplies the roof control module with information concerning the “Terminal 58g ON” status.

■ Roof control module

The roof control module contains the complete functions of the slide/tilt sunroof. The roof control module is always installed in connection with the slide/tilt sunroof.

The relays required to drive the slide/tilt sunroof motors are integrated in the roof control module.

Slide/tilt Sunroof Motors

One motor for the slide/tilt sunroof has two Hall sensors.

The Hall sensors are located on the motor shaft and are offset against one another by 90°.

When the motor is running, this results in two temporally offset Hall signals that are used to register the direction of rotation of the motor and for the anti-trapping protection function.

Note: Two motors are fitted to move the slide/. tilt sunroof.

Initialization

Initialization of the slide/tilt sunroof involves the following procedures that are necessary to ensure complete functionality of the slide/tilt sunroof:

- Normalization

  Normalization means locating the mechanical end position at the stop for the tilt position. This position is stored and is used in calculating the remaining end positions for the slide/tilt sunroof.

- Learning the characteristic curve

  The learning procedure registers the closing force necessary for each direction of the slide/tilt sunroof and stores this value.

Complete functionality of the slide/tilt sunroof can be guaranteed only by full initialization.

The initialization procedure can be initiated with the button for the slide/tilt sunroof or via the diagnosis system.

Initialization with the Button

Initialization is performed as follows:

- Press and hold control button in slide/tilt sunroof Tilt direction

  The glass panel moves into the tilt position and the sunroof shade into the ventilation position

- After approximately 15 seconds the initialization run starts in the tilt direction and stores the end position
- The slide/tilt sunroof is closed after 5 seconds in the Tilt position
- The slide/tilt sunroof is then opened and the end position stored.

Note: The control button must remain pressed during the entire initialization procedure. The initialization procedure must be repeated if the button is released.

Initialization takes approximately 120 seconds.

Interruption in Power Supply

An interruption in the power supply does not require a new normalization. The initialization is invalidated if the power supply is interrupted during the initialization. A new initialization will then be necessary.

■ Clearing the initialization

Initialization is cleared under the following circumstances:

- Failure of the power supply during initialization
- Hall sensor fault detected
- Position implausible
- Certain calls in the diagnostics
- Changed vehicle coding
- Coding data faulty.

Table of Contents

F01 Anti-theft System

Subject **Page**

Anti-theft System

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the anti-theft system used in the F01/F02

Introduction

Anti-theft System

The anti-theft system is available as an option. The task of the anti-theft system is to indicate unauthorized access to the vehicle by emitting an alarm. The alarm can be triggered both audibly and visually. To do this, however, the anti-theft system must be activated. When activated, the alarm monitors the whole of the vehicle interior.

In addition the anti-theft system monitors the engine compartment and the vehicle's rest position. In order that nothing can be stolen from the trunk, the anti-theft system monitors opening of the trunk lid.

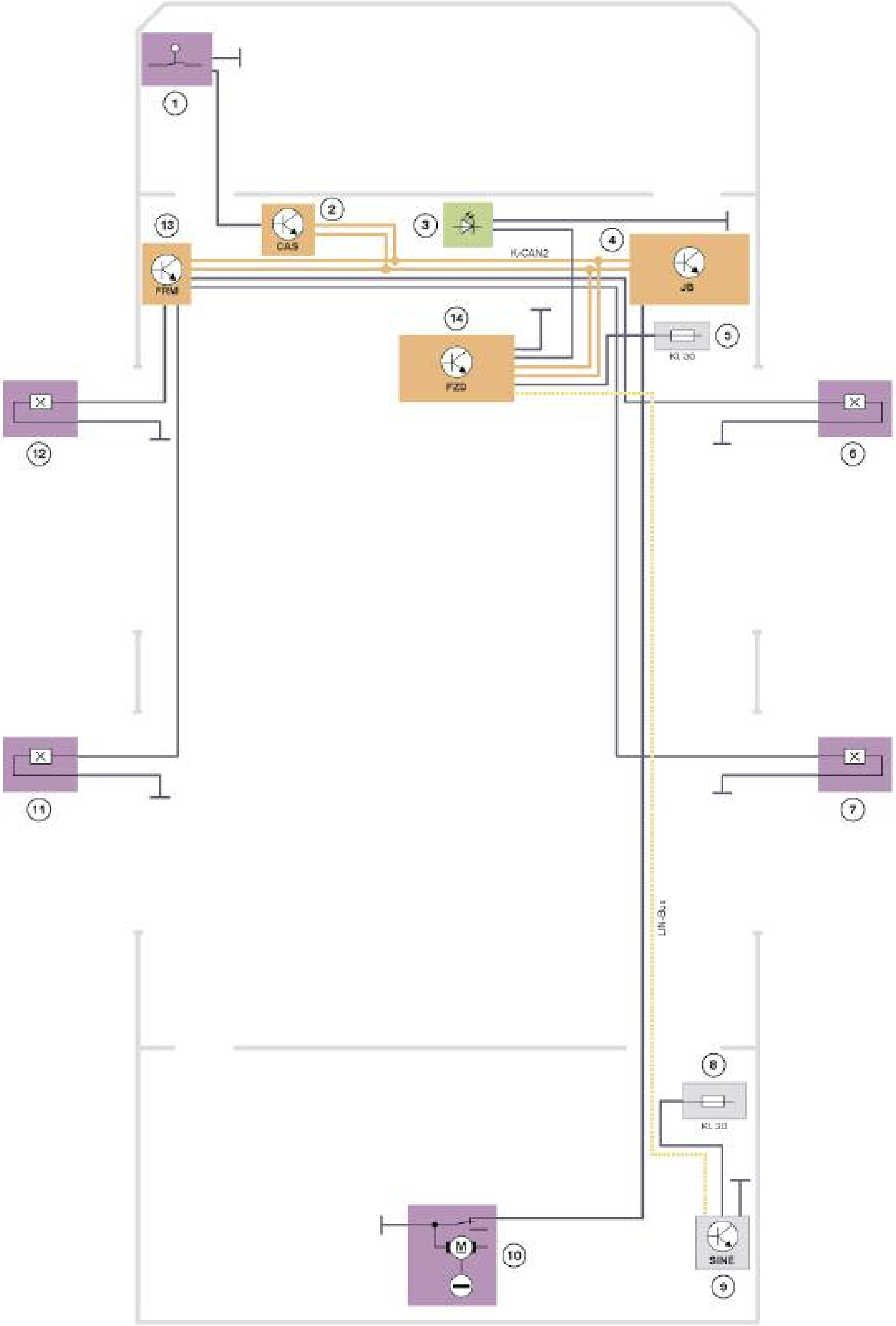
The alarm also signals an attempt to tamper with the vehicle, e.g. cutting of the supply line to the emergency power siren.

The anti-theft system's ultrasonic interior movement detector is entirely integrated in the roof function center.

The ultrasonic signal passes into the inside of vehicle through apertures in the grille of the roof function center. The emergency power siren and combined tilt sensor is located near the rear wheel arch.

System Overview

Anti-theft System Circuit Diagram



Index	Explanation	Index	Explanation
1	Hood switch	10	Trunk lock with trunk-lid switch
2	Car Access System 4 (CAS4)	11	Door contact, rear driver's side
3	Anti-theft system (DWA) LED	12	Door contact, driver's door
4	Junction Box electronics (JB)	13	Footwell module (FRM)
5	Front power distribution box	14	Roof function center (FZD) with ultrasonic interior movement detector USIS
6	Door contact, passenger's door	LIN-Bus	Local Interconnect Network bus
7	Door contact, rear passenger's side	K-CAN2	Body CAN2
8	Rear power distribution box	Kl. 30	Terminal 30
9	Emergency power siren with integrated tilt alarm sensor (SINE)		

The anti-theft system on the F01/F02 is equipped with an ultrasonic interior movement detector for monitoring the vehicle interior. The ultrasonic interior movement detector USIS is fully integrated in the FZD.

The anti-theft system is equipped with an ultrasonic interior movement detector. The ultrasonic interior movement detector has been fully integrated into the FZD.

The door switches (6, 7, 11, 12, Hall-effect sensors) are monitored by the footwell module (13). As soon as the status of a Hall-effect sensor changes, the ultrasonic interior movement detector (14) receives that information via the K-CAN2. If the anti-theft system is activated, an alarm is triggered.

The hood switch (1) is monitored by the Car Access System 4 (2). If the status changes, an alarm is triggered in the same way.

Opening of the trunk lid is monitored by the Junction Box electronics (4). If the status of the trunk-lid switch (10) changes, it triggers an alarm.

Functions

Overview

When activated, the anti-theft system on the F01/F02 monitors the entire vehicle. The doors and hood/trunk lid, emergency current siren, the vehicle interior and the DWA bus in particular are monitored. The anti-theft system can be activated or deactivated at terminal 30. It is not possible to activate the anti-theft system when the Terminal R or Terminal 15 signal is present.

Activating the Anti-theft System

The anti-theft system is activated when the vehicle is centrally locked. Activation can be triggered by the following components:

- Driver's door lock barrel
- ID transmitter
- Outside door handle with Comfort Access (sensitive surface)

After the vehicle has been centrally locked, the emergency power siren is first activated together with the tilt alarm sensor. Then the signals from all door switches, the hood switch and the trunk-lid switch are checked for plausibility. Once the contacts are set, they are then linked to the vehicle monitoring system by the anti-theft system.

The tilt sensor and the ultrasonic interior movement detector must be adjusted to the vehicle's situation each time the vehicle is centrally double-locked. This is called initializing. The tilt alarm sensor delivers information on the vehicle's rest position. If this value is plausible, the tilt alarm sensor is included in the vehicle monitoring process.

The anti-theft system's ultrasonic interior movement detector monitors the passenger compartment. It therefore takes a little time before the ultrasonic interior movement detector can actively be used for the anti-theft system. The ultrasonic interior movement detector is switched to 'activated' approximately 30 seconds after the contacts have been linked to the anti-theft system.

Note: You should wait approximately one minute before testing the interior motion detector.

■ Deactivating tilt sensor and ultrasonic interior movement detector

It is advisable to deactivate the tilt sensor and ultrasonic interior movement detector in the following situations:

- Vehicle in tilt-type duplex garage
- Vehicle on ship transport
- Vehicle on car transporter
- Persons or animals in vehicle

Deactivation is performed by centrally double-locking or auto-remote closing the vehicle a second time within 10 seconds of doing so the first time. To acknowledge, the anti-theft system LED is lit for 2 seconds.

Note: The tilt sensor/ultrasonic interior movement detector can be permanently deactivated by coding.

■ Deactivating the anti-theft system

The anti-theft system is deactivated by the “unlock” or “selective unlock” central locking functions. An audible and/or visual signal can be output in connection with deactivating corresponding to the country-specific version.

If an alarm was triggered during the time when the anti-theft system was activated, the anti-theft system LED flashes for 5 minutes. If a terminal status changes, e.g. if the central locking is unlocked, while the LED is flashing then the LED stops flashing. If the alarm is deactivated while the alarm is active, the deactivate instruction is not acknowledged and the alarm signal is completed.

■ Unlocking the trunk

The tilt alarm sensor and ultrasonic interior movement detector are blanked out if the luggage compartment is unlocked and opened on an armed vehicle. Loading the vehicle might result in a new vehicle resting position. Initialization of the ultrasonic interior movement detector and the tilt sensor starts 6 seconds after the trunk is closed again.

Note: When the trunk is closed, the visual confirmation signal is repeated to indicate to the driver that the trunk is properly closed.

■ No crosswise operation

If crosswise operation is not implemented, an alarm is triggered when the anti-theft system is deactivated.

This only applies to activating with the ID transmitter and deactivating via the driver’s door lock. The footwell module detects that the vehicle has been unlocked via the driver’s door lock and broadcasts that information via the K-CAN2.

The Car Access System detects that the driver’s door lock has been unlocked but does not unlock the vehicle. The anti-theft system remains activated and triggers the alarm when the driver’s door is opened.

This function is coded on the Car Access System.

Feedback from the Anti-theft System

When the alarm is activated, the system does not signal confirmation until all doors, the hood and the trunk have been closed. That confirmation may be in the form of a visual or audible signal. If confirmation is by a visual signal, the alarm LED or the hazard warning lights may flash, for example. If the confirmation signal is audible, it is produced by sounding the emergency power siren, for example.

Feedback via DWA LED

The DWA LED serves as an indicator showing the status of the anti-theft system. The roof functions center supplies the DWA LED with signals from the ultrasonic interior movement detector.

DWA Status	DWA LED
Deactivated	OFF
Activated	ON
Armed, but not all contacts closed	Blinks for 10 seconds, then continues flashing
Ultrasonic interior motion/tilt sensor OFF	Lights up for 2 seconds and then remains on
Alarm triggered	Flashes for 5 minutes, then continues flashing in bursts
Deactivating	Goes out
Deactivating after alarm	Flashes for 5 minutes or stops if a terminal status changes (central locking unlocked)

When blinking, the DWA LED is driven at a frequency of 0.5 Hz. The switch-on time is 60 milliseconds. When the DWA LED flashes, it is activated at a frequency of 2 Hz.

Confirmation from turn signal indicators

Visual confirmation by the turn signal indicators of anti-theft system activation and deactivation serves as an indication for the vehicle user.

The feedback is coded specifically to the country and/or vehicle.

DWA Status	Signal of hazard warning lights
Activation	Hazard warning lights flash once
Deactivation	Hazard warning lights flash twice
Activation after “Easy Access” to trunk	Hazard warning lights flash once after trunk is closed
Deactivating after alarm	Hazard warning lights flash four times at double frequency

Confirmation via the emergency power siren

The audible confirmation signal to the vehicle user when activating and deactivating the alarm is individually coded for the country of purchase.

DWA Status	Signal from siren
Activation	Signal tone sounds once
Deactivation	Signal tone sounds twice
Activation with doors open or trunk lid open	No signal tone, sounds only after closing last door or trunk lid

Comfort Access

If the vehicle is locked but the trunk is open, it is possible for the ID transmitter to be inadvertently left in the trunk. If the trunk lid is closed in such circumstances, it is automatically opened again to prevent the ID transmitter from being locked in.

In addition to automatically opening the trunk lid, the anti-theft system emits an audible warning. The warning consists of the emergency power siren sounding a two-tone signal three times. The footwell module also activates the visual signal by the hazard warning lights.

Alarm Trigger

The anti-theft system can be triggered by the following components:

- Door contacts
- Trunk lid switch
- Hood switch
- Ultrasonic interior movement detector
- Emergency power siren with integral tilt sensor.

Door contacts

The status of the door contacts is evaluated by the footwell module and signalled to the ultrasonic interior movement detector. The status of the individual door contacts is included in the vehicle monitoring system 6 seconds after the status signal “door closed” is issued. This means that an alarm can be triggered via a door that is already closed even if another door contact is still open.

Trunk lid switch

The status of the trunk lid switch is analysed by the Junction Box electronics and signalled to the ultrasonic interior movement detector. When the trunk lid is closed, the Junction Box electronics receives a low signal (approximately 0 V). If the trunk lid is unlocked when the anti-theft system is activated, the signals from the trunk lid switch, ultrasonic interior movement detector and tilt sensor are initially suppressed.

The signals are also suppressed if the trunk lid is unlocked using the ID transmitter when the anti-theft system is activated. The trunk lid switch is reinstated as part of the vehicle monitoring system 6 seconds after the lid is closed. Once there are no other doors open and the trunk lid is closed, the initialization procedure for the ultrasonic interior movement detector and the tilt sensor starts.

Because of the manipulation prevention system, unlocking the luggage compartment with the aid of the mechanical key when the DWA is activated will cause an alarm to be triggered.

Hood

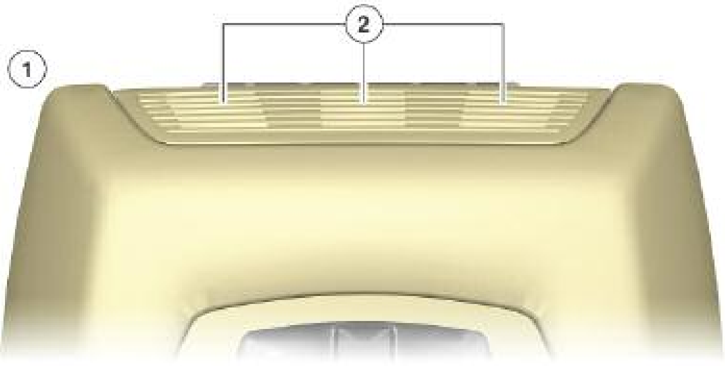
The status of the hood switch is analysed by the Car Access System and signalled to the ultrasonic interior movement detector. The status of the hood switch is included in the vehicle monitoring system 6 seconds after the status “hood closed” is signalled.

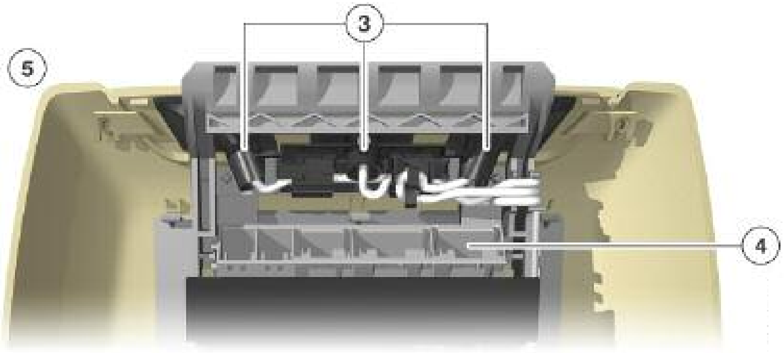
The Car Access System interprets a hood switch that is not connected as closed. When the hood is closed, the Car Access System receives a low signal (approximately 0 V).

Ultrasonic interior movement detector

The ultrasonic interior movement detector captures and evaluates movements in the vehicle interior. Initialization of the ultrasonic interior movement detector is started 6 seconds after the hood, trunk lid and the last door have been closed.

The ultrasonic interior movement detector is operational 30 seconds after the start of initialization and is included in the vehicle monitoring system. The ultrasonic interior movement detector has been integrated into the roof function center. The FZD is connected to the K-CAN2 and DWA bus.





Index	Explanation	Index	Explanation
1	Front of roof function center	4	Roof function center connector
2	Sensor ultrasound emission grille	5	Rear of roof function center
3	Funnels for the ultrasonic sensors		

Note: For the ultrasonic interior movement detector to function properly, it is very important that the grille (2) is fitted correctly. The funnels must be touching the grille to prevent/reduce interference between the ultrasonic sensors. The grille must be engaged at the sides and fully located in position in the center.

Tilt alarm sensor

The tilt alarm sensor registers the vehicle rest position when it is activated and detects changes in the position, e.g. jacking up the vehicle. The tilt alarm sensor is integrated in the emergency current siren.

Initialization of the tilt sensor is started 6 seconds after all doors, the trunk lid and the hood are closed. The tilt sensor is ready for operation 60 seconds from the start of initialization and is then included in the vehicle monitoring system.

If the tilt alarm sensor detects vehicle movement, a corresponding signal is sent to the ultrasonic interior movement detector. The anti-theft system decides whether the movement is sufficient to trigger an alarm.

To ensure a false alarm is not triggered as the result of the vehicle rocking, the angle values for the longitudinal and transverse axis are determined every 90 ms. An alarm is triggered only if the vehicle remains in an inclined position for longer than approximately 1.5 seconds.

Note: Testing the tilt sensor:

Activate the anti-theft system then wait for one and a half minutes. Then raise the vehicle with a jack at one of the wheels. The alarm should be triggered before the wheel has been raised completely off the ground.

Self-monitoring of emergency current siren

A self-monitoring facility that is activated immediately after the anti-theft system has been activated is implemented in the emergency current siren. The emergency current siren monitors its own power supply and detects overvoltage, undervoltage and line break (open-circuit).

If anyone attempts to manually interfere with the emergency power siren or its supply leads, the emergency power siren will trigger an alarm. At the same time, it reports this alarm to the ultrasonic interior movement detector regardless of whether the DWA bus has been affected.

Line monitoring - DWA bus

The ultrasonic interior movement detector and the emergency current siren are connected via the DWA bus. As soon as the anti-theft system has been activated, the DWA bus is monitored cyclically every 2 seconds.

If the anti-theft system does not register with the SINE within 3.2 s, an alarm is initiated.

The anti-theft system sends a line monitoring request on the DWA bus to the emergency current siren. The emergency power siren must respond within 100 ms. If no response is received, the anti-theft system triggers an alarm. The line monitoring facility is also active while the alarm is triggered.

The anti-theft system in the roof function center measures the system voltage. The line monitoring facility is switched off at a system voltage below 9 V. This avoids false alarms.

Alarm Output

If an alarm criterion is fulfilled with the anti-theft system activated, the alarm is output (triggered) audibly and/or visually corresponding to the country-specific coding.

■ Audible alarm

The emergency power siren receives a signal via the DWA bus when the ultrasonic interior movement detector triggers an alarm. It is fitted in the rear right wheel arch. The emergency current siren confirms receipt of the alarm request and triggers the audible alarm.

Emergency power siren on F01/F02

If the alarm request is not acknowledged, the anti-theft system will repeat the alarm request up to eight times.

Depending on the country-specific coding of the emergency current siren, an intermittent or interval tone is generated. If the anti-theft system is deactivated, the audible alarm is stopped immediately and without response.

■ Visual alarm

Depending on the country-specific version, the following components of the exterior lighting can be activated for the visual alarm:

- Turn signal indicators
- Dipped-beam headlights
- High-beam headlights.

When the anti-theft system triggers an audible alarm, a visual alarm is simultaneously triggered for 5 minutes. The anti-theft system sends the request for flashing lights to the footwell module via the K-CAN2. In turn, the footwell module activates the components of the exterior lighting system.

The visual alarm cannot be extended by repeated alarm triggering.

If the anti-theft system is deactivated, the visible alarm is stopped immediately and without response.

■ Autarkic alarm

If the emergency power siren's wires are tampered with, it initiates the autonomous alarm. If the DWA bus is also cut through, the ultrasonic passenger-compartment sensor detects this situation by the absence of the reply from the emergency current siren. In turn, the ultrasonic interior movement detector triggers the visual alarm.

■ Panic mode

Panic mode is a means of attracting attention by triggering an alarm when under threat from the outside or in the event of an accident, for example.

Panic mode is initiated by pressing the trunk lid button on the ID transmitter. The button must be pressed for longer than 2.5 seconds irrespective of whether the anti-theft system is activated or not.

The alarm is stopped by pressing any button on the ID transmitter. Panic mode is not stored. On completion of panic mode, the anti-theft system assumes the setting that was selected prior to panic mode.

Panic mode is at present only coded in US vehicles.

■ Alarm termination

An alarm initiated for testing purposes or by accident can be stopped by deactivating the anti-theft system.

Diagnosis

All information is stored in the non-volatile alarm memory.

Ultrasonic interior movement detector alarm memory

The alarm memory of the ultrasonic interior movement detector stores all alarms apart from the autonomous alarm. The alarm memory contains the following information:

- Cause of alarm trigger
- Subsequent alarm triggers
- Date
- Time
- Ambient conditions
  - Outside temperature
  - Window position
  - Sunroof position
  - Heating.

An alarm history is formed from the beginning to the end of the alarm. The manner in which the alarm is ended is also defined. The alarm can be terminated by deactivating it or by allowing it to run its course. The last 10 alarms are stored in the alarm memory.

Autonomous alarms are stored by the roof function center if the connection between the roof function center and the emergency power siren is in functional order.

Table of Contents

F01 Automatic Luggage Compartment Lid Actuating System

Subject **Page**

Automatic Luggage Compartment Lid Actuating System (HKL)

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the operation of the HKL system on the F01/F02

Introduction

Features of the Automatic Luggage Compartment Lid Actuating System

The automatic luggage compartment lid actuating system will be available on the F01 as from its launch in 09/08. It will be available to order as an option and only concerns the luggage compartment lid.

Automatic luggage compartment lid operation improves vehicle access in that the luggage compartment lid is opened or closed automatically at the press of a button.

A spindle-driven system is fitted in the F01 for the first time to actuate automatic opening or closing of the luggage compartment lid.

The automatic luggage compartment lid actuating system makes it possible to open and close the luggage compartment lid automatically at the push of a button.

If the vehicle is equipped with Comfort Access, it is even possible to open the luggage compartment lid while the vehicle is locked.

The luggage compartment lid can open automatically when the exterior luggage compartment lid button is pressed. The only requirement being that a vehicle-specific ID transmitter must be present in the immediate vicinity of the rear end of the vehicle.

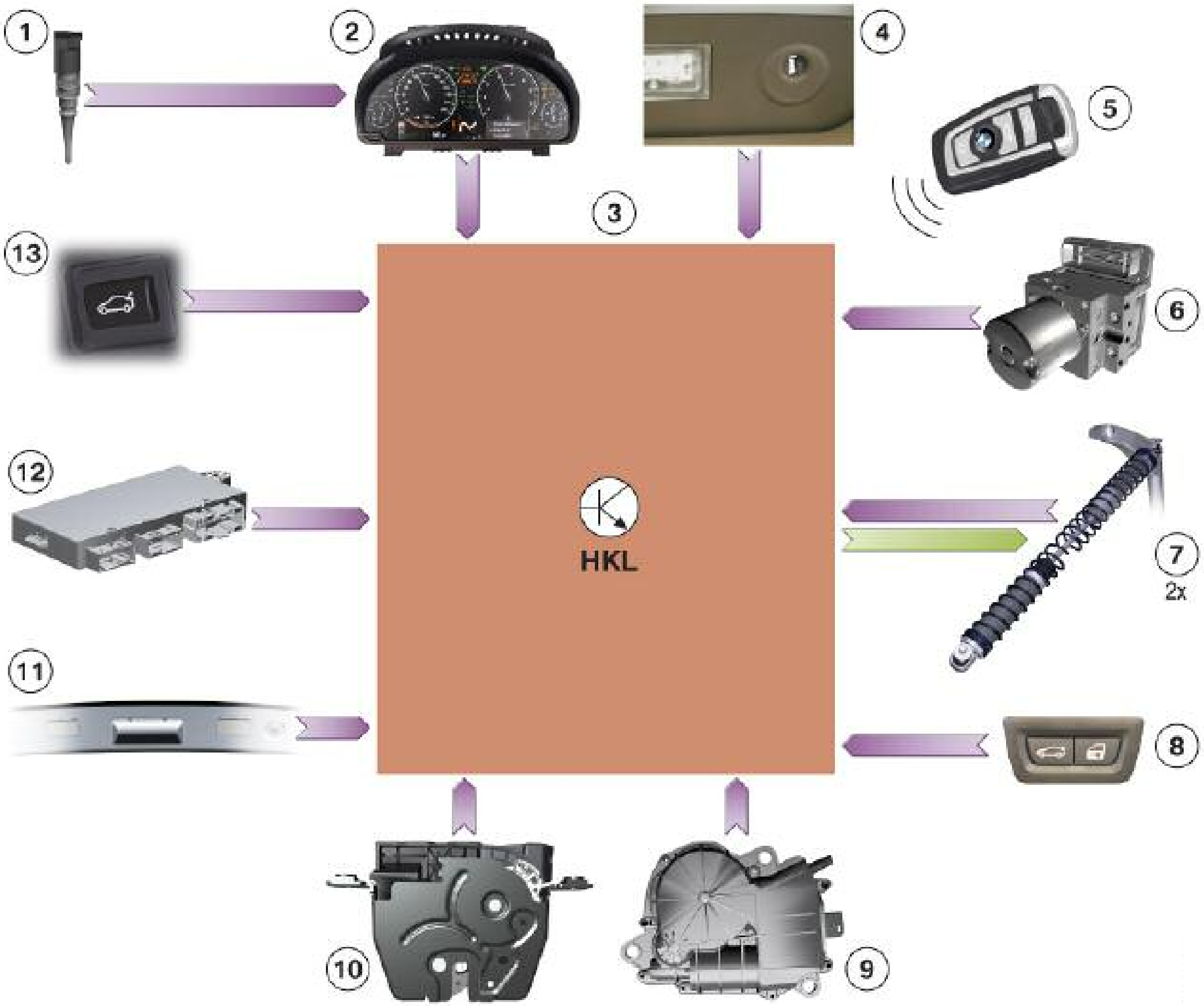
In connection with Comfort Access, it is now also possible to centrally lock the vehicle doors from the luggage compartment lid. The “central double-lock” button used for this purpose is located in the luggage compartment lid next to the button for automatically closing the luggage compartment lid.

Central double-lock button F01/F02

Closing the luggage compartment lid can also be initiated by pressing the “central double-lock” button.

System Overview

Automatic Luggage Compartment Lid Actuating System Input/outputs

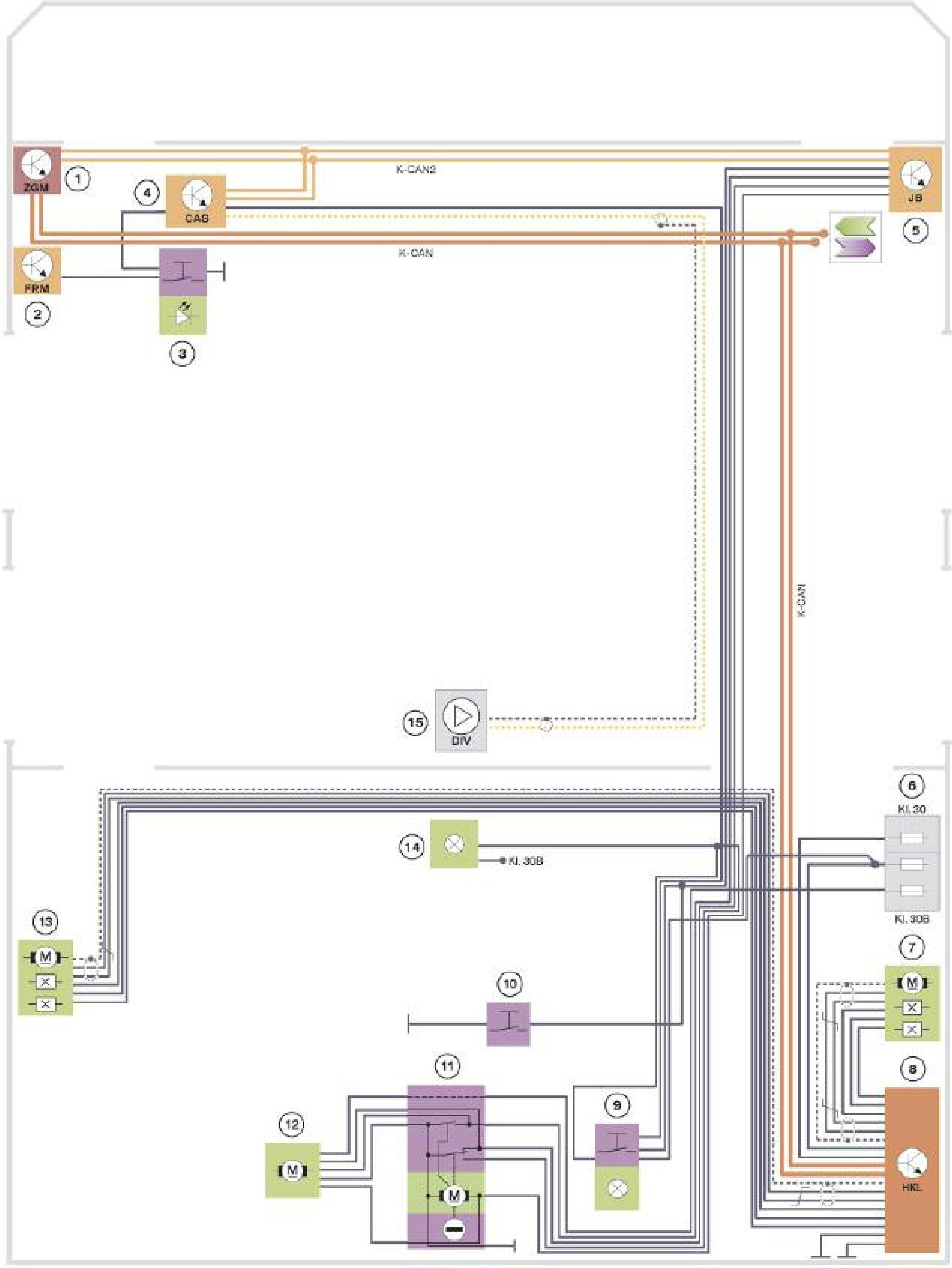


Index	Explanation	Index	Explanation
1	Outside temperature sensor	8	Interior luggage compartment lid button
2	Instrument cluster	9	Drive for automatic soft-close luggage compartment lid lock
3	Control unit for automatic luggage compartment lid actuating system HKL	10	Central locking, luggage compartment lid
4	Lock barrel, luggage compartment lid	11	Luggage compartment lid button, outer luggage compartment lid recessed handle
5	Identification transmitter	12	Car Access System
6	Dynamic Stability Control	13	Luggage compartment lid button, A-pillar drive
7	Luggage compartment lid spindle		

Luggage compartment lid lift (3) controls and monitors opening or closing of the luggage compartment lid. Opening or closing of the luggage compartment lid can be triggered by luggage compartment lid buttons (8, 11, 13). The luggage compartment lid can be unlocked and opened by purely mechanical means with the lock barrel in the luggage compartment lid (4).

The signals from the outside temperature sensor (1) and vehicle speed (6) are evaluated to determine whether the luggage compartment lid may be opened or closed in response to a press of a button.

Automatic Luggage Compartment Lid Actuating System Circuit Diagram



Index	Explanation	Index	Explanation
1	Central gateway module (ZGM)	11	Luggage compartment lid lock with luggage compartment lid switch/ lock barrel
2	Footwell module (FRM)	12	Automatic soft-close luggage compartment lid
3	Luggage compartment lid button, A-pillar	13	Spindle drive motor, left
4	Car Access System (CAS)	14	Luggage compartment lighting, underside of rear window shelf
5	Junction box electronics (JB)	15	Remote control receiver in diversity module
6	Rear power distribution box	K-CAN	Body CAN
7	Spindle drive motor, right	K-CAN2	Body-CAN2
8	Luggage compartment lid lift (HKL)	Kl. 30	Terminal 30
9	Inner luggage compartment lid button/ central double-lock button	Kl. 30B	Terminal 30, basic operation
10	Outer luggage compartment lid button	LIN-Bus	Local Interconnect Network bus

K-CAN signals at the luggage compartment lid lift

In/out	Information	Source/sink	Function
In	Outside temperature	Outside temperature sensor > instrument cluster	Value for calculating overheating protection for the spindle motors
In	Driving speed	Wheel speed sensors > Dynamic stability control > Integrated chassis management	Permit/deny control functions of the luggage compartment lid

The radio signal from the identification transmitter is received by the rear window antenna. The remote control receiver in diversity module (15) forwards the signal to Car Access System (4). The Car Access System is the master control unit for the central locking function.

Once the signal has been successfully verified, the Car Access System issues a command to control the central locking in the luggage compartment lid.

The junction box electronics (5) execute the command to control the central locking in the luggage compartment lid. The junction box electronics register the status of the luggage compartment lid switch (11) for the "automatic luggage compartment lid actuation" function. The status of the luggage compartment lid switch is sent on the K--CAN to the luggage compartment lid lift (8). The status is one of the triggering criteria for luggage compartment lid operation.

Sensors (13 and 7) in the spindle drives monitor the movement of the luggage compartment lid. The luggage compartment lid lift is therefore able to reverse the closing movement of an obstructed luggage compartment lid, allowing the obstruction to be freed.

An obstruction to luggage compartment lid movement during the opening procedure causes the luggage compartment lid to stop and it is not reversed.

As a backup to the Hall sensors, the luggage compartment lid lift monitors the power consumption of the spindle drive. An increase in current when the luggage compartment lid blocks causes the luggage compartment lid to stop and, if need be, reverse.

Functions

Luggage Compartment Lid Actuating Points

The luggage compartment lid can be unlocked and opened or closed from various operating points. The operating points are the:

- Outer luggage compartment lid button
- Luggage compartment lid button on the interior of the luggage compartment lid (only when the luggage compartment lid is open)
- Central double-lock button on the interior of the luggage compartment lid (only when the luggage compartment lid is open)
- Luggage compartment lid button on the identification transmitter
- Luggage compartment lid button on A-pillar in vehicle interior
- Luggage compartment lid lock barrel (mechanical unlocking).

The automatic luggage compartment lid actuating system cannot be activated when the vehicle is in motion, only when the vehicle is stationary.

Automatic luggage compartment lid actuation is controlled and monitored by a control unit. This control unit is designated luggage compartment lid lift HKL.

The HKL has an integrated “soft-opening” or “soft-closing” function. This means that the closing or opening speed is slowed shortly before the end stops are reached so that the luggage compartment lid moves softly into the respective end stop. The soft end stop is achieved by a change in the pulse width of the control voltage.

The luggage compartment lid moves quietly and smoothly. This gives the impression of a harmonious movement during the luggage compartment lid opening or closing procedure.

To achieve this, the speed of the luggage compartment lid movement is regulated by the HKL. Luggage compartment lid movement depends on whether the luggage compartment lid is covered with hoarfrost or snow. If the weight of the snow is too heavy for the luggage compartment lid, no luggage compartment lid movement will take place.

The HKL receives signals on the K-CAN from the following control units:

- Car Access System
  - Luggage compartment lid button, A-pillar
  - Central double-lock button
  - Enable for operating luggage compartment lid or terminal status
  - Request from identification transmitter
- Integrated Chassis Management Driving speed signal
- Junction box electronics
  - Outer luggage compartment lid button
  - Luggage compartment lid button on interior of luggage compartment lid.

Operation by Luggage Compartment Lid Buttons

The luggage compartment lid can be opened, stopped or closed by pressing one of the luggage compartment lid buttons. It is also possible to stop or resume the movement of the luggage compartment lid from any open position. Tapping a luggage compartment lid button is sufficient input for the luggage compartment lid to continue to the respective end position (luggage compartment lid open or closed). The luggage compartment lid movement stops automatically as soon as the end position is reached.

■ Direction of luggage compartment lid movement

The direction of movement of the luggage compartment lid changes with every second press of the interior or exterior luggage compartment lid button. Initial state of luggage compartment lid closed:

- Button stroke > Open
- Button stroke > Stop
- Button stroke > Close
- Button stroke > Stop
- Button stroke > Open, etc.

Luggage compartment lid button, A-pillar

The interior luggage compartment lid button on the A-pillar can only be used to open or stop the luggage compartment lid.

- Button stroke > Open
- Button stroke > Stop
- Button stroke > Open
- Button stroke > Stop, etc.

Central double-lock button

In vehicles equipped with Comfort Access, the inner luggage compartment lid button is installed together with the central double-lock button.

Inner luggage compartment lid button and central double-lock button F01/F02

The central double-lock button is connected to the Car Access System. The central double-lock button is used to lock and centrally arrest the vehicle doors. To provide maximum convenience for the customer, closing the luggage compartment lid can be initiated by pressing the central double-lock button.

The central double-lock button can only be used to close and stop the luggage compartment lid.

- Button stroke > Close
- Button stroke > Stop
- Button stroke > Close
- Button stroke > Stop, etc.

Note: A command sent from the central double-lock button can only be executed with the luggage compartment lid open. This is due to the fact that the button has a connection to ground via the luggage compartment lid contact switch only when the luggage compartment lid is open.

Outer luggage compartment lid button

The junction box electronics evaluate the status of the luggage compartment lid button.

Evaluation depends on whether or not the vehicle is in sleep mode. If the vehicle is in sleep mode, it will have to be woken first. Only then can the request be sent to the HKL on the K-CAN. The HKL triggers the appropriate request.

When closed, the luggage compartment lid is unlocked by the junction box electronics. The luggage compartment lid lift HKL then opens the luggage compartment lid. The luggage compartment lid is completely opened automatically.

The outer luggage compartment lid button can be used to open, stop or close the luggage compartment lid.

- Button stroke > Open *
- Button stroke > Stop
- Button stroke > Close **
- Button stroke > Stop
- Button stroke > Open
- Button stroke > Stop etc.

* Always in open direction with luggage compartment lid closed

** Always in close direction with luggage compartment lid completely open.

Note: Additional information on luggage compartment lid operation can be found under "Manual opening and closing".

Interior luggage compartment lid button

Parallel to the outer luggage compartment lid button, the inner luggage compartment lid button is connected to the junction box electronics. For this reason, the junction box electronics do not distinguish between the two luggage compartment lid buttons.

Inner luggage compartment lid button F01/F02

Note: A command sent from the inner luggage compartment lid button can only be executed with the luggage compartment lid open. This is due to the fact that the button has a connection to ground via the luggage compartment lid contact switch only when the luggage compartment lid is open.

ID transmitter luggage compartment lid button

If the complete vehicle is locked, it is possible to trigger an automatic opening of the luggage compartment lid by pressing the luggage compartment lid button with the luggage compartment lid symbol. Firstly, the luggage compartment lid is unlocked. Then the luggage compartment lid begins to open automatically.

Operation of the luggage compartment lid with the identification transmitter is subject to specific legal requirements. There are differences between the European variant, the US variant and the Canadian variant.

European variant

Pressing the luggage compartment lid button with the luggage compartment lid symbol on the identification transmitter:

- Luggage compartment lid closed
  - Short press Luggage compartment lid opens to end position
  - Press and hold Luggage compartment lid opens to end position
- Luggage compartment lid open
  - Pressed and held > Luggage compartment lid closed to end or until button released.

It is possible to initiate the opening procedure by means of the luggage compartment lid button while the luggage compartment lid is closed. Releasing the luggage compartment lid button has no effect. The luggage compartment lid is opened until it is completely open. A brief press of the luggage compartment lid button while the luggage compartment lid is opening stops the opening procedure.

A long press of the luggage compartment lid button while the luggage compartment lid is opening triggers the luggage compartment lid closing procedure. The opening procedure stops first to allow the luggage compartment lid to begin closing immediately. The closing procedure ends if the luggage compartment lid button is released or the “CLOSED” position is reached.

Note: The Car Access System evaluates the requests from the identification transmitter. The luggage compartment lid lift receives the requests on the K-CAN. The signal must be routed through various bus systems. These bus systems are:

- **LIN-bus (diversity module > CAS)**
- **K-CAN2 (CAS > ZGM)**
- **K-CAN > (ZGM > HKL).**

■ US variant

The luggage compartment lid movement does not begin until the luggage compartment lid button has been released. The identification transmitter sends a message indicating that the luggage compartment lid button has been released. From this message, it is possible for the luggage compartment lid button stroke to be detected. Automatic opening is initiated after the luggage compartment lid has unlocked. The luggage compartment lid is completely opened.

Note: The remote control cannot be used to close the luggage compartment lid on the US variant for legal reasons.

Automatic Opening

The luggage compartment lid is opened or closed automatically when one of the luggage compartment lid buttons is pressed. A basic prerequisite being that there must be no “inhibit condition” present. You will find a description of the inhibit conditions in the “Luggage compartment lid movement inhibit conditions” section of this Product Information.

Automatic Opening Procedure

The following procedure begins with a closed luggage compartment lid.

- Luggage compartment lid button with luggage compartment lid symbol pressed briefly

Note: On the US variant, the luggage compartment lid button on the identification transmitter must be released otherwise the luggage compartment lid will not be opened automatically.

- Power supply switched to luggage compartment lid lift and request to unlock the luggage compartment lid issued by the Car Access System
- The junction box electronics unlock the luggage compartment lid. Initially, the luggage compartment lid lock is actuated.
- The luggage compartment lid contact switch changes from closed to open.
- The HKL controls the spindle drives to open the luggage compartment lid.

The luggage compartment lid is completely opened. If one of the inhibit conditions becomes active during luggage compartment lid movement, this will stop further movement of the luggage compartment lid.

Luggage Compartment Lid Opening with Comfort Access

Vehicles equipped with the Comfort Access option also have a "keyless opening" luggage compartment lid function.

The junction box electronics wake a sleeping vehicle in response to the outer luggage compartment lid button being pressed. The junction box electronics send the request on the K-CAN2. The Car Access System with Comfort Access receives the request and arranges for the identification transmitter to register with the vehicle.

Once the identification transmitter has been successfully verified by the Car Access System, the latter arranges for the luggage compartment lid to be unlocked. The junction box electronics execute the unlocking procedure. As soon as the status of the luggage compartment lid contact switch changes, the junction box electronics issue a notification on the K-CAN2. The central gateway module implements the signal on the K-CAN. In response, the HKL then executes the automatic opening procedure.

Automatic Closing

With the exception of the luggage compartment lid button in the A-pillar, all luggage compartment lid buttons are able to initiate automatic closing.

This luggage compartment lid button cannot be used to start the automatic closing procedure.

Closing Luggage Compartment Lid

The luggage compartment lid can be closed by pressing the inner luggage compartment lid button, outer luggage compartment lid button or central double-lock button.

The junction box electronics wake a sleeping vehicle in response to the inner luggage compartment lid button being pressed. The junction box electronics send the request on the K-CAN2. The Car Access System with Comfort Access receives the request and initiates the automatic closing procedure.

In response, the HKL then executes the automatic closing procedure.

As soon as the status of the luggage compartment lid contact switch changes, the junction box electronics issue a notification on the K-CAN2. The central gateway module implements the signal on the K-CAN. The HKL then knows that the closing process has ended.

Manual Opening and Closing

Moving the Luggage Compartment Lid by Hand

It is possible to open or close an open luggage compartment lid at any time in any vehicle idle mode situation. Three vehicle statuses govern the manual opening and closing procedure. These are:

- Luggage compartment lid lift active
- Luggage compartment lid lift in sleep mode
- Luggage compartment lid lift at terminal 30B OFF.

■ Luggage compartment lid lift active

While terminal 30B is switched on, detection of manual luggage compartment lid movements is straightforward.

The HKL detects luggage compartment lid movement by means of Hall sensors located in the spindle drive motors. The HKL evaluates the pulses of the Hall sensors and stores the current position of the luggage compartment lid.

This position is used as the starting position for subsequent luggage compartment lid movement.

■ Luggage compartment lid lift in sleep mode

The current position of the luggage compartment lid is stored in the HKL before the vehicle enters sleep mode.

Once the vehicle is in sleep mode, the HKL checks the Hall sensors on a cyclical basis. The vehicle is woken if a luggage compartment lid movement is detected. The HKL is then switched on and detects the luggage compartment lid being moved by hand.

■ Terminal 30B OFF

If terminal 30B is switched off, the power supply to the spindle drives is switched off and so too are the Hall sensors. In this situation, therefore, manual luggage compartment lid movements can no longer be detected.

If the position of the luggage compartment lid has been altered manually, the stored value would no longer match the current value.

At the next request, the luggage compartment lid is always closed first. The HKL detects the lower end stop from the status of the luggage compartment lid contact switch. This enables the current position of the luggage compartment lid to be compared with the stored starting position. The position of the luggage compartment lid is, in this way, newly referenced.

Note: If the luggage compartment lid movement is stopped before the lower end stop is reached, the luggage compartment lid will be opened the next time it is operated.

Since the position of the luggage compartment lid has not yet been referenced, the luggage compartment lid is only opened by as much it was previously closed.

Luggage Compartment Lid Movement Inhibit Conditions

The luggage compartment lid is not permitted to be operated in various situations. These situations include engine starting or driving or cases where there may be a risk of vehicle damage.

If luggage compartment lid operation needs to be inhibited while the luggage compartment lid is closing, an attempt is made to complete the movement that has commenced through to the end. For example, an attempt is made to complete luggage compartment lid movement until it closes while the vehicle is driving off. The luggage compartment lid lift will terminate actuation if the luggage compartment lid comes up against a blocking situation.

The inhibit conditions are listed as follows:

Inhibit condition	Explanation/information
Vehicle speed v_{max} > 3 km	The speed signal is made available by the integrated chassis management. **Note: The luggage compartment lid can be set in motion in the presence of an invalid road speed signal.**
Outside temperature < - 30 °C and + 80 °C >	The outside temperature signal is issued by the instrument cluster. **Note: The luggage compartment lid can be set in motion in the presence of an invalid temperature signal.**
On-board supply voltage < 9 V to 16 V >	In the event of undervoltage < 9 V or overvoltage > 16 V, the luggage compartment lid can no longer be set in motion.
Engine start (status “terminal 50 ON”)	The signal is issued on the K-CAN2 by the Car Access System. Cancellation if luggage compartment lid movement in progress, luggage compartment lid operation is inhibited.

If the luggage compartment lid is reversing, the inhibit conditions are ignored and the luggage compartment lid movement is followed through to the end.

Additional Functions of the Luggage Compartment Lid Lift

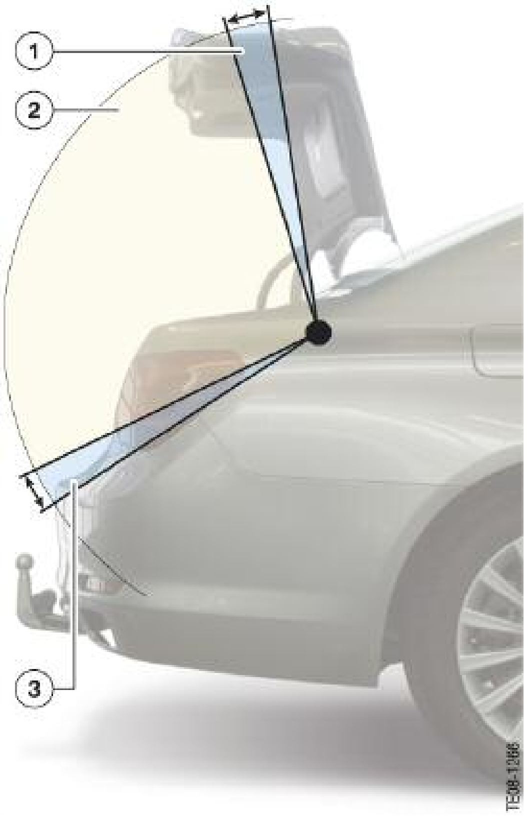
Position Detection

The spindle drives are each integrated with a motor. The motor contains two Hall sensors. The Hall sensors are arranged with relative offset. This enables detection of the motor's direction of rotation. In addition, it is possible to draw conclusions as to the remaining path of the luggage compartment lid based on the Hall sensor pulses.

The complete movement range of the luggage compartment lid from "CLOSED" to "OPEN" is recorded during assembly in the works. The HKL therefore knows how many Hall sensor pulses were generated between lower and upper end stop of the luggage compartment lid.

The number of Hall sensor pulses corresponds to the distance covered by the luggage compartment lid. With this information, the HKL is able to determine the opening angle of the luggage compartment lid.

The path of the luggage compartment lid is subdivided into various segments. From the Hall sensor pulses, the HKL knows the segment in which the luggage compartment lid is positioned. If the luggage compartment lid is fully open, it is positioned within the range of the upper segment. From there, the luggage compartment lid is always moved in the closing direction.



Luggage compartment lid segments F01

Index	Explanation
1	Upper segment
2	Range between the upper and lower segment
3	Lowermost segment

If the luggage compartment lid is in the range of the lower segment, i.e. closed, the luggage compartment lid is always moved in the opening direction.

The current position of the luggage compartment lid is stored by the HKL before it enters sleep mode. When the vehicle wakes up, the most recently stored position is used as the current position.

Obstruction Detection

Obstruction detection is active during the luggage compartment lid opening and closing procedure. An obstruction to luggage compartment lid movement during the opening procedure causes the luggage compartment lid to stop moving immediately. If the luggage compartment lid is obstructed in the closing direction, the HKL briefly controls the spindle drives in the opposite direction. If the luggage compartment lid remains obstructed, the HKL stops controlling the spindle drive motors.

There is no reversal of the direction of movement if the luggage compartment lid is obstructed as it opens or closes at the end stop.

■ Obstruction detection principle

The HKL evaluates the Hall sensor pulses in the spindle drive motors. The motor current is also recorded.

If the motor current increases and the Hall sensor pulses drop out, the HKL detects that the luggage compartment lid is being obstructed.

Note: Obstruction detection is deactivated during initialization of the luggage compartment lid lift. This allows the luggage compartment lid drives to be controlled with the maximum current available.

Repeat Interlock

The HKL is equipped with a repeat interlock to prevent the motors from overheating. The motor run-time is cumulated for the repeat interlock.

If the sum exceeds a maximum running time of 2 minutes, a new operation command will be rejected. An action that is already in progress always follows through to the end.

After a cooling phase of 6 minutes, it is possible for the motor to accrue a run-time of 2 minutes again.

The current motor run-time is stored by the HKL before it enters sleep mode.

The motor run-time of the repeat interlock is halved when the control unit is woken from sleep mode.

The repeat interlock is cleared in the event of a terminal 30B reset. This means that a motor run-time of 2 minutes is immediately available.

Control Units, Control Elements and Spindle Drives

Luggage Compartment Lid Lift

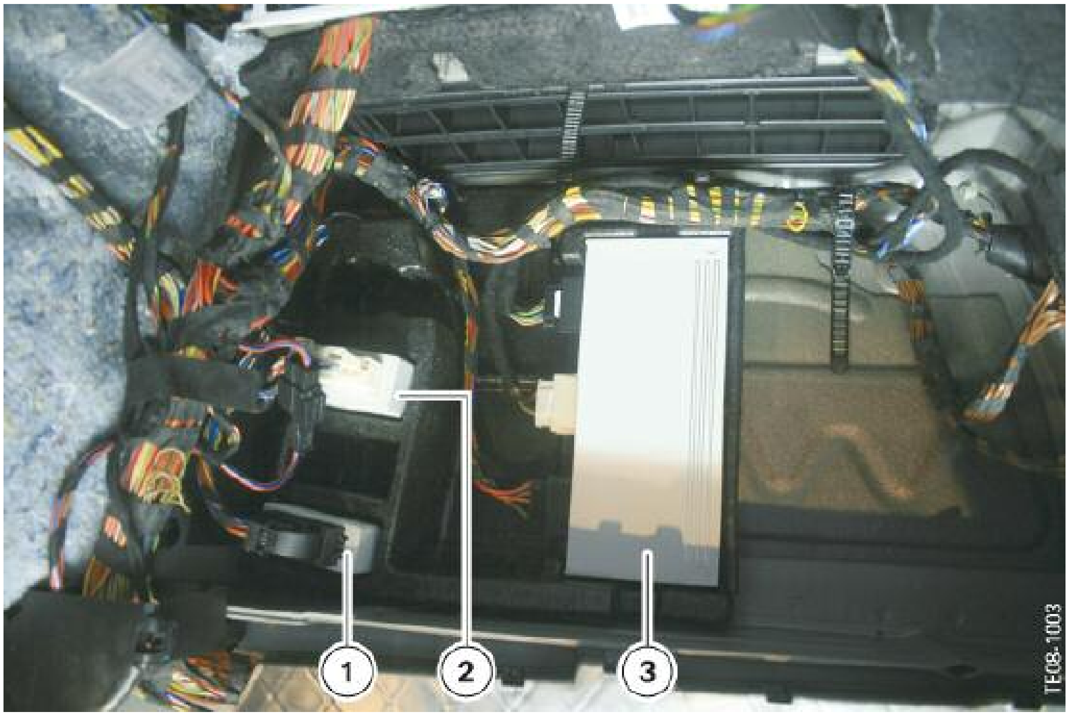
The luggage compartment lid lift is fitted on the right-hand side in the luggage compartment floor. The HKL controls and monitors the operation of the automatic luggage compartment lid actuating system.

The control logic module is connected to terminal 30B. The HKL is also connected to terminal 30 for the load current through the spindle drives.

In sleep mode, the HKL requires a certain amount of closed-circuit current. With terminal 30B OFF, the HKL is no longer supplied with off-load current.

Note: Terminal 30B is switched off with a delay.

The luggage compartment lid lift operates at a voltage of between 9 V and 16 V. Outside this range, the functions may no longer be supported.



Index	Explanation	Index	Explanation
1	Not for US market	3	HKL control module
2	Not for US market		

Car Access System

The Car Access System is fitted next to the steering column. It is the master control unit for the central locking. It is therefore also responsible for having the luggage compartment lid unlocked.

Junction Box Electronics

The junction box electronics are connected to the front power distribution box.

Note: The power distribution box and the junction box electronics are two separate components. This is an important point for the Service to note.

The central locking of the luggage compartment lid is controlled by a power output stage in the junction box electronics. The automatic soft-close drive is supplied by a relay in the distribution box at the rear. The junction box electronics control the relay.

Control Elements

Outer Luggage Compartment Lid Button

The outer luggage compartment lid pushbutton switches to ground. The signal from the outer luggage compartment lid button is sent to the junction box electronics. The junction box electronics signal the status of the outer luggage compartment lid button to the luggage compartment lid lift.

Interior Luggage Compartment Lid Button

The luggage compartment lid button switches to ground. The signal from the luggage compartment lid button is sent to the junction box electronics. The junction box electronics signal the status of the luggage compartment lid button to the luggage compartment lid lift.

The lighting of the luggage compartment lid button is only supplied with power under the following conditions:

- Luggage compartment lid open and
- Terminal 30B ON.

Note: A command sent from the inner luggage compartment lid button can only be executed with the luggage compartment lid open. This is due to the fact that the button has a connection to ground via the luggage compartment lid contact switch only when the luggage compartment lid is open.

Central Double-lock Button

The central double-lock button is connected to the Car Access System and switches to ground. The Car Access System makes the button status available on the K-CAN2.

Note: A command sent from the central double-lock button can only be executed with the luggage compartment lid open. This is due to the fact that the button has a connection to ground via the luggage compartment lid contact switch only when the luggage compartment lid is open.

■ ID transmitter luggage compartment lid button

The status of the luggage compartment lid button on the identification transmitter is evaluated by the electronics in the identification transmitter.

The identification transmitter sends an encrypted message to the vehicle by radio wave. The message reaches the remote control receiver via the antenna in the rear window. From there, the message is made available to the Car Access System.

The Car Access System verifies the message. Once the message has been successfully verified, the Car Access System sends out the request on the K-CAN2.

■ Luggage compartment lid button, A-pillar

The luggage compartment lid button is resistance-coded. The status of the luggage compartment lid button is evaluated by the Car Access System. The Car Access System issues the status on the K-CAN2.

■ Lock barrel, luggage compartment lid

The lock barrel in the luggage compartment lid is connected to the luggage compartment lid locking mechanism by means of a bowden cable. When the bowden cable is operated with the mechanical key, the luggage compartment lid lock releases and the luggage compartment lid can be opened.

Note: Opening the luggage compartment lid with the mechanical key can trigger an alarm in the antitheft system.

Spindle Drives

Each spindle drive comprises the following components:

- Spindle drive
- Drive motor
- Drive motor Hall sensor
- Spring
- Fixture of the spindle drive to the luggage compartment lid
- Fixture of the spindle drive to the body
- Ball bearing for the spindle drive.

Note: A defective spindle drive must be replaced as a complete unit.

Luggage Compartment Lid Contact Switch

The luggage compartment lid contact switch is switched to ground while the luggage compartment lid is not open. The status of the luggage compartment lid contact switch is evaluated and made available by the junction box electronics.

Service Information

Control Unit Replacement

Teaching in the Luggage Compartment Lid End Stops

If the luggage compartment lid lift control unit has been replaced, a new teach-in procedure will be necessary for the upper end stop. To do this, the luggage compartment lid has to be moved until obstructed by the upper stop.

The obstruction of the luggage compartment lid, and thus the drop-out of the Hall sensor pulses, marks the point at which the luggage compartment lid has reached its maximum opening angle. From this point, a value of approximately 5 % of the total opening angle is deducted. This will be the future opening angle of the luggage compartment lid. This point is also named the soft stop.

The soft stop prevents the luggage compartment lid from opening as far as the end stop and being damaged.

Note: The lower end stop is determined by the change in status in the contact switch of the luggage compartment lid lock from open to closed. The junction box electronics send out the status of the luggage compartment lid contact switch on the K-CAN2.

Spindle Drive Replacement

It is necessary to disconnect the plug connections when replacing the spindle drives. To protect the control unit or the spindle drives, terminal 30B should be switched off beforehand.

If the HKL is woken in this situation, it checks whether the spindle drives are connected. If the spindle drives are in fact not connected, a fault code memory entry will be generated. In response to the fault code memory entry, the HKL prevents control of the spindle drives. The automatic luggage compartment lid actuating system does not work, even if the spindle drives are connected now.

The HKL control unit must be allowed to enter sleep mode once more and terminal 30B switched off. The spindle drives are checked again the next time the control unit is woken. If the check is successful, the automatic luggage compartment lid actuating system is switched to active again.

After replacing the spindle drives, closing and opening of the luggage compartment lid must be adapted to given vehicle conditions. The luggage compartment lid lift does not recognize the position of the luggage compartment lid after installing the new spindle drives.

The spindle drives must be taught-in at the vehicle to enable the luggage compartment lid to recognize the position. The corresponding diagnosis order must be carried out for this purpose. This will ensure smooth opening and closing of the luggage compartment lid.

Note: The service information does not replace the current information available to Service, nor does it replace repair instructions.

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F01 Exterior Lighting

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Exterior Lighting

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the function of the Exterior lighting of the F01/F02
- Understand the functions of the adaptive headlights on the F01/F02

Introduction

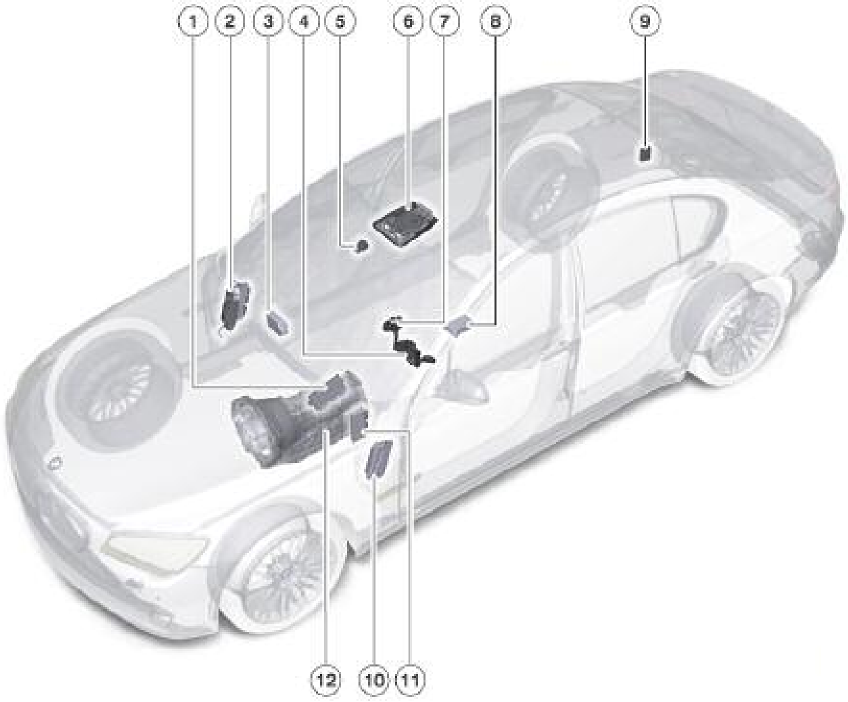
Comprehensive Exterior Lighting Systems

The following information outlines the function of the exterior lighting system and the adaptive headlights. The F01/F02 are equipped with standard adaptive headlights.

The F01/F02 features the welcome light, making the vehicle even more customer friendly. The exterior lighting system is switched on for approximately 20 seconds when the vehicle is unlocked. This has the advantage of locating the vehicle more easily under unfavorable light conditions.

A further feature is the daytime driving light that can be activated or deactivated via the Personal Profile.

Control units for the exterior lighting system F01/F02



Index	Explanation	Index	Explanation
1	Car Access System	7	Controller
2	Junction box electronics	8	Integrated chassis management
3	Crash safety module	9	Trailer module
4	Steering column switch cluster	10	Footwell module
5	Rain/light/solar/condensation sensor	11	Central gateway module
6	Roof functions center	12	Electronic transmission control

Exterior Lighting System with Adaptive Headlights

The adaptive headlights include the functions of the exterior lighting system. However it allows panning of the bi-xenon low-beam and high-beam headlights when cornering.

Note: Standard equipment for the vehicle includes bi-xenon headlights, fog lights and automatic driving lights function.

Panning of the bi-xenon low-beam and high-beam headlights is adapted continuously during cornering. Illumination during cornering therefore improves the driver’s vision.

Illumination during cornering results in:

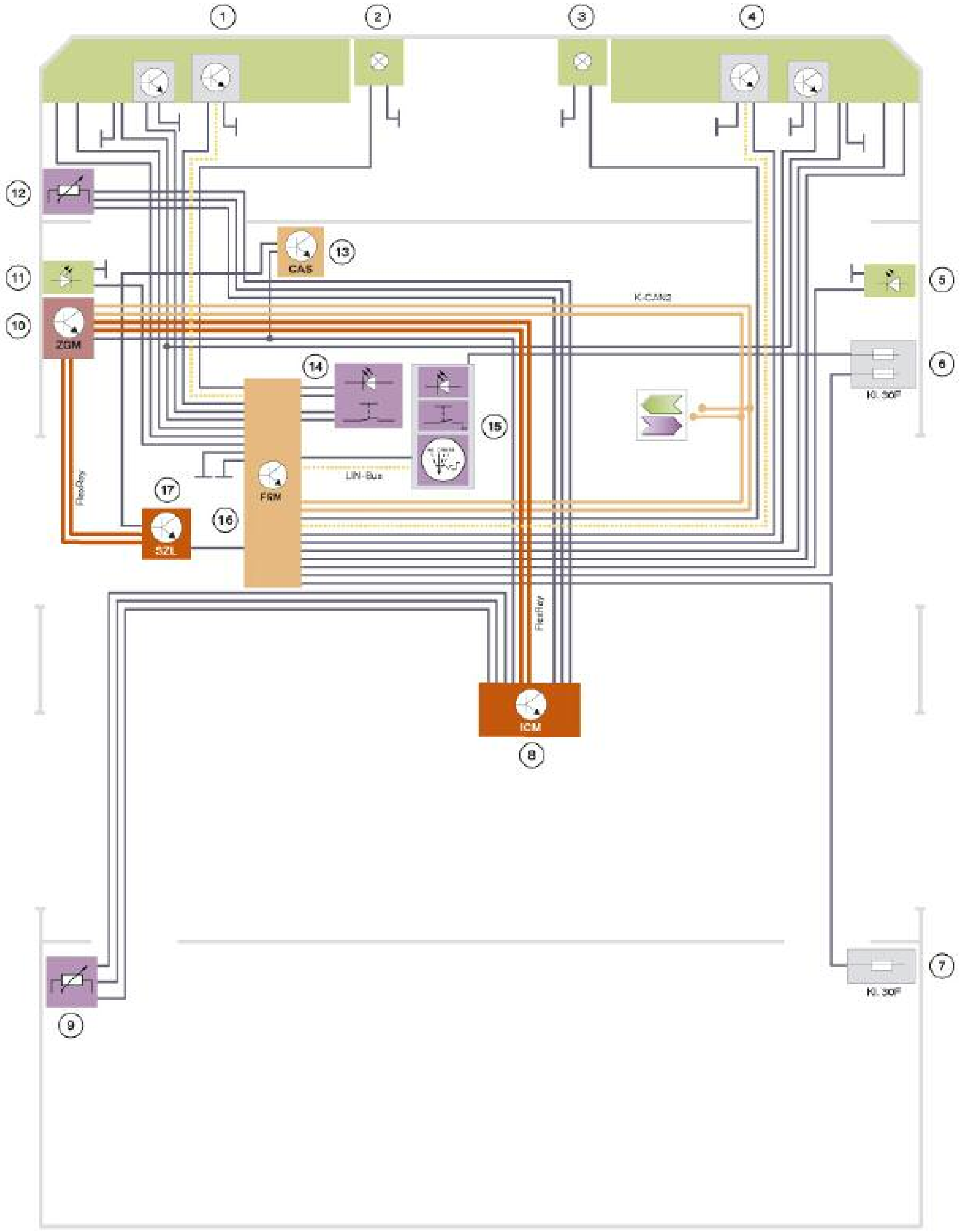
- Safer cornering with faster identification of obstacles
- Better perception of the environment
- Prevention of accidents.

The electronics of the adaptive headlight allow fast reaction to the current driving conditions. The system is controlled by the electronics and is less susceptible to malfunctions than purely mechanical systems.

Furthermore an emergency program can be activated via the electronics.

System Overview

Schematic Circuit Diagram - Exterior Lighting System, Front



Index	Explanation	Index	Explanation
1	Main headlight, left	12	Ride-height sensor, front
2	Front fog light, left	13	Car Access System (CAS)
3	Front fog light, right	14	Hazard warning lights switch
4	Main headlight, right	15	Control panel, light switch
5	Direction indicator repeater, right	16	Footwell module FRM
6	Power distribution box, front	17	Steering column switch cluster SZL
7	Power distribution box, luggage compartment	K-CAN2	Body CAN2
8	Integrated Chassis Management ICM	FlexRay	FlexRay
9	Ride-height sensor, rear	LIN-Bus	Local interconnect network bus
10	Central gateway module ZGM	KL. 30F	Terminal 30, fault switched
11	Direction indicator repeater, left		

K-CAN2 signals at footwell module

In/Out	Information	Sender/Receiver	Function
In	Crash signal	Crash sensor > Crash safety module	Interior lighting ON, hazard warning lights ON, Terminal 58g ON
In	Status, trailer module	Trailer socket outlet > trailer module	Trailer lighting
In	Outside temperature	Outside temperature sensor > instrument cluster	Outside temperature for calculation of the headlight overheating protection
In	Delayed switch-off home lights	Controller > Central information display	Switch-on time for the home lights function
Out	Driving lights status	Light switch > Footwell module	Trailer lighting ON/OFF (trailer module)
Out	Direction indicator	Turn-signal/high-beam switch > Footwell module	Direction indicator ON (trailer module)
Out	Direction indicator status	Turn-signal/high-beam switch > Footwell module	Synchronization flashing signal (e.g. display in the instrument cluster)

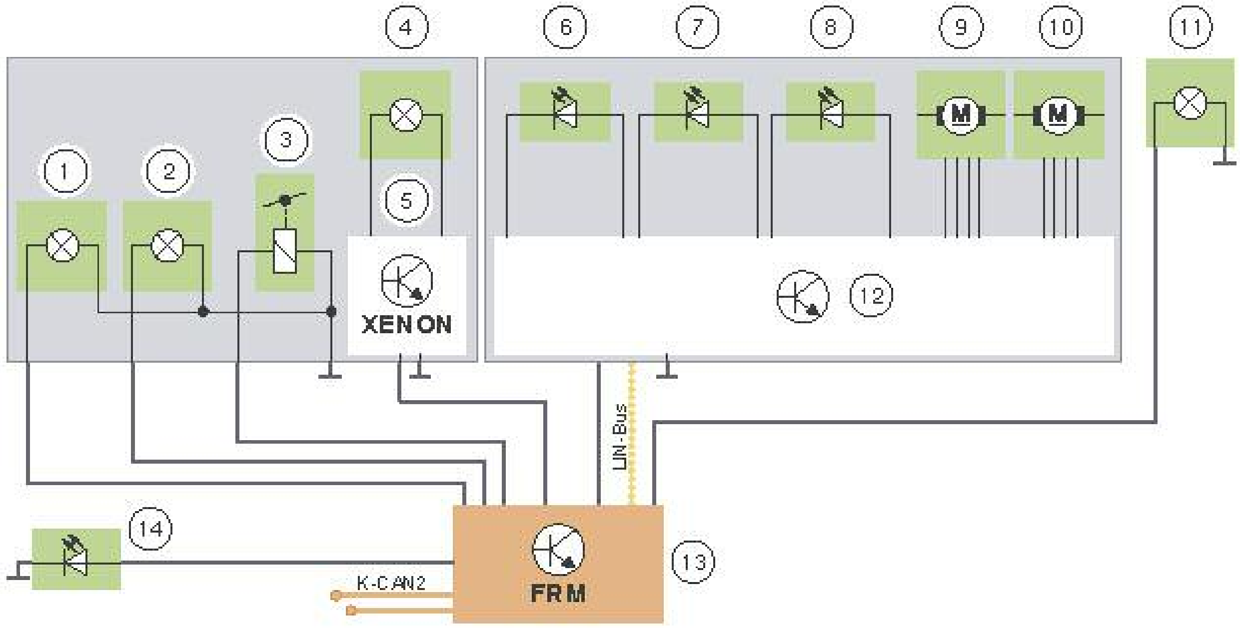
The lights control panel (15) includes:

- Light switch
- Fog light button
- Rear fog light button
- Thumbwheel, instrument lighting.

The steering column switch cluster (15) includes:

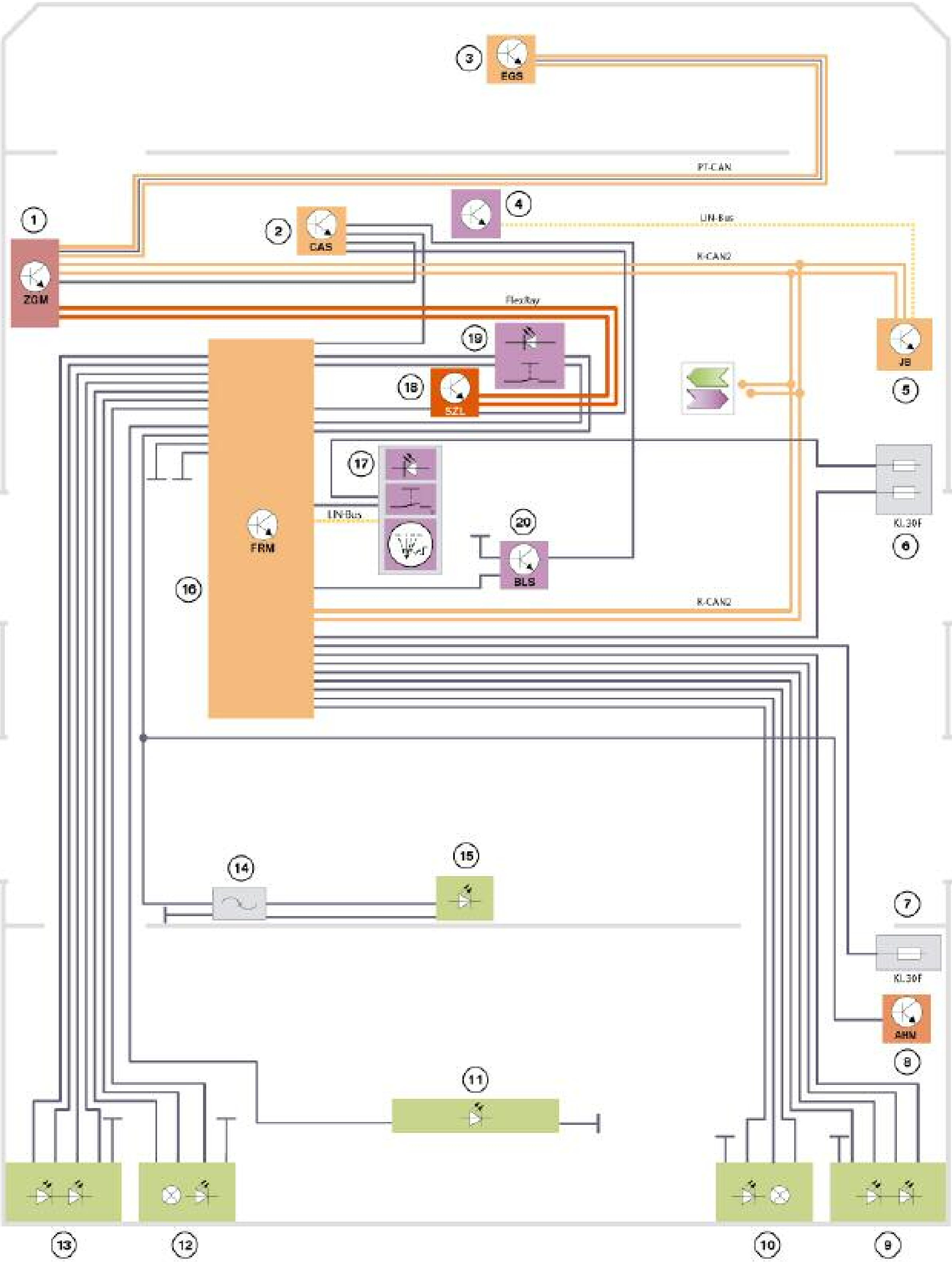
- Steering column stalk, turn-signal/highbeam switch
- Button for automatic driving lights control on wiper steering column stalk.

Illumination, Front



Index	Explanation	Index	Explanation
1	Turning light	8	Design light
2	Side lights/daytime driving light	9	Stepper motor, headlight vertical aim control
3	High beam shutter, bi-xenon	10	Stepper motor for adaptive headlight
4	Bi-xenon lamp for driving light / high-beam headlight	11	Fog lights
5	Xenon ballast	12	Headlight driver module
6	Side marker light	13	Footwell module
7	Direction indicator lights	14	Direction indicator repeater, left

Schematic Circuit Diagram - Exterior Lighting System, Rear



Index	Explanation	Index	Explanation
1	Central gateway module (ZGW)	14	Filter with trap circuit
2	Car Access System (CAS)	15	Additional brake light
3	Electronic transmission control (EGS)	16	Footwell module (FRM)
4	Rain/driving lights/condensation/solar sensor *	17	Control panel, light switch
5	Junction box electronics (JB)	18	Steering column switch cluster (SZL)
6	Power distribution box, front	19	Hazard warning switch
7	Power distribution box, luggage compartment	20	Brake light switch
8	Not for US	PT-CAN	Powertrain CAN
9	Outer rear light cluster, right	K-CAN2	Body CAN2
10	Inner rear light cluster, right	FlexRay	FlexRay
11	License plate light	LIN-Bus	Local interconnect network bus
12	Inner rear light cluster, left	Kl. 30F	Terminal 30, fault switched
13	Outer rear light cluster, left		

The rear light clusters (9 and 13) include:

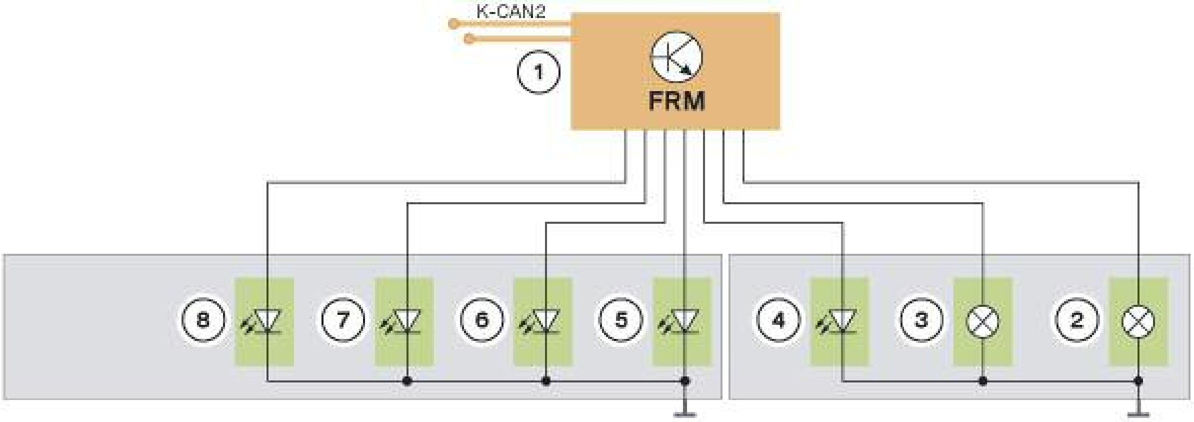
- Brake light
- Direction indicator lights
- Tail lights
- Side marker light.

The rear light clusters (10 and 12) include:

- Brake light
- Reversing light
- ail lights
- Adaptive brake light, US version.

Illumination, Rear

Rear light cluster, left



Index	Explanation	Index	Explanation
1	Footwell module (FRM)	6	Brake light 2
2	Reversing light	7	Brake light 1
3	Rear fog light/ brake force display	8	Direction indicator lights
4	Tail light 2	K-CAN2	Body CAN2
5	Tail light 1 including side marker light		

Functions

Overview

The functions of the exterior lighting are integrated in the footwell module.

These lighting functions are:

- Side lights
- Low beam headlight
- High-beam headlight
  - Headlight flasher
- Fog light
- Direction indicator light
  - Hazard warning light
- Tail light/license plate light
- Dynamic brake light
- Reversing light
- Parking lights
- Welcome light
- Delayed switch-off home lights
- Daytime driving light.

The headlight lighting functions are powered via a headlight driver module or the footwell module.

The footwell module controls a constant brightness level for each headlight. This is achieved with a pulse-width regulated voltage supply. Voltage fluctuations in the vehicle electrical and bus systems are compensated for by the pulse width.

The headlight driver module receives the information on the voltage supply for its light source via the LIN bus.

Note: The LEDs, e.g. in the additional brake light, tail light or bi-xenon headlight are not controlled but rather activated at 100 % pulse width.

In addition to the standard light functions, further functions for the exterior lighting are integrated in the footwell module:

- Dynamic beam throw adjustment system
- Lamp monitoring
    - Cold monitoring with lights “OFF”
    - Hot monitoring with lights “ON”
- Visual alarm/feedback
    - Central locking system
    - Antitheft alarm system
    - Crash signal
- Special case at “Terminal 15 OFF”
- Emergency operating mode
- Adaptive headlight with
    - Turning lights
    - Adaptive headlight-range adjustment system.

Light Functions

Side Light, Low Beam and High Beam

The exterior lighting system is switched on via the light switch.

The following table shows the terminal setting for switching on the exterior lighting.

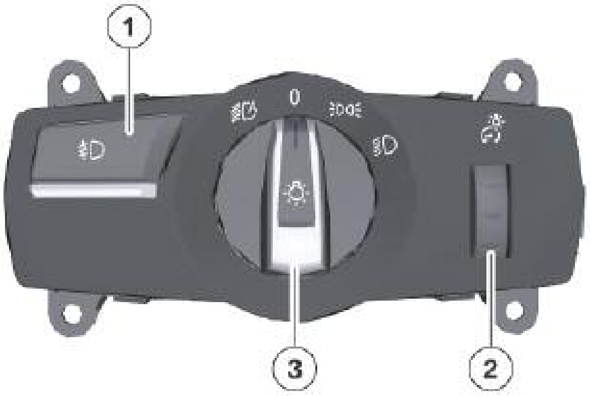
Light function	Activation by	Terminal
Side lights	Light switch, position 1	Terminal 30F ON
Low beam headlight	Light switch, position 2	Terminal 15 ON
High-beam headlight	Briefly press steering column stalk forward	Terminal 15 ON
Headlight flasher	Pull steering column stalk back	Terminal R ON

The control panel contains the light switch for the side lights and low beam headlights as well as the following components:

- Fog light button
- Display for automatic driving lights control
- Thumbwheel for dimming the instrument lighting.

Examples of the lights control panel:

Control panel with automatic driving lights control



Index	Explanation
1	Fog lights
2	Dimmer, instrument lighting
3	Light switch

Side Light

The light switch in the light control unit must be turned to switch position 1 to switch on the side light.

The following lamps are activated together with switching on the side light:

- Daytime driving light corona rings, dimmed on bi-xenon headlights
- Tail lights
- Left/right license plate light
- Terminal 58 switched.

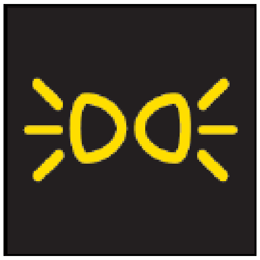
Low Beam Headlight

To switch on the low beam headlights, the light switch in the lights control panel must be turned to low beam headlight (switch position 2) When the low beam headlights are switched-on the bi-xenon headlights are activated.

After turning off the engine, the side lights stay on although the light switch is in switch position 2. The side lights are switched off automatically as the driver's door is opened.

Note: The light switch must be consciously set to switch position 1 in order to make the vehicle more easily detectable by means of the side lights when it is dark.

An audible signal (gong) sounds and the check control message opposite is shown in the instrument cluster as soon as the side lights are switched on. Leaving the side lights switched on can drain the vehicle battery.



High-beam Headlight

The high beam headlight is switched on under following conditions:

- Terminal 15 ON and
- Light switch in position 2 low beam and
- Turn-signal/high-beam switch for high-beam headlight ON.

The headlight flasher is activated by pulling on the turn-signal/high-beam switch. The function is operative as from Terminal 30F ON.

Direction Indicator/high Beam Switch

The steering column switch cluster contains the direction indicator/high beam switch. The signal from the turn-signal/high-beam switch is transmitted from the steering column switch cluster via the FlexRay. The central gateway module transfers the signal to the K-CAN2. The footwell module thus receives the signals from the turn-signal/high-beam switch.

Automatic Driving Lights Control

The following conditions must apply for the low-beam headlights to be switched on:

- Light switch in position A automatic driving light control and
- Status “Terminal 15 ON” and
- Rain/driving lights/solar sensor or rain/light/ solar/condensation sensor signals darkness.

Note: The rain/driving lights/solar sensor has now been extended with the condensation sensor function. It performs the condensation sensor function for the air conditioning system.

Only the rain/light/solar/condensation sensor is used from now on in the description. The description also applies correspondingly for the rain/driving lights/ solar sensor. Both sensors are connected over the LIN bus.

The footwell module switches on the low-beam light if the signal from the rain/light/solar/ condensation sensor fails due to a defect.

The low beam lights are switched on together with the side lights by the automatic driving lights control system as soon as the rain/light/ solar/condensation sensor detects a certain level of ambient brightness. The signal is sent from the rain/light/solar/condensation sensor via the LIN bus to the junction box electronics.

The junction box electronics routes the signal via the K-CAN2 to the footwell module. In turn, the footwell module evaluates the signal and switches on the driving lights.

The driving lights switched on by the automatic driving lights control system can be switched off with the light switch or by means of the rain/light/solar/condensation sensor.

The side lights can also remain on after “Terminal 15 OFF” because they were switched on by the automatic driving lights control function. The side lights are switched off automatically after opening the driver’s door.

If a different door is used to exit the vehicle, the side lights will be switched off when the vehicle is locked.

The rain/light/solar/condensation sensor supplies the switch-on signal for the driving lights at a specific level of darkness.

The roof functions center is responsible for the voltage supply to the rain/light/solar/ condensation sensor.

The junction box electronics queries relevant statuses via the LIN bus and transmits them over the K-CAN2.

Fog Lights

Switching Fog Lights ON/OFF

The fog lights can be switched on under the following conditions:

- Terminal 15 ON and
- Light switch in position 1 side lights or position 2 low-beam headlights ON or automatic driving lights control and
- Fog lights button pressed.

The fog lights are switched off by pressing the button again. When switched on, the fog lights can also be switched off by turning the light switch to the “Lights OFF” position.

The fog lights can be switched on again when the light switch is set to the side lights, low beam or automatic driving lights control position.

A H-8 35 W bulb is fitted in each fog light.

Direction Indicator Lights

The front and rear direction indicator light as well as the side direction indicator repeaters can be switched on as from Terminal R ON. They are operated by means of the switch on the steering column switch cluster. The signal from the steering column stalk is transmitted redundantly via the FlexRay and a separate wire. This increases system availability, for instance in the event of faults.

It is nonetheless still possible to use the direction indicators if the information does not arrive at the footwell module via the bus system. This is because the information is available redundantly over the separate wire.

Note: The redundant transmission is also used for the one-touch indicating and headlight flasher functions.

A defective light source in the front or rear direction indicator lights causes the remaining direction indicator lights to flash at double the rate. A defective light source in the front direction indicator repeaters has no influence on the flashing rate of the direction indicator lights.

All direction indicator lights are equipped with LEDs (Light Emitting Diodes).

One-touch Indicating

The direction indicator lights are activated once in connection with one-touch indicating. In the personal profile it is possible to set the one-touch indicating function from flashing once to three times.

Hazard Warning Lights

The hazard warning lights are switched on by pressing the hazard warning switch. As a result, all direction indicator lights are activated simultaneously and the indicator in the hazard warning switch flashes in time.

The steering column switch has priority if it is moved in left or right direction while the hazard warning lights are active. The hazard warning function resumes after "Terminal 15 OFF" or cancelling the direction indicator.

The hazard warning lights have priority when the direction indicator lights for turning left or right are switched on and the hazard warning light switch is pressed.

Hazard warning light switch on the dashboard F01/F02

Index	Explanation
1	Hazard warning switch
2	Central-locking button

Note: At Terminal 30/Terminal 30B ON the hazard-warning lights are switched on with reduced consumption. This means the hazard-warning lights are on for a shorter time and off for a longer time.

Hazard warning lights in connection with alarm triggered by the anti-theft alarm system

The footwell module receives the request for the hazard warning lights via the K-CAN2. The signal is sent by the ultrasonic interior movement detector.

The alarm time for the hazard warning lights is 6 minutes provided the antitheft alarm system is not switched off. The hazard warning light switch is blanked out during the alarm and therefore does not flash together with the lights.

Note: The ultrasonic interior movement detector is completely integrated in the roof functions center, both in terms of hardware and software.

Visual and Audible Indicators

The instrument cluster provides visual and audible indication of the turn signals. The footwell module informs the instrument cluster via the K-CAN2 to activate the acoustic generator and the indicator lights together with the direction indicator lights.

The visual/audible indicator in the instrument cluster switches off if the vehicle is locked with the central locking while the hazard warning light function is active.

Visual Feedback Through the Central Locking

The visual feedback is set at the factory. The direction indicator lights flash when the central locking is activated. The Car Access System makes available the signal necessary for this purpose via the K-CAN2.

The visual feedback can be deactivated in the personal profile.

The antitheft alarm system can also initiate visual feedback for the customer.

Tail Light / License Plate Light

In the same way as the side lights, the tail light can be switched on from Terminal 30F ON together with the license plate light by using the light switch (position 1).

Rear Light Cluster
The rear light cluster of the F01/F02 is based on a split design. One part is integrated in the body and the other in the luggage compartment lid. The two parts form the complete rear light cluster.

The rear light cluster in the body section is fitted with LEDs for the following lighting functions.

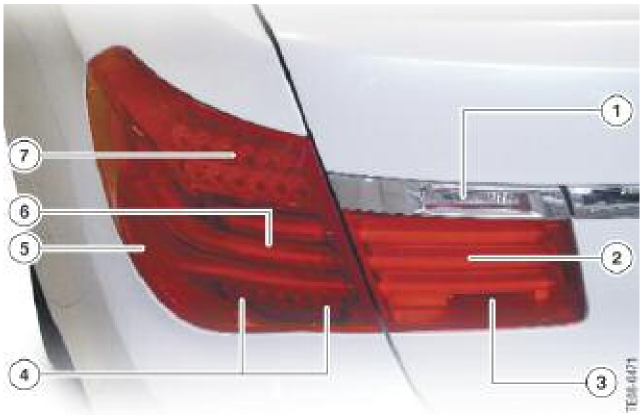
- Tail lights
- Brake light
- Direction indicator lights
- Side marker light, integrated in the tail light.

Three lighting functions are integrated in the rear light cluster. They are:

- Reversing lights 16 W
- Brake light (US version “Brake Force Display” - BFD)
- Tail lights based on LEDs.

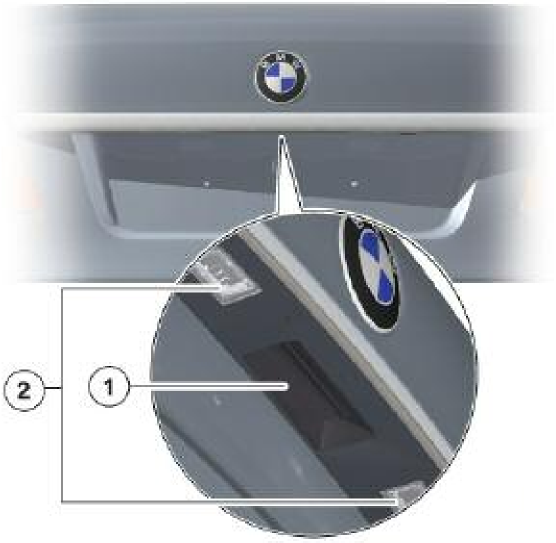
At Terminal 30 the consumption of the tail lights is reduced by only switching on the tail light in the rear side panel.

Design of the left-hand two-piece rear light cluster, F01/F02



Index	Explanation	Index	Explanation
1	Reversing light	5	Reflector, side marking
2	Tail light (LEDs)	6	Tail light (LEDs)
3	Brake light in US version (BFD)	7	Direction indicator light (LEDs)
4	Brake light (LEDs, in outside and inside chambers)		

License Plate Light
The license plate light is designed based on LEDs. The LEDs are integrated in the strip handle on the luggage compartment lid. Three LEDs are used for each license plate light.



Index	Explanation
1	L and R License plate lights
2	Trunk release button

Brake Light

As from "Terminal R ON", the brake lights can be switched on by activating the brake light switch.

The Car Access System powers the brake light switch with 5 V voltage. The footwell module evaluates the status of the brake pedal switch and actuates the brake light. The brake light switch provides two levels.

The signal of the brake pedal switch is also used for the beam throw adjustment (LWR).

Note: The brake light can also be activated by a braking assistant function such as ACC.

Adaptive Brake Light - US

The current adaptive brake light remains in the national-market version US. Braking is indicated by an increase in size and luminous intensity. It is not permissible for the red surfaces of the brake light to flash. The adaptive brake light is part of the standard equipment.

The following conditions must be met for operation of the adaptive brake light:

- Driving speed > 5 kph (3 mph)
- Brake deceleration above 5 m/s2 or
- Control intervention by the antilock braking system.

Reversing Light

The reversing light can be switched on as from “Terminal 15 ON”. The footwell module receives the signal via the K-CAN2. The electronic transmission control unit makes available this signal.

When the vehicle is in trailer towing mode, the reversing light of the trailer is additionally activated via the trailer module.

Parking Lights

The parking lights are switched on with the steering column switch as from “Terminal 30” and detected by the footwell module via the KCAN2.

For the parking light function, the footwell module activates the front side lights and the tail light in the outer chamber of the rear light cluster.

The steering column stalk for the parking lights must be pressed for longer than half a second. This prevents the parking lights being switched on by mistake, e.g. by knocking against the steering column switch while getting out of the car.

More Functions

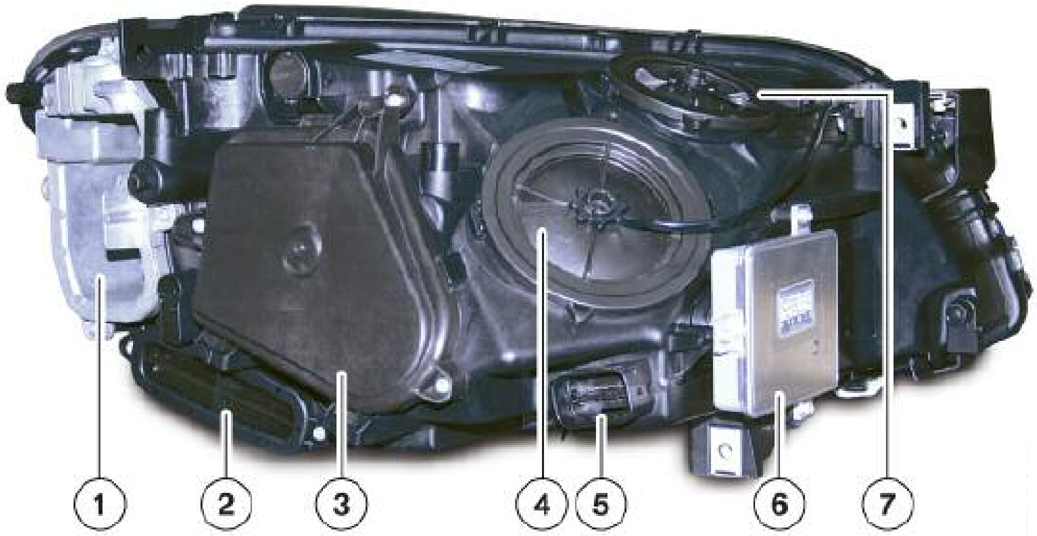
Bi-xenon Headlights

Bi-xenon headlights are installed as standard equipment and are located in the outer chamber of the headlights.

In connection with the bi-xenon headlights, the shutter for the low beam light is activated by the "high beam ON" signal thus enabling the high beam light. High beam is also used for the headlight flasher function

Index	Explanation	Index	Explanation
1	Turning lights	5	Direction indicator lights
2	Bi-xenon low beam/high beam	6	Side lights/daytime driving lights corona ring
3	Position light/daytime driving lights/ design light	7	Side lights/daytime driving lights corona ring
4	Side marker light (US only)		

Bi-xenon headlights F01/F02 viewed from the rear



Index	Explanation	Index	Explanation
1	Direction indicator lights heat sink	5	Headlight connection
2	Headlight driver module	6	Voltage supply for bi-xenon lamp
3	Cover for bi-xenon lamp	7	Cover for lamp, turning lights
4	Cover for lamp, side lights/daytime driving lights corona ring		

■ Daytime driving lights

A 35 W bulb for the daytime driving light is in the headlight inner chamber. The daytime driving light with respect to the side lights is produced by the inner and outer corona rings. The corona rings are fiber optics conductors.

The inner corona ring is illuminated from behind. The reflector is designed to ensure that the light mainly illuminates the corona ring. Light from the same headlight chamber is coupled in two fiber optics cables and fed to the outer corona ring.

The footwell module decreases the daytime driving lights as soon as the side lights or low beam lights are switched on. Consequently, both corona rings of the daytime driving light are now used for the side lights.

The light switch must be in position “0” in order to activate the daytime driving lights.

The daytime driving lights are also switched on at low beam OFF with automatic driving lights control. The light switch must be set to position “A”.

The daytime driving lights function is country-specific and is activated as from “Terminal 15 ON”. The daytime driving lights can be deactivated/activated via the personal profile.

The daytime driving lights are switched off after “Terminal 15 OFF”.

Note: The daytime driving lights cannot be deactivated in the personal profile in the US version. The daytime driving lights can also be activated in light switch position 1 side lights.

Welcome Light

The welcome light can not be activated when the light switch is in position “0” or “1”. Furthermore, the side lights are also not to be activated.

The welcome light is switched on as soon as the vehicle is unlocked. For this purpose, the Car Access System makes available the status of the central locking system via the K-CAN2.

The footwell module receives the “Unlock vehicle” status and switches on the exterior lighting for approximately 20 seconds.

While switched on, the welcome light can be deactivated with the “Terminal 15 ON” status.

The following light units are activated:

- Tail lights
- Corona rings
- Side marker light
- Interior lighting
- Courtesy lighting
- Indicator light in the instrument cluster.

Delayed Switch-off Home Lights

The delayed switch-off home lights are standard equipment. The lights can be switched on via the steering column switch for high beam as from lights OFF, at Terminal 30.

The switch-on time is set at the factory to 40 seconds and can be set between 0 and 240 seconds in the “Personal Profile”.

The low beam, side lights and tail lights are switched on when the home lights function is active.

Beam Throw Adjustment System

The F01/F02 has a dynamic beam throw adjustment system in the standard equipment. The dynamic beam throw adjustment system is a legal requirement for bi-xenon light. The dynamic beam throw adjustment ensures that oncoming traffic is not dazzled.

One ride-height sensor is installed at the front and one at the rear for the beam throw adjustment system.

■ Front and rear ride-height sensors

One ride-height sensor is mounted on the front axle and the other ride-height sensor on the rear axle of the vehicle. The signals from the ride-height sensors are used for the beam throw adjustment LWR.

The ride-height sensors are evaluated directly by the integrated chassis management. The footwell module receives the signals from the integrated chassis management via the KCAN2. In the central gateway module the signal must be transferred from the FlexRay to the K-CAN.

Lamp Monitoring

The footwell monitors all lamps of the exterior lighting system both when switched on and when switched off. The monitoring function starts as from “Terminal 15 ON”.

■ Cold monitoring with “Lights OFF”

Cold monitoring is based on measuring the current of the individual lamp outputs. The current pulse used for measurement purposes is so short that the lamps are not illuminated. The footwell module evaluates the individual lamp outputs to establish whether there is a line break or a lamp bulb is defective.

The number of current pulses is increased significantly during the first 4 seconds after “Terminal 15 ON”. To check whether the lamps are in working order before setting off. This function is referred to as the pre-drive check.

The number of pulses is then reduced after the pre-drive check. Power is then applied to the lamps every 1.5 minutes.

The lights fitted with LEDs are not included in the cold monitoring system. The LEDs react too fast to the current pulse and would consequently light up.

The bi-xenon headlight is also not included in the cold monitoring.

■ Hot monitoring with “Lights ON”

Hot monitoring is based on measuring the current of the individual lamp outputs. The lamp current is used to detect an overcurrent or interruption (break). The front and rear direction indicator lights are also included in the lamp monitoring system.

Visual Alarm/feedback

■ Central locking system

The Car Access System outputs signals for the central locking system function. The footwell module also receives the signals via the K-CAN2 and uses them for visual feedback of the central locking system.

■ Antitheft alarm system

The footwell module enables the antitheft alarm system to trigger the visual alarm via the direction indicator lights.

The roof functions center with integrated ultrasonic interior movement detector makes available the signal for the visual alarm via the K-CAN2. Furthermore, the footwell module receives the signals from the roof functions center for visual feedback of the antitheft alarm system.

■ Crash signal

The footwell module switches on the hazard warning lights and the interior lighting when the crash safety module sends a crash signal. The hazard warning lights can be switched off with the hazard warning light switch.

The light in the hazard warning light switch is switched off by pressing the light switch to position 0 “Lights OFF” or by means of the rocker switch on the steering column stalk.

Special Case at “Terminal 15 OFF”

The exterior lighting would be switched off if “Terminal 15 ON” fails during vehicle operation or Terminal 15 is inadvertently deactivated by pressing the START-STOP button. The driving lights remain switched-on in order to maintain road safety in this situation. When the driving speed drops below 20 kph (12 mph), the low beam light is also switched off after a delay of approximately 30 seconds.

Emergency Operating Mode

Emergency operating mode is assumed if a defect occurs in the software of the footwell module that could cause failure of the entire exterior lighting system. In this case, the tail lights and the additional brake light are activated. This function is active as from “Terminal 15 ON”.

Driving lights: Low beam headlight and one tail light on each side

Brake lights: Additional brake light and one tail light on each side

Adaptive Headlight

Adaptive headlight are an option and include the following functions:

- Adaptive headlight
- Turning lights
- Variable headlight beam pattern
- Adaptive headlight-range adjustment system.

The adaptive headlight were introduced with the E60. The F01/F02 therefore also includes, for instance, the functions variable headlight beam pattern or turning lights.

Furthermore, the adaptive headlight-range adjustment system is an additional function.

The light switch must be in the automatic driving lights control position.

Legal Regulation

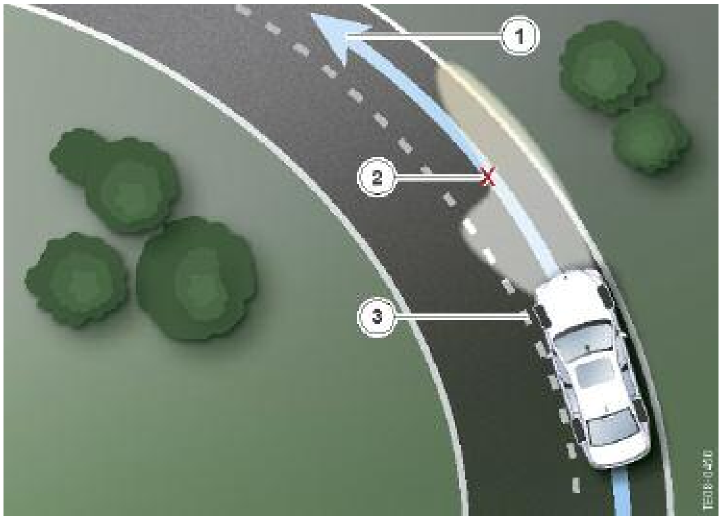
Panning of headlights for the adaptive headlights is permitted within certain limits. An important point is that oncoming traffic is not to be dazzled by the headlights.

When the driver turns the steering wheel the vehicle moves on a circular track. The circular track is defined by movement of the wheels and the angle setting of the front wheels.

In order to avoid dazzling oncoming traffic, the break point of the headlight cut-off line must not lie on the left of the circular track within the distance of 100 times the headlight installation height.

The statement for the cut-off line refers to driving on the right. For driving on the left the statement for the cut-off line is mirror-symmetrical.

Break point cut-off line for the F01/F02



Index	Explanation	Index	Explanation
1	Estimated circular track	3	Steering angle
2	Cut-off line break point		

Preconditions for the Adaptive Headlight

To ensure its operability, the adaptive headlight must be adapted to the vehicle-specific data. The vehicle-specific data are located in the footwell module and in the headlight driver modules.

The footwell module contains the data:

- Vehicle identification number
- Vehicle type.

The headlight driver modules contain the data for:

- Headlight and headlight swivel range
- Permitted acceleration and deceleration ramps
- Characteristic speed maps
- Encoding
- Vehicle identification number
- Vehicle type.

The footwell module has the central responsibility for the adaptive headlight function. The entire software for the adaptive headlight is therefore located in the footwell module.

The footwell module is connected via the LIN bus for communication with the headlight driver modules.

The footwell module requests the current headlight status. The footwell module sends the requests necessary for panning the light from the headlights to the headlight driver modules via the LIN bus.

The footwell module is also still connected to the vehicle electrical and bus systems via the K-CAN2. Signals important for the function of the adaptive headlights are received by the footwell module via the K-CAN2.

The table below lists those control units that provide input signals.

Control unit	Signal
Car Access System	Wake-up
Dynamic stability control	Vehicle speed and yaw rate
Rain/light/solar/condensation sensor	Switch on lights when dark
Integrated Chassis Management	Vehicle level

Bi-xenon Headlight

Each bi-xenon headlight contains following components:

- Bi-xenon control unit
- Swivel module for bi-xenon headlight
- Stepper motor for headlight vertical aim control
- Side light corona/daytime driving light corona
- Direction indicator lights
- Design light
- Side marker light
- Headlight driver module.

Bi-xenon Control Uunit

The bi-xenon control unit is located on the bi-xenon headlights.
It supplies the power and ignition voltage for the bi-xenon light bulb.

■ Swivel module for bi-xenon headlight

Among other things, the swivel module contains following components:

- Bi-xenon lamp
- Hall sensor for zero position
- Stepper motor.

The bi-xenon light bulb is integrated in the swivel section of the adaptive headlight. The zero position Hall sensor registers the zero position of the swivel module.

The stepper motor provides the swivel movement of the swivel module. A separate stepper motor is installed for the headlight vertical aim control.

The headlight driver module controls and monitors the movement of the stepper motors for the adaptive headlights and the vertical aim control system.

■ Side lights/daytime driving light

The side lights/daytime driving light is designed as a fiber optics light guide ring.
A 35 W bulb (H8) supplies the light to the fiber optics ring from below.

Switch-on Conditions

The adaptive headlight can be activated as from terminal status “Terminal 15 ON”.

The rain/light/solar/condensation sensor sends the request to switch on the low beam headlights as soon as it detects low light levels (darkness). Initially, the footwell module switches on the headlight driver modules. The adaptive headlight is ready for operation following a reference run of the bi-xenon headlights.

Note: A reference run is performed during every new start.

The conditions for switching on the adaptive headlight are:

- “Terminal 15 ON”
- Light switch in automatic driving light control position
- Rain/light/solar/condensation sensor detects darkness
- Both bi-xenon headlights are intact.

Note: The footwell module detects a defective bi-xenon headlight by measuring the intake current of the respective bi-xenon headlight.

Switching on Adaptive Headlight

The adaptive headlight is switched on as soon as the rain/light/solar/condensation sensor sends the switch-on signal for the low-beam headlight.

Function Indicator

The low beam headlight and the headlight vertical aim control remain active in the case of fault. The swivel function of the bi-xenon modules is deactivated. A Check Control message is output on the instrument cluster.

Reference Run

In order to determine the zero position, the adaptive headlight performs a reference run depending on the current position of the swivel module.

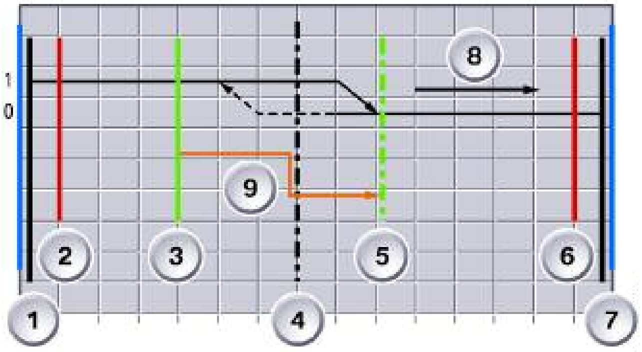
To avoid a hysteresis during calibration, the swivel module always moves from the same side over the zero position sensor.

This is achieved in that the swivel module is always moved to the same side of the zero position sensor before switching off the adaptive headlight.

Zero Position Sensor

The zero position of the swivel module with respect to the zero position sensor is detected by a 1/0 edge when swivelling from the direction of the off position in the direction of the optical axis. The swivel module is repeatedly calibrated during operation based on this “soft” reference point.

Zero position sensor



Index	Explanation	Index	Explanation
1	Mechanical stop, minimum	6	Electrical stop, maximum
2	Electrical stop	7	Mechanical stop
3	OFF position	8	Swivel direction
4	Position of zero position sensor	9	Reference run from left
5	Position of optical axis = 0		

Driving the stepper motor in positive direction of the swivel module corresponds to swivel movement to the right.

Mechanical Stop

Items 1 and 7 represent the mechanical stops of the swivel module. The mechanical stops are defined by the design of the headlights.

Differential Angle

A differential angle is required when the position of the swivel module is not known. A reference run that extends to the mechanical stops must be performed for this purpose. This is known as a “hard” reference run.

Optical Axis

The swivel position, in which the swivel module is in the straight-ahead direction of the vehicle is referred to as the optical axis. An angle of 0° is assigned to this position.

The optical axis is defined exactly as an angle with respect to the zero position sensor and as an angle with respect to the mechanical stop.

Consequently, the optical axis during swivel movement can be “normally” determined by way of the zero position sensor.

The differential angle with respect to the mechanical reference point is used in the case of fault.

Swivel Range

Normally, the swivel module does not move to the mechanical stop but rather to the electric minimum and maximum stops.

Adjustment of the swivel module to the electrical stops avoids the loss of pulses on reaching a mechanical stop.

The minimum and maximum electrical stops are defined as angles with respect to the zero position.

Note: The panning ranges define the maximum pan angles that the adaptive headlights can utilize.

■ Panning, raising and lowering headlights

Via the LIN bus the footwell module instructs the headlight driver modules to actuate the respective stepper motors.

The headlight driver modules activate the stepper motors for panning. For the variable headlight beam pattern, the headlight driver modules also actuate the stepper motors to raise or lower the headlights. The maximum adaptive headlight panning range must not be exceeded when cornering. This must also be considered for the variable beam pattern headlights.

The off-side headlight requires a certain outward pan angle combined with a certain amount of lowering according to the headlight beam pattern.

The outward pan angle must be subtracted from the adaptive headlight pan angle for left-hand bends.

The table below shows which headlights are moved to set the various headlight beam patterns. The first example illustrates the situation for movement when driving in a straight line.

Driving in a straight line, left-hand drive vehicle

Light function	Off-side headlight	Near-side headlight
Urban beam pattern	Pan approximately 12° outwards and lower slightly by approximately 0.7°	---
Single-carriageway beam pattern	Basic beam pattern	Basic beam pattern
Fog light	Pan approximately 8° outwards and lower slightly by approximately 0.7°	---
Highway beam pattern	Pan approximately 3.5° outwards and lower slightly by approximately 0.25°	Raise slightly by approximately 0.2°
High beam	Single-carriageway beam pattern and main beam	

The angles quoted relate to headlights in the straight-ahead position!

■ **Example for left-hand bend:**
When the urban beam pattern is active, the off-side headlight pans approximately 12° outwards. At the same time, the headlight is slightly lowered. Since, a panning range of up to 15°is available for left-hand bends, only 3° more is left for corner illumination.

■ **Example for right-hand bend:**
When the urban beam pattern is active, the off-side headlight pans approximately 12° outwards. At the same time, the headlight is slightly lowered. For a right-hand bend a panning range of 8°is available. The headlight pans the full 8°.

Traverse Rate

The traverse rate of the swivel modules is up to 30°/second.

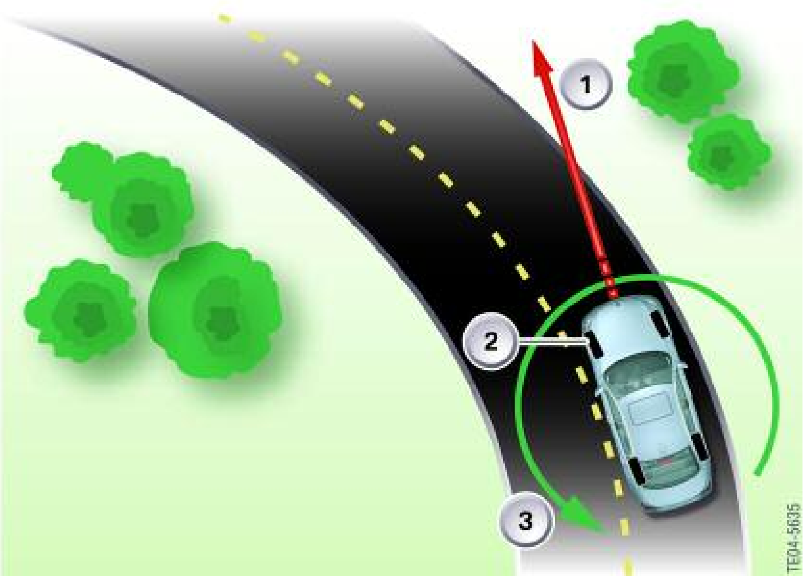
Swiveling

The following signals are made available to the footwell module for the purpose of moving the swivel module.

- Steering angle
- Road speed
- Yaw rate.

Under normal driving conditions, the adaptive headlight is controlled by the data from the steering angle sensor up to a speed of approximately 40 kph (25mph).

Input signals in the E90



Index	Explanation	Index	Explanation
1	Vehicle speed	3	Yaw rate
2	Steering angle		

The yaw rate sensor is included in the calculation

- at speeds higher than approximately 40 km/h (25 mph)
- in the event of vehicle oversteering or understeering
- a vehicle tending to yaw.

The wheel speed sensors supply the signals for the vehicle speed. The dynamic stability control evaluates the wheel speed sensor of each wheel.

The vehicle oversteering/understeering or yawing is detected by means of the steering angle sensor and the yaw rate sensor.

The adaptive headlight is deactivated in the event of the vehicle oversteering/ understeering or yawing. The swivel module returns to its zero position.

Note: The yaw rate sensor makes available signals relating to the yaw of the vehicle about the vertical axis. It is installed between the driver's and front passenger seats on the transmission tunnel.

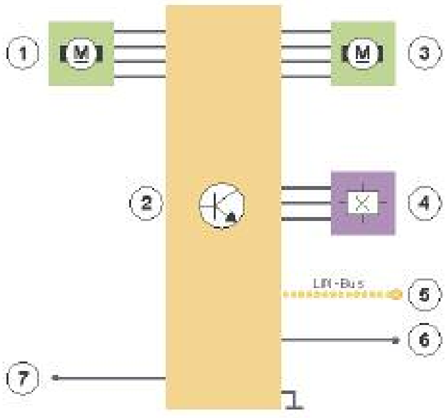
The steering angle sensor is integrated in the steering column switch cluster. It is an optical sensor and makes available data relating to the steering wheel lock angle.

Headlight Driver Module

The headlight driver module controls and monitors the stepper motors for the adaptive headlights and the headlight beam throw adjustment system of the respective bi-xenon headlight.

The integrated chassis management makes available the values for the dynamic headlight beam throw adjustment system to the footwell module. The footwell module receives these values via the K-CAN2. In this way the beam angle can be adapted to the different driving situations, e.g. laden/unladen.

The signal from the integrated chassis management must be transferred to the KCAN2 in the central gateway module.



Index	Explanation
1	Stepper motor for adaptive headlight
2	Headlight driver module
3	Stepper motor, headlight vertical aim control
4	Zero position sensor
5	LIN-Bus
6	Coding pin for right/left
7	Voltage supply +

The headlight driver module fulfils the following functions:

- Receiving and evaluating the data sent from the footwell module via the LIN-bus:
  - Reference run
  - Target position commands
  - Diagnosis requests
- Output control of the stepper motors
- Zero position acquisition of swivel module
- Reference run of swivel module
- Position feedback of swivel module to footwell module
- Diagnosis
- Feedback of diagnosis data to the footwell module.

The footwell module in its function as the central control unit for the adaptive headlight checks the status of the headlight driver modules every 20 ms.

Furthermore, the footwell module initiates activation of the LEDs in the front headlights.

Zero Position of Swivel Module

The zero position of the swivel module is determined by the zero position sensor. The zero position sensor is a Hall sensor. The falling edge of the Hall sensor is evaluated to determine the zero position. The zero position corresponds to exactly the position of the swivel module in the straight-ahead position of the vehicle.

The headlight driver modules prepare the data for data transfer via the LIN bus.
The footwell module requests the data from the headlight driver modules.

**Note: The sensor signal can be read out during diagnosis.
The sensor is defective if no sensor signal is applied.**

Switch-off Conditions

As from “Terminal 15 OFF”, the footwell module sends the request via the LIN bus to assume the rest position of both swivel modules to the headlight driver modules. On reaching the rest position of the swivel modules, the headlight driver modules send a confirmation to the footwell module. The headlight driver modules also activate the side lights function.

Afterunning Time

The afterunning time is 2 seconds.

Check Control Message

The Check Control messages below exist for the adaptive headlights and the beam throw adjustment system.

Check control message	Description	Information in central information display
	Beam throw adjustment system	Headlight beam throw Beam throw adjustment system of the headlights faulty. Road illumination not optimum. Possible dazzling of oncoming traffic. Have checked by your BMW dealer as soon as possible.
	Adaptive headlight failure	Adaptive headlights. Adaptive headlight failure. Have checked by your BMW dealer.

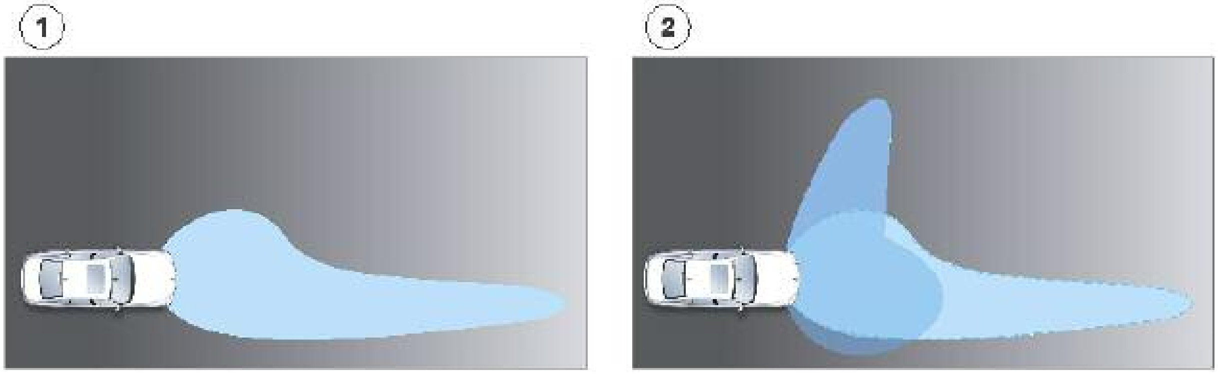
Turning Lights

The turning light function is available only in connection with the option Adaptive Headlight. In addition to the adaptive headlights, the turning light additionally illuminates the area in front of and beside the vehicle.

The turning light makes it possible to recognize persons or traffic situations earlier in the turn-off area.

Parameters such as the steering angle and vehicle speed are taken into account for the turning light function.

Fundamental illumination with the turning light F01/F02



Index	Explanation	Index	Explanation
1	Without turning light	2	With turning light

Condition for Switching the Turning Light on and off

The low beam headlight must be switched on by the automatic driving light control function for the turning light to be activated. The turning light is activated only under the following conditions.

Function matrix for activation of the turning light:

Driving direction	**Condition**	**Side with activated turning light**
Forward	• Speed below 40 kph (25mph) • Direction indicator activated.	Same side as activated direction indicator
	• Speed below 70 kph (43 mph) • Steering lock.	On side in direction of steering lock
Reverse	• Speed below 40 kph (25mph) • Reverse gear activated • Direction indicator activated.	Same side as activated direction indicator
	• Speed below 40 kph (25mph) • Reverse gear activated • Steering lock.	Opposite side in direction of steering lock
	Only for US version: • Vehicle speed below 40 kph (25mph) • Reverse gear activated.	Both sides

Note: The turning light is no longer switched off if only one signal fails, e.g. due to a defect.

The turning light is equipped with an overheating protection. Therefore the turning light may be briefly deactivated when it is used for a long time.

■ US Version

In the US version, both turning lights are switched on when reverse gear is engaged. The turning light can be activated up to speed below 40 kph (25mph).

■ **Turning lights at speeds up to 70 kph** (43 mph)
In very tight corners with a radius of less than 100 m, the turning light function can now be activated for even better illumination at speeds up to 70 kph (43 mph). This is particularly helpful on switchback roads. The function is activated if the steering wheel is turned to an appropriate angle.

Note: The turning light function can be activated below 40 kph (25 mph) by switching on the turn-signal indicator or turning the steering wheel by an appropriate amount.

Input parameters:

- Headlights switched on by automatic headlights function
- Steering angle
- Road speed
- Light switch in automatic driving light control position.

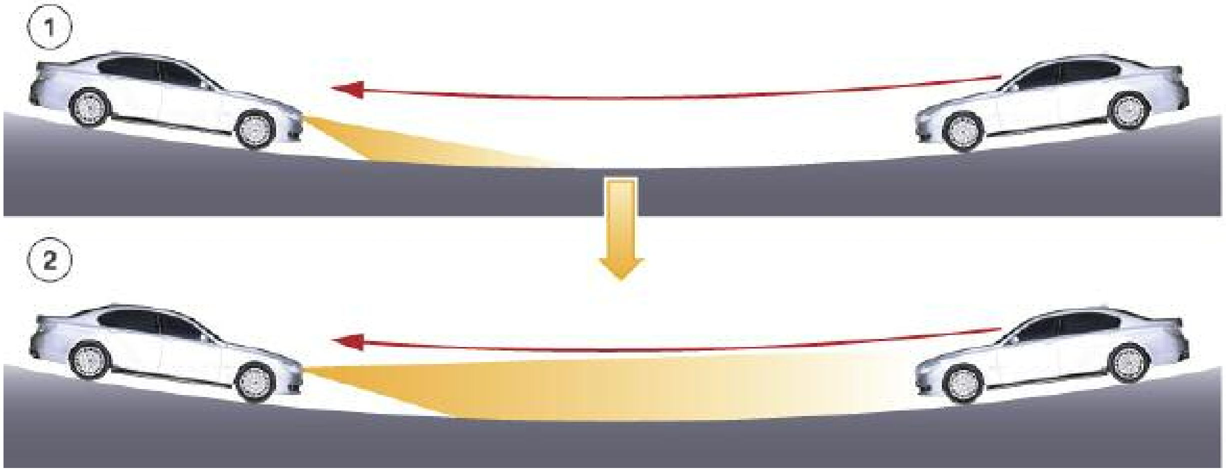
Adaptive Headlight-range Adjustment System

The adaptive headlight-range adjustment system is designed for driving through dips and over crests.

When driving through a dip the headlight beam throw is increased. The headlights are moved up a small amount. The driver can see further and oncoming vehicles are not dazzled. Obstacles on the roadway can therefore be detected earlier than with earlier headlight systems. This allows an early reaction to obstacles and initiation of any evasive action that may be required.

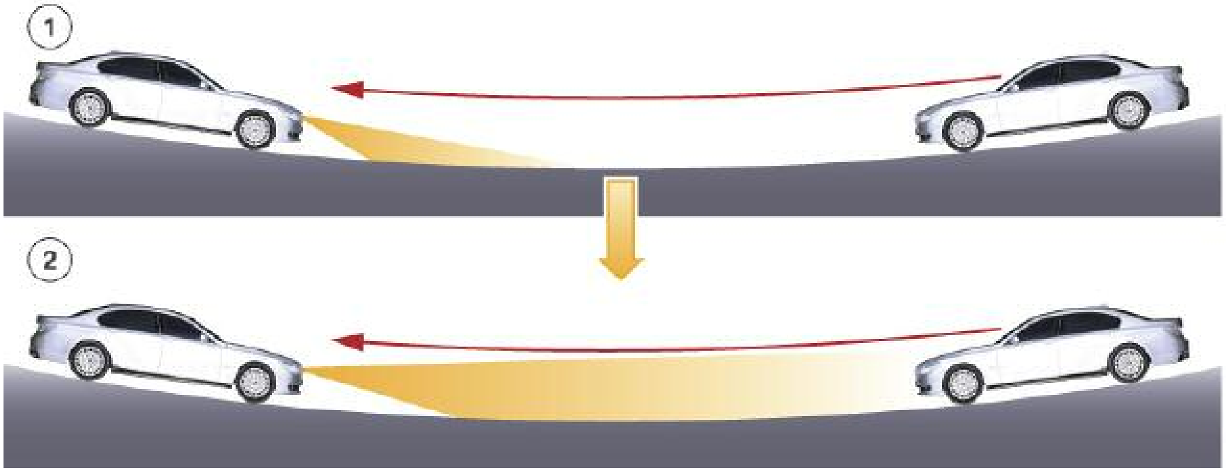
BMW makes an active contribution to safer driving with the adaptive headlight-range adjustment system.

Driving through a dip



When driving over a crest the beam pattern produced by the headlights is slightly lowered. Oncoming vehicles are not dazzled as much as with normal headlights. This contributes towards better road safety.

Driving over a crest



Index	Explanation	Index	Explanation
1	Vehicle without the adaptive headlight-range adjustment system without raising or lowering the headlights	2	Vehicle with the adaptive headlight-range adjustment system, headlights slightly raised or lowered

The red line shows the eye level of the oncoming traffic. The eye level is the location of the eyes when driving through a dip or over a crest.

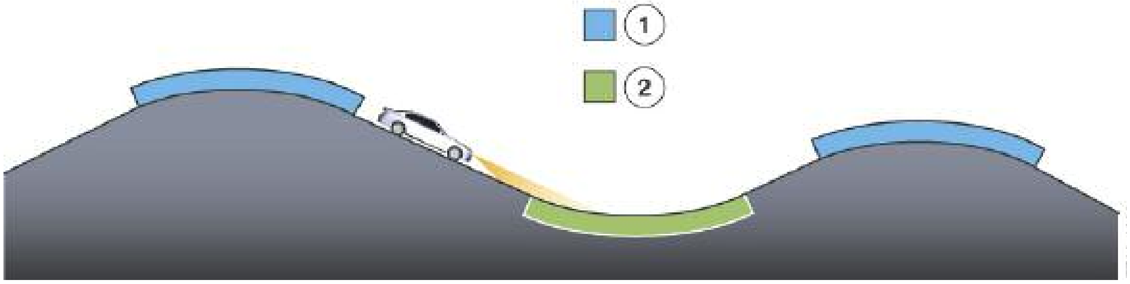
Note: In the figurative sense, the adaptive regarded as being adaptive headlights rotated headlight-range adjustment system can be by 90°.

Dip and Crest

The graphic illustrates the terms dip and crest as they are used in the road traffic engineering field.

Start of a Crest

When driving over a crest data on the incline angle of the crest are needed. Otherwise the crest can not be detected. Therefore the light is lowered with a short delay at the start of a crest.

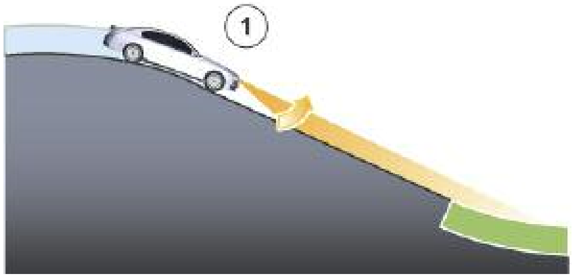


Index	Explanation	Index	Explanation
1	Crest	2	Dip

End of a Crest

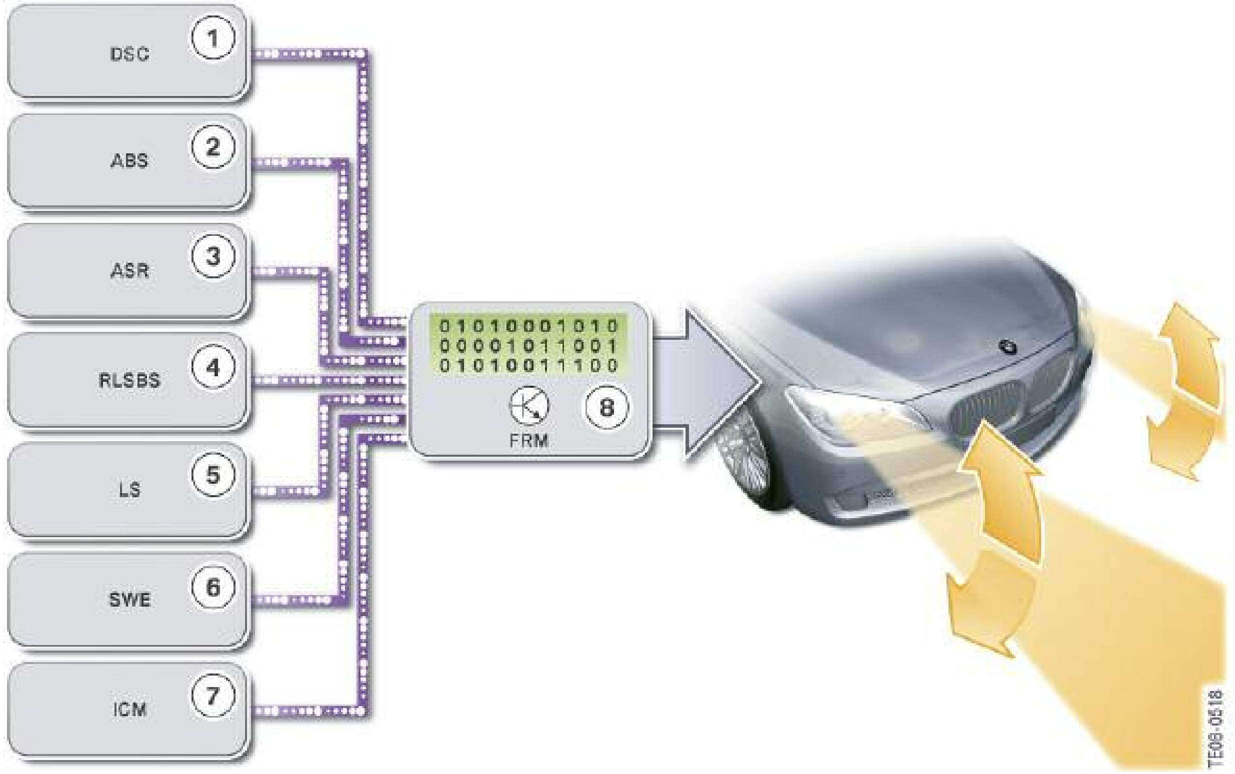
The cumulative negative change to the incline angle is used to detect that the end of a crest is being approached. The headlights are lowered for driving over the crest. If the headlights were to remain in this position the light would illuminate the “ground” after a crest. In order to avoid this situation occurring, the footwell module switches the headlights back to the normal beam angle before the end of the crest.

Vehicle at the end of a crest



Index	Explanation
1	Headlights with normal beam angle at the end of a crest

System Overview



Index	Explanation	Index	Explanation
1	Dynamic Stability Control intervention	5	Light Switch in Position "A"
2	ABS system intervention	6	Poor route detection system
3	Automatic Stability Control intervention	7	Footwell Module (FRM)
4	Rain/light/solar/condensation sensor	8	Headlight activation adaptive headlight range adjustment system

Functional Principle

The adaptive headlight-range adjustment system only becomes active when the light switch is in position "A" and the driving lights have been switched on by the rain/light/solar/ condensation sensor.

Raising or lowering of the headlight beam pattern is based to a great extent upon the calculation of two signals. The signals are the driving speed as well as the longitudinal acceleration of the vehicle. These signals are used to calculate the incline and respectively the downhill gradient compared with the horizon. The footwell module continuously imports the signals via the K-CAN2 and uses them to calculate the current values for the adaptive headlight-range adjustment system. The values correspond to the incline angles over the time period. The incline angles may be positive, negative or zero. The difference between the individual incline angles is used by the footwell module to calculate whether it is necessary to adjust the headlights.

The signal from the ride-height sensors is incorporated into the calculation. This allows the pitch angle of the vehicle body, due to a vehicle load for instance, to be included in the calculation.

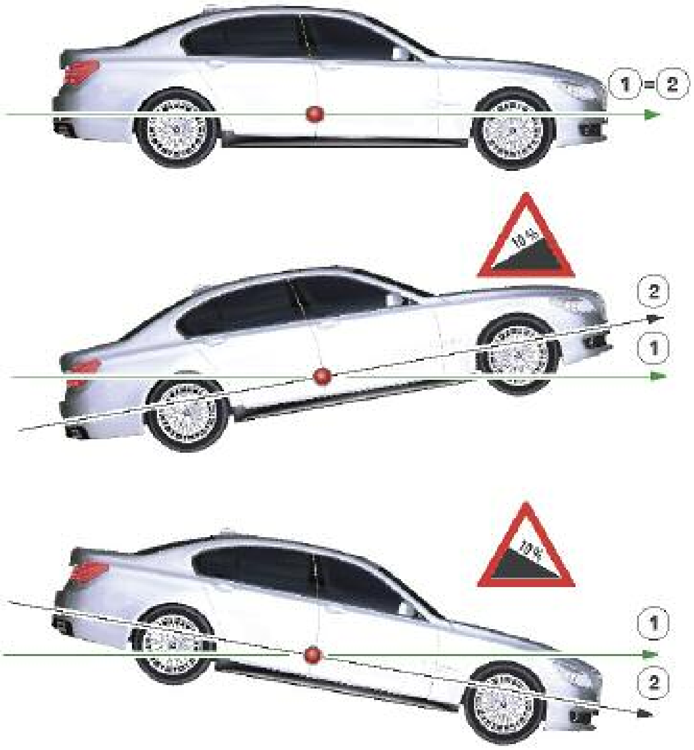
Data from the longitudinal acceleration sensor and the ride-height sensors are output through the integrated chassis management via the FlexRay. Data for the driving speed are provided by the integrated chassis management also via the FlexRay. The central gateway module transfers the data from the FlexRay to the K-CAN2. The footwell module receives the data via the K-CAN2.

Note: The integrated chassis management contains the sensors for the longitudinal and lateral acceleration of the vehicle as well as the yaw rate sensor.

Signals from the wheel speed sensors are registered by the Dynamic Stability Control for the driving speed signal. The Dynamic Stability Control outputs the data to the FlexRay. The integrated chassis management generates the driving speed signal from the data and makes the signal available to the vehicle electrical and bus systems. 1

Beam throw adjustment is soft to avoid the eyes becoming tired or irritated.

Incline angle (±) adaptive headlight-range adjustment system F01/F02



Index	Explanation	Index	Explanation
1	Horizontal axis	2	Positive or negative incline (negative incline is the downhill gradient)

Short-term function deactivation
In unfavorable, situations the light emitted by the headlights may be set incorrectly by the adaptive headlight-range adjustment system. One consequence of this could be dazzling of oncoming traffic. Therefore the footwell module interrupts the function for a short time to protect other road users.

The following conditions interrupt the function for a short time:

- Signal from the Dynamic Stability Control
  - Control intervention by the antilock braking system
  - Control intervention by the Automatic Stability Control
  - Control intervention by the Dynamic Stability Control
- Signal from the longitudinal acceleration sensor in the integrated chassis management
  - Very high longitudinal acceleration
- Signal from the footwell module from the dynamic beam throw adjustment system
  - Poor-route detection system signals uneven road.

Remote Light

The Remote Light function is the Vehicle Finder visual signalling. The driving lights are switched on for the signalling.

■ Switch-on conditions

The Remote Light function can be requested via the telematics service provider. The request is only carried out if the battery has not yet reached the limit for starting. The vehicle must be stationary and the engine switched off.

■ Switch-off conditions

Remote Light can be switched off by the following conditions:

- Battery has reached the limit for starting
- Interior light button is pressed
- Change in status of a Hall sensor in the door contacts
- Renewed request Start of a new sequence for the Remote Light function
- Remote Light time expired
- Terminal status change, START-STOP button pressed.

Adjusting Headlights

The same procedure as before can be adopted for adjusting the lights. On a vehicle with the adaptive headlights optional extra the light switch must be in position “2”.

If the lights have been switched on by the automatic headlights function, the urban beam pattern will be active. The headlights can only be correctly adjusted when they are set to the single-carriageway beam pattern.

Note: When the lights are set to the urban beam pattern, the off-side headlight turns slightly outwards and is simultaneously slightly lowered. If the lights are adjusted when set to this beam pattern, they will dazzle oncoming traffic when switched to the single-carriageway and highway beam patterns.

Therefore, you should always set the lights switch to position “2”.

When replacing headlights, make sure to use genuine BMW parts only.

Note: It is essential to follow the repair instructions.

Replacing Components

Different repairs may be made during the life of the vehicle. The repairs may mean that components for the adaptive headlights have been installed with different software and hardware states.

New parts and/or used parts are used with the components already installed in the vehicle.

The replaced components must definitely be adapted to the vehicle.

The components below are some of those that could have been replaced during servicing:

- Footwell module
- Headlight driver module
- Bi-xenon headlights.

Footwell Module

Follow the repair instructions when replacing the footwell module. Make sure that only genuine BMW spare parts are used. Only genuine BMW spare parts guarantee correct functioning of the headlights. In the case of a straight swap with a different footwell module there is no guarantee that the replacement will not cause malfunctions in the exterior lighting system.

Diagnosis

Diagnostic Mode

The exterior lighting system must be set to diagnostic mode for different diagnosis orders. These diagnosis orders may be:

- Read out of the relevant bus signals when stationary
    - Road speed
    - Yaw rate
    - Steering angle
- Check of signal plausibility
- Check of switch-on conditions
    - Status of the rain/driving lights/solar sensor
    - Status of the rain/light/solar/condensation sensor
    - Status of the high-beam headlight assistant
    - Status of the light switch.

Missing or non-plausible bus signals are saved in the footwell module as a fault. Fault types are saved in the headlight driver module.

Access to the headlight driver module is achieved via the footwell module.

Table of Contents

F01 Interior Lighting

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Interior Lighting

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the function of the interior lighting on the F01/02
- Locate and identify components of the interior lighting system on the F01/02

Introduction

All Interior Lighting Systems

The interior lighting is based on the interior lighting on the F01/02 is based on E90. The interior lighting comprises the lights in the passenger compartment roof, luggage compartment, footwell and the interior door lights.

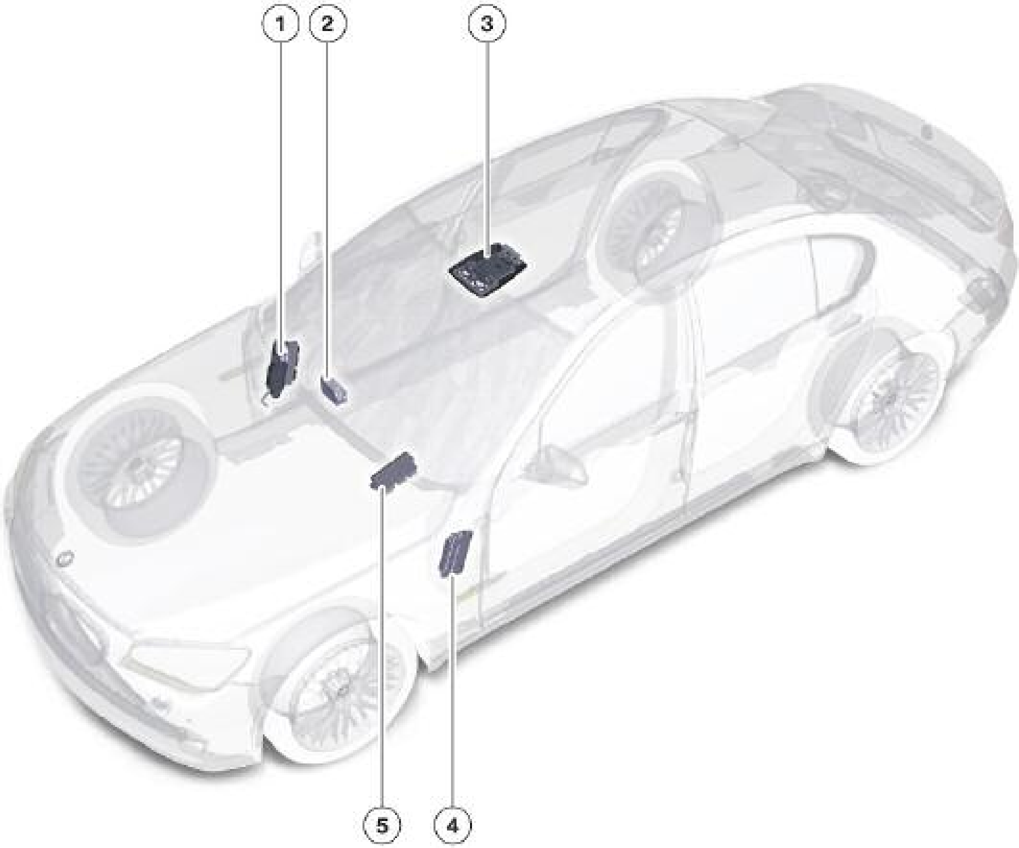
Exterior door lighting is provided by the courtesy lights (exterior door handles) and the doorway lights.

The front and rear passenger compartment roof lights are in the form single light units.

A new feature is the light for the map pocket on the backrest of the front seat.

The graphic below shows the control units that have an influence on the interior lighting:

Control units for interior lighting on F01/F02



Index	Explanation	Index	Explanation
1	Junction box module	4	Footwell module
2	Advanced crash safety management	5	Car Access System
3	Roof function center		

Interior Lighting

The following provides an overview of interior lighting.

- Interior light with interior light switch
- Reading light with reading light button for driver and front passenger
- Ambient interior light for driver and front passenger
- Front and rear door pocket lights, driver's/passenger side
- Front and rear interior door handle lights, driver's/passenger side
- Front and rear sill lights, driver's/passenger side
- Front and rear doorway lights, driver's/passenger side
- Driver's/passenger side courtesy lights, front and rear
- Driver's/passenger side exterior door handle lights, front and rear
- Driver's/passenger side vanity mirror lights, front and rear*
- Driver's/passenger side footwell lights, front and rear*
- Glove compartment light
- Center console stow compartment light, front and rear
- Map pocket lights in front seat backrests
- Rear center armrest stow compartment light
- Luggage compartment lighting

* Equipment option only available in rear on F02

System Overview

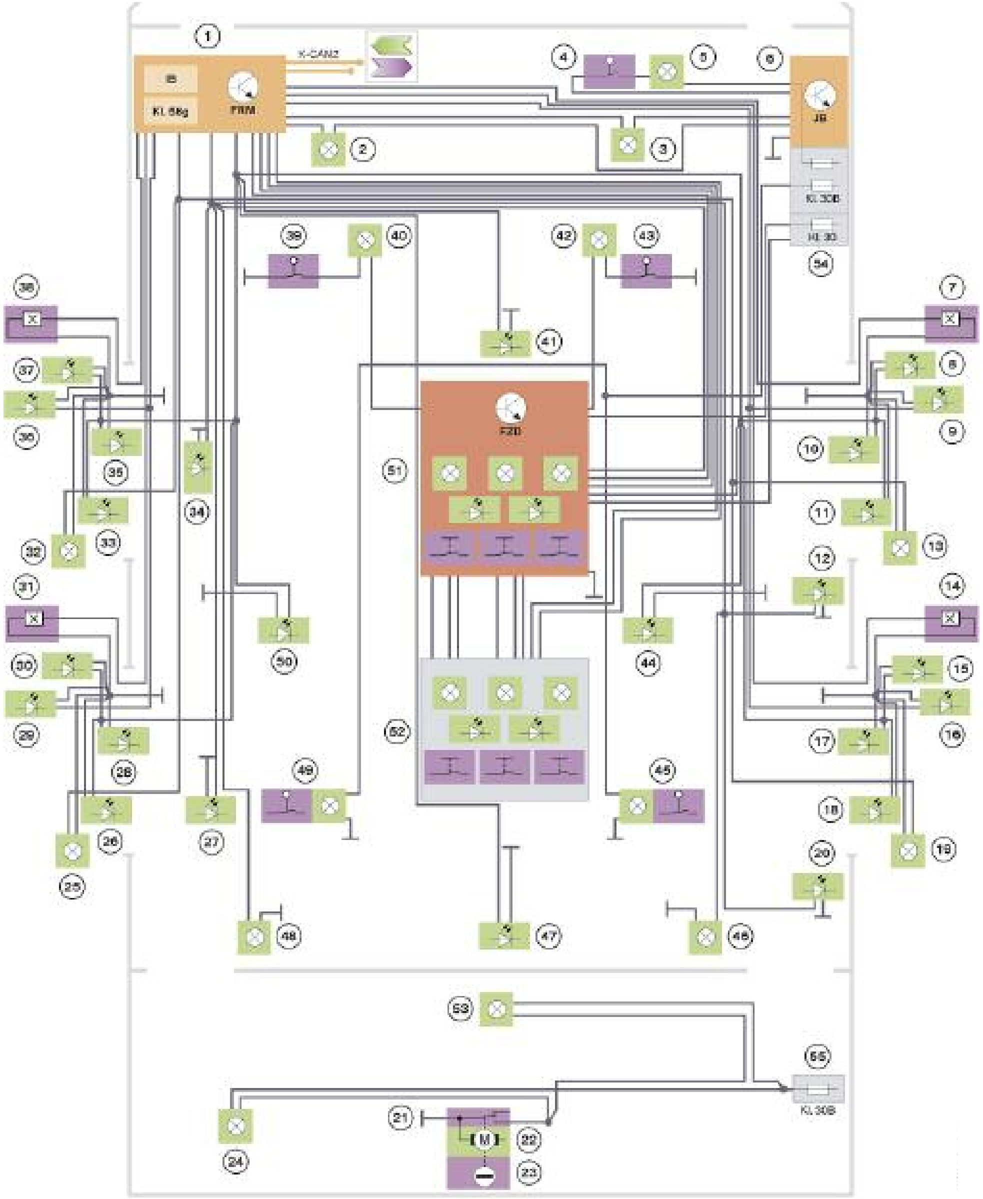
Schematic System Circuit Diagram - Interior Lighting

The system circuit diagram follows the description below and provides an overview of the full extent of all possible interior lighting options.

The status of the door contact (Hall sensor) in the lock (38) changes, for example, when the door is opened with the vehicle unlocked. The footwell module (1) evaluates the status and sends the request to switch on the interior lighting.

At the same time, the doorway light (13) for the door that is open and the footwell lights (2, 3, 46, 48) are switched on by the footwell module. The status of the door contact changes again when the vehicle door is closed. The footwell module initiates the procedure to switch off the interior lighting. If the tailgate is opened, the status of the tailgate switch (21) registered by the tailgate central locking module changes. The luggage compartment lighting (24, 53) is connected to the power supply via Terminal 30B so that the luggage compartment lights are switched on via the tailgate switch.

F01/F02 interior lighting, maximum possible configuration



Index	Explanation	Index	Explanation
1	Footwell module FRM	31	Door switch, driver's side, rear
2	Footwell light, driver's side	32	Doorway light, driver's side, front
3	Footwell light, front passenger's side	33	Door pocket light, driver's side, front
4	Glove compartment switch	34	Door pocket light, driver's side, front
5	Glove compartment light	35	Interior door handle light, driver's side, front

Index	Explanation	Index	Explanation
6	Junction box module JB	36	Courtesy light, driver's side, front
7	Door switch, passenger side, front	37	Exterior door handle light, driver's side, front
8	Exterior door handle light, passenger side, front	38	Door switch, driver's side, front
9	Courtesy light, passenger side, front	39	Vanity mirror light switch, driver's side, front
10	Interior door handle light, passenger side, front	40	Vanity mirror light, driver's side, front
11	Door pocket light, passenger side, front	41	Center console stow compartment light, front
12	Sill light, passenger side, front	42	Vanity mirror light, passenger side, front
13	Doorway light, passenger side, front	43	Vanity mirror light switch, passenger side, front
14	Door switch, passenger side, rear	44	Map pocket light, front passenger seat backrest
15	Exterior door handle light, passenger side, rea	45	Vanity mirror light with switch, passenger side, rear
16	Courtesy light, passenger side, rear	46	Footwell light, rear right
17	Interior door handle light, passenger side, rear	47	Rear center armrest stow compartment light
18	Door pocket light, passenger side, rear	48	Footwell light, rear left
19	Doorway light, passenger side, rear	49	Vanity mirror light with switch, driver's side, rear
20	Sill light, passenger side, rear	50	Map pocket light, driver's seat backrest
21	Tailgate switch	51	Interior/reading light unit, front
22	Tailgate lock motor	52	Interior/reading light unit, rear
23	Tailgate lock barrel	53	Rear center armrest stow compartment light
24	Luggage compartment light in tailgate	54	Front power distribution box
25	Doorway light, driver's side, rear	55	Luggage compartment power distribution box
26	Door pocket light, driver's side, rear	Kl. 30	Terminal 30
27	Sill light, driver's side, rear	Kl. 30B	Terminal 30 basic mode
28	Interior door handle light, driver's side, rear	Kl. 58g	Terminal 58g
29	Courtesy light, driver's side, rear	IB	Interior lighting control
30	Exterior door handle light, driver's side, rear		

K-CAN2 signals at footwell module

In/Out	Information	Source/sink	Function
In	Status, central locking	Car Access System > footwell module	Interior lighting ON
In	Status, central locking	Car Access System > footwell module	Interior lighting OFF
In	Crash signal	Crash sensor > advanced crash safety management	Interior lighting ON
Out	Electrical load cutout	Footwell module > Junction box module	Interior lighting OFF through electrical load cutout
Out	Status, terminal 58g	Light switch > footwell module	Instrument lighting ON (e.g. control buttons, instrument cluster, gear selector lever)
Out	Status, door switch	Footwell module > Car Access System	Condition for activation of central locking (enabling/allowing)

NOTES

PAGE

Functions

Important Control Units in the Interior Lighting System

The interior lighting on the F01/F02 is switched on and off by the footwell module (FRM).

The roof function center (FZD) is responsible for the interior lighting components in the passenger compartment roof.

The paragraphs that follow now describe the interior lighting functions in more detail.

Footwell Module

The footwell module is the central control unit for the interior lighting system. All interior lighting outputs of the footwell module are pulse-modulated. This ensures the interior lighting functions at a constant brightness level in the event of voltage fluctuations. The pulse width modulation is additionally used for the soft ON/soft OFF function.

The footwell module features the following functions for the interior lighting:

- Switching the interior lighting on/off
- Electric load shut-down after 8 minutes
- Lighting via terminal 58g.

■ Switching on the interior lighting

The footwell module receives numerous input signals that switch on the interior lighting. The input signals are read directly by the footwell module or are received via the K-CAN2. The input signals for the interior lighting are listed in the following.

Input signals	From
Central locking signals	CAS
Crash signal	ACSM
Door contacts	FRM
Driver's door barrel lock	FRM
Interior light switch	FRM
Rear reading light buttons	FZD

Switching-on conditions

If any of the following conditions for switching on the interior lighting is met, the interior lighting is switched on. The switch-on function is limited in terms of time. The electrical loads are:

- Unlock via barrel lock in driver's door
- Vehicle unlocked using ID transmitter
- Terminal 15 OFF if Terminal 58g was ON no more than 2 min previously
- Lock button on ID transmitter pressed after the central locking has been in double-locked status for longer than 10 seconds.

The interior lighting remains permanently switched on in certain situations. These situations are:

- Receiving crash signal
- Interior lighting button briefly pressed.

Note: Pressing the interior lighting button again switches it off.

Switching off interior lighting

The footwell module receives numerous signals to switch off the interior lighting. Those signals are received via the K-CAN2 or are read directly by the footwell module.

Switch-off conditions

The interior lighting is switched off under the following conditions:

- Central locking in central arrest, all doors and the tailgate are closed
- 8 min after Terminal 15 OFF (cut-out of electrical equipment)
- Interior lighting button pressed for longer than 3 seconds (continuous "OFF")
- Terminal 15 ON when doors closed
- Terminal 58g ON and Terminal 15 OFF. The interior lighting is switched off if no door is opened within 20 seconds.
- The interior lighting is switched off if the vehicle is unlocked via the ID transmitter and no door is opened within 20 seconds.
- "Power down" via diagnosis.

Cut-out of electrical equipment

As of Terminal 15 OFF, the interior lighting is switched off by the footwell module after 8 min. For that purpose, the footwell module broadcasts the electrical equipment cut-out instruction via the K-CAN2.

The roof functions center FZD receives this information and switches off the interior lighting in the roof area.

The interior lights that are switched on directly by the footwell module are also switched off.

Terminal 58g

The footwell module supplies the Terminal 58g signal via the K-CAN2 or conventional wiring. Terminal 58g is pulse width-modulated and features the following two brightness levels:

- The brightness level for the locator lighting is individually adjustable using the thumb wheel on the lights operating unit.
- The brightness level for the function lighting is not dimmed and is switched on at full brightness.

Hazard warning switch

As soon as the hazard warning switch is pressed, the footwell module switches on the switch lighting at full brightness.

Note: The hazard warning switch is not illuminated at full brightness level at terminal 58g. The brightness depends on the setting of the locator lighting.

Roof Function Center

The roof function center (FZD) incorporates the front interior light unit.

The FZD is the link to the interior light unit in the rear passenger-compartment roof.

■ Interior lighting functions

The interior lighting functions in the roof functions center are:

- Loop-through of power supply provided by the footwell module, e.g. IB and Terminal 58g
- Reading of signals from rear reading light buttons
- Power supply to vanity mirror lights or reading lights in the rear interior light unit.

■ Reading of signals from rear reading light buttons

The roof function center reads the signals from the rear reading light buttons. A flip-flop circuit is used for the purpose for each rear reading light button. Pressing the reading light button changes the status of the flip-flop circuit. The change of status causes the roof function center to switch the reading light concerned on or off accordingly.

The footwell module supplies the Terminal VA status signal. The rear reading lights are among the devices switched off by the electrical equipment cut-out function.

Luggage Compartment Lighting

The luggage compartment lighting is connected directly to Terminal 30B.

The luggage compartment lighting is functional as of status Terminal 30B ON and fused in the rear power distribution box.

When the tailgate is opened, the status of the tailgate switch changes. This means the luggage compartment lights are connected to ground and therefore switched on.

The status of the tailgate switch changes when the tailgate is closed again. The ground connection is interrupted and the luggage compartment lighting switched off.

Glove Compartment Lighting

The light is connected to Terminal 30B in the front power distribution box and protected against short circuits by a fuse.

When the glove compartment is opened, the glove compartment switch closes.
As a result, the glove compartment lighting is connected to ground.

The glove compartment lighting is switched off by closing the glove compartment.

Car Access System

The Car Access System supplies the central vehicle has been locking status signal via the K-CAN2. In this way, the footwell module recognizes when the unlocked and consequently switches on the interior lighting.

Courtesy Lighting

The courtesy lighting operates in sync with the interior lighting. That means that the courtesy lighting remains switched on as long as the interior lighting is on.

Note: Previously, the courtesy lighting was limited to 20 seconds. This functional feature on the F01/F02 is a change from other BMW models.

System Components

Interior Lighting, Front

The components for the interior lighting in the front roof area are integrated in the roof functions center and in the sun visors. The footwell lighting is located on the underside of the dashboard.

Interior Lighting in the Roof Function Center

The interior light unit on the F01/F02 is integrated in the roof function center.
The interior light unit consists of:

- Reading light with button for driver and front passenger
- Interior light with button
- Ambient interior light for driver and front passenger.

The roof function center is matched to the color of the roof lining.

Various equipment options make it necessary to install additional components in the roof functions center.

If a panoramic glass roof is installed, the roof functions center contains not only the button for the panoramic glass but also the necessary control and monitoring facilities.

The ultrasonic interior movement detector is completely integrated in the roof function center on vehicles equipped with an anti-theft alarm system.

The rood function center simply loops through the signals for all other components. This means the components are connected directly to their respective control units.

These components are:

- Emergency call button
- Passenger airbag OFF lamp.

Interior Light Unit, Rear

The rear interior light unit incorporates the following lights:

- Reading light with button for left and right rear passengers
- Interior light with button
- Ambient interior light for driver and front passenger.

Interior Door Lighting

The interior door lighting comprises the interior door handle light, armrest light and door pocket light. The lights are in the form of LEDs with fiber-optic leads for light distribution. In addition, the doorway light is fitted in the bottom of the door. A 5 W bulb is used for the doorway light.

Example of interior door lighting on driver's door - Left: view from front; right: angled view upwards from below

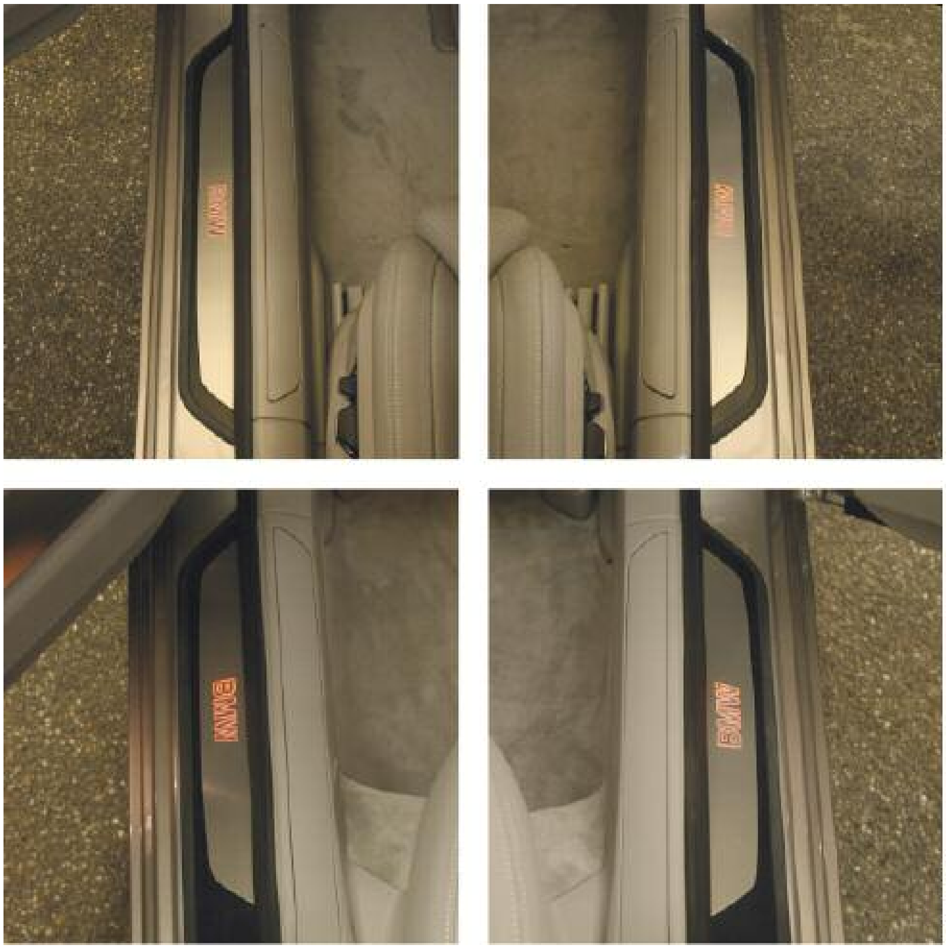
Map Pocket Lights

The map pocket lights are in the backrests of the front seats. An LED supplies light to a fiber-optic lead. The fiber-optic lead is integrated in the seat backrest. The light from the LED is directed downwards by the fiber-optic lead, thereby illuminating the map pocket.

Map pocket light in driver's seat backrest on F01/F02

Sill Lights

The sill lights are connected directly to the footwell module. LEDs are used as the light source. All four doors have sill lights.



Example of sill lights on F01

Vanity Mirror

Vanity mirrors are fitted as standard on the driver's and passenger side at the front. The vanity mirror lights are fused in the front power distribution box and connected to Terminal 30B.

Note: Terminal 30B is looped through by the roof function center. 1 On the F02, rear vanity mirrors are also available. The vanity mirror lights are supplied with power directly by the footwell module.

On the F02, rear vanity mirrors are also available. The vanity mirror lights are supplied with power directly by the footwell module.

A vanity mirror light has a power consumption of approximately 5 W.

Rear passenger side vanity mirror on F01/F02

Luggage Compartment Lighting

Two lights are used for the luggage compartment lighting. One of the lights is located on the underside of the rear parcel shelf. The other light is integrated in the tailgate. The light in the tailgate has two lenses. One of the lenses is colored red. When the tailgate is open, that lens serves as an indicator lamp for vehicles behind. The second lens directs the light downwards into the luggage compartment.

A 10 W bulb is used for each of the luggage compartment lights.

Luggage compartment lighting integrated in tailgate on F01/F02

Control Units

The “interior lighting” function is distributed between several control units that communicate with each other via the K-CAN2. The individual control units are described in the following.

Car Access System

The Car Access System sends the request to unlock/lock the central locking via the KCAN2.

The signals are required to switch the interior lighting on and off.

Footwell Module

The footwell module detects the request to switch the interior lighting on/off based on the signals from the Car Access System, for example.

The footwell module provides a number of outputs for the interior lighting functions.

Output	Light
Doorway light	All doorway lights in the doors
Terminal 58g	Interior door lights, center console stow compartment, center armrest stow compartment, ambient interior lights, map pocket lights and backlighting for various switches, etc.
Footwell light	Footwell lights, front
Interior lighting 1	Rear footwell lights, sill lights, front interior light
Interior lighting 2	Interior light, rear
Courtesy lighting	Courtesy lights in the doors
Electrical equipment cutout	Reading lights

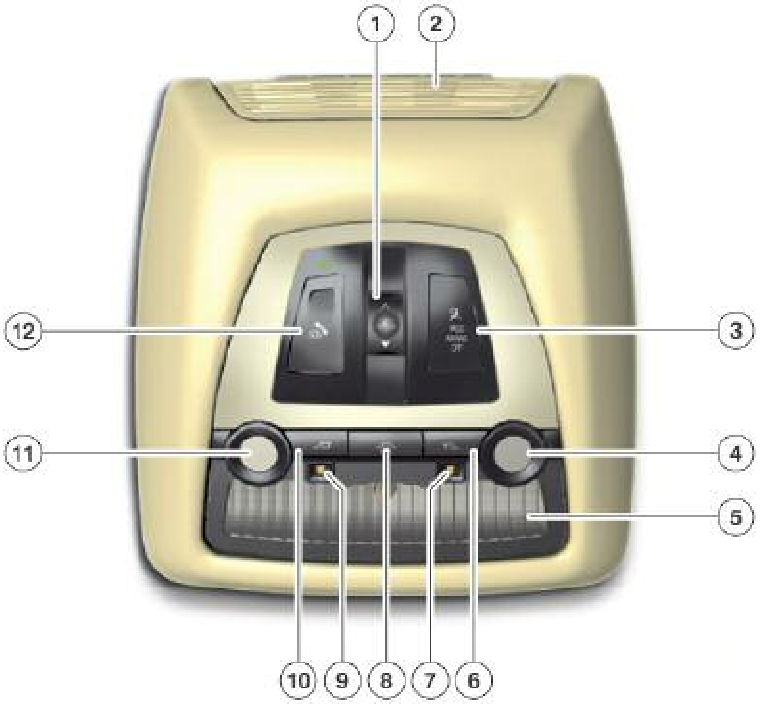
The footwell module evaluates the status of the door contacts. The interior lighting is switched on when a door is opened. Each door switch is connected individually to the footwell module.

The footwell module analyzes the status of the front reading light buttons and front/rear interior light buttons.

Roof Function Center

The roof function center provides the power supply for the rear interior light unit. The front vanity mirrors also receive their power supply from the roof function center.

Example of roof function center on F01/F02



Index	Explanation	Index	Explanation
1	Button for panoramic glass roof	7	Ambient lighting
2	Openings for ultrasonic interior movement detector	8	Interior lighting button
3	Passenger airbag OFF light	9	Ambient lighting
4	Passenger's reading lamp	10	Driver's reading light button
5	Interior light	11	Driver's reading light
6	Passenger's reading light button	12	Emergency call button

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F01 Interior Lighting

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F01 Wiper/Washer System

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Subject **Page**

Wiper/Washer System

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the operation and functions of the wiper/washer system
- Locate and identify wiper/washer system components

Introduction

Windscreen Wipers

The F01/F02 has a wiper/washer system for the windscreen as standard.

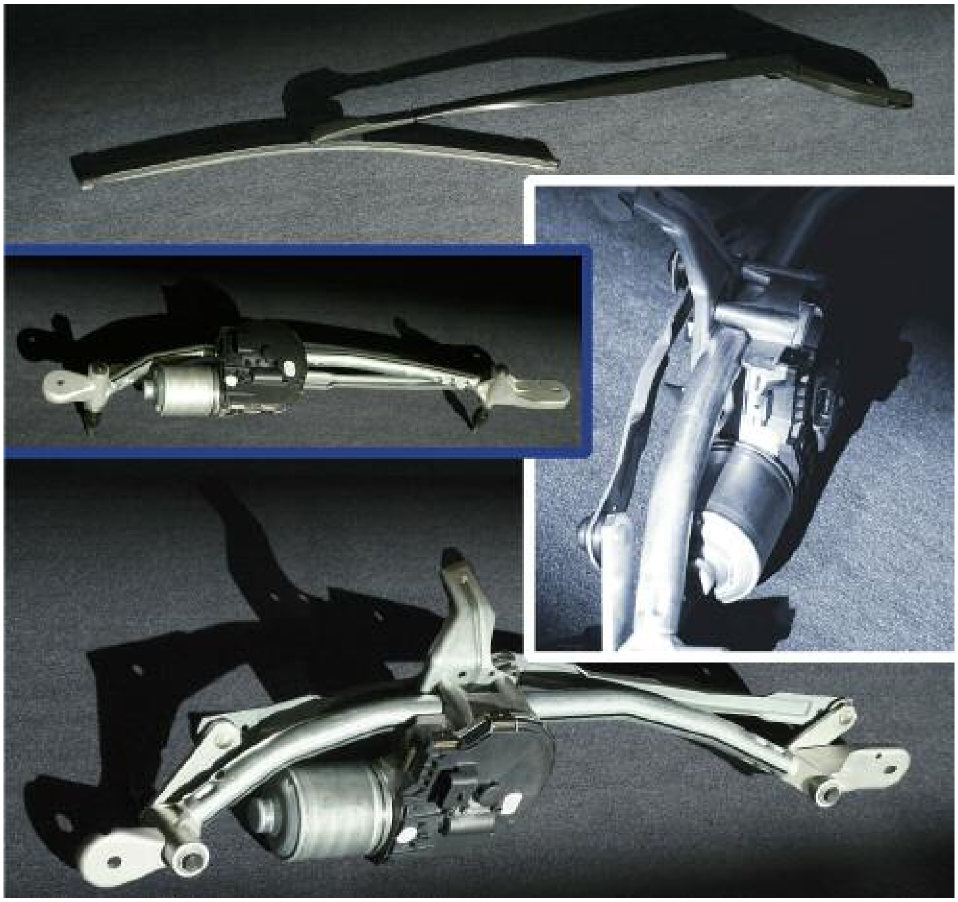
Windscreen wiping has the following functions:

- Continuous wipe in stage 1
- Continuous wipe in stage 2
- Flick wipe.

The following systems are also available:

- Headlight washer system
- Water jet heater
- Automatic mode using the rain/light/solar/condensation sensor.

The wiper motor for the wiper/washer system is connected via a LIN bus.



Rain/lights/solar/condensation Sensor

The rain/lights/solar/condensation sensor is the same as the rain/driving lights/solar sensor, but has been enhanced with the condensation sensor function. The functionality of the rain sensor, the driving lights sensor and the solar sensor have been retained in full. This means, for example, that the driver is still assisted by the rain sensor automatically initiating the procedure for switching on the windscreen wipers.

The automatic wiping does not relieve the customer from the responsibility of wiping the windscreen. For this reason, the customer can override the automatic wiping function at any time by moving the wiper switch on the steering column stalk up or down or pulling it towards him.

The driving lights sensor supplies the on and off signal for the automatic driving lights control function.

Index	Explanation
1	Rain/light/solar sensor (not F01)

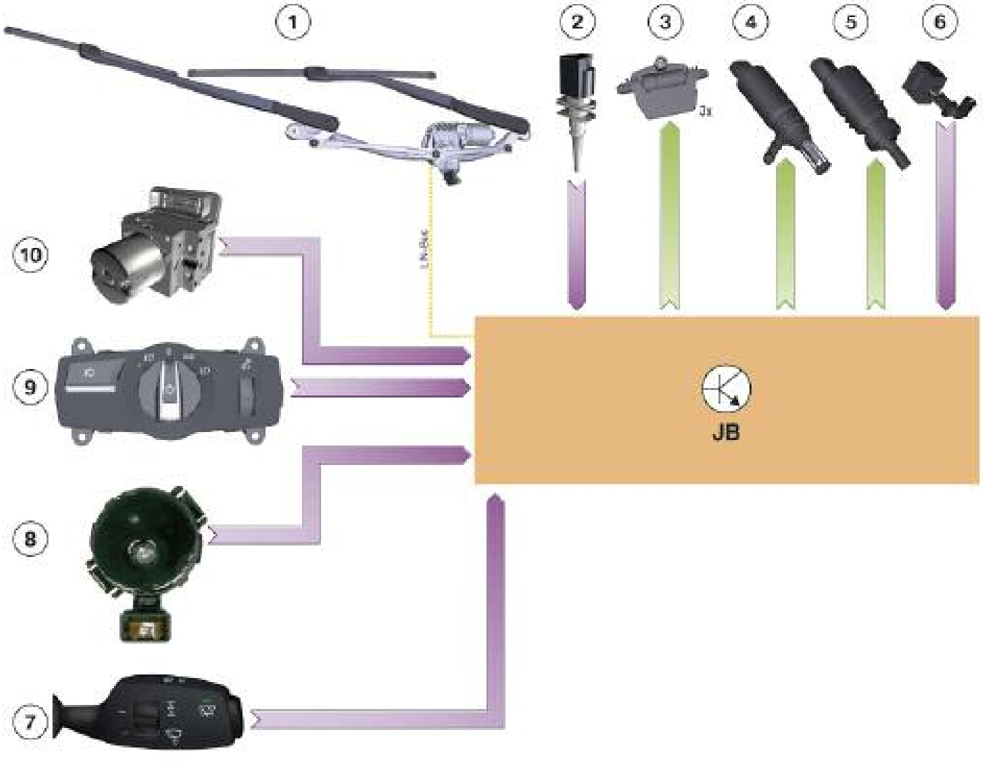
Index	Explanation
1	Rain/light/solar sensor
2	Sensor for HUD
3	Condensation sensor

Under unfavorable light conditions such twilight or when driving through a tunnel, the ON signal ensures the driving lights are switched on automatically.

The solar sensor makes sure the automatic climate control system provides optimum air conditioning distribution in the vehicle.

The condensation sensor allows the integrated automatic heating/air-conditioning system to detect when condensation is forming on the windscreen in good time, even before the driver is aware of it. Countermeasures can be taken automatically at an early stage, without the need for driver intervention.

System Overview



Index	Explanation	Index	Explanation
1	Front wiper motor with wiper	7	Wiper switch on the steering column stalk
2	Outside temperature sensor	8	Rain/lights/solar/condensationsensor
3	Heated washer jet 3x *	9	Lights operating unit
4	Headlight washer system motor	10	Dynamic stability control
5	Washer fluid pump motor	LIN-Bus	Local Interconnect Network bus
6	Washer fluid level sensor	JB	Junction box electronics

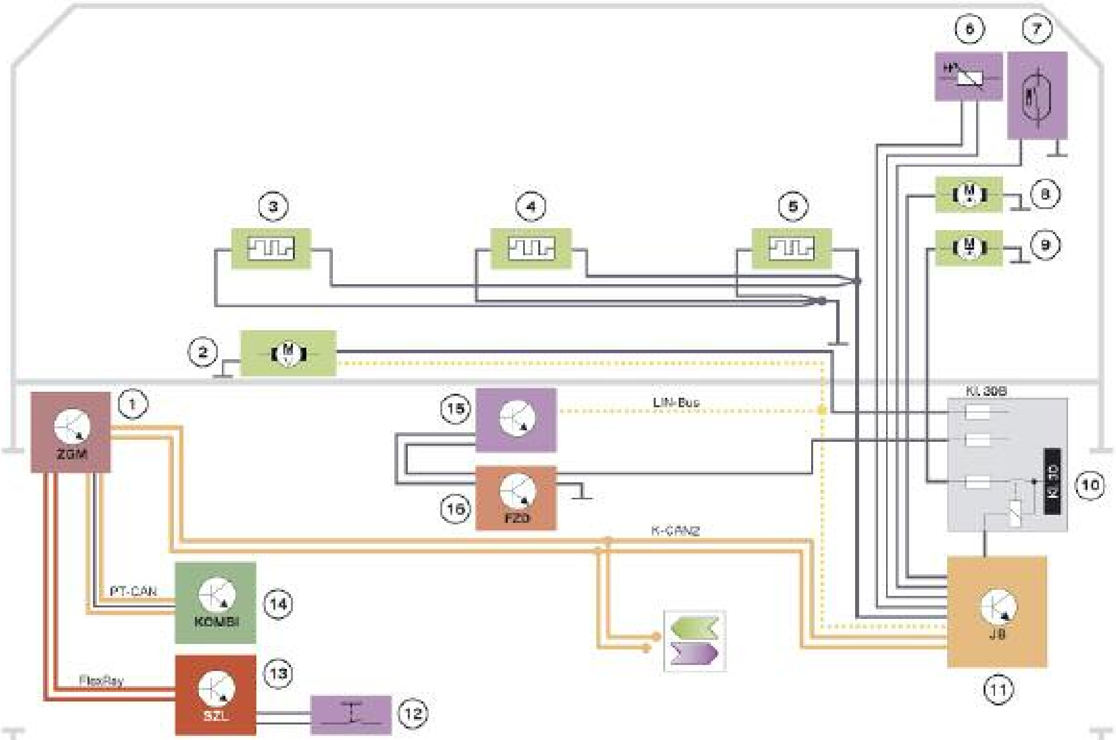
* Heated washer jets on the driver's side, in the center and on the front-passenger side

When the wiper switch on the steering column stalk (7) is operated, the wiper motor (1) is switched on or off. The junction box electronics execute the functions of the wiper/ washer system. The motor for the washer fluid pump (5) or for the headlight cleaning system (4) is switched on or off by the junction box electronics.

On vehicles with automatic driving lights control, the junction box electronics receive the information about switching the wiper/ washer system on/off from the rain/lights/solar/ condensation sensor (8).

The Dynamic Stability Control (10) provides information about the vehicle speed.

System Circuit Diagram for the Wiper/washer System



Index	Explanation	Index	Explanation
1	ZGM central gateway module	12	Wiper switch on the steering column stalk
2	Wiper motor	13	Steering column switch cluster (SZL)
3	Heated washer jet on the driver's side	14	Instrument cluster
4	Heated washer jet in the center of the vehicle	15	Rain/lights/solar/condensation sensor
5	Heated washer jet on the front-passenger side	16	Roof functions center (FZD)
6	Outside temperature sensor	Kl. 30	Terminal 30
7	Washer fluid level sensor	Kl. 30B	Terminal 30 basic operation
8	Washer fluid pump motor	K-CAN2	Body CAN2
9	Motor, headlight washer	PT-CAN	Powertrain CAN
10	Front distribution box	LIN-Bus	Local Interconnect Network bus
11	Junction box electronics (JB)		

The signal produced when the wiper switch on the steering column stalk (12) is operated is sent from the SZL steering column switch cluster (13) via the FlexRay to the central gateway module (1). The central gateway module transmits the signal on the K-CAN2. The junction box electronics (11) switch the wiper motor (2) on, for example and monitor its function.

The washer fluid pump (8) is switched on or off by the junction box electronics.

On vehicles with automatic driving lights control, the rain/lights/solar/condensation sensor (15) sends the request to switch on the wiper motor, for instance, via the LIN bus. The junction box electronics receives the request and implements it.

The roof function center (16) supplies the voltage for the rain/lights/solar/condensation sensor.

K-CAN2 signals to the junction box electronics

In/Out	Information	Source/Recipient	Function
In	Vehicle speed	Wheel speed sensor > Dynamic Stability Control	Wiper speed setting depending on vehicle speed
Out	Wiper status	Wiper motor > Junction box electronics	Information for driver assistance systems that involve a video camera at the base of the rear view mirror

Functions

Wiping

The wiper/washer system is switched on and off with the wiper switch. The wiper switch is an integral part of the steering column switch cluster SZL.

Wiper Switch

The wiper switch on the steering column stalk does not lock in position. It always returns to its start position after every operation. The button for the rain/lights/solar/condensation sensor also returns to its starting position after every operation. The wiper-stage switch does lock in position.

The following functions are switched on with the wiper switch on the steering column stalk:

- Automatic wipe with rain/lights/solar/ condensation sensor
- Continuous wipe, stage 1
- Continuous wipe, stage 2
- Flick wipe
- Wash windscreen

The signals from the wiper switch on the steering column stalk are sent from the steering column switch cluster via the FlexRay to the central gateway module. From the central gateway module, the signal is transmitted to the junction box electronics via the K-CAN2. The junction box electronics evaluates the signals and actuates the wiper motor via the LIN bus. The junction box electronics also monitor the wipe function via the LIN bus. To do so, the junction box electronics cyclically request the status of the wiper motor.

Directions of movement

Index	Explanation
0	Steering column stalk/start position of wiper-stage switch
1	Wiper stage 1
2	Wiper stage 2
3	Wiping while steering column stalk operated
4	Activates/deactivates the rain/lights/ solar/condensation sensor
5	Washer fluid and windscreen wiper at same time
6	Increases the sensitivity of the rain/ lights/solar/condensation sensor
7	Reduces the sensitivity of the rain/ lights/solar/condensation sensor

Windscreen Wipe Function

The following functions are available for wiping the windscreen:

- Intermittent wipe in stages
- Automatic wipe
- Continuous wipe, stage 1
- Continuous wipe, stage 2
- Flick wipe.

■ Intermittent wipe

The interval can be set with the multi-stage switch. Four intermittent wipe stages are available. The time intervals depend on the set intermittent wipe stage and the vehicle speed. The junction box electronics calculate the time intervals and actuate the wiper motor accordingly.

■ Automatic wipe

The automatic wipe function can be activated by pressing the axial button from status “terminal R ON”. The LED on the wiper switch indicates that the function is active. A one-off wipe function (acknowledgement wipe) is additionally started. The acknowledgement wipe is also initiated when the wipe interval is increased by means of the wiper-stage switch but not when the wipe interval is decreased.

The rain/lights/solar/condensation sensor initiates wipe requests according to the heaviness of the rain. The junction box electronics analyze the signal from the rain/lights/solar/condensation sensor every 20 ms. For this, the junction box electronics request the relevant signal values and execute the windscreen wipe according to the wipe request.

With the automatic wipe function, the wipe speed depends on the information from the rain/lights/solar/condensation sensor, i.e. continuous wipe stage 1 or stage 2 may be initiated depending on the rain intensity.

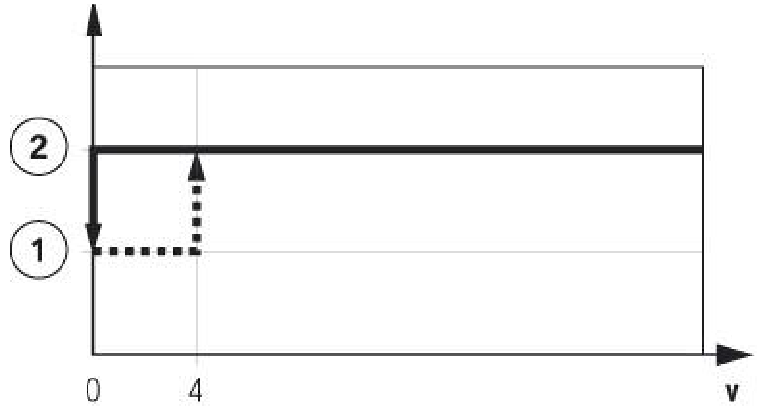
■ Continuous wipe, stage 1

The wiper motor runs at normal speed when stage 1 is switched on with the wiper switch on the steering column stalk. The wiper motor switches from continuous wipe in stage 1 to intermittent wipe if the vehicle speed is reduced down to standstill.

The continuous wipe function in stage 1 resumes as soon as the vehicle speed is higher than 2.5 mph (4 km/h).

The reset (switch-back) of the wiper stage when the vehicle is stationary can be decoded. In this case, the wiper blades operate in continuous wipe stage 1 mode also when the vehicle is stationary.

Continuous wipe, stage 1



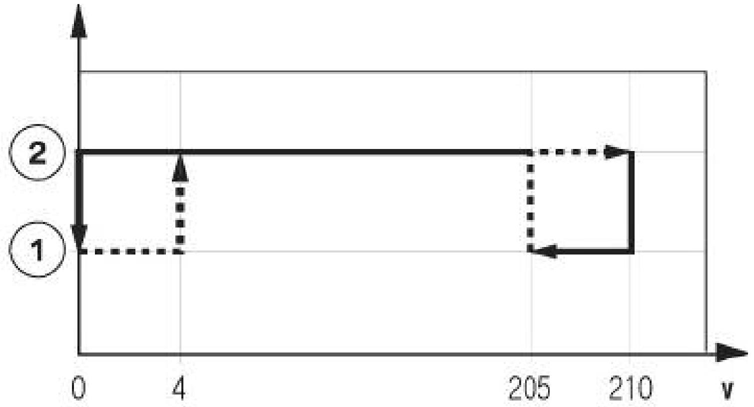
Index	Explanation
1	Intermittent wipe
2	Continuous wipe, stage 1
v	Vehicle speed in km/h

Continuous wipe, stage 2

The wiper blades are moved at double the speed in continuous wipe stage 2. When the vehicle is stationary, continuous wipe stage 2 automatically switched back to continuous wipe stage 1. The wiper blades then move at normal speed. Stage 2 is resumed again at a speed in excess of 2.5 mph (4 km/h).

The wipe function switches back to stage 1 at a speed in excess of 130 mph (210 km/h). Stage 2 is switched on again at a speed below 127 mph (205 km/h).

Decreasing wiper stage (continuous wipe stage 2)



Index	Explanation
1	Continuous wipe stage 1
2	Continuous wipe stage 2
v	Vehicle speed in km/h

The reset of the wiper stages when the vehicle is stationary can be decoded. In this case, continuous wipe stage 2 is retained also when the vehicle is stationary.

■ Flick wipe

Pressing the wiper switch on the steering column stalk triggers the flick wipe function for as long as the switch is pressed. When the wiper switch on the steering column stalk is released, the wiper movement is completed until the wiper blades reach the rest position.

Windscreen Wiper Anti-blocking Function

The windscreen wiper anti-blocking function is integrated into the electronics of the wiper motor. If the wiper motor is obstructed, the electronics cease the actuation of the motor. The electronics communicate this via the LIN bus the next time the junction box electronics query the status.

A further attempt can be made to switch on the wiper. If the wiper blocks again, it will no longer be operative for approximately 3 minutes.

The wiper interlock is cancelled when the status is switched from "terminal R ON" to "terminal R OFF". The wiper must then be switched on again.

Wash Functions

■ Wash windscreen

When the wiper switch on the steering column stalk is pulled, the washer fluid pump is first switched on, followed by the windscreen wiper. The washer fluid pump remains switched on for as long as the wiper switch on the steering column stalk is pulled.

The signal is routed from the steering column switch cluster via the FlexRay to the central gateway module. It is then transmitted from the central gateway module via the K-CAN2 to the junction box electronics. The junction box electronics actuate the washer fluid pump directly.

After the pump is switched off, the wipers continue to operate for several wipe cycles in order to wipe the windscreen dry.

The wipe function set before the windscreen wash cycle is continued after the windscreen has been washed.

The junction box electronics will no longer actuate the washer fluid pump if the fluid level in the washer fluid reservoir is too low. The junction box electronics receive the information necessary for this purpose from the washer fluid level sensor.

■ Washer fluid level sensor

The junction box electronics monitor the washer fluid level sensor from terminal status “terminal R ON”. The washer fluid sensor is integrated in the washer fluid reservoir and is switched to ground.

The junction box electronics receive a low signal when the washer fluid reservoir is full. The switch opens when the fluid level in the washer fluid reservoir drops below a certain level. The low signal changes to a high signal. The junction box electronics consequently generate a message indicating the low level in the washer fluid reservoir.

■ Terminal 50

The washer function is interrupted or not at all started while the vehicle is started.

If the windscreen washer function was interrupted, the started function is continued after the vehicle start procedure has been completed.

Headlight Washer System

The headlight washer system is switched on during the first wash cycle after terminal status “terminal R ON” and “lights ON”. Activation is then suppressed for 7 min. The headlight washer system is activated if the windscreen washer system is operated 5 times within the 7 minutes.

In response to the request from the junction box electronics, the headlight washer system is switched on by means of a relay in the distribution box.

The headlight washer system is no longer activated if the washer fluid level in the washer fluid reservoir is too low. The junction box electronics receive the signal from the washer fluid sensor.

The headlight washer system is not actuated either if obstruction of the wipers is detected.

■ BMW Night Vision

If the vehicle is equipped with BMW Night Vision with person recognition, the Night Vision Camera lens is cleaned at the same time as the headlights. The pump in the headlight washer system supplies water to all the washer jets for the headlights and the Night Vision Camera.

System Components

Involved Components

The following components are involved in the wiper/washer system:

- Control units
  - Steering column switch cluster
  - Central gateway module
  - Junction box electronics
  - Instrument cluster
  - Dynamic stability control
- Rain/lights/solar/condensation sensor
- Wiper switch on the steering column stalk
- Relay for headlight washer system
- Wiper motor
- Washer fluid pump
- Pump for headlight washer system
- Heated washer jets

Control Units

■ **Steering column switch cluster**
The steering column switch cluster evaluates the status of the wiper switch on the steering column stalk. The respective status is issued by the steering column switch cluster on the FlexRay.

■ **Junction box electronics**
The junction box electronics is the central control unit for all wipe and wash functions.

The junction box electronics communicate the current wipe requirement via the LIN bus. This request is received by the electronics in the wiper motor and the relevant wiper stage is initiated.

A separate relay is fitted in the front distribution box for the headlight washer system.

■ **Dynamic stability control**
The Dynamic Stability Control provides the road speed signal.

■ Rain/lights/solar/condensation sensor

The rain/lights/solar/condensation sensor consists of four sensors. The rain sensor is used for the wiper/washer system.

Condensation sensor

The condensation sensor consists of a sensor element with integrated processor on a flexibly mounted circuit board. The condensation sensor records the relative air humidity and the temperature on the inside of the windscreen.

The rain/lights/solar/condensation sensor is integrated in the base of the mirror and is held in place by a spring on a retaining plate. The retaining plate is securely bonded to the inside of the windscreen.

The visual connection between the rain/lights/solar/condensation sensor and the windscreen is formed by a silicone gel layer on the optical element. The condensation sensor is mounted directly on a “flexible” circuit board.

Due to the specified installation location, the flexible circuit board with the condensation sensor is pushed against the windscreen. This ensures a good thermal connection with the windscreen. A permeable membrane made from Teflon protects the condensation sensor from becoming dirty.

Fault code memory entries for the function of the rain/lights/solar/condensation sensor are stored in the junction box electronics.

If the condensation sensor fails, the junction box electronics transmits this via the K-CAN2. The central gateway module transmits the information on the K-CAN. The integrated automatic heating/air-conditioning system thus receives the information and deactivates the program to prevent condensation from forming on the windscreen.

Note: Replacing the rain/lights/solar/ condensation sensor:

It is permissible to replace a rain/lights/solar/ condensation sensor as long as no bubbles occur in the silicone gel layer (adhesive layer) when you do so. Please remember to initialize the sensor. Refer to the Repair Instructions for more information.

Wiper Switch on the Steering Column Stalk

The wiper switch on the steering column stalk with the following functions is located in the steering column switch cluster:

- Intermittent wipe
- Wipe in stages 1 and 2
- Windscreen washer
- Headlight washer
- Switch for the rain/lights/solar/condensation sensor
- Indicator for activated rain/lights/solar/ condensation sensor.

The wiper switch has sliding contacts that are located on the circuit board for the steering column switch cluster. The switch functions are realized by means of these sliding contacts.

The interval switch is a four-stage switch. Each stage produces different input values in the steering column switch cluster. The input values are evaluated for setting the sensitivity of the rain/lights/solar/condensation sensor or the intermittent wipe stage.

The button for the rain/lights/solar/ condensation sensor is designed as an ground-switching button. It is required for switching on the rain/lights/solar/condensation sensor. The LED is illuminated when the rain/lights/solar/ condensation sensor is activated.

Index	Explanation
1	Wiper switch on the steering column stalk
2	Wiper-stage switch for sensitivity of the rain sensor/intermittent wipe stage
3	Rain/lights/solar/condensation sensor LED
4	Rain/lights/solar/condensation sensor button

Function matrix for the wiper/washer system steering column stalk

Operation	Initial state	Function	Design
Push upwards briefly	OFF	Wipe 1	Returns to initial position
	Continuous wipe, stage 1	Wiper stage 2	Returns to initial position
	Continuous wipe, stage 2	Wiper stage 2	Returns to initial position
Push upwards	OFF	Wiper stage 2	Returns to initial position
	Continuous wipe, stage 1	Wiper stage 2	Returns to initial position
	Continuous wipe, stage 2	Wiper stage 2	Returns to initial position
Push downwards briefly	OFF	Flick wipe	Returns to initial position
	Continuous wipe, stage 1	Intermittent wipe	Returns to initial position
	Continuous wipe, stage 2	Wiper stage 1	Returns to initial position
Pull briefly towards the driver	OFF	Windscreen wash	Returns to initial position
Turn the knurled wheel up/down	Sensitivity of the rain/ lights/solar/ condensation sensor Intermittent wipe stage	Sets the sensitivity of the automatic wiping or intermittent wiping	Engages in position

Function matrix of the steering column stalk for the wiper/washer system with automatic wiping by the rain/lights/solar/condensation sensor

Operation	Initial state	Function	Design
Push upwards briefly	OFF	Wiper stage 1	Returns to initial position
	Automatic mode	Wiper stage 1	Returns to initial position
	Continuous wipe,	Wiper stage 2	Returns to initial stage 1 position
	Continuous wipe,	Wiper stage 2	Returns to initial stage 2 position
Push upwards	OFF	Wiper stage 2	Returns to initial position
	Automatic mode	Wiper stage 2	Returns to initial position
	Continuous wipe,	Wiper stage 2	Returns to initial stage 1 position
	Continuous wipe,	Wiper stage 2	Returns to initial stage 2 position
Push downwards briefly	OFF	Flick wipe	Returns to initial position
	Automatic mode	Flick wipe*	Returns to initial position
	Continuous wipe,	Intermittent wipe	Returns to initial stage 1 position
	Continuous wipe,	Wiper stage 1	Returns to initial stage 2 position
Pull briefly towards the driver	OFF	Windscreen wash	Returns to initial position
Briefly push the automatic wipe button in an axial direction	Automatic wipe switched off	Automatic wipe ON	Returns to initial position
	Automatic wipe switched on	Automatic wipe OFF	Returns to initial position
Turn the knurled wheel up/down	Sensitivity of the rain/lights/solar/ condensation sensor	Sets the sensitivity of the automatic wiping or	Engages in position

Wiper Motor

The front wiper motor is a little smaller than the wiper motor in the E65.
Advantages of the wiper motor:

- Lighter
- Less noise
- Reversing wiper motor
- Stable wiper speed
- Reduced tendency of the wiper blades to judder
- Alternating rest position of the wiper blades.

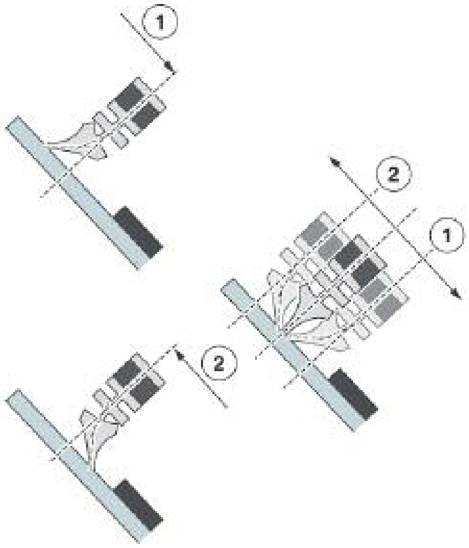
The wiper motor has two speed settings for wiping the windscreen.

The wiper motor receives information about the wiper stage via the LIN bus.
The LIN-bus messages are evaluated by electronics in the wiper motor.

A constant speed is generated by the electronics, enabling consistent wiping by the windscreen wipers.

The wiper motor stores the wiper arms, and therefore also the wiper blades, outside the field of vision, as in the E65. In addition, they are stored on alternate sides. This prevents unnecessary wear on the wiper blades and they will remain pliant for longer.

Storage position 2 of the wiper



Index	Explanation
1	Storage position 1 of the wiper blade
2	Storage position 2 of the wiper blade

Washer Fluid Pump

A washer fluid pump is located in the washer fluid reservoir for cleaning the windscreen. The pump is actuated directly by the junction box electronics.

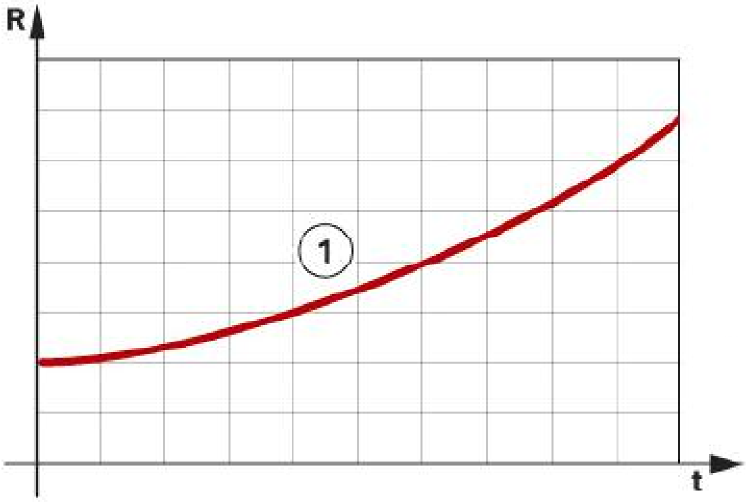
Pump for Headlight Washer

A high pressure pump is used for the headlight washer system. The pump is activated via a relay in the front power distribution box.

Heated Washer Jets

Three heated water jets are used for the windscreen washer. The washer jets have a PTC resistor that automatically limits the power consumption.

Characteristic of a PTC resistor



Index	Explanation
1	Characteristic of a resistor
R	Resistance
t	Time

Wiper/washer System Emergency Operating Functions

Emergency Operation in the Event of the Ssteering Column Switch Cluster Failing

The wipers can no longer be operated in the event of the steering column switch cluster failing or a break in the bus connection.

The junction box electronics switch to emergency operating mode and the windscreen wipers are switched on in stage 1.

Emergency Operation if the Rain/lights/solar/condensation Sensor Fails

If there is a fault in the rain/lights/solar/condensation sensor or it fails completely, the junction box electronics take over control of the wiper/washer system and switch to emergency operating mode. Emergency operating mode is an intermittent wipe function that is dependent on the vehicle speed.

Note: The same applies if the rain/driving lights/solar sensor fails.

Replacement of the Rain/lights/solar/condensation Sensor

The following steps are necessary after replacing the sensor:

- Code the rain/lights/solar/condensation sensor
- Clear fault code memory
- Initialize the rain/lights/solar/condensation sensor.

Please refer to the Repair Instructions.

Note: The same applies to the replacement of the rain/driving lights/solar sensor.

Replacement of the Wiper Motor

The wiper motor is connected to the LIN bus and this must be taken into consideration during the service.

Note: The Repair Instructions must be observed when the wiper motor is replaced. If the LIN bus fails, the wiper will go into emergency operation.

Replacing the Wiper Blades

The wiper arms can be moved to a service position in order to replace the wiper blades. This makes the wiper blades easily accessible and allows them to be replaced.

■ Activating the service position

- Switch on the ignition with the START/STOP button
- Switch off the ignition with the START/STOP button
- Operate the wiper switch on the steering column stalk (push it upwards and hold it there for more than three seconds).

The wiper arms now move into the service position (the upper reversal position of the wiper blades) and the wiper blades can be replaced.

Table of Contents

F01 Exterior Rear View Mirrors

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Exterior Rear View Mirrors

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the operation of the exterior rear view mirrors on the F01/F02

Introduction

Outside Mirrors

For the F01/F02, there is only one variant of the outside mirrors. The outside mirrors can be electrically adjusted as standard. The outside mirrors are equipped with a mirror heating system.

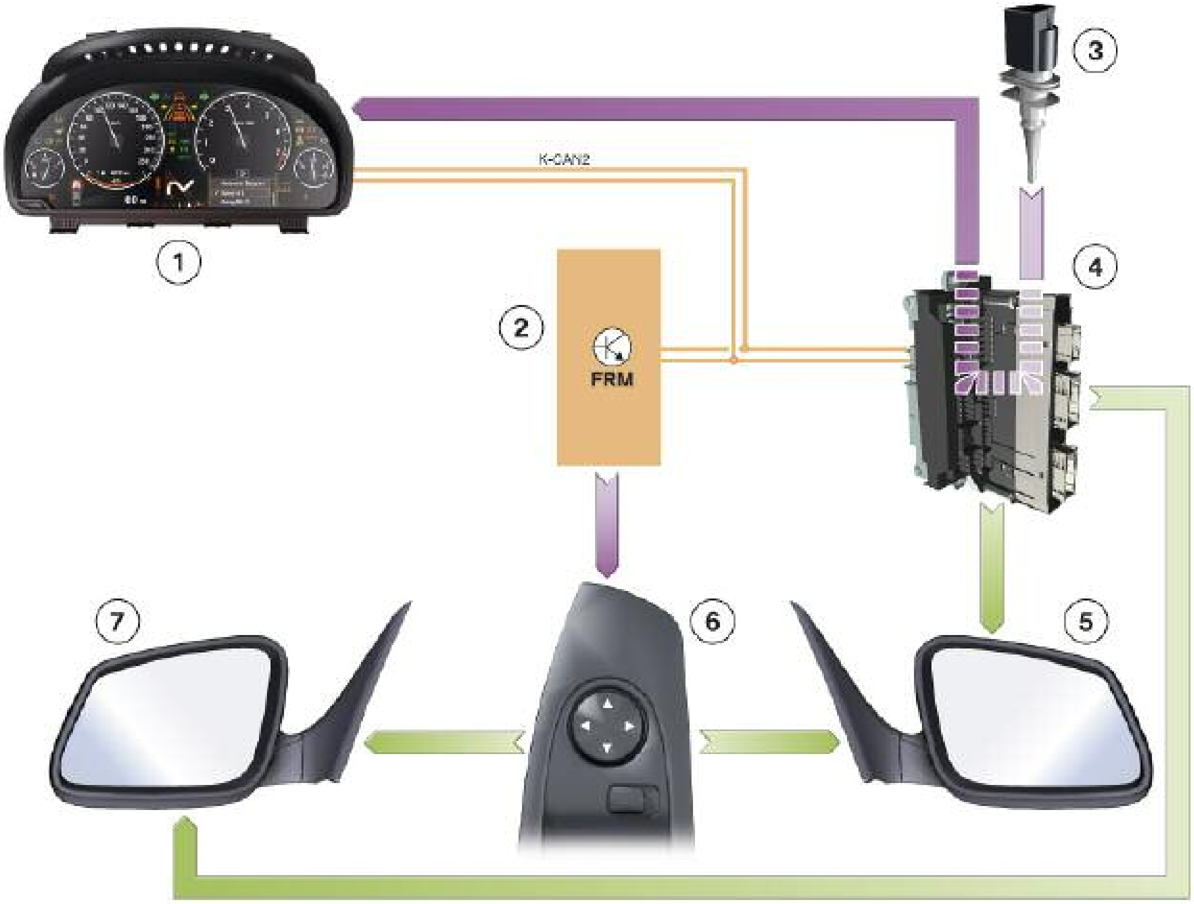
Optional Interior and exterior mirrors with automatic anti-dazzle function (electrochromic) can be ordered as an optional extra. This option requires the interior rear-view mirror with automatic anti-dazzle function.

The outside mirrors with memory function are connected via the LIN-bus and additionally feature the following functions:

- Outside mirror fold-in
- Electrochromic outside mirrors
- Electrical seat adjustment with memory

System Overview

Input/output - Outside Mmirrors

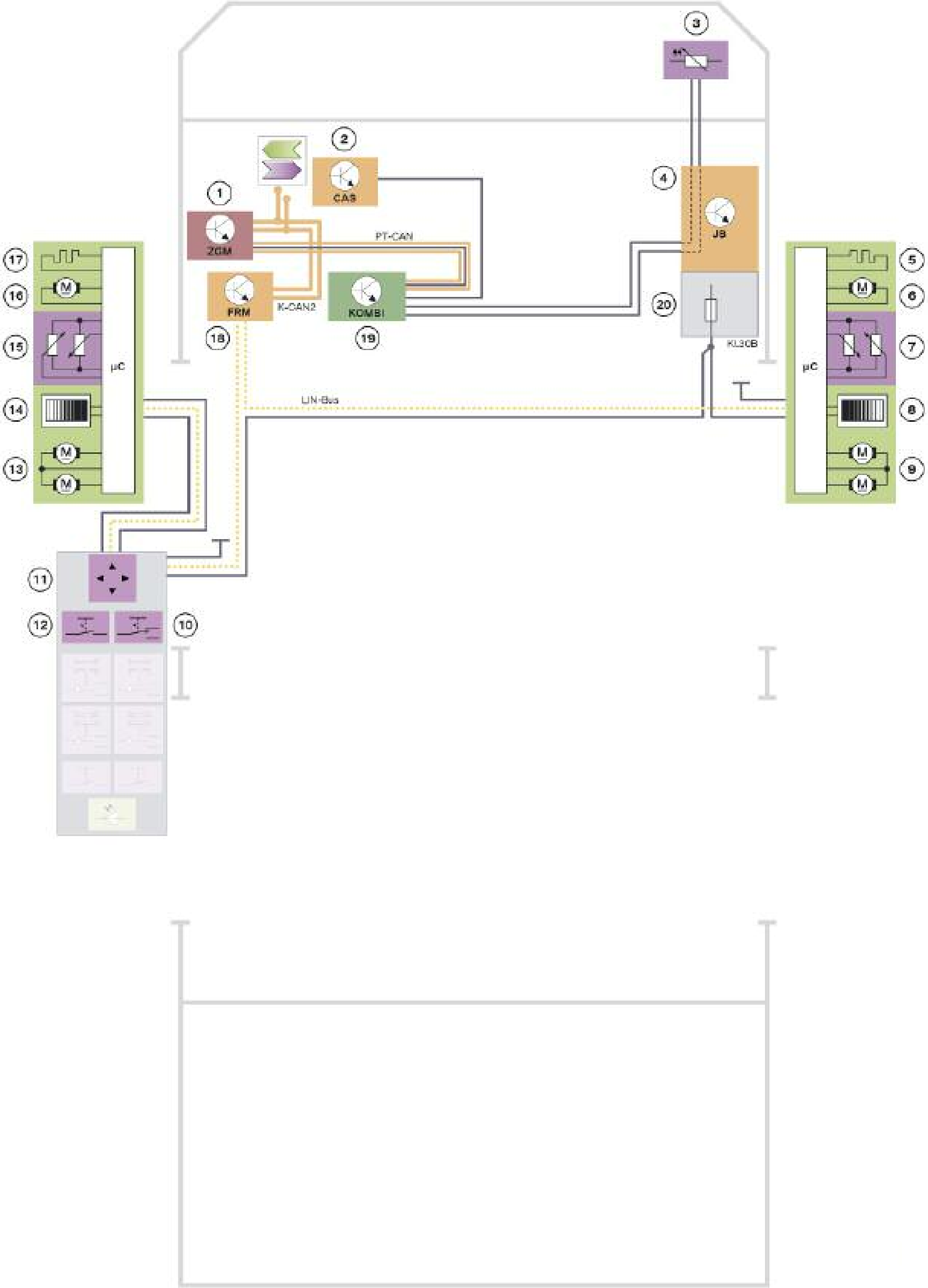


Index	Explanation	Index	Explanation
1	Instrument cluster	5	Outside mirror, passenger's side
2	Footwell module FRM	6	Mirror adjustment switch in driver's door switch cluster SBFA
3	Outside temperature sensor	7	Outside mirror, driver's side
4	Junction box electronics JB	K-CAN2	Body CAN 2

Instrument cluster (1) records the outside temperature and makes this information available to the vehicle electrical system.

Junction box electronics (4) supply the outside mirror heating. The outside mirrors (5 + 6) can be adjusted with the mirror adjustment switch in the driver’s door switch cluster (6).

System Circuit Diagram - Outside Mirror High



Index	Explanation	Index	Explanation
1	Central gateway module (ZGM)	14	Electrochromic outside mirror, driver's side
2	Car Access System (CAS)	15	Memory, outside mirror potentiometer, driver’s side
3	Outside temperature sensor	16	Motor for folding mirror function, driver’s side
4	Junction box electronics (JB)	17	Outside mirror heating, driver’s side
5	Outside mirror heating, passenger’s side	18	Footwell module (FRM)
6	Motor for folding mirror function, passenger’s side	19	Instrument cluster
7	Memory, outside mirror potentiometer, passenger’s side	20	Front distribution box
8	Electrochromic outside mirror, passenger’s side	LIN-Bus	Local Interconnect Network bus
9	Actuator motor for passenger’s side outside mirror	Kl. 30B	Terminal 30 basic operation
10	Driver’s door switch cluster (SBFA) with mirror selector switch	Kl. 58g	Terminal 58g
11	Driver’s door switch cluster (SBFA) with mirror adjustment switch	K-CAN2	Body CAN2
12	Driver’s door switch cluster (SBFA)	PT-CAN	Powertrain CAN with mirror folding switch
13	Actuator motor for driver's outside mirror		

K-CAN2 signals at footwell module

In/out	Information	Source/sink	Function
In	Vehicle speed	Wheel speed sensor > Dynamic Stability Control	Mirror fold-in lock (inhibit)
In	Status, electrochromic interior rear-view mirror	Photodiode, rear-view mirror > roof function center	Dip outside mirror

The instrument cluster (19) receives the value corresponding to the outside temperature from the outside temperature sensor (3) and makes it available via the PT-CAN. The footwell module (18) evaluates the K-CAN2 signal and initiates activation of the outside mirror heating (5 and 17).

The mirror adjustment motors (9 and 13) are driven by the electronic mirror module. The electronic mirror module receives the request to adjust the outside mirrors via the LIN-bus.

The outside mirrors are connected via the LIN-bus. All information such as the memory-position or mirror functions, e.g. dip outside mirrors, is transferred via the LIN-bus.

Functions

Overview

The following outside mirror functions are possible depending on the vehicle equipment:

- Mirror adjustment in up/down and left/right directions
- Mirror heating
- Mirror fold-in
- Electrochromic mirror, outside mirror with memory function
- Automatic parking function
- Manual adjustment
- Motor protection by repeat interlock

Mirror Adjustment

■ Outside mirror adjustment High

The driver’s door switch cluster is connected via the LIN-bus to the footwell module.

The footwell module checks the status of the mirror adjustment switch every 20 ms. The electronics in the driver’s door switch cluster evaluates the mirror adjustment switch and sends the signal via the LIN-bus to the footwell module. In turn, the footwell module initiates activation of the adjustment motors.

To protect the mirror drive unit, the mirror adjustment is limited to a maximum activation time of 10 seconds. Activation is maintained within this period of 10 seconds until the mirror adjustment switch is released.

Activation is also maintained until the outside mirror blocks or reaches its end position.

■ Detecting position of outside mirrors

The High version of the outside mirrors has two potentiometers that register the mirror adjustment. The potentiometers receive their 5V voltage supply from the electronic mirror module. The determined values of the potentiometers are stored in the footwell module for the memory function.

Mirror Heating

The mirror heating is operable as from terminal 15 ON.

■ Outside mirror

The mirror heating is activated by the footwell module. The corresponding information is passed on to the electronic mirror module via the LIN-bus.

The instrument cluster makes available the outside temperature value via the PT-CAN. The signal is transferred to the K-CAN2 by the central gateway module.

The junction box electronics provide the information for the wipers via the K-CAN2.

The percentage switch-on time is calculated from both values in the footwell module.

The following table shows the values for the percentage ON time:

Temperature in °C	**< -10**	**-10 to 5**	**5 to 15**	**15 to 25**	**25 to 35**	**> 35**
Heating capacity in %	100	75	50	0	0	0
Heating capacity with wipers ON in %	100	100	75	50	25	0

The percentage increase is still retained for 300 seconds after the wiper is switched off.

The maximum electric heating output is 28 W that is set by means of voltage and current measurement in the mirror.

■ Undervoltage

The electronic mirror module switches off the mirror heating in the event of undervoltage. This has a positive effect on the charge balance of the battery. The cutout threshold is at 10.8 V.

The electronic mirror module switches on the mirror heating again as from a voltage of 11.6 V.

■ Terminal 50

The “terminal 50 ON” status is output during the starting procedure. The mirror heating is switched off for the duration.

Mirror Fold-in

The mirror fold-in function is controlled by the footwell module. For this purpose, the footwell module requests the status of the mirror fold-in switch. The driver’s switch cluster evaluates the mirror fold-in switch and forwards the request via the LIN-bus. The footwell module initiates the fold-in function.

The electronic mirror module receives the request and executes this function by activating the corresponding fold-in motor. The footwell module receives the request via the LIN-bus. Both outside mirrors are folded in towards the vehicle thus reducing the vehicle width.

Electrochromic Outside Mirrors

The automatic dip function (anti-dazzle) of the outside mirrors is dependent on the setting of the interior rear-view mirror. The function is available as from “terminal 15 ON”.

The interior rear-view mirror forwards the anti-dazzle request to the junction box electronics on the LIN-bus. The junction box electronics transfer the request to the K-CAN. The footwell module is now able to receive the request.

The footwell module sends this request via the LIN-bus to the electronics in the outside mirrors. The electronics implement the request to dim the outside mirrors.

Outside Mirror with Memory Function

The outside mirror High features a memory function that is stored in the footwell module. Three memory locations are available for this purpose. They are:

- Current position when leaving the vehicle
- Memory position of memory button 1
- Memory position of memory button 2.

■ Identification transmitter

Up to three personalizable ID transmitters are possible per vehicle.

When the vehicle is locked using the ID transmitter, the current mirror position is stored in the memory location for the key memory of the ID transmitter currently used.

As a result, the mirror position last set, referred to the ID transmitter used, is always reassumed when the vehicle is unlocked.

■ Storing memory position

The position of the outside mirrors is stored in the footwell module by pressing the “M” button followed by pressing one of the memory buttons within 7 seconds.

The footwell module evaluates signals from the memory buttons on the LIN-bus and transmits this information on the K-CAN2. As a result, the seat module also knows when to store the current seat position.

■ Calling up memory position

When the memory button is pressed, the footwell module receives the request to adjust the outside mirrors to the memory position. The footwell module sends the request to the K-CAN2. The seat module is therefore aware of the request and instructs the seat to move to the memory position.

Automatic Parking Function

The outside mirror on the front passenger's side is swivelled downward when reverse gear is engaged so that the kerb can be easily viewed.

The automatic parking function is activated under following conditions:

- Terminal 15 ON and
- Reverse gear signal and
- Mirror selector switch set to driver position.

The footwell module receives the reverse gear signal via the K-CAN2. The automatic transmission control unit then makes this signal available.

Folding Mirror Manually

The outside mirrors can be folded in or out manually. The outside mirrors could lose their set position when folded in or out manually. It may be therefore necessary to fold out the outside mirrors, fold them in and then fold them out again.

The outside mirrors will then again be in the correct locked position.

Motor Protection by Repeat Interlock

The outside mirrors feature a repeat inhibit facility to avoid thermal overheating by frequently folding the mirrors in and out. The motors cannot be activated for 180 seconds when the repeat inhibit is active.

Mirror Auto Remote Fold-in Function (Comfort Function)

The auto remote fold-in function for the outside mirrors can be activated through following components:

- Identification transmitter
- Driver's door lock cylinder
- Outer door handle.

For example, the "Lock" button on the ID transmitter must be pressed for longer than 5 seconds to trigger the fold-in function. Fold-in is then initiated. Initially, the panoramic glass roof is closed, followed after a time delay by the front/rear windows.

With the option "Fold-in outside mirrors" The outside mirrors are folded in simultaneously with closing the rear windows.

System Components

Overview

The following components are installed in the F01/F02 for the purpose of operating the outside mirrors:

- Driver's door switch cluster with
  - Outside mirror adjustment switch
  - Outside mirror selector switch
  - LIN-bus link
- Outside mirrors
- Footwell module
- Junction box electronics
- Components for comfort/convenience function
  - Car Access System
  - Driver's door lock cylinder
  - Remote control receiver in the diversity module.

Driver's Door Switch Cluster

The driver's door switch cluster is connected via the LIN-bus to the footwell module.

The adjustment motors in the Low version of the outside mirrors are controlled directly by the mirror adjustment switch in the driver's door switch cluster.

The driver's door switch cluster in the High version of the outside mirrors is connected to the outside mirrors via the LIN-bus.

The electronic mirror module in the outside mirrors evaluates the LIN-bus signals and activates the adjustment motors.

Note: The driver's door switch cluster is connected to terminal 30B, terminal 31. The driver's door switch cluster receives the status of terminal 58g from the footwell module on the LIN-bus.

Design of the Outside Mirrors

■ Drive unit with memory

The drive unit with memory function additionally consists of the following components:

- Electronic mirror module
- Position potentiometer
- Folding mirror motor
- LIN-bus
- Electrochromic glass.

Note: In combination with the Active Blind Spot Detection (Lane Change Warning) the outside mirror also contains the display for the warning.

Footwell Module

The master function for controlling the outside mirrors is integrated in the footwell module.

On vehicles with memory function, the mirror position of the respective memory button (driver's seat) is stored in the footwell module.

The outside mirrors (high) and the driver's door switch cluster are connected to the footwell module via the LIN-bus. The outside mirror functions are activated via the LIN-bus.

Junction Box Electronics

The junction box electronics power the low version of the outside mirror heating system.

The signal is pulse width-modulated and has a frequency of 1 Hz.

The junction box electronics also request the status of the electrochromic interior rear-view mirror on the LIN-bus. The mirror electronics feed back the current status of the electrochromic interior rear-view mirror. The junction box electronics send the status to the footwell module on the K-CAN2. The footwell module is therefore aware of the status and is able to control the dimming of the outside mirrors accordingly.

Table of Contents

F01 Seats

Initial Print Date: 01/09 Revision Date:

Seats

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the seat configurations in the F01/F02
- Locate and identify components of the seat systems in the F01/F02

Front Seat Equipment

The front seating arrangement of the F01/F02 consists of the multi-function seat as standard equipment. The multi-function seat (Comfort Seat) features 16-way adjustment with 4-way lumbar support which includes the articulated upper backrest, adjustable backrest width, adjustable thigh support, and Active Head Restraints with adjustable side support.

The front seat also have memory settings for the driver and passenger seats.

An electropneumatic system is installed for lumbar support and the active seat. The advantage of electropneumatics lies in the fact that the overall weight of the seat is reduced.

The active seat is a part of the Luxury Seating package and features pneumatic control rather that the previous fluid based control system on the E65.

The front side airbag (1) is integrated into the backrest of the driver's and front passenger seat. The seat back extends into the seat side. This is known as "encompassing seat wall". When the airbag is triggered, the side is pushed a little. This allows the airbag to open and provide its protective function. The front seats are equipped with seat-occupancy recognition (passenger) and a belt tensioner.

In the F01/F02, the button for the passenger-assist function (gentleman function) is integrated into the armrest of the driver's door. After pressing the button, the driver is able to operate the front-passenger seat using his own seat adjustment buttons.

For example, this allows you to make more space, e.g. before someone gets in on the passenger's side.

The front seats are equipped with crash-active head restraints. In the memory seat, the head restraints have a button for adjusting the distance to your head.

In the multifunction seat, the distance is adjustable using the upper backrest adjustment.

Rear Seat Options

In the F01/F02, there are two seat models, the basic seat and the optional comfort (multi-function) seat. The rear comfort seat is part of the "Luxury Rear Seating" package which also includes the rear ventilated seats.

On the F02, there is also a "stand-alone" option for the massage function.

All seat equipment comes with the center armrest cup holder. There are two styles for the center armrest. See the following comparison.

Index	Explanation	Index	Explanation
1	Center armrest w/o comfort seat	2	Center armrest w/comfort seat

The buttons for the rear seat heating are integrated into the center console.

Multifunction Seat

The optional massage function can be ordered additionally with the multifunction seat. The massage function is based on current medical knowledge and is integrated into the backrest.

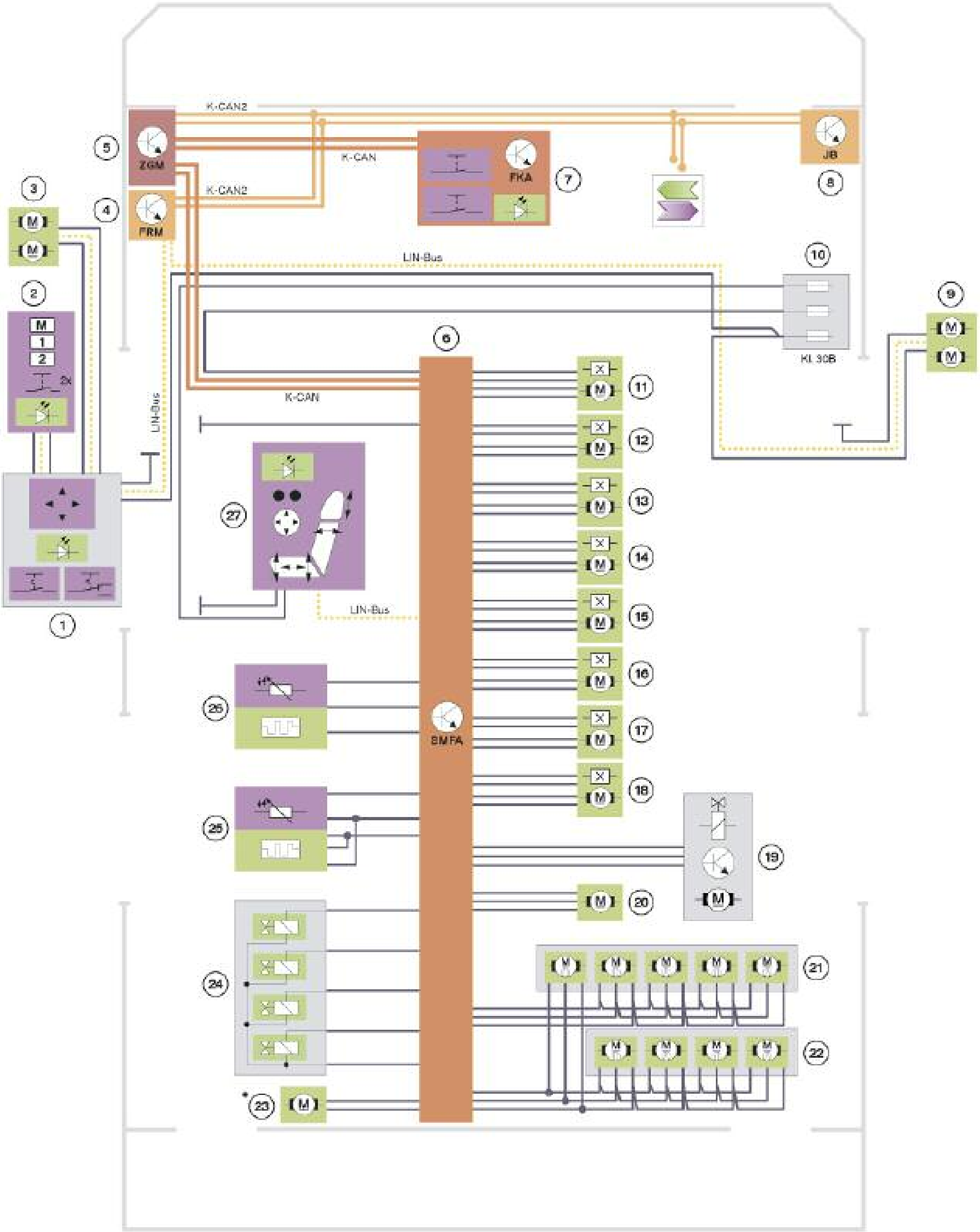
The multifunction seat helps you to feel perfectly refreshed, for example with a back massage on a stressful day.

So that customers are provided with the best sense of well-being, they can select from two different massage intensity levels.

A new feature of the seat air conditioning function in the multifunction seat is that only two fan motors are installed for the ventilation. The fan motors draw in some fresh air from the rear footwell. The fresh air is then guided via air ducts through the multifunction seat until it reaches the backrest and seat surfaces. This helps to provide a pleasant air-temperature control for customers.

System Overview

System Circuit Diagram, Multifunction Seat (comfort seat)



Index	Explanation	Index	Explanation
1	Switch block, driver's door	17	Motor, head-restraint height adjustment
2	Button block in the armrest, driver's side	18	Motor, backrest-width adjustment
3	Motors, mirror adjustment, driver's side	19	Pump, lumbar support/active seat
4	Footwell module (FRM)	20	Pressure distributor, active seat
5	Central gateway module (ZGM)	21	Fan, active seat ventilation, seat surface
6	Driver's seat module (SMFA)	22	Fan, active seat ventilation, backrest surface
7	Integrated automatic heating/air conditioning (IHKA)	23*	Lumbar support pump
8	Junction box electronics (JB)	24	Lumbar support, solenoid valves
9	Motors, mirror adjustment, passenger's side	25	Seat-heating pad, seat surface
10	Fuses in the front distribution box	26	Seat-heating pad, backrest surface
11	Motor, longitudinal seat adjustment	27	Seat function buttons, driver's seat
12	Motor, seat-inclination adjustment	K-CAN2	Body CAN2
13	Motor, seat-height adjustment	K-CAN	Body CAN
14	Motor, backrest-inclination adjustment	LIN-Bus	Local interconnect network bus
15	Motor, seat-depth adjustment	Kl. 30B	Terminal 30 basic operation
16	Motor, upper backrest adjustment (LKV)		

* Pump in a vehicle equipped with lumbar support. In a vehicle equipped with active seats, a different pump is used. This pump supplies the active seat and lumbar support with air.

K-CAN signals at the seat module

In/Out	Information	Source/sink	Function
In	Outside temperature	Outside temperature sensor > instrument cluster	Ambient conditions when faults are stored
In	Power reduction stage	Energy management system > digital engine control	Power reduction of seat heating

Functions

Electric Front Seat Adjustment

The seats can be adjusted from terminal 30B ON. The seat-adjustment switch simply has to be pressed in the desired direction. The seats can have up to eight adjustment axes.

The seat adjustment options are listed in the following table:

Index	Comfort (Multi-function seat)	
	Driver's side	Passenger's side
Seat height adjustment	X	X
Longitudinal seat adjustment	X	X
Seat inclination adjustment	X	X
Backrest inclination adjustment	X	X
Head restraint height adjustment	X	X
Seat depth adjustment	X	X
Backrest width adjustment	X	X
Upper backrest adjustment	X	X

Activation of the seat adjustment motors differ depending on the seat equipment.

For example, the seat-adjustment switches are evaluated either directly or via the LIN bus.

Seat Adjustment Options

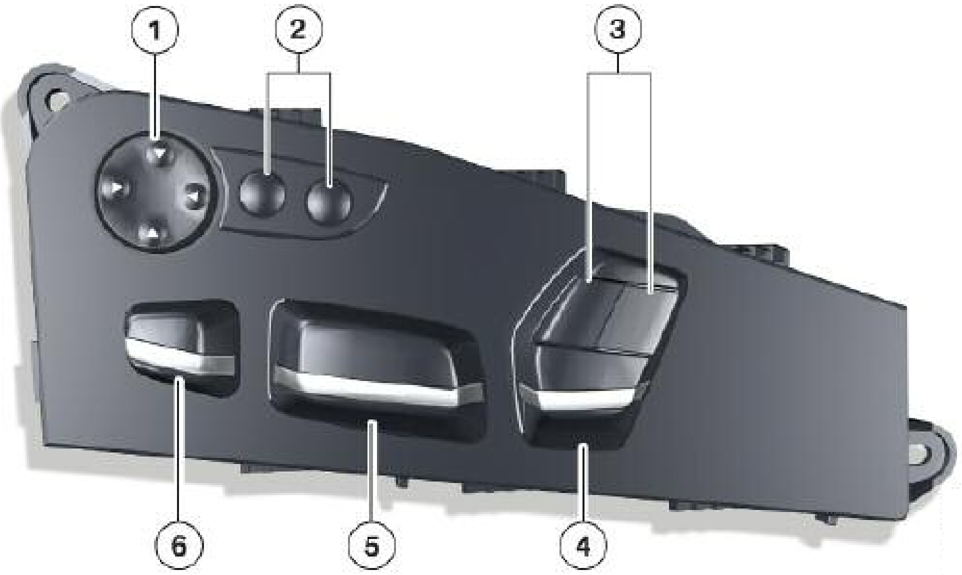
With the maximum equipment specification, the F01/F02 seats can be adjusted in eight directions back and forth.

Maximum seat adjustment axes using the F01/F02 multifunction seat as an example

Index	Explanation	Index	Explanation
1	Head restraint height adjustment	5	Seat height adjustment
2	Upper backrest adjustment	6	Seat inclination adjustment
3	Backrest inclination adjustment	7	Seat depth adjustment
4	Longitudinal seat adjustment	8	Backrest width adjustment

The seat can adjusted with the seat adjustment switches. The seat adjustment switches on the comfort seat (multifunction seat) are used again as an example here.

Seat adjustment switches in the F01/F02 multifunction seat with memory function



Index	Explanation	Index	Explanation
1	Lumbar support adjustment	4	Backrest inclination and head restraint height adjustment
2	Backrest width adjustment	5	Longitudinal seat, seat height and seat inclination adjustment
3	Upper backrest adjustment	6	Seat depth adjustment

■ Seat position recording in the US

There is seat calibration in the US version for the driver’s and the front-passenger seat. Seat calibration is important, because during the course of many seat adjustments, the seat position may lose accuracy. This generates a Check Control message. Refer to the section entitled Service information.

Front Seat Memory Function

The memory function is available for both the driver's and front-passenger seats. The memory buttons are located on the armrest. The memory function can be activated from terminal 30B ON. The memory function is integrated into the seat module. The seat module of the seat concerned has sole responsibility for this function.

Two memory positions and the current seat position can be stored.

The memory buttons are integrated into the armrest of the vehicle's doors and connected via the LIN bus to the footwell module.

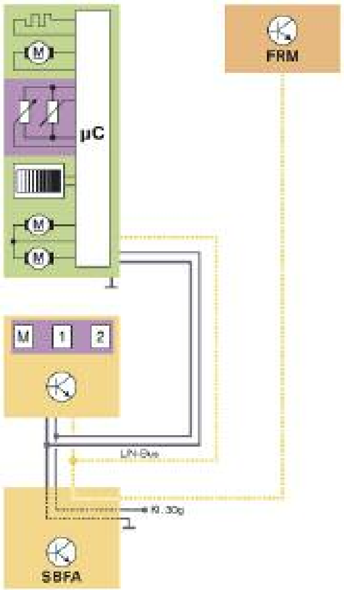
The LIN bus is "looped through" the switch block of the driver's door. This means that the LIN bus cable is routed from the footwell module to the switch block in the driver's door. From the switch block in the driver's door, the LIN bus is routed further to the memory buttons and the door mirror.

The footwell module evaluates the button status and sends it via the K-CAN2.

The footwell module sends the button status via the K-CAN2 to the central gateway module. The central gateway module receives the signal and issues it on the K-CAN. The seat module evaluates the signal and initiates the storing of the memory position, when requested to do so.

Press the memory button to prepare for storing the memory position. The seat module sends the request to switch on the function indicator. From the function indicator, for example, the customer can recognize that the memory function is ready for storing.

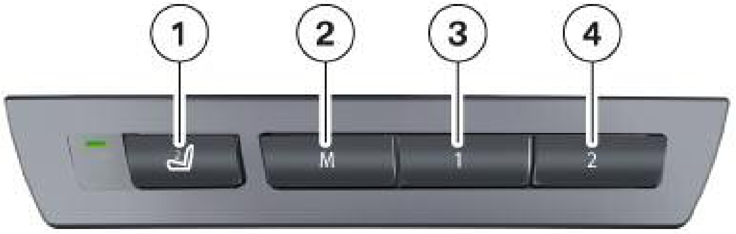
F01/F02 LIN bus loop-through connection



Index	Explanation	Index	Explanation
1	Door mirror, driver's side	3	Switch block, driver's door
2	Memory button block	4	Footwell module

Pressing button “1” or “2” assigns the current position of the driver’s seat to the pressed button. One memory position is available for each of the buttons “1” and “2”.

Button block in the armrests of the F01/F02 driver's side



Index	Explanation	Index	Explanation
1	Passenger assist function button	3	Button 1
2	M button	4	Button 2

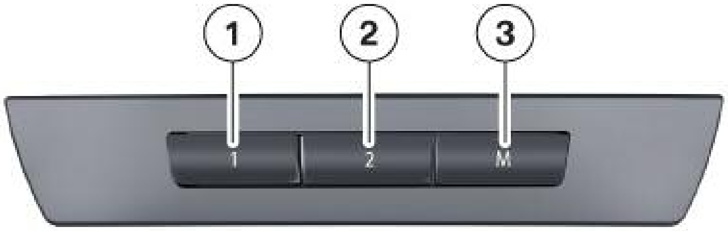
The data is assigned to the current ID transmitter as part of the Personal Profile, when the memory position is stored.

The button for the passenger-assist function is integrated into the armrest on the driver’s side. This function is available in seat models with memory function.

Button illumination

The footwell module sends the status of the terminal 58g. The seat module receives the status of the terminal 58g via the K-CAN. The seat module passes the status of terminal 58g via the LIN bus to the memory buttons.

F01/F02 memory buttons on the passenger's side



Index	Explanation	Index	Explanation
1	M button	3	Button 2
2	Button 1		

Memory function for the door mirrors and steering column

Pressing the memory "M" button followed by button "1" or "2" assigns the current position of the door mirrors and steering column to the pressed button.

The seat module sends the request to store the door mirror and steering column position via the K-CAN. The central gateway module transfers the signal to the K-CAN2. The footwell module then stores the position.

The door mirror position is assigned to the memory position of the driver's seat. Due to this fact, the current position of the door mirrors is also assigned to the pressed button "1" or "2".

Note: The memory position of the door mirrors and the electric steering column adjustment are stored in the footwell module.

Passenger-assist Function

The passenger-assist function is available from terminal 30B ON. The seat module on the driver’s side alone is responsible for the passenger-assist Function. The button status is read in by the footwell module via the LIN bus and sent via the K-CAN2. The central gateway module transfers the signal to the relevant bus system.

As soon as the driver’s seat module SMFA detects an operation request from the passenger-assist function button, it prepares the front-passenger seat module for an adjustment request via the K-CAN.

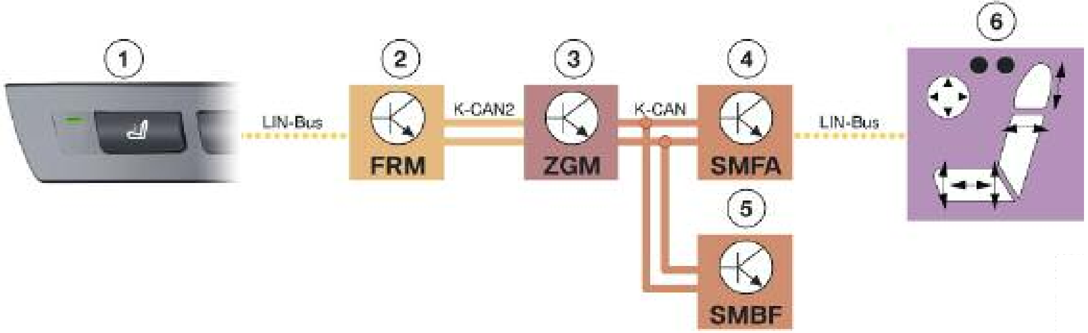
When the seat adjustment switch on the driver’s side is now activated, the seat module on the passenger’s side executes the request.

The K-CAN is used for communication between the seat modules. This allows all seat adjustment functions for the front-passenger seat and the memory function to be operated from the driver’s seat. The passenger-assist function is available for the memory seat and the multifunction seat.

The seat module sends the request via the K-CAN to the function indicator for the activated passenger-assist function button in order to switch on the LED in the button. The request must be transferred on more than one bus system.

Note: A seat adjustment made via the buttons on the front-passenger seat has priority over those made from the driver’s seat.

Signal path of the passenger-assist function in F01/F02 front seats



Index	Explanation	Index	Explanation
1	Passenger-assist function button	4	Driver’s seat module
2	Footwell module	5	Passenger’s seat module
3	Central Gateway Module	6	Buttons, seat functions, driver’s seat

Front Seat Heating

The seat heating is standard as part of the comfort seats. The seat module is functionally responsible for seat heating.

The seat heating can only be activated from terminal 15 ON. The status of terminal 15 ON is issued by the Car Access System 4 via the K-CAN2. The junction box electronics thus know the status of terminal 15.

The central gateway module transfers the signal to the K-CAN. The seat module is connected to the K-CAN and receives the status of terminal 15.

The button for the seat heating is located in the IHKA/audio control panel. The control panel is connected to the control unit of the integrated automatic heating and air conditioning system.

Pressing the seat heating button, selects the heating stage as shown in the following list.

Heating stage	Seat heating pads
3	High
2	Medium
1	Low
0	Off

If the button is pressed for longer than 1.2 seconds with the seat heating activated, the seat heating will be switched off.

If, after terminal 15 OFF, the junction box electronics receive the status terminal 15 ON within 15 minutes, then the last selected function that was activated will come into operation.

The indicator for the selected heating stage is controlled by the seat module. The signal must be sent via several bus systems.

The seat heating module is connected to terminal 30B for the seat-heating load current.

IHKA/audio control panel with buttons for F01/F02 seat heating

Index	Explanation	Index	Explanation
1	Seat-heating button, driver's seat	2	Seat-heating button, front passenger's seat

Seat Heating with Seat Module

When the vehicle wakes up, the junction box electronics determine whether a seat module is installed in the vehicle. It sends a corresponding query via the K-CAN2 for this purpose. The central gateway module transfers the signal to the K-CAN. This allows the seat module to receive the request, respond to it via the K-CAN and take control of the seat heating function.

The seat module has sole responsibility for the seat heating function. The integrated automatic heating and air conditioning system evaluates the button status and sends the button status via the K-CAN to the seat module.

The seat module evaluates the requests for the desired heating stage, as well as controls and monitors the seat heating functions. The seat-heating pads are connected to the seat module. A NTC resistor in the seat-heating pad is monitored to control the temperature.

Depending on the heating stage, the seat module sends the request for the function to be indicated in the button LEDs to the integrated automatic heating and air conditioning system.

The seat module is connected to terminal 30B for the seat-heating load current.

A fault in the seat-heating system results in a corresponding entry in the fault memory of the driver's seat module.

Power reduction of seat heating

The energy management system in the vehicle can activate the seat heating at a reduced power level corresponding to the vehicle's energy balance. The energy management is located in the digital engine-control system.

The digital engine control sends the request to reduce power via the PT-CAN. The central gateway transfers the information to the KCAN. This allows the seat module to receive the request to reduce power.

The reduction stages are:

- Operation of seat heating in Stage 2
- Operation of seat heating in Stage 2 at only 50%
- Seat heating OFF.

Note: In the event of a power reduction, the LEDs in the seat-heating buttons are not switched off.

During a starting cycle (terminal 50 ON) or when the seat adjustment switch is operated, the seat module prevents the seat heating from functioning. The LED indicator for the activated seat heating remains lit.

Heading Circuit for the Seat Heating

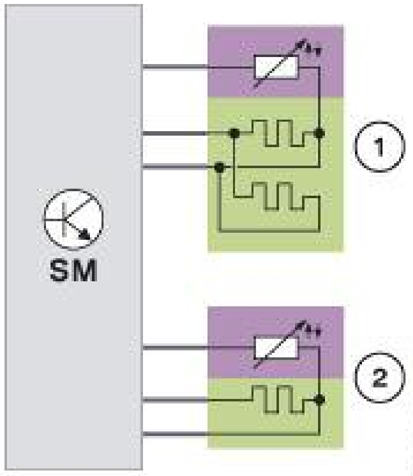
The F01/F02 seats are equipped with a two-circuit seat heating system.

Two-circuit seat heating system

A seat-heating pad is located in the surface of the backrest. Two seat-heating pads are integrated into the seat surface. Both seat-heating pads are supplied with power by the seat module.

There is a NTC resistor in each seat-heating pad in the backrest and seat surfaces. This serves as a temperature control.

Schematic diagram of the two-circuit seat heating system



Index	Explanation
1	NTC resistor in the backrest-surface seat heating pad
2	NTC resistor in the seat-surface seat heating pad

The customer can adjust the seat heating air stratification individually. Select the menu item “Settings” using the controller in the Central Information Display.

Settings

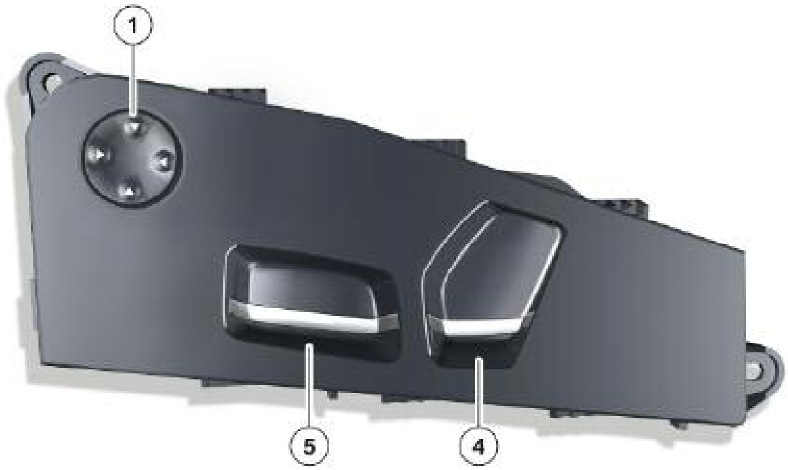
- > Air conditioning
  - > Seat heating distribution
    - > Driver
      - > Front passenger

Front Lumbar Support

Using lumbar support, the backrest can be individually adapted to the spinal column and thus ensures relaxed driving. Lumbar support is a standard feature in the multifunction seat.

The button for the lumbar support adjustment is located on the side of the front seat and is connected via the LIN bus to the seat module. The function of the lumbar support is integrated completely in the seat module. The lumbar support is adjustable from terminal 30B ON.

Seat adjustment switches and lumbar support switch



Index	Explanation	Index	Explanation
1	Button for lumbar-support adjustment	5	Longitudinal seat, seat-height and seat inclination adjustment
4	Backrest inclination and head restraint adjustment		

The seat module requests the button status for the lumbar support adjustment via the LIN bus an on a cyclical basis. Lumbar support is provided by two inflatable air cushions in the backrest. The desired air cushion is inflated with air or deflated via two solenoid valves until such time that the button for the lumbar-support adjustment is released.

The pump for lumbar-support adjustment delivers the required air pressure. The pump and the solenoid valves are activated from the seat module.

Note: Seats with the lumbar support option are generally fitted with a seat module. For this reason, all seat heating or seat adjustment functions are located in the seat module.

The seat adjustment switches are read in from the seat module via the LIN bus.

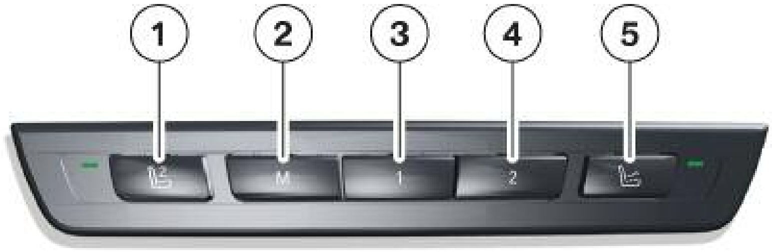
Front Active Seat

Active seat function can be activated from the status terminal 15 ON with the Active Seat button. The button is located in the armrests of the front door of the vehicle.

The seat module has sole responsibility for this function.

The footwell module requests the button status via the LIN bus and sends this via the K-CAN2. The central gateway transfers the signal to the K-CAN. This allows the seat module to receive the button status. The seat module evaluates the button status.
If there is a request to switch on the active seat, then this is executed by the seat module.

Button block in the armrest of the F01/F02 driver's side

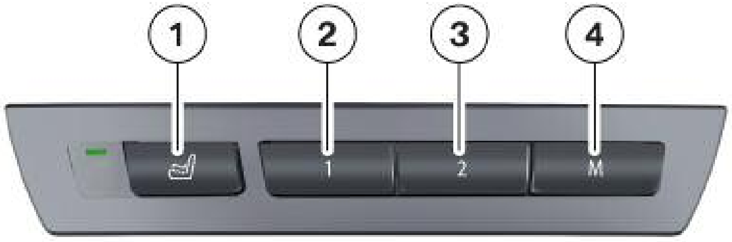


Index	Explanation	Index	Explanation
1	Passenger assist button	4	Button 2
2	M button	5	Active Seat button
3	Button 1		

A powerful pneumatic pump is used for the active seat and lumbar support functions. The pump supplies the air cushion, for the lumbar support and the active seat with the required volume of air. For this reason, the pump is somewhat larger than that which is found in a vehicle without the active seat option.

Note: Lumbar-support adjustment has priority over the active seat. For lumbar-support adjustment, the pump for lumbar-support adjustment runs at maximum speed. For the active-seat function, the pump for lumbar support adjustment runs at roughly half this speed.

Button block in the armrest of the F01/F02 front-passenger's side

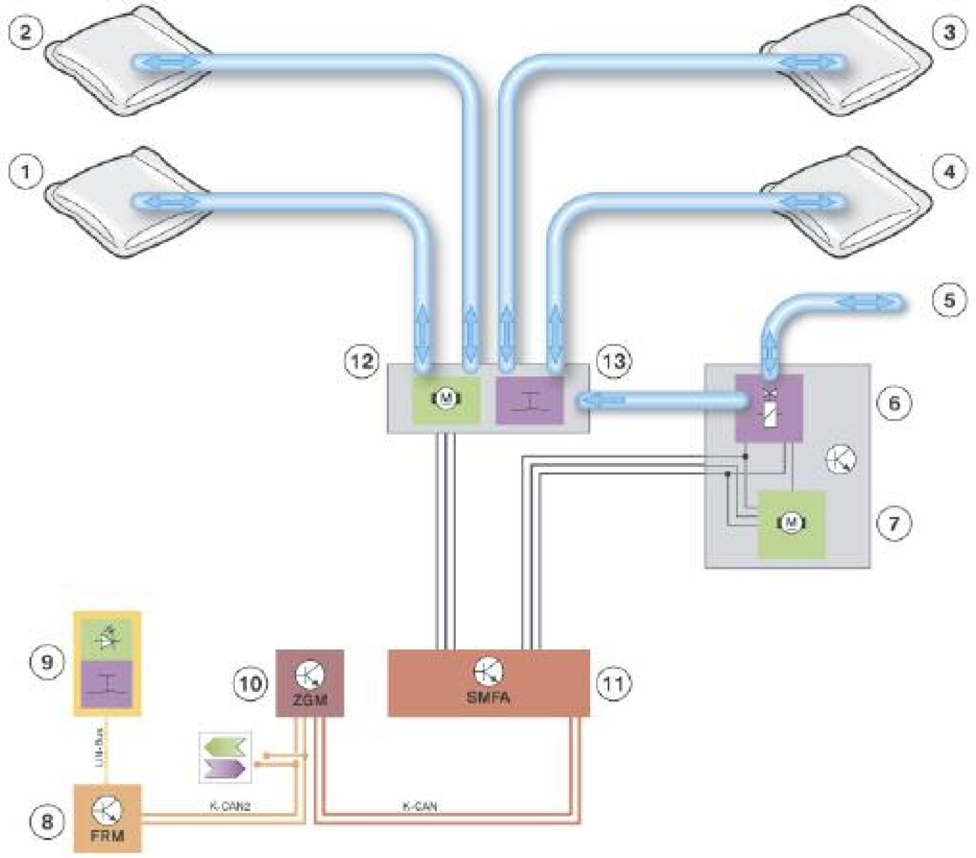


Index	Explanation	Index	Explanation
1	M button	3	Button 2
2	Button 1	4	Active seat button

If, after terminal 15 OFF, the seat module receives the status terminal 15 ON within 15 minutes, then the last selected function that was activated will come into operation.

System Overview

Basic activation of F01/F02 active seat



Index	Explanation	Index	Explanation
1	Lower air cushion, left	9	Active seat buttons with function indicator
2	Upper air cushion, left	10	Central gateway module (ZGM)
3	Upper air cushion, right	11	Driver's seat module (SMFA)
4	Lower air cushion, right	12	Distributor module, active seat
5	Output, lumbar-support adjustment	13	Air supply, active seat
6	Solenoid valve, changeover, active seat/lumbar-support adjustment	K-CAN	Body CAN
7	Pump for lumbar-support adjustment/ active seat	K-CAN2	Body CAN2
8	Footwell module (FRM)	LIN-Bus	Local Interconnect Network bus

K-CAN signals at the seat module

In/Out	Information	Source/sink	Function
In	Outside temperature	Outside temperature sensor > instrument cluster	Ambient conditions when faults are stored
In	Yaw rate	Yaw rate sensor > Integrated Chassis Management	Suspend active seat function
In	Power management	Digital engine control > Seat module	Brief suspension, in order to maintain enough power in the vehicle electrical system

Four air cushions are integrated in the seat surface for the active seat. Two air cushions, one on top of the other, are used in both the left and right seat halves.

The air cushions are inflated with air supplied by the pump for the lumbar-support adjustment. A solenoid valve is integrated in the pump unit. The function of the solenoid valve is to change over the air supply. This ensures that only one function (lumbar support adjustment or active seat) is ever executed.

A distributor module is available for inflating the air cushions. The seat module delivers power to the distributor module as soon as the active seat is switched on.

The distributor module houses a motor, which drives an eccentric shaft. The rotation of the eccentric shaft causes the air inlets to the seat cushions to open or close.

The seat cushions are alternately inflated or deflated, depending on the position of the eccentric shaft. The air inlets are closed when the system is switched off and in the breaks between inflation or deflation.

A switch contact is integrated in the distributor module to switch on the pump for lumbar-support adjustment. The rotation of the eccentric shaft actuates the contact, which thereby signals activation to the seat module. The seat module switches on the pump for lumbar-support adjustment and changes over the solenoid valve to inflation of the seat cushions.

■ Undervoltage

If the function fails due to undervoltage when the active seat is switched on, the active seat must be calibrated. The function does this by itself. The seat cushions are completely deflated the next time the active seat is switched on. The active-seat function is then ready for operation again.

■ Suspension of functions

In the interest of avoiding irritation when cornering at high speed, the active-seat function is stopped immediately in the event of excessive lateral acceleration.

The lateral-acceleration signal comes from the yaw-rate sensor. The Integrated Chassis Management issues the signal via the FlexRay.

The central gateway module transfers the signals to the K-CAN. This allows the seat module to receive the signal for the vehicle's lateral acceleration. The seat module cancels activation when a defined threshold is exceeded. The function indicator however remains lit.

The active seat is switched on again when the lateral-acceleration value drops again.

■ Power management

Power management is capable of briefly stopping the active seat from functioning. The function indicator however remains lit.

This applies, for example when pressing the starter or to maintain a sufficient energy balance for the vehicle's electrical system.

■ System faults

In the event of a system fault, the system shuts down or stops in the next center position in order to avoid further damage. A fault memory entry is stored in the seat module.

Active Seat Ventilation

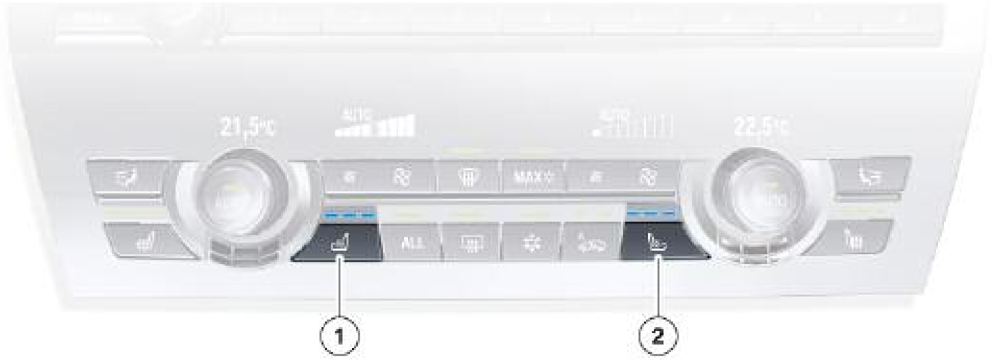
The active seat ventilation option provides the occupants with individual climate control for the seat and backrest surfaces.

Active seat ventilation is available for both the driver's and front-passenger seats. Active seat ventilation can be activated from the status terminal 15 ON.

Stage 3 is engaged when the button is pressed for the first time. This sets the maximum fan stage for seat and backrest.

The next stage lower or OFF is selected on further pressing of the button. Active seat ventilation is deactivated if the button remains pressed for longer than 1.2 seconds.

Button, F01/F02 active seat ventilation



Index	Explanation	Index	Explanation
1	Button for active seat ventilation, driver's seat	2	Button for active seat ventilation, pass seat

The button for the active seat ventilation is located in the IHKA/audio control panel. The seat module has sole responsibility for this function. The integrated automatic heating and air conditioning system evaluates the signals for operating the active seat ventilation and sends the button status to the seat module. This allows the seat module to receive the request, activate the fan and monitor their operation.

Depending on the heating stage, the seat module sends the request for the function to be indicated in the button LEDs to the integrated automatic heating and air conditioning system.

Nine fans are accommodated in each seat. The fans are switched on by the seat module and activated separately for backrest and seat surface. For active ventilation, the seat has two speed stages for the fans, depending on the air-conditioning stage. The seat surface has five fans, while the backrest has four fans.

Seat ventilation stages:

Ventilation stage	Fans, seat	Fans, backrest
3	High	High
2	High	Low
1	Low	Low
0	OFF	OFF

After having been activated for a period in excess of 10 minutes, active seat ventilation is automatically switched down from Stage 3 to Stage 2.

The activated seat ventilation function remains stored for up to 15 minutes after the status terminal 15 OFF. The previously selected seat ventilation stage is switched on again if in this time the status terminal 15 ON is received by the seat module.

The energy management system in the vehicle can deactivate active seat ventilation briefly depending on the vehicle's energy balance. The function indicator is retained however.

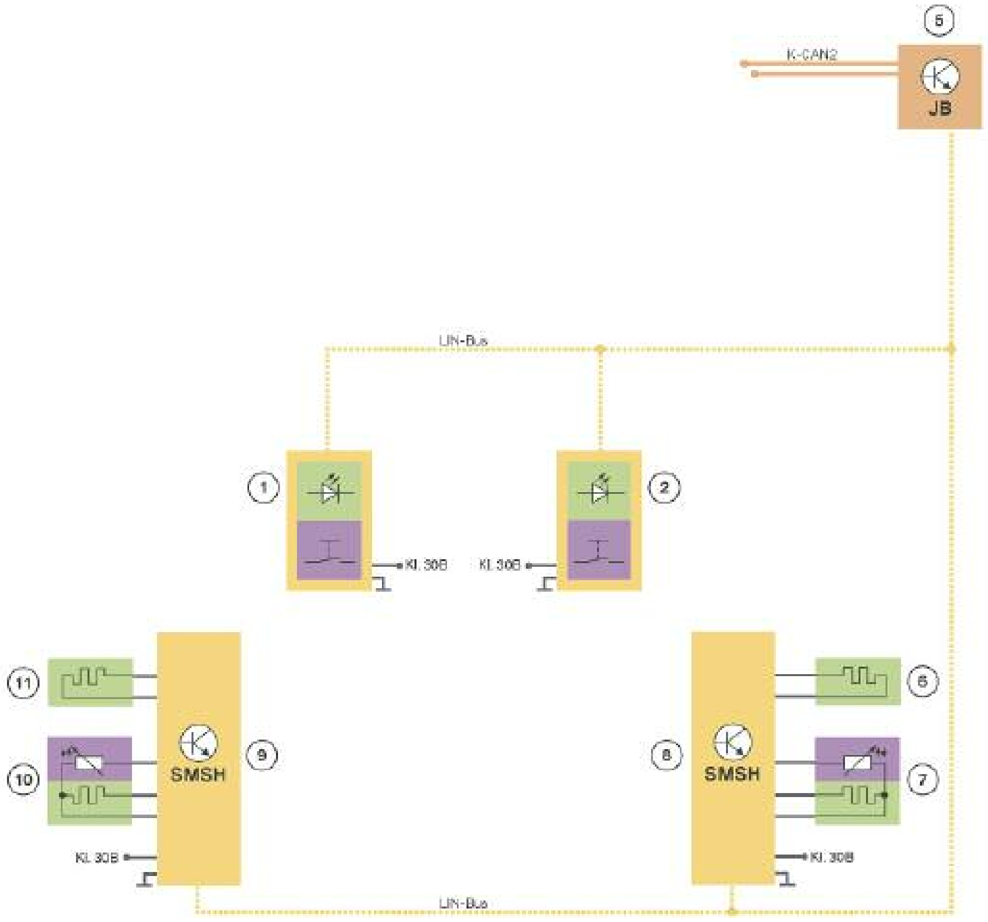
Rear Basic Seat

The standard rear seat for the F01 is the basic seat. Seat heating is available for the rear seat as part of the "Luxury seating package".

The rear basic seat offers seating for three people. The seat in the middle is fitted with a folding head restraint.

Seat Heating in the Rear Basic Seat

System Circuit Diagram, Rear Seat Heating



Index	Explanation	Index	Explanation
1	Seat-heating buttons, driver's side, with function indicator, rear	9	Seat heating module (SMSH), driver, rear
2	Seat-heating buttons, front-passenger's side, with function indicator, rear	10	Seat heating, seat surface
5	Junction box electronics (JB)	11	Seat heating, backrest surface
6	Seat heating module (SMSH), front passenger, rear	KL. 30B	Terminal 30 basic operation
7	Seat heating, seat surface	K-CAN2	Body CAN2
8	Seat heating, backrest surface	LIN-Bus	Local interconnect network bus

Rear seat heating

The seat heating is available for the left and the right seat and each has a heating circuit. A seat-heating pad is located in each backrest and seat surface. The seat heating can only be activated from “terminal 15 ON”.

The seat-heating buttons are integrated under the air vents in the rear center console.

The seat heating function is fully integrated into the junction box electronics.

The junction box electronics evaluate the buttons for the seat heating. To do this the junction box electronics request the current status of the buttons via the LIN bus.

The junction box control unit then transfers the status to the appropriate seat heating module.

The seat heating modules are connected to the junction box electronics via the LIN bus.

Note: The seat heating modules are coded to detect the installed position. Different pins are switched to terminal 31, i.e. to ground for coding. The connectors are coded.

The buttons and the seat heating modules are connected to terminal 30B.

The fuses for the buttons and seat heating modules are located in the distribution box in the luggage compartment.

The seat heating can be switched on in three heating stages. The heating stages and their indications are set out in the following table.

Heating stage	Seat	Backrest	LED
3	High	High	3
2	Normal	Normal	2
1	Low	Low	1
0	OFF	OFF	OFF

Regulation of the seat heating is controlled via an NTC resistor in the seat-surface seat-heating pad.

Electronic circuitry for indicating operation of the LED and communication via the LIN bus is integrated in each button.

Power reduction of seat heating

The energy management system in the vehicle can activate the seat heating at a reduced power level corresponding to the vehicle's energy balance. The energy management is located in the digital engine-control system.

The digital engine control sends the request to reduce power via the PT-CAN. The central gateway transfers the information to the K-CAN2. The junction box electronics thus know about the request for power reduction.

The junction box electronics send the request for power reduction to the seat heating module.

The reduction stages are:

- Operation of seat heating in Stage 2
- Operation of seat heating in Stage 2 at only 50%
- Seat heating OFF.

Note: In the event of a power reduction, the LEDs in the seat-heating switch are not switched off.

During a starting cycle (terminal 50 ON), the seat heating module prevents the seat heating from functioning. The LED indicator for the activated seat heating remains lit.

Rear-compartment Comfort Seat

The rear-compartment comfort seat is available as part of the luxury rear seating option which is currently only available on the F02.

F01/F02 rear-compartment comfort seat

Index	Explanation	Index	Explanation
1	Memory buttons	2	Seat adjustment function buttons

The rear-compartment comfort seat also has lumbar support. The comfort seat is also known as the multifunction seat.

The seating in the rear-compartment is designed for **two** persons to increase comfort.

As with its predecessor, the F01/F02 has the seat adjustment switch and memory buttons in separately installed positions.

The seat-adjustment switches are located on the center armrest and are connected via the LIN bus to the seat module. The button for adjusting the lumbar support is located next to the seat adjustment switches.

The memory buttons are integrated into the armrest of the vehicle's rear doors. The memory buttons are connected to the junction box electronics via the LIN bus.

As previously described with the basic seat, the comfort seat also has a method of transferring signals from the seat heating button that differs depending on the equipment installed on the vehicle.

The rear-compartment comfort seat can comes with the ventilation feature. Additionally, there is a "stand-alone" option for the massage function.

Electric Seat Adjustment for the Rear-compartment Comfort

The comfort seat has the following electric seat adjustment options:

- Seat-inclination adjustment
- Longitudinal seat adjustment SLV (seat distance to front seat)
- Head-restraint height adjustment
- Backrest-inclination adjustment
- Backrest head-inclination adjustment LKV.

The comfort seat has a large seat module that is integrated into the backrest of the seat concerned. All seat adjustment switches are read in by the seat module via the LIN bus. The seat module has sole responsibility for the seat functions. It controls and monitors the function sequences. The seat position of the comfort seat can be adjusted from terminal 30 ON.

Note: The seat module is connected via the K-CAN for communicating with other persons in the vehicle electrical system.

The seat module requests the status of the seat adjustment switches via the LIN bus. The seat module activates the adjustment motors in according to the status of the seat adjustment switches. The adjustment motors are activated via the relay in the seat module.

When the seat adjustment switch is released, the seat module cancels activation. The seat module also cancels activation when the adjustment motor is obstructed or when the end position is reached.

An obstructed motor is detected by the current measuring device integrated into the seat module and by failure of the Hall sensor pulses. In this case, the relays are no longer actuated thus shutting down the motors. The seat module also blanks out these adjustment motors when storing the memory position.

Once the motors are unobstructed, they are available to the memory function again.

The seat module stores the malfunctions. In the service workshop, the fault code entry is read out using the diagnostic system.

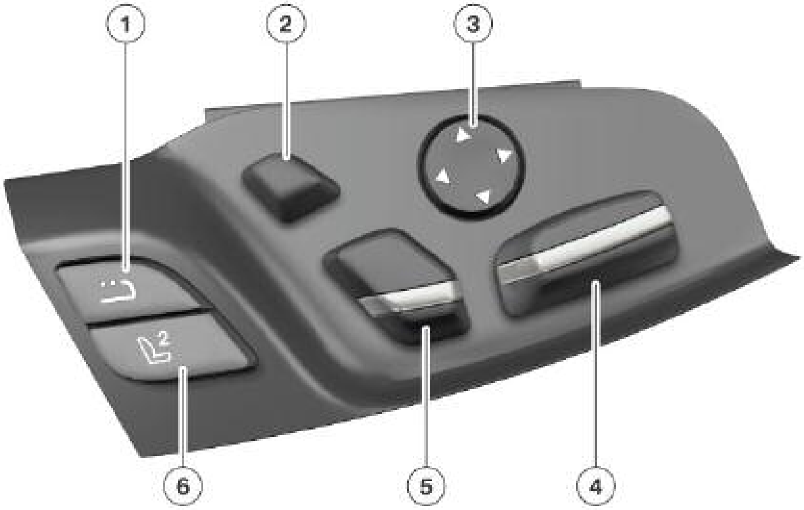
Fault code memory entries can be:

- Short-circuiting
- Line breaks
- Adjustment motor or Hall sensor is defective.

Buttons for the seat adjustment functions in the F01/F02 rear-compartment comfort seat, driver's side

Index	Explanation	Index	Explanation
1	Button for lumbar-support adjustment	4	Backrest inclination adjustment
2	Upper backrest and head restraint height adjustment	5	Longitudinal seat, seat height and seat inclination adjustment
3	Reset button		

Buttons for the seat functions in the F01/F02 rear-compartment comfort seat, front-passenger's side



Index	Explanation	Index	Explanation
1	Reset button	4	Longitudinal seat, seat height and seat inclination adjustment
2	Upper backrest and head restraint height adjustment	5	Backrest inclination adjustment
3	Button for lumbar-support adjustment		Buton for adjusting passenger seat from the rear seat

Other Seat Functions

Reset function

The reset function enables you to set the comfort seat to a pre-set seat position. After the reset button is pressed, the seat automatically moves into position. It can be used to make the seat more easily accessible during servicing. This, for example, is of benefit to customers and service technicians, because getting out of the vehicle and accessing the comfort seat becomes easier.

Note: The reset function can also be used for fitting a child seat. After the reset function is activated, the comfort seat is in a better position for fitting the child seat.

Reset button

Index	Explanation
1	Reset button for the rear compartment comfort seat

Position detection

The adjustment motors are equipped with Hall sensors. The Hall sensors generate Hall pulses during activation, which are evaluated by the seat module. The seat module calculates the fixed distance intervals based on the Hall pulses and determines the current seat adjustment position.

The seat position is stored in the seat module and used for the memory position.

Obstruction detection

The seat module records the Hall sensor pulses of the adjustment motors. If the adjustment motor is obstructed the Hall sensor pulses will fail. The seat module also detects an obstructed motor from the increased current when the obstruction occurs. The seat module then cancels activation of the adjustment motors.

The adjustment motor can be activated in the same direction again. If the motor remains obstructed, it must be activated in the opposite direction. If the seat can be moved in the opposite direction, then the seat module allows you to activate the original direction again.

If the obstruction in the adjustment motor cannot be cleared, then this motor is no longer used to store the memory function.

Rear seat adjustment button

In unfavorable situations, the leg room behind the front-passenger seat can seem quite narrow. Someone sitting behind the front-passenger seat may find this unpleasant.

In order to enlarge the space in front of the rear seat on the front-passenger's side, there is an additional button fitted on the center armrest in the rear seat area. This button allows you to operate the front-passenger seat.

The rear seat module behind the front-passenger seat requests the button status via the LIN bus.

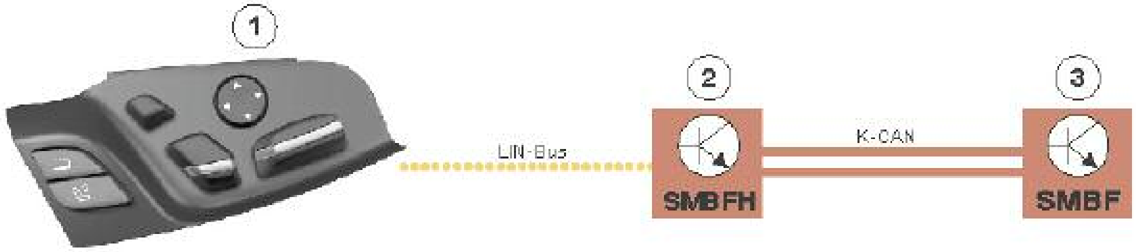
This enables it to detect when the button is pressed. If the button is pressed, the rear seat module behind the front passenger seat prepares itself to carry out a seat adjustment to the front-passenger seat.

When the seat adjustment buttons for the rear seat are now operated, they adjust the front-passenger seat accordingly.

The function is deactivated by pressing the button for operating the front-passenger seat again.

Note: A seat adjustment made via the buttons on the front-passenger seat has priority over those made from the rear seat.

Signal path button for making seat adjustments to the front-passenger seat from the F01/F02 rear seat



Index	Explanation	Index	Explanation
1	Buttons for seat functions	3	Passenger's seat module (SMBF)
2	Seat module, passenger side rear (SMBFH)		

Memory Function for the Rear-compartment Comfort Seat

The memory function is available for both the left and right rear passenger seat and can be activated from terminal 30B ON. The memory buttons are connected to the junction box electronics via the LIN bus.

The seat module of the seat concerned is responsible for the memory function. The junction box electronics request the status of the memory buttons via the LIN bus on a cyclical basis. To enable the seat module to read out the status of the memory buttons, the button status must be transferred on several bus systems. The bus systems are:

- LIN bus (JB > buttons)
- LIN bus (buttons > JB)
- K-CAN2 (JB > ZGM)
- K-CAN (ZGM > SM).

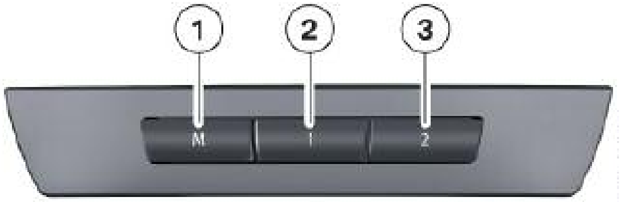
Press the memory button to prepare for storing the memory position. The seat module sends the request to switch on the function indicator. From the function indicator, for example, the customer can recognize that the memory function is ready for storing.

Pressing button “1” or “2” assigns the current position of the driver’s seat to the pressed button. One memory position is available for each of the buttons “1” and “2”.

The data is assigned to the current ID transmitter as part of the Personal Profile, when the memory position is stored.

If the seat module detects an obstructed adjustment motor, then memory adjustments to the motor remain disabled until the motor is no longer obstructed.

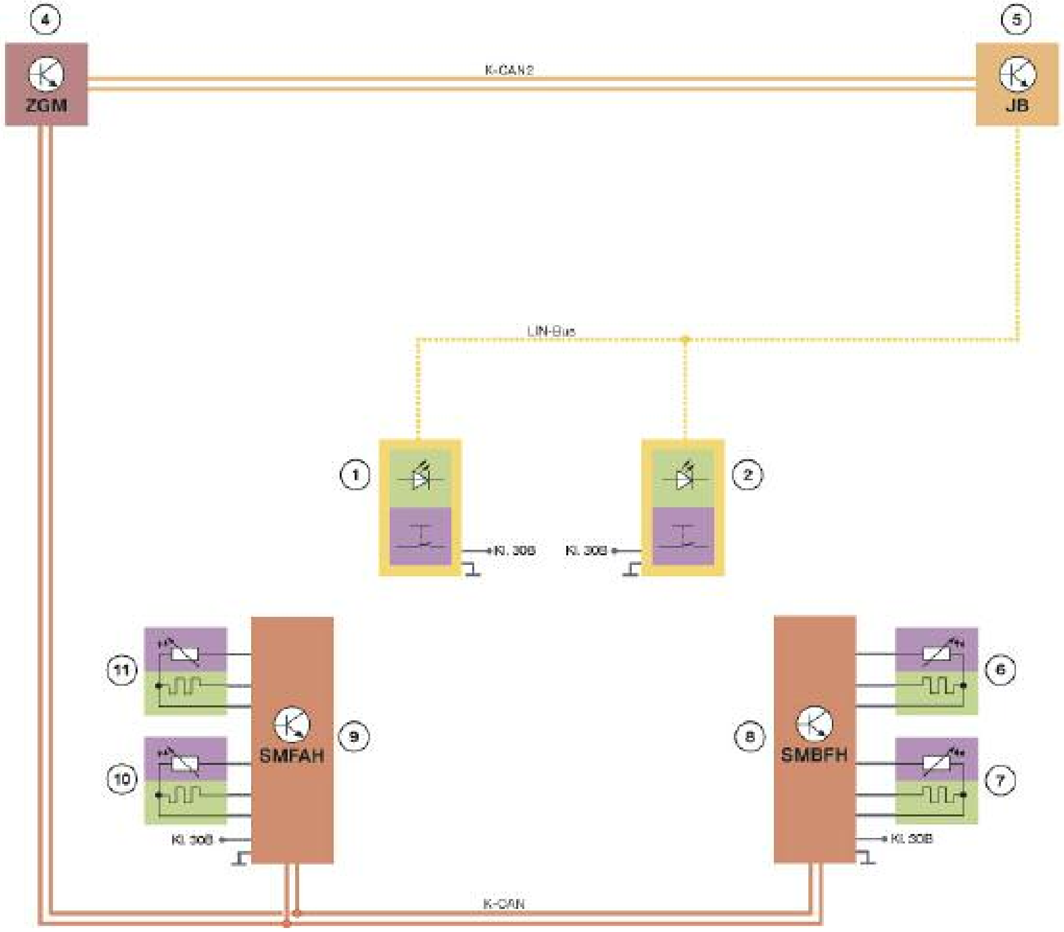
Memory buttons in the armrests of the F01/F02 driver's side



Index	Explanation
1	M button
2	Button 1
3	Button 2

Seat Heating in the Rear-compartment Comfort Seat

System Circuit Diagram, Seat Heating



Index	Explanation	Index	Explanation
1	Seat-heating buttons, driver's side, with function indicator, rear	9	Driver's rear seat module (SMFAH)
2	Seat-heating buttons, front-passenger's side, with function indicator, rear	10	Seat heating, seat surface
4	Central gateway module (ZGM)	11	Seat heating, backrest surface
5	Junction box electronics (JB)	Kl. 30B	Terminal 30 basic operation
6	Seat module, passenger side, rear (SMBFH)	K-CAN	Body CAN
7	Seat heating, seat surface	K-CAN2	Body CAN2
8	Seat heating, backrest surface	LIN-Bus	Local interconnect network bus

When the vehicle wakes up, the JBE determine whether a seat module is installed in the vehicle. It sends a corresponding query via the K-CAN2 for this purpose. The central gateway module transfers the signal to the K-CAN.

The ZGM transfers the signal to the K-CAN. This allows the seat module to receive the request, respond to it via the K-CAN and take control of the seat heating function. This means that the button status of the seat heating is evaluated, and the seat heating is activated and monitored.

The JBE request the button status for the seat heating via the LIN bus on a cyclical basis and sends it via the K-CAN2. The ZGM transfers the request for the heating stage to the K-CAN. The seat module evaluates the request for the desired heating stage and activates the seat heating accordingly. The seat heating is a two-circuit heating system.

■ Function indicator

In order to indicate that the seat heating function has been activated, the seat module sends a request via the K-CAN to switch on the LEDs in the button. The request must be transferred on more than one bus system.

The bus systems are, K-CAN (SM > ZGM), K-CAN 2 (ZGM>JB) and LIN (JB>buttons):

■ Back lighting buttons

The FRM sends the status of the terminal 58g ON via the K-CAN2. This is how the junction box electronics receive the status of terminal 58g ON. The JBE send the status of the terminal 58g ON to the seat heating buttons via the LIN bus.

■ Power reduction of seat heating

The energy management system in the vehicle can activate the seat heating at a reduced power level corresponding to the vehicle's energy balance. The energy management is located in the digital engine-control system.

The digital engine control sends the request to reduce power via the PT-CAN. The ZGM transfers the information to the K-CAN2.

The JBE then receive the request for power reduction and initiates it.

The reduction stages are:

- Operation of seat heating in Stage 2
- Operation of seat heating in Stage 2 at only 50%
- Seat heating OFF.

Note: In the event of a power reduction, the LEDs in the seat-heating switch are not switched off.

During a starting cycle (terminal 50 ON) or when the seat adjustment switch is operated, the junction box electronics prevent the seat heating from functioning. The LED indicator for the activated seat heating remains lit.

Lumbar Support in the Rear-compartment Comfort Seat

Lumbar-support Adjustment

Using the lumbar support, the backrest can be individually adapted to the spinal column and thus ensures relaxed driving.

The button for the lumbar support adjustment is located on the side of the center armrest and is connected via the LIN bus to the seat module.

The lumbar support function is fully integrated into the seat module and is adjustable from terminal 30B ON.

The seat module requests the button status for the lumbar support adjustment via the LIN bus an on a cyclical basis. The button responds with the current status via the LIN bus.

The seat module evaluates the button status and if necessary activates the lumbar support pump and solenoid valves.

Lumbar support is provided by two inflatable air cushions in the backrest. The desired air cushion is inflated with air or deflated via four solenoid valves until such time that the button for the lumbar-support adjustment is released.

The pump for lumbar-support adjustment delivers the required air pressure. The pump and the solenoid valves are activated from the seat module.

The seat module stores the malfunctions with the lumbar support. In the service workshop, the fault code entry is read out using the diagnostic system.

Fault code memory entries can be:

- Short-circuiting
- Line breaks
- Motor is defective.

Active Seat Ventilation for the Rear-compartment Comfort Seat

The active seat ventilation allows the passenger to have individual cooling of the seat and backrest surfaces.

In the F01/F02, a new concept has been introduced for the active seat ventilation. This concept requires only two fans for each seat. The integrated automatic heating and air conditioning system provides the vehicle with climate-controlled air. This means there is sufficient fresh and climate-controlled air in the footwell in front of the rear seats. The fans draw some air from the footwell. The drawn-in air is routed via each air-conditioning pad to the seat and the backrest.

The active seat ventilation is available for the seat and backrest on the rear comfort seat and can be activated from status terminal 15 ON.

The seat module has sole responsibility for the active seat ventilation function. Stage 3 is engaged when the button is pressed for the first time. This sets a high fan stage for seat and backrest.

The next fan setting or OFF is selected on further pressing of the button.

AC stage	Fans, seat	Fans, backrest
3	High	High
2	High	Low
1	Low	Low
0	OFF	OFF

After having been activated for a period in excess of 10 minutes, active seat ventilation is automatically switched down from Stage 3 to Stage 2.

Note: The active seat ventilation has 4-zone automatic air conditioning as a requirement. The buttons for the active seat ventilation are in the control panel of the automatic rear-compartment air conditioning.

Buttons for the F01/F02 active seat ventilation

Index	Explanation	Index	Explanation
1	Button, active seat ventilation, driver's side rear	2	Button, active seat ventilation, pass side rear

The air intensity of the active seat ventilation is coupled to the fan setting of the automatic rear-compartment air conditioning. This makes it possible to harmonize the fan noises in the rear compartment. The active seat ventilation therefore reaches its maximum value, when the automatic rear-compartment air conditioning is set to the maximum fan setting.

If the automatic rear-compartment air are activated based on a characteristic map conditioning is not switched on, then the fans that is stored in each seat module.

Switching on the Rear Active Seat Ventilation

The automatic rear-compartment air conditioning evaluates the button status and sends it via the K-CAN.

The seat module evaluates the status, activates the active seat ventilation with the selected air-conditioning setting, and monitors the function.

Two fans are fitted in each seat. The fans are activated from the seat module depending on the selected setting.

An activated seat ventilation function remains stored for up to 15 minutes after the status terminal 15 OFF. The previously active fan setting for the seat ventilation is switched on again if in this time the status terminal 15 ON is received by the seat module.

The energy management system in the vehicle can deactivate active seat ventilation briefly depending on the vehicle's energy balance. The function indicator is retained however.

■ Function indicator

In order to indicate that the seat ventilation function has been activated, the seat module sends a request via the K-CAN to switch on the LEDs in the button. The automatic rear-compartment air conditioning switches on the LEDs.

■ Back lighting buttons

The footwell module sends the status of the terminal 58g ON via the K-CAN2. The central gateway module transfers the signal to the K-CAN. Then the automatic rear-compartment air conditioning receives the status terminal 58g ON and activates the back lighting.

Note: The indicators in the control panel of the automatic rear-compartment air conditioning use black panel technology. A detailed description of the black panel technology can be found in the Product Information "F01/F02 display and control elements".

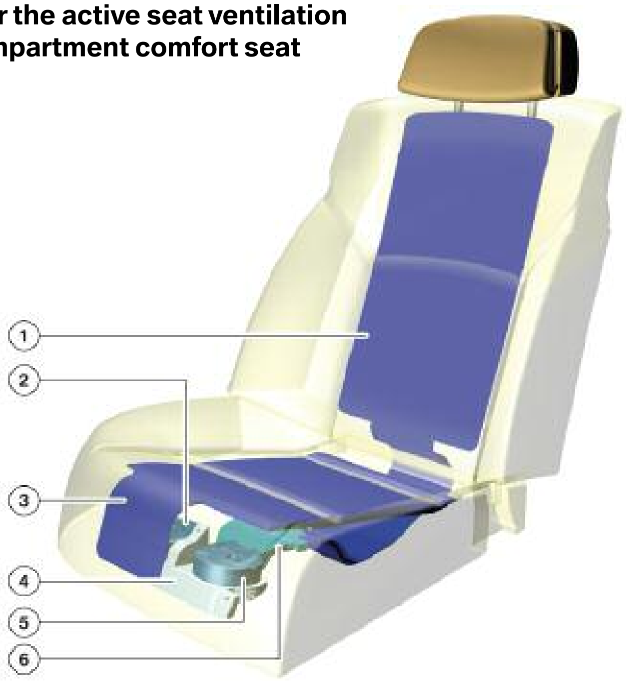
Air-conditioning Pad

The air-conditioning pad has openings in the area of the seat and backrest surfaces. Air can be drawn in through the openings in order to control the temperature of the seat cover.

Special covers are required for active seat ventilation. The covers have very small air outlets.

The air drawn in by the fans can flow through the air outlets. This cools the seat cover and ensures that the temperature of the seat cover remains pleasant.

Air-conditioning pad for the active seat ventilation in the F01/F02 rear-compartment comfort seat



Index	Explanation	Index	Explanation
1	Air-conditioning pad, backrest surface	4	Noise dampen for noise reduction
2	Fans, seat ventilation	5	Fans, backrest ventilation
3	Air-conditioning pad, seat surface	6	Adapter for air-conditioning pad, backrest surface

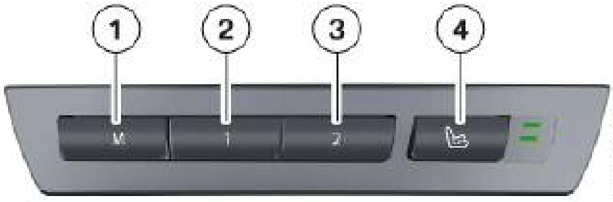
Massage Function in Rear-compartment Comfort Seat

The optional rear-compartment massage gives the rear-seat passenger even more comfort than in the E65. The rear-compartment massage function is being offered in the F01/F02 for the first time at BMW.

An electropneumatic system is used to implement the massage function.

The massage function is available for both the left and right rear passenger seat and can be activated from terminal 30B ON. The seat module is integrated into the back of the backrest in the left rear and the right rear seat and has sole responsibility for the massage function.

The buttons for the massage function are connected via the LIN bus to the junction box electronics.



Index	Explanation
1	M button
2	Button 1
3	Button 2
4	Massage function button

Button block in the armrests of the F01/F02 driver's side

The junction box electronics evaluate the status of the massage button and sends the status via the K-CAN2.

The central gateway module transfers the signal to the K-CAN. This allows the seat module to receive the current status of the buttons. The seat module evaluates the status, activates the massage function, and monitors it.

In the backrest of the comfort seat, there is a massage pad for the massage function. Pressing the button starts the massage function at the maximum massage intensity. Pressing the button again switches it to a lower massage intensity level.

Pressing the button once again switches the massage function off.

If the button is pressed for longer than 1.2 seconds during the massage function, the massage function will be switched off.

In order to indicate that the massage function has been activated, the seat module sends the request to switch on the LEDs in the button.

The signal terminal 58g ON is made available through the footwell module. The junction box electronics pass on terminal 58g ON to the button. The button then switches the back lighting on.

Massage

The massage function is divided into massage cycles. A massage cycle consists of the massage and includes back mobilization and lasts approximately 64 seconds. After this, a new massage cycle begins.

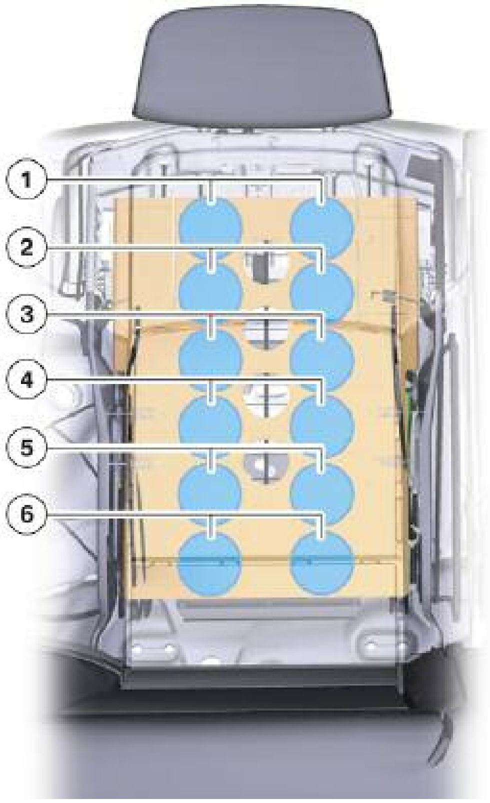
There are twelve massage cushions that help to relieve tension in the back muscles through a wave-like motion along the backrest from top to bottom.

The wave-type motion is created by inflating and deflating the massage cushions. The pressure distribution module activates the massage cushions in pairs simultaneously.

The massage function is designed so that the two upper massage cushions are activated first. Activation in this situation means inflating and deflating the massage cushions with air. Following this, the pair of massage cushions lying beneath are activated and this continues until the bottom massage cushions are reached.

Towards the end of the massage cycle, mobilization of the back begins.

F01/F02 massage cushions



Index	Explanation	Index	Explanation
1	Massage cushion pair 1	4	Massage cushion pair 4
2	Massage cushion pair 2	5	Massage cushion pair 5
3	Massage cushion pair 3	6	Massage cushion pair 6

Mobilization cushions are used for mobilization. There are six mobilization cushions arranged in the outside shoulder area, in the center of the thorax and in the lumbar area.

The mobilization cushions are simultaneously inflated and deflated periodically and sectionally. For example, the mobilization cushions in the right shoulder and right lumbar as well as the mobilization cushions in the left thorax are pumped up and deflated. Following that, the opposite side is inflated and deflated.

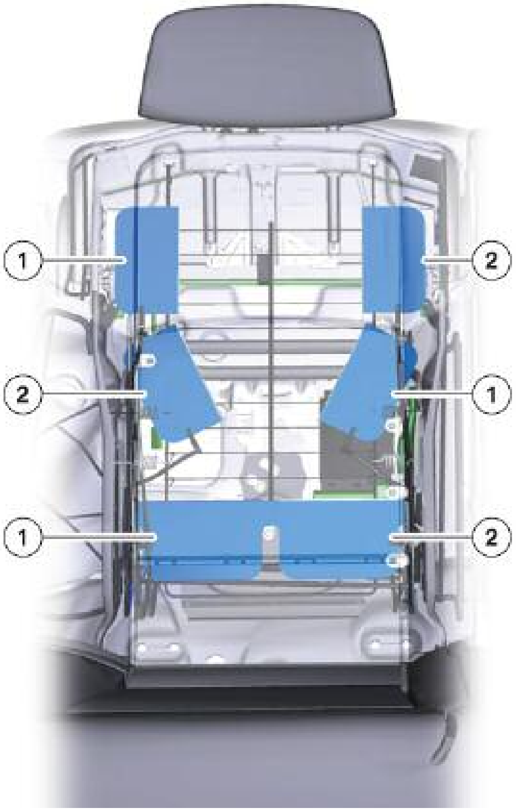
If the lumbar support is set when the massage function has been activated, the seat module deactivates the massage function. This allows the pump for the lumbar support adjustment to supply enough air flow to inflate the lumbar cushions.

After the lumbar support has been set, the massage function continues.

The massage function has a defined run-on. With this run-on the massage cushions and mobilization cushions are fully deflated. The run-on encompasses one massage cycle.

The pump for the lumbar support runs at various speeds depending on the function. Refer to the following table:

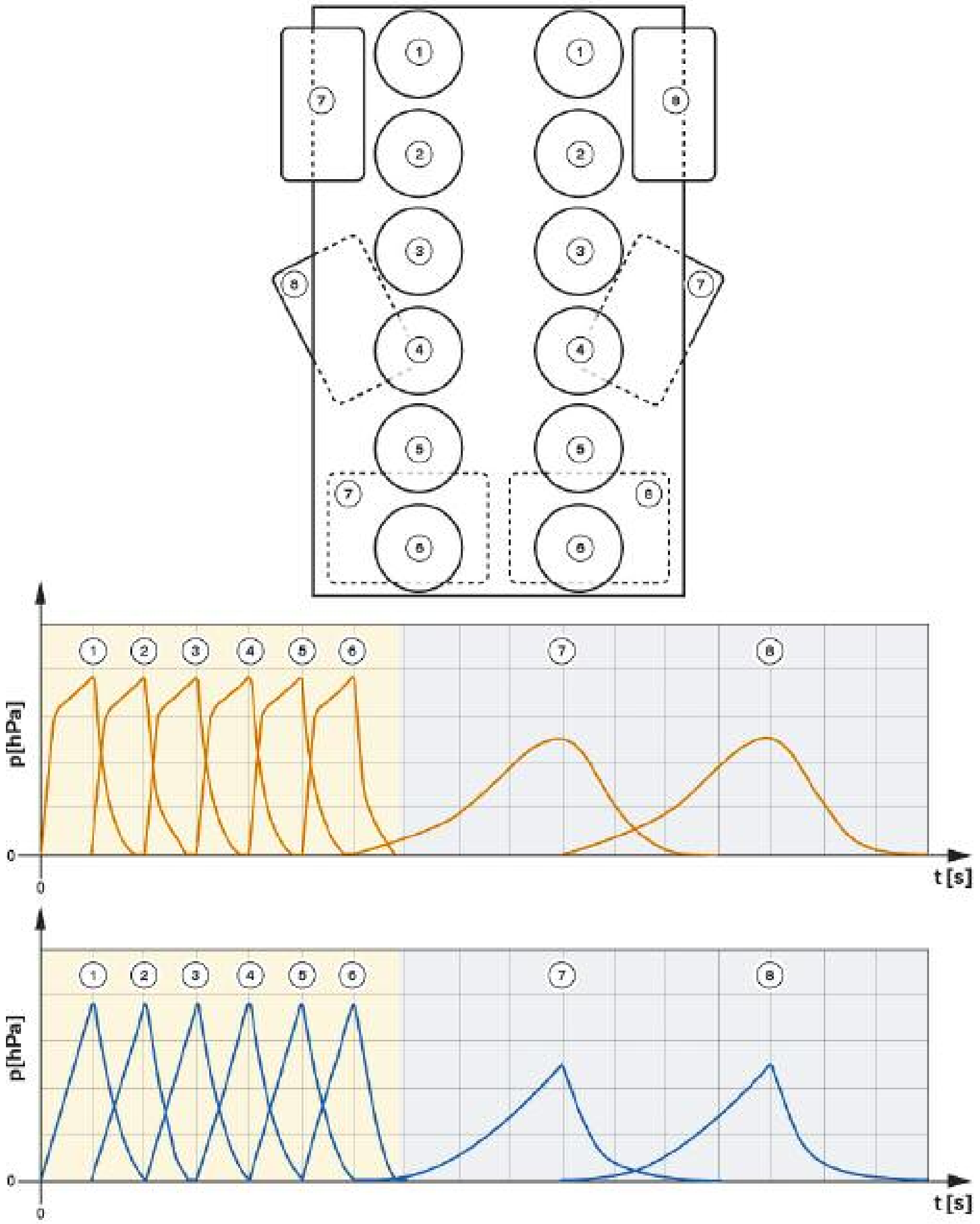
Function	Pump speed
Lumbar support	Maximum RPM
Maximum massage intensity	High RPM
Low massage intensity	Low RPM



Index	Explanation
1	Mobilization cushions, right shoulder, left thorax and right lumbar
2	Mobilization cushions, left shoulder, right thorax and left lumbar

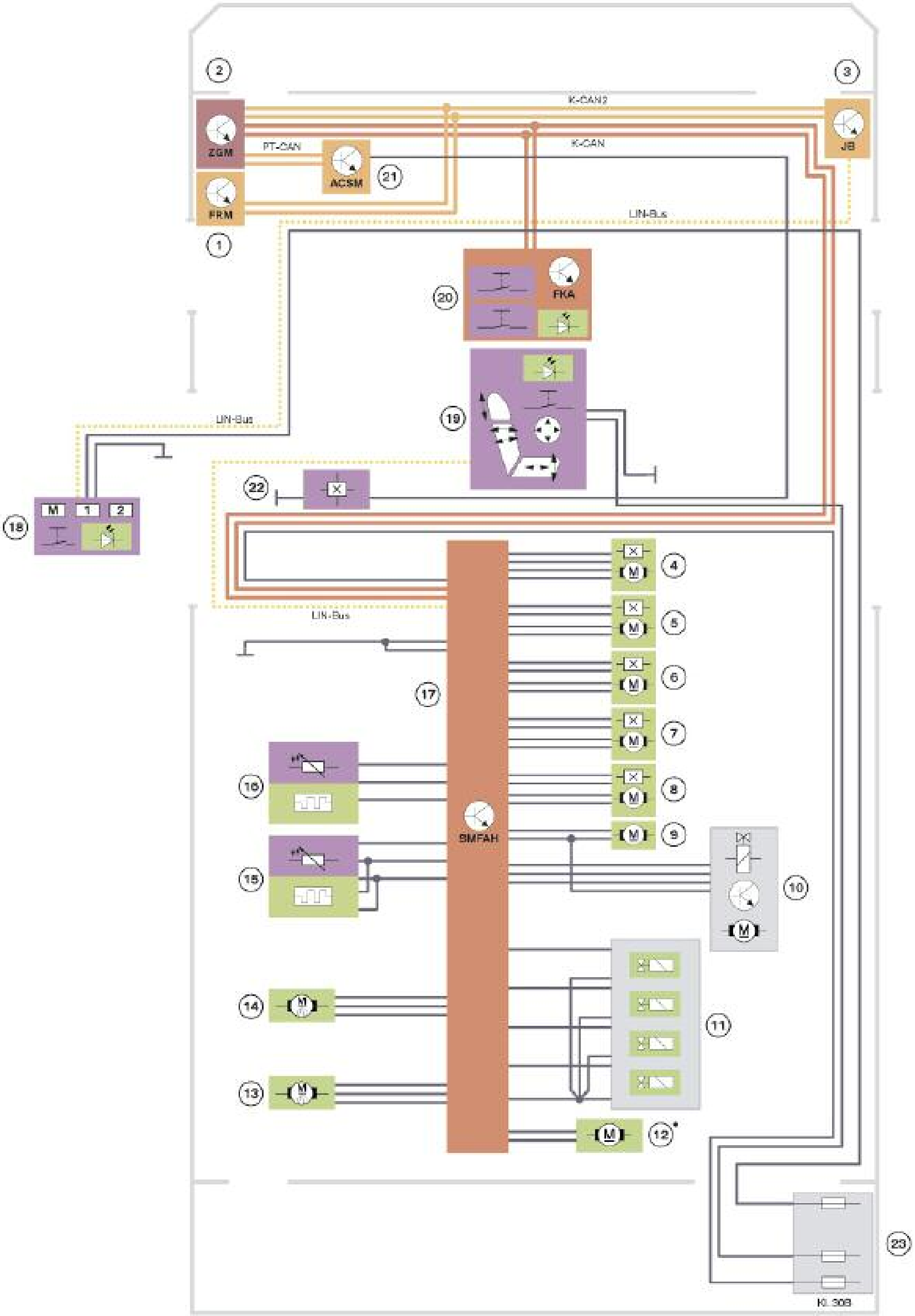
F01/F02 massage cushions

F01/F02 diagram of massage cycle sequence



Index	Explanation	Index	Explanation
1	Massage cushion pair 1	6	Massage cushion pair 6
2	Massage cushion pair 2	7	Mobilization cushions, right shoulder, left thorax and left lumbar
3	Massage cushion pair 3	8	Mobilization cushions, left shoulder, right thorax and left lumbar
4	Massage cushion pair 4	Orange	Graph of max. massage intensity
5	Massage cushion pair 5	Blue	Graph of min. massage intensity

System Circuit Diagram, Rear Comfort Seat Behind the Driver



Index	Explanation	Index	Explanation
1	Footwell module (FRM)	15	Seat-heating pad, backrest surface
2	Central gateway module (ZGM)	16	Seat-heating pad, seat surface
3	Junction box electronics (JB)	17	Seat module, driver's side, rear (SMFAH)
4	Motor, longitudinal seat adjustment (SLV)	18	Button block in the armrest, driver's side
5	Motor, seat-inclination adjustment (SNV)	19	Buttons, seat functions, driver's seat
6	Motor, backrest-inclination adjustment (LNV)	20	Integrated automatic heating and air conditioning IHKA
7	Motor, upper backrest adjustment (LKV)	21	Advanced Crash Safety Management (ACSM)
8	Motor, head-restraint height adjustment (KHV)	22	Seatbelt-buckle switch
9	Pump, lumbar support/massage function	23	Distribution box in luggage compartment
10	Pressure distribution module, massage/lumbar support	K-CAN2	Body CAN2
11	Solenoid valves for lumbar support	K-CAN	Body CAN
12	Pump for lumbar support*	LIN-Bus	Local interconnect network bus
13	Fan, active seat ventilation, backrest surface	Kl. 30B	Terminal 30 basic operation
14	Fan, active seat ventilation, seat surface		

* Pump in a vehicle equipped with lumbar support. In a vehicle equipped with massage seats, a different pump is used.

This pump supplies the massage seat and lumbar support with air.

K-CAN signals at the seat module

In/Out	Information	Source/sink	Function
In	Outside temperature	Outside temperature sensor > instrument cluster	Ambient conditions when faults are stored
In	Power reduction stage	Energy management system > digital engine control	Power reduction of seat heating

Seatbelt-buckle Switch in the Rear Seat

The seatbelt-buckle switch signals whether the seatbelt is fastened or not. When the seatbelt is fastened, the seat module adjusts the head restraint with an electric motor to the previously used head restraint height.

If the seatbelt has not been fastened, then the head restraint is fully retracted. This increases the field of vision out the back window.

The Advanced Crash Safety Management evaluates the seatbelt-buckle switch and sends its status via the PT-CAN. The central gateway module transfers the signal to the KCAN. This provides the seat module with information about whether the seatbelt is fastened or not. The seat module sets the head restraint to the maximum height if the seatbelt is on, or completely back if the seatbelt is not on.

System Components

Controls and Control Units

Controls

The controls for the seat functions are connected depending on the seat equipment. The controls are:

- Seat-adjustment switches
- Lumbar support switch
- Memory buttons
- Active-seat button
- Active seat ventilation button
- Massage function button.

Refer to the following table:

Switch/button connection	Application
Direct	Seat adjustment motor is directly activated.
Resistance-coded	The seat module reads in the switch directly and effects the request triggered by the switch.
LIN-Bus	The seat module cyclically requests the status of the switch and effects the request triggered by the switch.
LIN bus > K-CAN2	For example, the buttons in the armrests are connected to the footwell module or the junction box electronics. The control units evaluate the button status and send it via the K-CAN2. The signal is transferred from the central gateway module to the K-CAN.
Control unit > K-CAN	For example, the button status for the seat heating in the front seats is evaluated by the integrated automatic heating and air conditioning system and issued via the K-CAN. For example, the button status for the active seat ventilation in the rear seats is evaluated by the automatic rear-compartment air conditioning and issued via the K-CAN.

Control Units

- **Junction box electronics**

The junction box electronics each have a control outlet for the seat heating. In seat heating with a seat heating module, the junction box electronics activate the seat heating via the LIN bus.

Note: The junction box electronics cede activation of the seat heating to the seat module of the respective seat.

- **Seat heating module**

The seat heating module evaluates the LIN bus signal from the junction box electronics. The seat heating module is connected by means of three connectors. One connector establishes the connection to the junction box electronics. The other two connectors are responsible for connecting the seat heating.

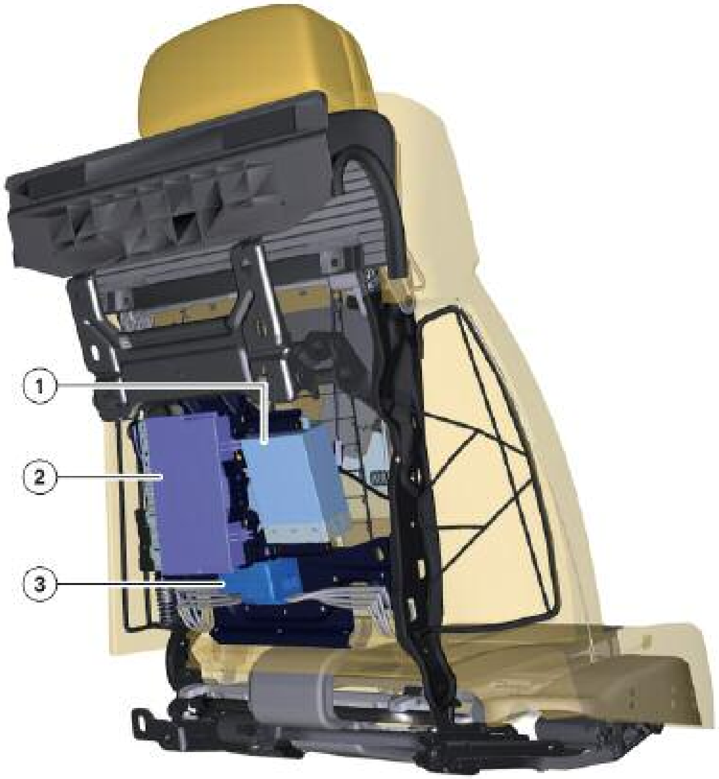
- **Seat module**

The seat module receives activation information for the seat heating via the K-CAN. Similarly, the seat module evaluates the button status of the controls for the various seat functions.

The requests made by the memory buttons for the door mirror are made available via the K-CAN. The positions for seat memory are stored in the seat module.

The requirements of the seat-adjustment switches are executed by the seat module.

Pressure Distribution Module



Index	Explanation	Index	Explanation
1	Lumbar support pump	3	Pressure distribution module, massage/lumbar support
2	Seat module		

A pressure distribution module located in the backrest is for inflating and deflating the respective massage or mobilization cushions. The pressure distribution module distributes the air for the massage cycle. There is a motor for this that drives an eccentric shaft. The eccentric shaft is designed so that it alternately opens and closes the air inlets and outlets of the massage cushions and mobilization cushions.

The required air is supplied by the pump for the lumbar-support adjustment. The seat module receives the request for the required air for the massage function from the pressure distribution module. The pump for the lumbar-support adjustment is activated by the seat module.

Note: Lumbar-support adjustment has priority over the massage function.

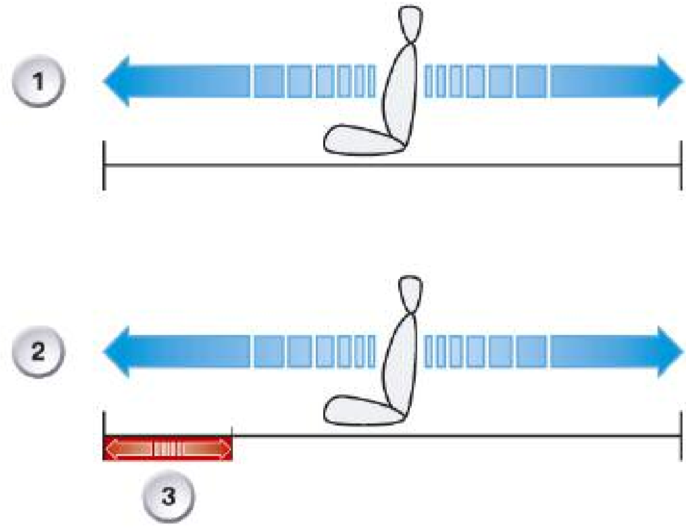
Service Information

Calibration of the Drivers/front-Passenger Seat in the US Version

The position of the driver's seat in the longitudinal direction can become implausible in the course of that seat's life. This can be caused by repeatedly moving the seat forward and back in the longitudinal direction.

These movements can give rise to an unauthorized position delta which no longer provides for a determination of the seat position.

The seat must therefore be recalibrated. Calibration is easy and can be performed by the customer him-/herself. Please refer to the Owner's Handbook.



Absolute seat position

Index	Explanation	Index	Explanation
1	Relative seat position	Blue arrow	Total seat-adjustment travel
2	Absolute seat position	Red arrow	Seat-adjustment travel (5% woman)
3	5% woman area		

Note: The seat must be moved in the mechanical front stop. Then the seat is calibrated and can be adjusted in the desired seat position.

If the seat is unable to reach the mechanical front stop, the calibration must be performed in the service garage/workshop.

This situation can come about if, for example, a coin is stuck in the seat-adjustment rail and blocks the adjustment travel.

If repairs are made to the seat, the seat must always be calibrated. This is necessary to guarantee seat-position recognition, or more precisely to increase the safe and reliable function of seat-position recognition.

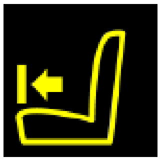
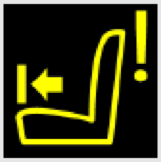
Switching the seat control unit for test purposes for example with one from another vehicle is possible. The seat calibration will be lost however. Because the possibility of the calibration being in order when the old seat control unit is reinstalled cannot be ruled out, it is necessary to calibrate the seat. Refer to the repair instructions for seat calibration.

Note: The ACSM receives a message from the seat module once a second as to whether calibration of the seat is necessary.

The signal is transferred in the central gateway module from the K-CAN to the PT-CAN.

As soon as the message contains the information “Calibration necessary”, the ACSM outputs a Check Control message via the PT-CAN to the instrument cluster.

The seat control unit can likewise trigger the Check Control message. This is possible if for instance the Hall sensor of the longitudinal drive motor is defective. A repair in the garage/ workshop will therefore be necessary. The seat must be calibrated after the repair.

Check Control Message	Meaning	Information in Central Information Display
	Seat must be recalibrated.	Seat calibration necessary.
	Seat-position recognition malfunctioning!	Seat-position recognition malfunctioning! Have the system checked by BMW Service at the next available opportunity.

Replacing Components

The seats consist of a large number of components. For this reason, the components can be replaced if one becomes faulty.

The Repair Instructions must be observed when replacing or making repairs to a seat. It is also important that only genuine BMW replacement parts are used. This ensures that the seat functions remain intact.

For example, the motors for the seat adjustment cannot be replaced separately from the corresponding output shaft, because they form one electromechanical unit.

Table of Contents

F01 Steering Column Switch Cluster

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Subject **Page**

Steering Column Switch Cluster

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the operation of the SZL in the F01/F02

Introduction

The Steering Column Switch Cluster - An Interface

The steering column switch cluster is a “mechanical and electrical interface” from the steering wheel to the vehicle; it is firmly connected mechanically to the steering column. On top of this purely mechanical connection, the steering column switch cluster is connected electrically via bus systems or directly to components.

In the F01/F02, the steering column switch cluster has a steering column stalk on either side of the steering column. The right-hand steering column stalk is for activating/ deactivating the wiper/washer system functions. The left-hand steering column stalk is for activating/deactivating the high-beam headlight or turn indicators and for operating the on-board computer functions.

A steering column switch cluster with optical steering-angle sensor is built into the F01/ F02. The steering-angle sensor uses a non-contact optical measuring system for steering-angle detection.

The steering column switch cluster receives the button signal of the steering wheel directly or across the LIN bus. These signals are forwarded from the steering column switch cluster to the respective control units.

Signals such as the buttons for controlling the volume of the radio are transmitted by the steering column switch cluster across the FlexRay. The steering column switch cluster receives e.g. the signal to activate the vibration actuator across the FlexRay.

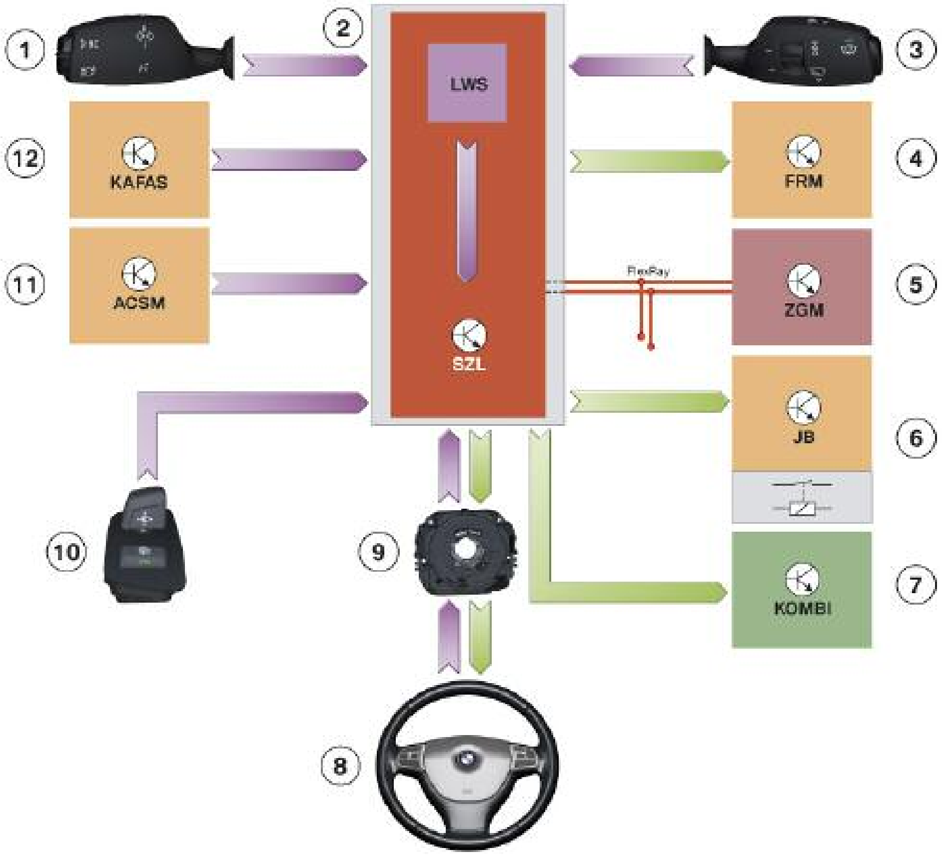
The steering column switch cluster forwards the trigger signal of the driver’s airbag directly to the priming caps of the airbag.

For the electrical steering column adjustment, the switch cluster evaluates the button and transmits requests across the FlexRay.

The steering column switch cluster also evaluate the button for the steering wheel heating. The steering column switch cluster forwards this signal across the LIN bus to the steering wheel electronics.

System Overview

Input/output Diagram, Steering Column Switch Cluster

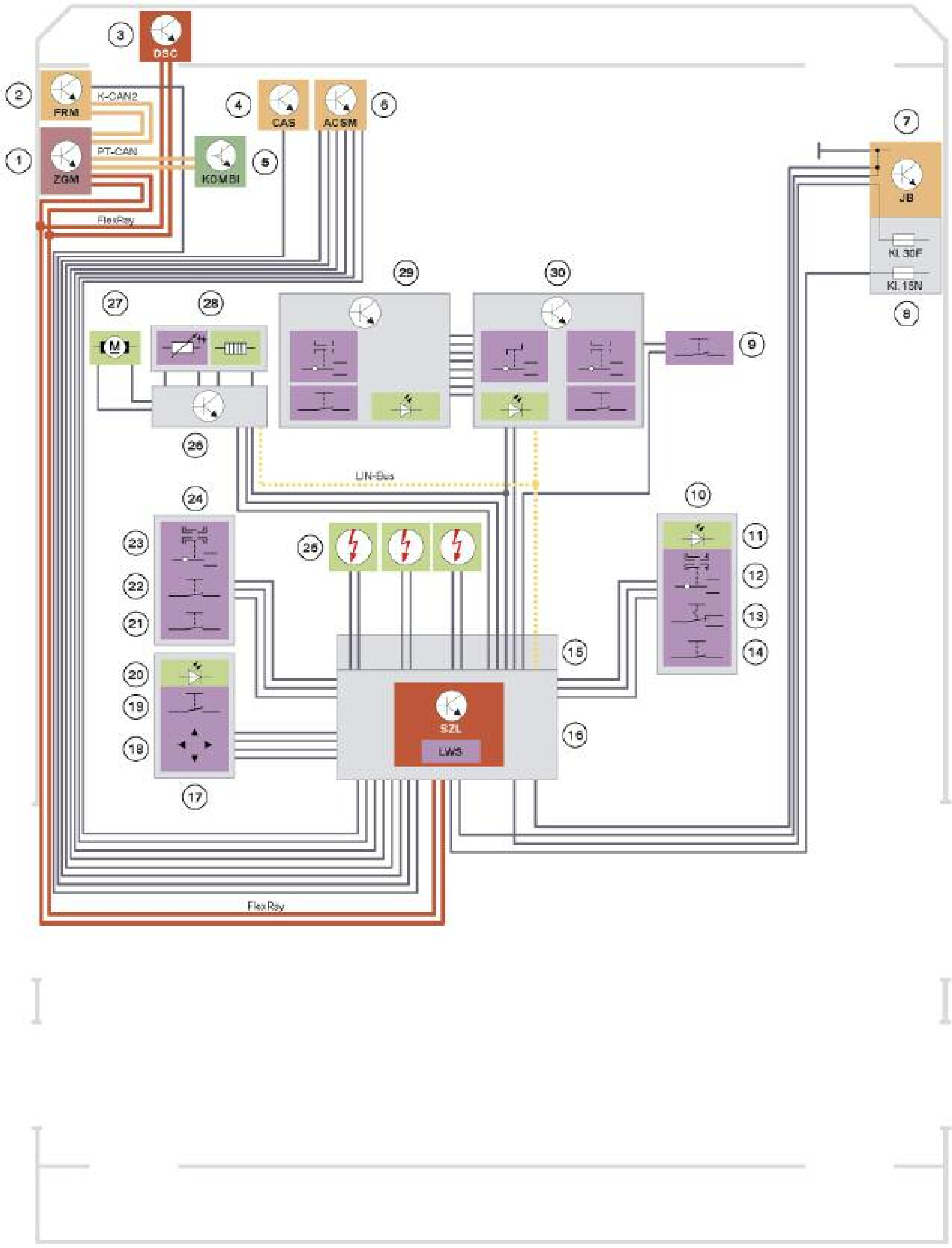


Index	Explanation	Index	Explanation
1	Steering column stalk for turn-indicator / high-beam switch	9	Coil-spring assembly
2	Steering column switch cluster (SZL)	10	Steering wheel heating / steering wheel adjustment buttons
3	Steering column stalk wiper switch	11	Crash Safety Module (ACSM)
4	Footwell module (FRM)	12	Control unit (KAFAS)
5	Central gateway module (ZGM)	FlexRay	FlexRay
6	Junction box electronics (JB)	LIN-Bus	Local Interconnect Network bus
7	Instrument cluster (KOMBI)	LWS	Steering-angle sensor
8	Multifunction steering wheel		

The signals which are triggered by the turn-indicator / high-beam switch steering column stalk (1) or wiper switch (3) are made available to the footwell module (4) or the junction box electronics (6).

The button signals at the multifunction steering wheel (8) are directed through the coil-spring assembly (9) to the steering column switch cluster (2), where they are evaluated and then transmitted across the FlexRay.

System Circuit Diagram, Steering Column Switch Cluster



Index	Explanation
1	Central gateway module (ZGM)
2	Footwell module (FRM)
3	Dynamic Stability Control (DSC)
4	Car Access System (CAS)
5	Instrument cluster (KOMBI)
6	Crash Safety Module (ACSM)
7	Junction box electronics (JB)
8	Front distribution box
9	Fanfare-horn button
10	Steering column stalk wiper switch
11	Automatic wiping LED
12	Wiper switch
13	Knurled wheel for intensity of the rain-light-solar-condensation sensor
14	Automatic wiping button
15	Steering column switch cluster coil spring
16	Steering column switch cluster (SZL)
17	Button combination steering wheel heating / electrical steering column adjustment
18	Electrical steering column adjustment button
19	Steering wheel heating button
20	Steering wheel heating button LED
21	High-beam assistant button
22	On-board computer button
23	Turn-indicator / high-beam switch
24	Steering column stalk for turn-indicator / high-beam switch
25	Driver's airbag priming caps
26	Steering wheel electronics
27	Vibration actuator
28	Steering wheel heating
29	Button block for cruise control system in the multifunction steering wheel
30	Button block for radio / telephone etc. in the multifunction steering wheel
FlexRay	FlexRay
Kl. 30	Terminal 30
Kl. 30B	Terminal 30 base operation
LIN-Bus	Local Interconnect Network bus
LWS	Steering-angle sensor

Note: A three-stage driver’s airbag is installed in the US version.

Functions

Signal Detection

The functions of the steering column switch cluster are:

- Detecting the switching signals of the steering-column switches
- Detecting the controls in the multifunction steering wheel
- Resetting the turn indicator
- Transmitting and receiving information.

Detecting the Switching Signals of the Steering-column Switches

The switching signals of the F01/F02 steering-column switches are triggered by the steering column stalks. The relevant switches are located on the printed-circuit board of the steering column switch cluster. The steering column stalks do not have detent notches. Therefore, each time the steering column stalks are operated, they return automatically to their starting position.

The resistance to movement of the steering column stalks is increased at the end stops and in the individual switching positions. This provides the customer with noticeable feedback on the respective lever position.

The toggle switch is designed as locking. Three stop positions are available.

Steering column switch cluster F01/F02

Index	Explanation	Index	Explanation
1	Steering column stalk for turn-indicator / high-beam switch	5	Connection to horn button, multifunction buttons and steering wheel electronics
2	Connection to the priming caps of the airbag	6	Power supply connection for vibration actuator
3	Retaining pin for steering column switch cluster	7	Steering column stalk wiper switch
4	Steering wheel driver		

Steering column stalk for turn-indicator / high-beam switch

The steering column switch cluster generates the switching signals depending on the respective position of the steering column stalk. The switching signals are made available by the steering column switch cluster across the FlexRay.

The footwell module receives the requests from the turn-indicator / high-beam switch as well as for the high-beam assistant.

Pressing the on-board computer button in the axial direction initiates the requests for the onboard computer. The steering column switch cluster sends the requests for display of the on-board computer functions across the FlexRay.

Note: In the case of vehicle equipment without the high-beam assistant, the button on the steering column stalk for turn-indicator / high-beam switch is not required. Instead, a large button is used.

Directions of movement of the steering column stalk F01/F02

Index	Explanation
1	High-beam assistant button
2	On-board computer button
3	High-beam headlights
4	Triple turn signal for turn indicator, passenger's side
5	Continuous flashing for turn indicator, passenger's side
6	Headlight flasher
7	Triple turn signal for turn indicator, driver's side
8	Continuous flashing for turn indicator, driver's side

Function matrix for turn-indicator / high-beam switch

Operation	Initial state	Function	Configuration
One-touch operation in upward direction	OFF	One-touch indicating	Setting with no detent notch
	Continuous indicating, right	OFF	Setting with no detent notch
	Continuous indicating, left	OFF	Setting with no detent notch
One-touch operation in downward direction	OFF	One-touch indicating	Setting with no detent notch
	Continuous indicating, right	OFF	Setting with no detent notch
	Continuous indicating, left	OFF	Setting with no detent notch
Overpressing in upward direction	OFF	Continuous indicating, right	Setting with no detent notch
	Continuous indicating, right	Continuous indicating, right	Setting with no detent notch
	Continuous indicating, left	Continuous indicating, right	Setting with no detent notch
Overpressing in downward direction	OFF	Continuous indicating, left	Setting with no detent notch
	Continuous indicating, right	Continuous indicating, left	Setting with no detent notch
	Continuous indicating, left	Continuous indicating, left	Setting with no detent notch
One-touch operation against direction of travel (pulling)	OFF	Headlight flasher	Setting with no detent notch
	High-beam headlights ON	High-beam headlights OFF	Setting with no detent notch
One-touch operation in direction of travel (pressing)	Dipped-beam headlights	High-beam headlights ON	Setting with no detent notch
One-touch in axial direction, on-board computer button (pressing)	On-board computer function switched off	On-board computer ON	Setting with no detent notch
	On-board computer function switched on	On-board computer OFF	Setting with no detent notch
One-touch in axial direction, high-beam assistant button	High-beam assistant switched on	Deactivate high-beam assistant	Setting with no detent notch
	High-beam assistant switched off	Activate high-beam assistant	Setting with no detent notch
Overpressing in downward direction	Terminal 30, light switch in "0" position	Parking light, left	Setting with no detent notch
Overpressing in upward direction	Terminal 30, light switch in "0" position	Parking light, right	Setting with no detent notch

Steering column stalk wiper switch

This steering column stalk is designed exclusively for the front wiper/washer system. All requests for the wiper/washer system are detected in the steering column switch cluster. The steering column switch cluster sends the requests across the FlexRay to the junction box electronics. The junction box electronics execute the requests.

Index	Explanation
1	Steering column stalk wiper switch
2	Intensity of rain-light-solar-condensation sensor
3	Function indicator, automatic wiping activated
4	Rain-light-solar-condensation sensor button

Function matrix, steering column stalk wiper switch

Operation	Initial state	Function	Configuration
One-touch operation in upward direction	OFF	Wiper stage 1	Setting with no detent notch
	Continuous wipe, Stage 1	Wiper stage 2	Setting with no detent notch
	Continuous wipe, Stage 2	Wiper stage 2	Setting with no detent notch
Overpressing in upward direction	OFF	Wiper stage 2	Setting with no detent notch
	Continuous wipe, Stage 1	Wiper stage 2	Setting with no detent notch
	Continuous wipe, Stage 2	Wiper stage 2	Setting with no detent notch
One-touch operation in downward direction	OFF	Flick wipe	Setting with no detent notch
	Continuous wipe, Stage 1	OFF	Setting with no detent notch
	Continuous wipe, Stage 2	Wiper stage 1	Setting with no detent notch
One-touch operation against direction of travel (pulling)	OFF	Windscreen wash	Setting with no detent notch

Rain-light-solar-condensation sensor

If the vehicle is in the automatic mode via rain-light-solar-condensation sensor, the function matrix of the steering column stalk is altered. Please refer to the following function matrix for the functions.

Function matrix, steering column stalk for wiper/washer system

Operation	Initial state	Function	Configuration
One-touch operation in upward direction	OFF	Wiper stage 1	Setting with no detent notch
	Automatic operation	Wiper stage 1	Setting with no detent notch
	Continuous wipe, Stage 1	Wiper stage 2	Setting with no detent notch
	Continuous wipe, Stage 2	Wiper stage 2	Setting with no detent notch
Overpressing in upward direction	OFF	Wiper stage 2	Setting with no detent notch
	Automatic operation	Wiper stage 2	Setting with no detent notch
	Continuous wipe, Stage 1	Wiper stage 2	Setting with no detent notch
	Continuous wipe, Stage 2	Wiper stage 2	Setting with no detent notch
One-touch operation in downward direction	OFF	Flick wipe	Setting with no detent notch
	Automatic operation	Flick wiping*	Setting with no detent notch
	Continuous wipe, Stage 1	Intermittent wipe	Setting with no detent notch
	Continuous wipe, Stage 2	Wiper stage 1	Setting with no detent notch
One-touch operation against direction of travel (pulling)	OFF	Windscreen wash	Setting with no detent notch
One-touch in axial direction, automatic wiping button (pressing)	Automatic wiping switched off	Automatic wiping ON	Setting with no detent notch
	Automatic wiping switched on	Automatic wiping OFF	Setting with no detent notch
Turning the knurled wheel upwards/downwards	Sensitivity of rain-light-solar-condensation sensor	Sensitivity of automatic wiping or	Setting with detent notch

(automatic mode is retained)

Detecting the Controls

The multifunction steering wheel has additional buttons. The buttons increase in-car comfort and convenience by providing for comfort and convenience functions.

The steering column switch cluster reads in the signals from the steering-wheel buttons. The steering column switch cluster transmits these signals across the FlexRay. The associated ECU executes the request.

■ Steering wheel

The steering wheel is equipped with the following components:

- Fanfare-horn button
- Priming caps for the driver's airbag
- Driver's airbag
- Buttons for radio operation
- Buttons for telephone operation
- Cruise control system buttons
- Steering wheel electronics
- Steering wheel heating
- Vibration actuator.

The fanfare-horn button is connected directly to the steering column switch cluster. The junction box electronics requests the button status of the fanfare-horn button in cycles.

The steering column switch cluster evaluates the button status and sends this across the FlexRay to the junction box electronics.

The buttons for the radio, telephone and cruise control system are connected via the LIN bus. The applies to the steering wheel electronics. The central control unit for this equipment attached to the LIN bus is the steering column switch cluster.

The right-hand button block contains the master function for the left-hand button block and has an electronic evaluation unit. The electronic evaluation unit picks up the button status of the individual buttons. The electronic evaluation unit implements the button status on the LIN bus. The steering column switch cluster requests the button status in cycles and thus finds out whether a button was operated or not. The steering column switch cluster transmits the button status across the FlexRay. In this way, the information reaches the other control units in the vehicle network.

Note: The signal sent from the steering column switch cluster across the FlexRay must be implemented in the central gateway module on the K-CAN2, PT-CAN or MOST. This enables the footwell module, the junction box electronics etc. to execute the desired requests.

Resetting the Turn Indicator

The footwell module the information regarding the steering-wheel turn requires to reset the turn indicator lights.

The steering column switch cluster determines this steering-wheel turn and makes it available across the FlexRay. The central gateway module implements the signal on the K-CAN2, thus providing the footwell module with the information. Depending on the steering-wheel position, the footwell module decides whether the turn indicator has to be deactivated or not.

■ Steering-wheel-rotation information

The optical steering-angle sensor detects the neutral position within 360° of the optical steering-angle sensor. With a steering wheel turn of more than 360°, the information regarding the steering-wheel turn is also included in the steering angle calculation.

Receiving and Transmitting Signals

The detected and calculated data from the steering column switch cluster are forwarded across the FlexRay to the corresponding control units.

The steering column switch cluster can be diagnosed via the central gateway module with the BMW diagnosis system. The diagnosis information can be called up via the FlexRay.

■ Vibration actuator

The KAFAS control unit, for example, requests activation of the vibration actuator via the PT-CAN. The central gateway module implements the signal on the FlexRay. This means the Integrated Chassis Management receives the request for activation. The Integrated Chassis Management co-ordinates activation of the vibration actuator.

Note: Coordination is necessary, as the lane departure warning and lane change warning can be fitted in the vehicle. Depending on the request from the two assistance systems, the Integrated Chassis Management forwards this to the vibration actuator.

The steering wheel electronics evaluate the request, activate the vibration actuator and monitor its function. In the event of a defect in the vibration actuator or steering wheel electronics, the steering column switch cluster indicates this via the FlexRay.

■ Priming caps for the driver's airbag

The priming caps of the driver's airbag are connected directly via the coil spring to the Crash Safety Module, ACSM. Triggering the airbag is the responsibility of the Crash Safety Module.

Redundant signal
The signals from the steering column stalk for turn-indicator / high-beam switch for turn indicator lights as well as headlight flasher are transferred across the FlexRay. To increase the availability, the steering column switch cluster is connected directly by a cable to the footwell module. The signals e.g. for the headlight flasher or turn indicator lights are transferred redundantly across this cable.

Optical Steering-angle Sensor

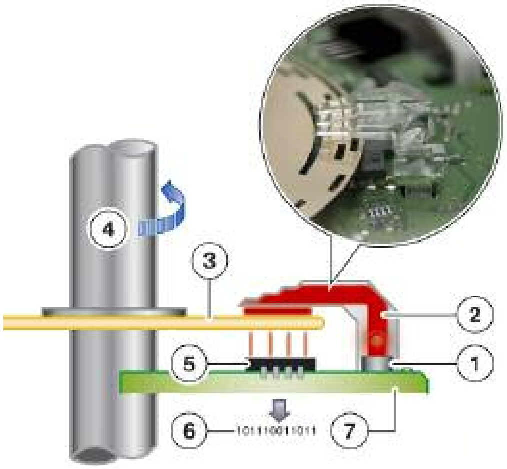
All systems that influence driving dynamics are required alongside other data for the steering angle and steering-angle speed as the basis for calculation.

The steering angle as well as steering-angle speed are picked up by a non-contact optical measuring system, the optical steering-angle sensor.

The data of the optical steering-angle sensor are processed by the electronics in the steering column switch cluster and sent across the FlexRay to the Integrated Chassis Management.

Information such as the absolute steering angle or the steering-wheel-turn is calculated. The optical steering-angle sensor picks up a steering angle of -640° / +640°.

Structural principle of the optical steering-angle sensor F01/F02



Index	Explanation
1	LED
2	Light-conducting element
3	Code disc
4	Steering column
5	Photo-transistors
6	Output: Conversion into electrical signals
7	Printed-circuit board

Detecting Steering Angle and Steering-Angle Speed

To pick up the steering angle, a code disc is illuminated from above by an LED and a light-conducting element. Due to the pattern in the code disc, the light from above only reaches down to certain areas. There, the light encounters photo-transistors.

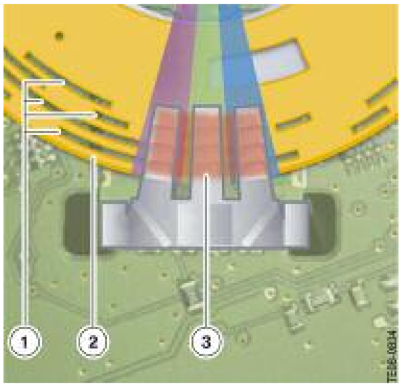
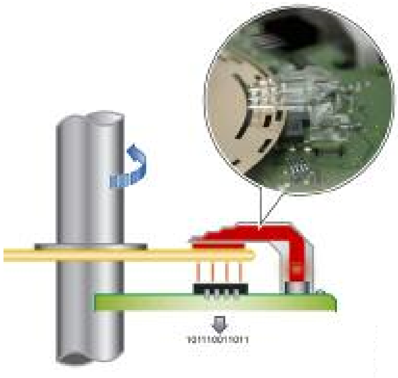
The pattern of the code disc corresponds to the digital code of the steering angle.

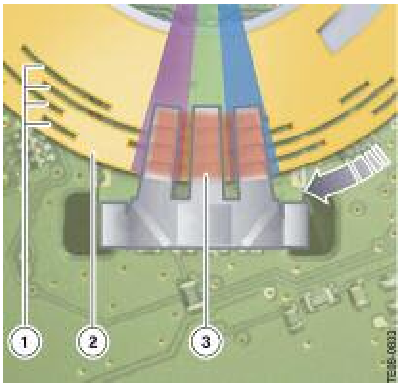
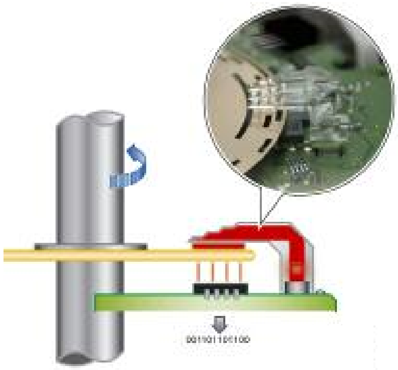
The photo-transistors convert the light signals into electrical signals. As the signals are not yet sufficiently unambiguous, they are processed by downstream electronics.

Thereafter, the signals are digitized and have the signal states 1 or 0.

The steering column switch cluster receives the current value of the steering angle, the digital code, and forwards this across the FlexRay.

A section of the code disc and the optical sensor are shown below.

Section on the code disc	Optical sensor
	
The code disc (1) rotates depending on the steering-wheel position. The pattern of the digital code (2) on the code disc changes in 0.5° steps. The light of the light-conducting element (3) penetrates the pattern of the digital code of the code disc.	The light beams encounter the photo-transistors in accordance with the pattern of the digital code. The photo-transistors convert the light beams into electrical signals. The downstream electronics ensure that the electrical signals have the signal states 1 or 0. This means that the steering angle is available to the steering column switch cluster as a digital code.

Section on the code disc	Optical sensor
	
If the code disc (1) continues to rotate, the pattern (2) on the code disc changes. The light of the light-conducting element (3) penetrates the code disc in other areas.	A new digital code is generated in accordance with the changed pattern of the digital code. This means that the new steering angle is available to the steering column switch cluster as a digital code.

Relative steering angle (± 640°)

The relative steering angle specifies the angle position of the steering wheel. The information regarding the relative steering angle is always retained, even if the power to the control unit is switched off. A renewed zero-point adjustment is only necessary if the steering column switch cluster has been replaced. This also applies if the dynamic stability control system is replaced or repairs become necessary on the steering / steering column.

Absolute steering angle

The absolute steering angle is a calculation based on the relative steering angle and the information regarding steering-wheel turn. The absolute and relative steering angles are defined during the zero-point adjustment of the steering column switch cluster. The steering column switch cluster knows every position of the steering wheel across the entire range of steering rotation.

A precondition before every zero-point adjustment is the straight-ahead setting of the wheels and of the steering wheel.

Steering-angle speed

The steering-angle speed is the product of the change in the individual steering-angle data during steering wheel turn.

The steering column switch cluster calculates the value and forwards it across the FlexRay to the vehicle network.

System Components

The Steering Column Switch Cluster as Standard Equipment

The steering column switch cluster (SZL) consists of, among other things, the following components:

- Electronic steering column switch cluster module
- Coil-spring assembly
- Steering-column switch for turn indicators
- Steering column switch for wipers
- Optical steering-angle sensor.

The steering column switch cluster (SZL) can only be replaced as a **complete** unit. The individual components such as the coil-spring assembly or steering column stalk can **not** be removed or replaced.

The design and the components of the steering column switch cluster are explained in brief in the following.

Installation location of the steering column switch cluster F01/F02

Index	Explanation
1	Steering column switch cluster

Rear View of the Steering Column Switch Cluster

Index	Explanation
1	Connection, vehicle wiring harness
2	Connection for wiring harness in the vehicle (airbag signals)
3	Connection for steering wheel heating / electrical steering column adjustment button block

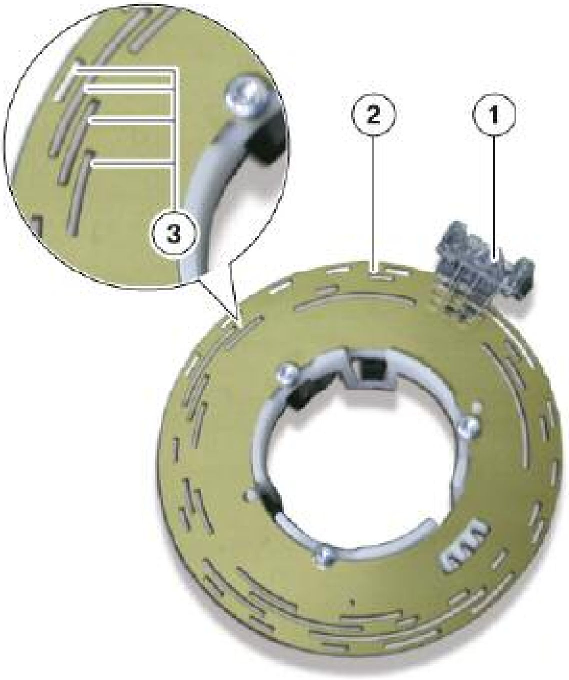
Optical Steering-angle Sensor

The steering column switch cluster contains the optical steering-angle sensor as well as the associated electronics. A second processor on the underside of the board backs up the information regarding the steering angle and steering-angle speed. This is why the steering angle and steering-angle speed are evaluated and calculated in the second processor in addition to the main processor of the steering column switch cluster.

The steering-angle sensor is designed as a non-contact optical angle measurement system. The system consists of a code disc and an optical sensor. The code disc is connected directly to the steering wheel via a driver. If the steering wheel is moved, the code disc rotates within the optical sensor.

The code disc has a pattern of holes. The pattern of holes is arranged in such a way that four circular tracks are formed. The four tracks represent the digital range of the sensor. The digital code changes when the steering is turned every 0.5°.

Code disc and optical sensor F01/F02

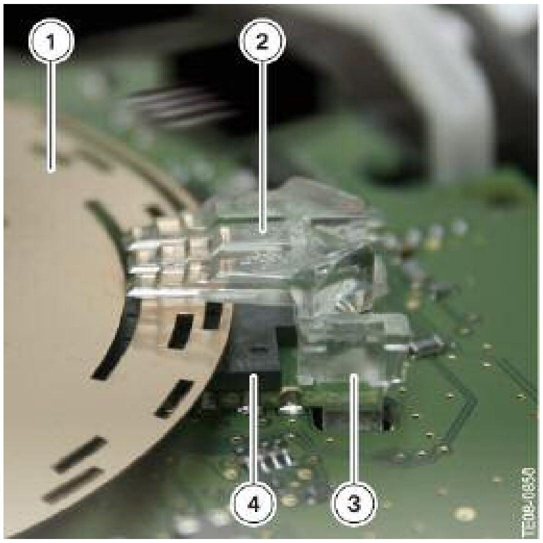


Index	Explanation
1	Optical sensor
2	Code disc
3	Hole pattern tracks

Optical sensor

The optical sensor is located on a circuit board soldered onto the board of the steering column switch cluster. The major components of the measuring system are:

- LED
- Light-conducting element
- Code disc
- Photo-transistors.



Index	Explanation
1	Code disc
2	Light-conducting element
3	LED
4	Photo-transistors

LED and light-conducting element

The LED - in conjunction with the light-conducting element - has the task of projecting light from above onto the code disc. The LED is directly soldered onto the sensor circuit board. The light-conducting element is clipped onto the board of the steering column switch cluster.

The light-conducting element is split three ways at the light exit. The light is projected in such a way that a light field is formed at each light exit and beamed downwards onto the code disc. Depending on the pattern on the code disc, light is allowed through or not.

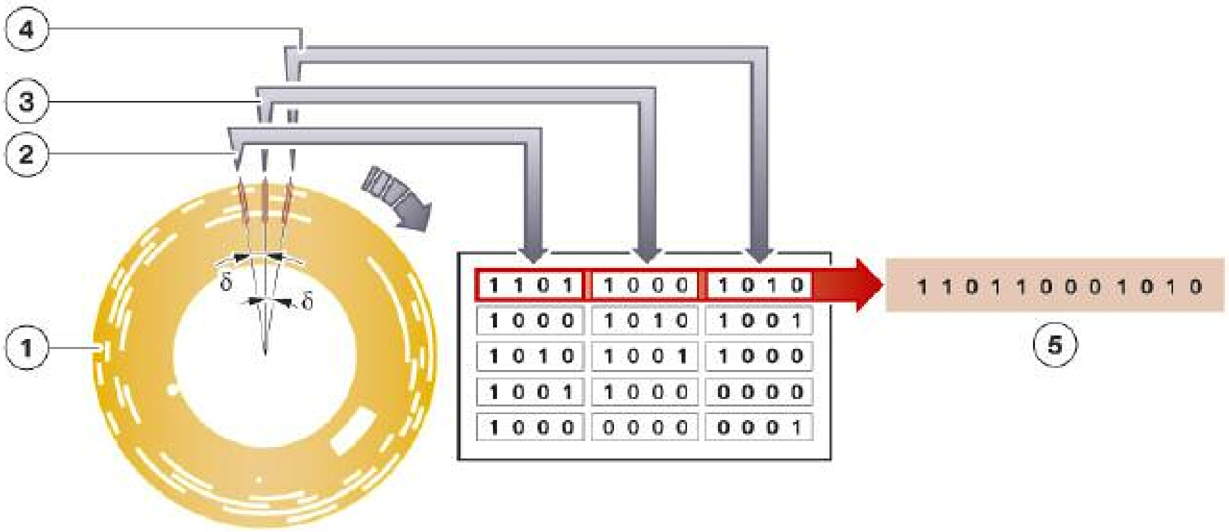
Photo-transistors

There are four photo-transistors below the light exits on the circuit board of the optical sensor of the steering column switch cluster. The photo-transistors detect the optical signals that penetrate the code disc. The photo-transistors convert the optical signals into electrical signals.

Operating Principle of Optical Steering Angle Detection

Steering angle detection

The code disc enables a 4-digit digital code to be generated for each light field. The 12-digit digital code is formed by lining up the 4-digit digital codes. The steering-angle speed can be ascertained from the changes to the individual digital codes.

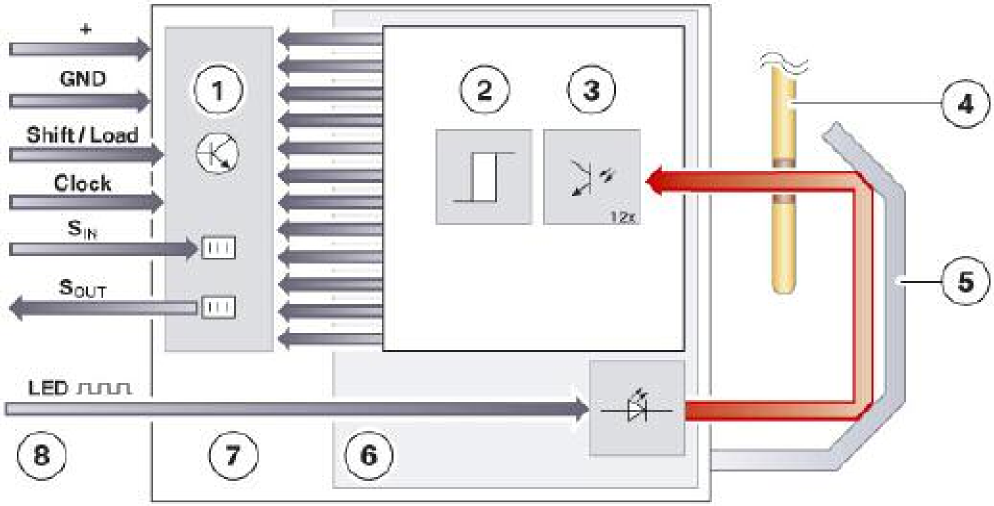


1 1 0 1	1 0 0 0	1 0 1 0
1 0 0 0	1 0 1 0	1 0 0 1
1 0 1 0	1 0 0 1	1 0 0 0
1 0 0 1	1 0 0 0	0 0 0 0
1 0 0 0	0 0 0 0	0 0 0 1

Index	Explanation	Index	Explanation
1	Code disc	4	Digital code for light field 3
2	Digital code for light field 1	5	12-digit digital code
3	Digital code for light field 2		

Block diagram of steering angle detection

The following block diagram shows the steering angle detection in simplified form.



Index	Explanation	Index	Explanation
1	Sliding register	5	Light-conducting element
2	Schmitt trigger	6	LED (infrared)
3	Photo-transistor	7	Sensor circuit board
4	Code disc	8	Activation of LED

The LED (8) is supplied with pulse-width modulated voltage, thus also supplying the light-conducting element (5) with infrared light. The light-conducting element projects the light onto the code disc (4). The photo-transistors (3) pick up the light signals.

The signals of the photo-transistors are processed in the downstream electronics (2) into the signals “1” or “0”. The signals of the 12 photo-transistors are put together to form the digital code.

The sliding register (1) picks up the digital code and forwards it to the electronics of the steering column switch cluster.

Steering Wheel

Depending on the vehicle equipment, the following components are located in the steering wheel:

- Button block for telephone / radio
- Button block for cruise control system / Active Cruise Control
- Airbag with associated priming caps
- Horn button
- Vibration actuator for lane departure warning
- Steering wheel electronics
- Steering wheel heating.

Steering Wheel Structure

Important components in the steering wheel F01/ F02

Index	Explanation	Index	Explanation
1	Steering wheel heating	4	Vibration actuator for lane departure warning
2	Button block for cruise control	5	Steering wheel electronics system
3	Airbag unit	6	Button block for telephone / radio

The button blocks as well as the steering wheel electronics are linked across the LIN bus to the electronics in the steering column switch cluster.

With the corresponding request, the steering wheel electronics control and monitor the function of the vibration actuator and steering wheel heating.

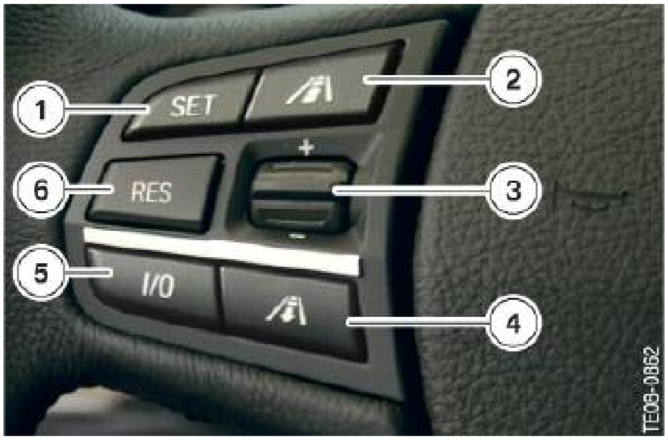
The priming caps of the airbags are connected directly and are activated by the Crash Safety Module, ACSM.

The fanfare-horn button is evaluated by the electronics of the steering column switch cluster.

Steering Wheel Button Block

■ Button block for driving functions

The steering wheel contains a button block for the Dynamic Cruise Control (DCC) or Active Cruise Control (ACC) Stop & Go functions. The button block is located on the left-hand side of the steering wheel.



Index	Explanation
1	Set button
2	Reduce distance button (ACC)*
3	Toggle switch
4	Increase distance button (ACC)*
5	Switching DCC/ACC to standby or switching off
6	Resume / call-up stored speed button

* Buttons 2 and 4 are only present on vehicles with the option Active Cruise Control Stop & Go.

Position	Explanation
+2	Increase driving speed in steps of 10 kph (6 mph)
+ 1	Increase driving speed in steps of 1 kph (.5mph)
± 0	Toggle switch in home position
-1	Reduce driving speed in steps of 1 kph (.5 mph)
-2	Reduce driving speed in steps of 10 kph (6 mph)

The SET button can be used to set the desired driving speed.

The toggle switch be moved upwards or downwards and is not designed as locking. Each time the toggle switch is operated, it returns to its home position. Each direction of the toggle switch has two stages. See table.

The I/0 button can be used to switch the Dynamic Cruise Control (DCC) and Active Cruise Control (ACC) Stop & Go function to standby or to switch it off.

Pressing the RES button (resume) calls up and activates the last stored driving speed value.

Button block for telephone / radio

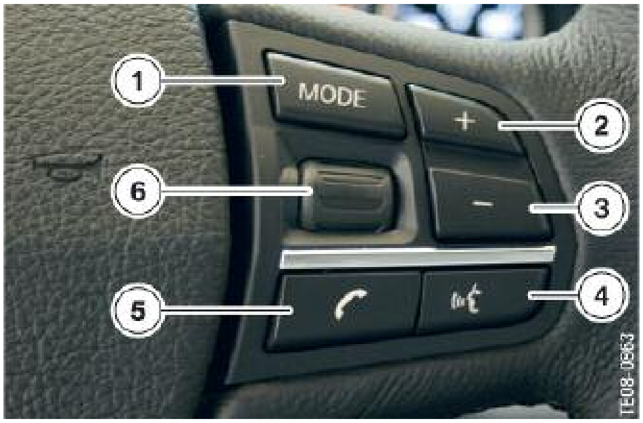
The button block is located on the right-hand side of the steering wheel. The buttons can be used to operate functions for the radio or telephone.

The MODE button can be used e.g. to switch between the individual audio sources.

Operating the toggle switch + or -changes the radio volume, for example.

The knurled wheel is designed as locking. Operating the knurled wheel (turning upwards or downwards) selects individual radio stations, for example.

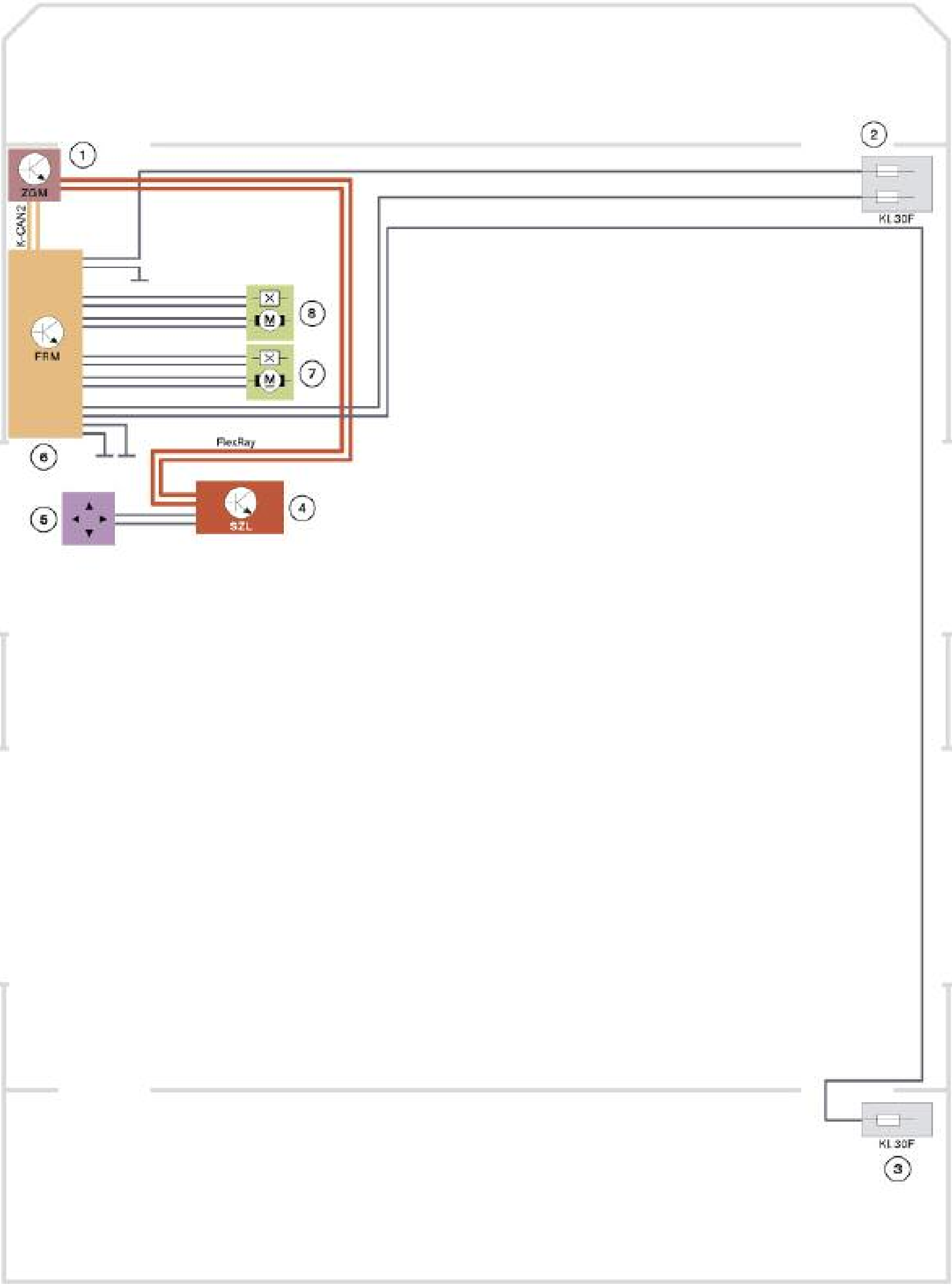
Pressing the knurled wheel memorizes the selection of the radio station, for example.



Index	Explanation
1	MODE button
2	Toggle switch +
3	Toggle switch -
4	Hands-free button
5	Telephone button
6	Knurled wheel

Electrical Steering Column Adjustment

System Circuit Diagram for Electrical Steering Column Adjustment



Index	Explanation	Index	Explanation
1	Central gateway module ZGM	7	Motor for electrical steering column adjustment, height
2	Front distribution box	8	Motor for electrical steering column adjustment, vertical
3	Distribution box in luggage compartment	K-CAN2	Body CAN2
4	Steering column switch cluster	FlexRay	FlexRay
5	Steering column adjustment button	Kl. 30F	Terminal 30 incorrectly switched
6	Footwell module		

Steering Column Adjustment and Steering Wheel Heating Button

The button for the steering column adjustment can be moved in four directions. It can be used to adjust the steering column upwards and downwards; the distance to the driver can also be adjusted.

The steering column switch cluster evaluates the button status and forwards it to the footwell module. The signal must go across the FlexRay to the central gateway module. From there, the signal is sent on the K-CAN2 to the footwell module. Accordingly, the footwell module activates the motors for steering column adjustment.

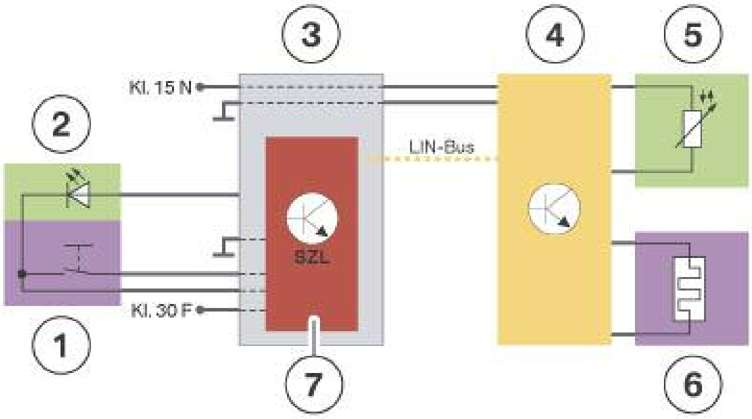
The footwell module monitors activation and function.

Note: The footwell module is the central control unit for the electrical steering column adjustment. The position of the steering column can be called up or stored in the footwell module for the memory function.

The button for the steering wheel heating is evaluated by the electronics of the steering column switch cluster. The electronics in the steering column switch cluster send a request across the LIN bus to the steering wheel electronics to switch the steering wheel heating on / off.

The steering wheel electronics switch the steering wheel heating on and monitor its function. The steering wheel heating has an NTC resistor. This resistor is required for temperature control of the steering wheel heating.

Signal path for the steering wheel heating F01/f02



Index	Explanation	Index	Explanation
1	Steering wheel heating button	6	Steering wheel heating
2	Steering wheel heating function indicator	7	Electronics of the steering column switch cluster
3	Steering column switch cluster (SZL)	Kl. 15N	Terminal 15 after-run
4	Steering wheel electronics	Kl. 30F	Terminal 30 incorrectly switched
5	NTC resistor	LIN-Bus	Local Interconnect Network bus

Replacing the Steering Column Switch Cluster

Particular care must be taken when replacing the steering column switch cluster or working on the steering column. Comply with the repair instructions.

The coil spring is a very sensitive component of the steering column switch cluster. If sufficient care is not taken when replacing the steering column switch cluster, the coil spring or another component can be destroyed. A consequence of this can be that the steering column switch cluster only works in part or does not work at all.

Note: If e.g. communication with the steering column switch cluster across the FlexRay is disrupted, the junction box electronics switch the windscreen wipers to the emergency mode.

The steering column switch cluster can only be ordered as a complete exchange part. After replacement, the new steering column switch cluster must be adapted to the car.

This involves among other things:

- Initialization of the steering column switch cluster
- Zero-point adjustment of the steering-angle sensor
- Front wheels in the straight-ahead position
- Function test.

For further information, refer to the repair instructions and the BMW diagnosis system.

Note: The transportation lock of the steering column switch cluster is only to be removed after replacement, shortly before fitting the steering wheel.

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F01 Displays, Indicators and Controls

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Subject **Page**

Displays, Indicators and Controls

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Explain the various stages of operation of the instrument cluster
- Explain the operation of the new controller and steering wheel controls
- Navigate through the CID menus
- Access an instrument cluster self test
- Access the service menu on the CID

Introduction

As in all other BMW models, the operating and control concept of the new BMW 7 Series F01/F02 is based on clear and optimum structuring of the cockpit. Fewer switches simplify logical operation. The display, indicator and control elements are organized in a hierarchical arrangement corresponding to their function.

This product information covers exclusively the following topics:

- Instrument cluster and
- Central Information Display, CID.

Note: All other display systems such as "Head-Up Display", "Night Vision 2", "Connected Service" and "Personal Profile" are described in detail in separate sections of this course's reference material.

Display, Operating and Control Concept

With the new BMW 7 Series F01/F02, a new operating and control concept is being introduced at BMW. In addition to the main menu, there is an arrangement of four direct access buttons, a Back button and an Option button in the immediate vicinity of the controller.

Display, operating and control concept BMW 7 Series F01/F02

Index	Explanation
1	Head-up display (HUD)
2	Instrument cluster
3	Central Information Display (CID)
4	Favorite buttons for individual assignment
5	Controller
6	Gear selector switch (GWS)
7	Steering column stalk/steering wheel
8	Operating unit for driver assistance systems (BEFAS)

Instrument Cluster

The instrument cluster is a new development. It has four analog needle instruments based on full-surface Black Panel technology.

With this display technology, the symbols of the individual functions only become visible when the ignition is switched on.

At first glance, the instrument cluster appears as a black surface, without an arrangement of digits and different-colored function symbols.

The two large dials show the road speed and engine speed.

The two small dials indicate the fuel level on the left-hand side and the oil temperature on the right-hand side.

Most of the indicator lamps arranged are in the center, at the top between the two large dials and above the two small dials.

A permanent background image in orange gives the instrument cluster a certain 3D representation.

The TFT display is located in the lower part of the instrument cluster, in the center between the two small dials.

The display for the Entertainment mode is located on the right-hand side of the display; the Navigation display is in the center; and the display for Check Control messages is on the left.

BMW 7 Series instrument cluster

Central Information Display (CID)

The Central Information Display, CID, is a further development of the CID already used in BMW models.

The new BMW 7 Series F01/F02 features very similar software as used in the CID installed in the BMW 3 Series with a CIC.

As on all new BMW models, the system is operated by means of the central control element, the controller.

The is an operating unit for the following functions:

- CD/Multimedia
- Radio
- Telephone
- Navigation
- Contacts
- BMW Assist
- Vehicle Info (Owner's Manual)
- Settings

Personal Profile

The "Personal Profile" systems allows the driver to set several functions in the BMW 7 Series F01/F02 to suit his/her personal requirements.

Personal Profile stores the data entered by the driver such as automatic setting of the outside mirrors or speed-dependent volume in the corresponding control units.

As soon as the vehicle is unlocked using the identification transmitter, the system recognizes the corresponding settings belonging to the identification transmitter.

Up to three different basic settings can be adapted for three different persons. The precondition is that each of the three persons has his/her own identification transmitter.

Controls on the Steering Wheel

There are blocks of buttons in the steering wheel on the left and right.

The controls for the cruise control function are located on the left-hand side of the steering wheel.

The controls for operation of the radio and telephone functions are on the right.

Controls on the steering wheel

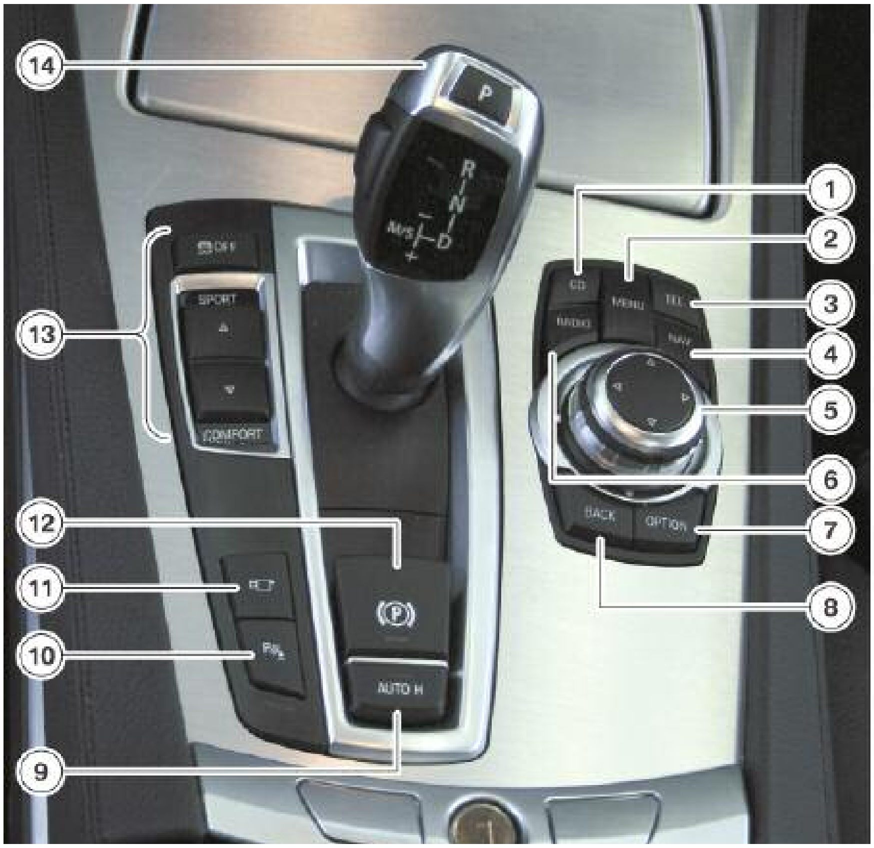
Index	Explanation
1	Set button, Save speed
2	Reduce distance button
3	Toggle switch + - Change speed
4	Increase distance button
5	Enable / disable, interrupt DCC/ACC
6	Resume / call-up stored speed button
7	Knurled wheel Select radio station
8	MODE button Switch audio sources
9	Toggle switch + Change volume
10	Toggle switch - Change volume
11	Hands-free button
12	Telephone button

Controller

The operating and control concept of the controller on the F01/F02 has been extended to include a number of toggle switches that can be a great advantage for menu guidance.

In addition to a possibility to open the main menu in the CID, an arrangement of toggle switches for the most important menu items in the main menu is located in the immediate vicinity of the controller.

Center console on BMW 7 Series F01/F02



Index	Explanation	Index	Explanation
1	CD toggle switch	8	Back toggle switch
2	Main Menu toggle switch	9	Parking brake, automatic
3	Telephone toggle switch	10	PDC button
4	Navigation toggle switch	11	Side View button
5	Controller	12	Parking brake, electrical
6	Radio toggle switch	13	Driving dynamics switch, DSC button
7	Option toggle switch	14	Gear selector lever

System Overview

The system circuit diagram for the outside temperature is displayed below.

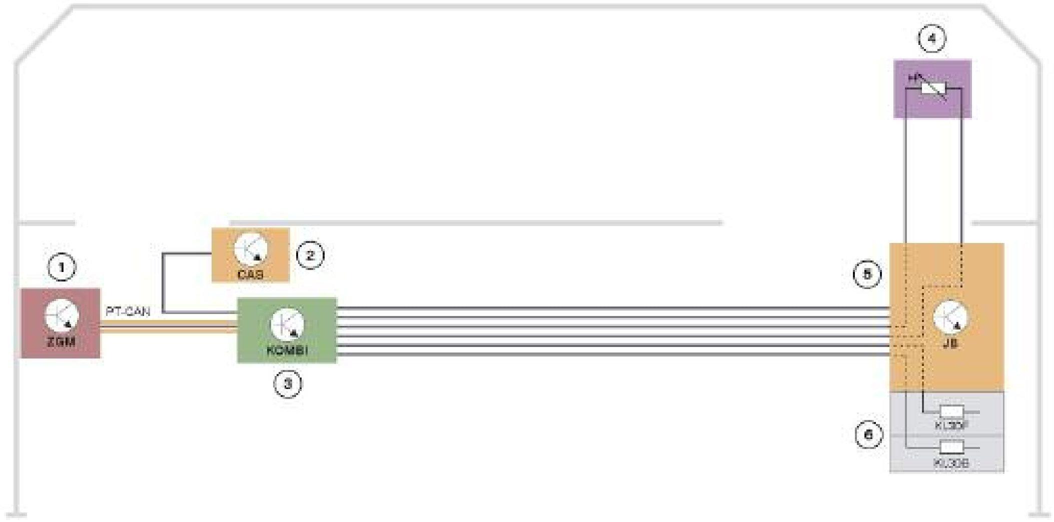
The diagram is structured in such a way that only the control units and control elements directly involved in the instrument cluster are shown.

The instrument cluster receives a large number of different bus signals that provide information (speed, CC messages, etc.) for the various displays and indicators. These bus signals are requests to the instrument cluster and are therefore not listed in this product information.

The only directly connected component that can be seen in the system circuit diagram is the outdoor temperature sensor.

This input signal is read directly in the instrument cluster and made available from here to all other bus users. The outdoor temperature sensor wiring "passes through" the junction box and is processed directly by the instrument cluster.

System circuit diagram for outside temperature



Index	Explanation	Index	Explanation
1	Central Gateway Module (ZGM)	4	Outside Temperature Sensor
2	Car Access System (CAS)	5	Junction Box
3	Instrument Cluster	6	Front Distribution Box

Principles of Operation

Instrument Cluster

The instrument cluster receives information on the wiring harness in the form of analog and digital electrical signals. These signals are processed and displayed in the instrument cluster or passed on as information to other control units.

On the new BMW 7 Series F01/F02, the instrument cluster has a number of functions that are new to BMW or have changed in relation to existing BMW models.

Black Panel Technology

The F01/F02 is the first BMW vehicle to utilize Black Panel technology. This is a panel, the back of which is coated with black film that virtually covers the entire surface portion of the instrument cluster.

Black Panel technology is used on the instrument cluster, control panels for IHKA/AUDIO and FKA.

On the instrument cluster, the area that is not covered by the Black Panel is designed in such a way that the symbols of the lamps are not visible when switched off.

The Black Panel surface appears homogeneously dark, which means that no details from the background area can be detected.

The two large accentuating rings for the speedometer and tachometer and two small dial areas for the fuel gauge and oil temperature are galvanized.

Instrument Cluster - Off
When the instrument cluster is switched off, the analog indicators are at their zero point, the active area of the display is switched off and the rings in the display area are not closed.

Instrument Cluster - Vehicle Awake
When the vehicle is awake, the analog indicators are at their zero point, the active area of the display is switched on only to complete the lower portion of the rings in the display area.

Note: The control panels for the integrated automatic air-conditioning system (IHKA), AUDIO and rear automatic heater / air conditioner (FKA) are also designed in this new technology.

TFT Display

A horizontal TFT display with a resolution of 960 x 160 pixels is integrated in the instrument cluster underneath the dials.

The large mechanical, analog dials are open at the bottom. These dials are closed by graphics. The graphics are displayed digitally and contain specific functional indicators such as the range or current consumption.

The display enables the prioritization of information with the following representations:

- under right dial - display of audio and telephone lists that can be operated via the multifunction display, MFL
- under left dial - display of longer, two-line Check Control texts
- center display area - the navigation information, including other navigation texts under the left-hand and right-hand dial.

This structure of the instrument cluster enables flexible use of the display area and keeps the signature BMW appearance for the large dials for road speed and engine speed.

The most important information that appears depending on the content and prioritization is:

- Navigation display
- Voice input acknowledgement
- Traffic information
- Infotainment (audio and telephone)
- Check Control messages
- Acknowledgements of assistance systems.

The background image is activated in orange and is always displayed as soon as anything appears in the display.

■ Schematic Breakdown of the Display Area

The graphic in the page below shows the schematic breakdown of the display area in the instrument cluster. Nighttime design is activated in the display when the parking lights or headlights are on.

Daytime-nighttime Design

The daytime-nighttime design differs with regard to the color assignment of some text and graphic elements.

Nighttime design

Daytime design

The following displays change from white to orange:

- Scales and scale lettering of the large and small dials
- Basic indicators, e.g. time, outside temperature
- Gear indicators
- On-board computer and navigation displays
- CC texts and texts for operation acknowledgements
- Text and line for rear seat belt status

Under the following conditions, nighttime design is activated in the display:

- Side lights ON
- Low-beam headlights ON, in darkness or in a tunnel.

Note: The texts in the CBS reset menu and the test functions are always in white, independently of the daytime / nighttime view.

Schematic Breakdown of the Display Area

The following graphic shows the schematic breakdown of the display area in the instrument cluster.

Index	Explanation	Index	Explanation
1	Two-color flush-mounted pointer	6	Navigation (junction view) Lane Guiding Condition Based Service Test menu
2	FAS status indicator FAS information FAS warnings	7	Check Control messages Operation acknowledgements Traffic information Navigation (Distance to Junction)
3	Rear seat belt status Entertainment (symbols) Communication (symbols) PTT acknowledgement (symbols)	8	Range (analog and digital) On-board computer Operation acknowledgements (symbols) Speed Limit Info
4	Fuel consumption indicator (analog) Gearbox position Manual gear indicator Shift recommendation Display FDS menu Automatic engine start-stop function	9	Check Control (symbol) Traffic information (symbols)
5	Entertainment lists FDS menu Navigation "Coming Road"	10	Reset button Trip distance recorder

On-board Computer

On-board computer function in the instrument cluster.

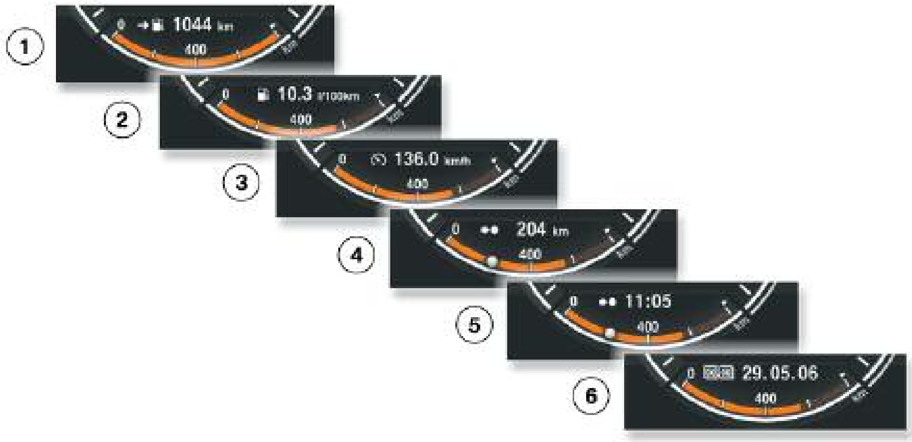
The on-board computer functions can be called up by briefly pressing the on-board computer button on the steering column stalk.

Pressing the on-board computer button again displays information in the following order:

- Range
- Average fuel consumption
- Average speed
- Distance (Nav destination entered)
- Estimated time of arrival (Nav destination entered)
- Date

Steering column stalk

Index	Explanation
1	On-board Computer Button
2	High Beam Assistance Button
3	Left Stalk switch



Index	Explanation
1	Range: If the value displayed for the range is greater than the highest value on the scale, the analog indicator is on the right-hand edge of the scale. The digital indicator shows the current value.
2	Average fuel consumption: The display is a maximum of 2 digits plus one decimal place in US mpg.
3	Average speed: The display is a maximum of 3 digits plus one decimal place in US mph.
4	Distance (Nav destination entered): In addition to the 4-digit display of the digital distance value, the distance to the destination is shown in the analog range display as a dot. Distances are always shown without decimal places.
5	Estimated time of arrival (Nav destination entered): In addition to the display of the estimated time of arrival, the distance to the destination is shown in the analog range display as a dot.
6	Date: The date is always shown with a leading "0" and with the last two numbers of the year.

Low Range Warning

If the range is too low, the driver is given a visual warning.

The analog bar gauge and the bar background change color from orange to yellow. The range appears in numbers, overlaying any other on-board computer displays.

The range can be called up by pressing the on-board computer button again.

Warning if the range is too low

Operation Acknowledgements

Operation acknowledgements are shown for 6 seconds in the display area in the left-hand dial. These are overlaid on top of the numerical range display and/or the on-board computer display as well as the average value of the range scale lettering. Any necessary supplementary texts are shown centrally below the dial; the basic indicator "Time" is then hidden.

System erst ab 60 km/h verfügbar!

Operation acknowledgements

Central Information Display

Main Menu

The display in the main menu consists of the following menu items:

- CD/Multimedia
- Radio
- Telephone
- Navigation
- Contacts
- Vehicle Info
- Settings.

Main menu 15:21 FM 91.3

CD/Multimedia
Radio
Telephone
Navigation
Contacts
BMW Assist
Vehicle Info
Settings

Central Information Display (CID)

In addition to this main menu, an arrangement of toggle switches for the most important menu items in the main menu is located in the immediate vicinity of the controller.

The relevant button can be used to call up the following menu items:

- MENU
- CD
- Radio
- TEL
- NAV
- BACK and OPTION.

Option Menu

The "Options" menu always consists of three permanently active (selectable) menu items and, depending on the submenu, a number of variable additional functions.

The three permanently active (selectable) menu items are:

- Split screen on
- Split screen content
- Screen off.

Note: Whenever a menu is selected, if the controller is moved to the right in the open "TV" menu, the Options menu for this menu is displayed.

Status Bar

The most important information on the various functions, for example the reception level of the telephone, the time, or the selected radio station as of ignition on, are displayed permanently in the status bar.

Index	Explanation
1	Menu item
2	Time
3	Reception level of the telephone
4	Audio selection

CD/Multimedia Menu

This menu item groups the higher-level drives such as CD/DVD, the created music collections, the interface connections IPOD/USB, AUX and Bluetooth as well as the Tone functions.

The main menu is displayed as of terminal 15 ON.

To call up the menu:

- Press the controller and then push it to the left
- Turn the controller until the desired function is highlighted, then press to activate

Note: Direct selection of the first menu level is also possible by pressing the CD button twice.

The first menu level contains the following submenus:

- CD/DVD
- Music collection
- External devices
- Tone

Further entries or information are linked to each menu item.

CD/Multimedia menu

Radio Menu

The "Radio" menu is one of the most frequently used functions. Certain menu items are specific to the vehicle equipment and are not available to the customer before they have been enabled.

The main menu is displayed as of terminal 15 ON.

To call up the menu:

- Press the controller and then push it to the left
- Turn the controller until the desired function is highlighted, then press to activate.

Note: Direct selection of the first menu level is also possible by pressing the RADIO button twice.

The first menu level contains the following submenus:

- FM
- AM
- Stored radio stations
- Tone.

Further entries or information are linked to each menu item.

Radio menu

Telephone Menu

In the Telephone menu, the phonebook entries can be displayed and sorted according to various criteria. This menu is also used for showing missed calls.

In addition, the interface for Bluetooth connectivity is integrated in this menu.

Note: Certain services are not available to the customer before they have been enabled.

The main menu is displayed as of terminal 15 ON.

To call up the menu:

- Press the controller and then push it to the left
- Turn the controller until the desired function is highlighted, then press to activate.

Note: Direct selection of the first menu level is also possible by pressing the TEL button twice.

The first menu level contains the following submenus:

- Active calls
- Telephone book
- Repeat dialling
- Dial number
- Bluetooth.

Further entries or information are linked to each menu item.

Telephone menu

Navigation Menu

The Navigation menu contains all the functions necessary for operating the navigation system.

The main menu is displayed as of terminal 15 ON.

To call up the menu:

- Press the controller and then push it to the left
- Turn the controller until the desired function is highlighted, then press to activate.

Note: Direct selection of the first menu level is also possible by pressing the NAV button twice.

The first menu level contains the following submenus:

- Destination input
- Address book
- Last destinations
- Points of interest
- Map
- Traffic information
- Course of route.

Further entries or information are linked to each menu item.

Navigation menu

Contacts Menu

The "Contacts" menu is another function in which new addresses of persons or companies can be stored in the vehicle.

Note: Certain services are not available to the customer before they have been enabled.

The main menu is displayed as of terminal 15 ON.

To call up the menu:

- Press the controller and then push it to the left
- Turn the controller until the desired function is highlighted, then press to activate.

The first menu level contains the following submenus:

- New contacts
- My contacts.

Further entries or information are linked to each menu item.

Keine Kontakte vorhanden

Contacts menu

Vehicle Info Menu

BMW ASSIST Menu

The "Vehicle Info" menu contains all the information regarding the condition, service intervals, the on-board computer and the journey computer of the vehicle.

In addition, this menu contains for the first time a Quick Guide and the electronic Owner's Handbook for the vehicle.

Note: Certain services are not available to the customer before they have been enabled.

The main menu is displayed as of terminal 15 ON.

To call up the menu:

- Press the controller and then push it to the left
- Turn the controller until the desired function is highlighted, then press to activate.

The first menu level contains the following submenus:

- Quick Guide
- Picture search
- Owner's Handbook
- On-board computer
- Journey computer
- Vehicle status.

Further entries or information are linked to each menu item.

Vehicle Info menu

Settings Menu

The individual user settings can be defined in the Settings menu.

Note: Certain services are not available to the customer before they have been enabled.

The main menu is displayed as of terminal 15 ON.

To call up the menu:

- Press the controller and then push it to the left
- Turn the controller until the desired function is highlighted, then press to activate.

The first menu level contains the following submenus:

- Head-Up Display
- Central screen
- Time/date
- Language/units
- Tone
- Limit
- Air conditioner
- Light
- Door locking
- Luggage compartment lid.

Further entries or information are linked to each menu item.

Uhrzeit: 2:28
Zeitformat: 24 h
Datum: 30.04.2051
Datumsformat: tt.mm.jjjj

Settings menu

System Components

Instrument Cluster

The instrument cluster is clipped into place in the dashboard with two clips. A shroud prevents reflections in the acutely angled windscreen.

The instrument cluster comprises the following components:

- Four dials
- Indicator and warning lamps
- TFT color display
- Acoustic output takes place via the head unit
- Button for resetting the trip distance recorder and selecting Condition Based Service in CBS menu.
  Press the button for > 4 seconds to select the Workshop menu. Operation is then by means of the reset button of the trip distance recorder.
- Connected components which serve to activate the displays and indicators in the instrument cluster (see system overview/system circuit diagram).

The following components are described in detail:

- Display areas
- Indicator and warning lamps
- TFT display.

Display Areas

The instrument cluster features display areas for:

- Speedometer
- Rev counter
- Economy control (fuel consumption indicator)
- Fuel gauge
- Oil-temperature indicator
- Indicator and warning lamps
- Display
- Programme and gear indicator in the display.

Rev Counter

On theBMW7 Series F01/F02, engine speed is displayed using the following signal chain:

- The DME control unit sends the engine speed across the PT-CAN to the instrument cluster.
- Using a characteristic curve, step pulses for actuating the stepper motor are assigned to the effective engine speed.

Economy Control (fuel consumption indicator)

The fuel consumption indicator (economy control) is an analog indicator in the instrument cluster.

Fuel Gauge

The fuel level is indicated in the small dial on the left.

A pictogram of a fuel pump lights up in the display of the instrument cluster when the level drops below a factory-coded threshold (standard = 8 l gasoline).

A warning tone additionally sounds on reaching the reserve threshold.

Outside Temperature Indicator

The temperature sensor measures the outside temperature and displays it in the instrument cluster.

In ignition key position "0", the instrument cluster applies terminal 30g current to the temperature sensor every 20 minutes.

The instrument cluster makes the current outside temperature available in the form of a data telegram via the PT-CAN.

Indicator and Warning Lamps

The indicator and warning lamps are activated by the processor in the instrument cluster.

All important and legally stipulated indicator and warning lamps are activated at terminal 15 ON during the pre-drive check.

The indicator and warning lamps can be illuminated in different colors or combinations.

Note: The indicator lamp for the rear fog light is not active.

Indicator and warning lamps

TFT Display (thin-film transistor)

The TFT display is divided into the following 7 display areas:

- Symbols, e.g. CBS messages
- On-board computer
- Messages, e.g. traffic information
- Navigation display
  Service Interval Display (CBS)
- Entertainment list, e.g. radio
- Gear program indicator
- Symbols, e.g. outside temperature.

TFT display

Manipulation Dot

If a dot appears in the middle under the trip distance recorder and odometer, different data are stored in the TFT display and in the CAS 4.

The manipulation dot is shown when, for example, a comparison of the stored vehicle identification numbers indicates that they do not match.

Note: Different data may be caused, for example, by replacing one of these two control units.

Acoustic Generators

Audible warnings are given in support of check control messages. All of the acoustic outputs requested in the instrument cluster are generated in the Car Information Computer, CIC. The sound patterns of the various acoustic outputs are also stored in the CIC.

An acoustic generator is built into the instrument cluster fro the turn indicator sound.

The footwell module is responsible for control of the direction indicator function via the K-CAN2.

The vehicles additionally feature an ignition key warning and a seat belt warning.

An uninterrupted warning tone sounds when the driver's door is opened with terminal 15 OFF and the identification transmitter in place.

The audible signal is switched off by closing the door or after 30 minutes.

The seat belt warning is activated at terminal 15 ON if the seat belt buckle contact is not closed.

The audible warning is intermittent and is no longer than 6 seconds. The indicator and warning lamp remains on.

On-board Computer

The on-board computer available for the BMW 7 Series F01/F02 contains a journey computer which includes the following functions:

- Start of journey
- Duration of journey
- Distance covered
- Average fuel consumption 2
- Average speed 2.

Showing Indicators

The on-board computer displays are shown and scrolled in the instrument cluster via the on-board computer button on the steering column lever for the direction indicator lights.

The individual functions appear in the display of the instrument cluster directly underneath the speedometer.

Once terminal R is switched on, the computer will display the on-board computer function that was displayed last.

Steering column stalk

All other functions can be selected by pressing the on-board computer button on the steering column lever.

The sequence of the displayed on-board computer functions is always the same.

The menu guidance is described in detail in the section entitled "Functions".

Instrument Cluster Test Functions

The test functions are shown in the TFT display of the instrument cluster.

To Start Function Test

- Terminal R ON or terminal 15 ON.
- Press and hold the reset button in the instrument cluster for 10 seconds (set/reset).

or

- by holding down the setting button in the instrument cluster and simultaneously switching on terminal R.

Display of Test Functions

The test functions appear in the center of the TFT display, between the two dials.

Only tests one through four are unlocked. All other test functions are unlocked by entering the sum of the digits in the vehicle identification number while in test function 4.

To End Test Function

- Ignition key at terminal R or terminal 15 ON.
- Press and hold the reset button for longer than 10 seconds.

The main menu appears in the instrument cluster

- Press the reset button repeatedly until "Test End" is highlighted and then hold down the reset button until the words "Test End?" appear or
- call up test function 19 (RESET).

Note: To protect against unauthorized access, all test functions (with the exception of test 1 and test 2), are locked again after a RESET and "sleep cycle".

Overview of Test Functions

Only the main test functions are listed in the following table.
In addition to the majority of test functions, there are further equivalent functions for which a similar display appears in the instrument cluster.

All the described test functions can also be performed via the BMW diagnostics system.

Index	Explanation
1	Identification
2	System test
3	Test End
4	Unlock test functions
5	Current consumption
6	Range consumption
7	Fuel gauge values
8	Coolant temperature, outside temperature
9	On-board computer average values
10	Speedometer / revolution counter
11	Display of operating voltage
12	Trigger acoustic signals
13	Read fault codes
14	Dim LCD
15	Dim / PWM signal
16	Condition Based Service
17	Check Control
18	Correction factor for consumption values
19	Software reset / RAM reload

Component Replacement and Trial Replacement

There are three possible combinations for replacing the instrument clusters and Car Access System 4, CAS 4.

- Instrument cluster defective, CAS 4 OK
- CAS 4 defective, instrument cluster OK
- CAS 4 and instrument cluster must be replaced.

Simultaneous replacement of CAS 4 and the instrument cluster should be avoided. The odometer reading will be lost as a result.

In principle, it is also possible to carry out a trial replacement of the instrument cluster and CAS 4.

Central Information Display (CID)

Service Mode

The controller can be used to activate the Service mode functions.

The Service mode is a special facility which provides information about the status of the display and user control system.

Note: This function was created to aid in diagnosis and is not intended for the customer.

The Service mode can be used, for example, to read out hardware/software versions for the Central Information Display or control units in the CIC system network.

As an addition to the comprehensive facilities of the diagnosis system, the Service mode serves as a simple means of quickly accessing diagnostic data without a BMW diagnosis system.

Activating the Service Mode

In the main menu, push the controller forwards and hold there for longer than 10 seconds.

Tactile feedback will then be generated.

Then proceed as follows:

- Turn the controller 3 stops clockwise
- Turn controller 3 stops anticlockwise
- Turn controller 1 stops clockwise
- Turn controller 1 stops anticlockwise
- Turn controller 1 stops clockwise
- Press the controller; the Service mode is added as the last menu item in the "Settings" menu.

The first menu level contains the following submenus:

- Navigation Service
- Telephone
- Gracenote.

Service mode

Note: Push the controller in any direction to return to the main menu.

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Head-up Display (HUD)

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the Head-up Display of the F01/F02
- Describe the functions of Head-up Display of the F01/F02
- Identify the components of the Head-up Display of the F01/F02

Introduction

The very name “Head-Up” describes the principle benefit of this system. The Head-up Display (HUD) projects a virtual image into the driver’s field of vision. Important information such as cruise control details or graphical directions from the navigation system are projected onto the windshield and are thus permanently visible within the driver’s field of view.

The driver of a BMW thus has the important data and graphics put up in his field of view, just like a pilot in his jet fighter.

The head-up display in the new BMW 7 Series incorporates various functions aimed at enhancing road safety and driver convenience.

That includes display of:

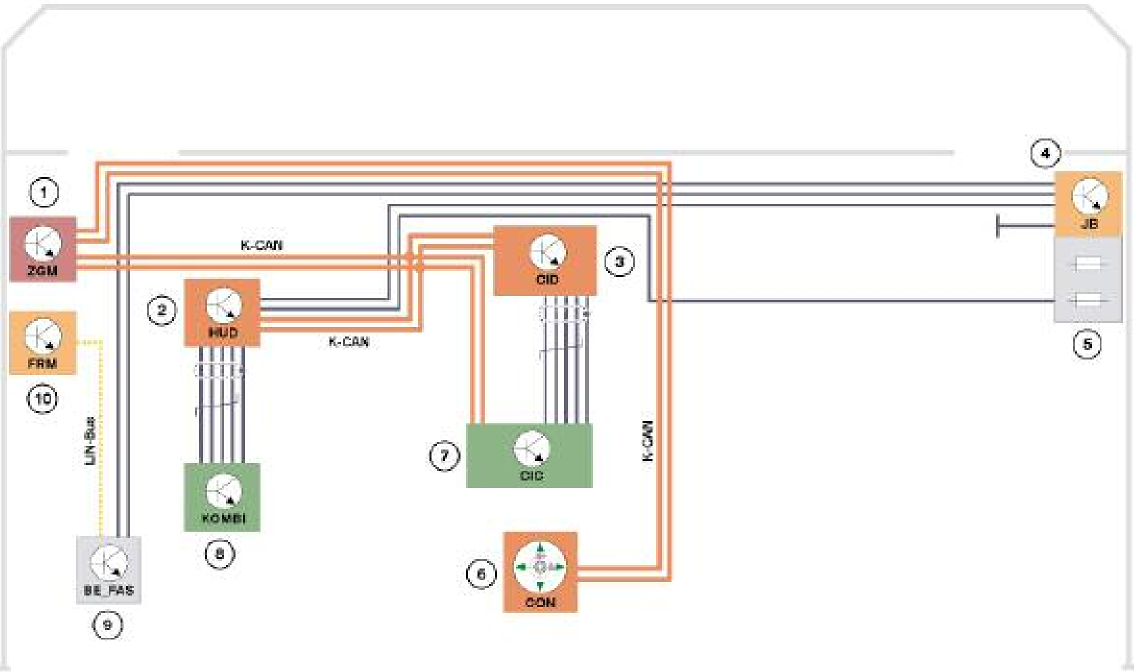
- Information from the DCC cruise control system
- Information from the navigation system
- Check Control messages
- Road speed

Having the displays in the driver’s direct field of view increases safety, as the eyes are always on the traffic.

Head-up Display (HUD) in F01/F02

System Overview

Head-up Display System Schematic Circuit Diagram



Index	Explanation	Index	Explanation
1	Central Gateway Module (ZGM)	7	Car Information Computer (CIC)
2	Head-up display (HUD)	8	Instrument cluster (KOMBI)
3	Central Information Display (CID)	9	Driver assistance system control panel (BAFAS)
4	Junction box (JB)	10	Footwell module (FRM)
5	Front power distribution box	K-CAN	Body controller area network
6	Controller	LIN-Bus	Local Interconnect Network bus

K-CAN signals to HUD control unit

In/out	Information	Source/sink	Function
In	Road speed	Instrument cluster	Display in the HUD
In	Check control message	Instrument cluster	Display in the HUD
In	Dimming/ brightness	Rain and driving light sensor (RLS) via roof function Center (FZD)	Brightness adjustment
In	Height adjustment	CIC	Height adjustment
In	Brightness offset	CIC	Brightness adjustment
In	DCC	EHB3 (Adaptive Brake Assistant Warning)	Display in the HUD
In	Function selection	CIC	What is displayed in the HUD
In	On/Off switch	BAFAS	Switching the HUD On/Off
In	Navigation	CIC	Display in the HUD

System Functions

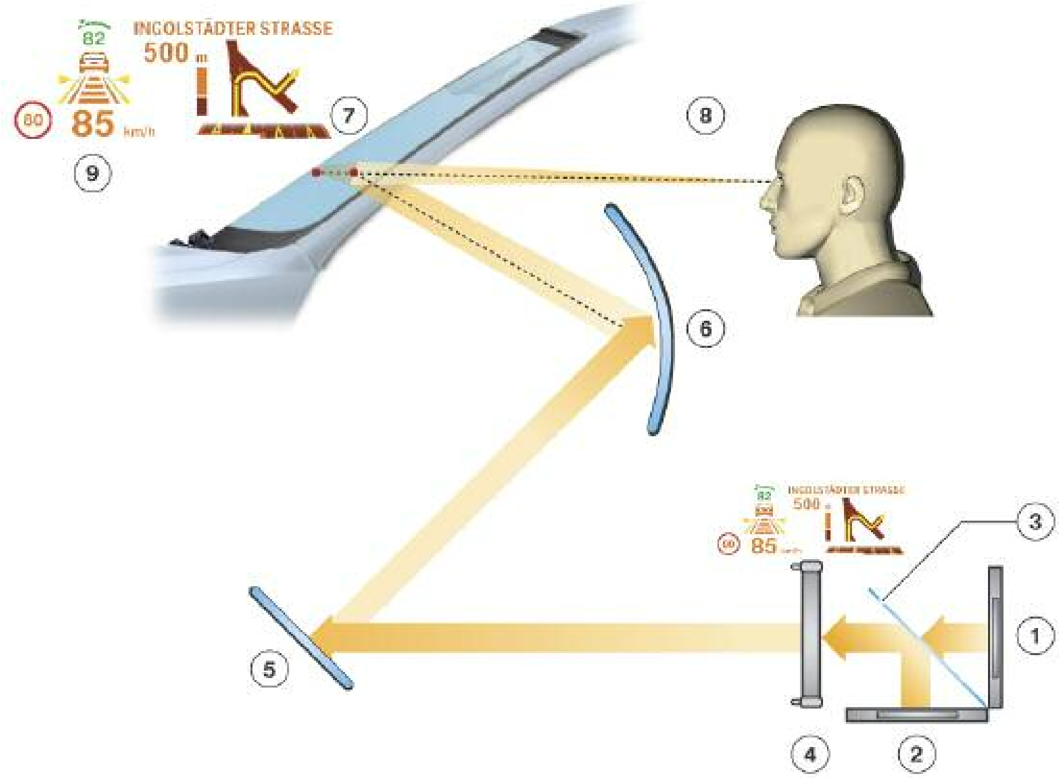
The Principle

The HUD can be compared to a projection device. A light source is required to project the HUD information. The two LED arrays (red and green) serve as the light source. The image content is created by the TFT projection display. The TFT projection display can be compared to a filter which admits or blocks light.

An optical imaging element determines the shape, distance and size of the HUD images.

The image appears to float freely over the road, the windshield acts as a deflecting mirror.

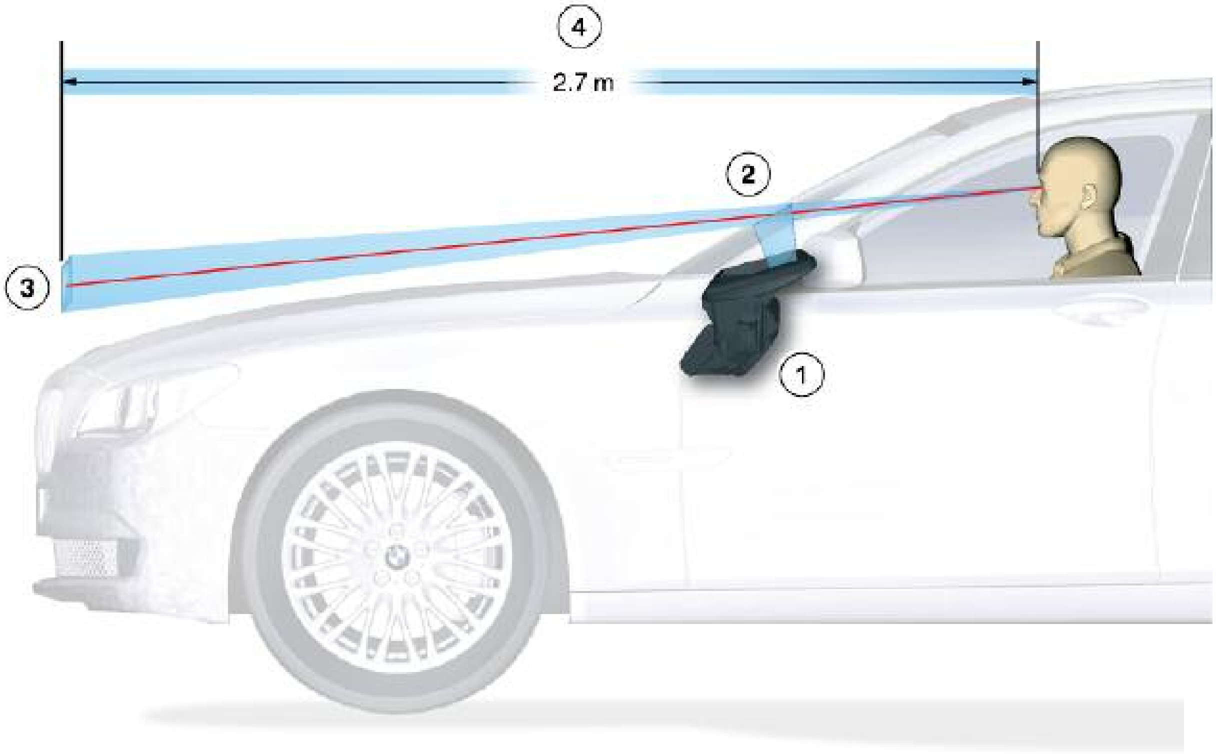
Principle of the head-up display



Index	Explanation	Index	Explanation
1	LED array, green	6	Curved mirror
2	LED array, red	7	Windshield
3	Transparent mirror	8	Observer's point of vision
4	TFT projection display	9	Projected image
5	Plane mirror		

Projection Distance

The projected HUD image content appears at a distance of approximately 2.7 m from the observer’s eye.



Projection distance

Index	Explanation	Index	Explanation
1	Head-up display	3	Projected Image
2	Windshield	4	Projected distance

Switch-on Conditions

The following conditions are required to release the light:

- Terminal 15 ON
- Button (HUD) pressed on the driver assistance system control panel, BEFAS.

Switch-on Performance

The HUD receives the terminal 30 ON status via the K-CAN. The HUD is partially ready for operation from terminal R ON. That means that:

- The HUD can communicate with the other electrical-system devices via the K-CAN
- The TFT projection display is initialized and blanked
- The LEDs are off.

The HUD receives the terminal 15 ON status via the K-CAN. The HUD is ready for operation from terminal 15 ON. This permits the following actions:

- Switching on of the backlighting by the button on the BAFAS
- HUD height adjustment
- Adjustment of HUD brightness
- Display of information via the HUD.

When the vehicle is started, the vehicle is set to terminal 50 status. In terminal 50, i.e. Lights Off, the HUD goes into a hold status. This hold status is maintained until shortly after the end of the terminal 50 status.

ON/OFF button on the BAFAS

Switch-off Conditions

The HUD is switched off under the following conditions:

- Button on the BAFAS pressed
- Terminal R OFF

Brightness Offset

Brightness offset is a PIA Personal Profile function. Brightness offset allows the customer to set and save his/her own individual HUD default brightness setting. Each time the HUD is switched on, this setting is used as the brightness offset for the HUD.

The brightness setting is adjusted with the controller via the CID. Any value between -10 and +10 can be set. The mid-position value is 0.

The value is transferred via the K-CAN to the HUD.

Brightness setting

The brightness setting is automatically corrected in order to compensate for different light conditions. Compensation is based on signals from the rain and light sensor.

The automatic brightness setting is configured in such a way that no HUD brightness jumps occur.

The differing light conditions depend, for instance, on:

- Environmental conditions, such as day, night, sunshine, clouds, rain, fog, snow, etc.
- Surrounding structural features, such as tunnels, underground car parks, etc.
- The driver can adjust the brightness of the instrument lighting with the knurled wheel.
- From terminal 58g lights on, the HUD brightness is determined by the brightness setting of the instrument lighting.

The brightness is dependent on the following conditions:

- Dimmer-wheel setting
- Brightness offset
- Rain/light sensor, RLS

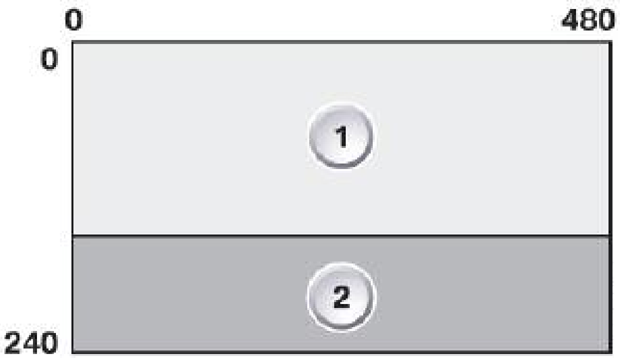
Operating-hours Counter

The HUD incorporates individual service-time counters for the HUD and the LED arrays.

Display Area of Head-up Display

The HUD size is approximately 200 mm x 100 mm with a display resolution of 480 x 240 pixels. The HUD is separated into 2 display areas. The individual fields are "optically" separated in the image so that they can be identified more easily.

Display area in the head-up display



Index	Explanation
1	Navigation/CC display area
2	Road speed/Cruise control display area

The upper area shows navigation information and CC messages in the form of symbol, bar display and text.

The lower area shows speed-related displays in the form of unit, current speed and cruise control.

Color Selection

Symbols (such as e.g. warning symbols) are specified by the individual control units. The color specifications are adopted by the instrument cluster for display and representation on the HUD.

“Flat” 2D symbols are used for optimum visibility and readability.

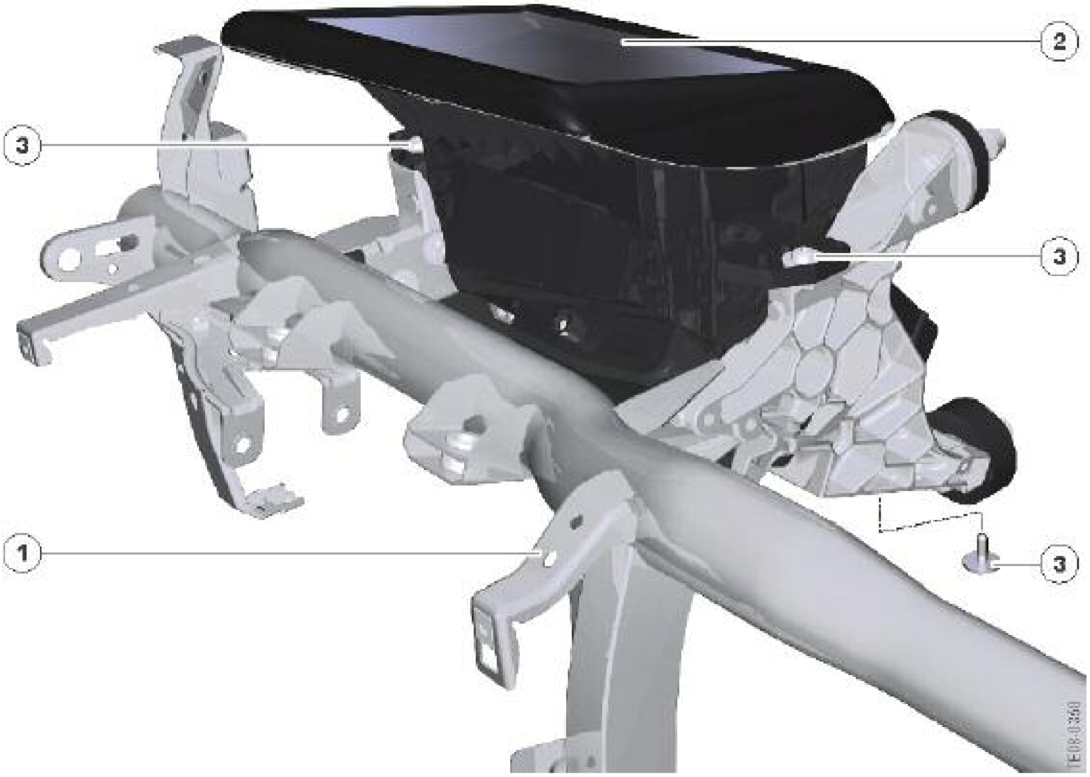
The colors are:

- Orange as the standard color
- Red or yellow for warning messages
- Green for the set speed
- The HUD background is transparent

System Components

The head-up display is fitted above the steering column, immediately behind the instrument cluster. It is fastened to the bulkhead supporting structure by three hexagon-head bolts.

Location of head-up display (HUD) in F01/F02



Index	Explanation	Index	Explanation
1	Carrier bracket	3	Hexagon bolt
2	Head-up display HUD		

The head-up display comprises the following components:

- Cover glass
- Mirrors
- 2 LED arrays
- TFT projection display
- PCB
- Housing

The following components are required in addition to the components listed above:

- Windshield
- Light module and BEFAS
- Rain/light sensor
- Roof function Center and junction box
- HUD trim

The following controls are required to operate the HUD:

- On/Off button on the BEFAS
- Light switch in the light switch cluster
- Instrument-lighting dimmer
- Controller

Cover Glass

The cover glass is made from scratch-resistant, coated polycarbonate (PC) and forms the top cover of the HUD. The cover glass protects the interior of the HUD against dust and objects accidentally placed on it.

The glass combined with the HUD trim are curved so that any incident light is not reflected back to the driver.

It also guarantees unobstructed projection of the display information onto the windshield without interference from stray light effects, for instance.

Plane mirror

Mirrors

Two mirrors are fitted in the head-up display. They reflect the information in the display onto the windshield.

The concave mirror (1) is responsible for compensating for the curvature of the windshield and for the size and distance of the image.

The flat mirror (2) is a deflecting mirror to keep the beam in the space provided.

The convex mirror is made of plastic while the flat mirror is made of glass.

Index	Explanation
1	Curved mirror
2	Plane mirror

Mirrors in the HUD

LED Array

There are two LED arrays. The LED array is an arrangement of LEDs in one plane and acts as the back lighting for the TFT projection display. The LED array generates the light required for the HUD brightness. The LED arrays consist of red and green LEDs. The LEDs generate the brightness of the HUD content as controlled by the master PCB.

PCB

The following components among others are incorporated on the PCB:

- K-CAN interface
- Processor (CPU)
- LVDS controller
- EEPROM memory
- Power supply

The video signals are passed on to the display by the instrument cluster via an LVDS lead.

Housing

The casing is made of aluminum and consists of a bottom section and the plastic cover. The (aluminum) cooling fins and the electrical power supply are attached to the bottom section. The cover glass is integrated into the cover.

Windshield

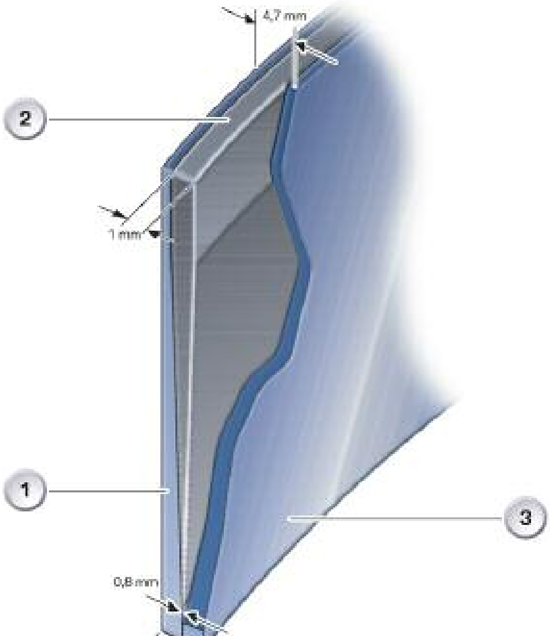
The windshield is a “special design” that is essential for projection of the displays. The outer and inner glass panes are bonded to a plastic film, just like in the standard windshield. Unlike in the standard windshield, this plastic film is not parallel but is tapered over the entire area of the windshield.

The taper prevents the HUD from displaying images twice. The taper tip points downwards and starts at a distance of approximately 10 cm to the bottom edge of the windshield.

The end of the taper is located at approximately 2/3 windshield height. In the top third of the windshield, the plastic film runs parallel to the outer and inner glass panes. The thickness of the taper tip is 0.8 mm. The thickness of the end of the taper is 1 mm.

The total thickness of the bottom edge of the windshield is 4.5 mm. The total thickness of the top edge of the windshield is 4.7 mm.

Windshield

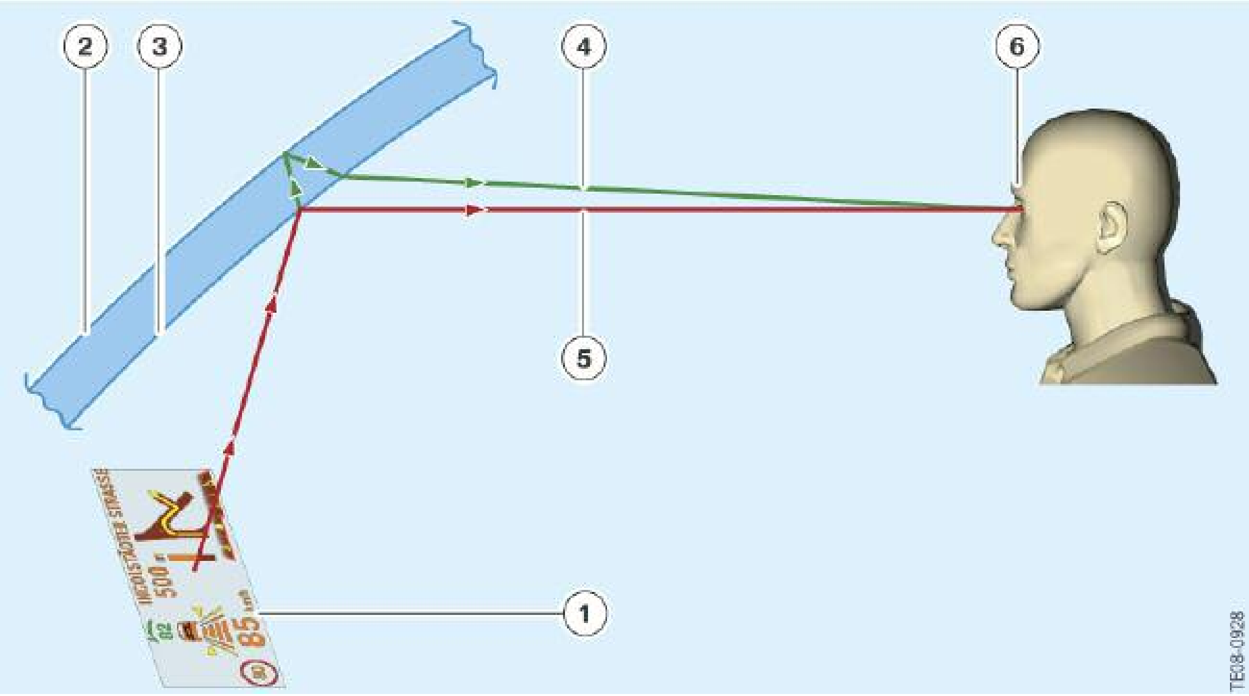


Index	Explanation	Index	Explanation
1	Outer glass pane	3	Inner glass pane
2	Plastic film	mm	Unit of measurement in mm

Incorrect Windshield Fitted

The HUD image is always reflected on the These two images are overlaid by the angle of inner surface and outer surface of the taper in the HUD screen, so that the driver windshield only sees “one” image.

Double reflection



Index	Explanation	Index	Explanation
1	Display	4	Reflection on the outer surface of the windshield
2	Outer surface of the windshield	5	Reflection on the inner surface of the windshield
3	Inner surface of the windshield	6	

Because of the angle of tilt of the glass in a standard windshield, the two reflected images are offset against one another.

The illustration below shows the result when a Rain/light sensor standard windshield is fitted.

Double display by HUD

The rain and light sensor provides the brightness signal over the LIN bus to the roof function Center FZD and then to the K-CAN.

Eyebox

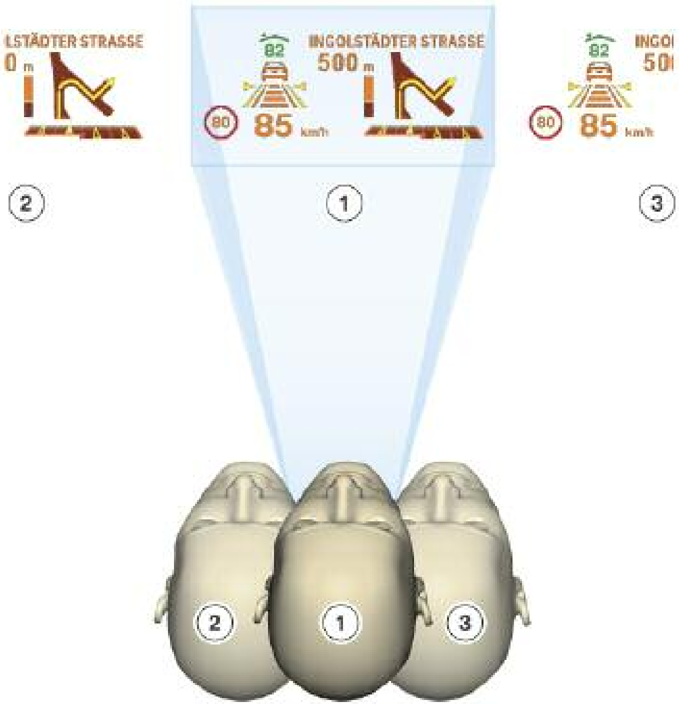
The eyebox is the movement space in which the driver can move without his view of the image in the HUD being impaired.

The freedom of movement within the eyebox is roughly:

- 70 mm vertically plus ± 30 mm range of adjustment
- 130 mm horizontally.

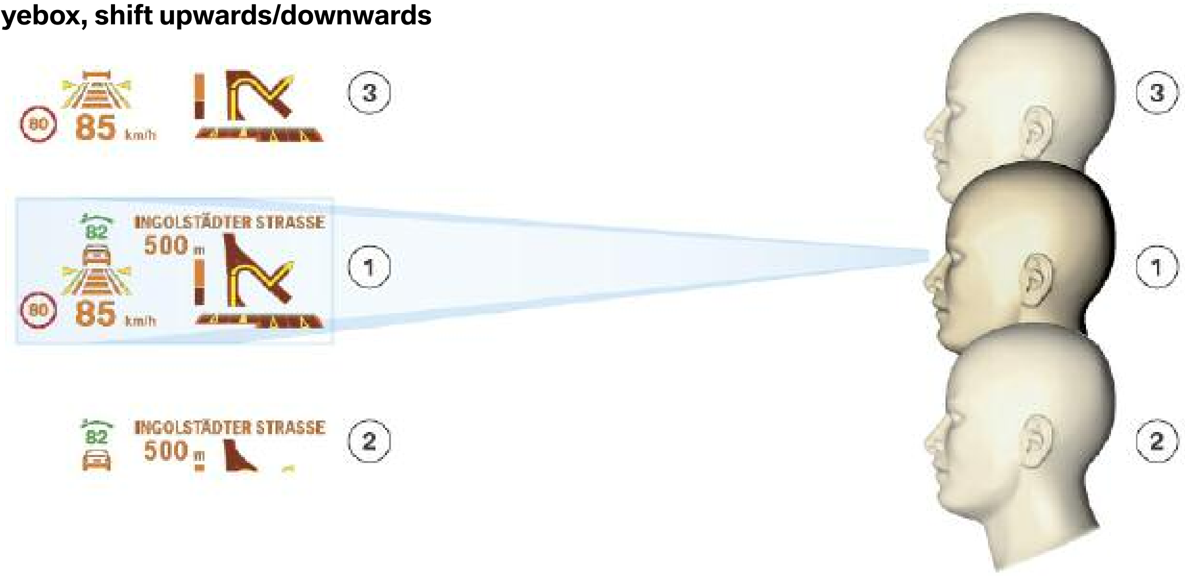
The HUD image is not clearly visible outside the eyebox limits.

Eyebox, shift to the left/to the right



Index	Point of vision	HUD image
1	Within the eyebox	Optimum illumination of the image
2	Offset to the left	Image cut off on the left
3	Offset to the right	Image cut off on the right

Eyebox, shift upwards/downwards



Index	Point of vision	HUD image
1	Within the eyebox	Optimum illumination of the image
2	Offset downwards	Image cut off at the bottom
3	Offset upwards	Image cut off at the top

Instrument Cluster

For the purposes of filtering the speed reading, a distinction is made between acceleration, braking and coasting phases.

When the car is in the coasting phase, 3 successive values are averaged and then the speed is updated.

Check Control Messages

All CC messages are also displayed on the HUD. The instrument cluster has the master function for the messages. The symbol together with the associated text is transmitted by the instrument cluster. CC messages are given precedence over the display of other information such as navigation-system directions, for instance.

Note: A Check Control message is displayed for 8 seconds. If several CC messages occur simultaneously, each one is displayed for 3 seconds.

Controls

The following controls are used in the operation of the HUD:

- ON/OFF button on the BEFAS
- Dimmer wheel in the light switch cluster
- Controller.

Driver Assistance System Control Panel

The HUD On/Off button is located on the BEFAS. The button is resistance-coded and routed directly to the HUD. The HUD can identify the button signals or a button fault using the resistance coding.

ON/OFF button on the BEFAS

Instrument-lighting Dimming

The dimmer setting is also used for the HUD with active headlights. The dimmer signal is emitted by the light module.

Instrument-lighting dimming

Controller

The HUD brightness and height settings are adjusted with the Controller via the CID. Brightness setting is also termed brightness offset.

Functions such as e.g. navigation can also be set with the Controller in the Function selection menu. Therefore these settings have an indirect effect on the HUD display.

Service Information

The following information for the technician is described in this section:

- Adjusting the brightness
- Adjusting the height of the horizon on the HUD
- Vertical rotation of the image
- Test functions
- Replacing the HUD
- HUD
- Diagnostics

Adjusting the Brightness

The brightness of the HUD can be individually adjusted. The CID is the display instrument and the controller the control element for brightness adjustment.

The brightness is set as follows:

- Call up the main menu by pressing the menu button.
- Press the Controller and select the menu option “Settings”.
- Turn the Controller until “Head-up display” is selected on the menu bar and then press the Controller to confirm selection.
- Turn the Controller until “Brightness” is selected and then confirm.
- Set the desired brightness by turning the Controller and confirm by pressing.

Adjusting the brightness

Adjusting the Height of the Horizon on the HUD

On the BMW 7 Series F01/F02, the driver can adjust the location of the image and the eyebox to suit his/her particular requirements using the iDrive controller.

The eyebox can be shifted up to a maximum of ± 30 mm upwards or downwards.

The height setting is adjusted as follows:

- Call up the main menu by pressing the menu button.
- Press the Controller and select the menu option "Settings".
- Turn the Controller until "Head-up display" is selected and then press the Controller to confirm selection.
- Turn the Controller until "Height setting" is selected and then press to confirm.
- Set the desired height by turning the Controller and confirm by pressing.

Note: The height can only be adjusted when the HUD is active.

The height adjustment is in the scope of the PIA. The setting is stored in the EEPROM for each key. If the signal "Radio remote key status" is received when Terminal 30 is on, the mirror moves to the position set for the current key.

The mirror remains in that position as long as the HUD is switched on.

Vertical Rotation of the HUD

The HUD is supplied as standard with a defined basic setting. The HUD image can be rotated in the horizontal by a service technician using vertical rotation, after a change of windshield, for instance.

The display is adjustable within a range of -3° to +3° by means of a motor.

Detailed information may be found in the BMW diagnostic system.

Test Functions

Calling/quitting Test Functions

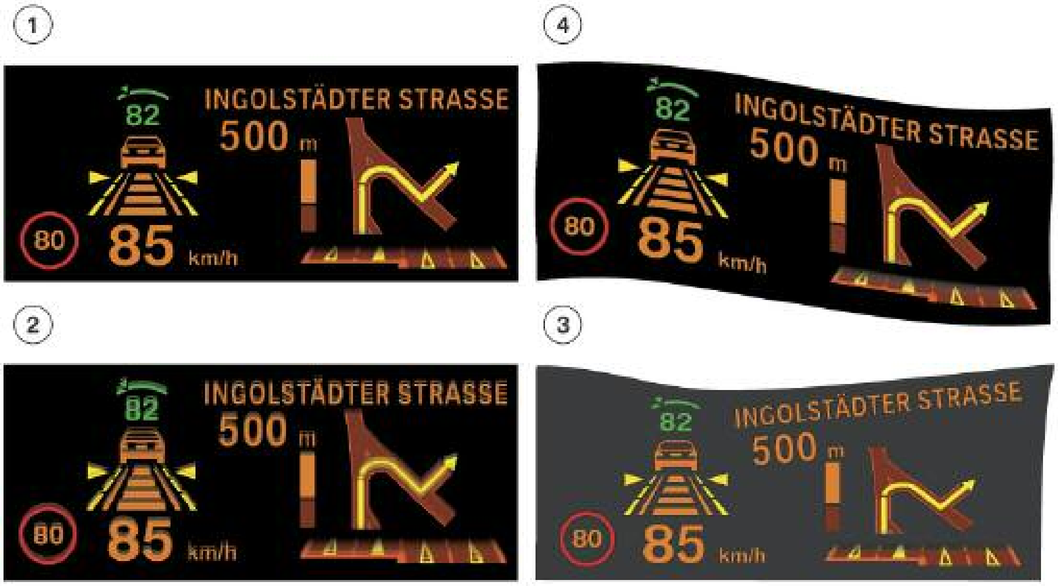
Certain test functions may be also invoked directly on the HUD without using a BMW diagnostic system, as follows:

- Press and hold the button on the BEFAS for approximately 20 seconds and then release.
- Call up further test functions by pressing the button again.
- To exit this function, press and hold the button on the BEFAS for more than 20 seconds.

Replacing the HUD

Image Defects

Incorrect installation of the HUD or of the windshield may result in faulty HUD projections.



HUD image defects

HUD Image defects are explained as follows:

- Image 1 is compressed, (windshield installed incorrectly)
- Image 2 is duplicated, (wrong windshield installed)
- Images 3 and 4 are distorted, the HUD has been fitted incorrectly

The image is blanked out by light striking the windshield or the HUD in unfavorable light conditions. Excessive heat in the HUD will also cause the image to fade.

Image defect caused by incident light or overheating in the HUD

Correcting Distortion (Warping)
Should the image be distorted after a change of windshield, the image display can be improved using the Warping function. Warping is the technical term for the improvement of the image display.

Detailed information on the subject of warping can be found in the BMW diagnostic system.

Diagnosis

The most important functions for service can be called up in diagnosis.
These functions are:

- Initiate self-test
- Read out fault memory
- Delete fault memory
- Read out status
- Specify status

The following errors/faults are stored in the HUD and can be read out with the aid of the diagnosis program:

- Communication faults with the connected bus systems
- Internal HUD faults

Sleep Mode

The following functions are possible in sleep mode:

- Terminal 30b OFF,
  - HUD is switched off completely
- Terminal 30b ON,
  - Monitor K-CAN
- Terminal R soft,
  - Display and LED array off
  - Switch query
  - Diagnostics
  - System test (no display of test cards)
  - Flash program
  - Output data to the display
- Terminal 15 soft,
  - LED array on

Table of Contents

F01 BMW Night Vision 2

Subject **Page**

Initial Print Date: 01/09 Revision Date:

BMW Night Vision 2

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the Night Vision 2 System in the F01/F02
- Describe the functions of the Night Vision 2 System in the F01/F02
- Identify the components of the Night Vision 2 System in the F01/F02

Introduction

The BMW Night Vision 2 system provides the driver with a black-and-white image of the driving environment ahead of the vehicle in the control display CD or central information display CID.

BMW Night Vision 2 is a passive system without active infrared illumination. Objects situated ahead of the vehicle are shown in varying degrees of brightness depending on the temperature of these objects. This enables the driver to detect in good time heat-emitting objects such as, for example, persons, animals and other vehicles.

This thermal image is recorded with a Far Infrared camera (FIR) via a special imaging sensor which detects the infrared radiation in a specific wavelength range.

Intelligent algorithms in the control unit makes it possible to automatically detect persons in the image. Following evaluation of distance and direction of movement, a symbol on the central information display CID and in the head-up display HUD warns the driver of any persons at risk.

The BMW system is distinguished from infrared systems by its robust resistance to dazzling, its long range and its clearly structured image.

The system offers the customer the following advantages:

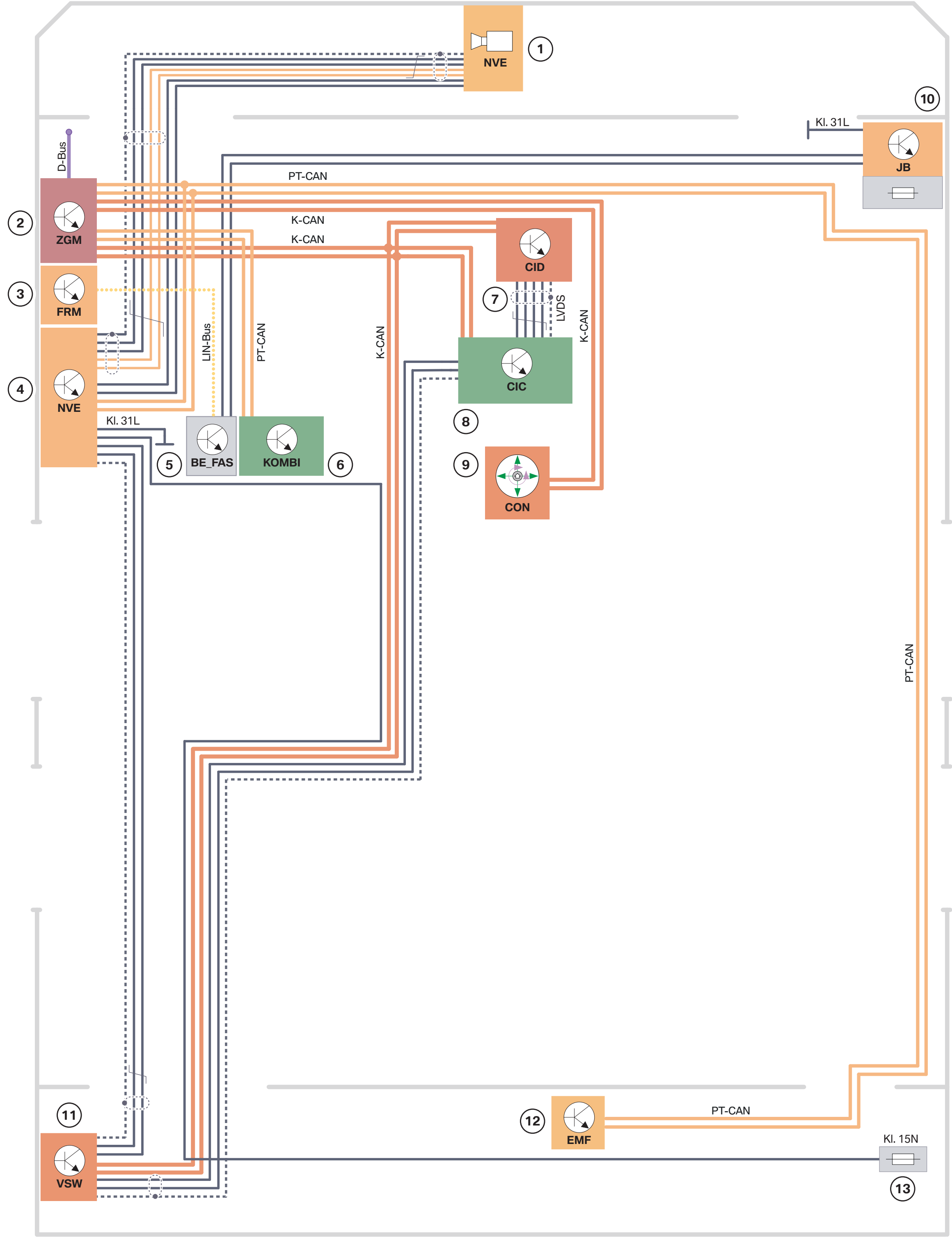
- Highlighting of non-illuminated, heat emitting objects such as pedestrians, cyclists, vehicles and animals.
- Better overview of the driving situation thanks to the depiction of the route of the road beyond the headlight cone.
- Improved vision in twilight (dawn/dusk) and darkness.
- Symbol warning of persons at risk in the area ahead of the vehicle.
- No dazzle in the screen image caused by the headlights of oncoming vehicles.
- Display of dark courtyard and garage entrances.

Night Vision 2 is designed as a supporting system, which, with a modified driving style, affords the driver a better overview of the road conditions ahead of the vehicle.

Note: The driving speed must be adapted to the relevant visibility conditions.

System Overview

System Circuit Diagram F01/F02



Legend for System Circuit Diagram F01/F02

Index	Explanation	Index	Explanation
1	Night Vision 2 camera	11	Video switch (VSW)
2	Central gateway module (ZGM)	12	Electromagnetic parking brake (EMF)
3	Footwell module (FRM)	13	Power distribution box, rear right
4	Night Vision 2 control unit (NVE)	PT-CAN	Powertrain controller area network
5	Control panel, driver assist systems (BEFAS)	K-CAN	Body controller area network
6	Instrument cluster (KOMBI)	LIN-Bus	Local Interconnect Network bus
7	Central information display (CID)	D-Bus	Diagnosis bus
8	Car Information Computer (CIC)	Kl.31L	Terminal 31, ground
9	Controller (CON)	Kl.15N	Terminal 15, after running (voltage)
10	Junction box (JB)		

Connection of Control Units and Camera

The Night Vision 2 control unit and the night vision camera are connected through the following cables:

- Private CAN-bus; Diagnosis, programming and camera control
- LVDS-Video; Video signal from the camera
- CAN_POW; Power supply from control unit to camera, heating of camera lens
- Ground; Common ground of camera and control unit for suppressing interference.

The video signal is sent via a shielded LVDS cable between the camera and control unit. In the control unit the signal is converted into an dCVBS (d = differential) video signal and, depending on the equipment specification, transmitted to the CIC or the video switch.

The camera is powered under the following conditions:

- BMW Night Vision 2 switched on by pressing button in control panel of driver assist systems BEFAS
- Rain-driving lights sensor detects twilight or darkness.

The BMW Night Vision 2 control unit is powered by the rear distribution box via terminal 15N.

PT-CAN

The PT-CAN connection of the Night Vision 2 control unit serves to transmit the diagnosis and programming data and to read out the information from the RLS (brightness), the JB (driving lights status, wiper speed) and ICM (road speed and yaw rate). In addition, the terminal status and the vehicle identification number (VIN) are transferred to the control unit via the PT-CAN.

System Functions

The BMW Night Vision 2 System Principle

The BMW Night Vision 2 camera is a heat image camera that converts thermal radiation into electronic signals.

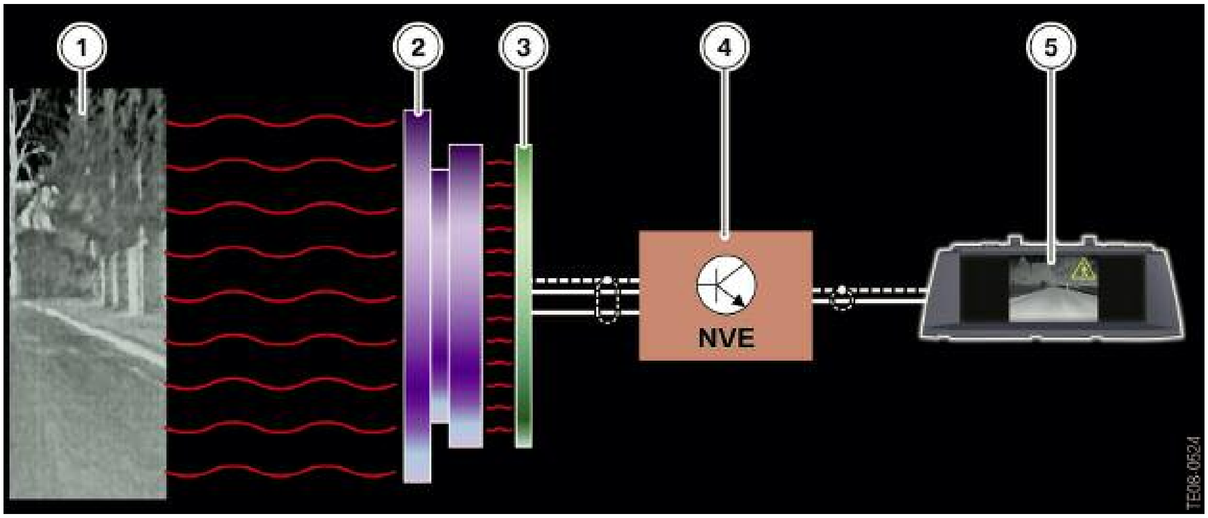
The thermal image is converted first by the sensor into electrical signals and then, with the aid of image-processing software, into a visible image in the control display or central information display.

The sensor elements alter the resistance in proportion to the temperature. The higher the temperature, the higher the electrical signal and the whiter the pixel will be shown.

Heat radiation is absorbed and dissipated by virtually every solid or liquid body. However, the heat emitted is not visible to the human eye because it is located in the long-wave infrared range. From a physical standpoint, this represents electromagnetic waves with a wavelength of 8 μm to 15 μm. This long-wave infrared radiation is known as Far Infrared (FIR).

The advantage of utilizing radiation in the far infrared range is the greater range compared with near infrared systems (NIR) with a wavelength of 0.7 μm to 1.4 μm. These systems additionally require illumination in precisely this wavelength. Essentially, FIR systems consist of an optical element, a thermal imaging camera, a control unit and a display.

The principle



Index	Explanation	Index	Explanation
1	Environment ahead of vehicle	4	BMW Night Vision 2 control unit
2	Optical element	5	Control display
3	Thermal imaging sensor		

The BMW Night Vision 2 system collects in its front lens the infrared radiation of heat-emitting objects such as persons, animals or vehicles in a specific wave range.

Principle of Pedestrian Detection

The Night Vision 2 control unit is equipped with three processors containing software, which, in addition to image processing for display, execute an automatic person detection function. The software searches the image for objects with human shape and classifies these objects as persons.

Their position, speed and distance to the vehicle are then determined. The risk level is analyzed based on these parameters as well as on the speed and yaw rate of the vehicle and a warning is triggered.

The warning for the driver, indicating persons at risk, is given in the form a corresponding symbol in the central information display CID or head-up display HUD.

Symbols in CID

These ranges change with increasing vehicle speed and follow the direction of the vehicle as a function of the current steering angle (yaw rate).

In order not to unnecessarily distract the driver not all persons identified in the image are signalled by a symbol. Only persons who are in a certain area directly in front of the vehicle are indicated by a symbol.

The system also warns of pedestrians located in an extended area to the left and right of the vehicle and are moving towards the central area (threat of collision).

Symbols in HUD

People who are within the central zone are always indicated. Persons in the extended area are only indicated if they are moving in the direction of the central area.

Under optimum conditions, the automatic pedestrian detection function operates at a distance of up to 100 m. At a driving speed in excess of 100 km/h (62 mph), the time between signalling and passing the person and therefore the reaction time for braking and evasive maneuvers is reduced.

Note: The pedestrian detection function is deactivated at speeds below 10 km/h (6mph). For more information regarding this feature refer to the Vehicle Owner's Manual.

Various Forms of Indication

The following table shows the different forms of indication in the two display instruments CID and HUD.

Situation	Indication in CID	Indication in HUD
No pedestrians in the danger zone.		
There is a person at a great distance from the vehicle.		
There is a person at a closer distance from the vehicle.		
A person is crossing the road from right to left.		
A person is crossing the road from left to right.		

Availability Indicator in CID

The availability of the Night Vision 2 system can be restricted by environmental conditions such as heavy rain, extreme +/- temperatures or fluctuations in light conditions.

Availability indicator in CID

Note: Only non-availability of person detection function is indicated. The symbol corresponds to the "Pedestrian Detection" button in the function bar.

The possible situations for the availability indicator in the CID are listed in the following table.

Situation	Symbol	Display
The driver has activated the person detection function and the system is available		
The driver has activated the person detection function but the system is not available, the Night Vision 2 image is still shown		
The driver has deactivated the person detection function, the Night Vision 2 image is still shown		

Symbols in HUD (Head-up Display)

If a person is detected at a great distance inside the warning range of the system the pedestrian figure will be shown distinctly above the road symbol. This is refered to as long-distance warning.

Long-distance warning

If a person is detected in close range, inside the warning zone of the system, the pedestrian figure will be shown distinctly on the road symbol. This is refered to as short distance warning.

Short-distance warning

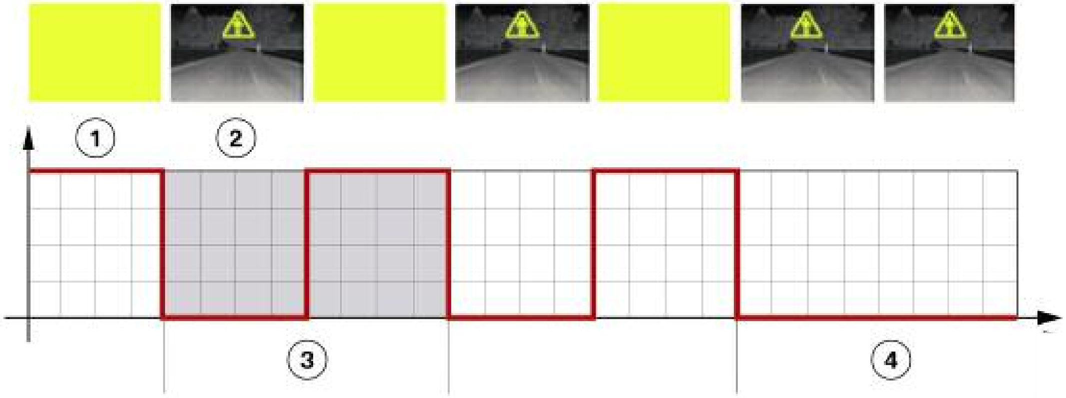
Warning in Vehicles w/out HUD

The warning symbol is shown on the CID in vehicles without HUD or with HUD deactivated. In addition, the CID initially flashes yellow 3 times when the warning comes on in order to catch the driver's attention.

The warning is shown as soon as a person enters the warning zone directly ahead of the vehicle or a person crosses the road from the left or from the right.

Sequence of signals

The following graphic shows the exact sequence of warning signals and is designed to illustrate the functional principle in connection with the table.



Functional principle

Functional principle legend

Index	Explanation
1	Yellow display
2	Normal display
3	Interval approximately 0.5 seconds
4	The warning symbol remains for as long as there is a pedestrian in the danger zone, but at least 3 seconds

Switch-on Conditions

The BMW Night Vision 2 is activated as soon as the button in the control panel of the driver assist systems BEFAS is pressed.

The following basic conditions can exist:

- The rain/driving lights sensor detects sufficient ambient light and the driving lights are switched off; BMW Night Vision 2 is ready for operation approximately 2 seconds after the button in BEFAS is pressed. A message is shown in the control display during this period of 2 seconds.
- The rain/driving lights sensor detects insufficient ambient light and the driving lights are switched on; BMW Night Vision 2 is ready for operation immediately after the button is pressed. BMW Night Vision 2 cannot be activated when
- The driving lights are switched off
- The rain/ driving lights sensor detects insufficient ambient light
- The driving speed is greater than 5 km/h (3 mph).

Once BMW Night Vision 2 has been activated, a message appears in the control display to the effect that the system cannot be used at night without headlights.

Night Vision 2 button in the BEFAS

Operation by iDrive

The individual functions and settings can be selected and activated through the iDrive.

The following settings can be selected on the F01/F02:

- Brightness
- Contrast
- Pedestrian detection.

BMW Night Vision 2 menu in the F01/F02

Calling Up Menu

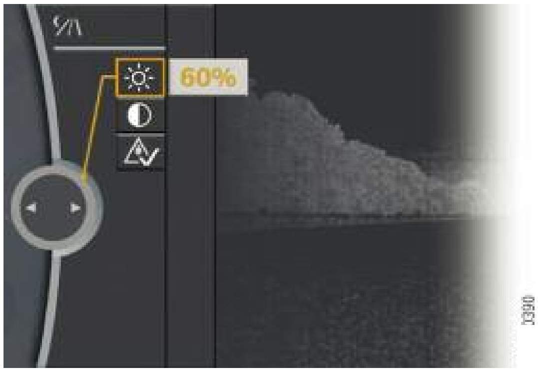
The "Night Vision 2" menu can only be selected if the system has been activated by pressing the button in the BEFAS.

Providing the preconditions have been met, the menu can be selected as follows:

- Press the controller, the "BMW Night Vision" menu is shown on the control display.
- Select the desired menu item, e.g. "Brightness", by turning the controller.
- Press the controller to activate the function.
- Set the required value and confirm by pressing.

Contrast and Brightness

Both values can be personalized and changed on a scale between 0 % and 100 %.



Adjusting brightness

Note: For detailed information on the operation and functions of the Night Vision 2 System refer to the vehicle Owner's Manual.

Pedestrian Detection

The person detection function can be activated and deactivated.

Activating/deactivating person detection

Visibility

The illumination range in front of the vehicle with low beam is less than 50m/54yd.

Normal driving light illumination by fitted halogen headlights is 100m/109yd.

The high beam illumination range provided by xenon headlights is 150m/164yd. However, people can only be detected in this range if they are wearing reflective clothing.

Night Vision 2 will detect heat-emitting objects in the image up to a distance of about 300m/328yd, regardless of the amount of reflection their clothing gives off.

Automatic pedestrian detection has a maximum range of 100m/109yd. This specified distance is dependent on weather factors.

The range of vision is also reduced in the Night Vision 2 image in the case of thick fog or heavy rain. Night Vision 2 is designed as a supporting system, which provides the driver a better overview of the road conditions ahead of the vehicle.

Comparison of BMW Night Vision 2 range of vision with different headlights

Note: The driving speed must be adapted to the relevant visibility conditions.

System Components

The BMW Night Vision 2 system consists of the camera, control unit, camera washer jet, button and the sensor system.

The BMW Night Vision 2 system consists of the following components:

- Night Vision 2 camera with camera bracket in the kidney grille and camera washer jet
- Night Vision 2 control unit
- Button in BEFAS
- Sensor system

Installation locations - Night Vision 2, BMW 7 Series, F01/F02

Index	Explanation
1	Night Vision 2 camera
2	Night Vision 2 control unit
3	Button in control panel of driver assist systems BEFAS

Night Vision 2 Camera

The thermal imaging camera consists of a heated protective window, optical element and a thermal imaging sensor. The thermal imaging sensor is made up of a multitude of sensor elements.

Each display pixel is assigned one such sensor element. The sensor elements generate an electrical signal as a function of the impinging intensity of heat radiation.

The higher the temperature, the brighter the corresponding pixel will be displayed. The heat radiation is converted into electrical signals on the basis of the principle of a change in resistance.

The image can be replaced up to 30 times per second. In order to ensure an image of consistent quality, it is necessary for the camera to be calibrated approximately every 120 - 180 seconds. This calibration can take up to approximately 0.3 seconds. For this reason, the image may be seen to freeze briefly in the display.

The Night Vision 2 camera is mounted with a bracket directly behind the left kidney grille. The camera is equipped with a sensor which detects heat-emitting objects in the far infrared range (wavelengths from 8 µm to 14 µm). The camera resolution is 324 x 256 pixels.

The maximum angle of view is 24°. The camera operates in an ambient temperature range of -40°C/-40F to +80°C/176°F. The imaging sensor is thermally insulated to provide protection against heat influences from the camera surroundings.

The washer jet is screwed to the camera bracket and is situated directly below the protective window. It is directly connected to the headlight washer system and therefore operates in connection with it.

A heater element is incorporated on the inside of the protective window to prevent it from misting over or freezing up. The heater is located at the edge of the protective window outside the camera's field of vision.

Night Vision 2 Control Unit

The control unit is installed behind the compartment in the area of the A-pillar directly under the light switch cluster.

The control unit calculates the displayed 720 x 480 pixel image from the 324 x 256 pixel raw data image supplied by the camera. Automatic pedestrian detection is executed in the control unit. The diagnosis, programming and coding data are also transmitted to the camera through the control unit.

BMW Night Vision 2 control unit

The camera and the protective window heater are powered via the control unit. The raw image data from the camera are transmitted through a LVDS cable to the control unit.

The image output by the control unit is made available in the head unit in the form of a dCVBS signal.

The camera-housing cover features a 6-pin plug connection.

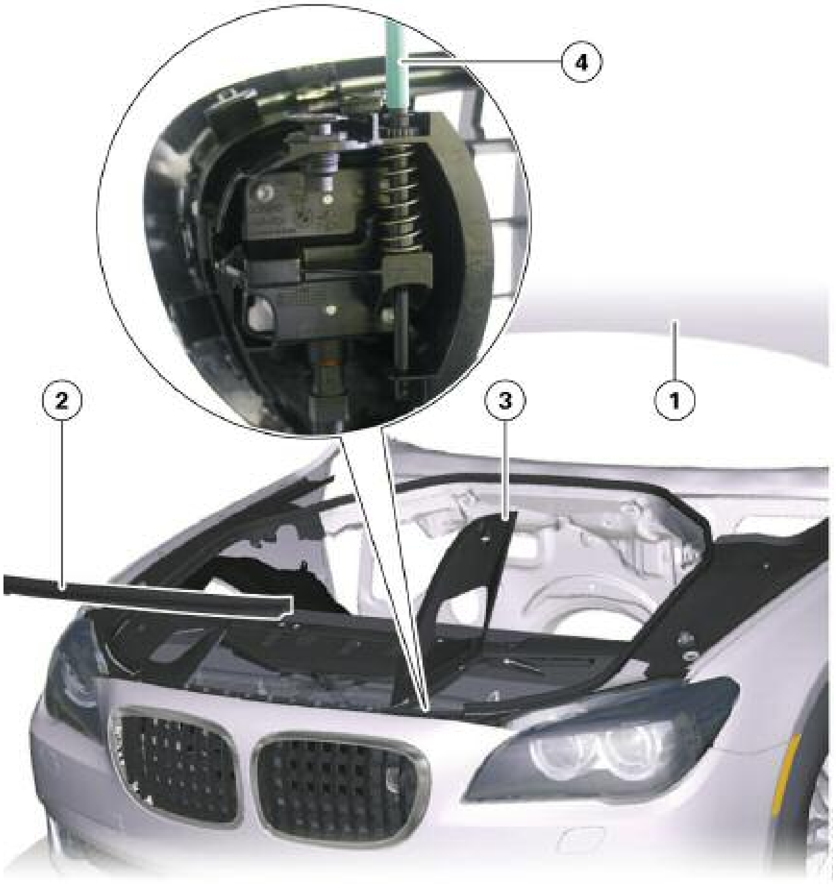
6-pin plug connection

The button for switching BMW Night Vision 2 on and off is integrated in the BEFAS.

Button in the BEFAS BMW 7 Series

Adjusting Camera Pivot Position

The pivot position of the camera can be adjusted by means of an adjusting screw at the bracket.



Camera alignment

The following steps must be taken to adjust the camera on the F01/F02:

- Open hood(1).
- Remove sealing lip (2) on front panel.
- Open headlight cover (3).
- Position headlight adjustment unit with spirit level in front of vehicle.
- Insert Allen key (4) through the opening in the front panel and set the camera to the required position; the line in the image must be parallel to the spirit level.
- Reassemble all parts that have been removed in reverse order.

Changing Protective Window

In the event of damage the camera protective window can be replaced.

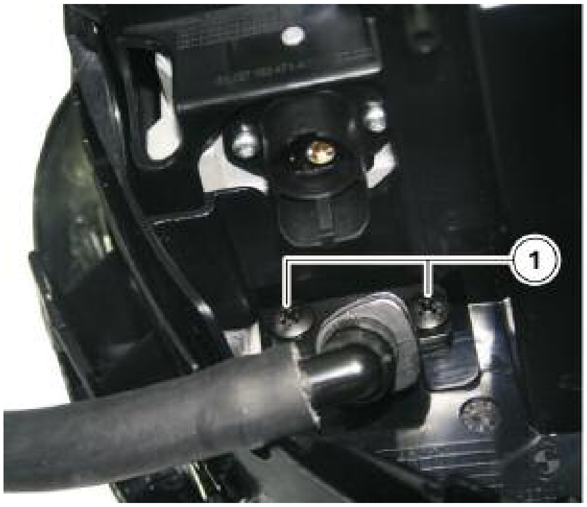
Replacing front lens

Replacing Camera Washer Jet

A washer jet with a direct connection to the headlight washer system for cleaning the protective window is mounted on the camera.

Follow the procedure below to replace the washer jet:

- Remove bumper panel.
- Remove left-side kidney grille.
- Undo two recessed cross head screws (1).
- Release the hose clip on the connecting hose to the headlight washer system and remove the washer jet towards the front.
- Reinstall all parts that have been removed in reverse order.



Camera washer jet

Note: Camera alignment is only possible with a BMW diagnosis system. For detailed information on how to service the Night Vision 2 camera, lens or washer jet please refer to the Repair Instructions available in TIS.

Displays Indicating Defective System

In the event of a system defect, the following warnings are shown in the F01/F02:

- Check Control message in the instrument cluster.
- The same Check Control message in HUD if installed.

Display indicating defective system

Programming and Coding

Initializing Software

When replacing the camera, it is always necessary to initialize the software by entering an enable code (FSC).

Note: The vehicle identification number (VIN) must always be entered when ordering a new camera or a new control unit.

The camera is programmed by through of the control unit. The control unit receives the programming data for the camera through PT-CAN. The control unit forwards this data to the camera through the "private CAN-bus".

Table of Contents

F01 Active Blind Spot Detection System

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Active Blind Spot Detection System

Model: F01/F02

Production: From Start of Production

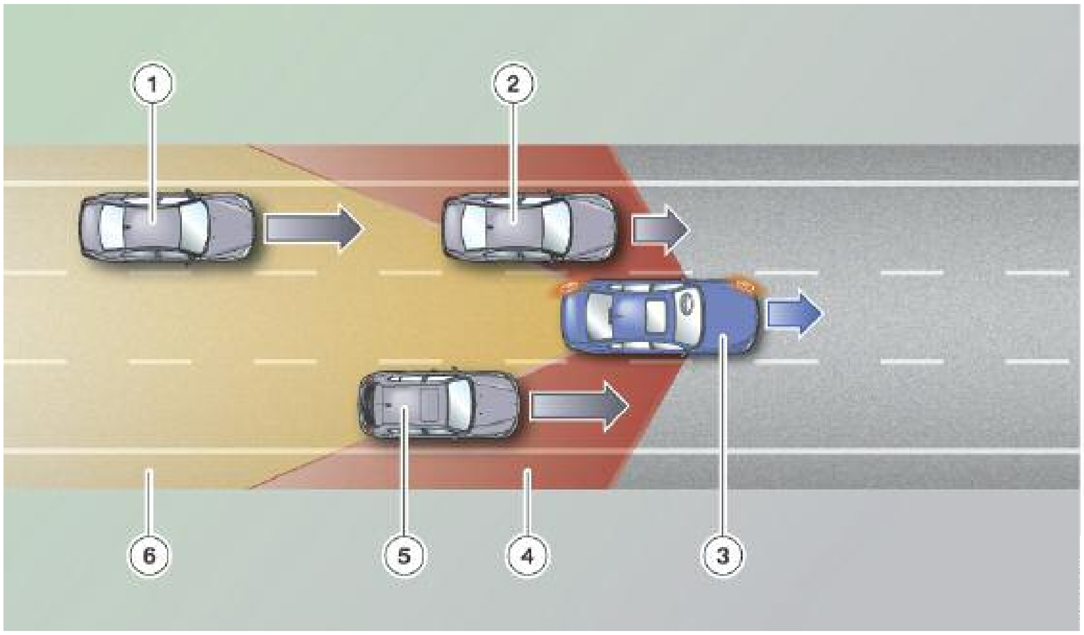
OBJECTIVES

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.

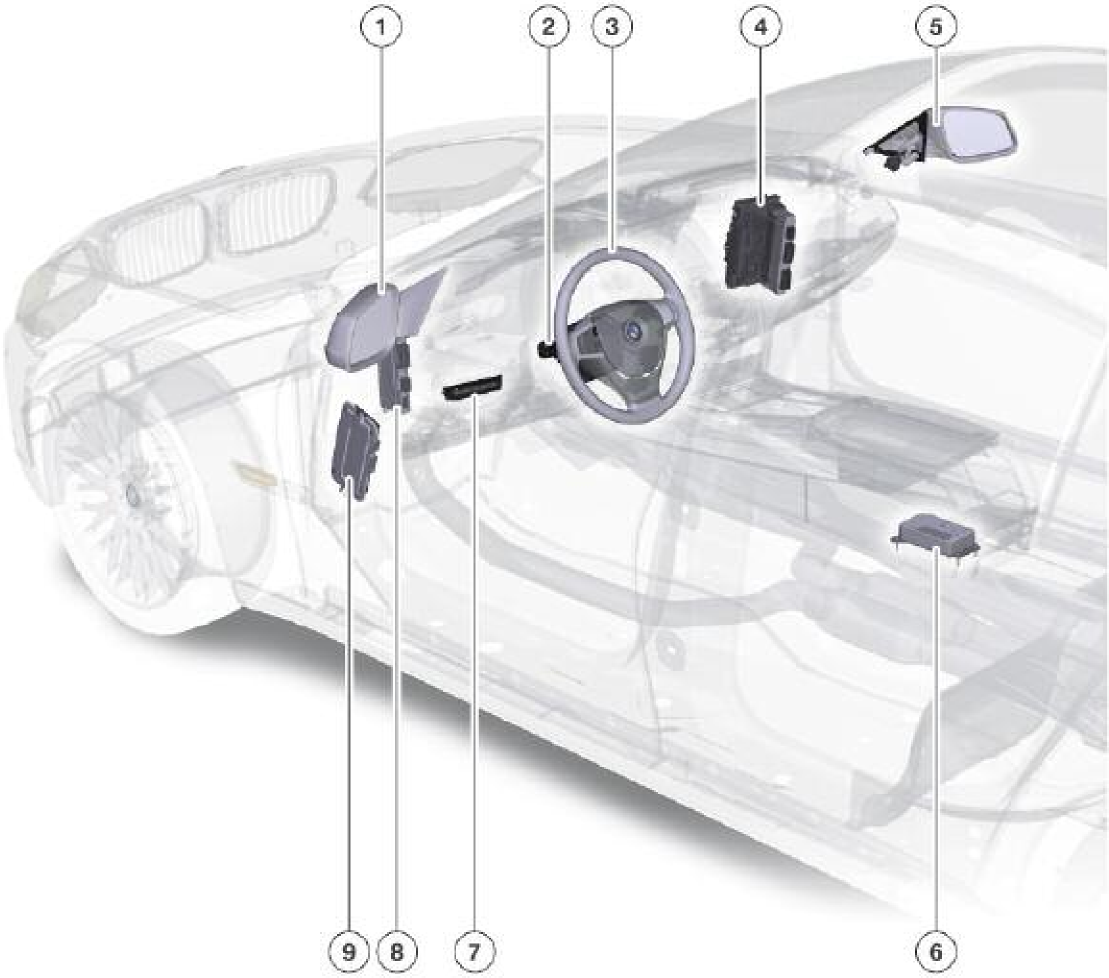
If the driver intends to make a lane change and uses the turn signal stalk to indicate this, a second, more intense stage will then be issued, the "warning".

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

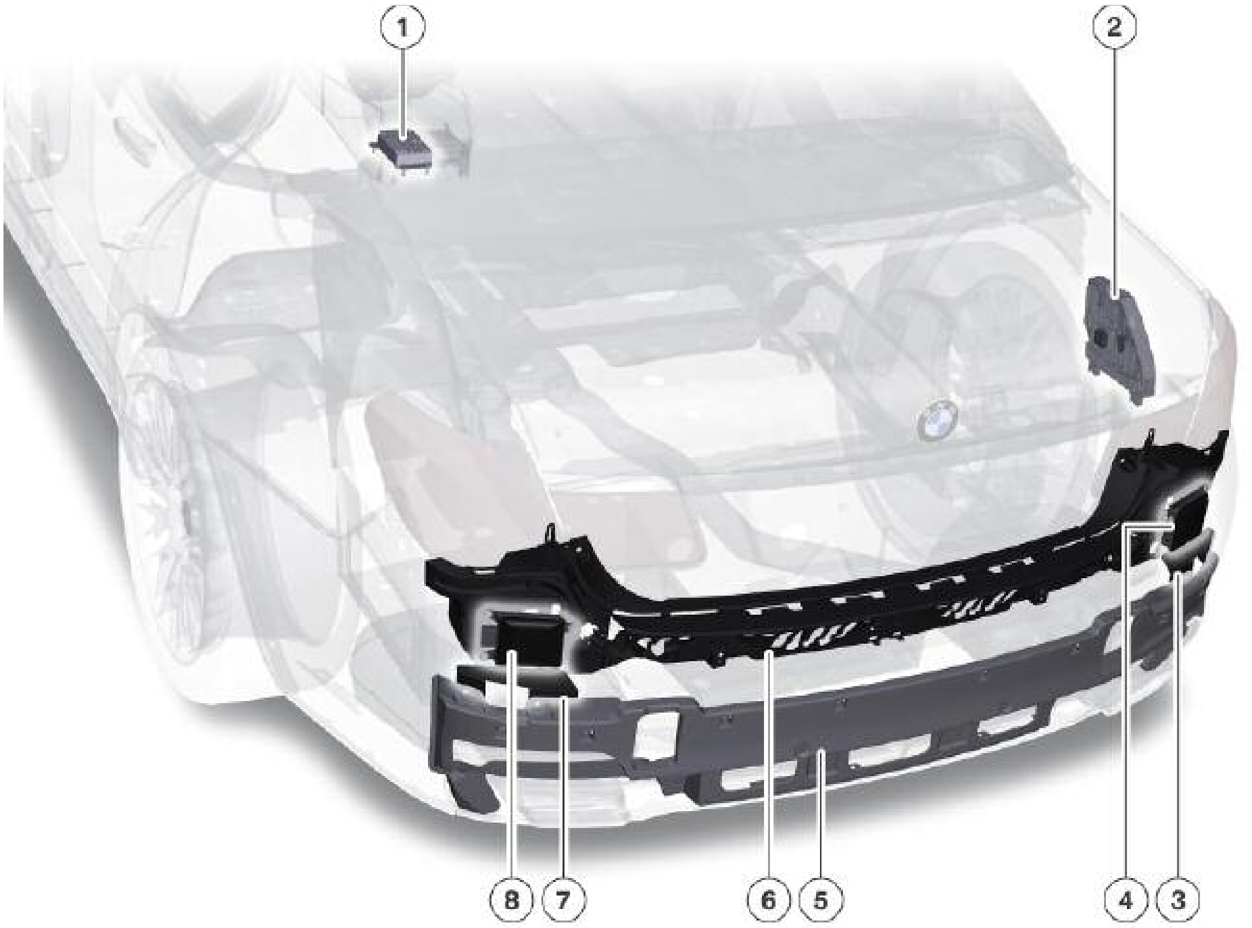
The Active Blind Spot Detection system is available as an option on the F01/F02.



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

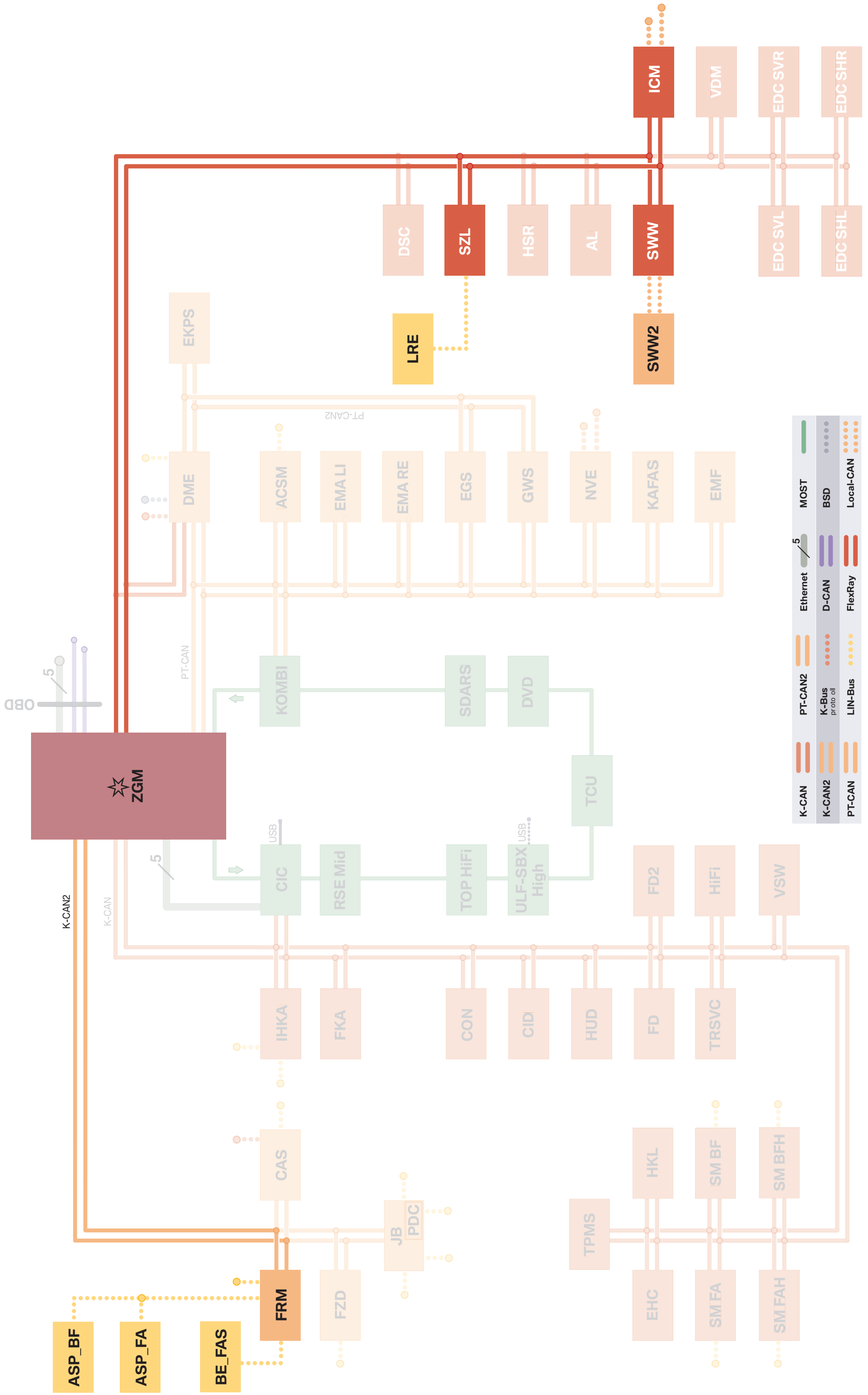
Index	Explanation
1	Driver's door mirror
2	Steering column switch cluster
3	Steering wheel with steering wheel module and vibration actuator
4	Junction box electronics and front fuse carrier
5	Front passenger door mirror
6	Integrated Chassis Management control unit
7	Operating unit for driver assistance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

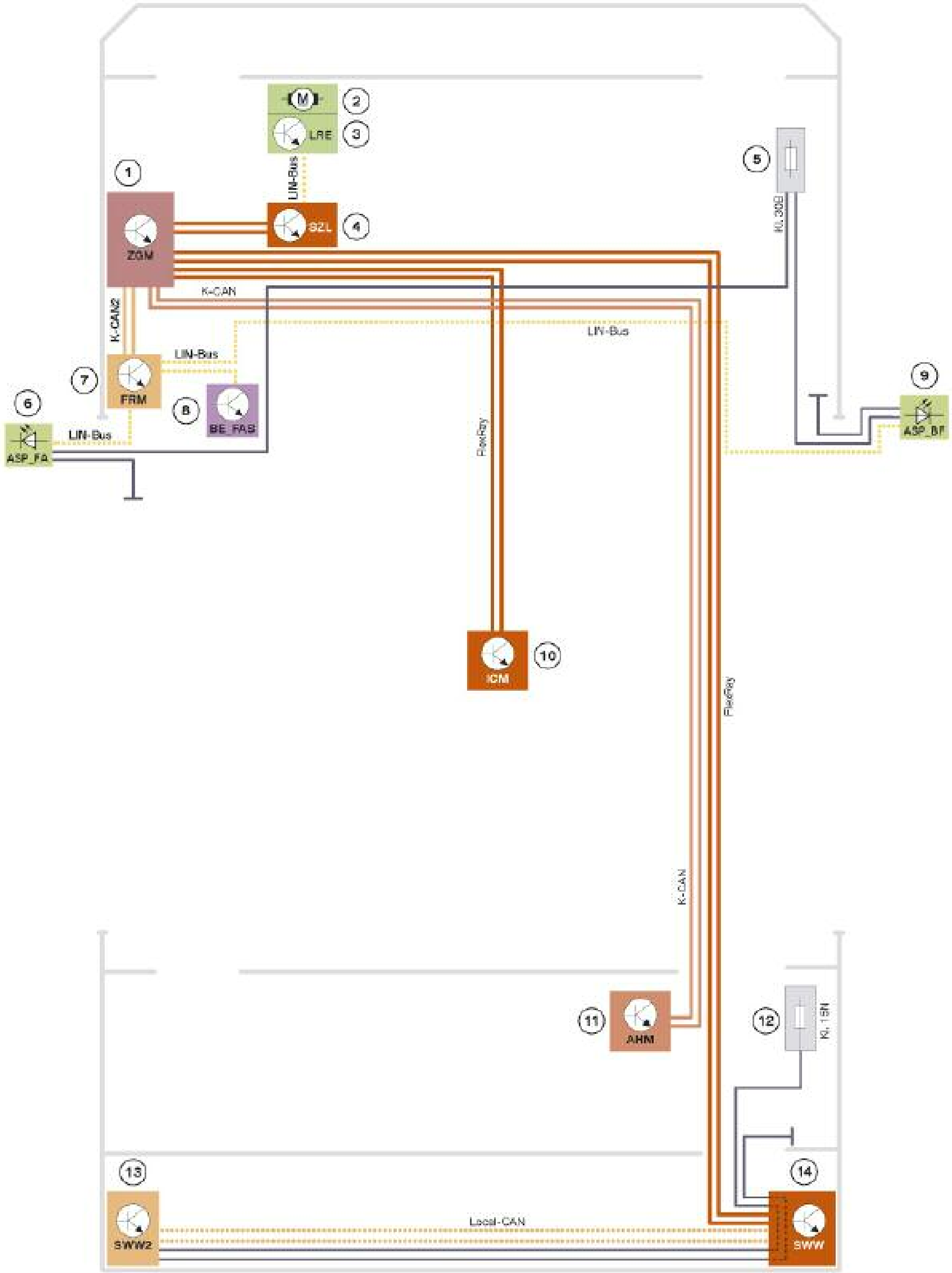


Bus system overview of the Active Blind Spot Detection system in the F01/F02

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



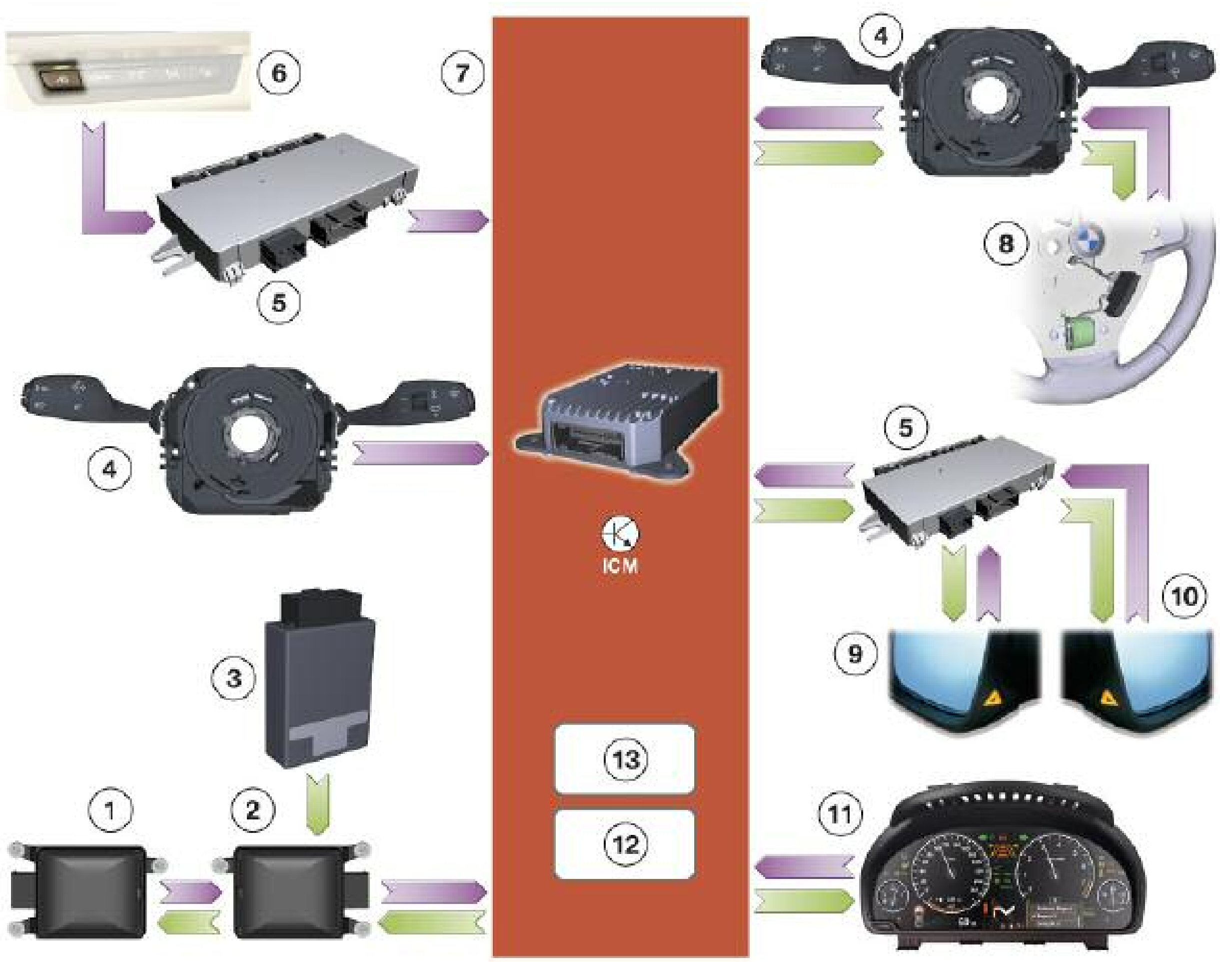
System circuit diagram for the Active Blind Spot Detection system in the F01/F02

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

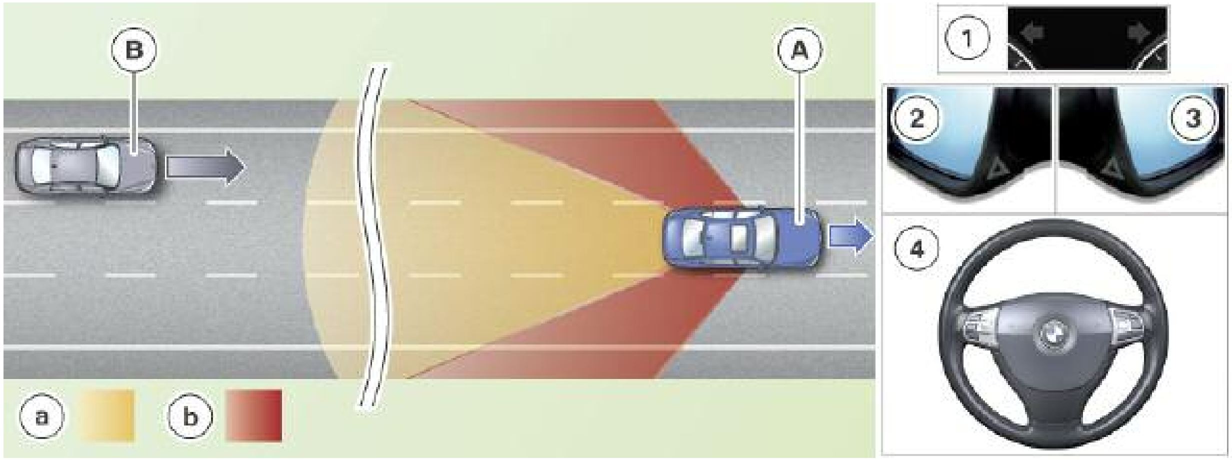
Like the blind spot detection, the lane departure warning (KAFAS control unit) also uses the vibration actuator to produce a warning signal for the driver. For this, the systems use different amplitudes of vibration.

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

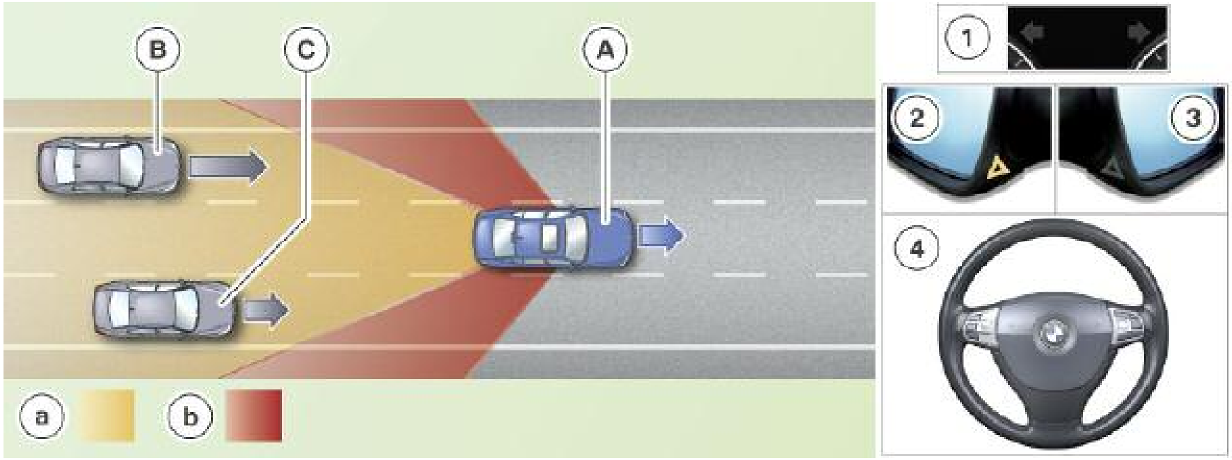
Index	Explanation
A	Your own vehicle with blind spot detection
B	Faster vehicle in the left-side neighboring lane outside of the lane change zones
a	Lane change zone
b	Blind spot area
1	Turn signal OFF
2	Warning light in the driver's door mirror OFF
3	Warning light in the front passenger door mirror 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

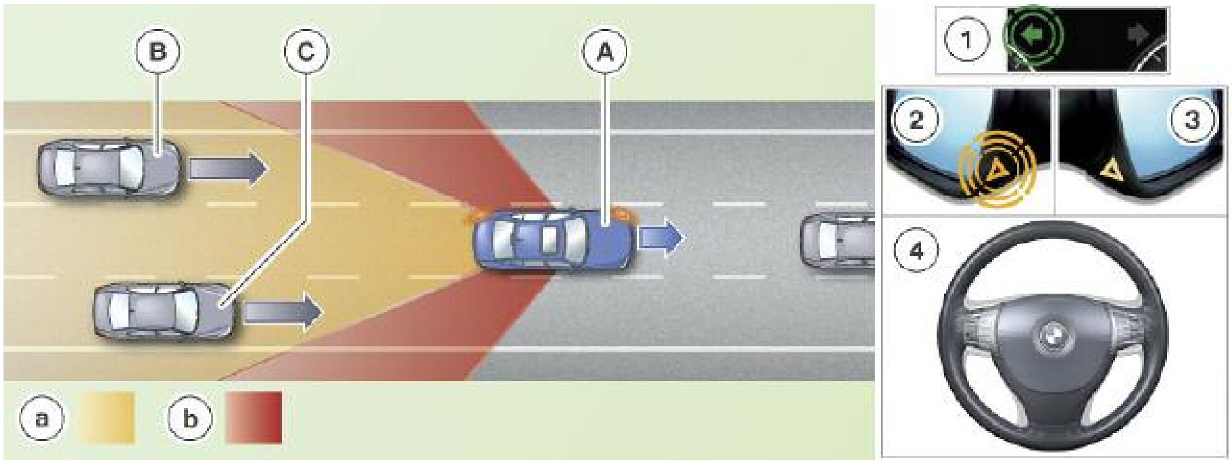
Index	Explanation
A	Your own vehicle with blind spot detection
B	Faster vehicle in the left-side neighboring lane within the lane change zone
C	Equally fast vehicle as our own, in the right-side neighboring lane within the lane change zone
a	Lane change zone
b	Blind spot area
1	Turn signal OFF
2	Warning 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

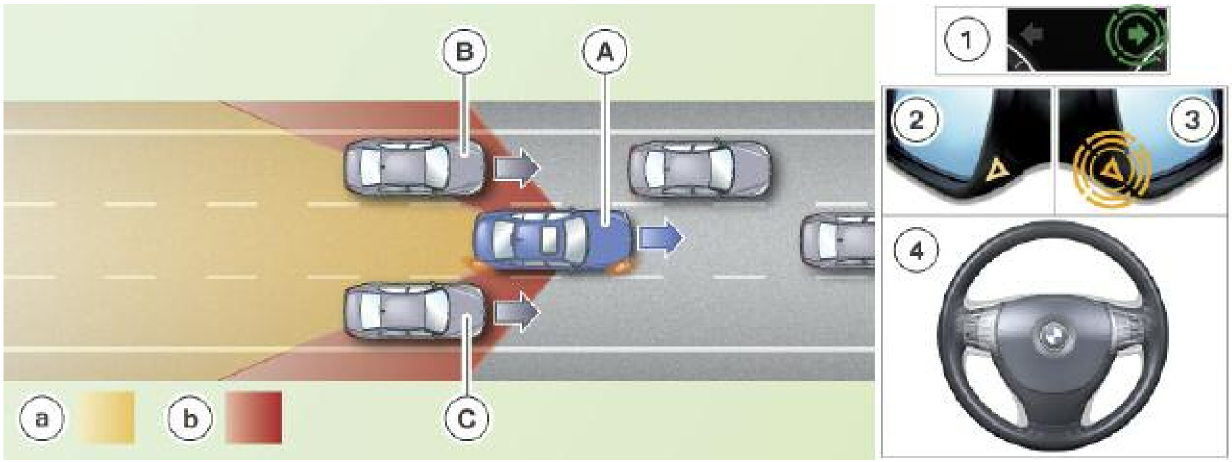
Index	Explanation
A	Your own vehicle with blind spot detection
B	Faster vehicle than our own, in the left-side neighboring lane within the lane change zone
C	Equally fast vehicle as vehicle B, in the right-side neighboring lane within the lane change zone
a	Lane change zone
b	Blind spot area
1	Left turn 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

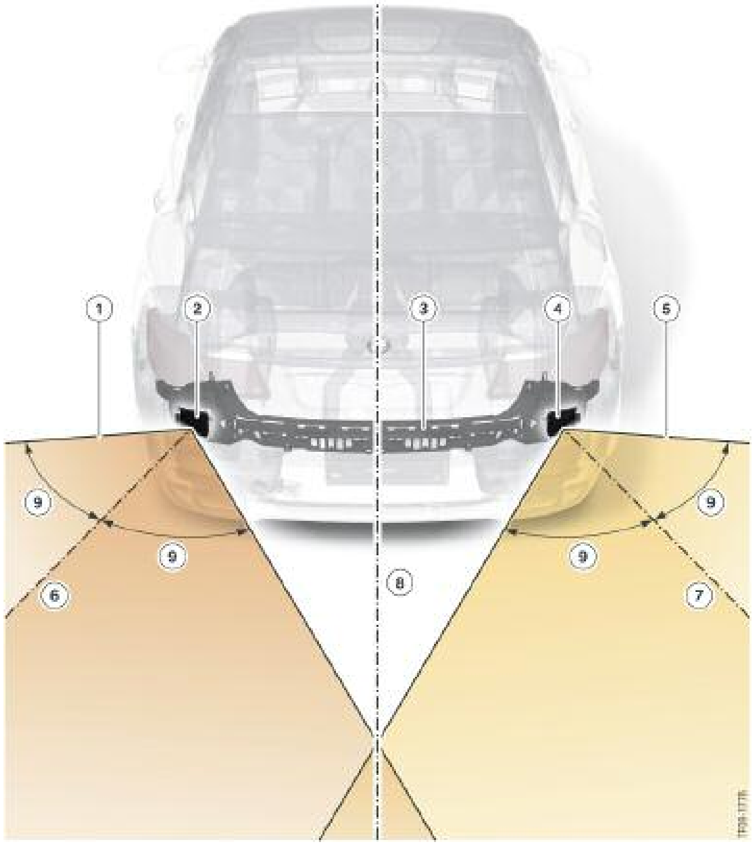
The sensors of the Active Blind Spot Detection system work according to the RADAR principle (radio detection and ranging). They have some features in common, but also some differences in comparison with the short-range radar sensors for the ACC Stop & Go function. These are listed in the following table.

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.



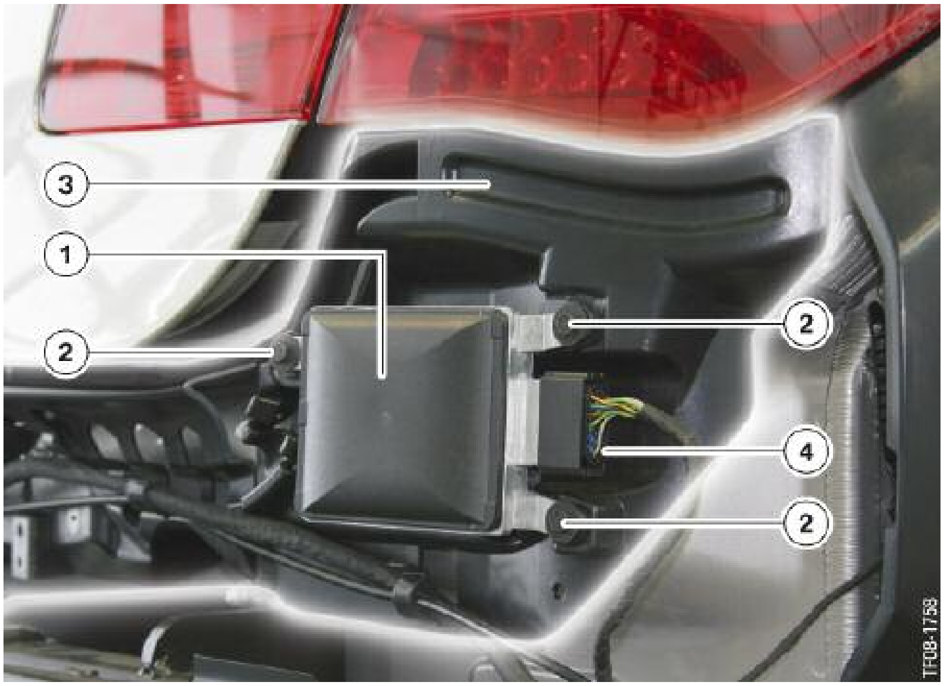
Overview and installation location of the radar sensors

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.

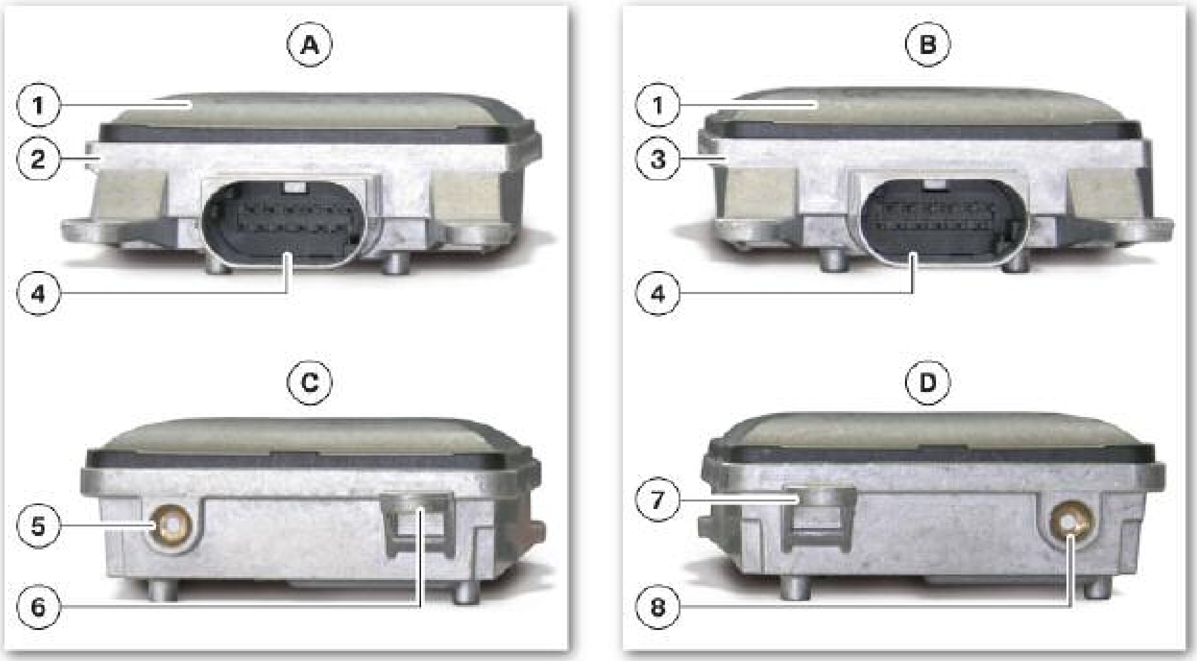
The board always has a signal processor. This evaluates the radar signals and uses them to generate a list of the objects detected by the sensor. The list contains the distance to each object in a longitudinal and lateral direction and the relative speed. In addition, information is supplied about whether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



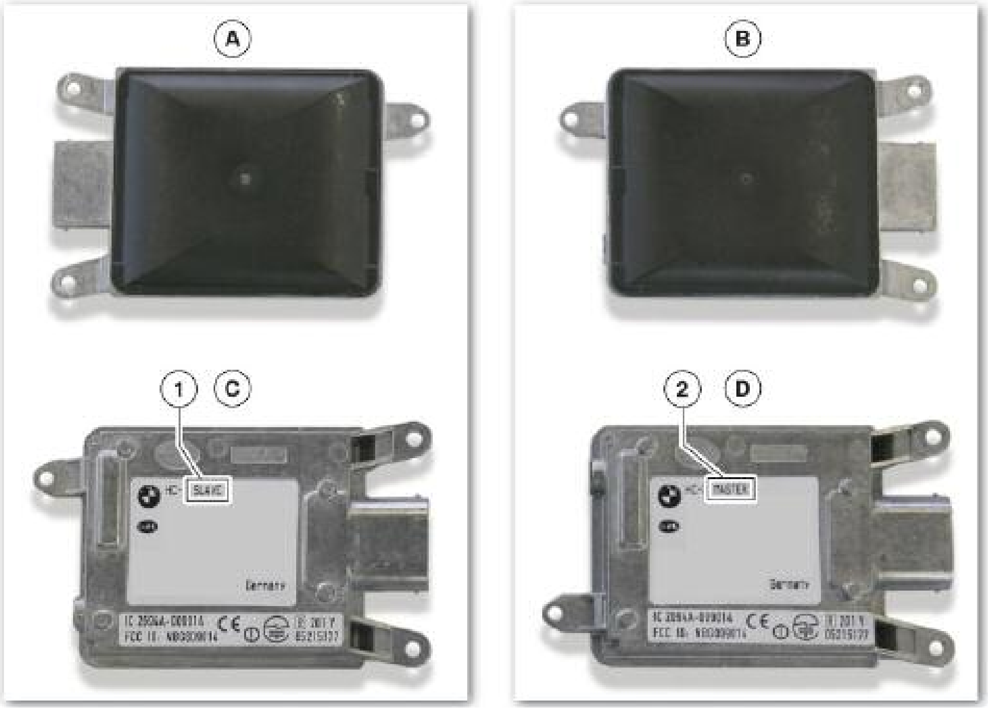
Index	Explanation	Index	Explanation
A	Outside view of the SWW2	3	Lower section of housing, master
B	Outside view of the master	4	Connector
C	Inside view of the SWW2	5	Pressure-compensating element, SWW2
D	Inside view of the master	6	Mounting eye for the SWW2
1	Radome	7	Mounting eye, master
2	Lower section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

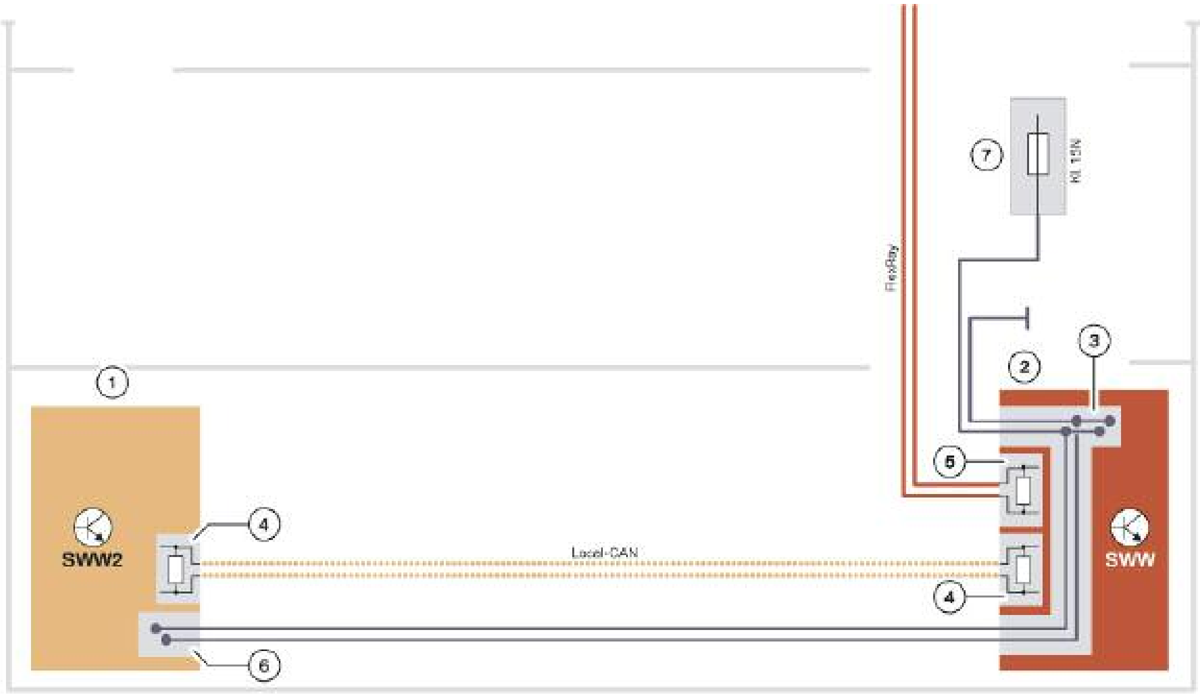
Voltage Supply

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.

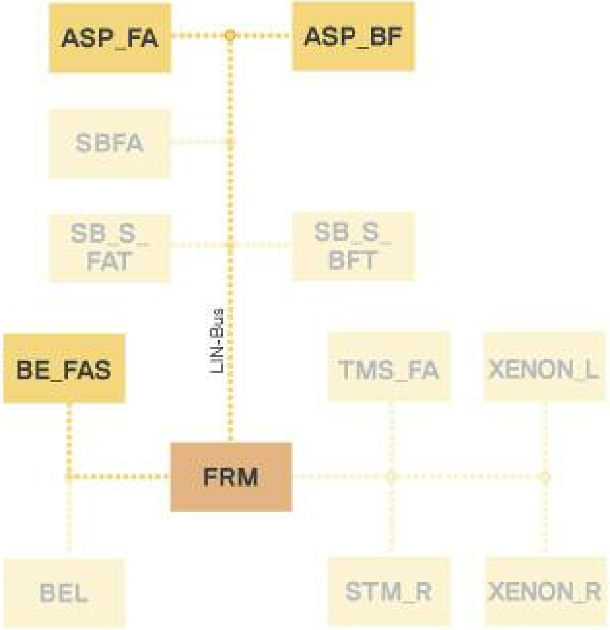
Based on the spacers that act as gauges, the correct alignment can be restored. In any case, after this kind of body repair, the sensors will have to be calibrated.

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

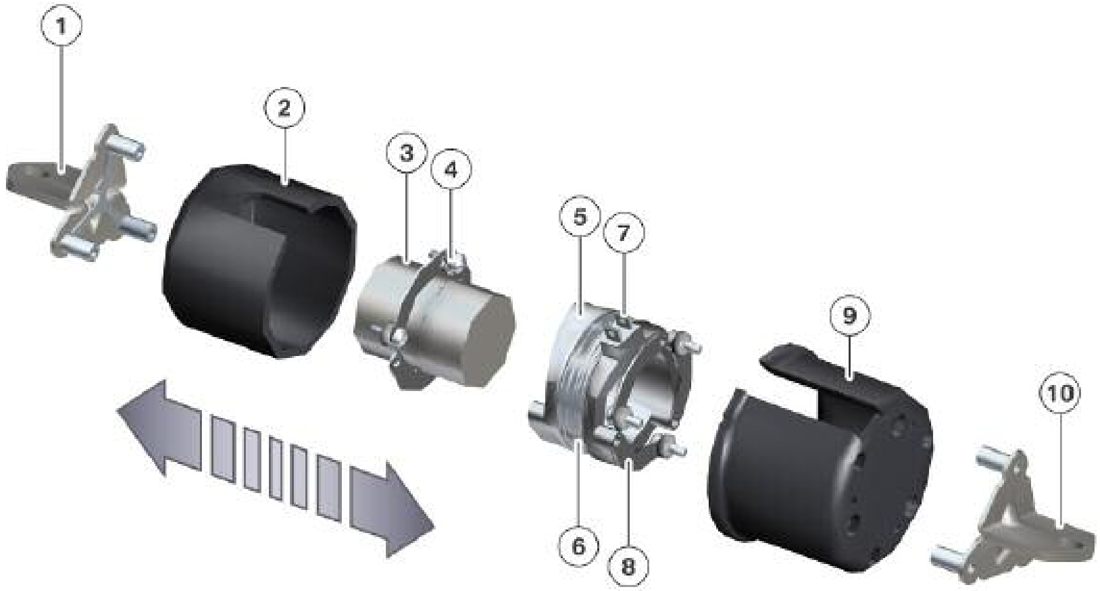
Index	Explanation
1	Steering wheel module (LRE)
2	Vibration actuator

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

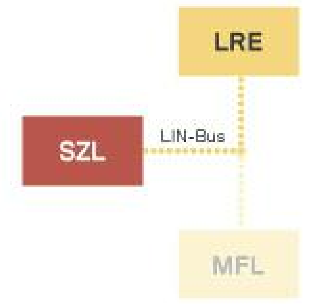


Index	Explanation	Index	Explanation
1	Left bracket	6	Coil
2	Left case section	7	Electrical connection
3	Permanent magnet	8	Spring
4	Spring	9	Right case section
5	Coil carrier	10	Right bracket

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)

Table of Contents

F01 KAFAS

Initial Print Date: 01/09 Revision Date:

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.

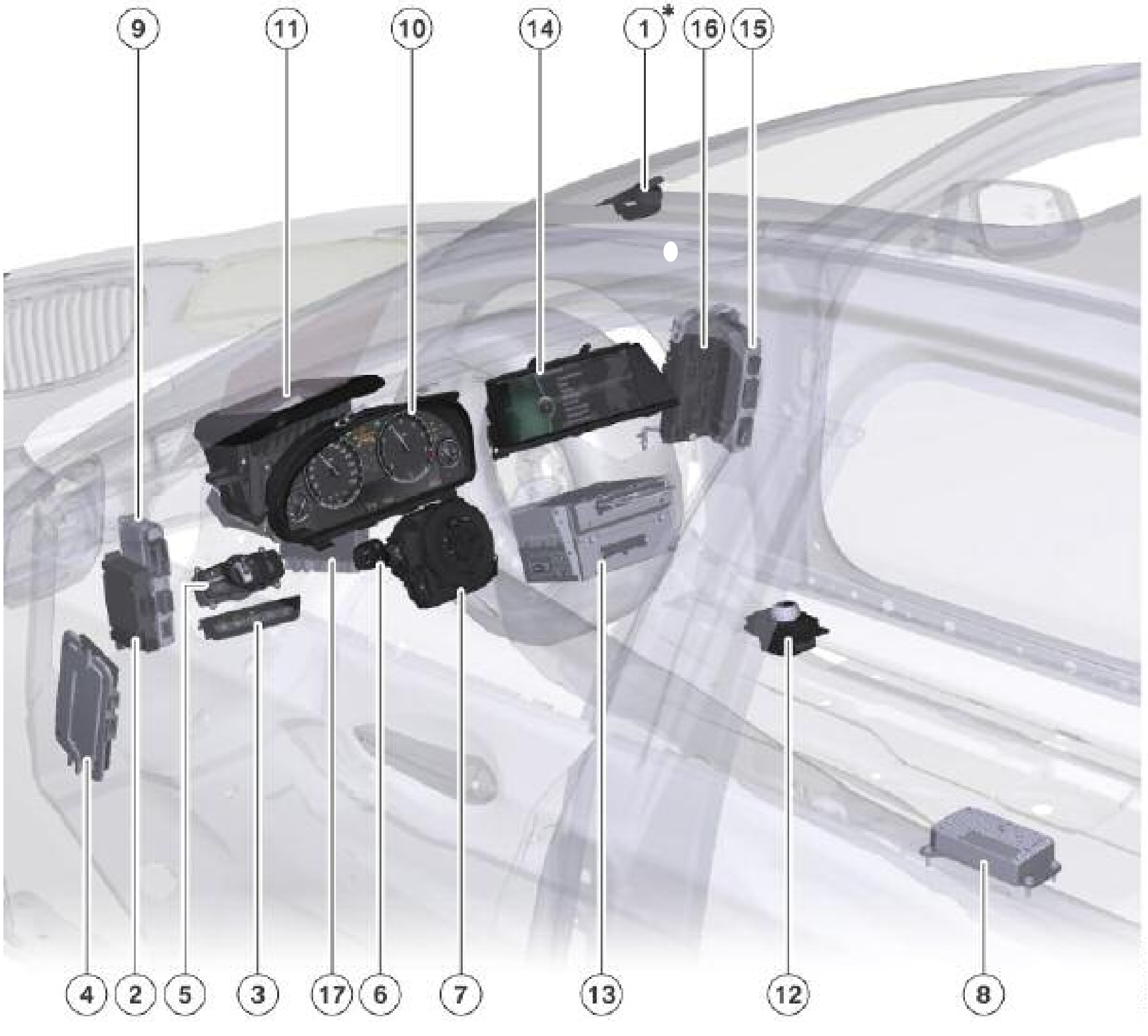
Options/Technical specification	
	KAFAS 1 camera 1 control unit 2 functions
Lane departure warning	**X**
High-beam assistant	**X**

System Overview

Lane Departure Warning and High-beam Assistant

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

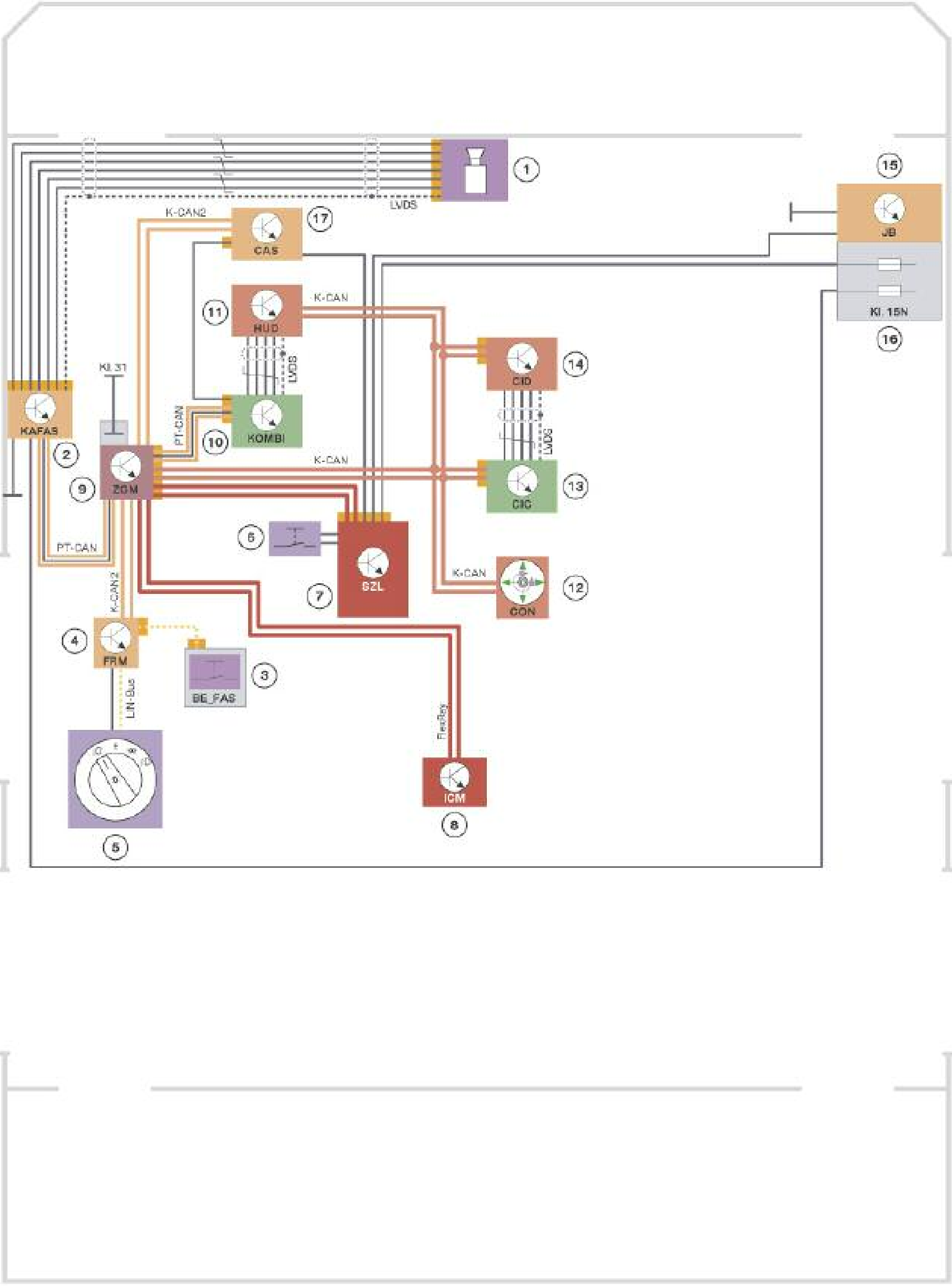
System overview of KAFAS components



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
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System Components

Lane Departure Warning

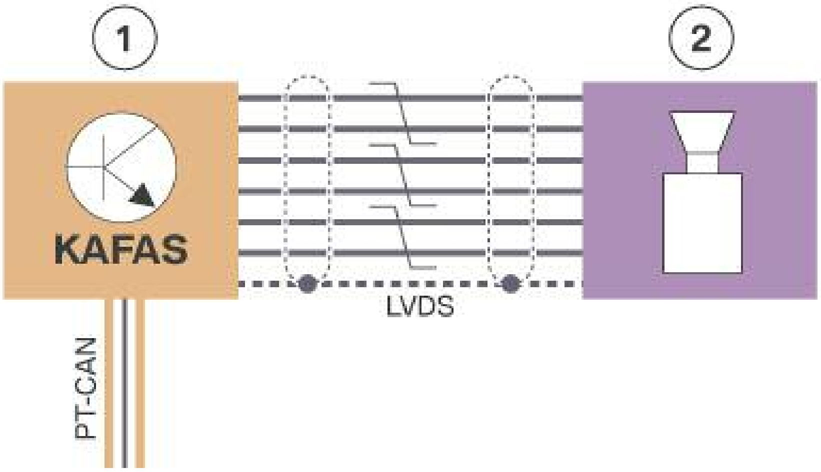
In the F01/F02, a front facing video camera and the corresponding button in the BEFAS control panel indicate that the vehicle is equipped with the lane departure warning.

Video camera for lane departure warning

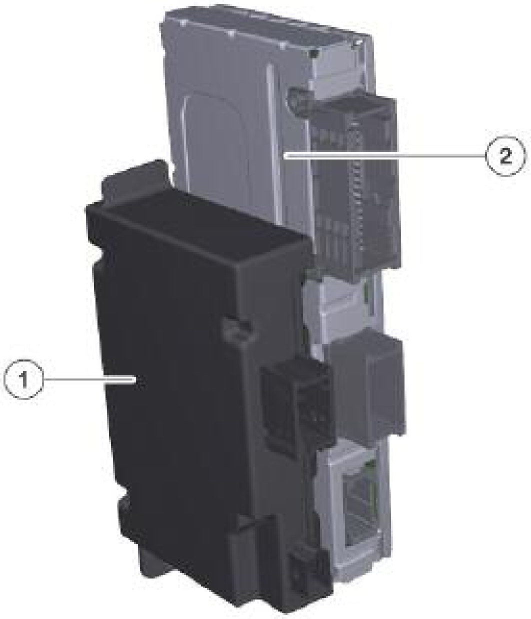
Driver assistance control panel with lane departure warning

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



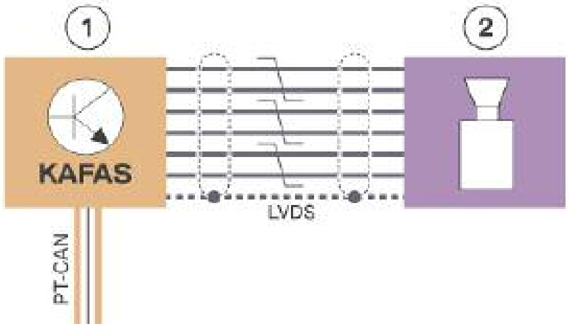
Index	Explanation	Index	Explanation
1	KAFAS control unit with PT-CAN	2	Lane departure warning video camera with LVDS connection to KAFAS control unit



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

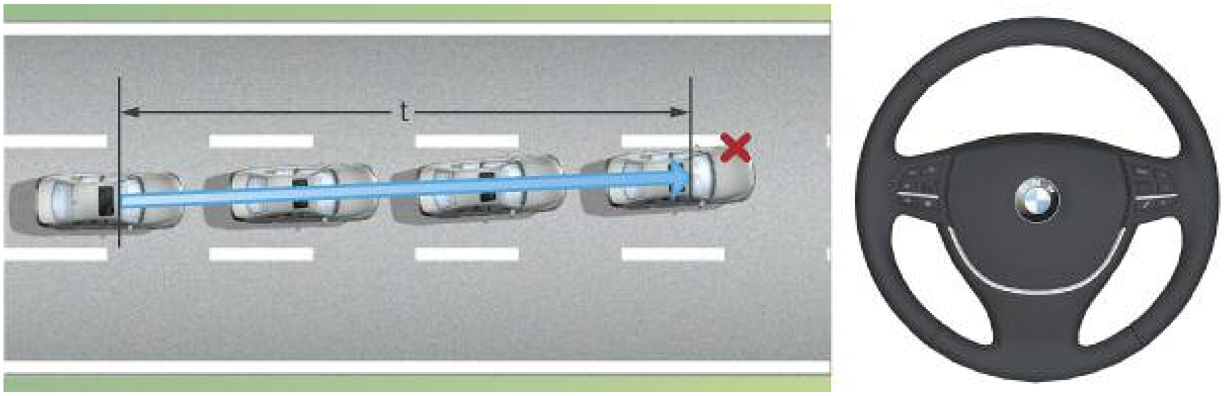
The lane departure warning causes the steering wheel to vibrate to warn the driver that the vehicle is threatening to leave the current lane without driver intending it to do so. The prerequisite for this function to work is the presence of road or lane markings that can be recognized by the control 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.

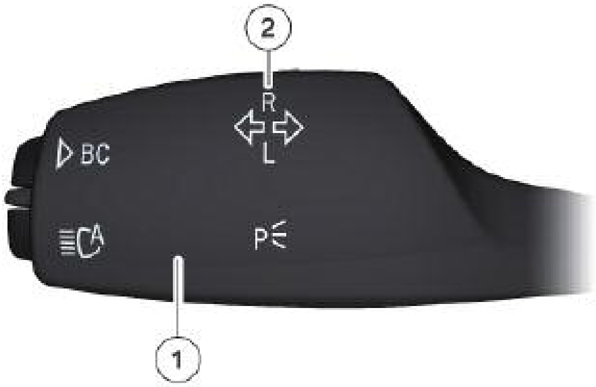
The lane departure warning senses an intentional change of lane made by the driver from the activation of the turn signal. In this case there is no warning when the vehicle is driven over the lane marking.

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.

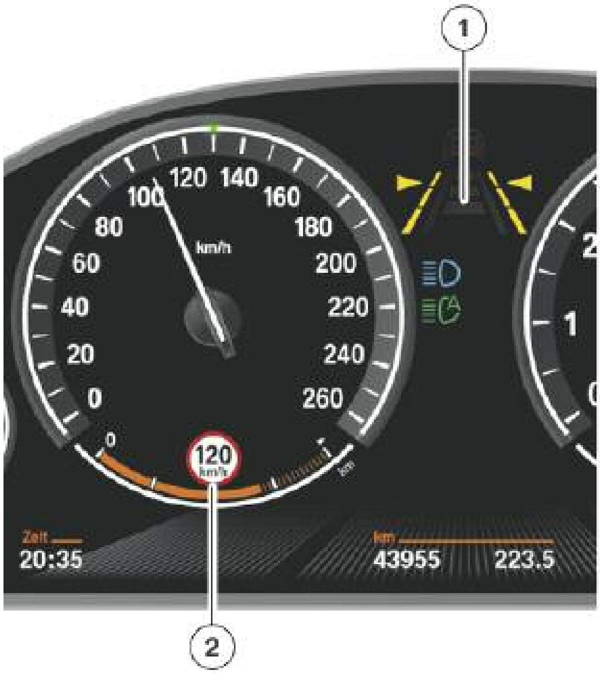
Displays of the lane departure warning with ACC

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.

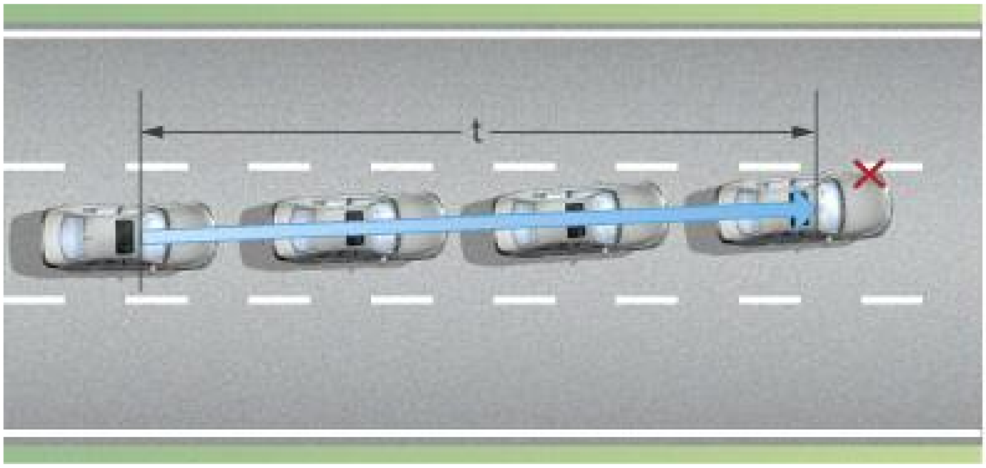
If the vehicle threatens to drive over the lane marking, the system warns the driver by causing the steering wheel to vibrate.

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).

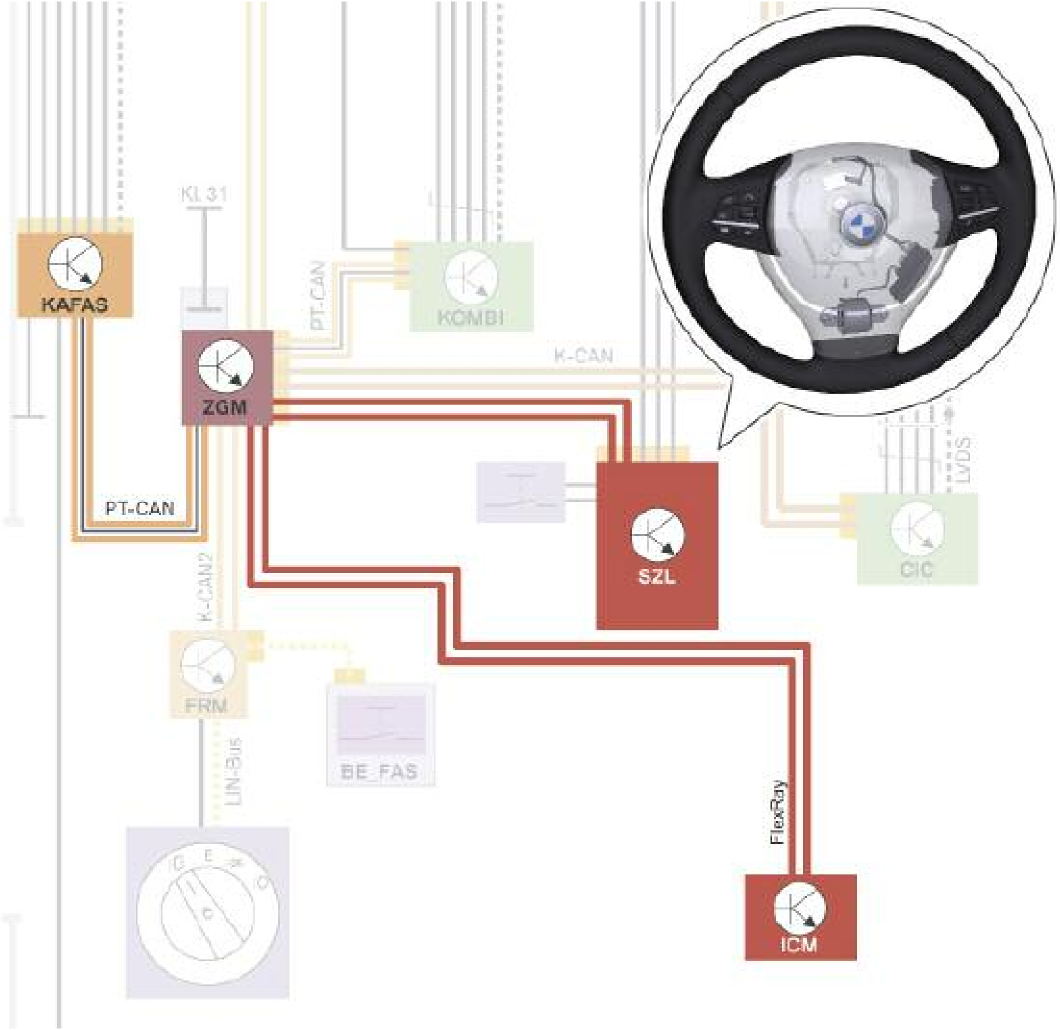
Activation/ threshold	Deactivation/threshold
40 mph	37 mph

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.

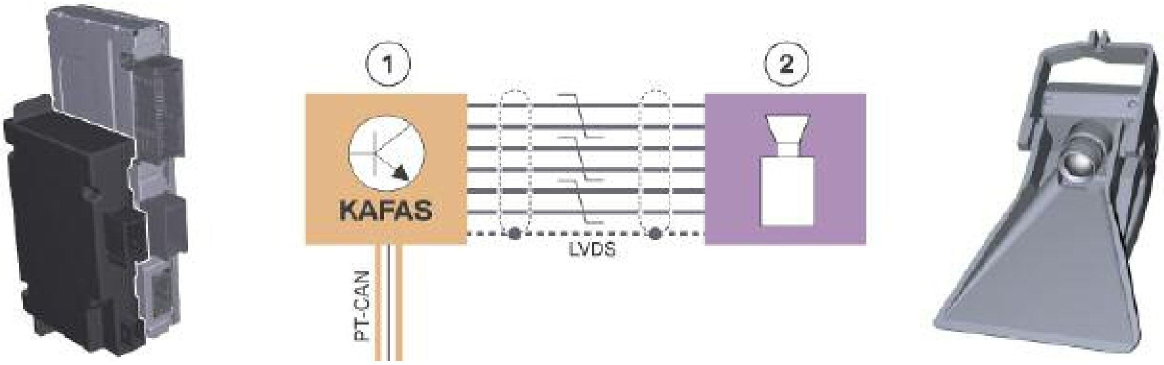
High-beam assistant display and button

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.

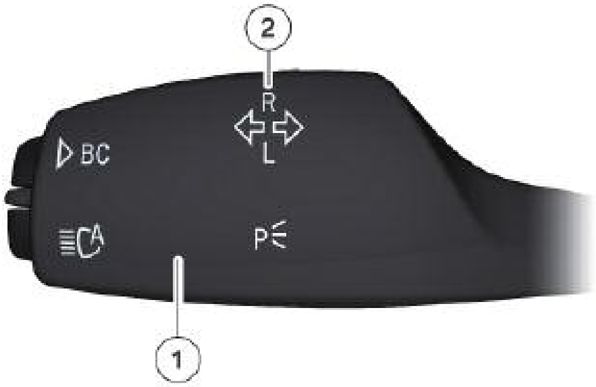
In the F01/F02, the high-beam assistant has its own activation button in the turn signal/ high-beam stalk on the steering column.

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

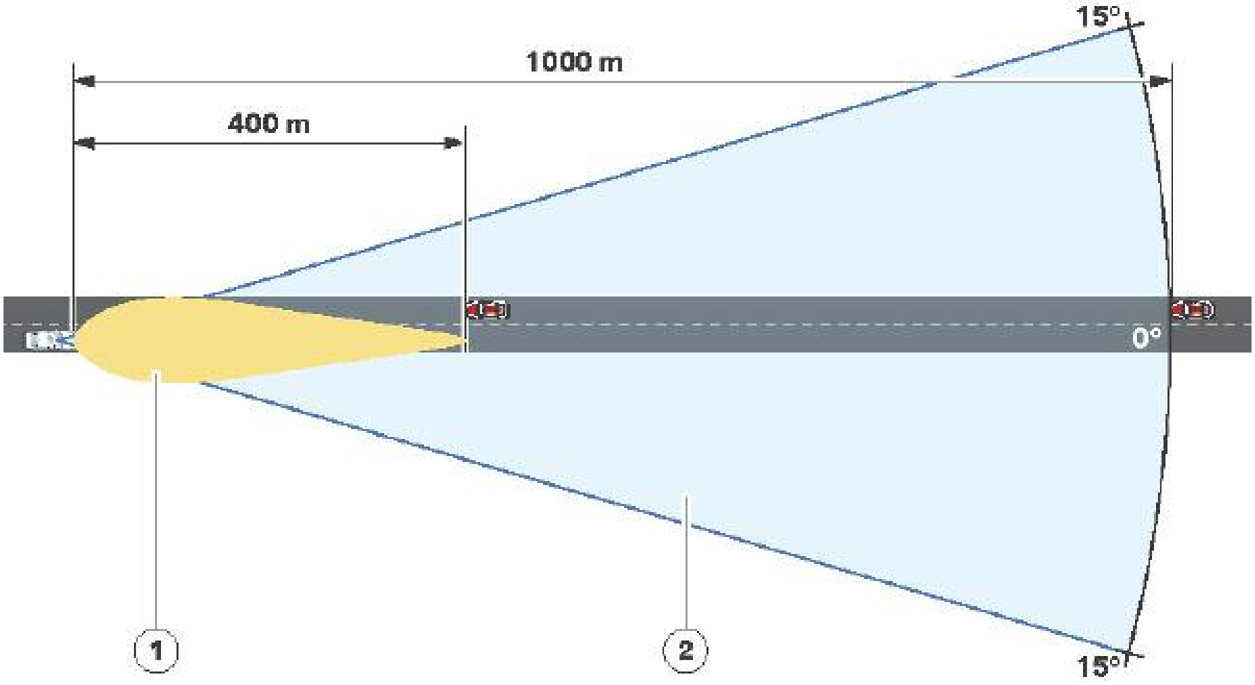
The switching on and off of the high-beam headlights is indicated by the conventional symbol in the instrument cluster.

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.

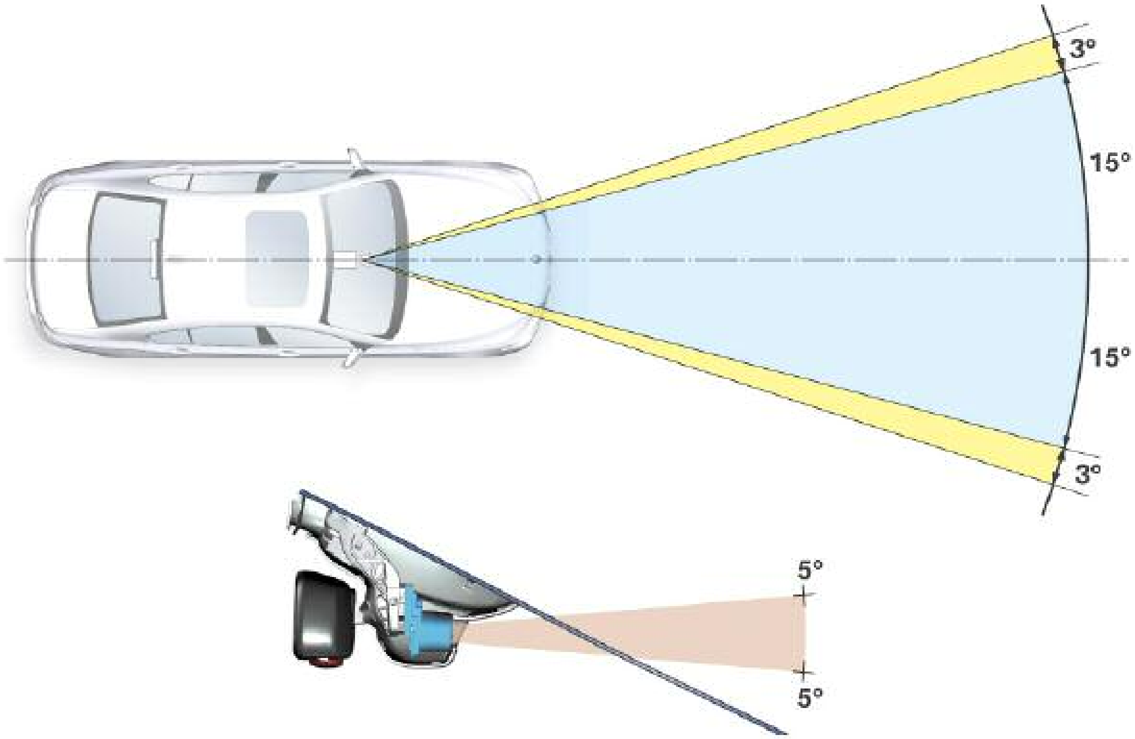
When active, these special video cameras capture dots of light and, in the process, are able to distinguish between various parameters, e.g. light color and light intensity.

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.

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.

Table of Contents

F01 PDC-TRSVC

Subject **Page**

Initial Print Date: 01/09 Revision Date:

PDC-TRSVC

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the PDC-TRSVC system in the F01/F02
- Identify the components of the PDC-TRSVC system in the F01/F02

Introduction

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

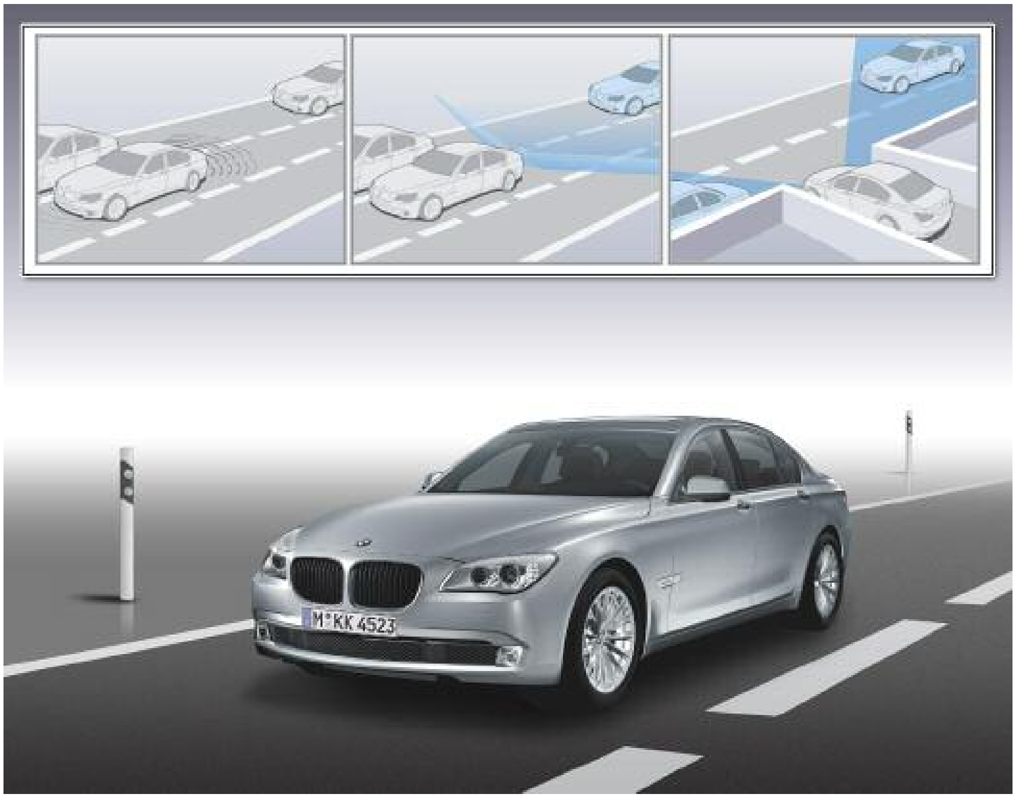
The individual systems and function units are becoming ever more densely networked as a result of the shared use of components, signals and displays in some areas.

These are the optionally available combinations:

- PDC
- Rear-view Camera
- Side View Camera

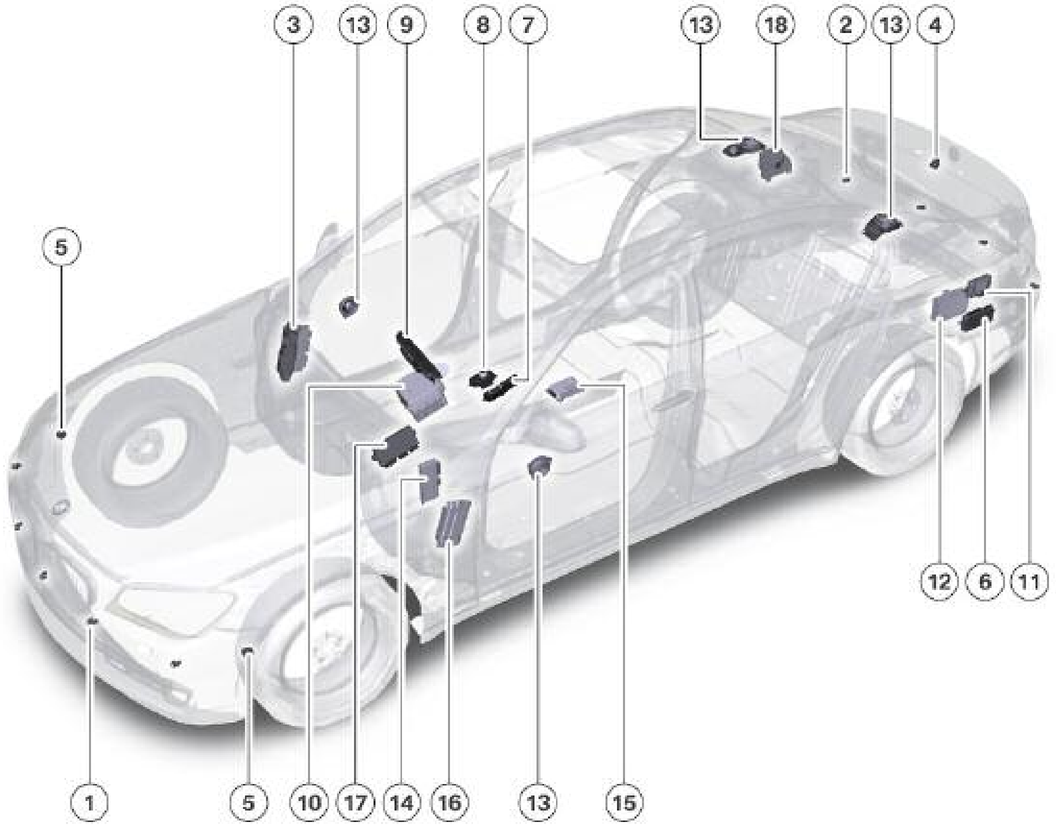
Park Distance Control (PDC) is standard equipment on the F01/F02, with the ZCE Camera Package available as an option. The Camera Package includes the Rear-view Camera and the Side View Cameras. The TRSVC control unit is used to manage the different video feeds and display them on the CID in combination with PDC functions.

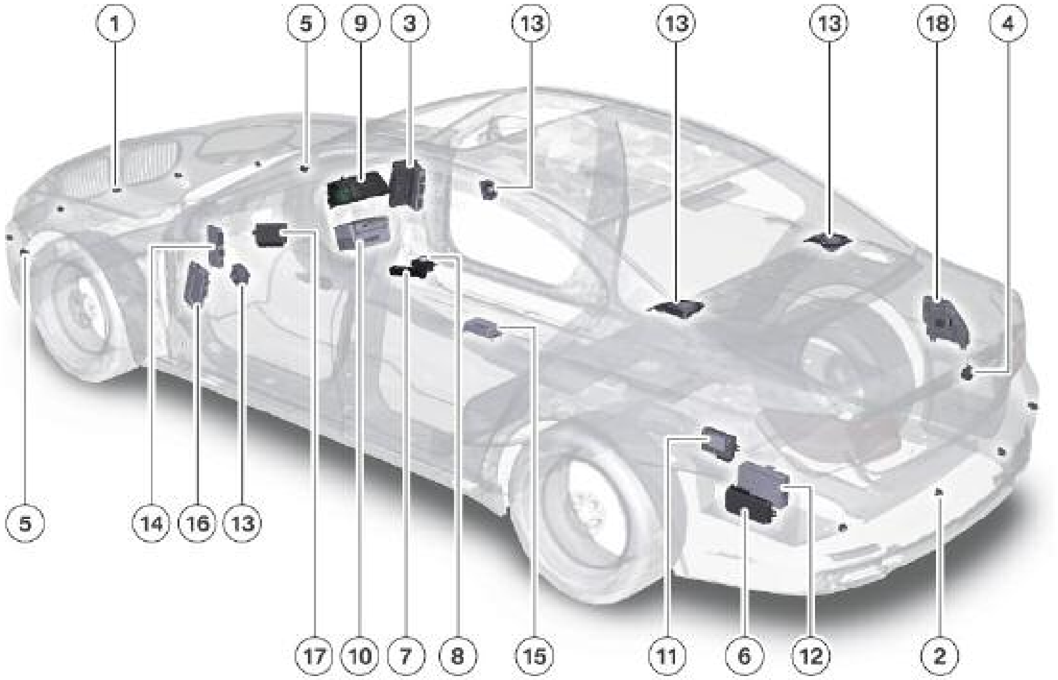
TRSVC stands for Top Rear Side View Camera diver assistance system.



System Overview

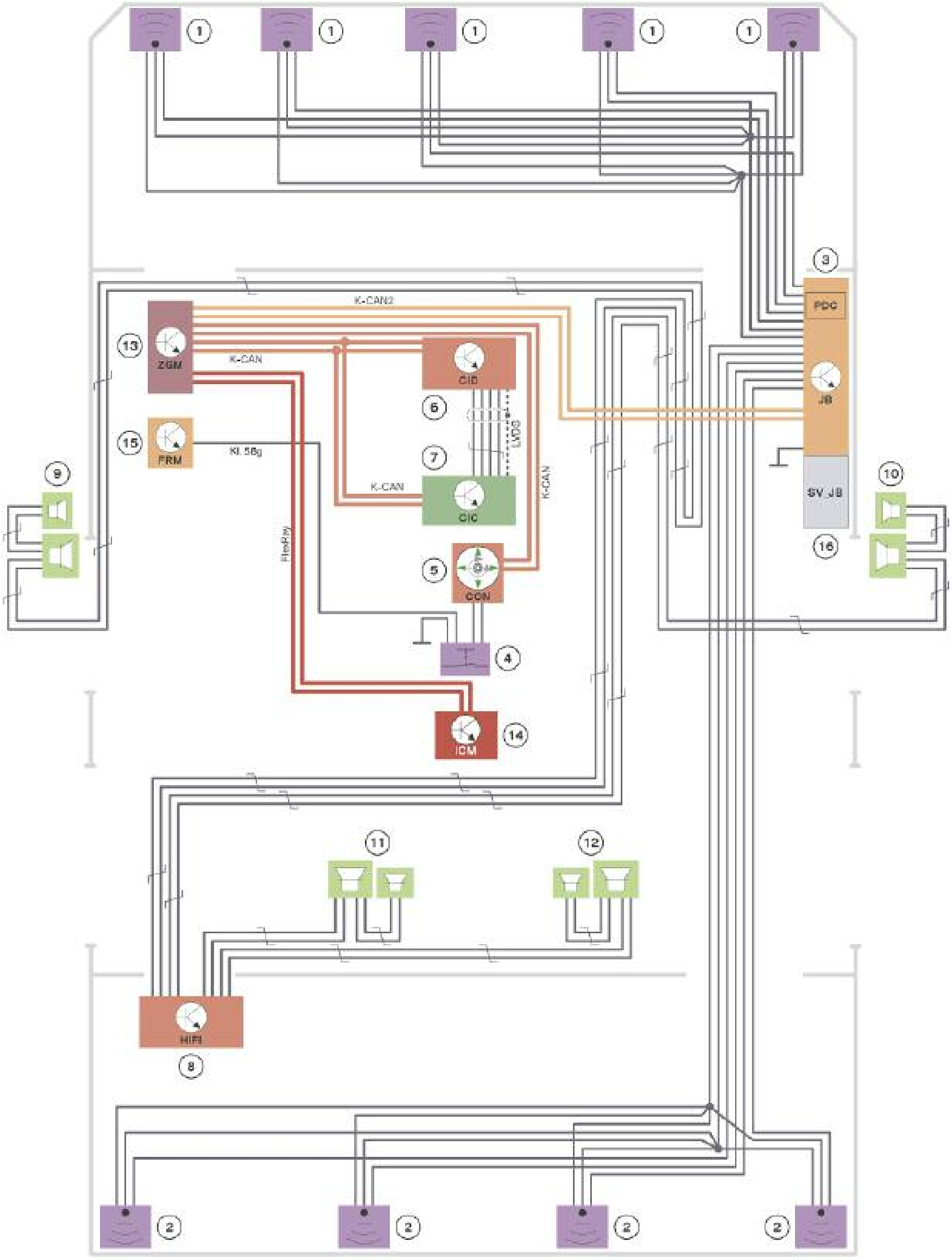
PDC, rear view camera, Side View





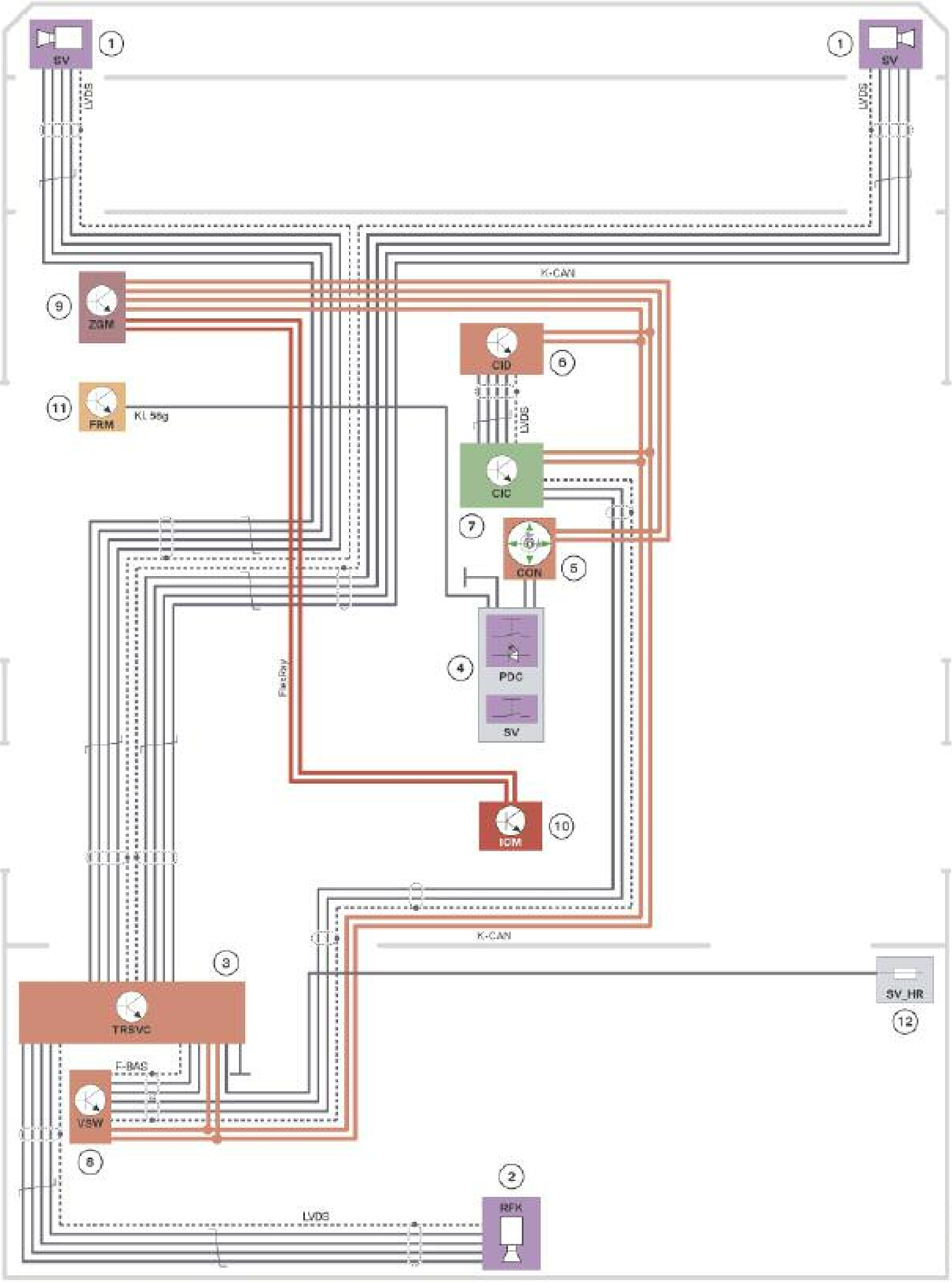
Index	Explanation	Index	Explanation
1	Park Distance Control (PDC) - Five ultrasonic sensors in the front bumper	10	Car Information Computer (CIC) data preparation for displays in the CI
2	Park Distance Control (PDC) - Four ultrasonic sensors in the rear bumper	11	Video switch (VSW)
3	Junction box electronics with integrated PDC control unit	12	Audio amplifier (HiFi) - Audible Distance Warning (PDC)
4	Rear view camera	13	Loudspeakers front left/front right rear left/rear right - Audible Distance Warning (PDC)
5	Side View cameras, left/right	14	Central gateway module (ZGM)
6	TRSVC control unit (Top Rear side View Camera)	15	Integrated Chassis Management (ICM) road-speed signal
7	PDC/rear view camera on/off button and Side View on/off button	16	Footwell module (FRM)
8	Controller Control unit for PDC/rear view camera on/off button and Side View on/off button	17	Car Access System (CAS)
9	Central Information Display (CID) for displays of PDC/rear view camera/Side View	18	Rear distribution box, luggage compartment

PDC system circuit diagram



Index	Explanation	Index	Explanation
1	Five ultrasonic sensors in the front bumper	9	Loudspeaker, front left - Audible distance warning (PDC)
2	Four ultrasonic sensors in the rear bumper	10	Loudspeaker, front right - Audible distance warning (PDC)
3	Junction box electronics with integrated PDC control unit	11	Loudspeaker, rear left - Audible distance warning (PDC)
4	PDC on/off button	12	Loudspeaker, rear right - Audible distance warning (PDC)
5	Controller control unit with PDC on/ off button	13	Central gateway module (ZGM)
6	Central Information Display (CID) for PDC displays	14	Integrated Chassis Management (ICM) road-speed signal
7	Car Information Computer (CIC) data preparation for displays in the CID	15	Footwell module
8	Audio amplifier (HiFi) - Audible distance warning (PDC)	16	Junction box electronics, front distribution box

System circuit diagram for rear view and side view cameras



Index	Explanation	Index	Explanation
1	Side View cameras, left/right	7	Car Information Computer (CIC) data preparation for displays in the CID
2	Rear view camera	8	Video switch (VSW)
3	TRSVC control unit (Top Rear Side View Camera)	9	Central gateway module (ZGM)
4	PDC on/off button and Side View on/off button	10	Integrated Chassis Management (ICM) road-speed signal
5	Controller PDC/rear view camera on/off button and Side View on/off button	11	Control unit for Footwell module (FRM)
6	Central Information Display (CID) for displays of PDC/rear view camera / Side View	12	Distribution box, luggage compartment

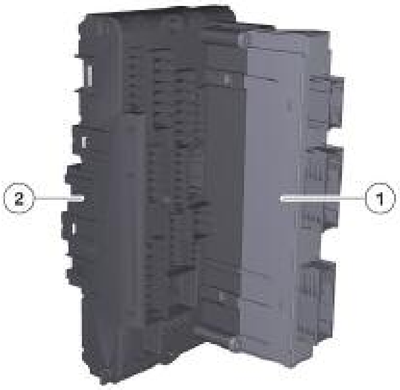
System Components

Park Distance Control

The Park Distance Control of the F01/F02 is identifiable by the five ultrasonic sensors on the front bumper. The fifth sensor enables a high level of reliability in obstacle recognition to be achieved despite the large front end of the F01.

F01/F02 front bumper with five Park Distance Control ultrasonic sensors

PDC ultrasonic sensor



Junction box electronics and front distribution box

In the F01, the PDC control unit function has been integrated into the junction box electronics for the first time.

Index	Explanation
1	Junction box electronics with integrated PDC control unit
2	Front distribution box

Rear View Camera

In the F01, the optional rear view camera requires the vehicle to have been equipped with the PDC option. The rear view camera is located to the right of the recessed handle on the luggage compartment lid.

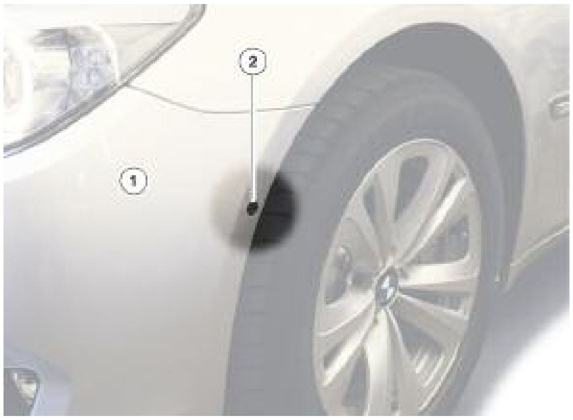
Rear view camera located to the right of the recessed handle on the luggage compartment lid

Side View

The F01/F02 is the first of BMW's vehicles to feature the new Side View Camera.

The function is realized by two digital cameras, one on the front right wheel housing and one on the front left wheel housing. They make it easier for the driver to pull into roads and junctions in which the driver's view to the side is obstructed.

Index	Explanation
1	Bumper, front wheel housing
2	Side View camera, left



Side view

The driver can activate the Side View cameras using a button in the control panel next to the gear selector lever.

Index	Explanation
1	PDC and rear view camera on/off button
2	Side View button

Button in the center console control panel

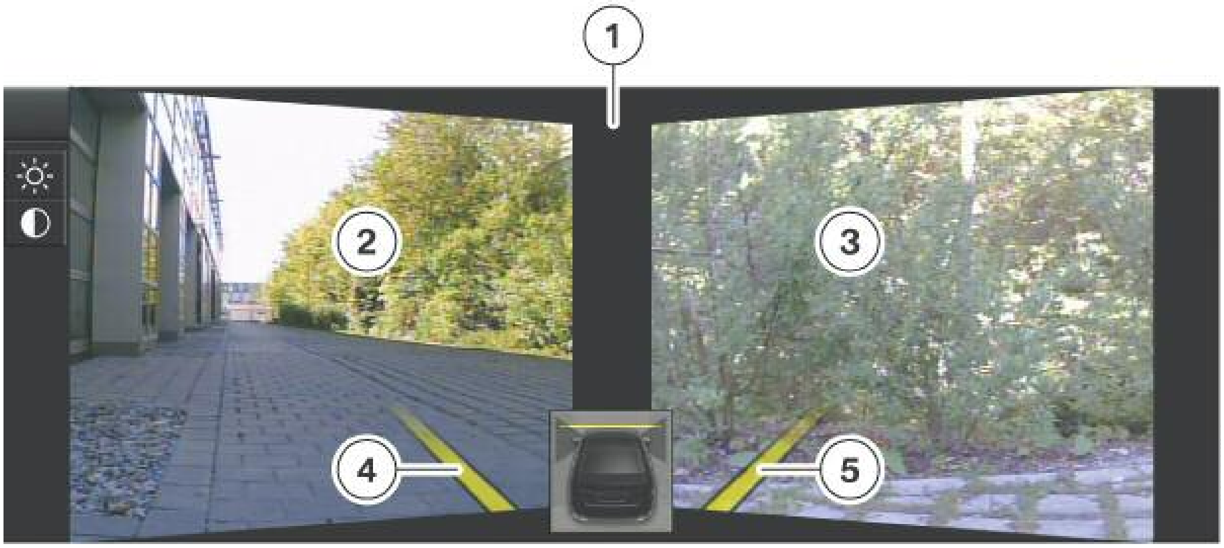
The camera images are shown in the CID in splitscreen view up to a road speed of 30 km/h/19mph.

Like the rear view camera, the two side view cameras send their video signals to the TRSVC control unit along LVDS data lines.

The signals are forwarded along CVBS lines to the video switch VSW and CIC. The CIC sends image data to the CID along LVDS data lines.

The CID is where the image data are displayed.

Side view images



Index	Explanation	Index	Explanation
1	Splitscreen images from the Side View cameras	4	Projected front of vehicle, view to left
2	Splitscreen images from the Side View camera on the left-side wheel housing	5	Projected front of vehicle, view to right
3	Splitscreen images from the Side View camera on the right-side wheel housing		

System Functions

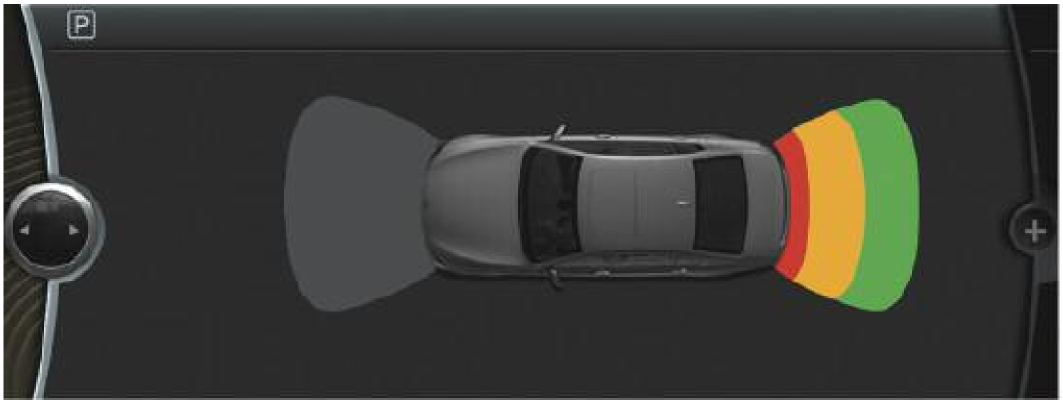
Park Distance Control

PDC is activated in response to the engagement of reverse gear or the operation of the PDC button next to the gear selector switch.

PDC and rear view camera on/off button and Side View function button

Index	Explanation	Index	Explanation
1	PDC and rear view camera on/off button	2	Side View button

The audible and visual distance warnings (the results of distance measurements) given to the driver are provided by the audio loudspeakers and by displays in the CID respectively.



Distance warning PDC display

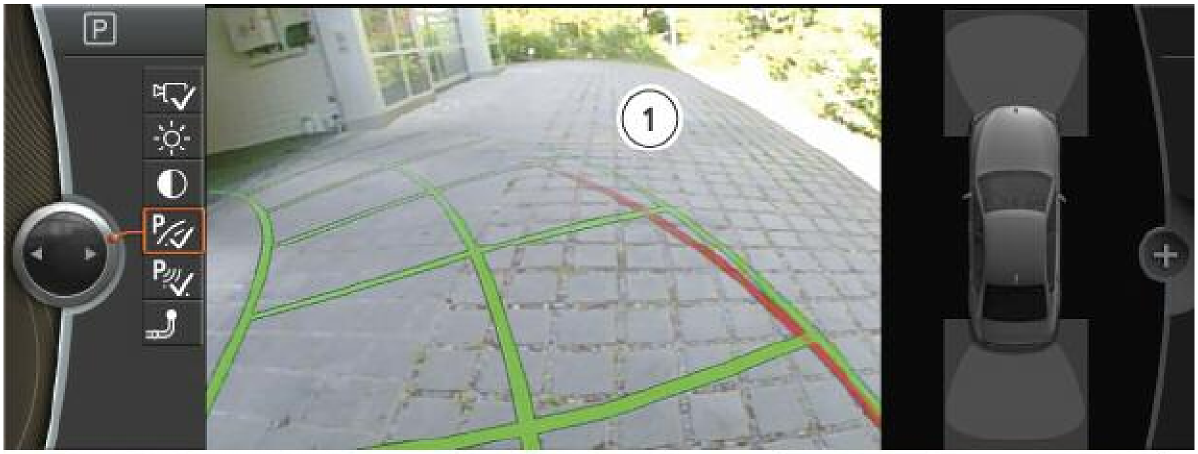
Rear View Camera

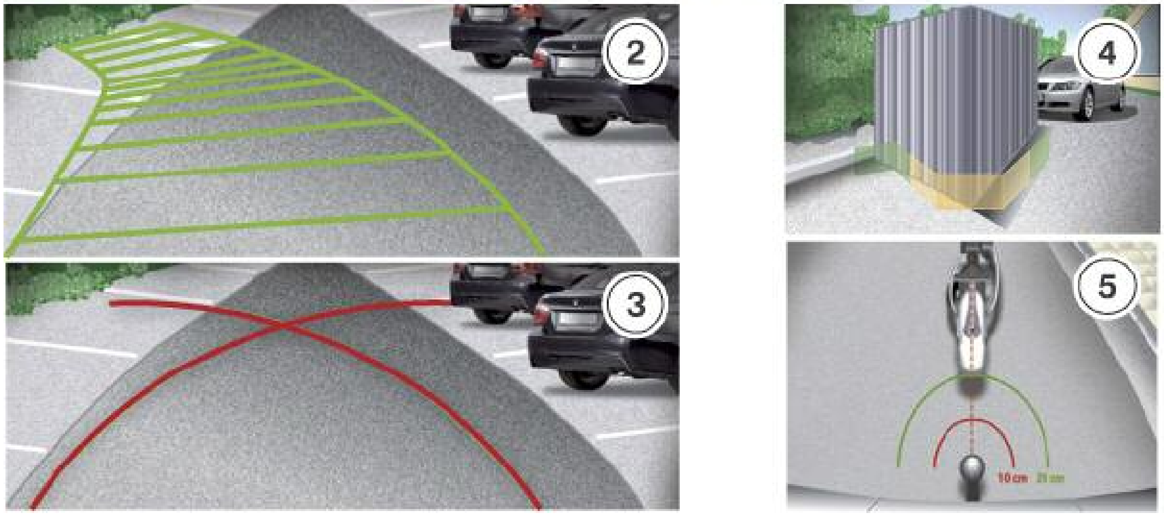
With the PDC and rear view camera equipment combination, the controller and the operating menu can be used to toggle between the basic PDC display and the rear view camera image with PDC.

Distance warning PDC display and option to select rear view camera image with PDC

Index	Explanation	Index	Explanation
1	Distance warning (PDC) display with option to select rear view camera image	2	Rear view camera image and distance warning (PDC)

To assist the driver, the rear view camera image contains turning-circle lines, lane/ parking-aid lines, obstacle markings and, where applicable, zoomed views of the trailer coupling.



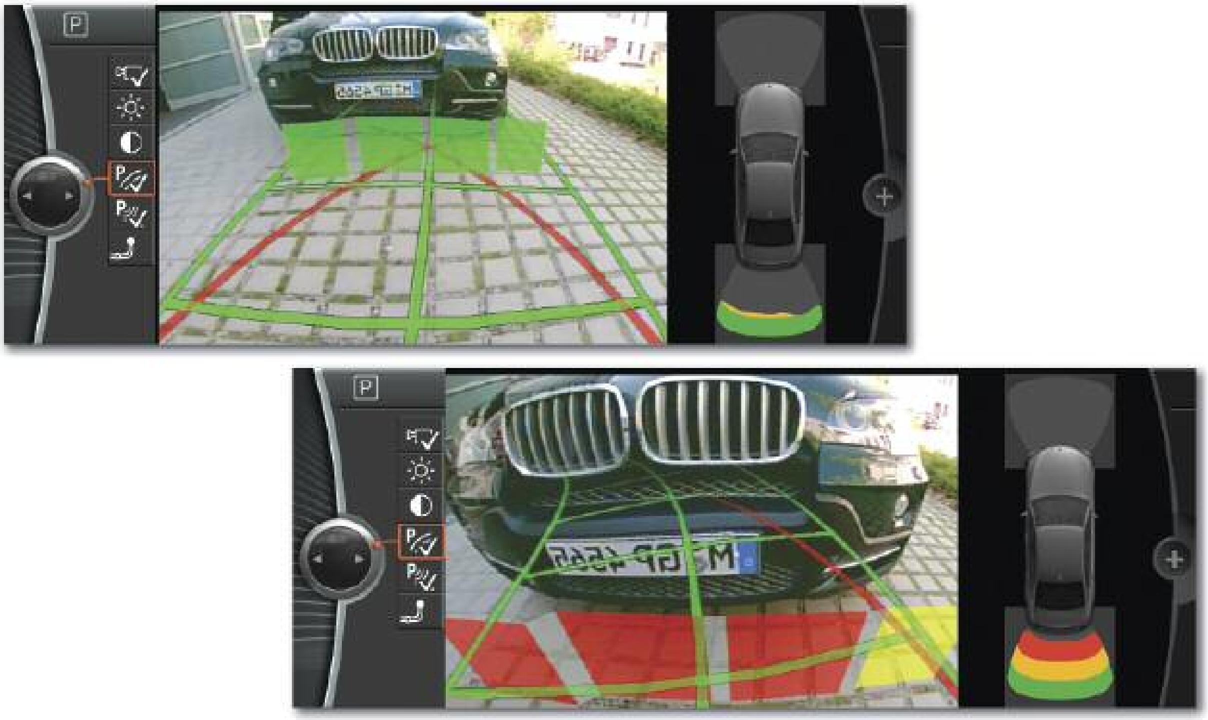


Example of a parking-aid line Overview of rear view camera assistance functions

Index	Explanation	Index	Explanation
1	Image showing example of a parking-aid line	4	Obstacle marking assistance function
2	Parking-aid line assistance function	5	Zoomed trailer coupling assistance function (Not for US)
3	Turning-circle line assistance function		

The rear view camera is deactivated automatically as soon as the vehicle exceeds 12 mph or a distance of 20 m in a forward gear.

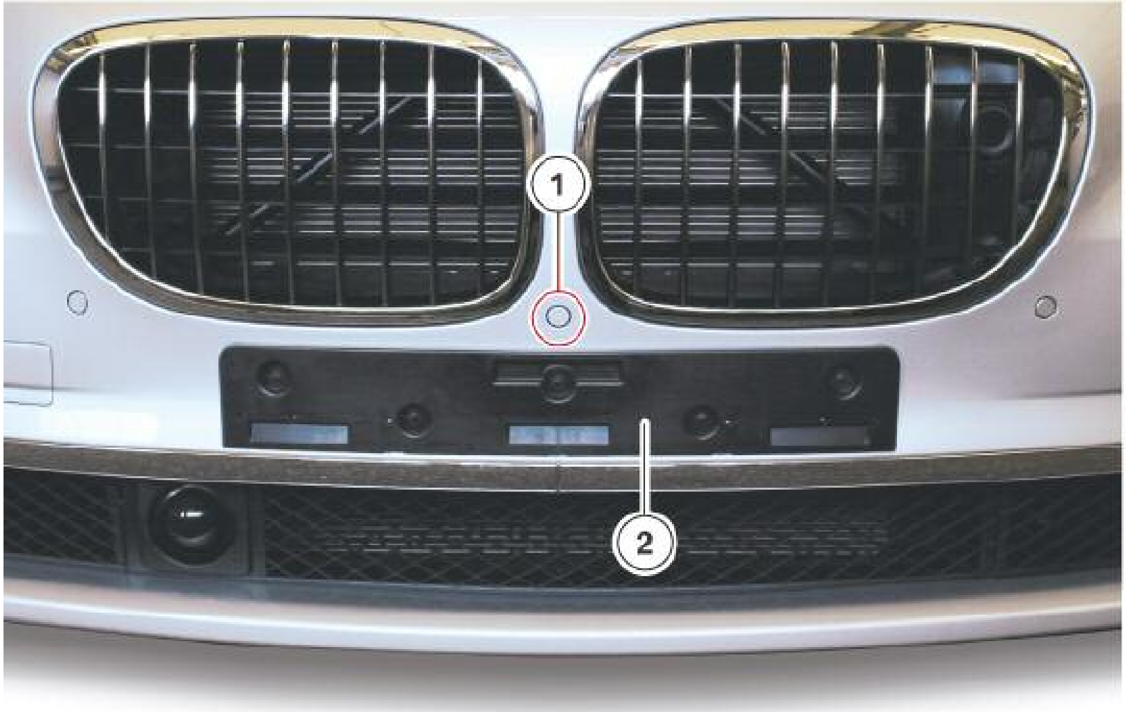
Example of a distance warning display and obstacle recognition with PDC and rear view camera image



Park Distance Control

During the installation of license plates, license plate carriers and baseplates, care must be taken not to cover the center sensor in the front bumper. Obstructions caused by license plate carriers or even deposits of dirt, snow and ice on the carriers could impair the operation of the center sensor.

F01/F02 front bumper with ultrasonic sensor and license plate carrier



Index	Explanation	Index	Explanation
1	Ultrasonic sensor in center of front bumper	2	License plate carrier

Note: The procedure for calibrating the rear view camera is based on the E70 rear view camera calibration procedure.

Table of Contents

F01 Rear Seat Entertainment System

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Rear Seat Entertainment System (RSE)

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the Rear Seat Entertainment System of the F01/F02
- Identify the components of the Rear Seat Entertainment System of the F01/F02
- Describe the functions of the Rear Seat Entertainment System

Introduction

History

Rear Seat Entertainment - E65
The rear seat entertainment system in the E65/E66 featured a folding rear display with a screen diagonal of 6.5” and a resolution of 400 x 240 pixels. The display was driven by the MOST control unit -rear display SG-FD. It converted the analog RGB signals into a digital LVDS signal.

In the E65/E66 it was already possible to listen to several audio sources simultaneously. For instance, while the driver listened to the radio through the speakers, the rear passenger could enjoy a CD through hard-wired headphones. The analog signals made available by the audio devices were placed on the MOST-bus. The headphone interface KHI prepared the signals separately for each headphone socket.

Hard-wired headphones could be connected to the headphone connection module.

Rear Seat Entertainment - E70
A larger rear display with a screen diagonal of 8” and a distinctly higher resolution of 800 x 480 pixels is fitted in the E70 with rear seat entertainment. The folding display is installed between the seats.

The rear display control unit and rear seat entertainment RSE are connected to the K-CAN. Picture transmission takes place directly via LVDS and the signal no longer needs to be converted. The RSE control unit features its own DVD player making it possible to conveniently change DVDs while driving.

External devices such as game consoles, video cameras and hard-wired headphones can be connected directly to the RSE control unit. A headphone interface KHI for signal processing is not required.

An infrared transmitter is integrated in the base of the rear display to allow operation of wireless infrared headphones.

The rear seat entertainment system is remote-controlled. All audio settings made with the remote control relate only to the hard-wired headphones.

Rear Seat Entertainment - F01/F02

Rear seat entertainment option (6FG) is part of the ZRP Rear entertainment Package available on the F01/F02 and is refered to as the " Mid version" in the ISTA Diagnostic Equipment.

The rear seat entertainment system F01/F02 features several innovations in terms of equipment and operation.

Two folding 800 x 480 pixel displays with an infrared transmitter are integrated into the backrests of the front seats. For the first time in a BMW vehicle, the RSE control units are integrated in the MOST-bus.

The Car Information Computer CIC serves as the master control unit of the MOST-bus. Please refer to the F01/F02 Bus Systems training material for detailed information on the MOST.

The rear seat entertainment system features:

- Two displays with a screen diagonal of 8" are fitted.
- The same program can be viewed on both screens.
- An external device (e.g. game console) may be connected to the right or left side of the RSE and the feed from the external device shown on the selected side.
- The system is controlled by remote control.

System Overview

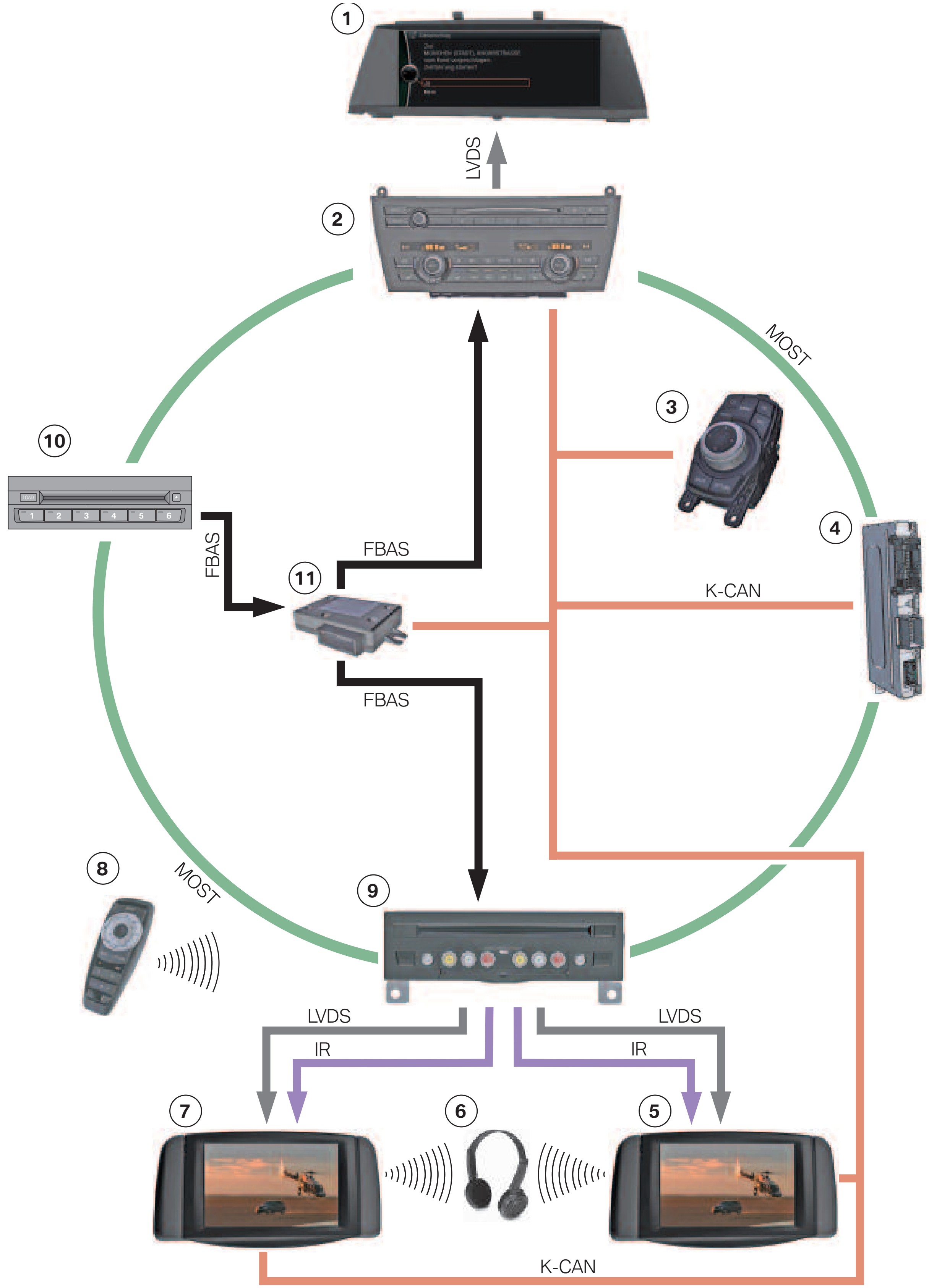
Audio playback takes place either through the vehicle's speakers or via headphones. The volume of the speakers can be adjusted via the multifunction steering wheel, the head unit or with the remote control. The volume is controlled speed-dependent during playback through the speakers. The driving speed is registered by the wheel speed sensors.

The sound settings can be configured on the CIC or with the remote control. If audio is played back via the headphones, the volume can be adjusted either on the headphones (infrared headphones) or using the remote control (hard-wired headphones). The infrared headphones receive their signals from the infrared transmitter.

Rear Seat Entertainment System (RSE)

External devices can be connected via the two AV inputs directly to the RSE control unit or via the AUX-In connection or the USB-audio interface in the center console. The USB-audio interface provides an additional jack and a USB connection for a type A USB connector.

Function diagram of the rear seat entertainment system



Index	Explanation	Index	Explanation
1	Central information display (CID)	7	Rear display FD with rear display control unit and infrared transmitter
2	Head unit, Car Information Computer (CIC)	8	Remote control
3	iDrive controller	9	Rear seat entertainment control unit (RSE MID)
4	Central gateway module (ZGM)	10	DVD changer (DVD)
5	Rear display FD2 with rear display control unit and infrared transmitter	11	Video switch (VSW)
6	Infrared headphones	12	Not for US

When playing a DVD in the CIC, the picture cannot be transmitted to the rear seat entertainment system. When playing a DVD in the RSE control unit the picture is not transmitted to the CIC. However audio playback is possible in both cases.

During playback via the DVD changer, picture and sound are transmitted to the CIC and the rear seat entertainment system.

For safety reasons, no picture is shown in the CID while the vehicle is being driven, although audio playback is still possible.

When an external device (e.g. game console) is connected to one of the AV inputs of the RSE control unit, the video signal is output on the right or left display depending on where the source is connected. A selected DVD can still be viewed on the other display.

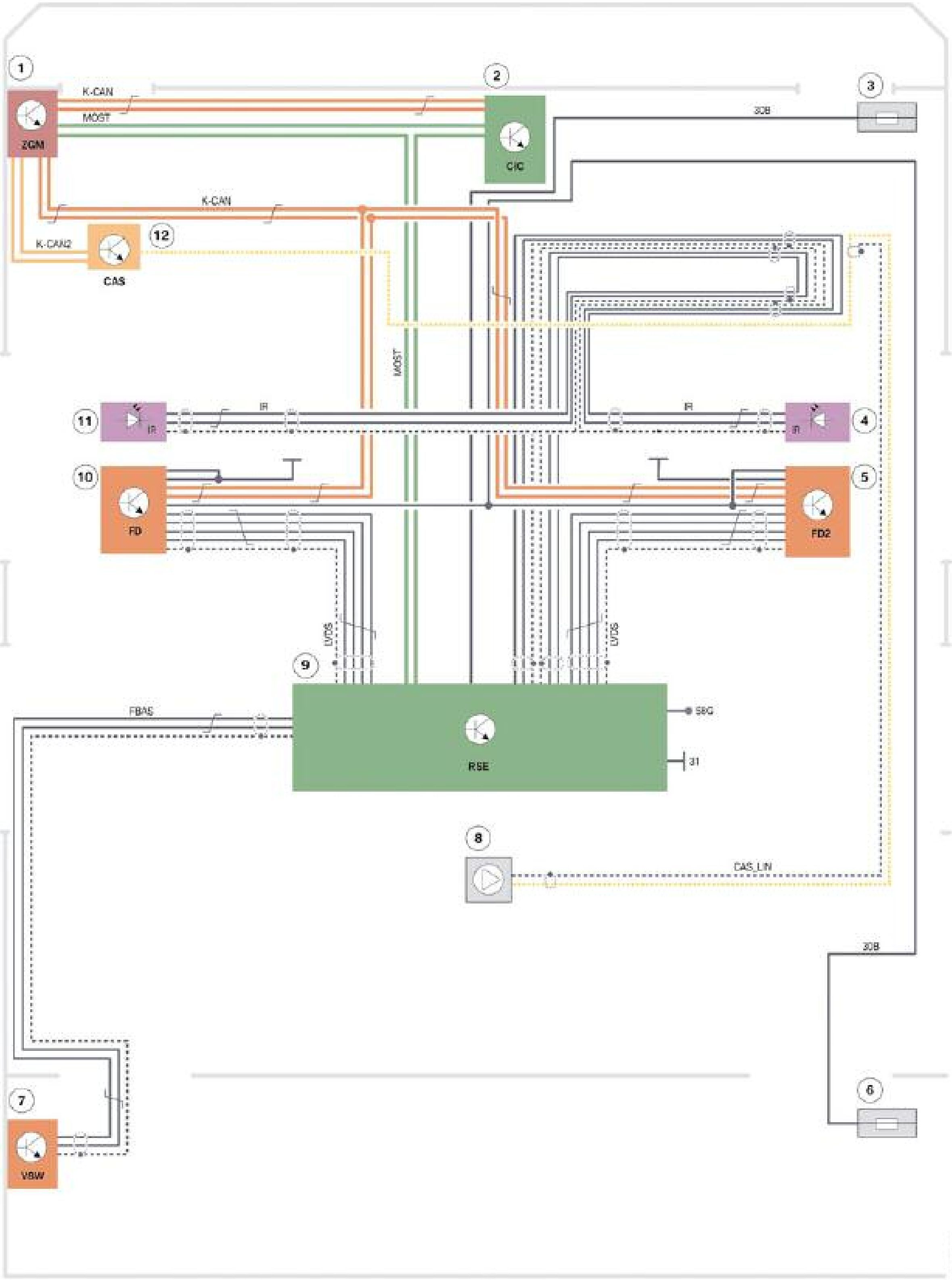
The RSE control unit features a FBAS or CVBS (composite video baseland signal) video signal input.

The RSE control unit has a CVBS video signal input connected to the DVD Changer through the video switch to display of media played in the DVD Changer on the rear screens. In this case the video switch is needed because a source with a CVBS output (e.g. DVD changer) is connected to the CIC and the RSE.

The CIC has only three CVBS inputs, If there are more than three video sources to be connected to the CIC a video switch has to be included to comply with the equipment configuration.

Note: (FBAS) Farb-Bild-Austast-Synchron is CVBS (Composite Video Baseband Signal) in which just the video signal is transmitted through a single wire with the audio signal handled separately.

RSE Circuit Diagram



Index	Explanation	Index	Explanation
1	Central gateway module (ZGM)	12	Car Access System 4 (CAS4)
2	Car Information Computer (CIC)	KL.30B	Terminal 30 basic operation
4	Infrared transmitter, right	KL.58G	Signal, footwell module light (FRM 3)
5	Rear display (FD2) with rear display control unit (SG-FD2)	FBAS	FBAS signal
6	Fuse	IR	Infrared signal
7	Video switch (VSW)	K-CAN	Body CAN
8	Aerial diversity module with aerial amplifier	K-CAN2	Body CAN2
9	Rear seat entertainment control unit (RSE)	LVDS	Low voltage differential signal
10	Rear display (FD) with rear display control unit (SG-FD)	MOST	Media Oriented System Transport
11	Infrared transmitter, left		

MOST Signals at RSE Control Unit

In/Out	Signal	Source/sink	Function
In	Control signals	FBD antenna > Antenna diversity module > CAS4 > ZGM >	RSE control (entertainment source, track selection, etc.)
In	Date, time	Instrument cluster>	Display in FD and FD2
In	RSE release	iDrive controller > CIC >	Access rights
In	Terminal status	> CAS4 > ZGM >	Activation conditions
Out	Control signals	> FD and FD2 > Display	ON/OFF, setting

K-CAN Signals at SG-FD and SG-FD2

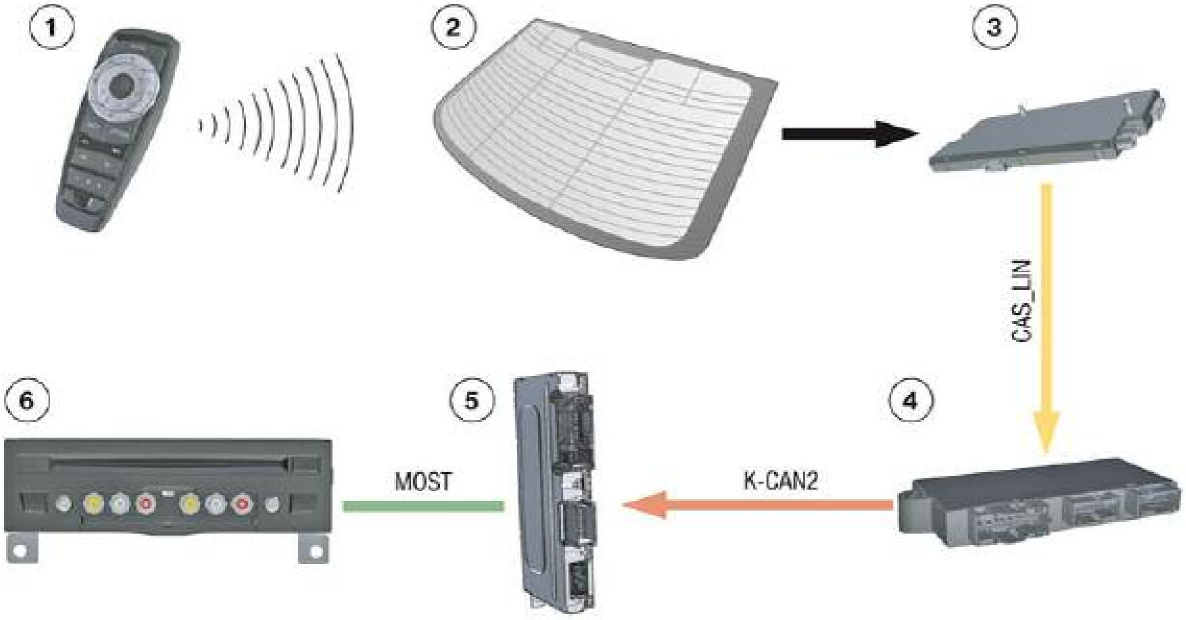
In/Out	Signal	Source/sink	Function
In	RSE status	RSE > ZGM >	RSE standby
In	FD and FD2 status	ZGM > RSE >	FD and FD2 standby

The FD and FD2 rear displays each have their own control unit. The SG-FD and SG-FD2 control units are connected to the K-CAN. The rear displays are connected via LVDS to the RSE control unit. All video information is transmitted via the LVDS link. The rear displays receive the ON/OFF signal from the RSE control unit. The ZGM places the MOST signal on the K-CAN and is sent to the rear displays.

During audio playback through the vehicle's speaker system, the RSE control unit routes the audio signal via the MOST to the head unit CIC or the Top-HiFi amplifier.

Programming, coding and diagnosis of the rear seat entertainment system (6FG) take place via MOST.

Function diagram - remote control of rear seat entertainment system



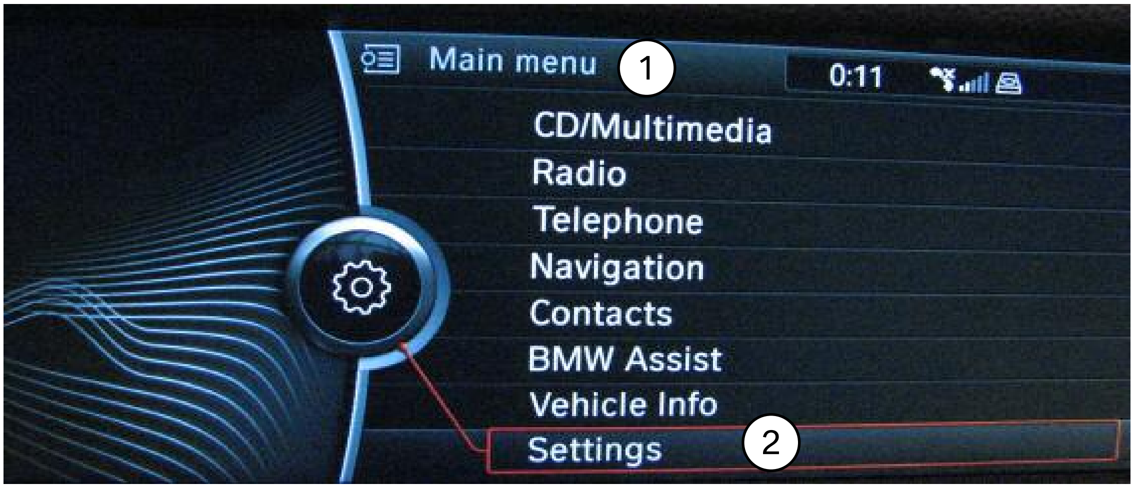
Index	Explanation	Index	Explanation
1	Remote control	4	Car access module 4 (CAS4)
2	Rear window with antenna, remote control services (FBD)	5	Central gateway module (ZGM)
3	Antenna diversity module with antenna amplifier	6	Rear seat entertainment control unit (RSE)

The commands entered by means of the remote control are transmitted by radio waves. The same frequency is also used for the radio remote control key. The frequency used is dependent on the national variant and therefore relevant for coding. The commands are received by the FBD antenna and routed via the antenna diversity module to the CAS4.

The CAS4 converts the signals into K-CAN2 messages and routes the signals to the ZGM. The ZGM places the signals on the MOST-bus. The RSE control unit receives the signals via the MOST.

System Functions

The rear seat entertainment system must be switched on to execute all its functions. The driver can use the iDrive to select the access rights for the rear seat entertainment system.



CID main menu - settings

Select submenu "Settings" (2) in Main menu (1) with the iDrive.

Select the submenu "Rear system enable" in the "Settings" menu.

CID rear system enable, driver

Four different functions can be selected in the “Rear control” menu (1):

- “Driver control” (2):
  Everything that does not disturb the driver can be controlled in the rear compartment.
- “Equal control” (3):
  The driver and the rear passengers can execute all functions with equal authorization.
- “Rear control” (4):
  The driver can control everything that does not disturb the rear passengers.
- “Switch off rear DVD system” (5):
  Switch off rear seat entertainment system. The rear seat entertainment system cannot be switched on again before any other priority is selected.

Note: The driver can control the volume of the speakers in all four settings. Audio playback is muted by pressing the (ON/OFF) rotary pushbutton on the CIC.

Speaker Control

Speaker control must be switched on to facilitate audio playback through the speakers. The hard-wired headphones are muted when speaker control is activated.

The rear displays adopt the feed from the currently active source.

The speakers can then be controlled from the rear seat entertainment system.

FD Options - speakers

To switch on speaker control, select “Rear operated speakers” (2) in the “Options” menu (1).

Connecting External AV Devices

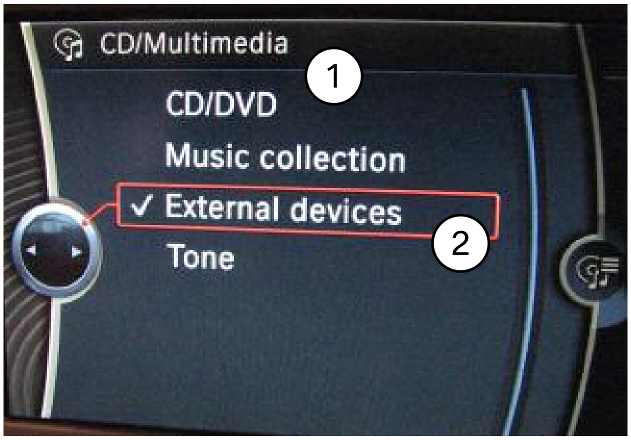
External devices can be connected to the RSE control unit via the AV inputs. External devices can also be connected via the AUX-In connection or the USB-audio interface (6FL) in the center console. Connected video devices are recognized automatically.

Note: The connection is automatically deactivated after unplugging the external video device. A blue image may be shown on the rear screen if the connection is not deactivated automatically.

The corresponding input must be activated when a pure audio device is connected.

Follow the following steps to connect an external device:

- Switch on the rear seat entertainment system.
- Open the flap on the RSE control unit when connecting to the AV inputs.
- Fold open the center armrest when connecting to the AUX-In connection or USB-audio interface (6FL).
- Connect the external audio device to the corresponding input and switch on.
- Select the "CD/Multimedia" menu item (1) in the Main Menu.



FD CD/Multimedia - external devices

- Then select the "External devices" menu item (2) in the "CD/Multimedia" menu (1).

The available connections and their status are now shown:

- USB-audio interface (1)
- AUX-In connection, Center console (2)
- RSE control unit, AV input, left (3)
- RSE control unit, AV input, right (4).

Note: Once an external device has been connected to the RSE it remains connected until it is turned off or disconnected.

FD - activating external devices

Digital and Satellite Tuners

The digital tuner and the satellite tuner can also be controlled from the rear seat entertainment system. Various satellite and digital radios are available corresponding to the national market specification.

- In Band On Channel (IBOC) is the digital tuner in the USA
- Satellite Digital Audio Radio Service (SDARS), is the satellite supported subscription radio in North America.

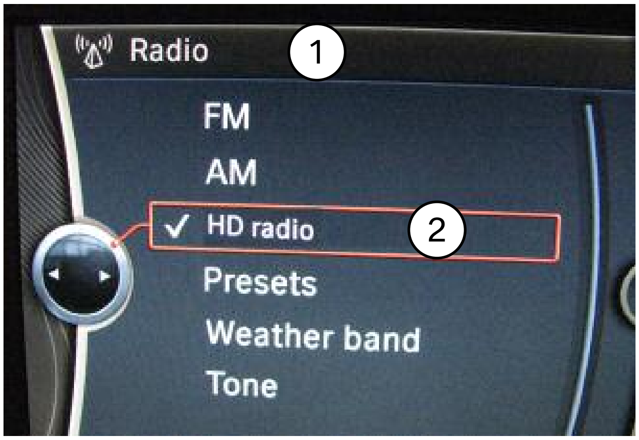
In the F01/F02, the digital tuners are integrated in the CIC and no longer installed externally.

The SDARS satellite tuner is installed in the luggage compartment and connected to the MOST-bus.

Proceed as described in the following to select a digital or satellite tuner.

Digital Tuner

Select the HD Radio "IBOC" menu item (2) in the "Radio" menu (1).



Digital Radio

Satellite Tuner

Select the “Satellite radio” menu item (2) in the “Radio” menu (1). The stations can be scanned and selected in the same way as terrestrial stations.

Satellite Radio

Language

The selected language always applies to the complete vehicle. When the language is changed in the CIC, this language will also be adopted by the rear seat entertainment system. After changing the language in the rear seat entertainment system, the change will also be adopted in the CIC.

System Components

The rear seat entertainment system consists of the following components:

- RSE control unit with DVD player
- One FBAS/CVBS (composite video baseland signal) video signal input
- Two separate AV (audio video) inputs
- Headphone connections in the rear center console
- Two 8” rear displays (built into the backrests of the front seats) with incorporated rear display control units and infrared transmitters.
- Remote control

Component Location

Rear Entertainment Component Locations

Index	Explanation	Index	Explanation
1	Central information display (CID)	4	Remote control
2	Head unit (CIC)	5	RSE control unit
3	Rear display FD2 8"	6	Rear display FD 8"

RSE System

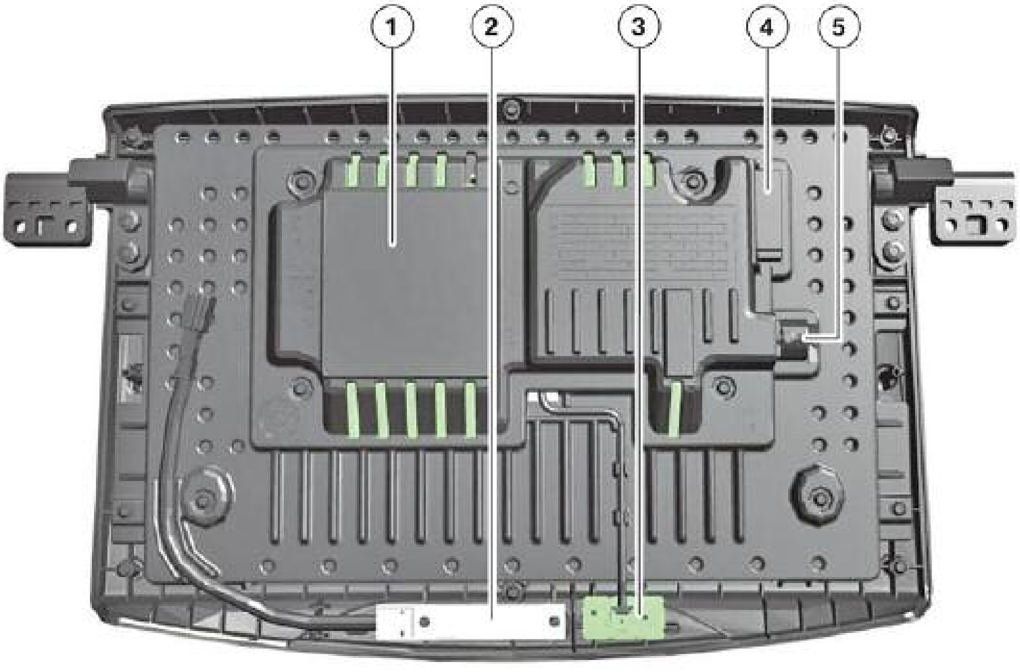
The rear seat entertainment system offers the following equipment:

- Radio tuner with RDS
- Audio playback through
  - Infrared headphones
  - Hard-wired headphones
  - Audio speakers in the vehicle
- AUX-In connection in center console (analog jack)
- Connection to external equipment via AV input, e.g. video camera, games console or portable playback equipment
- Operation through remote control.

Optional extras:

- DVD changer (above glove compartment)
- USB/audio interface in center console (for connecting media USB sticks or mp3 players e.g. Apple iPod®)
- Digital and satellite radio tuners
  - In Band On Channel IBOC
  - Satellite Digital Audio Radio Services, SDARS (with subscription)

Rear Displays



Rear View of the Rear Display

Index	Explanation	Index	Explanation
1	Rear display control unit SG-FD	4	K-CAN and power supply connection
2	Infrared transmitter	5	Rear display connection
3	Photodiode		

Both the FD and FD2 rear displays have their own control unit SG-FD. The control units are connected to the K-CAN.

The rear displays are connected via LVDS to the RSE control unit and are switched on and off by the RSE control unit via MOST > ZGM > KCAN.

In comparison to earlier systems with 8-wire LVDS cable, the signals in the F01/F02 are sent via a 2-wire LVDS cable.

Signal transmission via this 2-wire LVDS line offers four distinct advantages:

- Higher data transfer rate
- Simplified wiring
- Runtime differences between the individual lines are avoided
- Serial 2-wire LVDS data transmission is now much more cost-effective

The photodiode is used to automatically control the brightness of the rear display.

Technical data TFT-LCD Displays	Rear seat entertainment
Visible screen diagonal	8"
Resolution in pixels	800 x 480
Luminous intensity in Candela	625 Cd/m2
Colors	WVGA 262144 (18-bit colors)
Switching time at 25°C	20-25 ms
Format	15:9

Note: For further information on the 2-wire LVDS system refer to the F01/F02 CIC training material.

Infrared Transmitters

The infrared transmitters consist of six infrared diodes. They are located behind a plastic cover in the housing of the rear display.

The RSE control unit powers the infrared transmitters which use infrared light to transmit the audio signals to the headphones. The infrared diodes begin to light as soon as the RSE control unit is switched on.

The infrared diodes then stay on for as long as at least one side of the RSE is still active. The diodes go out 5 seconds after switching off the last rear display.

The infrared transmitters use the following frequencies to send the audio signals:

Left channel	Right channel
2.3 MHz	3.2 MHz
2.8 MHz	3.8 MHz

To ensure trouble-free operation of the infrared headphones, note the following:

- An unimpeded line of sight between the receiver on the headphones and the infrared transmitter is essential.
- The cover on the infrared transmitter is clean and free from scratches.

Headphones

Headphones are not included on delivery of the F01/F02. BMW recommends the use of headphones that have been specifically designed for the rear seat entertainment system and are available to order from BMW Parts.

■ Infrared Headphones

The infrared headphones used must comply with IEC DIN 61603-2.

If infrared headphone accessories are used, they must match the frequencies of the infrared transmitter.

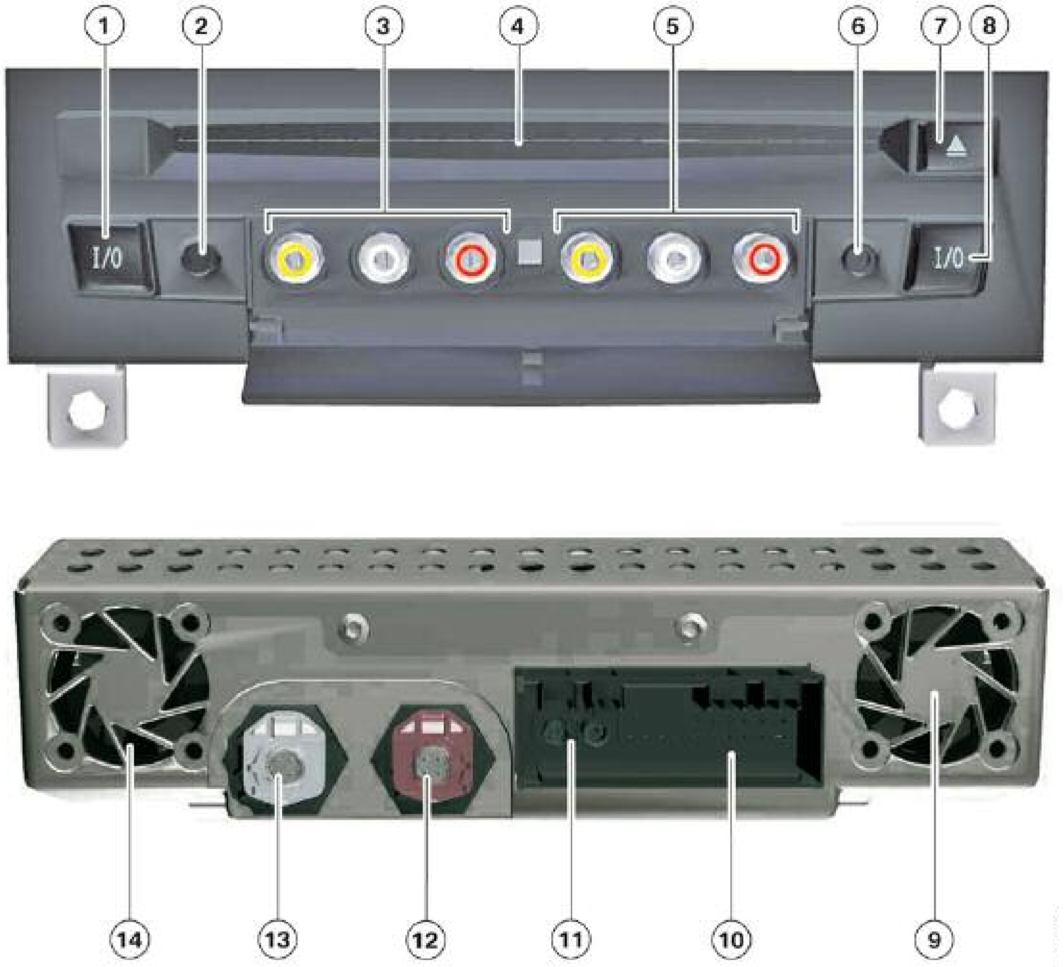
There is no restriction regarding the maximum number of infrared headphones that can be used.

■ Hard-wired Headphones

All commercially available hard-wired headphones with a minimum impedance of 8Ω can be connected.

The connection jacks have a diameter of 3.5mm. These connection jacks must be used for headphones only.

RSE Control Unit



Front and Rear View of the RSE Control Unit

Index	Explanation	Index	Explanation
1	ON/OFF switch, left	8	ON/OFF switch, right
2	Jack plug for hard-wired headphone, left	9	Fan, left
3	AV input, left (yellow: video, white:audio signal, left, red: audio signal, right)	10	Power supply, connection for infrared transmitters, one CVBS video input
4	Slot in DVD player	11	MOST connection
5	AV input, right	12	FD connection
6	Jack plug for hard-wired headphone, right	13	FD2 connection
7	DVD drive Eject button	14	Fan, right

Switch-on Conditions

The two ON/OFF switches are used to switch the rear seat entertainment system on/off. They switch the RSE control unit and the rear display on/off on the selected side.

The infrared diodes begin to light as soon as the RSE control unit is switched on. The infrared diodes then stay on for as long as at least one side of the RSE is still active. The diodes go out 5 seconds after switching off the last rear display.

The RSE control unit can be switched on as of terminal 30B. After “terminal R OFF”, the RSE control unit can be switched on within the run-on time of 30 minutes. After the control unit has been switched on, it remains active until the energy management detects the start capability limit.

Further information on terminal control and the new terminal designations can be found in the F01/F02 Energy Management training material.

The RSE control unit supports following media:

- Video DVD
- Video CD
- Super Video CD
- Audio CD
- DVD or CD with compressed data formats

The following compressed data formats are supported:

- Video
  - MPEG-1 video
  - MPEG-2 video
- Audio
  - MPEG-1 Layer 2 Audio
  - MPEG-1 Layer 3 Audio MP3 with ID3-Tags
  - MPEG-2 Layer 2 Audio
  - Windows Media Audio WMA with WMA-Tags
  - Advanced Audio Coding AAC

The DVD audio format is not supported by the RSE control units. However, if the DVD contains a video track, it is usually played.

Note: Data that is protected with Digital Rights Management DRM cannot be reproduced.

RSE Remote Control

RSE Remote Control Buttons explanation

Index	Explanation	Index	Explanation
1	Menu	7	Volume
2	Thumbwheel	8	Track search/track skip
3	Confirmation button	9	Wireless symbol
4	Option	10	Back
5	Battery symbol	11	Four-way directional controller (four buttons)
6	Selector slide, left/right		

RSE Remote Control Function

The remote control features two LED for checking operation and battery voltage. Transmission of a wireless signal is acknowledged by the green send signal lighting.

The remote control signals are only sent if the rear seat entertainment system is switched on.

If the battery voltage reaches a critical level, the red battery symbol will light instead of the green send symbol each time a button is pressed. The battery in the remote control must be replaced to ensure continued operation.

The thumbwheel, the confirmation button and the four-way directional controller mimic the iDrive controller functions:

- Turning the thumbwheel corresponds to turning the iDrive controller.
- Pressing the corresponding button on the four-way directional has the same effect as operating the iDrive controller to the left, right, forwards or back.
- Pressing the confirmation button corresponds to pressing down on the iDrive controller.

The entire remote control changes over to the selected side by operating the selector slide.

The remote control is available in a frequency of 315 MHz for the US version.

Diagnosis

The BMW diagnostic system contains the diagnostics for the rear seat entertainment systems under “Rear seat entertainment”. The RSE, the two rear display SG-FD and SG-FD2 are defined as the control units.

Fault code memory checks, testing schedules and test modules are available for following components:

- Rear seat entertainment control unit
- Rear displays
- Remote control

Component activation is also possible for the control unit:

- General
  - Reset of RSE control unit
- Display
  - Test card, test of video inputs and video outputs
- Audio
  - Sine generator (test noise)
- Drive
  - DVD emergency eject

Teaching-in the Remote Control

There is a Service Function for teaching-in the remote control in the diagnostics under Rear Seat Entertainment.

The testing schedule works through the following steps:

- The entry of the currently assigned remote control for the rear seat entertainment system is deleted in CAS4.
- The remote control for the rear seat entertainment system is taught in.
- Successful teaching-in of the remote control is acknowledged by automatic closing and opening of the central locking.

It is not possible to exchange the remote control. Only the taught-in remote control is functional in the vehicle.

Programming and Coding

DVD Area Code

The RSE control unit can be programmed and coded. The DVD area code can be changed during coding.

DVD area codes were introduced to restrict playback of DVDs to particular markets. DVDs are generally released earlier in one region than in another region. The earth has been divided into different regions and an area code has been assigned to each region:

Area Code	Region
1	Canada, USA and US Territories
2	Europe, Japan, Middle East, Egypt, South Africa, Greenland
3	South east Asia including Hong-Kong and South Korea
4	Australia, New Zealand, Caribbean, Central and South America, Pacific Islands
5	Former CIS States, Indian subcontinent, Mongolia, North Korea, Africa (except Egypt and South Africa)
6	China

So that the area code functions, each DVD player is equipped with its own area code, determining for which market the device is intended.

European devices are preset with area code 2, whereas American devices have area code 1. Each DVD can have one or more area codes, depending on the region(s) for which it is intended.

Area code 0 identifies DVDs that are released for all regions. A DVD may also be released for certain regions, e.g. 2, 3, 4, 5 and 6, i.e. all countries except the USA.

When inserting a DVD, the RSE control unit checks whether the region defined in the control unit matches the DVD country code. As a result, only DVDs with the area code defined in the RSE control unit can be played.

The area codes are changed by coding the RSE control unit. During the first 100km, the area code can be changed as often as desired. After the first 100km, the RSE control unit permits the area code to be changed a maximum of five times. If changes are no longer possible, the RSE control unit must be replaced when a DVD with a different area code is to be played.

■ Audio Test CD

A new audio test CD has been released for testing the drive in the RSE control unit in the F01/F02.

The audio test CD can be used to check following problems:

- Drive test
- Problems during medium playback
- Permanent or sporadic interruption in CD/ DVD operation
- Disc cannot be read by drive.

Note: Only the current version of the audio test CD must be used for testing purposes. The audio test CD can be ordered through BMW Parts.

Table of Contents

F01 Telephone System

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Telephone System

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the telephone system of the F01/F02
- Describe the new functions of the telephone system of the F01/F02
- Identify the components of the telephone system of the F01/F02

System Overview

The Telematics Control Unit (TCU) and the interface box ‘High’ (ULF-SBX-H) control units are connected to the MOST bus. TCU and interface box ‘High’ may both be fitted in the vehicle for certain equipment options. In this case, the telephone function is always implemented in the TCU.

The head unit transmits the audio signal in analog form to the HiFi amplifier and the amplifier distributes the audio output to the loudspeakers in the car.

The HiFi system is fitted as standard in the F01/F02.

If the “Top HiFi system” is installed in the car, the audio signal is transmitted digitally on the MOST bus to the HiFi amplifier and the amplifier distributes this signal to all the loudspeakers.

Audio playback of the call recipient is via the front right, front left and center loudspeakers.

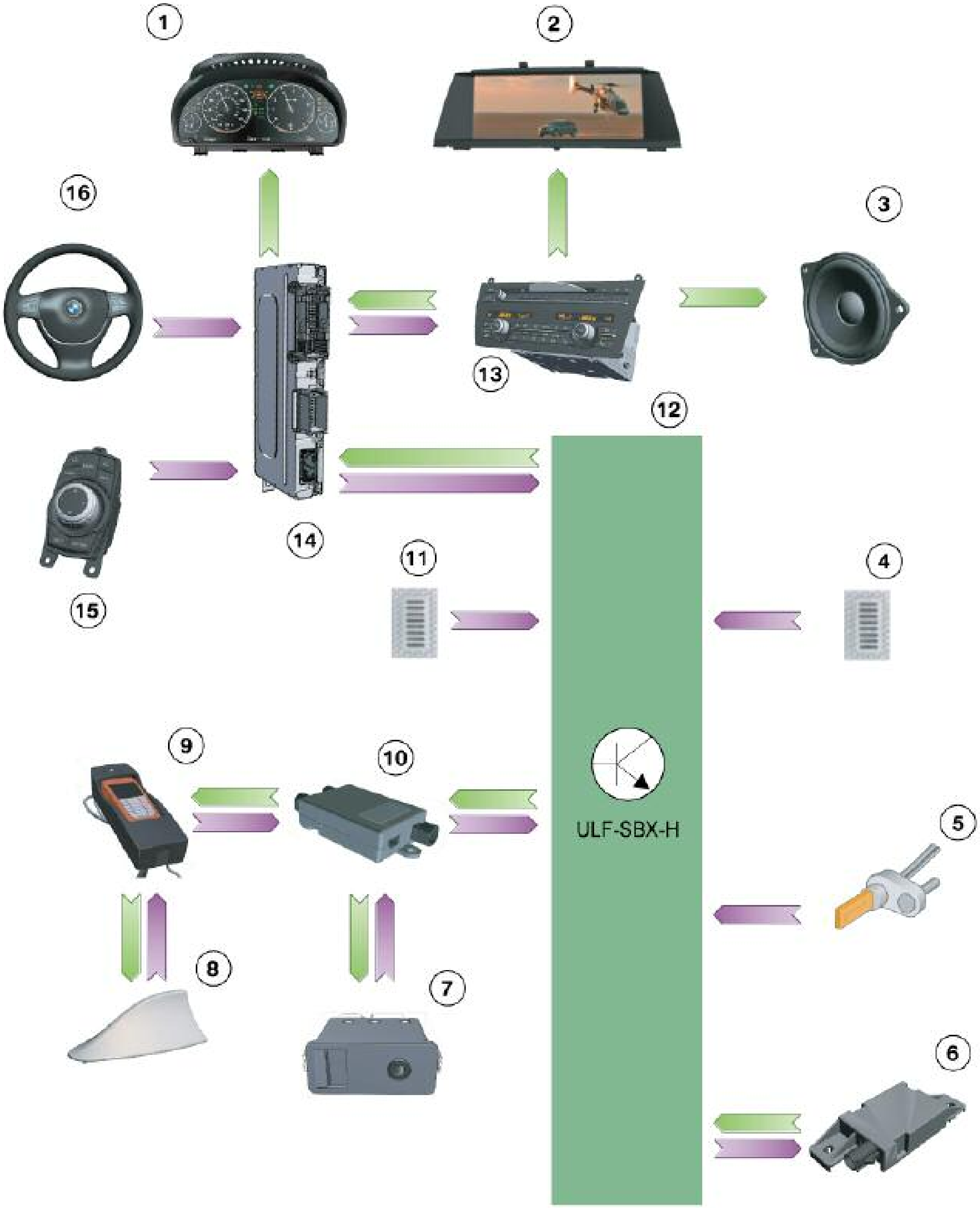
For the sake of clarity the various individual loudspeakers are not shown in the schematic circuit diagrams.

The Telematics Control Unit (TCU) used in the F01/F02 is similar to one used in the E70.

The pairing wizard is again integrated in the F01/F02 to assist the customer in pairing the mobile phone.

Note: The specified range of functions will only be achieved with Bluetooth-enabled mobile phones recommended by BMW. See a list of compatible phones at www.wireless4bmw.com.

Inputs/outputs, ULF- SBX High Interface Box



Index	Explanation	Index	Explanation
1	Instrument cluster	9	Snap-in adapter with mobile phone or Smartphone Integration
2	Central Information Display (CID)	10	USB hub
3	Speaker	11	Microphone (driver's side)
4	Microphone (passenger's side)	12	Interface box 'High' (ULF-SBX-H)
5	Wheel speed sensor	13	Car Information Computer (CIC)
6	Bluetooth antenna (Connects to TCU in US cars)	14	Central gateway module (ZGM)
7	USB audio interface; if no USB hub is installed the connection is to the ULF-SBX-H	15	Controller (CON)
8	Roof antenna (for snap-in adapters mobile phone	16	Multifunction steering wheel (MFL)

Optional extras “USB/Audio interface” and “Smartphone Integration” require the installation of the ULF-SBX-High Interface box.

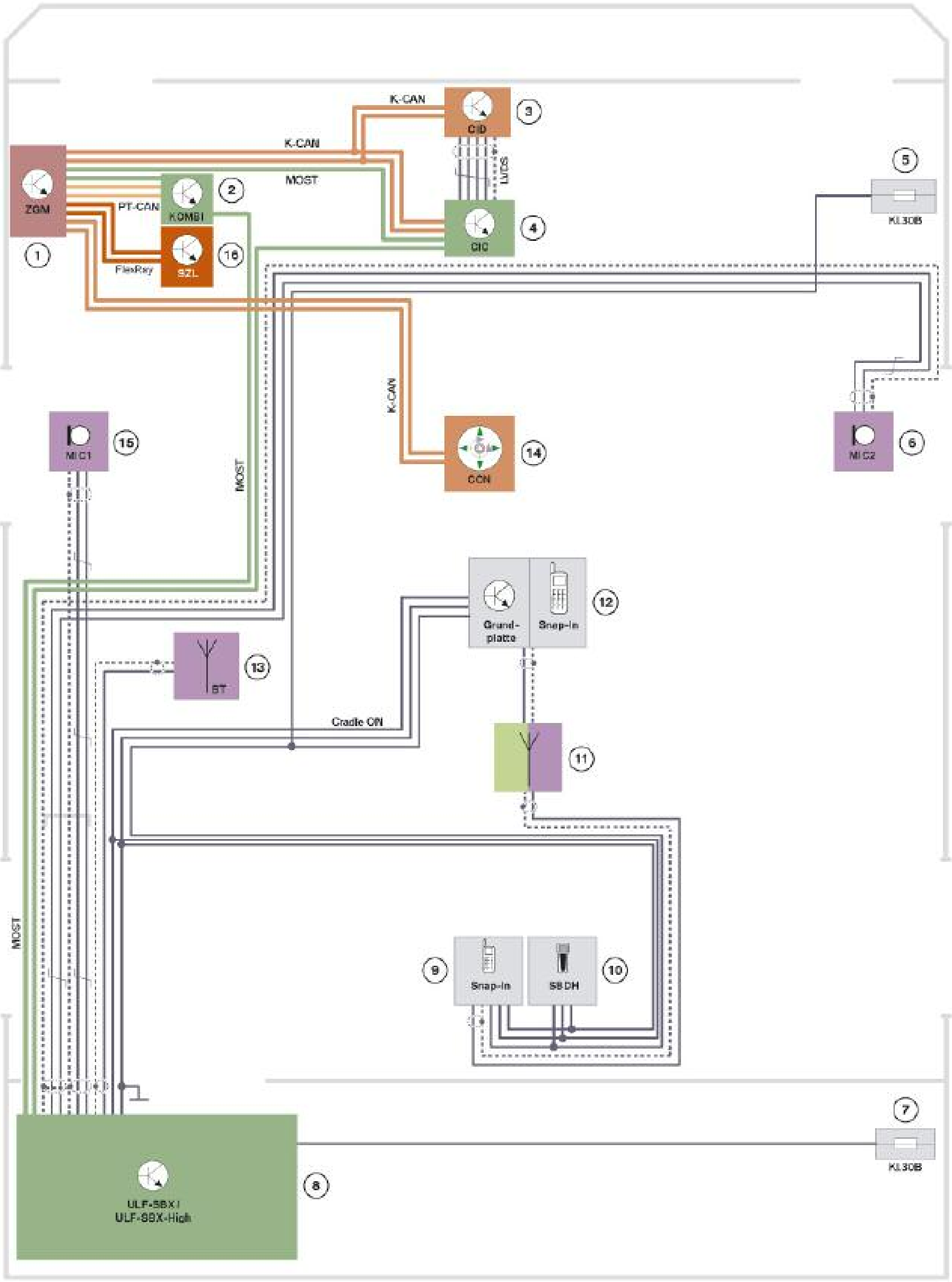
The USB hub is installed only if the car is ordered with the “Smartphone Integration” optional extra.

The mobile phone and the interface communicate via the Bluetooth antenna.

Voice output by the telephone system is via the vehicle’s front right, front left and center loudspeakers. Volume can be adjusted by means of the multifunction steering wheel and the CIC. Speed-related volume control is also active.

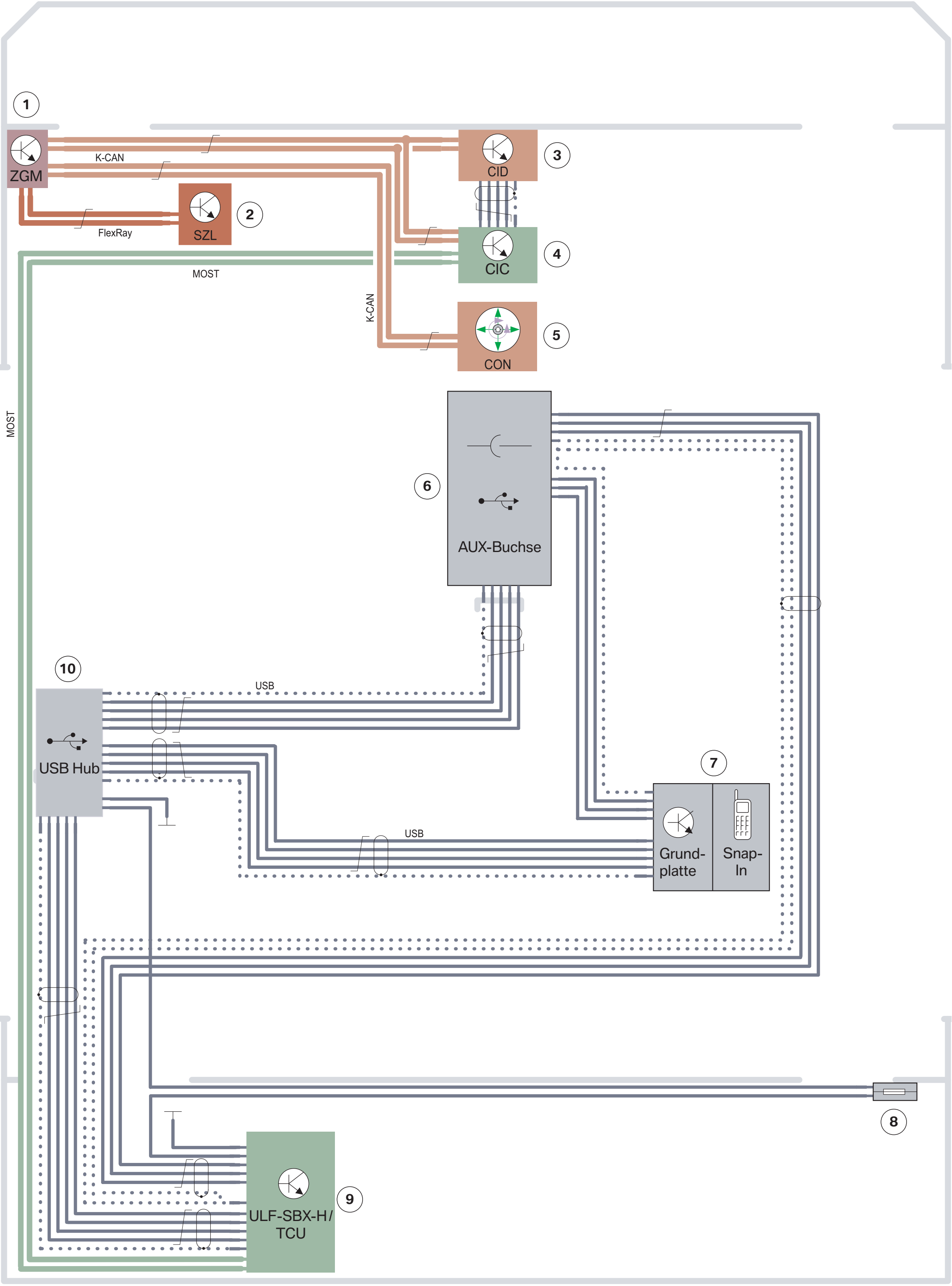
Although both the ULF-SBX-H and the TCU may be fitted in a vehicle at the same time, the TCU always provides the telephone functions. In this case the telephone functions are not available in the ULF-SBX High and the module is only installed to provide the "USB audio interface" option.

ULF- SBX High Interface Box Circuit Diagram



Index	Explanation	Index	Explanation
1	Central gateway module (ZGM)	9	Not for US
2	Instrument cluster	10	Not for US
3	Central Information Display (CID)	11	Roof antenna
4	Car Information Computer (CIC)	12	Base plate with snap-in adapter
5	Fuse in the junction box	13	Bluetooth antenna
6	Microphone (passenger's side)	14	Controller (CON)
7	Power distributor, rear	15	Microphone (driver's side)
8	Interface box 'High' (ULF-SBX-H)	16	Steering column switch cluster (SZL)

Smartphone Integration Option Circuit Diagram



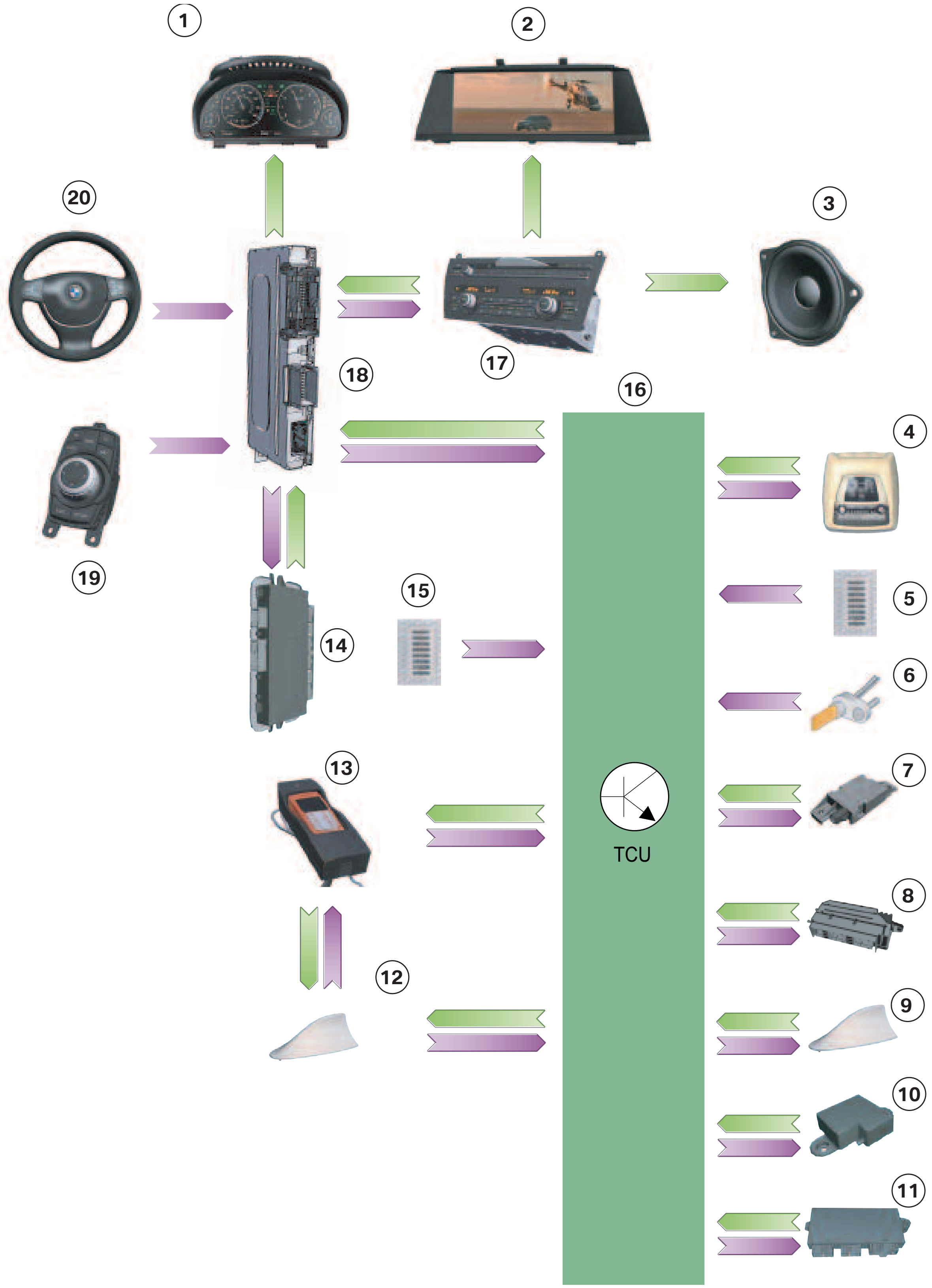
Index	Explanation	Index	Explanation
1	Central gateway module (ZGM)	6	USB audio interface (AUX)
2	Steering column switch cluster (SZL)	7	Base plate with snap-in adapter
3	Central Information Display (CID)	8	Fuse in fuse carrier at rear right
4	Car Information Computer (CIC)	9	Interface box (ULF-SBX-H)
5	Controller (CON)	10	USB hub

MOST signals to the ULF-SBX/ULF-SBX-H control units

In/out	Signal	Source/sink	Function
In	Control signals	CIC	Phone book connection set-up, incoming-call acceptance
In	Control signals	CAS	Terminal control
Out	Control signals	CIC	Audio signals, call recipient, mobile phone

Note: For detailed information on the Smartphone Integration optional extra (option 6NF), refer to the F01/F02 Audio systems training material.

Input/outputs, Telematics Control Unit

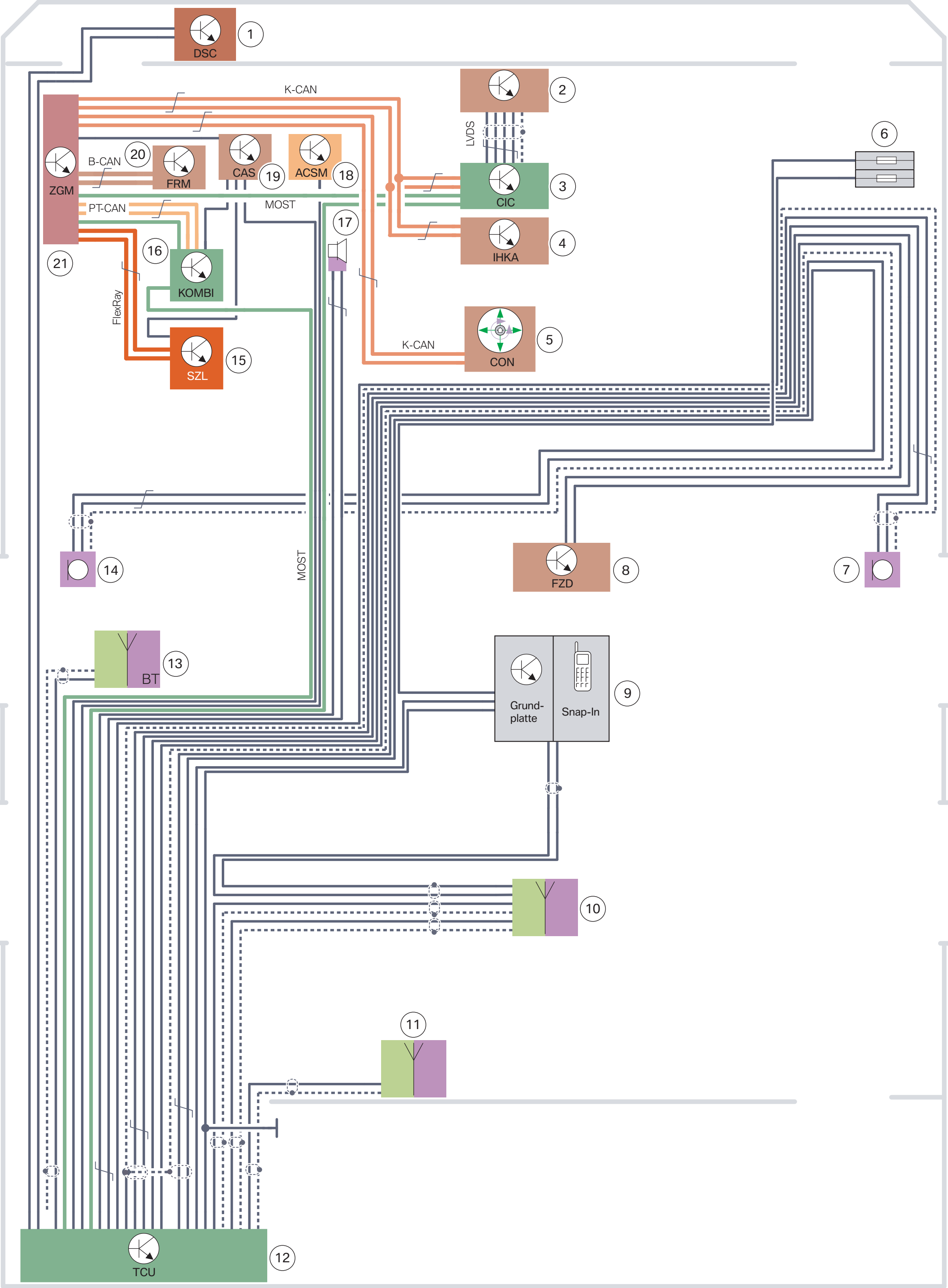


Index	Explanation	Index	Explanation
1	Instrument cluster	11	Car Access System (CAS)
2	Central Information Display (CID)	12	Roof antennal for TCU and snap-in cradle adapter and internal telephone module of the TCU
3	Speaker	13	Snap-in adapter cradle with mobile phone
4	Roof function module (FZD)	14	Footwell module (FRM) for remote door unlocking and remote door locking
5	Microphone (passenger's side)	15	Microphone (driver's side)
6	Wheel speed sensor	16	Telematics Control Unit (TCU)
7	Bluetooth antenna	17	Car Information Computer (CIC)
8	Crash safety module (ACSM)	18	Central gateway module (ZGM)
9	GPS antenna	19	Controller (CON)
10	Emergency-call GSM antenna (back-up)	20	Multifunction steering wheel (MFL)

Voice output by the telephone system is via the vehicle’s front right, front left and center speakers.

Volume can be adjusted by means of the multifunction steering wheel and the IHKA/ audio control unit.

Telematics Control Unit (TCU) Circuit Diagram



Index	Explanation	Index	Explanation
1	Dynamic Stability Control (DSC)	12	Telematics Control Unit (TCU)
2	Central Information Display (CID)	13	Bluetooth antenna
3	Head unit (CIC)	14	Microphone (driver's side)
4	Integrated automatic heater and A/C control (IHKA)	15	Steering column switch cluster (SZL)
5	Controller (CON)	16	Instrument cluster
6	Fuse in the junction box	17	SOS speaker
7	Microphone (passenger's side)	18	Crash safety module (ACSM)
8	Roof function module (FZD)	19	Car Access System (CAS)
9	Base plate phone snap-in adapter	20	Footwell module (FRM)
10	Roof antenna	21	Central gateway module (ZGM)
11	Emergency-call GSM antennal (back-up)		

MOST signals on the control unit TCU

In/out	Signal	Source/sink	Function
In	GPS signals	GPS antenna to CIC	Position data
In	Control signals	CIC	Phone book, connection set-up, incoming-call acceptance, terminal control, etc.
Out	Audio signals	CIC	Audio signals, call recipient BMW ASSIST
Out	Audio signals	CIC	Audio signals, call recipient mobile phone

The TCU receives its power supply via terminal 30F. The power supply via terminal 30F is necessary for the provision of the BMW ASSIST services, including for example:

- Remote Door Unlock
- Vehicle Finder/Stolen Vehicle Recovery
- Remote Climate Control.

These services are implemented via the MOST bus. The TCU reacts to a call from the provider, placed at the customer's request. The TCU sends a signal via the MOST bus to the Car Access System (CAS). The CAS then wakes up the vehicle.

Functions

Bluetooth Pairing (pairing wizard)

The pairing wizard presents the step-by-step instructions for the entire pairing process via the Central Information Display (CID). Detailed help texts and instructions for further assistance are available in case pairing is not successful.

This pairing wizard for Bluetooth is found by selecting the “Telephone” menu and then selecting “Bluetooth”.

Pairing process:

- Once “Add new device” has been selected, the in-car display shows the Vehicle Identification Number (VIN). At the same time, the pairing wizard issues a message to the effect that from this point on the mobile phone has to be used in the process.
- The mobile phone should now be used to search for new Bluetooth devices.
- If the search is successful, the VIN appears in the display of the mobile phone.
- The next step is to key a freely selectable PIN code into the mobile phone, and then key the same PIN code into the vehicle.
- If pairing is successful the data of the newly paired mobile wireless device appear in the vehicle’s phonebook.
- This can take from a few seconds to several minutes to complete, depending on how many entries there are in the phonebook.
- The telephone entries for the entries from the “Contacts” menu are also shown.

Up to four mobile phones can be paired with the car. Before a fifth mobile phone can be paired, one of the other four entries must be removed from the list.

Note: Not all system compatible phones are capable of these features. For more information see a list of compatible phones at www.wireless4bmw.com

Calls with Multiple Users

This function can be used to conduct two phone conversations at the same time. Services such as call waiting, toggle calls and teleconferencing are possible in this way.

Call Waiting

If a second call is incoming while a call is in progress this is indicated by a call waiting tone and also by an accept/reject prompt in the display. The user can now reject the second call and continue the active call or accept the second call. In which case the first caller will hear a call waiting melody and is placed on hold.

Toggle Calls

When calls with multiple users are in progress, one call can be "active" and one "on hold".

The "toggle calls" function can be used to toggle these calls between the "active" status and the "on hold" status.

Display showing active calls

✓ Müller
00:06

Mustermann
00:36 (wird gehalten...)

Teleconference

If the user has an active call and a call on hold, the "Conference" menu item can be selected to place all phone users in a shared conference call.

✓ Konferenz
01:28

Display showing a teleconference

Phonebook Contacts

Contacts

All contact information can be viewed and saved under ‘Contacts’. Contacts transferred from the user’s mobile phone to the car are also listed here. A symbol after the contact shows where the information for this contact is saved. When the mobile phone is removed from the car the contacts from the phone/ Bluetooth pairing can no longer be selected in the vehicle.

Display showing ‘My contacts’

Index	Explanation	Index	Explanation
1	Contacts from phone/Bluetooth pairing	4	Contact on the hard disc of the CIC

Other information, including e-mail addresses and postal addresses can be saved and administrated along with the phone numbers on the CIC contacts. This information can only be transferred from the mobile phone to the car if the former supports the PBAP (Phone Book Access Profile) function.

Note: Not all system compatible phones are capable of these features. For more information see a list of compatible phones at www.wireless4bmw.com.

Phonebook

The entries in the phonebook show only contacts for which a phone number has been saved. These can be either entries from mobile phones or contacts saved in the car. Up to four telephone numbers can be saved for each contact and the individual numbers retrieved using the phonebook functionality.

Display showing the phone numbers for a contact

+1472----- [redacted]
089382-----
+491234-----
9638-----

Call Register (Dialled numbers, missed calls)

All dialled numbers and missed calls in the car are listed clearly in the call register under “Dialled numbers” and “Missed calls”. The entries are sorted by date and time.

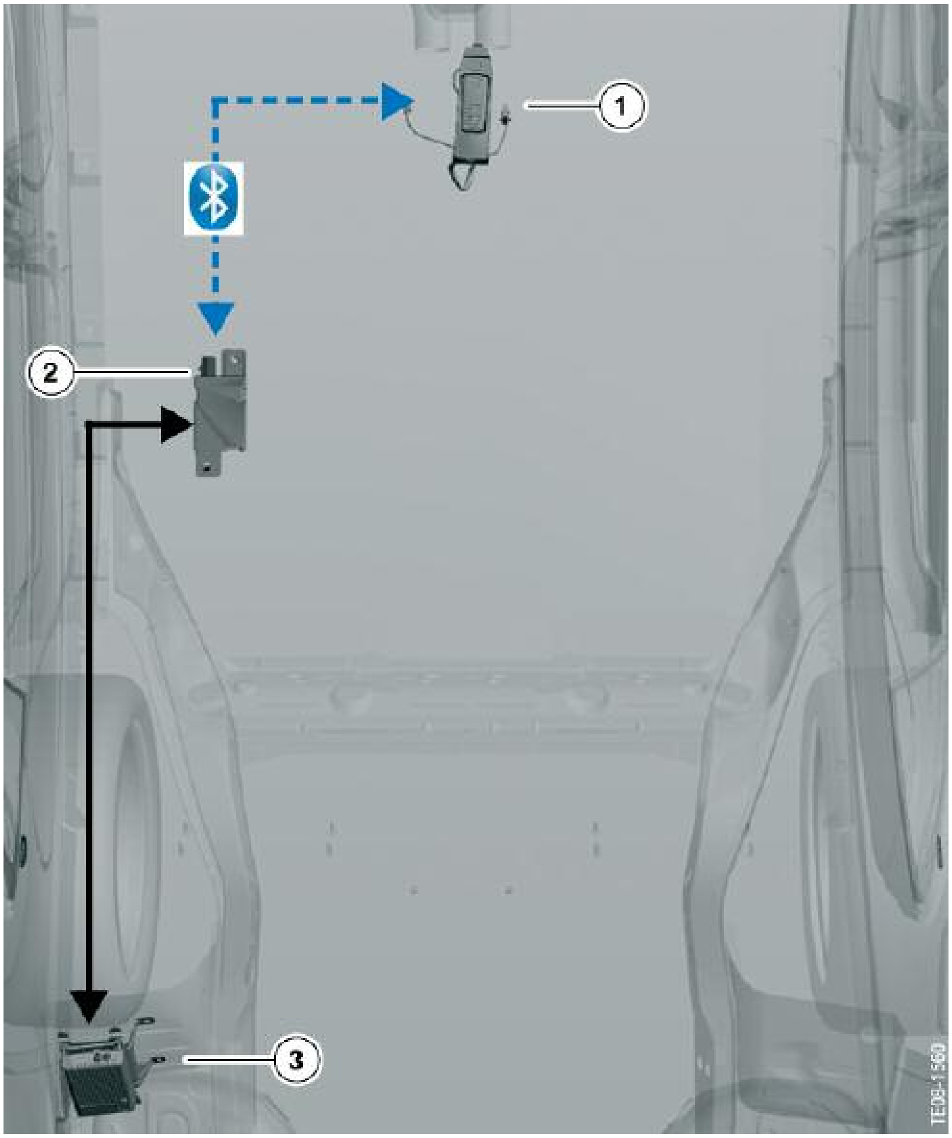
The driver uses the controls on the multifunction steering wheel to select from the dialled numbers list shown in the instrument panel.

+4989382-----
17.10.2007 13:14
Entgangener Anruf:
+4989382----- am 17.10. um 12:07
Uhr
T-Mobile

Displaying showing a missed call

The graphic below shows Bluetooth connections between the Mobile phone in the center console and TCU are through the Bluetooth antenna.

Bluetooth connections in the vehicle



Index	Explanation	Index	Explanation
1	Front center console with mobile phone	3	Telematics Control Unit (TCU)
2	Bluetooth antenna		

Note: Although up to four phone may be paired to the vehicle, only one device can be active at any given time.

BMW Services

These services are offered to customers under the generic term “BMW Assist”.

From the customer’s point of view, “BMW Assist” is a convenient service guaranteeing more safety, more mobility and comprehensive information.

In an emergency or a breakdown, “BMW Assist” helps save crucial time in might well be a life-or-death situation, and it also helps the driver in day-to-day situations, such as searching for a parking space in congested urban areas.

“BMW Assist” is split into two services:

- Safety Plan (Standard)
- Convenience Plan (Optional)

Safety Plan

- Automatic Collision Notification:
  Is an emergency calling Service which, in the event of an accident, forwards the relevant GPS data to a rescue-services command post to ensure optimum deployment of rescue and recovery facilities. If airbags deploy this is fully automatic.
- Emergency Request (SOS):
  Pushing the SOS button in an emergency will transmit the vehicle location and information. A response specialist will contact the driver to aid in the situation.
- Enhanced Roadside Assistance:
  Is used when stranded on the road, to request a tow truck, fuel or a flat tire replacement.
- Stolen Vehicle Recovery:
  This service makes it simple to track a stolen vehicle via GPS. The GPS data are forwarded to the police.
- Remote Door Unlock:
  New service enabling the customer to have the doors of the car opened by remote control in the event of the identification transmitter being locked inside.
- TeleService:
  With TeleService the vehicle’s operating status and upcoming service needs are transmitted to the BMW center automatically or manually with the push of the “Service Request” menu option in the iDrive display.

- Customer Relations:
  This service can be used to request day-to-day information about the locality. Pressing the SOS button or the Customer Relations menu option will contact the Customer Relations staff.

- My Info:
  This enables the customer search Google Maps from a home PC and to send business listings, street addresses and phone numbers as well as messages to the vehicle. This information appears on the "My Info" menu and can be exported to the Navigation system as a new destination.

Convenience Plan (Optional)

- Critical Calling:
  This service allows up to four operator assisted calls per year just by pressing the SOS button. This is useful when the customer is with out a working mobile phone and need the assistance of a relative or colleague.

- Concierge:
  This service accessed through the "Concierge" option in the iDrive. It can be used to request day-today information about the locality, for example locations of restaurants, hotels (including reservation service), addresses, etc.

- Directions:
  To receive the shortest route or directions to the nearest gas station, ATM or a point of interest. Select "Concierge" from the iDrive menu or press the SOS button to speak to a response specialist

- Traffic Information:
  To receive up to date traffic reports along a traveled route, select "Concierge" from the iDrive menu or press the SOS button to speak to a response specialist.

- Weather Information:
  Select "Concierge" from the iDrive menu or press the SOS button to speak to a response specialist to receive the latest weather forecast, locally or at your destination.

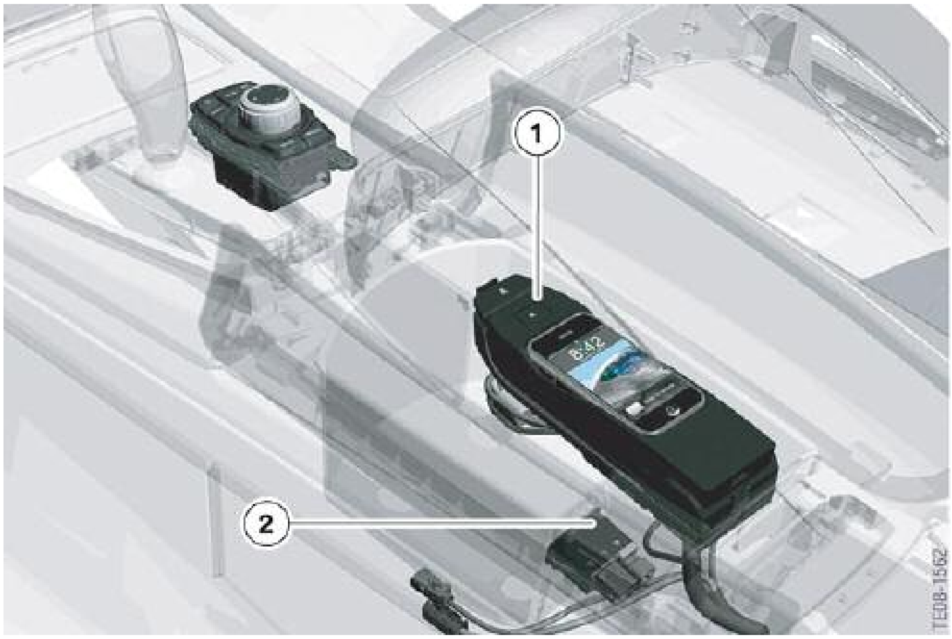
- BMW Search:
  Available only with the Navigation option, BMW Search allows online access to the Google Maps database from the iDrive. The desired business information (address and phone number) can then be sent to the navigation system or to the phone system.

Smartphone Integration

The “Smartphone Integration” optional extra enables the customer to play back audio files saved on a mobile phone. The option adds a USB port to the telephone base plate snap in cradle. The mobile phone can be connected to the car with a compatible snap-in cradle adapter, with all telephone functions remaining fully available.

Simultaneous use of the mobile phone in the snap-in adapter and the USB port in the center console is possible. However, the audio files on the mobile phone cannot be accessed while a device is connected to the USB port.

Smartphone Integrated audio player function



Index	Explanation	Index	Explanation
1	Base plate with snap-in adapter and mobile phone	2	USB audio interface

The audio files can be selected in the 'CD/Multimedia' menu, where they are in the "External devices" submenu.

Smartphone Integration is offered only in combination with "USB audio interface" option and is currently only available with the iPhone.

Note: For detailed information about these systems, see the F01/F02 “Audio Systems” training material.

System Components

Components and Installation Locations

The following control units act as the interface between the mobile phone and the vehicle:

- ULF-SBX-High Interface box (Only for USB/Audio Interface)
- Telematics Control Unit (TCU)

The preconditions under which TCU or TCU and interface box together are installed are listed below:

Optional extra	Telephone control units installed
Option 639 "BMW Assist"	TCU
Option 639 "BMW Assist" + option 6FL "USB audio interface"	TCU ULF-SBX-H
Option 639 "BMW Assist" + option 6NF "Smartphone Integration"+ option 6FL "USB audio interface"	TCU, ULF-SBX-H base plate/cradle adapter

Note: Although both the ULF-SBX-H and the TCU may be fitted in a vehicle at the same time, the TCU always provides the telephone functions. The ULF-SBX High is only installed to provide the "USB audio interface".

ULF-SBX-H Interface Box

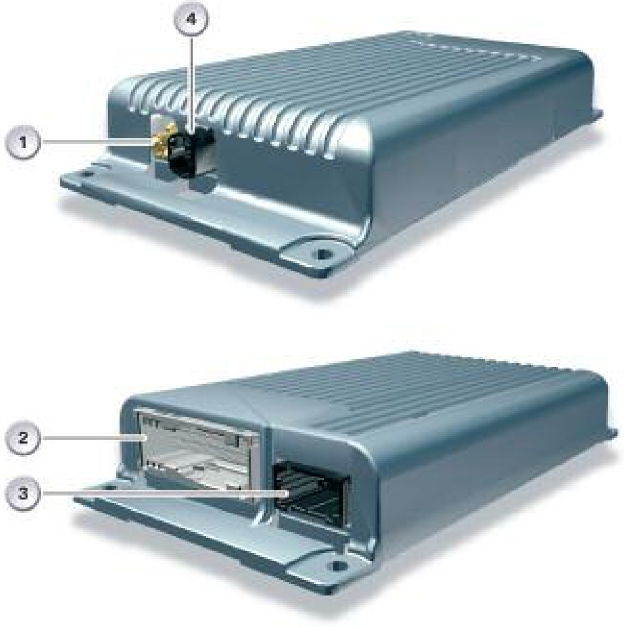
The ULF-SBX High interface box has been used in BMW vehicles since the introduction of E93.

The (SBX High) interface box is capable of performing the following tasks:

- USB connection for USB/audio interface
- Bluetooth interface with hands-free mode and phone book
- Basic voice input and activation system through the telephone

Interface box and interface box ‘High’ support various techniques for downloading phone book entries from Bluetooth-enabled mobile phones. One of these techniques is Phonebook Access Profile (PBAP). The number of compatible mobile phones increases with the support of several downloading techniques. In addition, it is possible to download all the phone numbers attached to a name entry.

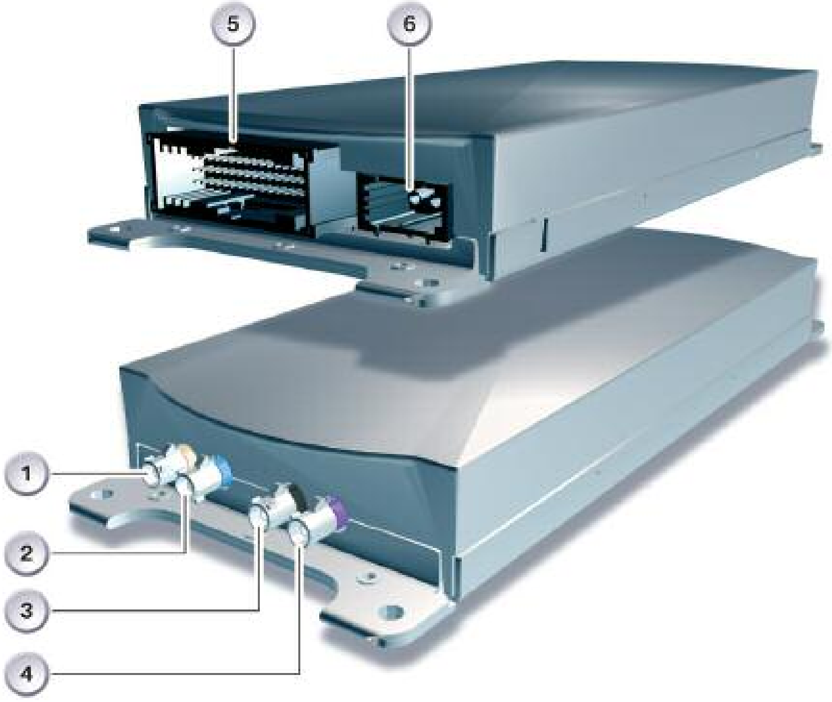
Although both the ULF-SBX-H and the TCU may be fitted in a vehicle at the same time, the TCU always provides the telephone functions. In this case the telephone functions are not available in the ULF-SBX High and the module is only installed to provide the "USB audio interface" option.



Index	Explanation	Index	Explanation
1	Bluetooth connection (Not for US)	3	MOST connection
2	54-pin connector	4	USB connection

Telematics Control Unit (TCU)
The Telematics Control Unit used on the F01/F02 evolved from the E70 TCU.

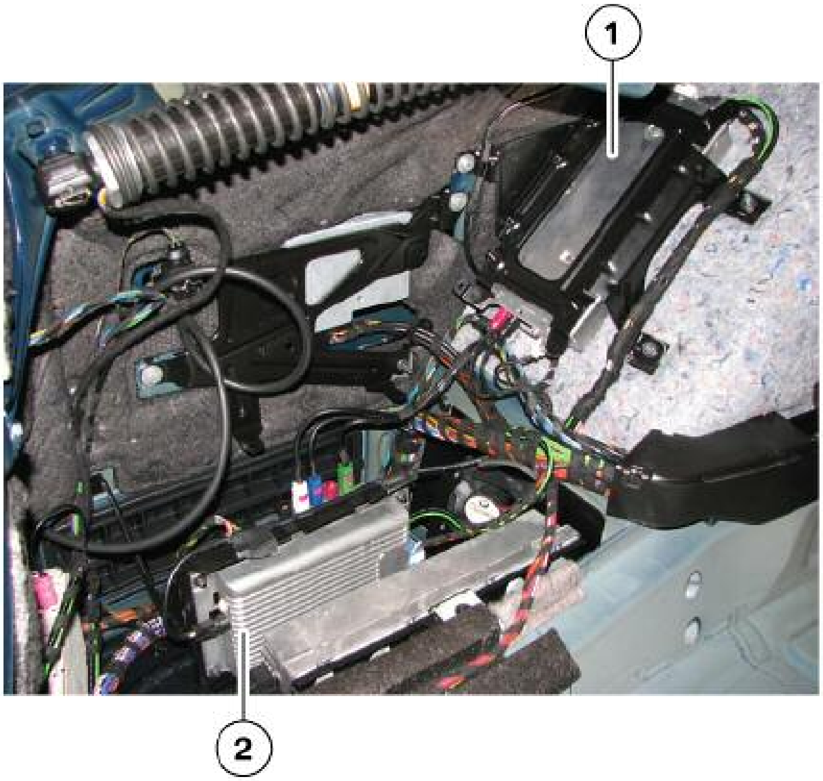
The TCU always incorporates a GPS receiver and a GPS connection. In the F01/F02, however, this connection is not used because the GPS signals are processed by the CIC.



Index	Explanation	Index	Explanation
1	Bluetooth antenna connection, transparent connector	4	Emergency antenna connection purple connector
2	GPS antenna connection blue connector	5	54-pin connector
3	Roof antenna connection black connector	6	MOST connection

Location of ULF-SBX/ULF-SBX-H and TCU

Interface box or interface box 'High' and the TCU are seated in the luggage compartment on the left.

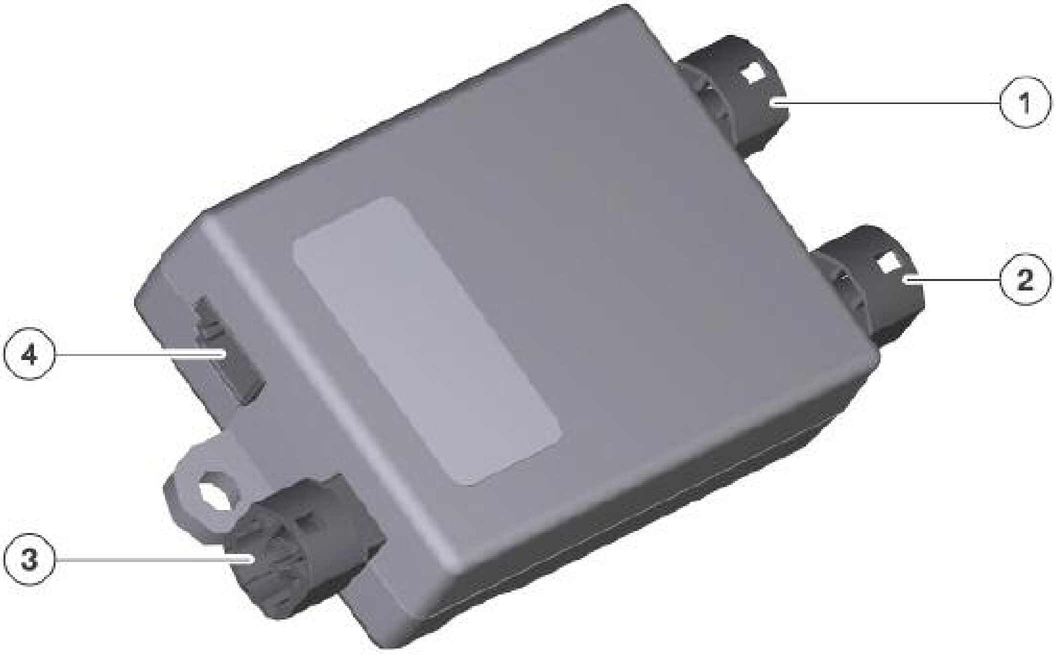


Index	Explanation
1	Telematics control unit (TCU)
2	Interface box (ULF-SBX-High)

USB Hub

The USB hub is for connecting multiple USB interfaces to the interface box 'High'. The USB hub incorporates an active USB signal amplifier and has two USB inputs and one USB output.

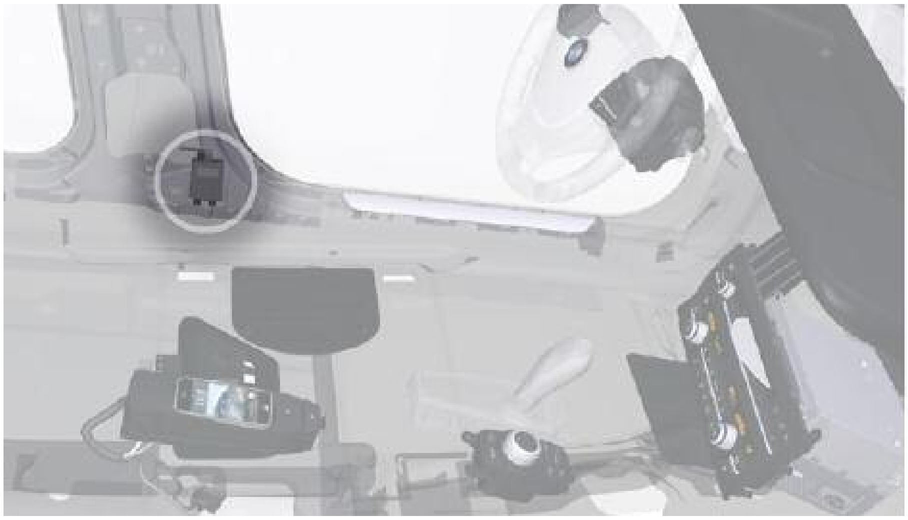
The USB hub is installed only if the car is ordered with the "Smartphone Integration".



Index	Explanation	Index	Explanation
1	USB connection to AUX-in connection (blue connector)	3	USB connection to (ULF-SBX-High) interface box (black connector)
2	USB connection for base plate of the Smartphone audio link (neutral color connector)	4	Power supply for the USB hub (black connector)

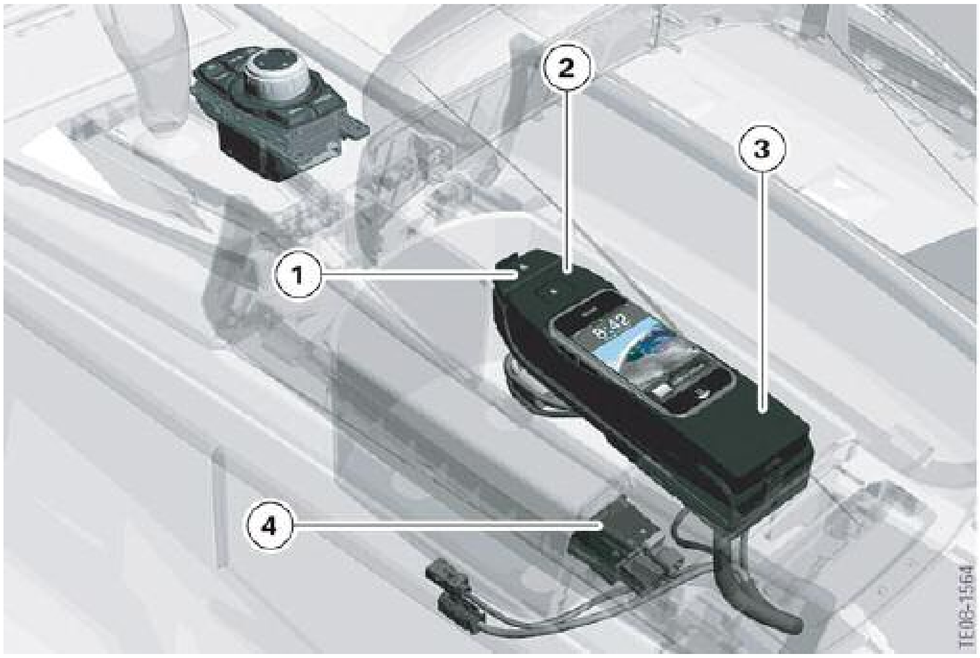
Location of USB Hub

The USB hub is installed at the left B pillar. This applies to both RHD and LHD cars.



USB Base Plate/snap-in Adapter

The base plate with snap-in adapter and USB AUX-IN connection are installed in the front center console, underneath the armrest.



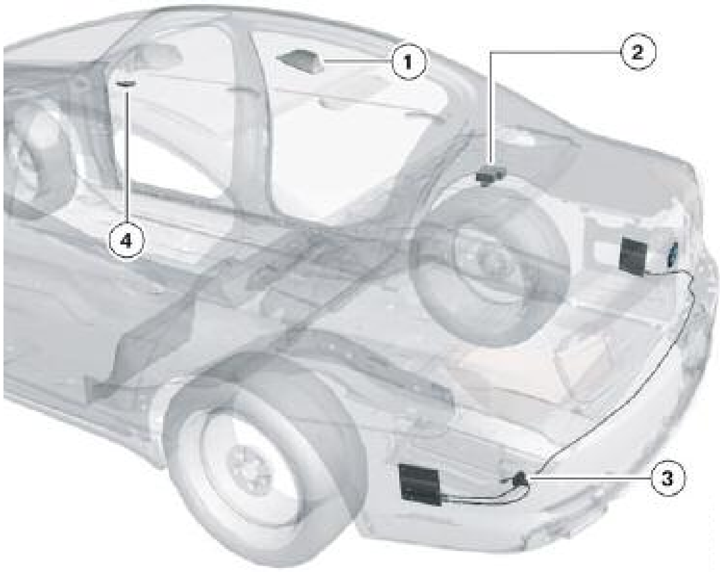
Index	Explanation	Index	Explanation
1	Button for removal of the snap-in adapter	3	Snap-in adapter
2	Button for removal of the mobile phone	4	USB connection and AUX-IN

Telephone Antenna System

In order to meet the high quality requirements that apply to the telephone system of the F01/ F02, several antennas are installed in the vehicle, with the configuration depending on equipment trim level.

The following antennas are used for this purpose:

- Roof antenna
- Bluetooth antenna
- Emergency-call GSM antenna

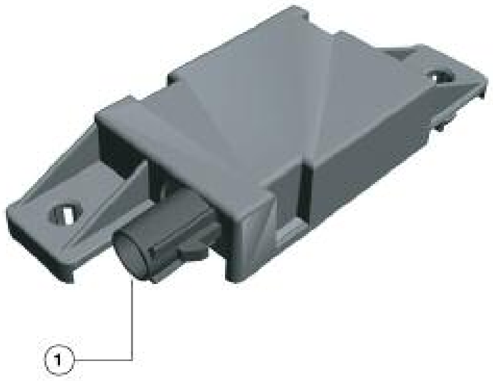


Index	Explanation	Index	Explanation
1	Roof Antenna	3	Not for US
2	Emergency-call GSM (back-up) antenna	4	Bluetooth antenna

Emergency-call GSM antenna
The emergency-call GSM antenna is needed for the ASSIST service so it is installed in combination with the Telematics Control Unit. “Preparation for mobile phone with Bluetooth interface”.

Bluetooth antenna

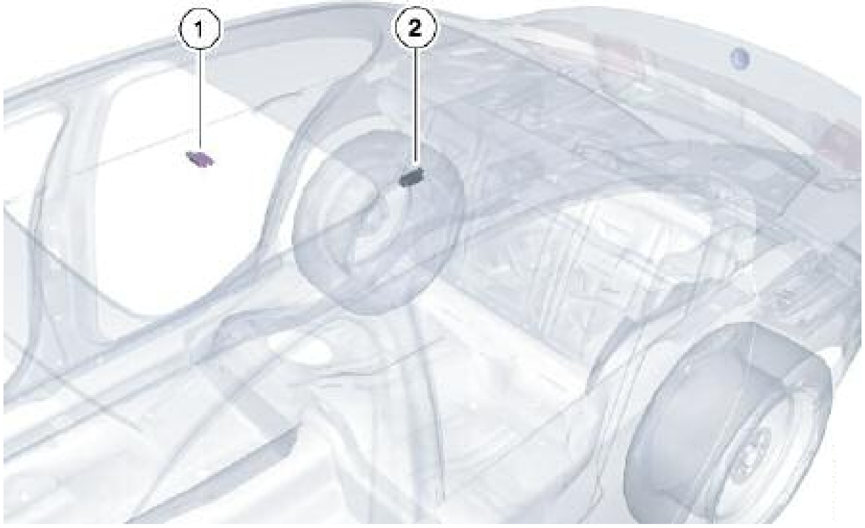
The Bluetooth antenna is a newly designed component. It is smaller than the predecessor model, which means that it can be accommodated in the roof.



Index	Explanation
1	Connection to the TCU

There are two different locations for the Bluetooth antenna. The position actually occupied depends on whether or not the car is fitted with the slide/tilt sunroof option.

Location of the Bluetooth Antenna



Index	Explanation	Index	Explanation
1	Bluetooth antenna without slide/tilt sunroof (in middle of roof)	2	Bluetooth antenna with slide/tilt sunroof (on B pillar)

Roof antenna

The roof antenna is in the middle of the roof, toward the trailing edge. Depending on the equipment installed, the car might have two GSM antennas (roof 1 and roof 2). Both are inside the housing of the roof antenna.

Overview of the GSM antennas installed and relationship to optional extras:

Optional extra	GSM 1 (roof antenna)	GSM 2 (roof antenna)	Emergency-call GSM antenna	Bumper antenna
BMW Assist	X	X	X	O

Table of Contents

F01 Voice Activation System

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Voice Activation System

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the Voice Activation options available for the F01/F02
- Describe the functions of the Voice Activation System
- Identify the components of the Voice Activation System

Introduction

History

Voice-activated control was offered for the first time as an option for the E38. The system enabled the driver to operate the telephone and the navigation system without taking his or her eyes off the road and the traffic situation.

As the voice recognition system evolved, the number of spoken command the system could recognize increased by leaps and bounds from the initial 30 to the current figure of about 470 (CCC with the "Voice Activation" option in the E60, E90). This means that in the current models, voice control can be used not only for the telephone and the navigation system, but also for entertainment, the address book, the air-conditioning functions and vehicle individualization settings.

Voice Activation is standard equipment on the F01/F02 and it is always combined with the "Navigation System".

Note: The Voice Activation System and the "Navigation System" are both standard on the F01/F02.

The Voice Activation system has been further enhanced.

There is now an even larger range of spoken commands and for the first time the user has the option of individualizing the voice recognition system in accordance with specific needs and preferences. For example, users can match the voice recognition system to their own knowledge base and use the controller to change the spoken-language setting.

Other innovations of the voice activation system include:

- Visual feedback in the instrument panel.
- No audible beep signal during a dialog with the system.
- Combined mode with both voice inputs and controller inputs.
- Intersections and zip codes can be entered as destinations.
- Voice control of contacts, phone book and address book with up to 3000 entries.

System Overview

The following pages show the input/outputs and the schematic circuit diagrams of the F01/ F02 voice input and activation systems.

The driver's side microphone is the only device used for voice input.

Voice input is always activated by pressing the PTT button (push-to-talk button) on the steering wheel.

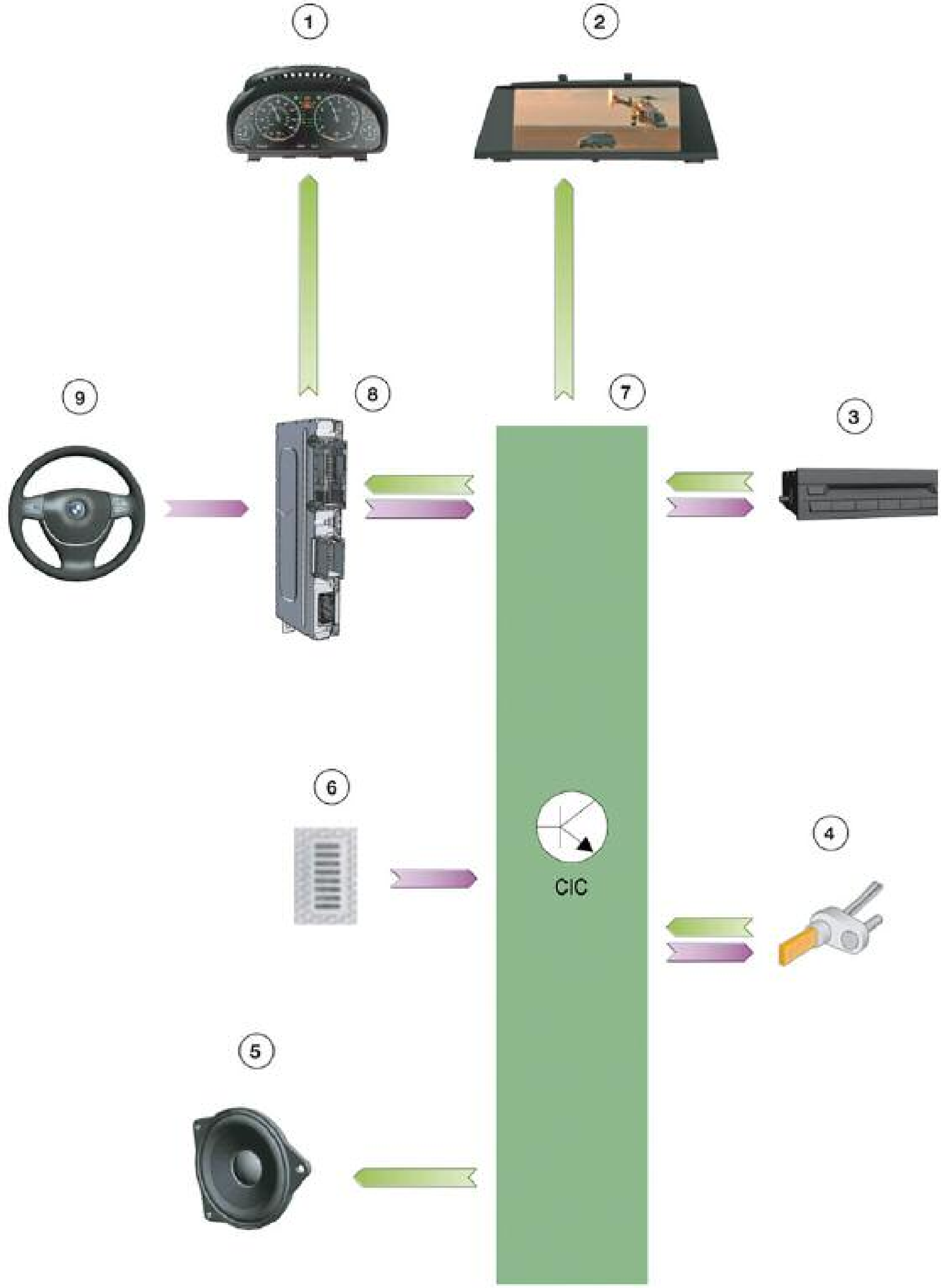
The control units, sensors, control elements and components involved in the system are shown in the input/output diagrams. A block diagram representation of a specific control unit is additionally shown.

The input/output diagram provides an overview of the system in the form of a signal flow diagram. It does not indicate whether the signals are sent via busses, other control units, hard wiring or by wireless means. This detailed information can be found in the schematic circuit diagram.

The graphic representation is always followed by the corresponding legend which can be found either under the graphic or on the next page.

For the sake of clarity the various individual speakers are not shown in the schematic circuit diagrams.

Inputs/outputs, Voice Activation System



Index	Explanation	Index	Explanation
1	Instrument cluster	6	Microphone (driver's side)
2	Central information display (CID)	7	Car Information Computer (CIC)
3	Other controlled systems such as DVD changer	8	Central gateway module (ZGM)
4	Wheel speed sensor	9	Multifunction steering wheel (MFL)
5	Speaker		

The voice input function is always implemented in the CIC.

The DVD changer serves as an example of the other voice-activated systems that can be controlled.

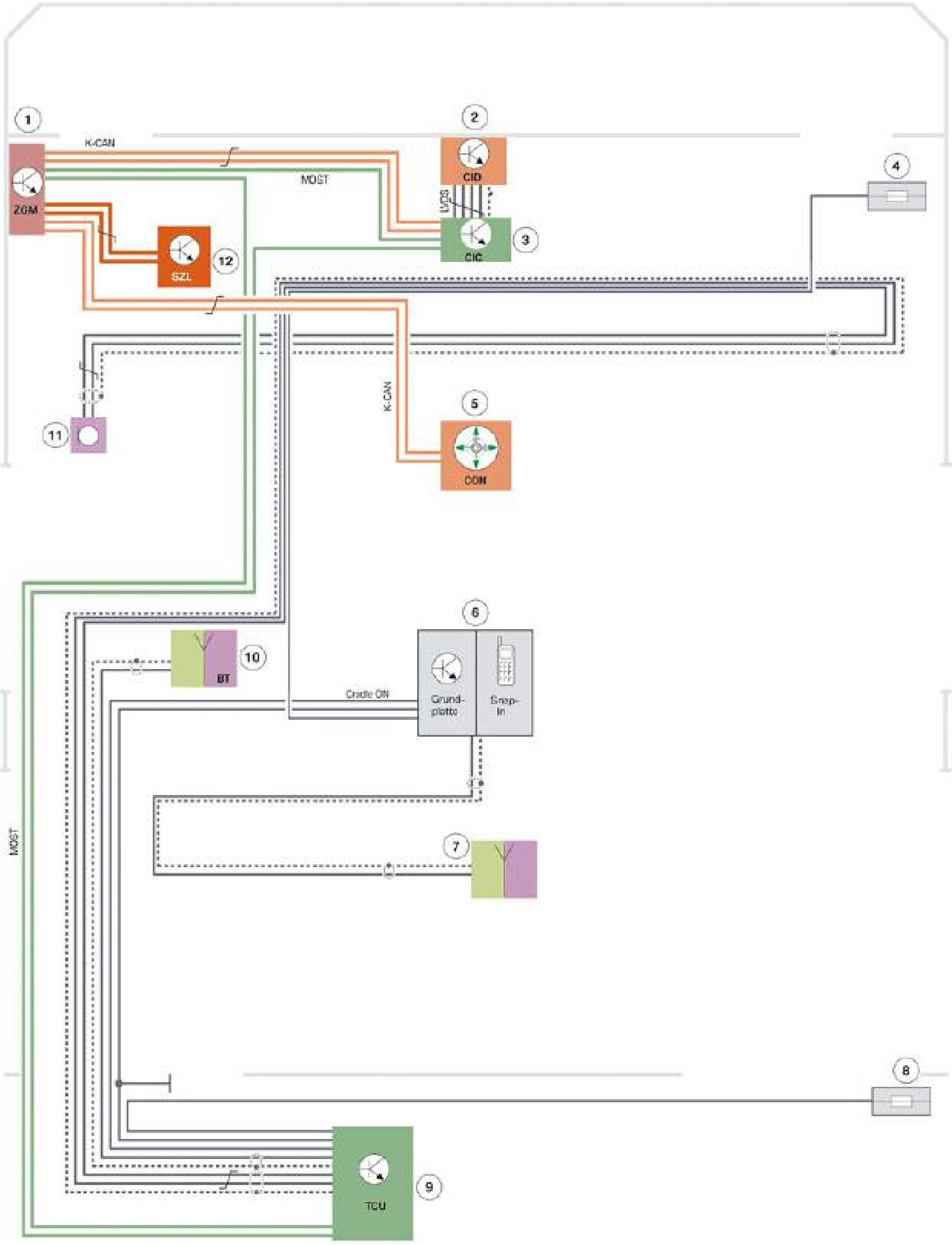
The wheel speed signals are used for speed- dependent volume control.

Volume can be adjusted by means of the multifunction steering wheel and the IHKA/audio control unit. Speed-related volume control is also active.

The microphone is connected to the TCU and the telephone commands are processed by the telephone control unit and made available on the MOST bus.

Optional extra	Control unit installed
Voice Activation	TCU CIC
Voice Activation + "USB/audio interface" (option 6FL)	TCU CIC ULF-SBX H
Voice Activation (option 620) + “Smartphone Integration” (option 6NF)	TCU CIC ULF-SBX H

Schematic Circuit Diagram for the Voice Activation System with TCU



Index	Explanation	Index	Explanation
1	Central gateway module (ZGM)	7	Roof antenna
2	Central information display (CID)	8	Fuse in fuse carrier at rear
3	Car Information Computer (CIC)	9	Telematics control unit (TCU)
4	Fuse in the junction box	10	Bluetooth antenna
5	Controller (CON)	11	Microphone (driver's side)
6	Baseplate with snap-in adapter	12	Steering column switch cluster (SZL)

MOST signals at TCU

In/Out	Signal	Source/sink	Function
Out	Control signals	MOST control units	Controlled systems
Out	Control signals	CIC	Display control of the CIC
Out	Audio signals	CIC	Answer, voice input

System Functions

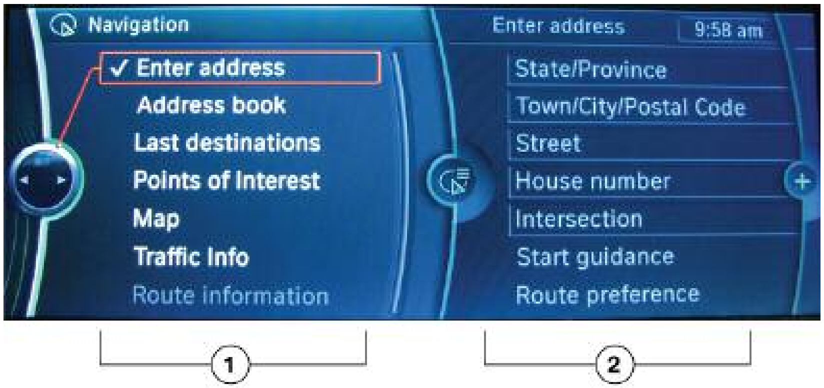
What can be operated by voice input?

In the F01/F02, broadly speaking all the menus that can be viewed in the CID can be voice-controlled to the second level of a menu.

The graphic below shows the first level of the “Navigation” menu on the left, and the second level on the right.

Direct entry to the first level of the menu is a possibility for reducing the length of operating time needed to activate a particular function. This is done by saying aloud a term from the menu in question. Instead of having to say first "Navigation" and then "Destination entry", the user can simply say "Destination entry" to go directly to this function. The command is executed regardless of which menu is currently open.

”Navigation” menu



Index	Explanation
1	First level of "Navigation" menu
2	Second level of "Navigation" menu

Standard and Short Dialogs

Until now, all voice recognition systems have suffered from the drawback of appearing complicated to inexperienced users (beginners). The difficulties were due to the fact that the user was unaware of how many voice commands were available, or failed to enunciate the commands correctly and completely.

Experienced users (experts) on the other hand, had the advantage of knowing how to use the system quickly by using short commands.

In order to ensure that users in both these groups can use the system to their satisfaction, in the F01/F02 it is possible to select a “Standard” dialog for inexperienced users or a “Short” dialog for experts.

The “Standard” dialog provides detailed information while operation is in progress, but the “Short” dialog dispenses with this information for the sake of rapidity.

Example:

Standard dialog:

SYSTEM: “Say the name of a place”

USER: “Munich”- shows up on the display

SYSTEM: “Did you mean “Munich”?”

USER: “Yes”

Short dialog:

SYSTEM: “Place”

USER: “Munich”- shows up on the display

SYSTEM: “Did you mean “Munich”?”

USER: “Yes”

The dialog setting can be toggled between standard and short by selecting “Settings” “Language/units”.

Language: English
Speech mode: Default
Consumption: mpg
Distance: mls
Temperature: °F

Language/units

Language Setting

The current voice recognition systems do not offer the customer the option of changing the input language without expert assistance. The car has to be brought to the workshop, where BMW Service can change the language setting. The language is changed either by recoding or by replacing the appropriate control unit.

The new 7 Series BMW enables the customer to change not only the display language but also the input and output language of the voice activation system by means of iDrive.

The full range consists of eight languages:

- English (UK)
- French
- German
- English (US)
- Italian
- Spanish
- Dutch
- Japanese

All eight languages are saved on the hard disc.

Depending on the national-market specification, however, only three different languages are selectable with iDrive. The other languages can be activated by coding.

The menu item for changing the language setting is:

“Setting” - “Language/units”.

No beep after each step in a dialog sequence

Until now, before enunciating a command the user always had to wait for a confirmation beep marking the conclusion of a system message. This does not conform to the natural flow of speech, and often results in errors because the user speaks too soon.

In the F01/F02 there is no beep between the individual steps in a dialog sequence. There are now only two audio signals: One signal confirms the start of a dialog sequence and sounds immediately after the user presses the PTT (push-to-talk) button on the steering wheel. A second signal sounds to mark the end of the dialog.

PTT button

Index	Explanation
1	PTT

Visual feedback in the instrument panel

In addition to the acoustic feedback issued by the voice input and activation system, the user also receives visual confirmation of the result (e.g. after enunciating the command “New number” via the instrument panel. The system’s input prompt “e.g. Enter digits” appears at the same time in the instrument panel.

Consequently, the user has improved orientation and can more easily follow the sequence of functions and the changes from menu to menu in the CID.

Display on the instrument panel

Index	Explanation
1	Readout showing result of interaction with the voice input and activation system
2	Input prompt issued by the voice input and activation system

Combined mode with voice and iDrive inputs

This new function enables the user to operate the system by a combination of spoken commands and iDrive actions.

Until now, voice input has always aborted as soon as the controller was used to select an entry. This meant that the user had to press the PTT button again in order to resume voice input to complete the sequence.

In the F01/F02 the voice-input dialog remains open even if the controller is moved, so the user can immediately resume voice input to continue interacting with the system. This makes it much easier, for example, to enter a destination for the navigation system by selecting a street name from a list.

Extended destination entry in navigation

Voice-assisted destination entry has been extended in the following ways:

- Entry of intersections spoken command
- Entry of Zip codes

Voice control with up to 3000 entries

Until now, the phone book was the only administration function for which voice input could be used. In the F01/F02 it is now possible to use spoken commands to administrate the contacts, phone book and the address list. This means that three lists with up to 3000 entries can be operated by voice control.

System Components

The voice input and activation system is implemented in the following control units:

- Telematics Control Unit (TCU)
- Voice input and activation system
  - CIC

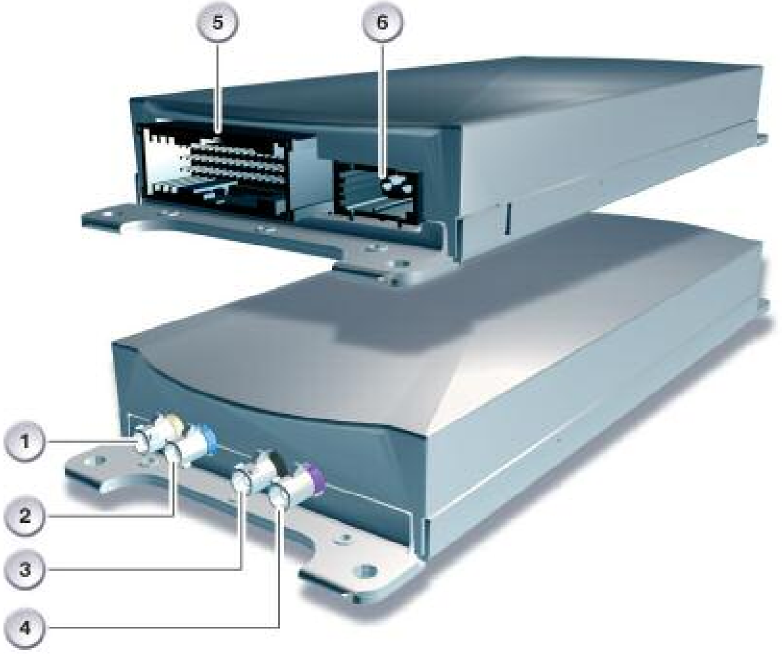
The voice-input commands are transmitted via MOST or the central gateway module (ZGM) to the receiving control unit.

Voice output consists of recorded audio signals stored in the control unit for the voice input and activation system. The audio signals are then made available on the MOST bus in the form of digital signals.

TCU

The TCU used on the F01/F02 is an evolved unit based on the TCU from the E70.

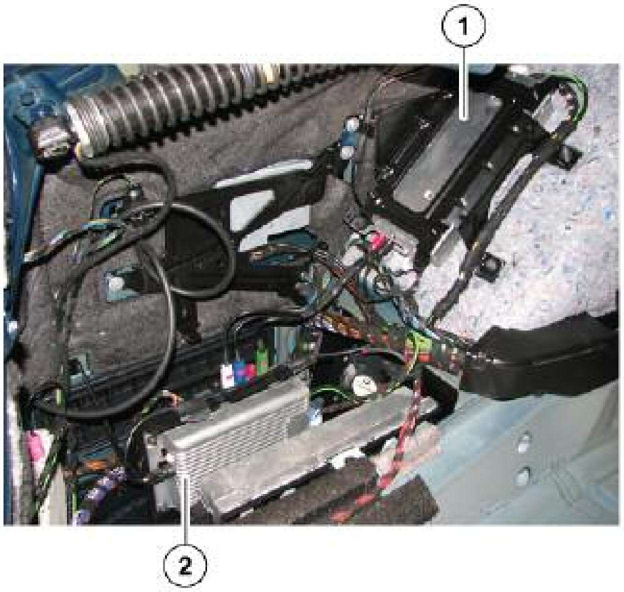
Telematics Control Unit



Index	Explanation	Index	Explanation
1	Bluetooth antenna connection, transparent connector	4	Emergency antenna connection purple connector
2	GPS antenna connection blue connector	5	54-pin connector
3	Roof antenna connection black connector	6	MOST connection

TCU Location

ULF-SBX “High” and the TCU are located on the left side of luggage compartment



Location of the TCU and ULF-SBX-H

Index	Explanation
1	TCU
2	ULF-SBX High

Voice Activation System

IHKA/audio control panel

Index	Explanation	Index	Explanation
1	Turn/push button for volume control of the audio system (ON/OFF)	3	Slot in DVD player
2	Favorite buttons	4	Eject button for the DVD player

The Voice Activation system supports all the menus viewable on the CID. Voice control also extends to the second level of the menu tree.

The CIC has eight languages, all saved on the internal hard disc. Three of these languages are user-selectable by iDrive. The other languages can be activated by coding.

The volume of voice output can be adjusted by means of the multifunction steering wheel and the IHKA/audio control unit.

The CIC is mounted behind the IHKA/audio control panel in the instrument panel.

Hard Disc

For the first time, a hard disc for storing applications (programs) and data is used in a head unit. It is a 2.5” hard disc with a capacity of 80GB.

0.5 GB of storage space is reserved on the hard disc for the data of the voice recognition system (iSpeech).

CIC hard disc

Index	Explanation
1	CIC
2	Hard disc (slide-in tray)

Table of Contents

F01 Audio Systems

Subject **Page**

Subject **Page**

Audio Systems

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the Audio System on the F01/F02
- Identify the components of the Audio System on the F01/F02
- Describe the CIC system and its relation to the Audio System of the F01/F02
- Identify the components of the CIC system

Introduction

History

With the launch of the E65, an optical bus (MOST) was used for the first time in a series production vehicle for the purpose of transmitting digitized audio signals.

With the introduction of the E93 in 2007 a USB interface for external audio devices was offered for the first time in BMW vehicles. The media can be accessed from the iDrive and the audio data played through the vehicle speakers.

New Features

The CIC system is a further development of the previous CCC system. The CIC head unit was installed for the first time on the BMW 1 Series and 3 Series in 2008.
The New BMW 7 Series, the F01/F02 is equipped with an enhanced version of the CIC system.

By storing data on a 80 GB hard disk, the new head unit provides many new functions and options.

In the audio systems, this development is reflected by the new music collection function. Music files can be converted (ripped) or copied for the music collection onto the hard disk.

Storing the music on the CIC-dedicated hard disk allows fast access to these music files at all times.

A selection of up to 3700 music files (12 GB) is possible.

A USB interface is provided in the glove compartment for import/export purposes (data copy or data backup).

The digital radio systems IBOC tuner/decoder is now integrated in the CIC.

A common station list together with the analog systems provides added convenience.

An improved antenna system makes reception of the radio stations even more stable and less prone to interference. An additional interference suppression filter enhances the reception over long distances, particularly in the AM range.

A modified base plate makes it possible to connect to and play back music tracks stored in the mobile phone with the Smartphone Integration option (6NF). This option is currently available only with the iPhone®.

Music tracks stored in the mobile phone can now be easily accessed. Simple menu navigation and playback of these music tracks can now be controlled via the iDrive.

System Overview

General Information

The system overview of the F01/F02 audio system begins with a general bus overview. It shows the interconnection of all IKT components in the bus system network.

A block diagram of the Car Information Computer is also provided.

Particular reference is made to the individual levels within the CIC head unit:

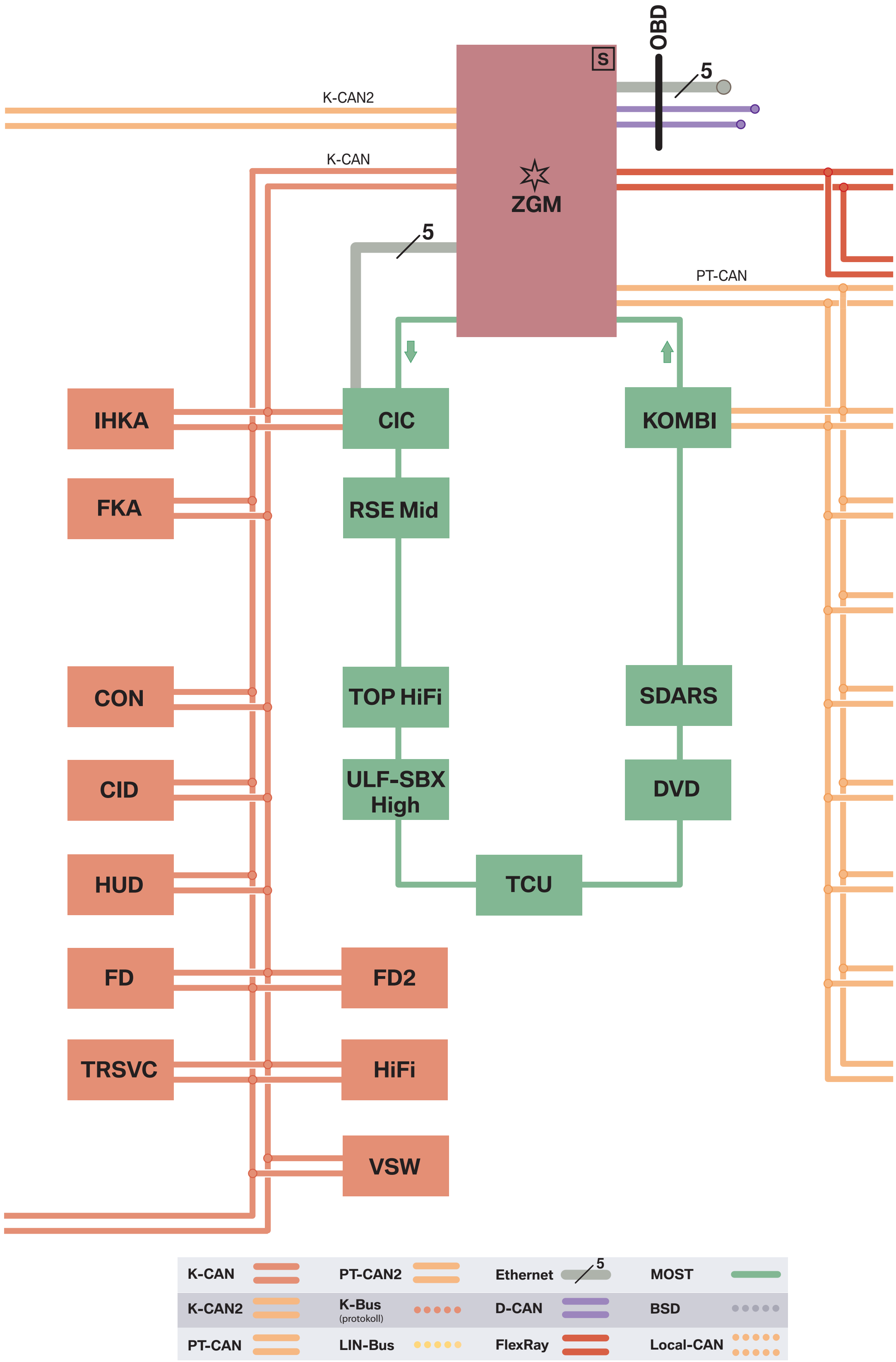
- User interface
- Application software
- Hardware components

Detailed information can be found in the following pages on the individual circuit diagrams:

- CIC Head unit circuit diagram
- HiFi speaker system circuit diagram
- TOP-HiFi speaker system circuit diagram
- Antenna system circuit diagram
- USB/audio interface circuit diagram
- Smartphone Integration circuit diagram
- DVD changer circuit diagram

Note: The Top HiFi System refers to the Premium-HiFi System.

F01/F02 Audio/Bus System Overview

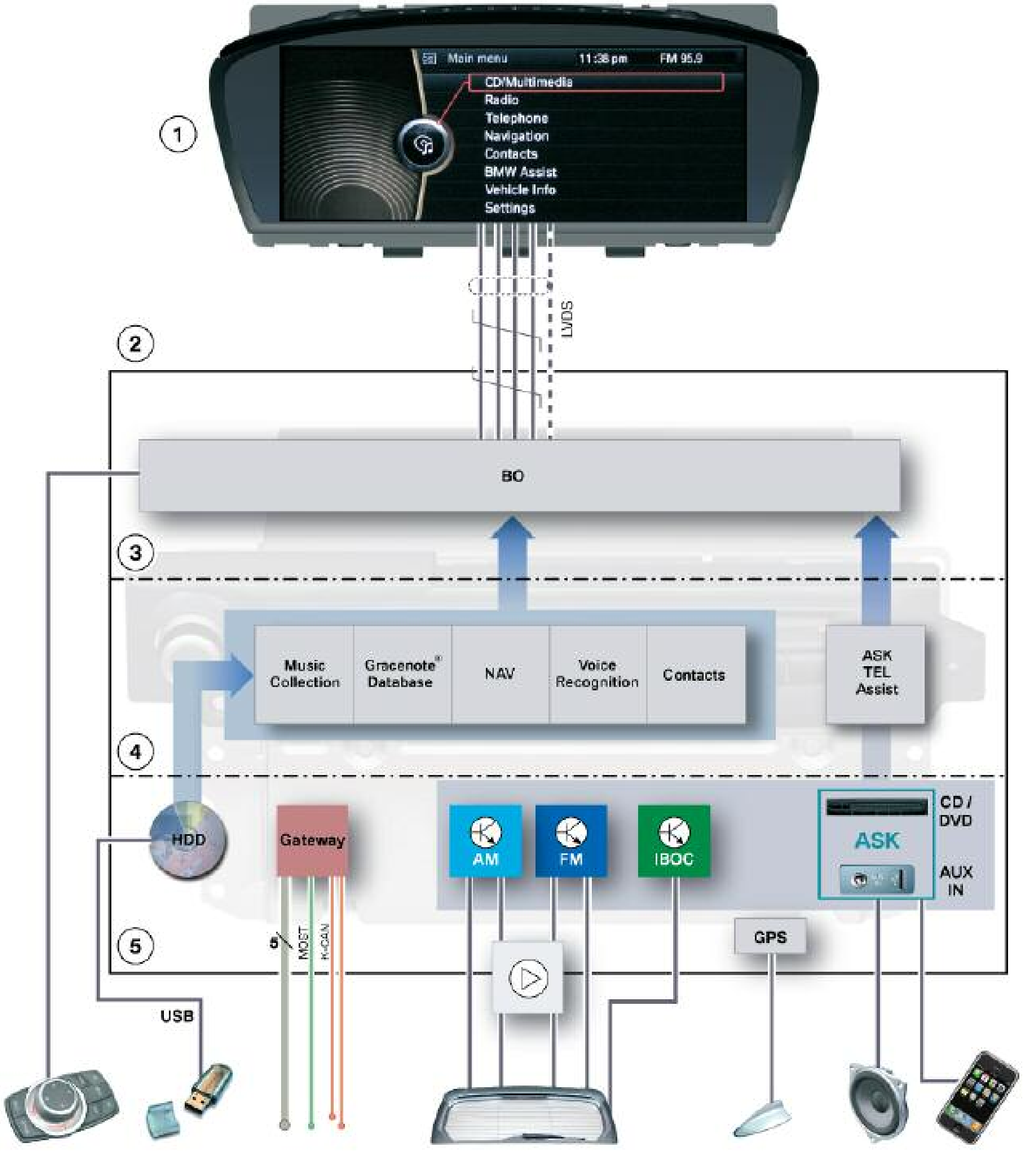


Index	Explanation
CAS	Car Access System
CIC	Car Information Computer
CID	Central information display
CON	Controller
DVD	DVD changer
FD	Rear-seat display
FD2	Rear seat area display 2
HiFi	HiFi amplifier
HKA	Automatic A/C, rear seat compartment
HUD	Head-Up Display
IHKA	Automatic climate control
KOMBI	Instrument cluster
OBD	Diagnosis socket
RSE	Rear Seat Entertainment
SDARS	Satellite tuner
TCU	Telematics control unit
TOP HIFI	Top-HiFi system
SBX High	ULF Interface box “High” (Bluetooth telephone, voice input and USB audio interface)
VSW	Video switch
ZGM	Central gateway module

Key to abbreviations - bus overview

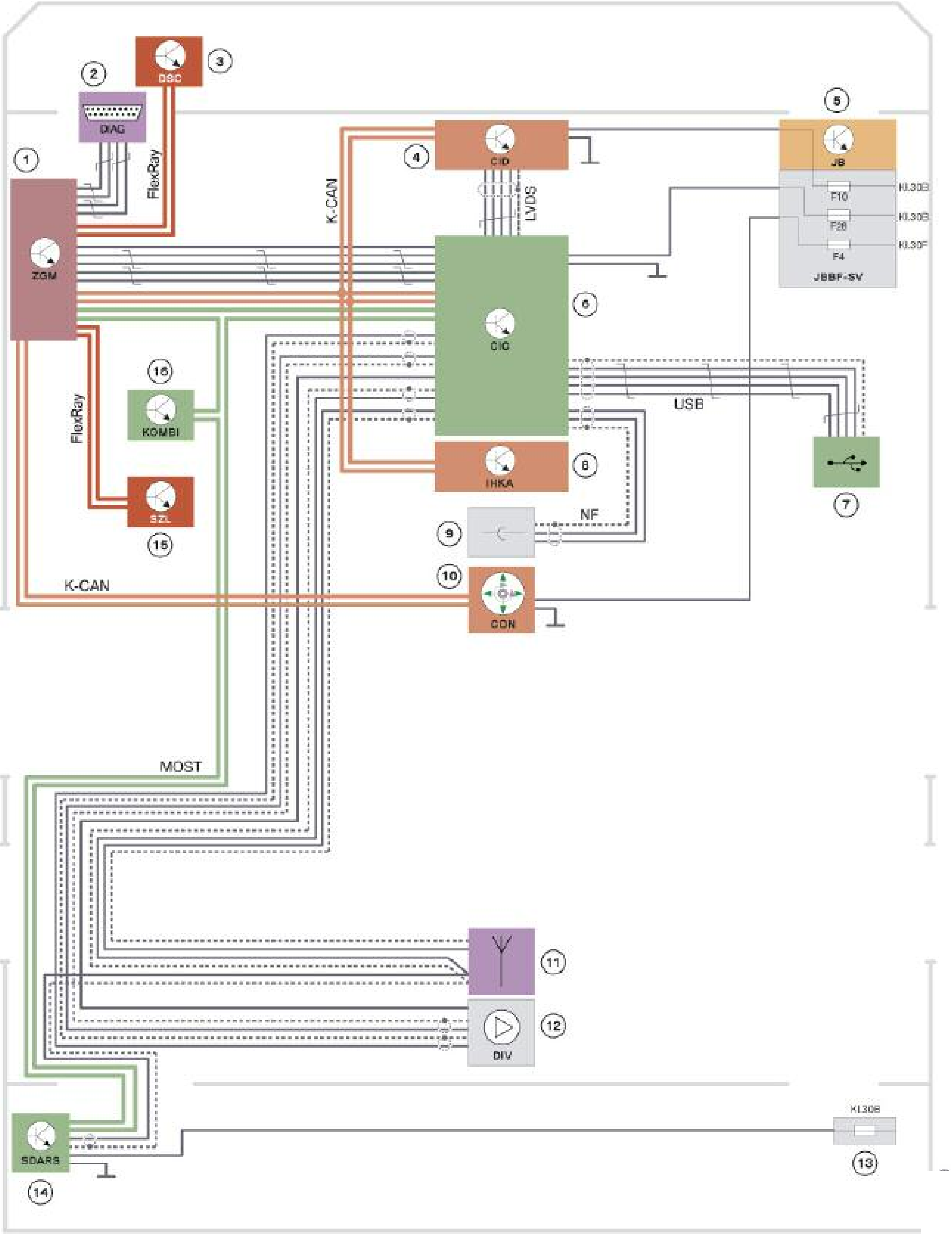
Index	Explanation
D-CAN	Diagnosis CAN
K-CAN	Body CAN
K-CAN 2	Fast body CAN
MOST	Media Orientated System Transport
PT-CAN	Powertrain CAN
PT-CAN 2	Powertrain CAN 2

Block Diagram of Head Unit CIC



Index	Explanation	Index	Explanation
1	Central Information Display (CID)	4	Application software
2	Car Information Computer	5	Hardware and interfaces
3	User interface application		

CIC Head Unit Circuit Diagram



Index	Explanation	Index	Explanation
1	Central gateway module	12	Antenna amplifier with diversity
2	Diagnosis interface	13	Rear power distribution box
3	Dynamic stability control	14	SDARS satellite radio tuner
4	Central information display	15	Steering column switch cluster
5	Junction box electronics module with power distribution box	16	Instrument cluster
6	Car Information Computer	LVDS	Low voltage differential signalling
7	USB port in glove compartment	MOST	Media Orientated System Transport
8	Automatic climate control	USB	Universal serial bus
9	AUX-In connection in center console (jack plug)	FlexRay	FlexRay bus system
10	Controller	K-CAN	Body CAN
11	Roof antenna		

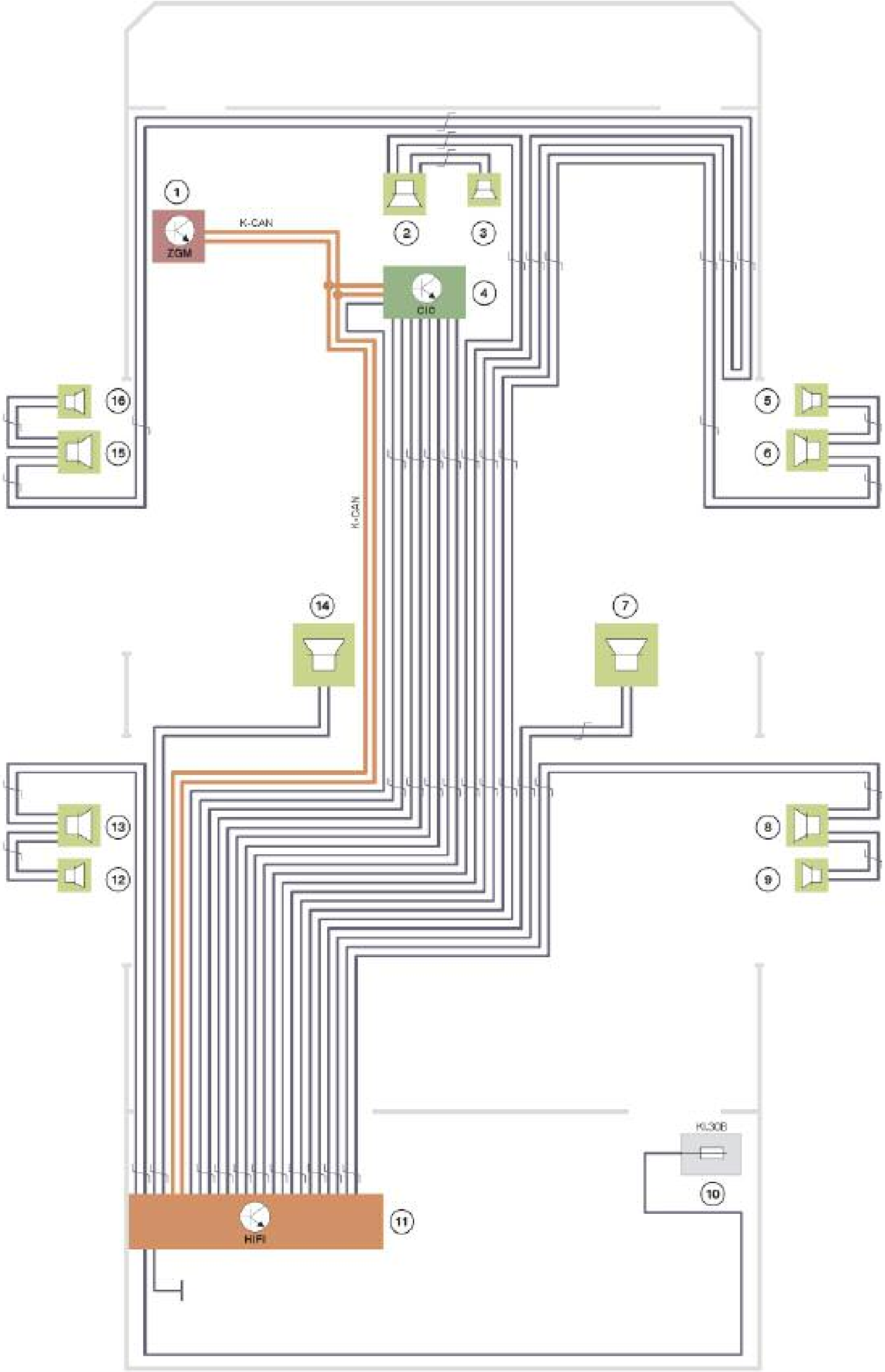
K-CAN signals at the CIC control unit, that are not defined in the system circuit diagram:

In/Out	Signal	Source/sink	Function
In	Speed signal	Wheel speed sensor > DSC > ICM > ZGM >	Speed-dependent volume control
In	Terminal status	CAS > ZGM >	Terminal control
In	Timer bus signal	Instrument cluster > ZGM >	Transfer of ambient conditions
In	Control	CON > ZGM >	User interface control
In	Kl. 58g	Light switch > FRM > ZGM	Button lighting/instrument lighting
Out	Rad_on signal	> ZGM > HiFi amplifier	Rad_on signal for HiFi amplifier

MOST signals at the CIC control unit, that are not defined in the system circuit diagram:

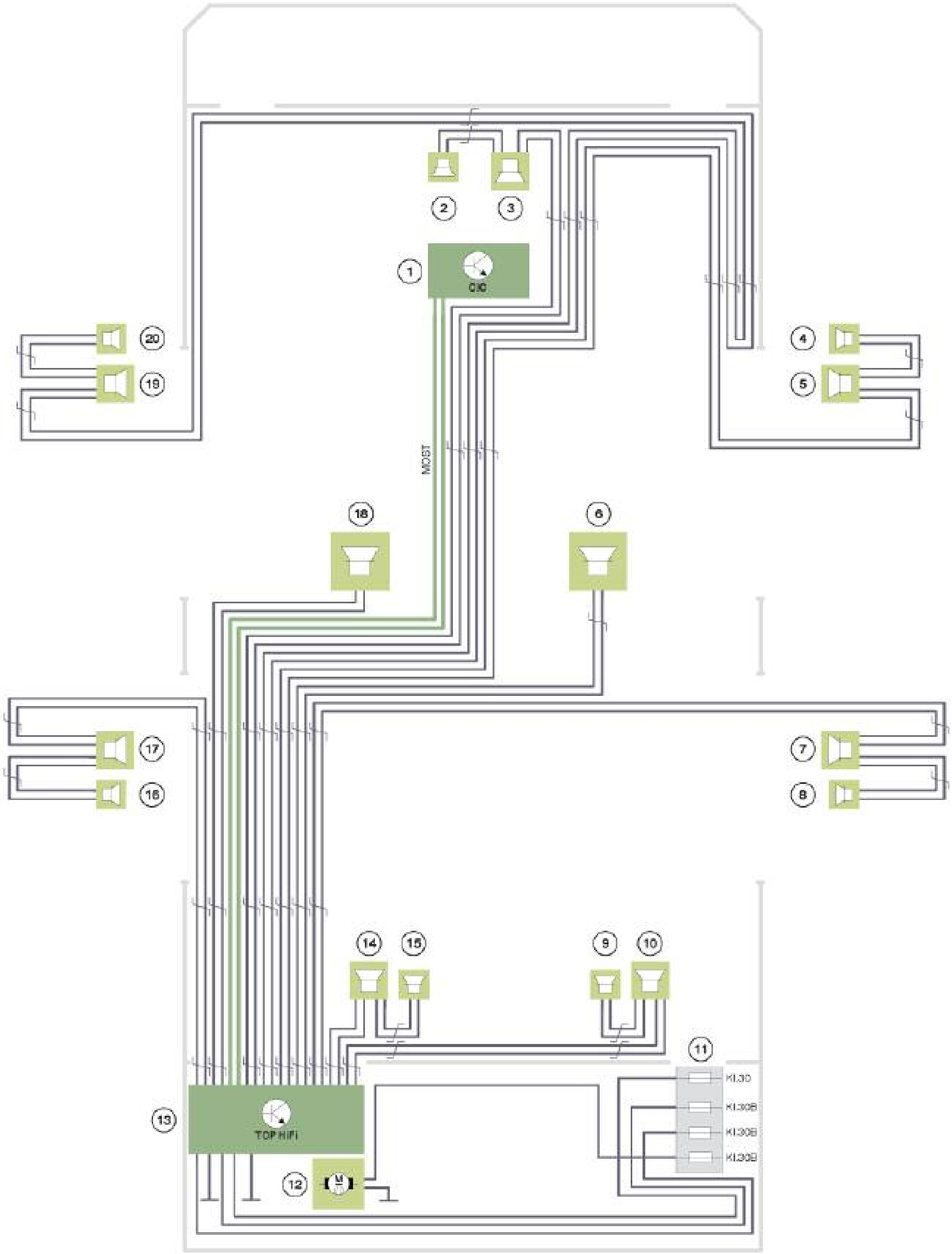
In/Out	Signal	Source/sink	Function
In	Decoded audio signals	DVD changer >	Speed-dependent volume control
In	Information	DVD changer >	Metadata (ID3 tags)
In	Date, time, language	Instrument cluster > ZGM >	Transfer of ambient conditions
In	Kl. 58g	Light switch > FRM > ZGM >	Button lighting/instrument lighting
In	Data, audio signal	ULB-SBX >	Data, audio signal, USB interface, Center console
In	Data, audio signal	ULB-SBX >	Data, audio signal, mobile phone in snap-in adapter
Out	Rad_on signal	> Top-HiFi amplifier	Rad_on activation signal for Top-HiFi amplifier
Out	Audio signals	>Top-HiFi	Audio signals (subsequently converted in Top-HiFi amplifier and output to individual speakers)

HiFi Speaker System Circuit Diagram



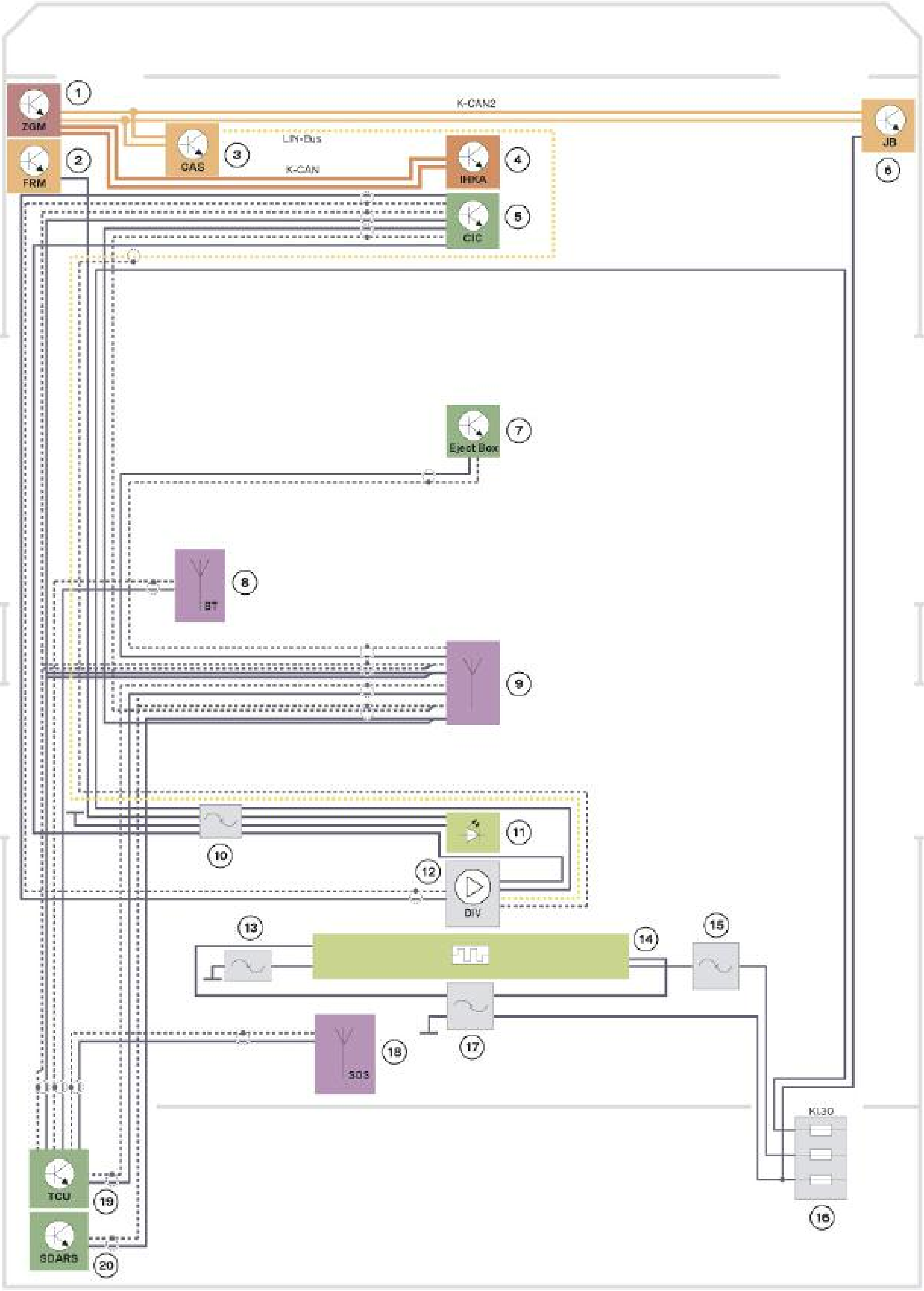
Index	Explanation	Index	Explanation
1	Central gateway module	10	Rear power distribution box
2	Mid-range speaker, front center	11	HiFi amplifier
3	Tweeter, front center	12	Tweeter, rear window shelf, left
4	Car Information Computer	13	Mid-range speaker, rear window shelf, left
5	Tweeter, front right door	14	Woofer, under left front seat
6	Mid-range speaker, front right door	15	Mid-range speaker, front left door
7	Woofer, under right front seat	16	Tweeter, front left door
8	Mid-range speaker, rear window shelf, right	K-CAN	Body CAN
9	Tweeter, rear window shelf, right		

TOP-HiFi Speaker System Circuit Diagram



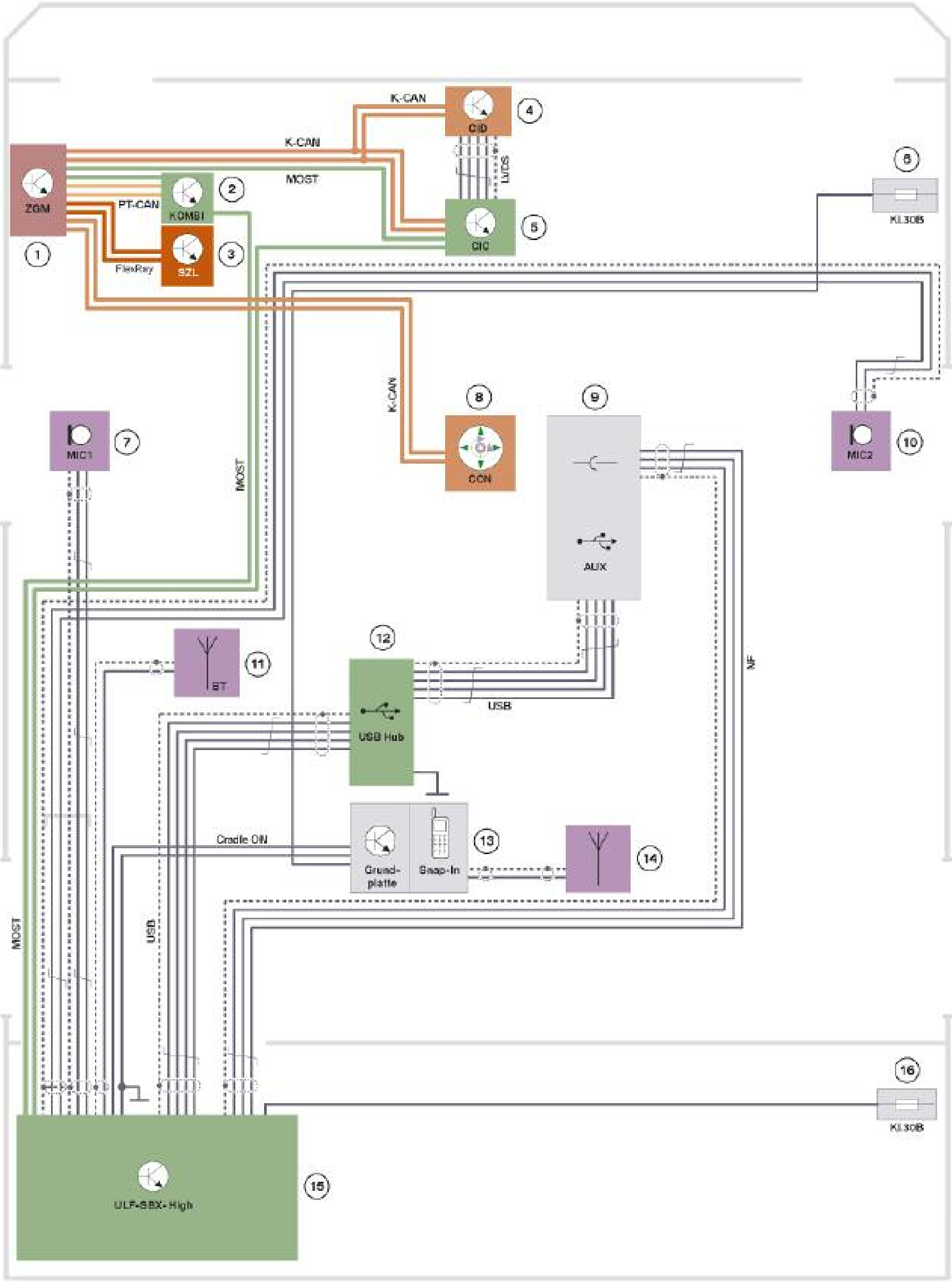
Index	Explanation	Index	Explanation
1	Car Information Computer	12	Axial-flow fan, TOP-HiFi amplifier
2	Tweeter, front center	13	Top-HiFi amplifier
3	Mid-range speaker, front center	14	Mid-range speaker, rear window shelf, left
4	Tweeter, front right door	15	Tweeter, rear window shelf, left
5	Mid-range speaker, front right door	16	Tweeter, rear left door
6	Woofer, under right front seat	17	Mid-range speaker, rear left door
7	Mid-range speaker, rear right door	18	Woofer, under left front seat
8	Tweeter, rear right door	19	Mid-range speaker, front left door
9	Tweeter, rear window shelf, right	20	Tweeter, front left door
10	Mid-range speaker, rear window shelf, right	MOST	Media Orientated System Transport
11	Rear power distribution box		

Antenna System Circuit Diagram



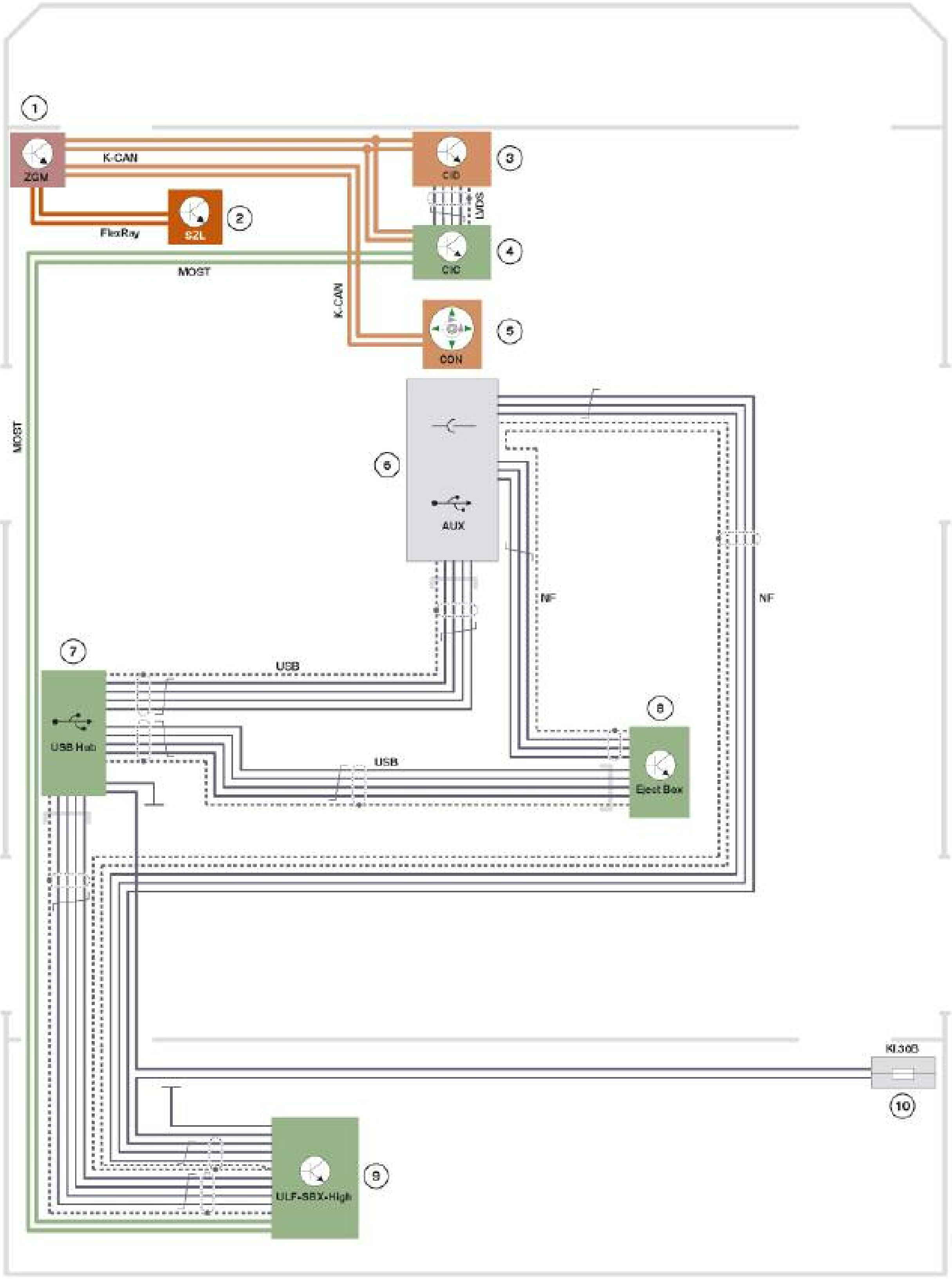
Index	Explanation	Index	Explanation
1	Central gateway module	13	Rejector circuit, rear window defogger_1
2	Footwell module	14	Rear window with individual FM/ AM antenna
3	Car Access System	15	Rejector circuit, rear window defogger_2
4	Automatic climate control	16	Rear power distribution box
5	Car Information Computer	17	Rejector circuit, rear window defogger for AM range
6	Junction box electronics	18	Emergency call antenna (backup)
7	Base plate of universal charging and hands-free (Not for US)	19	Telematics control unit
8	Bluetooth antenna	20	SDARS satellite tuner
9	Roof antenna	K-CAN	Body CAN
10	Interference suppressor filter, rear brake light	K-CAN 2	Fast body CAN
11	Rear brake light	LIN	Local Interconnect Network
12	Antenna diversity		

USB/audio Interface Option Circuit Diagram



Index	Explanation	Index	Explanation
1	Central gateway module	12	USB hub
2	Instrument cluster	13	Not for US
3	Steering column switch cluster	14	Roof antenna
4	Central information display	15	ULF-SBX-High (6FL)
5	Car Information Computer	16	Rear power distribution box
6	Junction box	K-CAN	Body CAN
7	Microphone, left side of vehicle	PT-CAN	Powertrain CAN
8	Controller	FlexRay	FlexRay bus system
9	AUX-In connection combined for USB connection + jack plug	MOST	Media Orientated System Transport
10	Microphone, right side of vehicle	LVDS	Low voltage differential signal
11	Bluetooth antenna		
12	Antenna diversity		

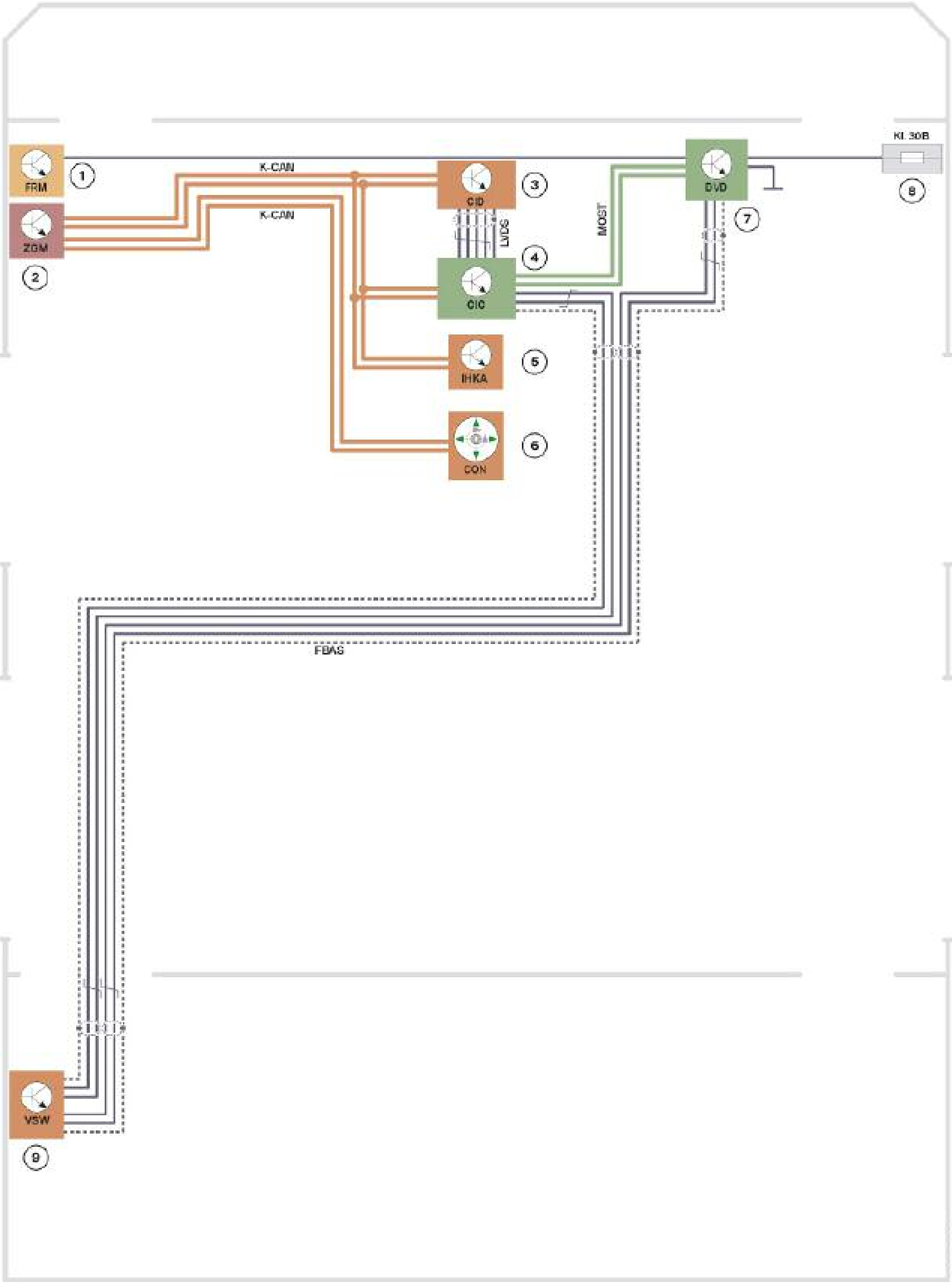
Smartphone Integration Option Circuit Diagram



Index	Explanation	Index	Explanation
1	Central Gateway Module	9	ULF-SBX-High (6FL)
2	Steering column switch cluster	10	Rear power distribution box
3	Central Information Display	K-CAN	Body CAN
4	Car Information Computer	K-CAN 2	Fast body CAN
5	Controller	FlexRay	FlexRay bus system
6	AUX-In connection combined for USB connection + jack plug	MOST	Media Orientated System Transport
7	USB hub	LVDS	Low voltage differential signal
8	Base plate of universal charging and hands-free (Not for US)		

Note: Smartphone Integration uses a cradle to connect and play music stored in a mobile phone. Currently this feature is only available with the Apple iPhone®.

DVD Changer Circuit Diagram



Index	Explanation	Index	Explanation
1	Footwell Module	8	Junction box
2	Central Gateway Module	9	Video switch
3	Central Information Display	K-CAN	Body CAN
4	Car Information Computer	K-CAN 2	Fast body CAN
5	Automatic climate control	FlexRay	FlexRay bus system
6	Controller	MOST	Media Orientated System Transport
7	DVD changer	LVDS	Low voltage differential signal

Comparison of CIC with CCC

The ASK system was installed in E65/E66. With the E60, ASK developed into M-ASK and the further developed CCC which was available as an option.

The multi-audio system controller M-ASK is the central control unit of the information and communications systems. The M-ASK combines up to four control units in one.

The M-ASK combines the following control units in one housing:

- ASK
- Antennal amplifier/tuner
- MOST CAN gateway, interface to control display

In the E65, these modules were separate control units.

The car communication computer CCC is the central control unit which combines the functions of the M-ASK, plus some additional functions.

Voice control of the systems and the navigation system with map presentation were made possible with the CCC.

The CCC also contains the driver for the rear passenger compartment display.

The CCC performs all the functions of the M-ASK as well as offering Navigation and additional programming possibilities.

As part of this development from the ASK to the CCC system, the radio tuner, navigation, voice recognition and actuation as well as video signal processing were integrated in the CCC.

A comparison is repeatedly made in this training information between the predecessor, Car Communication Computer head unit and the new CIC head unit.

Note: For further information on the CIC refer to the Vehicle Owner’s Manual and the CIC training material available in TIS and ICP.

The following table shows a comparison between the previous menu items of the CCC (bold print) and the menu items of the CIC (bold print).

CCC main menu		CIC main menu
		
Communication	=	**Telephone**
Telephone		Telephone
A-Z		Telephone/Phonebook
Telephone => Phonebook Navigation => Address Book	=	**Contacts** (imported/self-entered contacts)
Communication	=	**BMW Services**
Assist services		BMW Services
Navigation	=	**Navigation**
Navigation, onboard information, BC	=	**Vehicle information**, onboard computer
Air conditioning (climate control)	=	Settings (limited)
Entertainment	=	**CD/Multimedia**
CD, DVD, CDC		CD/DVD
Radio (FM, AM, IBOC)	=	**Radio** (FM, AM, IBOC)
Not available		Music collection (on hard disk)
Settings (5th menu)	=	**Settings**
Audio		Sound
Display screen		Central screen
Time/Date		Time/Date
Language		Language/Units
Vehicle/Tires	=	**Vehicle information**/Vehicle status
Service	=	**Vehicle information**/Vehicle status
Vehicle Owner’s Manual only paper form	=	**Vehicle Owner’s Manual (Dital Form)**

The star-shaped operating concept of “**Turn-Press-Push**” of the CCC has been further developed in the CIC.

The sub-menus in the main menu now are arranged in lists.

All listed sub-menus can be accessed in the start menu by “**turning**” and “**pressing**” the controller.

Several sub-menus can now also be selected by means of the direct access buttons on the controller.

The windows of the selected submenus are placed horizontally one over the other.

Display

The display used for the Car Information Computer is the same CID (Central Information Display) known from the CCC.

In the F01/F02, the screen size has increased to a diagonal of 10.2” (26cm).

The number of pixels has doubled in the CID from 640x240 pixels for the CCC display to 1280x480 pixels in the CIC central display.

The new display delivers a crisp and improved picture quality compared to the previous system.

The graphic layout of the user interface has been totally redesigned.

The rear view of the F01/F02 control display is shown in the following with the two connections.

Front view of control display F01/F02

Rear view of control display F01/F02

Index	Explanation	Index	Explanation
1	Connection 2-wire LVDS input signal, connector color: Bordeaux red	2	Connector power supply, K-CAN connector color: Black

Controller

The second most inportant hardware component of the BMW iDrive system is the controller.

The new controller has been completely redesigned compared to the CCC controller.

The most noticeable new feature of the CIC controller are the seven direct access buttons.

It is now possible to access the following menus directly:

- Main menu
- CD/Multimedia
- Radio
- Navigation
- Telephone

The following menus can still only be selected from the main menu,
i.e. with no direct access:

- Contacts
- BMW Services
- Vehicle information
- Settings

The “Back” button is pressed to go back to the last display view. Up to 30 “back” steps are possible with this button.

The option button makes it possible to make fine adjustments or carry out special functions in the sub-menu last selected.

The direct access buttons replace the “long push” function. With this function is was possible to change from a sub-menu directly to another sub-menu in the CCC by pushing the controller in the corresponding direction for at least two seconds.

The respective sub-menus are now selected directly by pressing the CD/multimedia, radio, navigation or telephone buttons twice.

Controller of the CIC

Index	Explanation	Index	Explanation
1	Direct access button for Main menu	5	Direct access button for Options sub-menu
2	Direct access button for CD/Multimedia	6	Direct access button for Navigation
3	Direct access button for Radio	7	Direct access button for Telephone
4	Direct access button to go Back		

CD/Multimedia

In terms of their functionality, the CD/DVD, external devices and sound submenus located under CD/Multimedia are similarly configured as the iDrive “Entertainment” menu of the CCC.

This training material mainly deals with the **Music collection** selection menu. The other selection menus are described in detail in the Vehicle Owner’s Manual.

With the music collection, it is possible to store music data within the CIC on an 80GB hard disk. A total of 12 GB is reserved for the music collection, corresponding to about 3700 music tracks.

A **music search** function has been implemented, which searches for information (metadata) on the individual music tracks (artist, album, etc.).

A music track database (Gracenote®) provides further information to the music track (metadata). This takes place as a supplementary function to the conversion process from Digital Audio CD to a WMA file. A storage space of 4 GB is reserved for this purpose on the CIC-internal hard disk.

CD/Multimedia sub-menu with “Music collection” checked

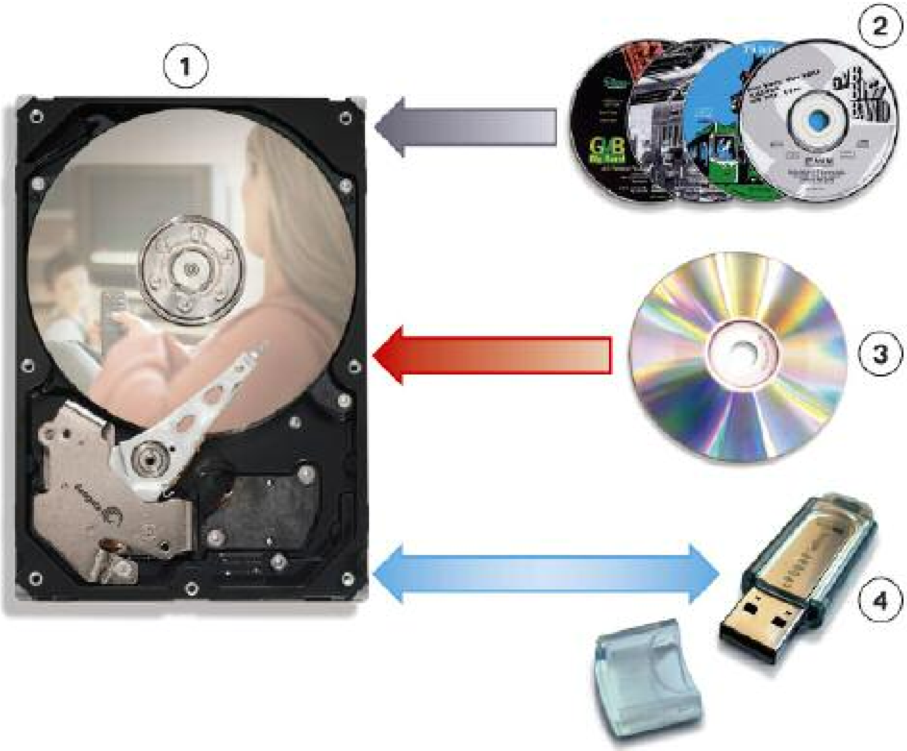
Storing Music Data on the HDD

The music collection is stored in a partition on the internal hard disk drive (HDD) of the CIC. This device makes it possible to store a large selection of music data in the vehicle, while allowing the option to retrieve it when necessary.

Up to 12GB of the total 80 GB hard drive is set aside for the music collection.

The following three options can be used to store music data on the hard disk:

- Rip function from Compact Disk Audio format
- Copying data via the CD/DVD drive
- Copying data from the USB



Index	Explanation	Index	Explanation
1	Hard disk (HDD)	3	DVD/CD ROM with compressed audio data (WMA, CDA, MP3, AAC)
2	Commercially available audio CDs (Compact Disk Digital Audio CDA)	4	USB stick

■ Rip Function

This function rips commercially available audio CDs (marked with the Compact Disk Digital Audio logo) and converts them to compressed music files.

This function can be performed when the vehicle is stationary or while driving.

The music on the CD can also be played back during the conversion and storage process of the rip function.

The music data is converted at a speed between 3 and 12 times the playback speed. Following the conversion the music data is stored on the hard disk in WMA file format.

The data is then displayed in the form of file folders in the music collection menu. These folders are identified with the corresponding title and with a round CD icon.

After the conversion process the files will be displayed and can now be selected individually by using the music search function.

Start of rip function for a loaded Digital Audio CD

Music data (WMA) of a Digital Audio CD stored in the music collection

Copying Data via the CD/DVD Drive

Self-recorded CD/DVD ROMs with audio files in MP3, WMA or AAC (M4A) format can be read, copied and stored using the DVD player (drive).

All CD/DVD formats (from CD-R to DVD Double Layer) are supported, except for CD-RAM and DVD-RAM.

The audio data is then stored in the form of file folders in the music collection together with the title of the respective CD/DVD ROM.

If the CD/DVD ROMs are untitled, they will be stored as "Audio-CD 1", "Audio-CD 2", etc. To facilitate identification, a folder icon is shown next to the file folder.

Copying a music file from a CD-ROM

Copying Data from the USB

Data contained on a USB stick (music files in MP3, WMA or AAC format) can be imported via the import/export USB port located in the glove compartment.

Copying music data from audio devices such as an MP3 players or iPods using the USB connection is possible although not advisable.

The folder and file structure of the player are also copied when copying music files from an audio player (MP3 player, iPod®). In this case, the copied folder names are represented by means of cryptic characters instead of al album title. This makes a subsequent search for a music file virtually impossible.

Copying USB music file using the import/export music feature

USB Import/export interface in glove compartment of the F01/F02

The imported USB music data is stored in file folders with USB 1, USB 2 etc. in the music collection. These folders are also shown together with a folder icon as the files copied through the DVD drive.

Copied USB1 folder Stored in the Music Collection Menu

Compatible USB sticks must be FAT formatted and must support the Mass Storage Class USB protocol. The format can be easily checked on any PC running the Windows operating system.

The file system (FAT 16, FAT 32 or NTFS) is shown under properties of the USB stick in the Windows Explorer. The protocol which is used is shown by clicking the hardware icon in the windows information area.

When using a USB stick device with several partitions, the music data files must be located in the first partition in order to be recognized and processed.

USB hard drives, USB hubs and USB memory card readers with several slots cannot be read when connected to the USB jack in the glove compartment and therefore can not be used.

Depending on the USB lead used, the mass storage device may be able to be charged through the USB interface. However, the power consumption of the mass storage device must not exceed the maximum level of 500 mA permitted.

It is recommended that when charging a storage device, only the USB audio interface in the center console be used and not the USB in the glove compartment.

Note: The USB interface in the glove compartment is only intended for the import and export of data (music or personal profiles) to and from the vehicle.

File System

The folders of the converted or copied music files can subsequently be renamed in the “Options” menu.

For this purpose, the corresponding album entry must be marked in the music collection and then the “Options” menu selected.

It is important to note the following when coping music files with Digital Rights Management (DRM) protection to the music collection:

- AAC music data in the M4P format (P = Protected) cannot be copied to the hard disk.
- Only music data in WMA format with copy protection can be copied.

This data will be shown in the music collection and in the music search. However, these protected tracks **cannot** be played. The track will be “skipped” or ignored and a different non-protected music track will be played.

The reason for this is that it is not possible to provide purchaser authentication in the CIC because a link to the online provider cannot be established. It is suggested that the customer import the audio files using a self recorded Digital Audio CD.

All music download portals allow the creation of a Digital Audio CD for the downloaded music track. However, the number of copies that can be created is limited by licensing legislation.

Data Saving (Backup)

The customer has the option of saving his/her complete music collection under the "Options" sub-menu. This is achieved by copying it back to a USB stick installed in the glove box port. It is necessary to ensure that the USB stick has sufficient storage capacity. A maximum storage capacity of 12 GB is required for saving the music collection data.

Import/export submenu screen shot showing how to back up music files

The process is similar to the data saving procedure on a PC. This function makes it possible to import data when changing vehicles or when replacing a head unit or hard disk.

Data saving will only be possible if the hard disk of the CIC has not been damaged and the interfaces to the CIC are still fully operational.

Data back up should be done prior to programming the vehicle after replacing control units. Without data saving (backup), all of the music data could be lost. However, this can only be done by the customer prior to bringing the vehicle in for service. Detailed instructions on how and where the data backup can be performed are provided in the Vehicle Owner's Manual.

WARNING!!!

For copyright reasons, the service personnel are not permitted to perform the data backup for the customer. The service personnel, can, however, instruct the customer on how to perform the backup procedure.

Music Search

The "Music search" sub-menu is provided in the music collection for the purpose of managing a large quantity of music files.

The music search takes place in accordance with a special filtering process. The search can be started at any menu item in the music search. For example, if the menu item "Genre" is selected as the starting point, all albums of all artists together with all the tracks in this music direction will be made available for selection.

In the next step, only the artist is selected and all his/her albums are displayed.

The search is now filtered further with each step until at the end, only the required entry remains.

The information for the music search is stored in the form of a metafile, similar to the ID3 tags of an MP3 file.

An example of how these metafile or meta information could appear is shown below:

Music search	Search for:	Example
1	Genre	Rock
2	Artist	Queen
3	Album	Greatest Hits II
4	Track	A Kind Of Magic

Music collection menu with a stored album selected

"Genre" selected in the Music Search sub menu

Data management is achieved with the aid of a music track database.

The music track database information is stored on the hard disk of the CIC for the purpose of managing the music file's metadata. A 4 GB partition is allocated to the music search function.

The CIC is equipped with special software provided by Gracenote® for the purpose of identifying the complete albums of ripped Digital Audio CDs. It provides additional information about the music track on the respective Digital Audio CD converted to WMA files.

This music track database (Gracenote®) uses TOC (Table of Contents) as the identification pattern. This means, complete albums on Digital Audio CDs are identified based on the number of tracks and the track length.

The corresponding data (track, artist, etc.) is then accordingly assigned to the music files in the music search database.

On conclusion of the conversion procedure to WMA files, the new metadata is automatically added to the directory structure in the music search. It is not possible to rename or edit this metadata after it is in the hard disk.

Note: Albums with newly released metadata at the time of vehicle delivery will no longer be identified. The music track database would require a permanent link with the server in order to keep this data up to date and this is not possible.

Unrecognized metadata of Digital Audio CDs is stored in the music collection as "Audio-CD 1", "Audio- CD 2", etc., together with the CD icon.

The metadata for the music track database from copied CD/DVD-ROMs or USB sticks is adopted identically in the music search function. This metadata does not stem from the music track database but rather from the user/customer himself.

The metadata, copied from a USB stick or CD/DVD ROM, cannot be renamed in the CIC.

In order to correct the faulty metadata on a track or file, the file must first be deleted from the hard disk in the CIC.

The user can then rename or add to these metadata files corresponding to the music track database structure (genre, artist, album and track) by using software on a personal computer.

When the file is imported back into the CIC hard disk, the correct metafiles will be displayed. This procedure also ensures that the music search will also find the copied music data with the music track, artist, etc.

Updating unknown music tracks is only possible with WMA files from ripped Digital Audio CD. If the user/customer does not follow this procedure, in time the music search will become unusable.

A “current” version of the music track database is stored in the vehicle on delivery.
The information about music CDs (Digital Audio CDs) released after the vehicle delivery will not be found in the vehicle's music track database.

Note: If the metadata is not found because the Gracenote database in the CIC is outdated, the tracks will not be recognized.

Updating the (Gracenote®) Database

To keep the entire contents of the music track database (Gracenote®) up to date, BMW Service is equipped with the latest CD of the music track database (Gracenote®).

This update takes place in connection with the media package, which also contains the Gracenote Update CD.

The CD can be loaded directly in the CIC drive and updated via the Service menu of the CIC (See Service Information).

The update of the music track database (Gracenote®) will become effective in the WMA music files only after subsequent conversions (rip function) of Digital Audio CD.

Metadata will no longer be added to files that were ripped before the update of the music track database (Gracenote®).

The reason for this is that the music track database is only accessed when a Digital Audio CD is loaded and subsequently ripped.

Gracenote Update CD

Radio

FM Stations

The layout of the "FM stations" in the Radio menu has been adapted to the new operating concept.

The former layout of the “All stations" list in the form displayed by the CCC has been replaced in the CIC by a list layout.

FM menu "All stations" in CCC

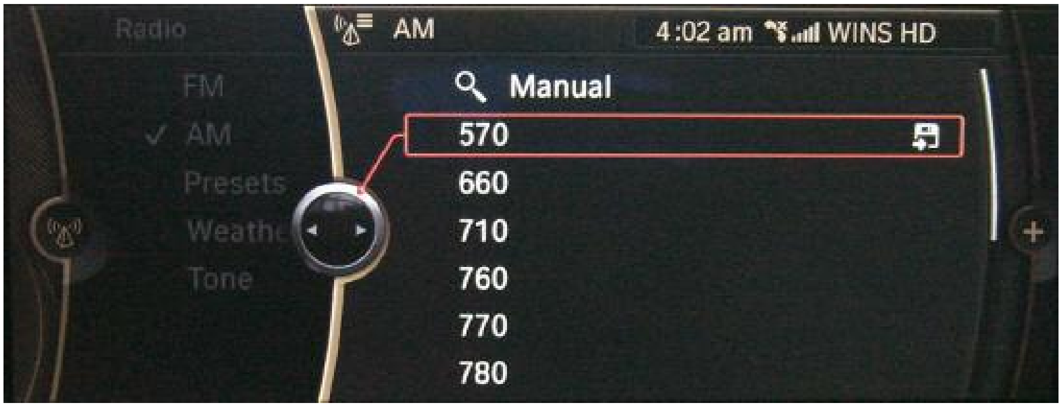
FM menu "All stations" in CIC as list

Manual station search in a CCC system

Manual station search in a CIC system

AM Stations

A double tuner has now made it possible to receive the "All stations" list in the AM range. However, no station information can be displayed because the RDS data is not transmitted for AM.



AM stations list

AM stations manual setting

IBOC

The IBOC functions in connection with the IBOC decoder which is now installed inside the CIC. IBOC makes it possible to receive digital radio signals. The IBOC components are described in detail in the "System Components" section of this training material.

SDARS

The Satellite radio service is available with a subscription to Sirius satellite radio. An example of how a station list would look like in the CIC with channels that have not yet been subscribed to is shown in the illustration below.

Station list with SDARS channels still disabled

Stored Stations

Under the menu item "Stored stations", the required stations from all frequency ranges can be stored in a common menu and then selected at a later time.

The following frequency bands are available for storage:

- FM
- AM (SW, MW, LW)
- IBOC

Stored stations

Settings Menu

The following settings options can be edited under the Settings submenu:

Head-up display	Brightness, picture position
Central screen	Brightness
Time/Date	Time, date, format
Language/Units	Languages
	Voice dialog: Standard/Short
	Fuel consumption: l/km, km/l, mpg
	Distance: km, mls
	Temperature: °C, F
Sound	Trebles, basses etc.
	Volume adjustment: Speed Volume
	Volume adjustment: Navigation
	Volume adjustment: PDC
	Volume adjustment: Gong
Limit	Setting limit, acceptance limit
Air conditioning (climate control)	Auxiliary heating, auxiliary ventilation
Lights	Home lights
	One-touch indicators
	Daytime driving light
	Welcome light
	High beam assistant
Door locking	Remote control key, lock automatically etc.
Luggage compartment lid	Adjust opening angle

Settings Menu

Favorite Buttons

CIC controller has eight favorite buttons.

The buttons have two operating modes:

- Short press : Activation of button assignments
- Long press: Storage of function currently shown in the CID

The long press function stores:

- The required audio media: Radio stations, CD, DVD player or DVD changer access
- Navigation destinations: However, they must already be stored under “Contacts” or entered from “Last destinations”
- Phone numbers

A new feature is that it is possible to assign all submenus such as “CD/ multimedia” or selection menus such as “Music collection” or “External devices” to the favorite.

System Components

This section describes the audio systems in F01/F02 vehicles.

It is subdivided into the following subsections:

- Head unit, Car Information Computer CIC
- Amplifiers and speakers
- Antennas
- Digital tuners
- Peripherals
  - DVD changer
  - USB/audio interface
  - Smartphone integration option

The new head unit (CIC) replaces the CCC head unit and is standard equipment on the F01/F02.

The IBOC digital tuner is now integrated into the CIC.

The navigation system is also integrated into the CIC. The navigation software and navigation map material are stored on the CIC internal hard disk.

The Car Information Computer can be combined with the following speaker and amplifier systems:

- HiFi system (676)
- TOP-Hifi system (677)

With the F01/F02 the antenna reception has been enhanced.

The satellite tuner “SIRIUS satellite radio” and IBOC digital radio for HD radio reception are optionally available.

A CD changer is no longer offered for the F01/ F02.

The single-slot DVD changer is offered on the F01 and F02. The DVD changer can accept up to six disks. The disks are inserted in the unit without the use of a magazine.

A USB/audio interface is also available as an optional extra. External audio and storage media are incorporated in the vehicle entertainment system via this USB/audio interface.

Devices such as the iPhone® can now be integrated in the vehicle network by means of the Smartphone Integration Option. With the mobile phone cradle it possible to navigate in the device menu and play back selected audio files. Although the device can also be connected with the USB Y-cable it is no longer necessary for this function.

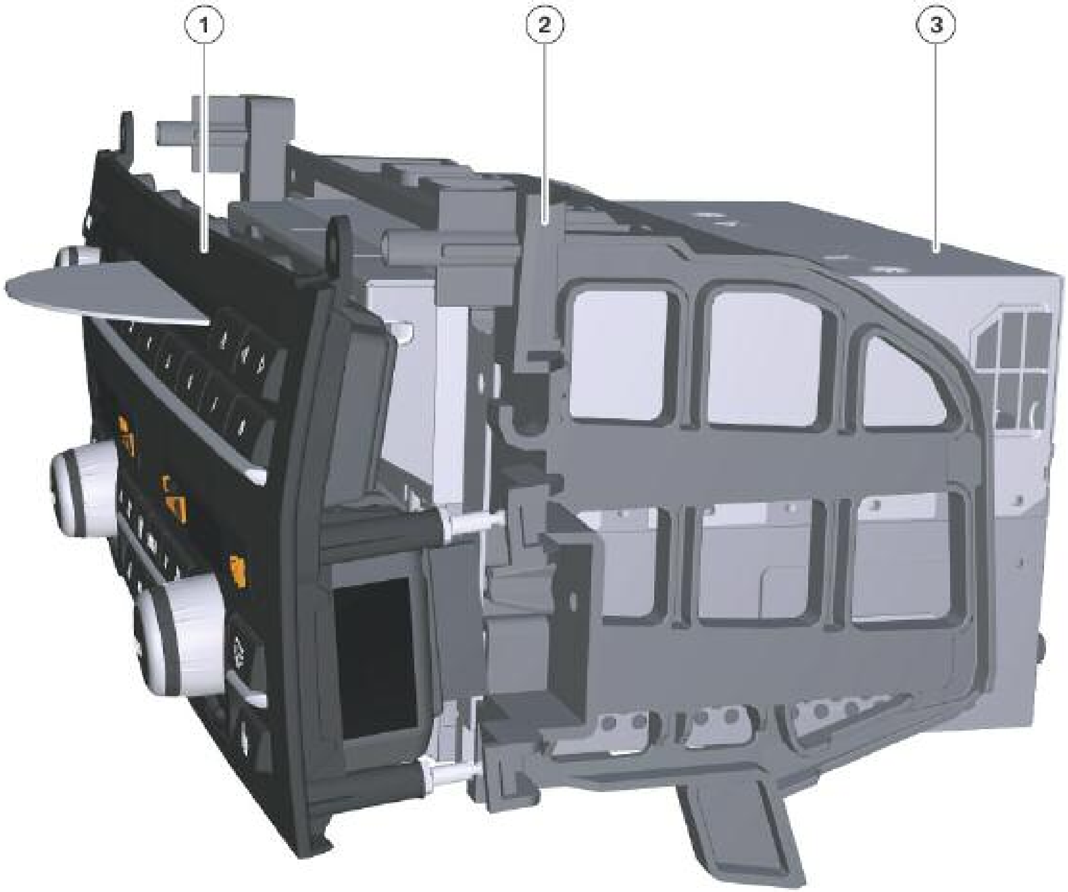
Car Information Computer (CIC)

The IHKA control unit is integrated into the IHKA/audio control panel.

The faceplate of the CIC is the common control panel for the main entertainment functions as well as for the heating and air conditioning functions.

The CIC and the IHKA/audio control panel are connected to the center console unit carrier.

Side view of IHKA/audio control panel



Index	Explanation	Index	Explanation
1	IHKA/audio control panel	3	Car Information Computer
2	Center console unit carrier		

Front view of IHKA/audio control panel of the F01/F02

Index	Explanation	Index	Explanation
1	Selector button for FM and AM	4	Eject button for DVD/CD player
2	MODE button for selecting audio sources	5	Station search/track "forward and back"
3	CD/DVD slot	6	Eight freely selectable Favosites buttons

Similar to a personal computer, the Car Information Computer contains a processor, RAM modules (= main memory) and extra peripheral components.

The following applications of the CIC are stored on the integrated hard disk:

- Music collection
- Music track database (Gracenote®)
- Navigation software (application)
- Navigation map material
- iSpeech (voice recognition system)
- Contacts (database with address book data)

The CIC is the central control unit for the listed applications. It is linked to the central information display (CID) for the purpose of transmitting and displaying information.

The Car Information Computer is also connected to the controller. The controller serves as a selection and input device for the user interface.

The CIC is based on a modular design. The most important systems of the communication network are integrated in the CIC board as solid state components.

The CIC combines the following control units in one enclosure:

- Navigation computer, HIP module and yaw rate sensor
- Tuner (FM)
- Tuner (AM)
- Tuner (FM-RTTI)
- IBOC decoder
- Audio system controller, and music search database
- MOST-CAN gateway
- Interface to control display (LVDS)

The upper half of the CIC consists of the optical drive player where CDs and DVDs of digital audio media can be played. The player also has ability to playback video DVDs on the front CID. The video signal is only displayed when the vehicle is stationary with the gear selection in the “Park” postilion.

For the navigation system, the optical drive can be used for updating the map material stored on the hard disk.

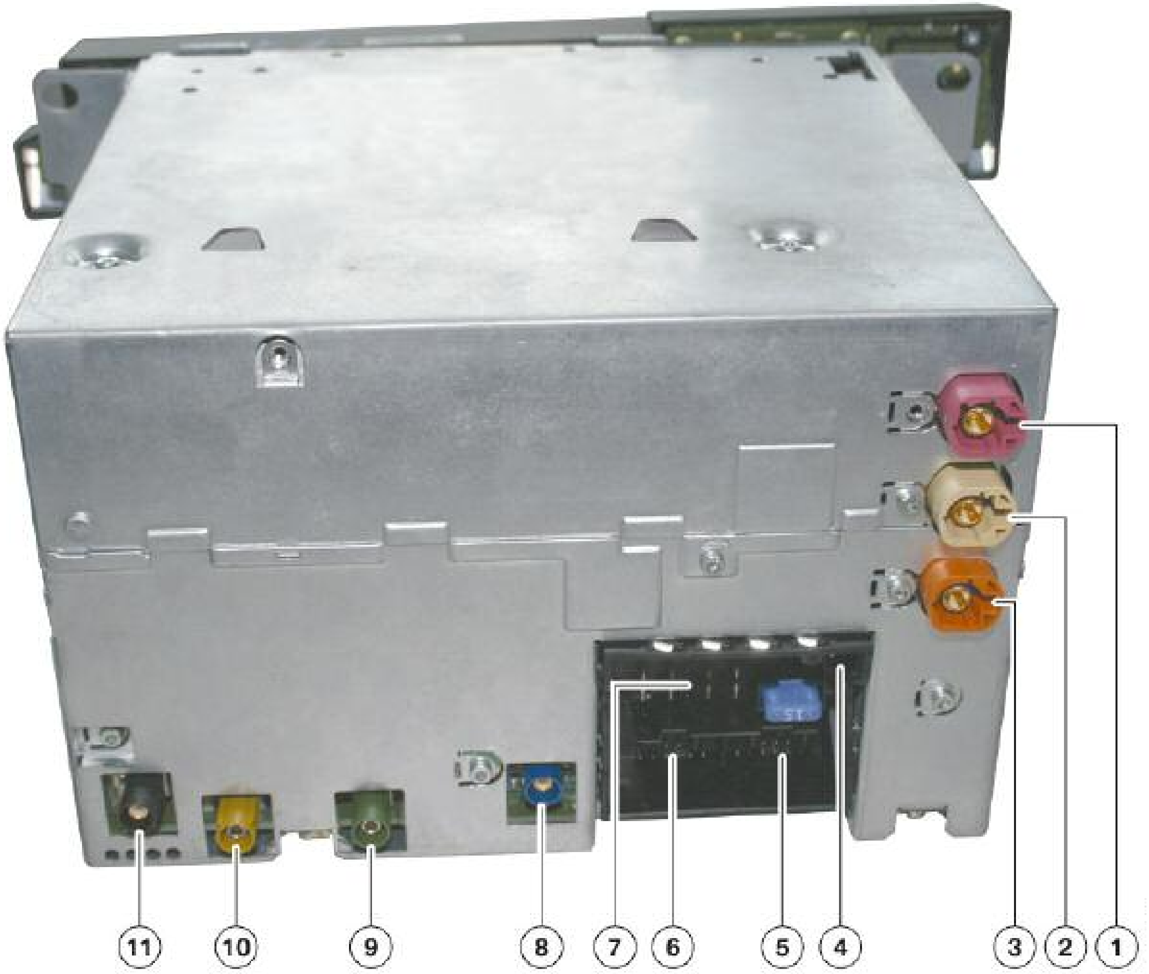
The processors for the main board and application board are located in the lower half of the CIC. This section also contains the main memory, the individual modules as well as the hard disk drive. The CIC together with the controller and CID, make up the iDrive system.

Advantages of the Car Information Computer

Combining several modules in one enclosure provides the following advantages:

- The combination of several systems enhances the functionality
- Outstanding software expansion options through suitable software interfaces
- Fewer plug connections increases reliability
- Less overall package space required for control units

Front view of IHKA/audio control panel of the F01/F02



Index	Explanation	Index	Explanation
1	LVDS signal for the CID; violet connector	7	16-pin connector (K-CAN, audio output AF; power supply, Rad-on signal)
2	USB connection for glove compartment beige connector	8	GPS antenna signal Blue connector
3	Ethernet connection (future expansion for rear seat entertainment) orange connector	9	Not for US
4	MOST connection	10	Not for US
5	12-pin connector; right-hand chamber (Ethernet, TEL_AF, AUX-In)	11	AM/FM tuner signal black connector
6	12-pin connector; left-hand chamber (video input signals - CVBS)		

LVDS Technology

The transmission of picture data from the CCC to the CID was performed by means of an 8-wire LVDS (low voltage differential signaling) line. With the introduction of the Car Information Computer, the video signal is now transmitted through a 2-wire LVDS line.

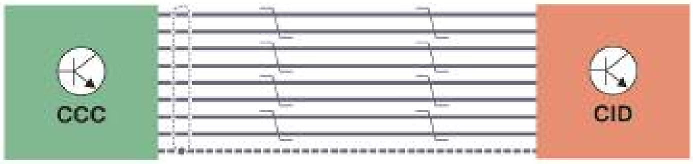
The change in picture data transmission in the vehicle reflect the changes made in PC technology. While the printer was formerly connected to the PC via a parallel cable, data transmission now takes place using serial USB technology.

In the following graphics, 8-wire LVDS technology is compared to the new 2-wire LVDS technology:

8-wire LVDS

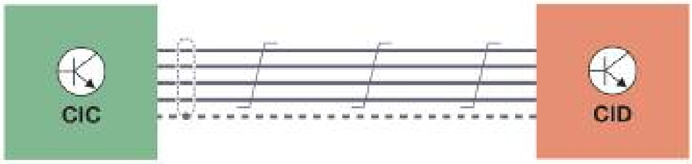
Transmission of video signals via 8-wire LVDS technology with CCC and CID.

(LVDS+ and LVDS- for each of the four signal lines and an additional synchronization line)



2-wire LVDS

Transmission of video signals via 2-wire LVDS technology with CIC and CID.



Signal transmission through this 2-wire LVDS line offers four distinct advantages:

- Higher data transfer rate
- Simplified wiring
- Runtime differences between the individual lines are avoided
- Serial 2-wire LVDS data transmission is now much more cost-effective than 8-wire LVDS technology

The main advantage of using serial 2-wire LVDS is the resulting high picture resolution.

A 4-core, shielded cable is used for the 2-wire LVDS technology. The cable consists of the four cores, LVDS+, LVDS-, 2x ground and shielding.

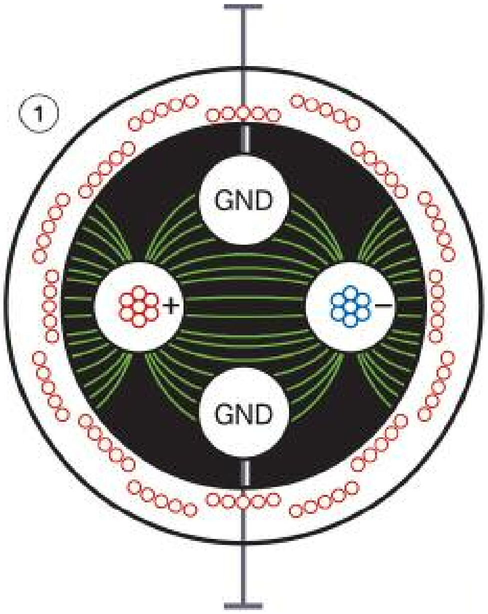
For Electromagnetic compatibility (EMC) reasons, the unused wire is also connected to ground.

In the illustration to the right, the advantages of both cores connected to ground are shown with the aid of field lines.

The capacitive interference of the signals is deflected to ground. The wires connected to ground form a defined potential and cannot act as antennas.

This ensures that additional interference is avoided.

Graphical Illustration of EMC protection using 2-wire LVDS technology



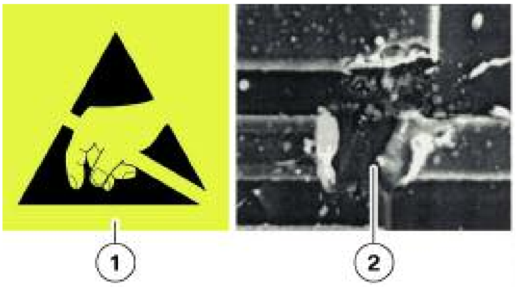
Index	Explanation
1	Two signal-carrying cores, two cores connected to ground

Electrostatic Discharge (ESD)

It is essential to follow ESD (Electrostatic Discharge) guidelines when replacing individual components in order to avoid damage to internal components of the CIC. These requirements also apply when storing or sending back components.

Special packaging (ESD bags, ESD boxes with film or foam material cladding) is available for this purpose and should be used instead of conventional packaging materials.

The following picture illustrates the effects of electrostatic discharge (ESD) on electronic components.



Index	Explanation
1	ESD symbol (protection measures necessary)
2	ESD damage to a conductor (magnified 5000 times)

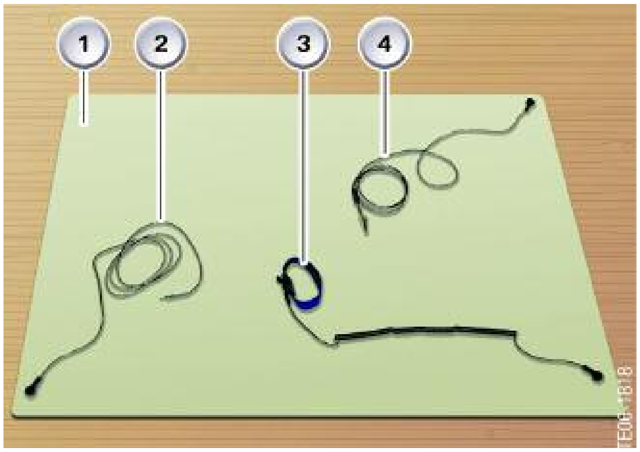
Effects of ESD (Electrostatic Discharge) on electronic components

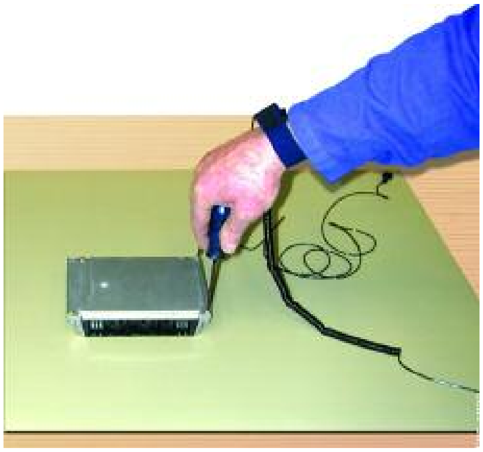
Working on Electronic Components

The following requirements must be observed when working on electronic components on the Car Information Computer.

- The work must be performed on a conductive and grounded workbench (special tool 12 7 192 is used for this purpose).
- The grounding cable must be connected to a secure grounding point (water pipe, heating pipe, electric socket ground).
- The person carrying out the work must first put on the grounding cuff in order to ground himself before removing the components from the packaging.
- The electronic components are placed on the anti-static mat which is also connected to a grounding cable.

Anti-static mat Special tool 12 7 192





Index	Explanation
1	Anti-static mat
2	Grounding cable for the mat
3	Anti-static cuff
4	Grounding cable for the component

CIC Components

The components listed above are defined as separate or modular. These components are attached to the main/complete head unit.

Of these components, only the faceplate remains a serviceable and replaceable component. Failure of any other internal component will necessitate the replacement of the entire CIC unit once proper authorization has been obtained through PuMA.

The functions of the individual components are briefly described in the following pages.

The installation and removal instructions for the individual components and the complete CIC control unit are available in TIS (Technical Information System) or the workshop system ISTA.

Individual components of the CIC on the F01/F02

Index	Explanation	Index	Explanation
1	DVD/CD player including CIC housing cover	3	Hard Drive Disk
2	Car Information Computer		

Optical Drive (CD/DVD Player)

The Car Information Computer is equipped with a DVD-ROM player.
The optical drive is used for playing audio and video media.

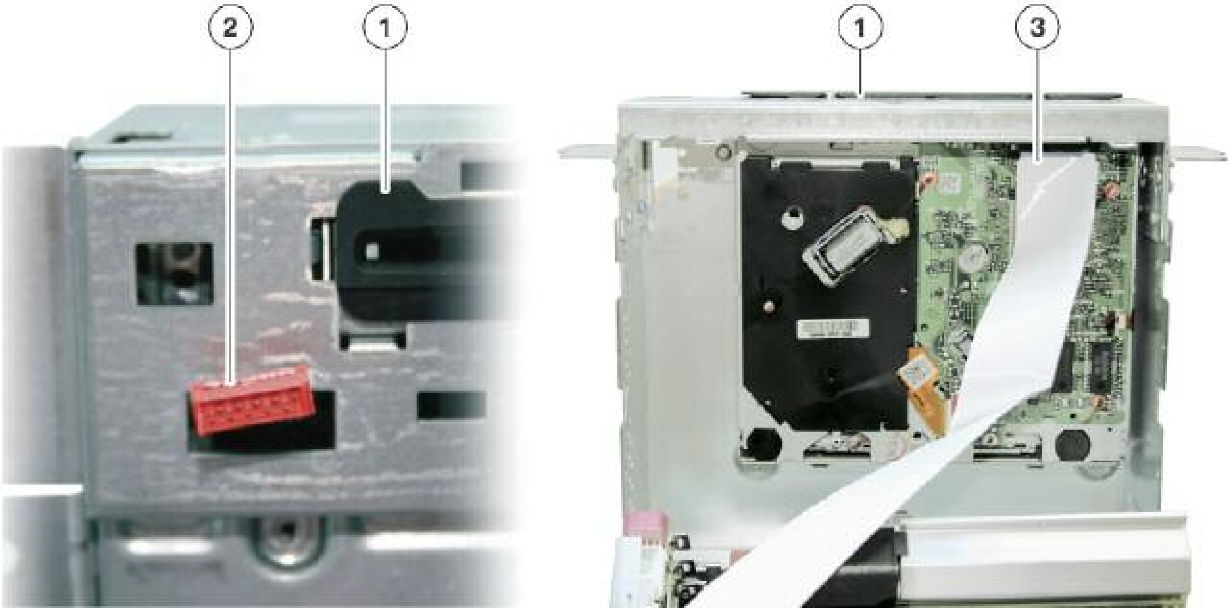
This drive makes it possible to play the following media file formats:

- Audio CDs (CD Digital Audio)
- Audio CD-ROM with MP3, WMA or AAC files
- DVD Audio (only stereo track if contained on the data medium)
- Audio DVD-ROM with MP3, WMA or AAC files
- Video DVD

Playing video on the (front) CID display is only possible when the vehicle is stationary with the gear selector in the “Park” position. When the vehicle is moving or in gear, only the audio track of the video will be played.

Although the CD/DVD drive is no longer used for the navigation system (as in CCC), it may be used to update navigation map data from a navigation DVD.

DVD player of the CIC



Index	Explanation	Index	Explanation
1	DVD player	3	Ribbon cable connection, DVD player to CIC head unit
2	Front panel connection		

Hard Disk Drive

With the development CIC, a hard disk for storing applications (programs) and data is used in a head unit of a BMW vehicle for the first time.

A 2.5" hard disk drive with a storage a capacity of 80 GB is installed.

This makes it possible to display complex graphics like 3D models in the perspective view of the navigation system.

This system provides the option of converting, storing and playing music tracks. The hard disk makes it possible to maintain a music collection with a music track database (Gracenote®).

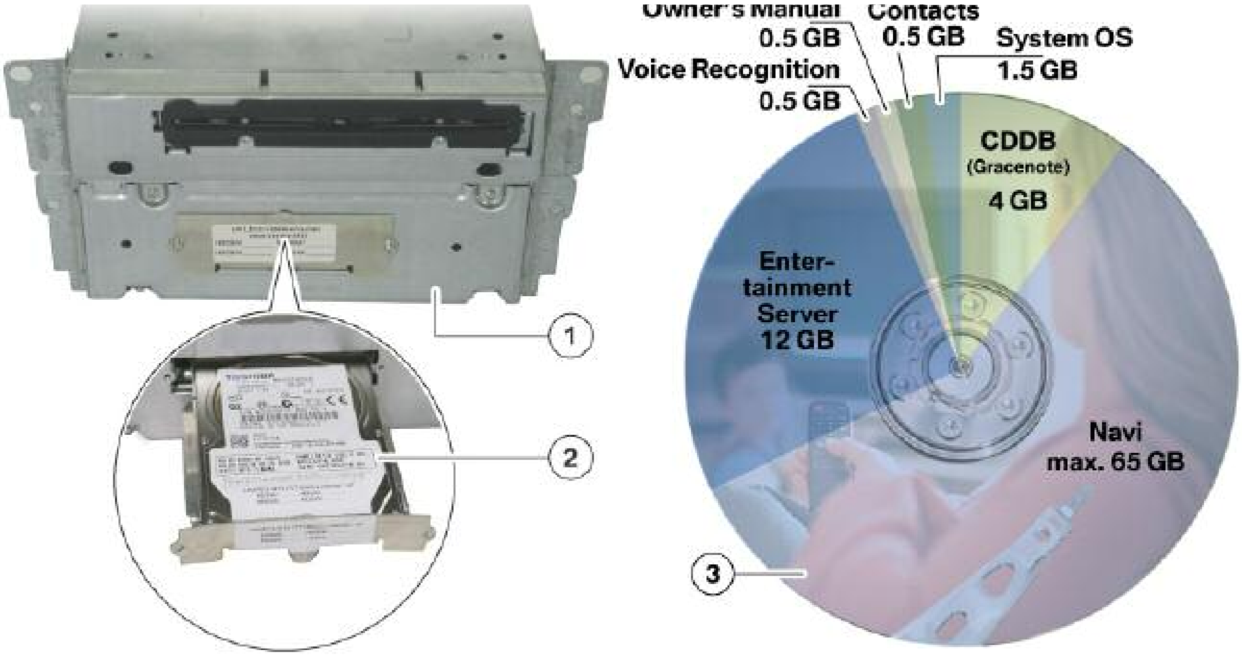
The HDD (hard disk drive) also provides a data storage option for the three languages of the voice recognition system.

The hard disk drive is a replaceable component of the CIC. Proper repair instructions and ESD guidelines must be followed when replacing the unit.

The Music collection backup should only be performed by the customer and not the service technician. For more information refer to “Music Collection Backup” in the Principles of Operation section of this training material.

The following illustrations show the hard disk location and the individual partitions.

Hard disk location and the individual partitions



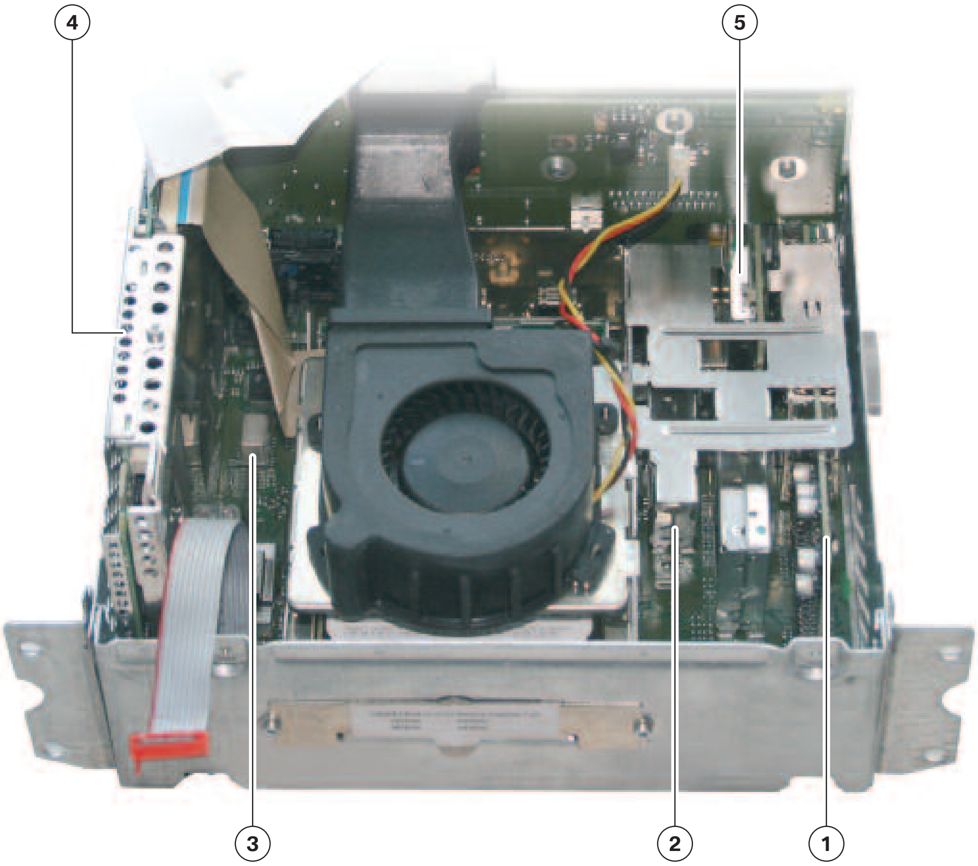
Index	Explanation
1	Car Information Computer
2	Hard disk (slide-in tray)
3	Pie diagram with individual storage units on the hard disk (partition)

Fixed Components

Some of the components that were modular in the Car Communication Computer are now integrated into the CIC as solid state components.

In the event of defects to some of the components, it may be necessary to replace the entire head unit after submitting a PuMA case.

Bottom open view of the CIC components

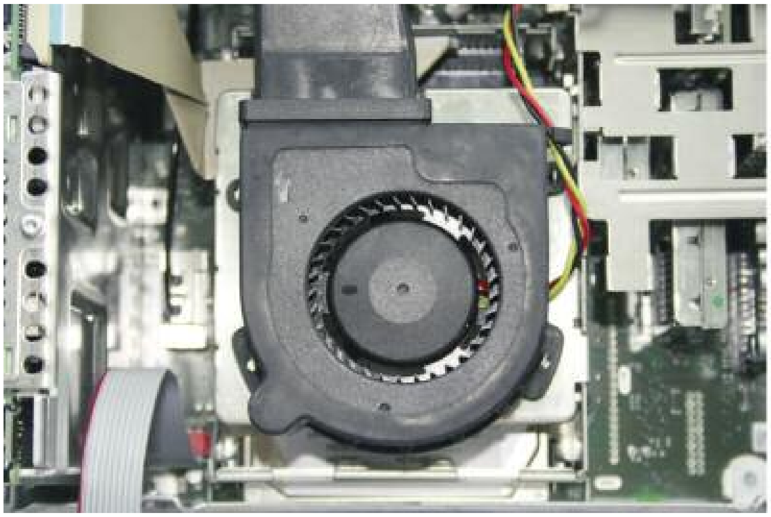


Index	Explanation	Index	Explanation
1	FM/AM double tuner module	4	Application board
2	IBOC decoder	5	FM - RTTI module
3	Yaw rate sensor		

Fan

Unlike with CCC, it is not possible to replace the fan of the Car Information Computer separately as part of a service procedure.

The fan provides cooling for the entire hardware assembly, including the hard disk drive and the gateway processor (located directly below it). The exhaust air cools the cooling fins of the HiFi output stage in the power board as it is routed through a cooling channel out of the unit.



CIC system's Cooling Fan location

GPS Receiver Module

The GPS receiver module is also known as the HIP module (Host Independence Positioning).

Location and route of the vehicle are calculated in the navigation system with the data from the GPS receiver module.

This module was already integrated in the head unit with the CCC system. It has the task of converting the signals received from the GPS antenna together with the data from the DSC control unit and yaw rate sensor.

The following information is calculated in the GPS receiver module:

- Longitude
- Latitude
- Altitude above sea level
- Direction (bearing)
- Speed

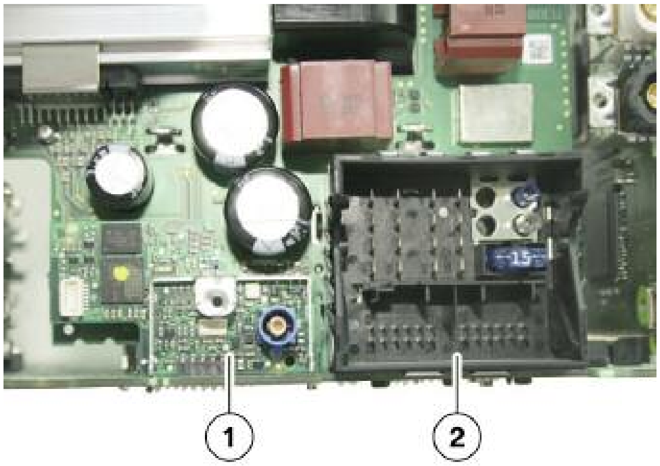
This information is known as Almanac data and it is transferred to the navigation system for further processing. The Almanac data must be permanently stored for future reference. One of the reasons for this is that it takes a long time for data to be received again from satellites after switching to terminal 15 from terminal status ignition "OFF".

This Almanac data ensures the position of the vehicle is recognized immediately after starting the vehicle. Therefore the navigation system can also be used immediately.

Compared to the GPS receiver module of the Car Communication Computer the GPS receiver module in the CIC has been greatly reduced in size while maintaining the same functionality.

The graphic shows the size of the GPS receiver module compared to the main connection plug of the head unit.

Index	Explanation
1	GPS receiver module
2	CIC main connection plug



CIC system's GPS receiver size compared to the Main Connector

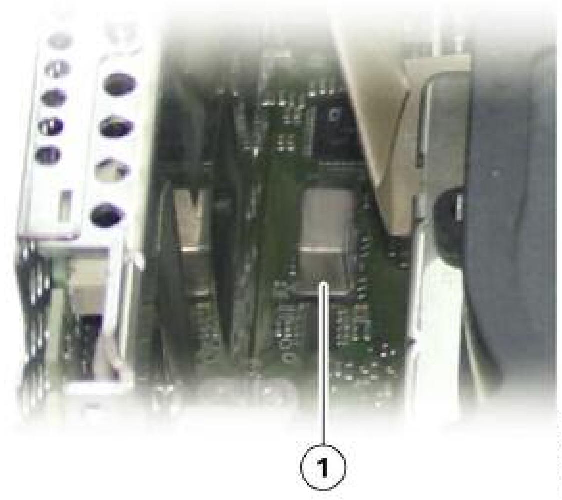
Yaw Rate Sensor

The Car Information Computer features a yaw rate sensor. It supplies the data relating to changes in driving direction for the navigation system.

This data is required for the purpose of determining the exact position as satellite signals cannot be received everywhere (tunnels, underground parking lot etc.).

The yaw rate sensor is a separate module soldered on the main board. It has been greatly reduced in size compared to the yaw rate sensor in the Car Communication Computer.

Unlike with CCC, it is no longer possible to replace the yaw rate sensor separately from the entire unit.



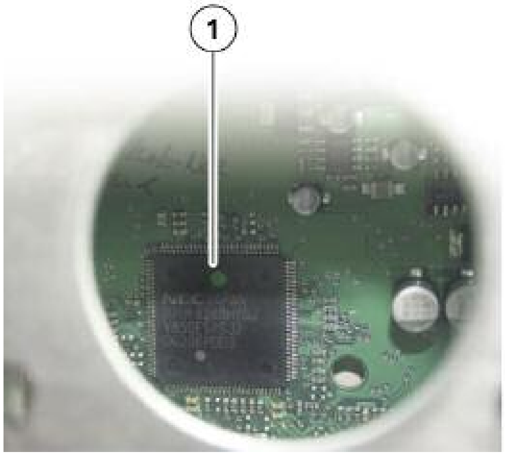
Location of the yaw rate sensor soldered to the CIC main board

Gateway Processor

The gateway processor converts all relevant data of the K-CAN system into MOST-bus telegrams and vice versa.

The electronic module is soldered into the board directly under the hard disk drive and cannot be replaced separately.

The gateway processor has its own control unit address in the BMW diagnosis system.



CIC system's Gateway Processor location

Analog Tuner Modules

The tuner modules in the Car Information Computer have enhanced functions compared to the tuners used in the CCC system. The FM/AM and the traffic information (RTTI) range have been expanded.

■ FM and AM Station List

A double tuner module (see item 1) is installed in the CIC for the FM/AM range.

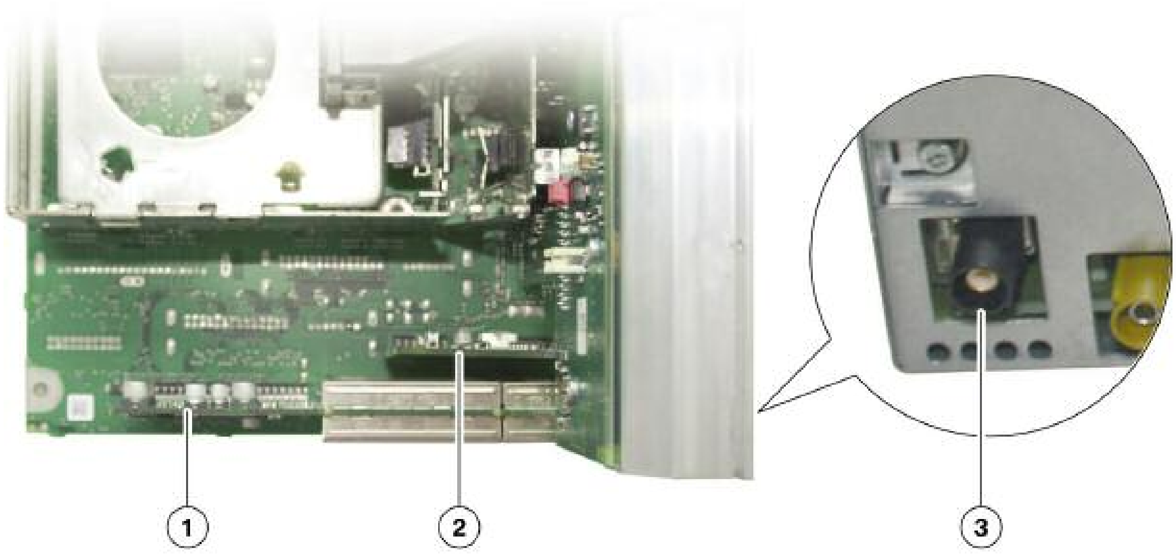
While one tuner in the network receives the required station and outputs the music signal, the other tuner works in the background searching the station landscape for additional signals and shows them on the display. ("All stations" menu item).

This function in the FM range is already known from the CCC and is now available in the AM range.

The third module in the tuner network enables expansion of the FM-RTTI (Real Time Traffic Information) functions. The FM/AM double tuner module and the FM-RTTI module combine to form the triple tuner.

The RTTI messages are used by the navigation system for displaying congestion and traffic information in the form of pictograms.

FM tuner module component location in the CIC



Index	Explanation
1	FM/AM double tuner module
2	FM-RTTI module
3	Black FAKRA connector below the CIC heat sink

IBOC System/HD Radio

The IBOC (In-Band- On-Channel) system is offered as the digital radio. With the introduction of the CIC, the control unit of the IBOC system has been integrated in the head unit as the IBOC decoder.

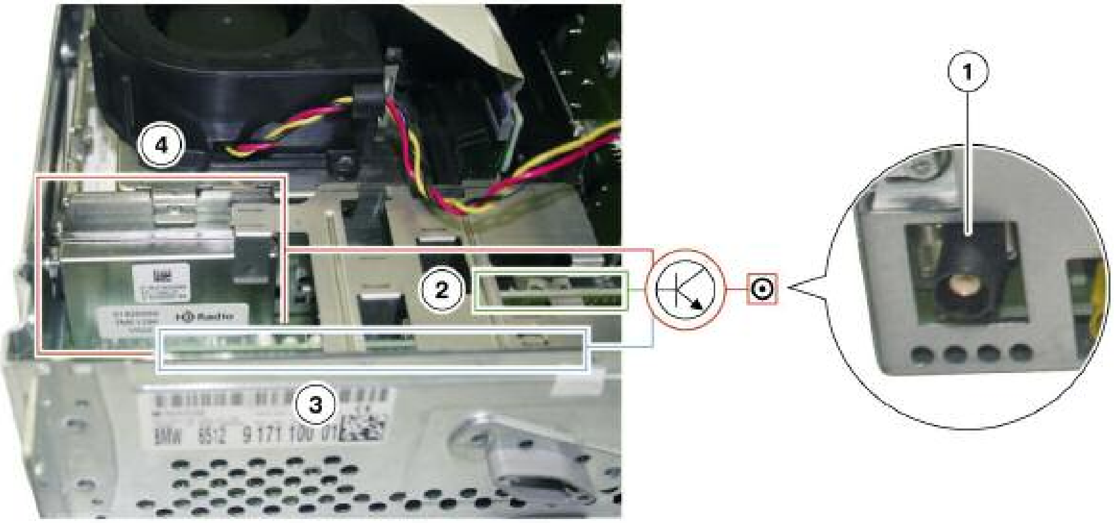
The IBOC system was developed by the company Ibiquity and, with the aid of a decoder, enables the reception of HD (High Definition) radio through the FM/AM double tuner.

This system simultaneously broadcasts an analog and digital signal.

A special oscilloscope (spectrum analyzer) would show the digital components at both sides of the analog wave of the FM frequency (step shape).

The IBOC system receives the signals with the aid of the FM double tuner module.

These signals are then routed to the IBOC decoder which adds the digital data stream to the audible music signals.



Location of the IBOC decoder in the CIC

Index	Explanation	Index	Explanation
1	FM/AM antenna connection	3	FM/AM double tuner module
2	FM-RTTI module	4	IBOC decoder

There are two types of broadcast services:

- MPS = Main Program Service
- SPS = Secondary Program Service

IBOC Station List Menu

Both services differ to the effect that the signal previously broadcast analog in the MPS is now used in digital form.

The decoder delays digital reception for several seconds until it is synchronous again with the analog signal previously heard.

SPS offers additional radio stations that are only broadcast in digital form. Using the multicast method, it is possible to accommodate up to seven digital stations in the submenu of the SPS main station. Normally, however, a maximum of 3 sub-menu are offered in the SPS.

Sub-menu of the IBOC main station

The system automatically switches over to analog FM reception if the digital signal is no longer available.

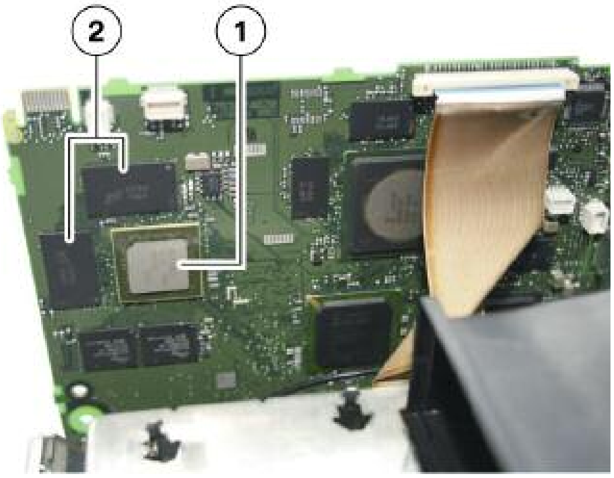
HD radio is also available in the AM frequency range. In this case, the digital signals are transmitted on directly adjacent frequencies of the analog station. Multicast is not supported on AM. The content of the digitally broadcast station is the same as that of the analog station.

HD radio plays AM radio stations in near-FM quality and FM radio stations in near-CD quality.

CIC Application Board with Processors

The application board accommodates the main processor (Central Processing Unit) and the main memory modules (Random Access Memory) for the CIC. These components are soldered into the board and cannot be replaced.

Index	Explanation
1	CPU - Central processing unit
2	Main memory (RAM) of the CIC



CPU and Main Memory Location

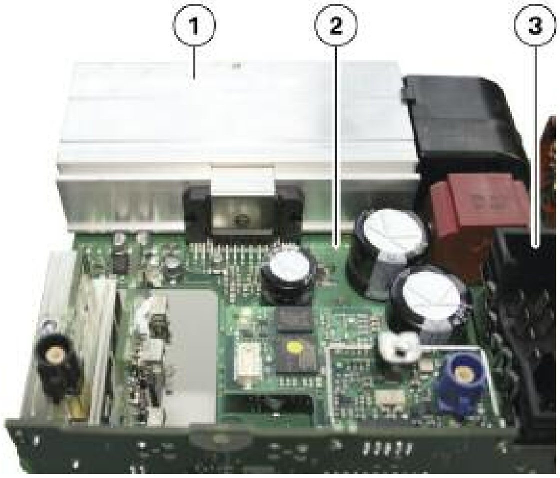
Power Board

The power board is located beneath the CIC heat sink and on the left next to the CIC main connector. It contains both the audio output stages for the speakers of the stereo system as well as the power supply unit for the CIC.

The heat sinks and CIC fan cool the system by dissipating the heat from the power supply unit and amplifier.

The unit interfaces with the vehicle’s electrical system (power supply, MOST link, etc.) through the main connector.

Index	Explanation
1	Heat sink
2	Power board
3	Main connector of the CIC



CIC Main Board and Heat Sink Location

Amplifiers and Speakers

The speaker systems on the F01/F02 are available in two versions:

- HiFi system (Standard)
- Top-HiFi system. (Option)

The HiFi system is the standard audio equipment for the F01/F02 . The HiFi system is equipped with a 8-channel amplifier with digital equalizer. However only 7 of the 8 channels are used in the HiFi system.

The central bass speakers are located under the front seats. They are coupled to the side sills (rocker panels). That increases the resonance volume necessary for bass reproduction.

The head unit CIC can be combined with any of the two amplifier/speaker systems.

The HiFi and Top-HiFi systems feature separate speakers for the treble and midrange frequencies.

Even though the diameters of the speakers in the HiFi and Top-HiFi systems are the same, there are differences in the power output of the speakers. This is achieved by the use of different materials for the diaphragms, coils and magnets. The designations HiFi and Top-HiFi are used in the table in the next page to distinguish the systems.

The Top-HiFi system achieves double the sound level of the HiFi system.

A digital 10-channel amplifier is used in the Top-HiFi system. However only 9 of the 10 channels are used in the Top-HiFi system.

The Top-HiFi system supports playback of multichannel formats. Multichannel audio formats can be played back with the player in the CIC or with the 6 DVD changer.

Optimum audio reproduction in the vehicle is achieved by way of complex digital signal processing.

The HiFi system has 12 speakers while the Top-HiFi system has 16 speakers each with different auxiliary amplifiers.

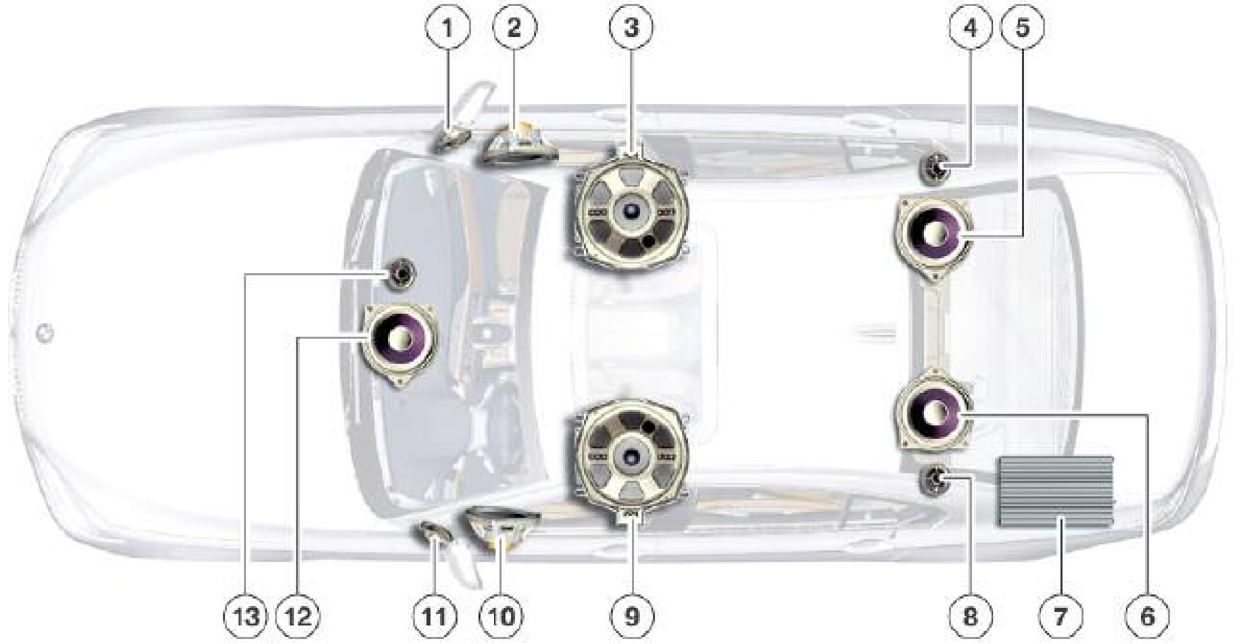
The following chart explains the two available sound systems for the F01/F02:

	HiFi system	Top-HiFi system
Number of speakers	**12** 2 - woofers (2 Ohm) 5 - mid-range speakers (4) 5 - tweeters (4 Ohm)	**16** 2 - woofers (2) 7 - mid-range speakers (4) 7 - tweeters (4)
Output of 7-channel HiFi amplifier:	**205 W** 2 - 40 W (2 .) Bass 5 - 25 W (4 .) Mid-range/treble	
Output of 9-channel Top-HiFi amplifier:		**600 W** 2 - 125 W (8.) Bass 7 - 50 W (4.) Mid-range/treble
Sound pressure	>104 dB as from 50 Hz	>110 dB as from 40 Hz
Bandwidth	30 Hz up to 20 kHz	20 Hz up to 20 kHz
Linearity	+/-4.5 dB	+/-3 dB
Tweeter Manufacturer	26 mm (Medium) Denon & Marantz PSS	26 mm (High) Denon & Marantz PSS
Mid-range speaker Manufacturer	100 mm (Medium) Denon & Marantz PSS	100 mm (High) Denon & Marantz PSS
Woofer Manufacturer	217 mm Denon & Marantz PSS	217 mm Denon & Marantz PSS

HiFi Speaker System

The digital 7-channel HiFi amplifier is supplied by Lear. The HiFi system consists of a HiFi amplifier with the 12 speakers. This system is fitted as standard on the F01/F02.

HiFi Speaker System on the F01/F02



Index	Explanation	Index	Explanation
1	Tweeter, front right door	8	Tweeter, rear window shelf, left
2	Mid-range speaker, front right door	9	Woofer, under left front seat
3	Woofer, under right front seat	10	Mid-range speaker, front left door
4	Tweeter, rear window shelf, right	11	Tweeter, front left door
5	Mid-range speaker, rear window shelf, right	12	Mid-range speaker, front center
6	Mid-range speaker, rear window shelf, left	13	Tweeter, front center
7	HiFi amplifier		

HiFi Amplifier

The HiFi amplifier is connected to the K-CAN for coding and diagnostics. The HiFi amplifier can be programmed but it is supplied by the manufacturer already preprogrammed at the factory.

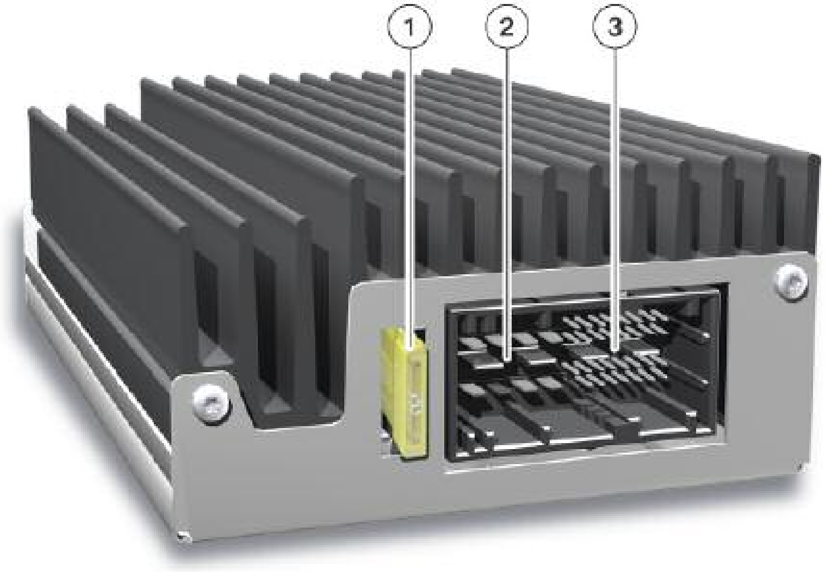
The Audio signals are transmitted in analog form from the head unit to the HiFi amplifier. The internal digital equalizer adapts the audio signals specifically to the vehicle, as determined by the coding. The iDrive does not equalize any signals.

The adapted and amplified signals of HiFi quality are distributed through seven audio channels to a total of twelve speakers:

- One tweeter and one mid-range speaker in each of the front doors.
- One tweeter and mid-range speaker in the dashboard (center).
- One tweeter and one mid-range speaker on the rear shelf.
- One central bass speaker under each of the front seats.

The HiFi amplifier is located at the rear left of the luggage compartment behind the side panel trim.

HiFi amplifier

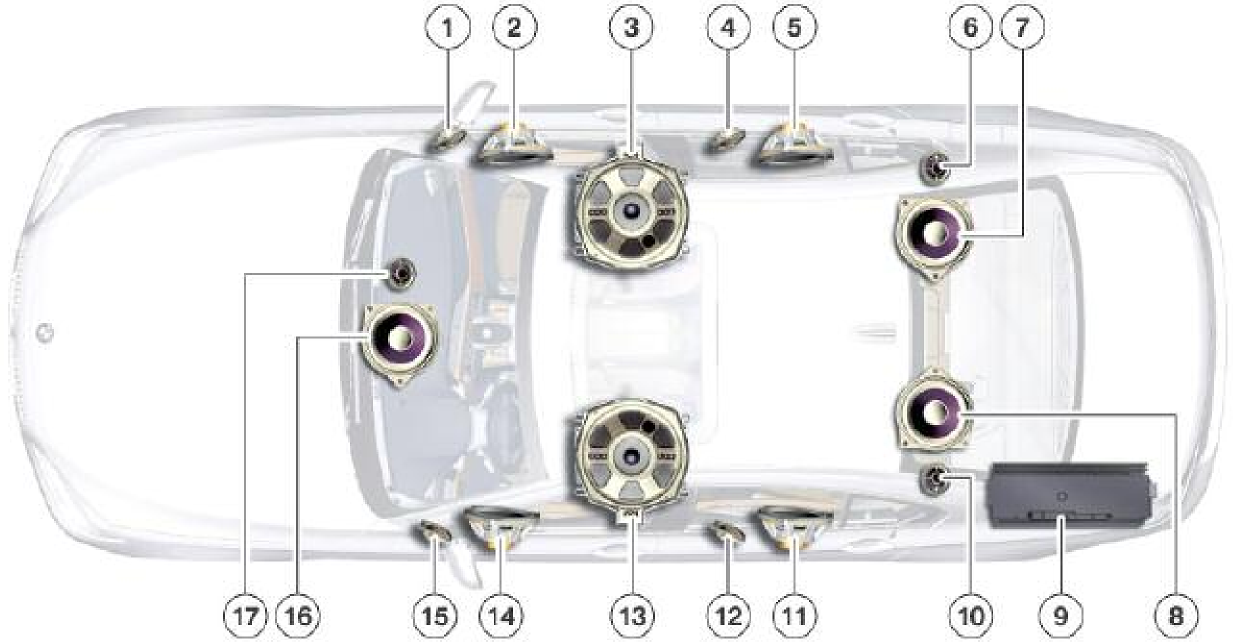


Index	Explanation	Index	Explanation
1	Safety fuse	3	Connection for audio signals, K-CAN and control signals
2	Connection for central bass speakers and power supply		

Top-HiFi Speaker System

The digital 10-channel Top-HiFi amplifier is also supplied by Lear. The 16 speaker Top-HiFi system is available as the premium option.

Top-HiFi Speaker System F01/F02



Index	Explanation	Index	Explanation
1	Tweeter, front right door	10	Tweeter, rear window shelf, left
2	Mid-range speaker, front right door	11	Mid-range speaker, rear left door
3	Woofer, under right front seat	12	Tweeter, rear left door
4	Tweeter, rear right door	13	Woofer, under left front seat
5	Mid-range speaker, rear right door	14	Mid-range speaker, front left door
6	Tweeter, rear window shelf, right	15	Tweeter, front left door
7	Mid-range speaker, rear window shelf, right	16	Mid-range speaker, front center
8	Mid-range speaker, rear window shelf, left	17	Tweeter, front center
9	Top-HiFi amplifier		

Top-HiFi Amplifier

The features of the Top-HiFi amplifier are:

- MOST control unit
- Graphic 7-channel equalizer controlled by iDrive
- Playback of multichannel audio formats
- Higher output power in the low frequency range
- 15 V output voltage for each mid-range speaker/tweeter
- 30 V output voltage for each central bass speaker

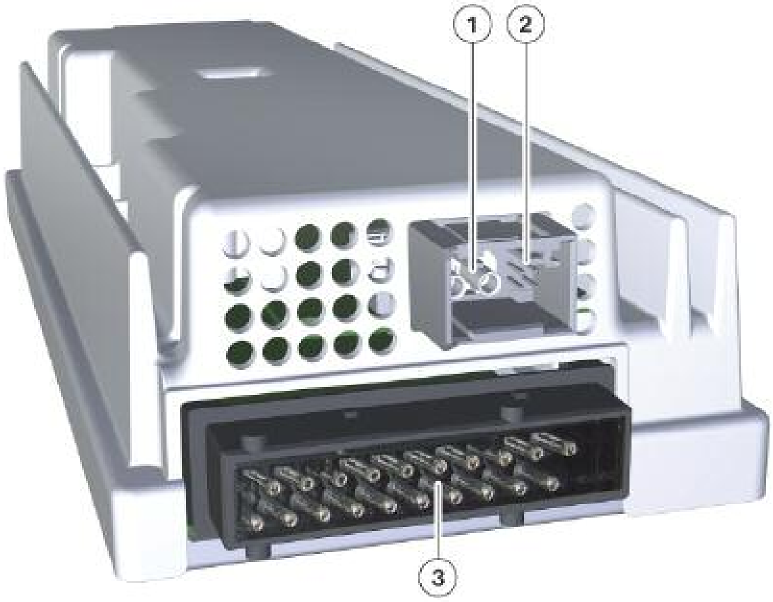
The audio signals and the control signals are sent in digital form to the Top-HiFi amplifier through the fiber-optic cable (MOST).

Programming, coding and diagnostics are carried out via the MOST.

The Top-HiFi amplifier supports playback of multichannel signals in 5.1 format.

The signals are output in 7.2 format (seven mid-range/treble channels and two central bass channels).

Top-HiFi amplifier



Index	Explanation	Index	Explanation
1	MOST connection	3	Power supply, audio signals to speakers
2	Reserved for load/logic separation, 10th channel preparation		

Using those channels, the sound tracks on a DVD can be played directly and entirely independently on each individual channel. In combination, those sound tracks produce a surround sound effect. For that reason, the process is described as discrete multichannel playback.

There are normally two sound tracks recorded on a CD to reproduce the stereo signal, the usual practice on a DVD is to use the 5.1 format with 6 sound tracks.

To adapt that format best to the vehicle environment (two rows of seats), it is converted into 7.2 format and reproduced through seven mid-range/tweeter and two central bass channels.

For multichannel playback, the Top-HiFi amplifier decodes the digital data from the data source.

Multichannel audio formats can be played back both with the CIC player as well as the DVD changer.

The following multichannel audio formats are supported:

- Dolby Digital Surround
- Dolby Digital Surround Ex
- DTS (Digital Theater System)
- DTS-ES (Digital Theater System-Extended Surround)

The multichannel audio format is indicated on the DVD case.

The Top-HiFi amplifier supports **Dolby Pro Logic II** for calculating the spatial sound information from an existing stereo signal.

This process replaces Logic 7 known from other BMW vehicles. A surround sound effect can be computed from the stereo signal, which consists only of a left and right channel.

The signals of the individual channels are output with time correction from the 16 available speakers of the Top-HiFi system in the F01/F02. This produces a homogeneous sound effect for the listener in 7.2 format.

Audio playback can also be adjusted by the customer through the iDrive with the aid of the 7 channel equalizer integrated in the Top-HiFi amplifier.

After signals have been processed, the audio signals are forwarded as analog low frequency signals to the speakers.

The Top-HiFi amplifier supports speed-dependent equalization in addition to speed-dependent volume control. The effect is that the frequency response is adjusted in relation to the speed of the vehicle.

A total of 16 speakers are controlled through nine amplifier channels with Top-HiFi quality:

- one tweeter and one mid-range speaker in each of the front doors.
- one tweeter and one mid-range speaker in the dashboard (center).
- one tweeter and mid-range speaker in each of the rear doors.
- one tweeter and one mid-range speaker on rear shelf.
- one central bass speaker under each of the front seats.

The Top-HiFi amplifier is located in the rear left of the luggage compartment behind the side panel trim. It is cooled by it’s own cooling fan.

Top-HiFi amplifier with additional fan

Antenna System Overview

Depending on the optional equipment, F01/ F02 vehicles are equipped with different antennal systems:

- FM/AM radio with IBOC system (rear window antennas)
- Roof antenna for SDARS satellite radio
- Navigation system (roof antenna)
- Remote control services (rear window antenna)
- Telephone (roof antenna)

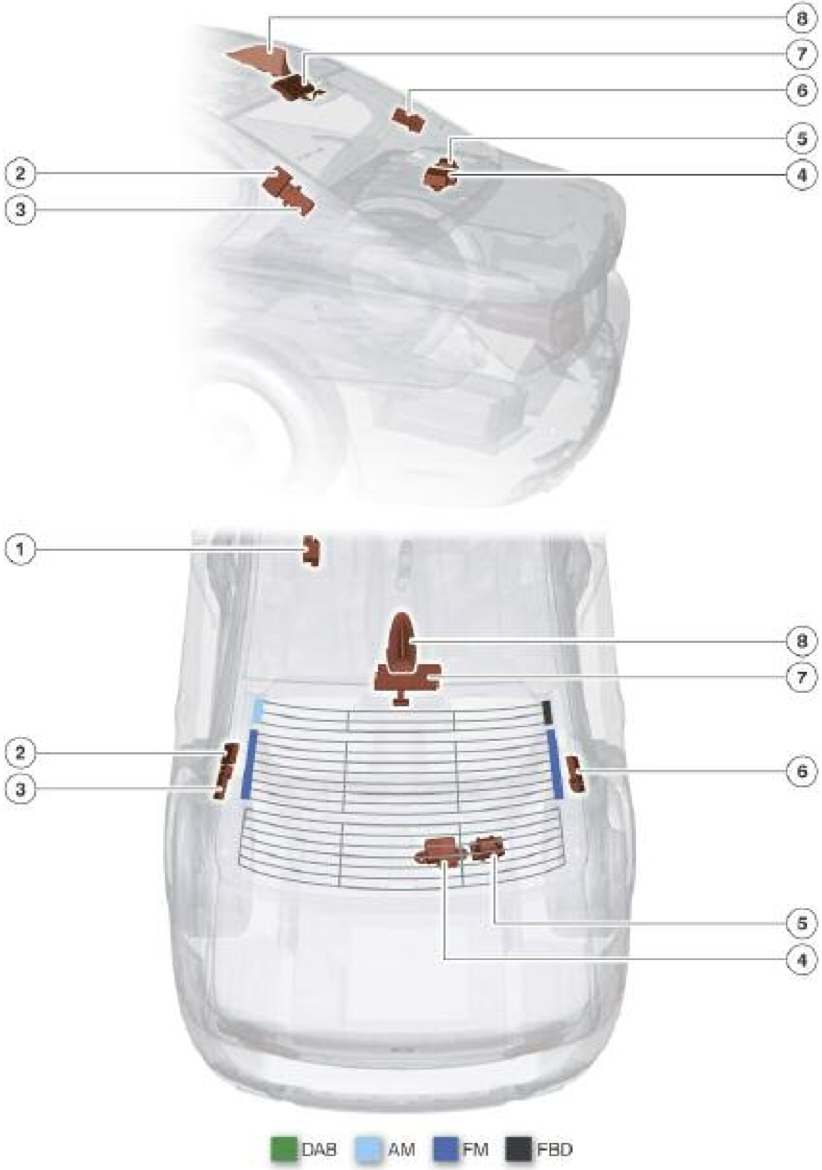
The vehicles are also equipped with the following telephone system antenna:

- Bluetooth antenna in area of sunroof; for connecting a mobile phone with Bluetooth capabilities.
- Emergency call GSM antenna (with telematics control unit (TCU) and BMW Assist.

A description of the individual antenna and rejection filters for the antenna diversity module with antenna amplifier for outstanding radio reception.

Reference is also made to the antenna for the telephone systems, navigation and remote control services (FBD). These antenna are described in detail in the respective training material.

F01/F02 Antenna System



Index	Explanation	Index	Explanation
1	Bluetooth antenna	5	AM restrictor
2	HBL filter (HBL = additional brake light)	6	FM rejector circuit, right
3	FM rejector circuit, left	7	Antenna amplifier with diversity module and remote control service (FBD)
4	Emergency call GSM antenna	8	Roof antenna (GPS receiver for navigation, telephone antenna, digital tuners)

Antenna Diversity Module with Amplifier

The high frequency signals broadcast by the radio stations are received via the rear window antennas (FM1, FM2, FM3 and AM)

The antenna amplifiers are in the antenna diversity module. There are separate amplifiers for AM and FM. The antenna amplifier (of the antenna diversity module) is located between the 3rd brake light and roof antenna.

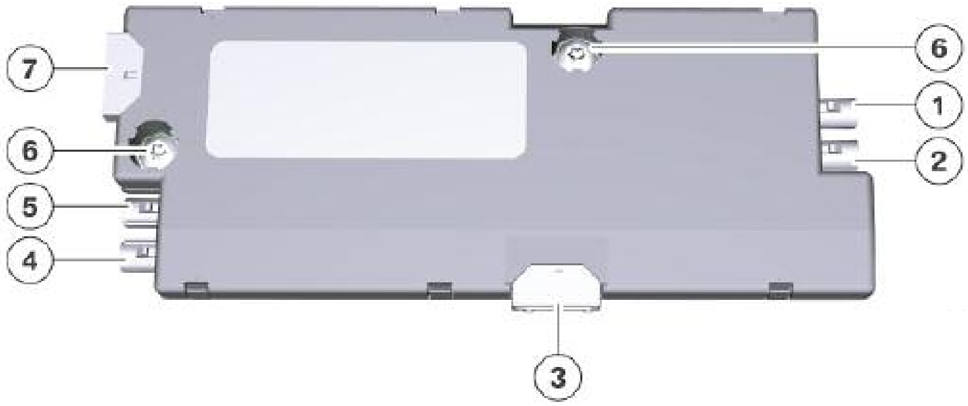
When the CIC is switched on, the antenna diversity/amplifier is activated and powered by the Rad_On signal. The remote control service part of the antenna diversity module is powered via terminal 30.

The high frequency signals from the AM and FM antennas as well as from the is amplified. These signals are routed via a ribbon cable from the rear window to the antenna diversity module.

The antennal amplifier also supports the frequencies of the weatherband.

Weatherband is transmitted over seven channels in the frequency range from 162.400 MHz to 162.550 MHz. The weatherband tuner is incorporated in the FM module of the head unit.

F01/F02 Antenna Diversity module with Antenna Amplifier



Index	Explanation	Index	Explanation
1	Not for US	5	AM/FM RF signal, IF for diversity, Radio diagnosis (black connector)
2	Not for US	6	Threaded ground connection to vehicle body
3	Ribbon cable from rear window to antenna diversity module with antenna amplifier	7	Power supply of antenna diversity module with antenna amplifier; Rad_on, Kl. 30, CAS-LIN, shielding
4	Not for US		

FM Antenna Diversity

In the F01/F02, an FM antenna diversity is standard equipment.

The FM antenna diversity comprises:

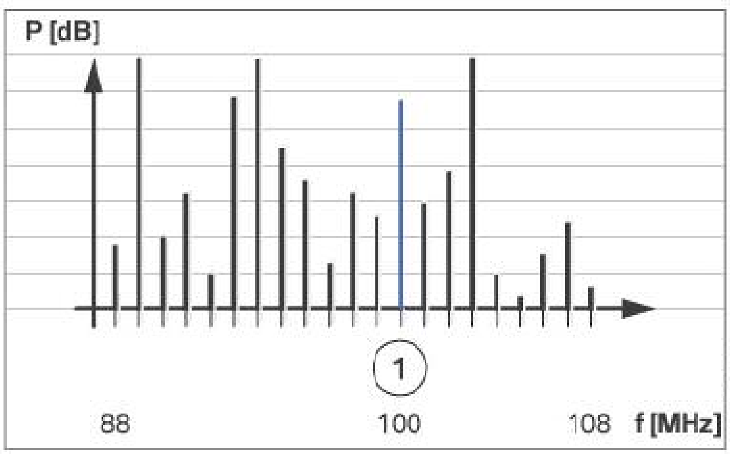
- FM1, FM2 and FM3 antennas
- FM antenna amplifier with diversity module

The FM1 to FM3 antennas route their RF signal to the antenna amplifier in the antenna diversity module.

The signal quality of the currently selected FM antenna (FM1 to FM3) is now evaluated in the antenna diversity module.

The high-frequency signal from the active FM antenna at any particular time is fed by the antenna amplifier and antenna diversity module via a coaxial cable to the tuner module in the head unit.

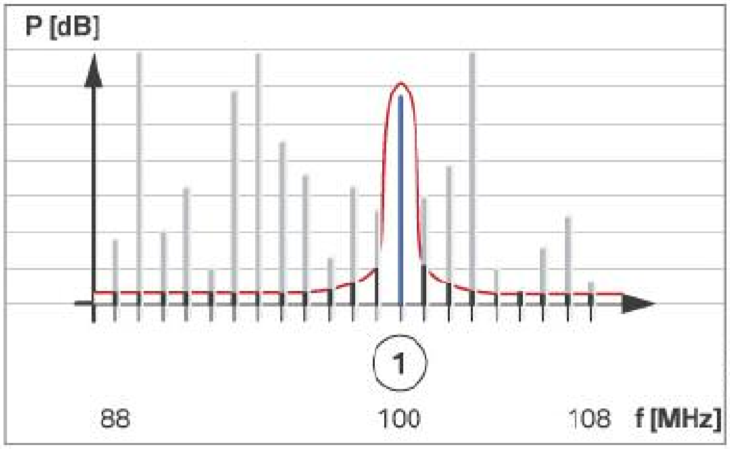
Input frequency at tuner module in CIC



Index	Explanation
1	Station frequency prior to selection by customer

The tuner module in the CIC is now informed of the station selected by the customer using iDrive. As a result, the tuner module in the CIC selects the matching frequency. This is done by setting a bandpass filter. The bandpass filter suppresses all frequencies above and below the selected station frequencies.

Selected station frequency after bandpass filtering in the tuner module



Index	Explanation
1	Station frequency after selection by customer

The remaining RF signal is then demodulated in the tuner and output in the form of an audio signal through the speakers.

The tuner module in the CIC detects that an antenna diversity module is installed and generates the changeover voltage (Us) and the signal of the intermediate frequency (IF) necessary for diversity operation.

■ Selection of the individual antennas (diversity function)

The intermediate frequency is an RF signal (10.7 MHz) and is evaluated by the electronic circuitry inside the diversity module. The antenna diversity module will switch to the next FM antenna if the signal quality of the current radio station on the active antenna deteriorates to a certain level in terms of quality and field strength.

The changeover takes place in a way that no interruption can be heard.

■ Selection of the various reception modes of the antenna diversity module

The changeover between AM reception, FM diversity operation and diagnostic mode occurs in response to the DC voltage Us.
This is performed in the head unit and analyzed in the diversity module with the following criteria:

- Diversity mode is active when U_S = 2.5 V.
- AM mode is active, or the FM1 antenna is selected, when U_S = 0 V.
- Diversity mode is active at U_S = 5 V.
- The changeover in diagnosis mode to the next antenna takes place by 8 V pulses.

AM Diversity

For AM services (SW, MW and LW) no antenna diversity system is provided as there is only one AM antenna.

Remote Control Services (FBD)

In addition to the antennas listed above there are the antennas for the remote control services (FBD) and the nine antennas for comfort access (four antennas on the outside and five in the interior).

Note: For detailed Information on the antennas system refer to the F01/F02 "Central locking", "Comfort Access" and "Car Access System" Training Material.

FM Rejector Circuit

The two rejector circuit modules for FM are located on the left and right of the rear window.

One rejector circuit is intended for the power supply of the lower section of the rear window.

The second circuit is for the upper section of the rear window defogger which is powered by the AM restrictor described in the following pages.

Index	Explanation
1	Rejector circuit on left side Terminal 31, rear window: lower section of rear window
2	Threaded ground connection to vehicle body
3	Rejector circuit on left-side Terminal 31, connection, vehicle wiring harness

Left side antenna amplifier

Index	Explanation
1	Rejector circuit on right side Terminal 30, rear window: lower section of rear window
2	Threaded ground connection to vehicle body
3	Rejector circuit on right side Terminal 30, connection, vehicle wiring harness

Right side antenna amplifier

HBL Filter

The HBL filter is fitted to suppress interference pulses from the additional brake light during radio reception. HBL stands for high-level brake light (third brake light).

A pulse-modulated signal (PWM) activates the third brake light. This kind of activation (PWM rectangular signal) can cause high-frequency interference. This is especially common with AM reception. The reason for this is that the audio information is contained in the amplitudes in the AM signal.

Index	Explanation
1	HBL filter - connection to additional brake light and for powering the diversity module with antenna amplifier
2	Securing screw with ground connection
3	HBL filter, connection to vehicle wiring harness

HBL (high level brake light) filter

AM Restrictor

AM reception has been improved on the F01/F02.

Due to the great distances with relatively few radio broadcasting towers, in less populated areas of the US AM radio is more accessible than FM radio.

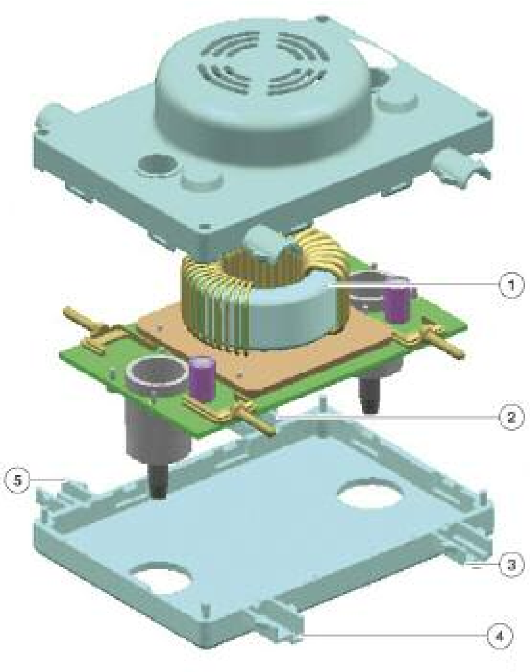
Interference frequencies from the vehicle electrical system pose reception problems in terms of the quality of AM radio. In an unrestricted antenna system, these interference frequencies spread from the vehicle electrical system through the power supply to the rear window defogger into the antenna system.

The AM restrictor was specially developed to address this issue.

The AM restrictor supplies voltage to the upper section of the rear window. In addition, the rejector circuit components provide sound quality filtering.

The main component is a coil which acts as an extremely high resistance to RF signal, resulting in significantly improved AM reception.

Restrictor circuit AM for the rear window



Index	Explanation	Index	Explanation
1	Interference suppression coil for AM range	4	Ground supply from vehicle wiring harness
2	Positive supply to rear window	5	Ground supply to rear window
3	Positive supply from vehicle wiring harness		

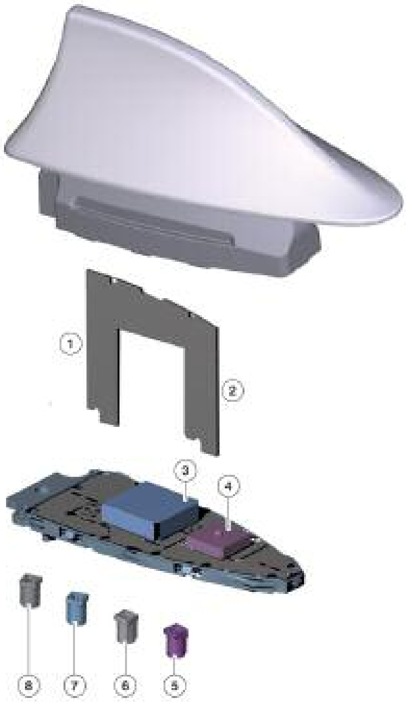
Roof Antenna

The roof antenna housing is always fitted regardless of the equipment options on the vehicle.

The roof antenna includes the following components:

- Mobile phone antenna
- Telematics Control Unit (TCU) telephone antenna
- GPS antenna
- SDARS satellite radio reception antenna

F01/F02 Roof antenna



Index	Explanation	Index	Explanation
1	Telephone antennas for telematics control unit (TCU)	5	SDARS signal, satellite and terrestrial (violet connection)
2	Telephone antennas for mobile phone	6	Telephone signal: mobile phone; metal color connector; Bordeaux violet coding connector
3	GPS antenna	7	GPS signal (blue color connector)
4	SDARS antenna for satellite reception	8	Telephone signal: TCU; metal color connector; grey color coding connector

SDARS Satellite Tuner

The SDARS (Satellite Digital Audio Radio Service) control unit enables reception of digital radio signals.

Digital transmissions are superior in quality to analog transmissions. The radio stations of the satellite tuner can be selected under the “Satellite radio” submenu.

Advantages of digital satellite radio:

- Reception of same radio station across the entire US mainland (excluding Alaska).
- Digital reception of music, news and talk stations.
- Wide choice of available music genres.
- No commercial breaks.
- Digital signal transmission provides greater immunity to external interference.

SDARS control unit

Index	Explanation	Index	Explanation
1	MOST	3	SDARS signal (pink connector)
2	Power supply		

The satellite tuner is designed for the Sirius Satellite Radio subscription service. The SDARS signals are transmitted by three satellites. In areas without coverage, the SDARS signals are beamed terrestrially.

Both SDARS signals (satellite and terrestrial) are received by a single antenna in the roof antenna assembly and supplied to the SDARS control unit.

The SDARS satellite tuner is located in the luggage compartment on the left-hand side.

When the system is activated for the first time, the weather channel (channel 184) is available for 360 days free of charge for test purposes.

The other channels are blocked by the provider Sirius (not yet subscribed) and therefore still show a credit card symbol.

Boom Bip
Roads Must Roll
181 ESPNHisp
182 CNN Esp
183 Korea
184 Weather
185 TWN

Blocked SDARS channels

If a channel that is not yet subscribed is selected, the request to register with the provider Sirius with the ESN number of the SDARS module will be shown.

Call Sirius to subscribe
ESN: 020 373 356 757
1-888-539-SIRIUS

Request to contact the service provider

Important information for enabling SDARS:

- Park vehicle with clear view of the sky; tune in to weather channel on channel 184 (The weather channel is enabled for 360 days)
- Call SIRIUS and apply to enable the SDARS module
- The radio is muted and the “Updating list...” information appears during activation

Updating list...
No audio available

Search of SDARS station list

- Wait until the pop-up disappears and the radio can be heard again
- Check that a credit card symbol no longer appears next to the enabled channels (see picture below). Otherwise, repeat the previous steps.

After successfully enabling the channels, on selection, the diskette symbol appears to the right next to the station. It indicates that the station can now be stored in the “All channels” list.

Rihanna
Say It
All Channels
001 Hits 1
002 StarLite
003 Love
004 Movin EZ

SDARS successfully enabled

The ESN number is always shown in the “Options menu” of the satellite radio.

ESN: 020 373 356 757

ESN number

External Audio Sources

DVD Changer

The 6-DVD changer is offered as part of the ZPS Premium Sound Package on the F01/F02 and it is located above the glove compartment behind the dashboard trim panel. A CD Changer is no longer offered.

The DVD changer forms part of the MOST network.

A single-slot changer means that the DVDs or CDs are loaded in the unit individually without a magazine.

A DVD can be loaded by pressing the Load button, followed by the button for the DVD tray into which the DVD is to be inserted.

If no button is pressed after the Load button has been tapped, the LED in the tray button for the first empty tray flashes. The tray moves into position during this time. Once tray positioning is completed, the status display begins to flash and the DVD can be loaded.

DVD Changer

Index	Explanation	Index	Explanation
1	Buttons for DVD trays with status indicator	5	DVD drive eject button
2	Load button for DVD drive	6	MOST
3	Slot lighting	7	Power supply
4	Slot for DVD player		

The DVD directory is read directly after loading. The contents of the DVD have to be read before the next DVD can be inserted by pressing the Load button again followed by the button for the DVD tray.

The quick-load function must be activated in order to load all DVDs one after the other.

The Load button must be pressed for approximately 2 seconds for this purpose. The LEDs in the tray buttons for trays that are empty begin to flash.

Up to six DVDs can be inserted one after the other, depending on the number of empty trays. The contents of the DVDs inserted are read either once the final empty tray is occupied, after a timeout period or if the Load or Eject button is pressed.

The shutter must be open in order to insert the DVDs. The slot lighting flashes when it is possible to insert a disk. Operation is described in detail in the Owner’s Handbook for the vehicle.

An individual DVD can be ejected by pressing the Eject button followed by the operating button concerned. Pressing and holding the Eject button ejects all the DVDs immediately one after the other.

Supported compressed audio formats:

- MPEG-1 Layer 3 Audio (MP3) with ID3 tag version 1 and version 2
- Windows Media Audio (WMA) up to version 9 with WMA tags
- Advanced Audio Coding (AAC)

Audio formats that are protected by Digital Rights Management (DRM) cannot be played.

The data on the DVDs is decoded by the DVD changer and converted into digital MOST signals (audio) or analog CVBS picture signals (video).

If the vehicle is equipped with the HiFi speaker system, the digital data on the DVD is sent to the head unit through the MOST. Here it is converted to analog data and output through the HiFi amplifier and the speakers.

If the Top-HiFi system option is installed, the decoded audio data is sent directly to the Top-HiFi amplifier through the MOST.

This direct transmission bypassing the head unit is made possible because data conversion and sound adjustment take place exclusively in the Top-HiFi amplifier.

The analog CVBS (Composite Video Baseland Signal) video signals are sent directly through the CVBS link to the CIC.

In come cases (depending on equipment options installed) all three CIC CVBS inputs are already occupied and the video signals are distributed through a video switch (see video switch section in this training material for further information).

The DVD changer is located above the glove compartment, concealed behind the interior trim equipped with a flap mechanism.

The following picture shows the location of the DVD changer with the interior trim open.

Single-slot DVD changer is located behind dashboard trim panel above the glove compartment

USB/Audio Interface

The “USB/audio interface” supports the playback of audio files stored on mass storage devices with USB connections such as USB sticks, MP3 players etc.

USB is a serial bus system that allows fast and simple connection of terminal devices to computer systems.

The mass storage medium can be found under the “External devices” submenu in the “CD/Multimedia” menu of the iDrive.

Activation of an external USB/audio interface in the center console

All USB mass storage devices that support the “USB Mass Storage Class” standard can be connected. This includes mass storage media for the playback of compressed audio files with a USB interface such as MP3 players, USB memory sticks, etc. The Apple iPod® is also supported as from the 4th generation version.

Due to the large number of devices on the market, no guarantee can be given that every available “USB Mass Storage Class” device will function through the USB interface. If a device of a different device class is connected, the message “Incompatible device” will appear.

When a USB mass storage device is connected, the contents of the device are read and the folder structure is processed for display on the CID. A plausibility check is performed as to whether the tracks can be played by the vehicle’s sound system.

Only those tracks that can be played are displayed.

While the database of the content (details of the music tracks is constructed, the music files can only be selected by navigating through the folder structure. On completion of the database, music tracks can also be selected by genre, artist and album.

Media Transfer Protocol (MTP) is currently not supported. MP3 players that use MTP are therefore not supported. More information on the protocols used can be obtained from the operating instructions of the mass storage device.

WARNING!!! **With certain mobile phones, Bluetooth is deactivated if they are connected to the vehicle through the USB interface.**

Note: It is not recommended to use mobile phones via the USB interface in the center console (Option 6FL). The Smartphone Integration Option 6NF is better suited for this purpose and is described in the following pages.

The following compressed file formats are normally supported with fixed and variable bit rates:

- MP3 (MPEG-1 Audio Layer 3) with ID3 tags Version 2
- Windows Media Audio (WMA) with WMA tags
- Advanced Audio Coding (AAC)

The WAV file format is also supported. USB mass storage devices must be formatted using the FAT file system. If more than one partition (logical drive) has been set up on the device, only the first partition is supported.

The USB mass storage device cannot be accessed if the files are password-protected or are subject to Digital Rights Management (DRM).

iPod® Connection

When music tracks are to be played back using the Apple iPod® the iPod must be connected through an adaptor cable that simultaneously uses the auxiliary jack socket and the USB.

The y-cable (cable adapter for iPod®; BMW part number 61 12 0 429 645) included with the vehicle.

With the adaptor cable, the USB connection is used to control the iPod® and the jack socket for audio playback.

The reason for this method of connection is that music tracks obtained from iTunes® (Apple music portal) are subject to DRM and can only be played on the device to which they were downloaded. The copyright protection prevents digital transmission of the music track via USB.

If a video file is selected on the iPod®, only the sound track is played. If other supported USB mass storage devices are used, video files are not displayed.

It is only possible to access the files on the mass storage device using the iDrive when the USB mass storage device is connected to the USB interface. If the mass storage device is connected using the Audio jack plug, the iDrive cannot be used to operate the device.

AUX-in connection (USB/jack 3.5 mm) of option 6FL in the center console of the F01/F02

Note: USB hard drives must not be connected to the USB interface due to their high power draw. It is not permissible for hard disks to draw their power supply from the vehicle's electrical system (e.g. from the cigarette lighter socket) and can cause faults.

“USB/audio interface” Components

“USB/audio interface” consists of the following components:

- Interface box High (ULF-SBX-High)
- USB hub
- Audio socket with USB interface
- Application software in the head unit

The USB interface is on the center console and is protected by a sliding cover.

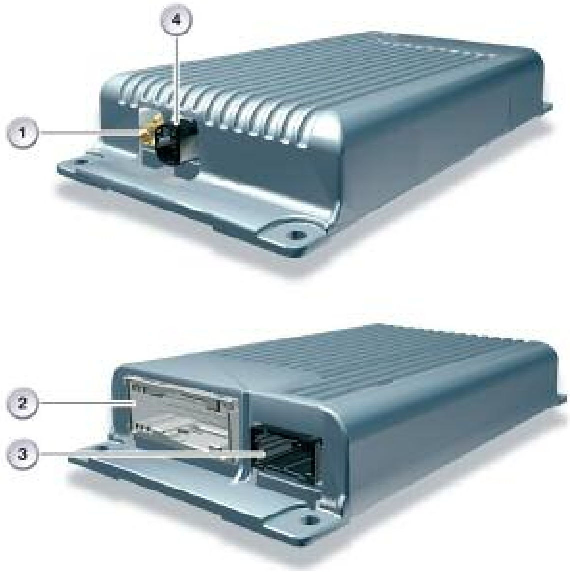
Simultaneous use of the USB interface and the 12 V socket for charging the mass storage device is not recommended.

Depending on the USB lead used, the mass storage device may be able to be charged through the USB interface. However, the power consumption of the mass storage device must not exceed the maximum level of 500 mA permitted by the SBX High.

The (SBX High) interface box is capable of performing the following tasks:

- USB connection for USB/audio interface
- Bluetooth interface with hands-free mode and phone book
- Basic voice input and activation system through the telephone

ULF-SBX High connections



Index	Explanation	Index	Explanation
1	Bluetooth connection (Not in US)	3	MOST connection
2	54-pin connector	4	USB connection

The ULF-SBX High interface box is always fitted if the “USB/audio interface” is fitted to the vehicle.

Although both the ULF-SBX-H and the TCU may be fitted in a vehicle at the same time, the TCU always provides the telephone functions. The telephone functions are not available in the ULF-SBX High and the module is only installed to provide the "USB audio interface" option.

The (TCU) and the (ULF-SBX-H) interface box control units are connected to the MOST bus.

The ULF-SBX-H decodes the digital audio signals collected through the USB interface.

The audio files are then broadcast through the MOST.

The analog LF (low frequency) signals from the audio socket are also broadcast on the MOST.

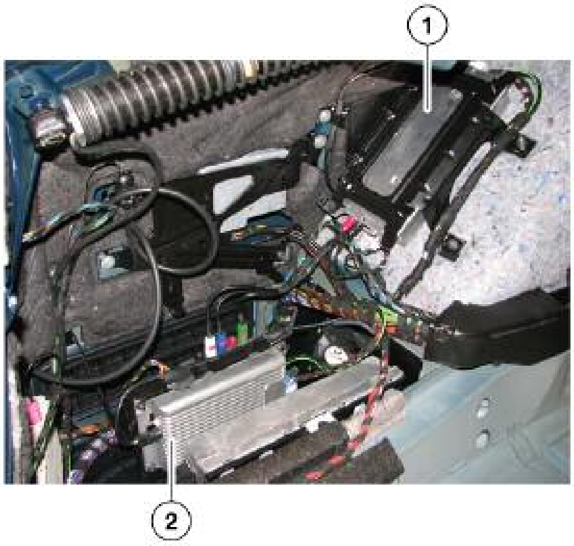
The audio signal is transmitted digitally on the MOST bus to the HiFi amplifier and the amplifier distributes this signal to all the vehicle’s speakers.

The ULF-SBX High supports USB 1.1 with the following technical data:

- Maximum data rate: 12 Mbit/s
- Voltage: 5 V
- Current: 500 mA

The ULF-SBX High is located in the luggage compartment on the left-hand side.

Location of interface box (ULF-SBX-High) on rear left in luggage compartment of F01/F02



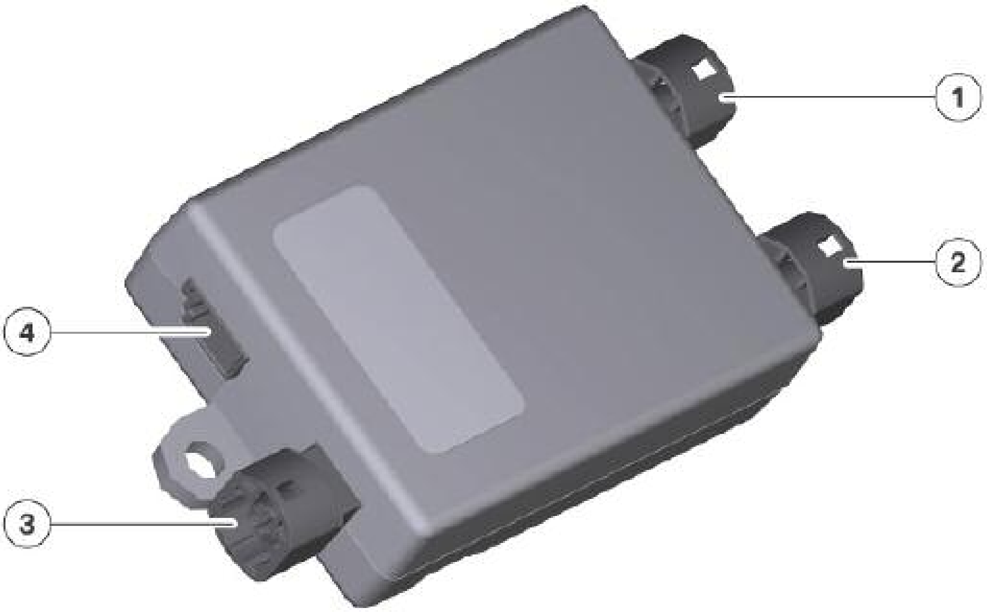
Index	Explanation	Index	Explanation
1	Telematics control unit (TCU)	2	Interface box (ULF-SBX-High)

USB Hub

The USB hub allows multiple USB interfaces to be connected to the ULF-SBX High.

The USB hub incorporates an active USB signal amplifier and is equipped with two USB inputs and one USB output.

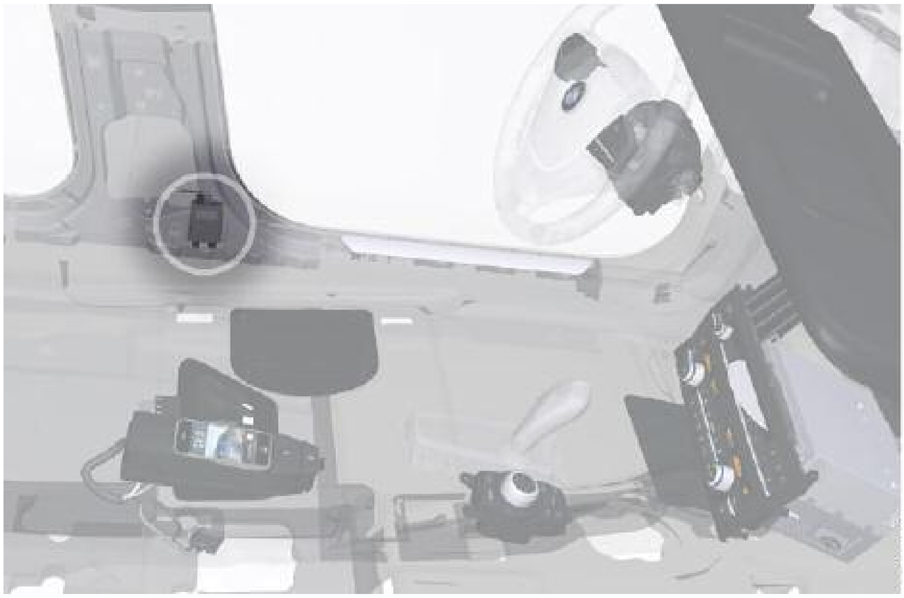
USB Hub connections



Index	Explanation	Index	Explanation
1	USB connection to AUX-in connection (blue connector)	3	USB connection to (ULF-SBX-High) interface box (black connector)
2	USB connection for base plate of the Smartphone audio line (neutral color connector)	4	Power supply for the USB hub (black connector)

Note: The USB hub is only used if the vehicle has the Smartphone Integration option.

The USB hub on the F01/F02 is installed behind the trim panel for the left-hand B-pillar. It is installed in the same place on both right-hand drive and left-hand drive vehicles.



Location of USB hub at left-hand B-pillar

Audio Jack

The audio jack is used for connecting an external audio source such as an MP3, cassette or CD player using a 3.5 mm jack plug.

The AUX-In connection without USB interface is standard equipment on the F01/F02. It is located below the Center armrest. A plug. 12 V power socket is located in the immediate vicinity of the audio socket.

Smartphone Integration

It is now possible to connect to and play back (through the iDrive system) music tracks stored in a mobile phone. Currently, only the iPhone may be integrated in the vehicle network by means of the Smartphone Integration audio link.

Smartphones may be connected through the USB Y cable or through the installation of a Smartphone integration snap in cradle adapter, available as option 6NF.

The audio files can be selected and played from the submenu "External devices" in the "CD/Multimedia" iDrive menu

This feature works independently from the iPod/USB interface.

The new AUX-In connection features an internal switch function to accommodate both the USB interface and the Smartphone integration options.

It is possible to select audio from the snap in cradle or, switch to an external audio device connected to the (AUX) audio jack or Y-cable to the ULF-SBX-High. The second switch position is triggered by inserting a plug in the (AUX) jack.

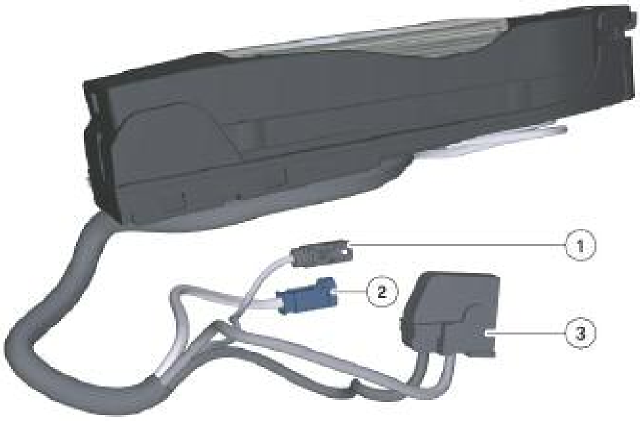
The electronic control module is installed in the base plate of the phone cradle. The link to the USB hub and AUX-In connection are already integrated in the vehicle wiring harness.

Smartphone - iPhone with matching snap-in adapter

iPhone with snap-in cradle adapter on the base plate for Smartphone Integration

The following illustration shows the arrangement of the individual components on the base plate for the Smartphone Integration.

Index	Explanation
1	Base plate connection to roof antenna (black connection)
2	USB connection from base plate to USB hub (blue connector)
3	18-pin plug connector: (power supply, cradle-on, AUX-AF signals)



Audio Data Control Line

The audio data of the snapped in cradle adapter for the mobile phone is controlled by a four-core USB data cable.

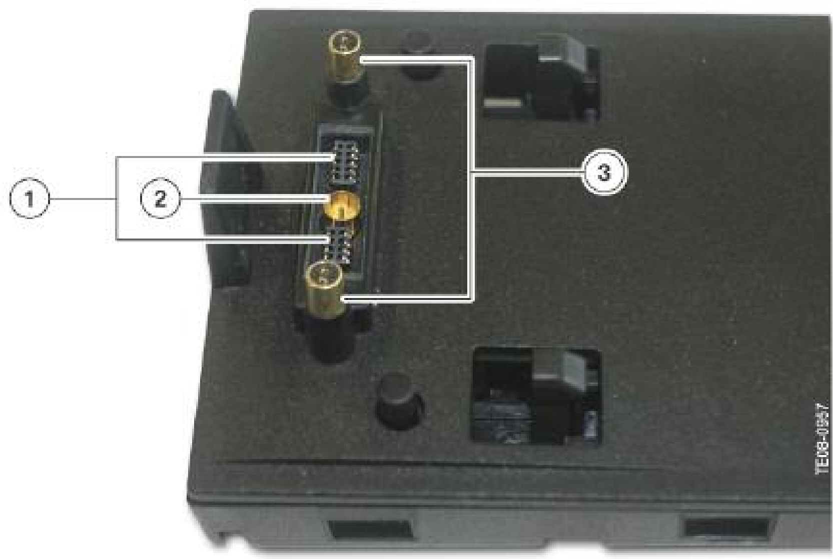
The base plate and cradle specifically developed for the Smartphone Integration option (6NF) is immediately recognizable by the two gold-plated pin connectors.

These two gold-plated pin connectors are also used as lock pins for the snap-in cradle adapter.

Plastic pins are used in the same position in the standard snap-in telephone cradle adapters.

In this way it is possible to distinguish at a glance whether the correct base plate is installed for the Smartphone Integration option.

Base plate for Smartphone Integration



Index	Explanation	Index	Explanation
1	18-pin plug connector of base plate (power supply, cradle-on, AUX-AF signals)	3	USB connection: Distribution of the USB supply voltage and data lines over two gold-plated pin housings with shielding
2	Antennal connection to roof antenna		

Service Information

Unlocking the Service Menu Option

Several important functions can be checked directly at the CIC with the aid of the Service menu. This menu can be used to select and adjust settings that are not visible for the customer.

The procedure for starting the Service menu with the "safe grip" has changed compared to the CCC system:

- Call up Start menu
- Push controller in forward direction for at least 10 s
- Controller 3 notches to the right
- Controller 3 notches to the left
- Controller 1 notch to the right
- Controller 1 notch to the left
- Controller 1 notch to the right
- Press controller once
- The “Service menu” is now added as the last submenu to Settings

Four selection menus are available in the Service menu of the CIC:

- Navigation
- Telephone and BMW Service
- TV (Not for US)
- Gracenote®

Service menu hidden

Service menu “unlocked”

Note: Although it appears in the Service menu, TV is not available on US vehicles.

Navigation

CIC Service menu with Navigation item selected.

Navigation	Screen content (example)	Explanation
GPS		
GPS	Status Latitude: 12°34'56"N	GPS position data
GPS	Tracking 01: 03 14,3, 02 xx, yy, z	GPS satellites
GPS	Version Receiver SW Version/Date	Software version and date of manufacture of GPS receiver
Sensor test	Wheel sensors, GPS satellites, Gyro	Check of input signals
Map version	Map Database: 1.067	Map version number Database: 1.067
Location entry	Location Entry: Entry	Loop same as destination entry
Voice output test		

Note: Although it appears in the Service menu, TV is not available on US vehicles.

Telephone and BMW Service

CIC Service menu with Telephone and BMW Service selected

Telephone	Screen content (example)	Explanation
BT Name	BMW 57502	Bluetooth name of BMW vehicle for pairing
NAD	51 dBm	GSM signal level of built-in telephone module
MCC/MNC	262 01	Mobile Country Code + Mobile Network Code; unique code for country and network provider with which the phone is currently registered.
ICC ID	89490200000537151529	Integrated Circuit identifier = Identifier of SIM card
IMEI	351231004373763	International Mobile Equipment Identity (IMEI) is a unique 15-digit serial number of the telephone transceiver
Registration status	Registered	Registered = SIM card enabled and logged into network; Not registered = SIM card enabled but currently no
Reception		
Signal strength	20/100	Relative signal strength of the built-in telephone module in percent (max 100 %)
GPS T/D	14:41:57 27.05.2008	Assist cannot be enabled if time and date are incorrect

Note: Although it appears in the Service menu, TV is not available on US vehicles.

TV

Screen Shot of the TV Sub-menu in the Service Menu

There are five sub-menus which can be selected under the TV sub-menu:

- Ch = channel currently tuned in
- Frequency in MHz
- Channel information (transmission standard, bandwidth and program name)
- DVB-T parameter (modulation type, analog, digital TV distinction)
- Antenna information (field strength in **dBµV** (Decibel micro Volt)

Note: Although it appears in the Service menu, TV is not available on US vehicles.

Gracenote®

The sub-menu for Gracenote under the Service menu

The music track database can be updated under the menu item Gracenote.

Once the update CD has been loaded in the CIC drive, it is possible to compare the currently installed data status with the data status of the CD in the Service menu selection (See illustration below).

If the CD corresponds to the current status, the latest version of the Gracenote® music track database is downloaded after selecting "Start installation". The previous version is overwritten.

No data is added to unrecognized music tracks. The update only serves the purpose of identifying music tracks in connection with future music data storage converted with the aid of the rip function.

GNDB HDD Version = 1 - 01/08

GNDB Update Version = 1 - 04/08

The sub-menu for Gracenote/Start installation under the Service menu

Resetting the CIC

The Car Information Computer can be reset by pressing the rotary push button (ON button) for 25 seconds. After 25 seconds, the control display becomes blank as a confirmation that the CIC is being restarted.

CIC Start Screen After a Successful Reset

Note: When resetting the MOST control unit, the MOST gateway is muted for 2 seconds.

Programming

Programming the CIC is done with the use of the respective optical testing and programming interface modules.

The interface modules OP(P)S or ICOM (A+B) are simultaneously connected to the OBD interface and to the MOST interface of the vehicle.

Table of Contents

F01 Climate Control

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Climate Control

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the operation IHKA/FKA (4 zone) system used on the F01/F02
- Identify the components of the BMW IHKA/FKA system used on the F01/F02

Introduction

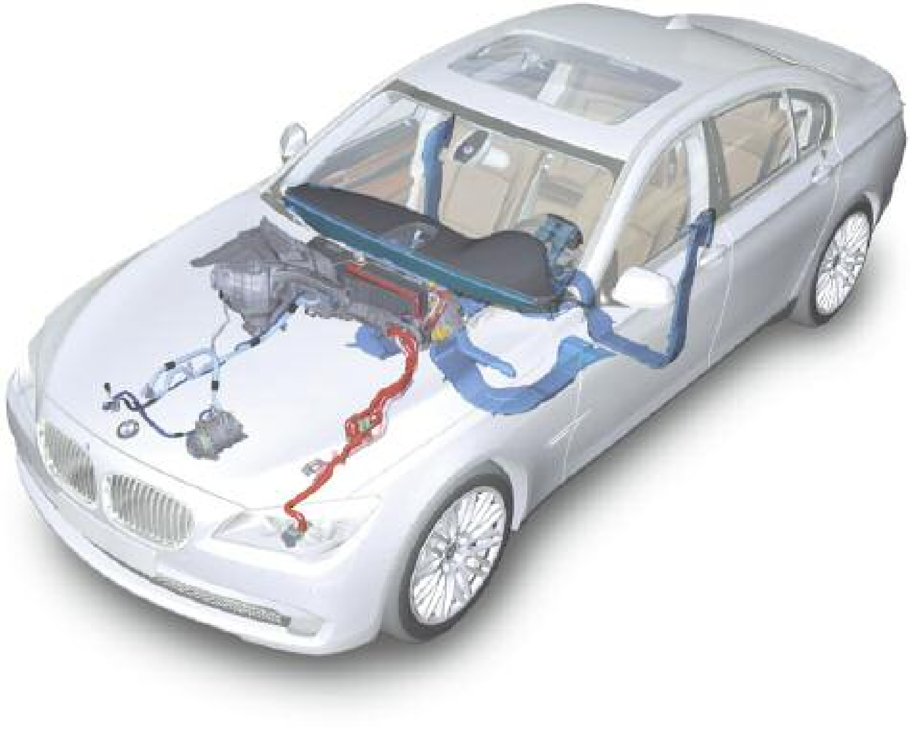
The F01/F02 heating and air conditioning system has been enhanced in terms of heating/cooling capacity, airflow distribution, noise and convenience when compared with the previous 7 Series system.

The F01/F02 will only be available with IHKA 4 zone (IHKA with FKA). The new 4 zone IHKA system is similar (in operation) to the system used on E70 and E71 vehicles.

The (IHKA) Integrated automatic climate control with rear climate control (FKA) is a 4-zone system.

Regardless on the equipment option selected, all essential climate control functions are individually accessible by each occupant.

IHKA integrated automatic climate control on F01/F02



IHKA (4 zone)

System Overview

The IHKA 4 zone has an additional control panel and control unit in the rear passenger compartment (FKA) allowing the rear passengers full control of temperature, air flow rate and airflow distribution with a choice of 5 intensity levels.

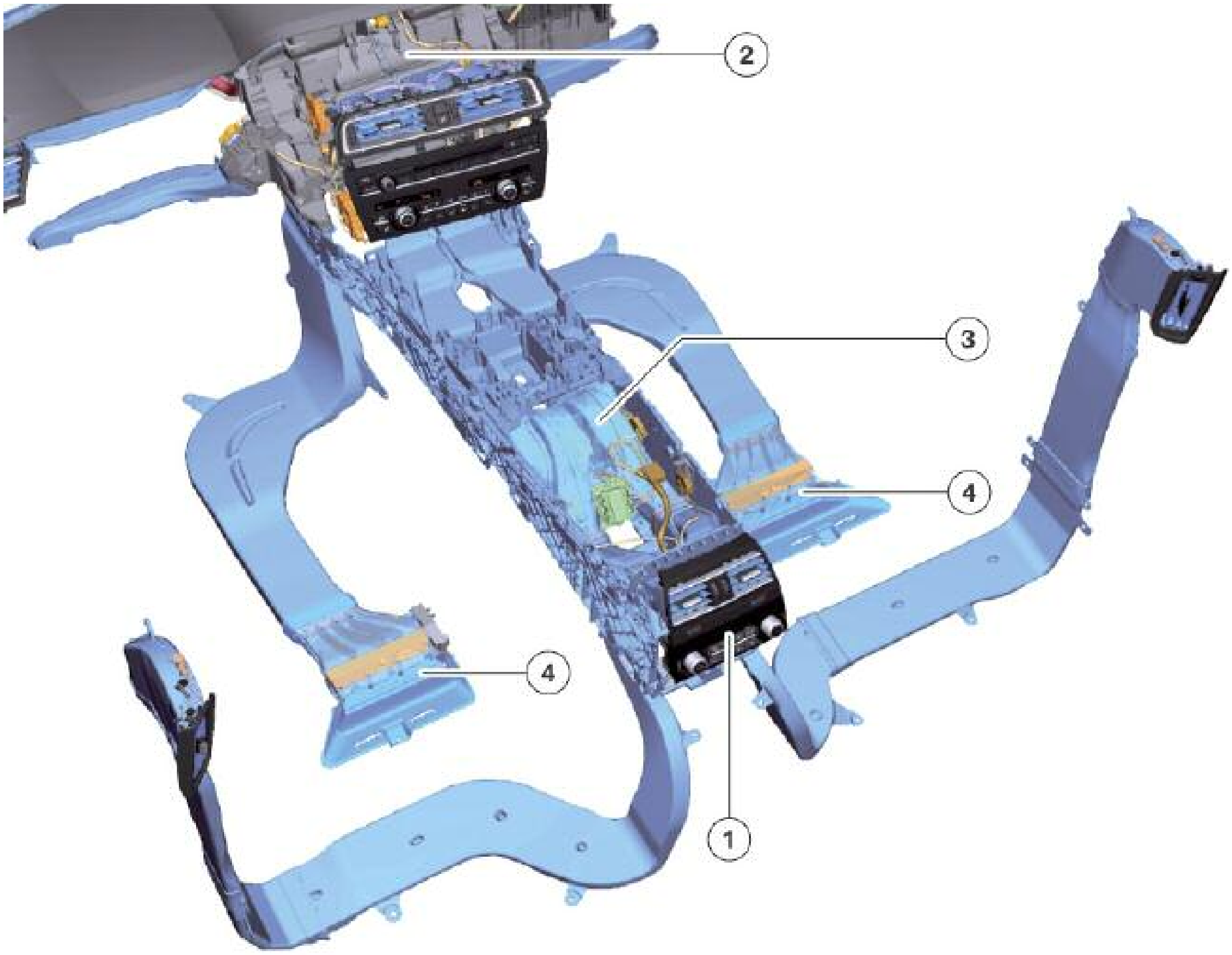
The IHKA 4 zone system is equipped with15 stepper motors.

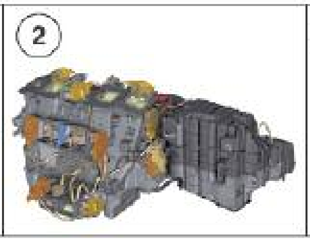
There is an extra blower fan located in the center console to enhance the air flow in the rear passenger compartment.

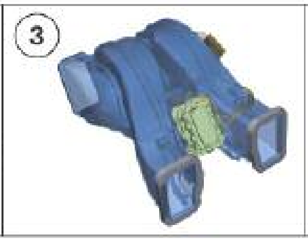
The rear footwell ducts are each fitted with a PTC heater element to warm up the outlet air temperature. They are individually adjusted depending on the rear passengers requested temperature settings.

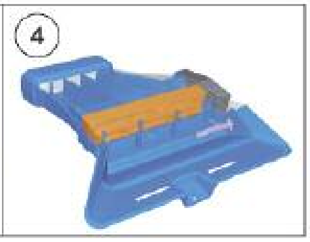
The rear occupants can also adjust the air temperature from the rear center air vent and the left and right B-pillar vents by means of two stratification adjusters (potentiometers) located on the rear center air vent.

Control panel for IHKA with FKA rear climate control with IHKA 4 zone.









Index	Explanation	Index	Explanation
1	Control panel for FKA rear climate control and center rear air vent	3	FKA fan in center console
2	IHKA climate-control housing with15 stepper motors	4	Left/right rear footwell PTC heater elements

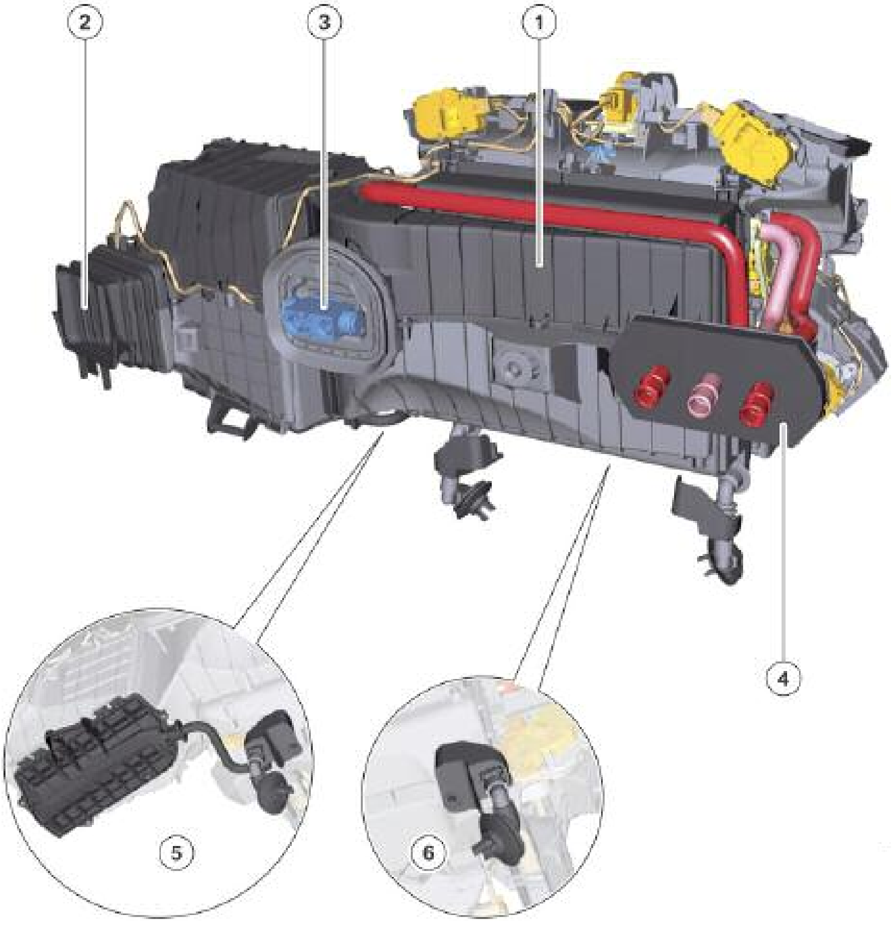
System Air Flow

The air flows through a flap between the fan motor and the climate control housing into the filter housing of the IHKA.

In the filter housing, the air is filtered by two combination filters (with activated charcoal) whether it is fresh air or recirculated air, it then flows on to the evaporator and heater core.

Depending on the IHKA settings and the in side and outside temperature, the air is initially cooled and dried by the evaporator and, if necessary, then re-heated by the heater core to deliver the requested outlet temperature.

F01/F02 Climate Control Unit

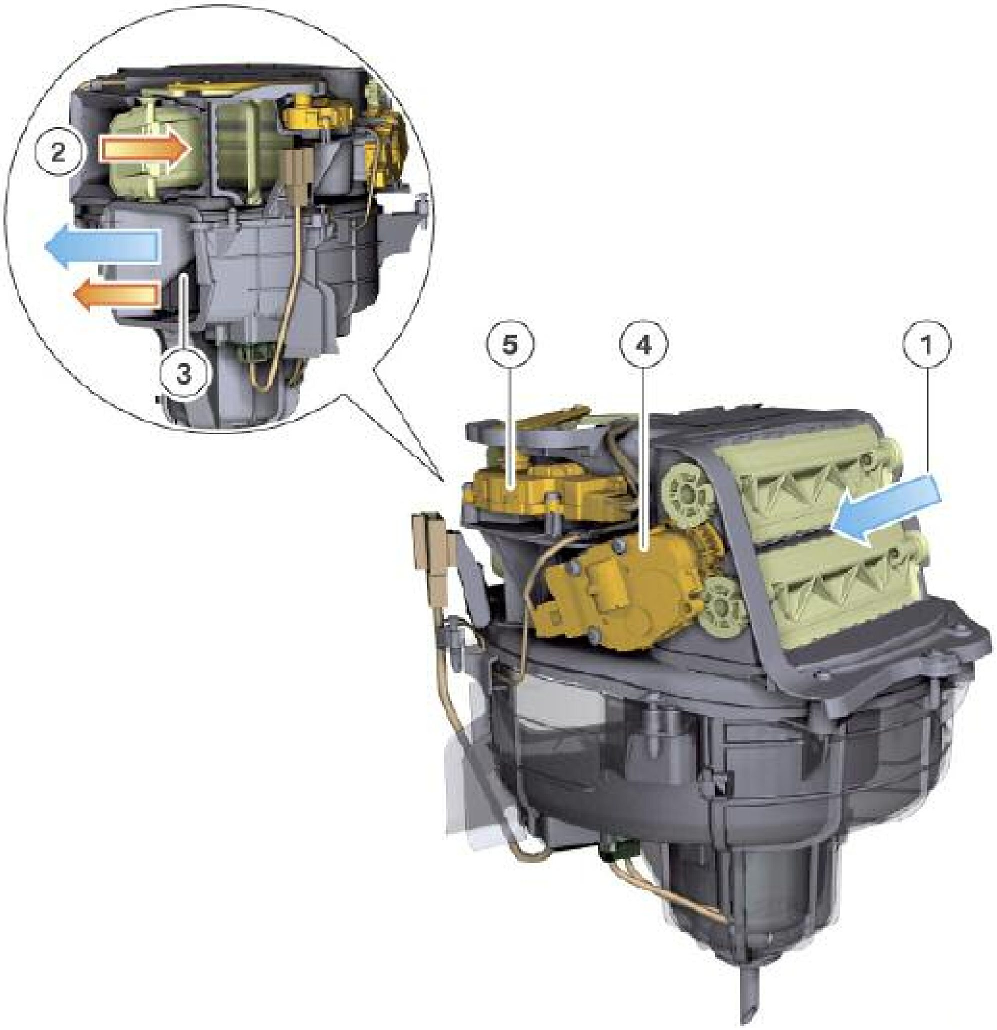


Index	Explanation	Index	Explanation
1	F01/F02 climate control housing	4	Pipe connections for heater core
2	Air inlet via flap	5	Right condensation drain from filter housing and climate control unit
3	Connection for refrigerant circuit/expansion valve	6	Left condensation from climate control housing

IHKA Blower Fan

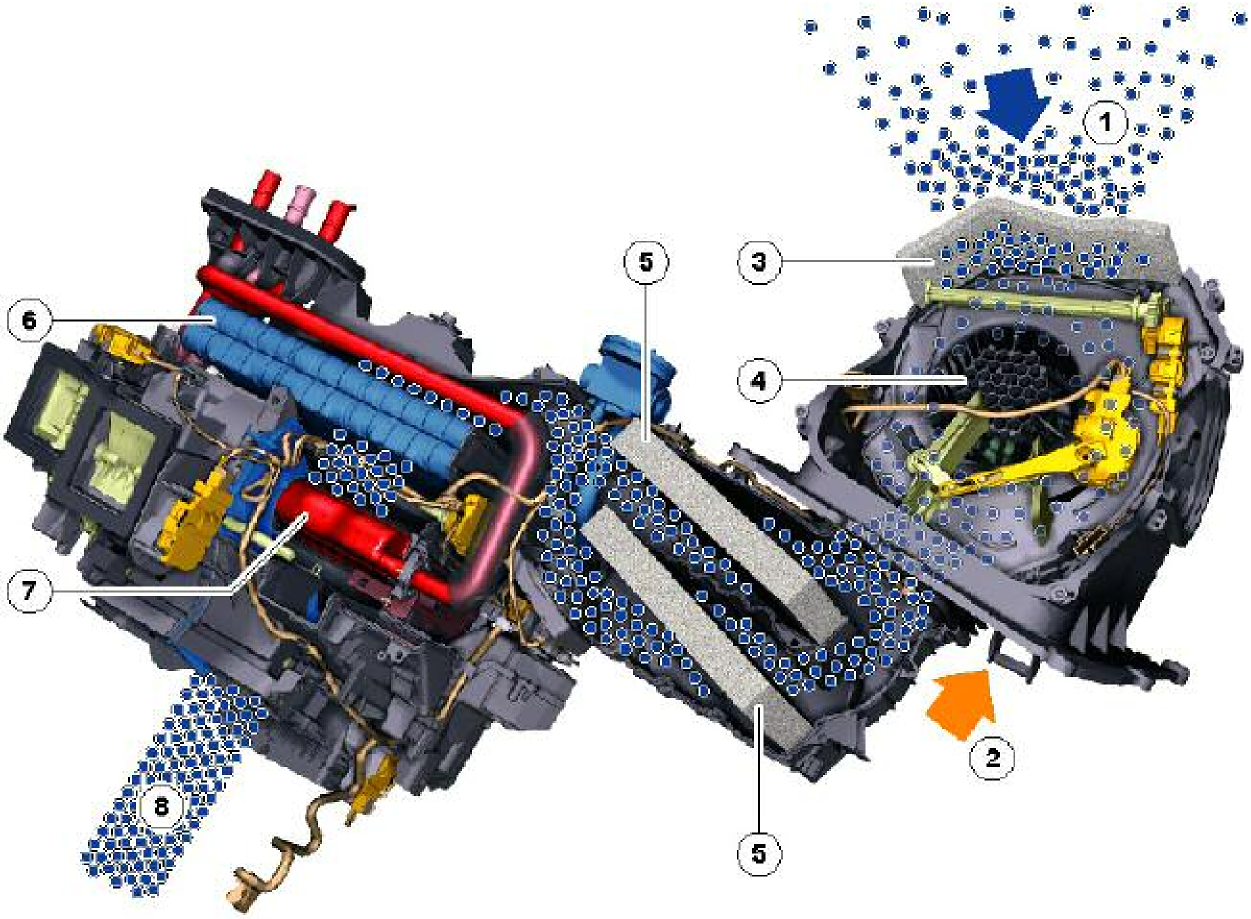
The fan draws in the recirculated air from the passenger compartment through an opening in the bulkhead.

Climate Control Air Intake Assembly on F01/F02



Index	Explanation	Index	Explanation
1	Fresh air intake	4	Fresh-air/ram-air stepper motor
2	Recirculated-air intake	5	Recirculated-air stepper motor
3	Air outlet via gaiter to climate control housing		

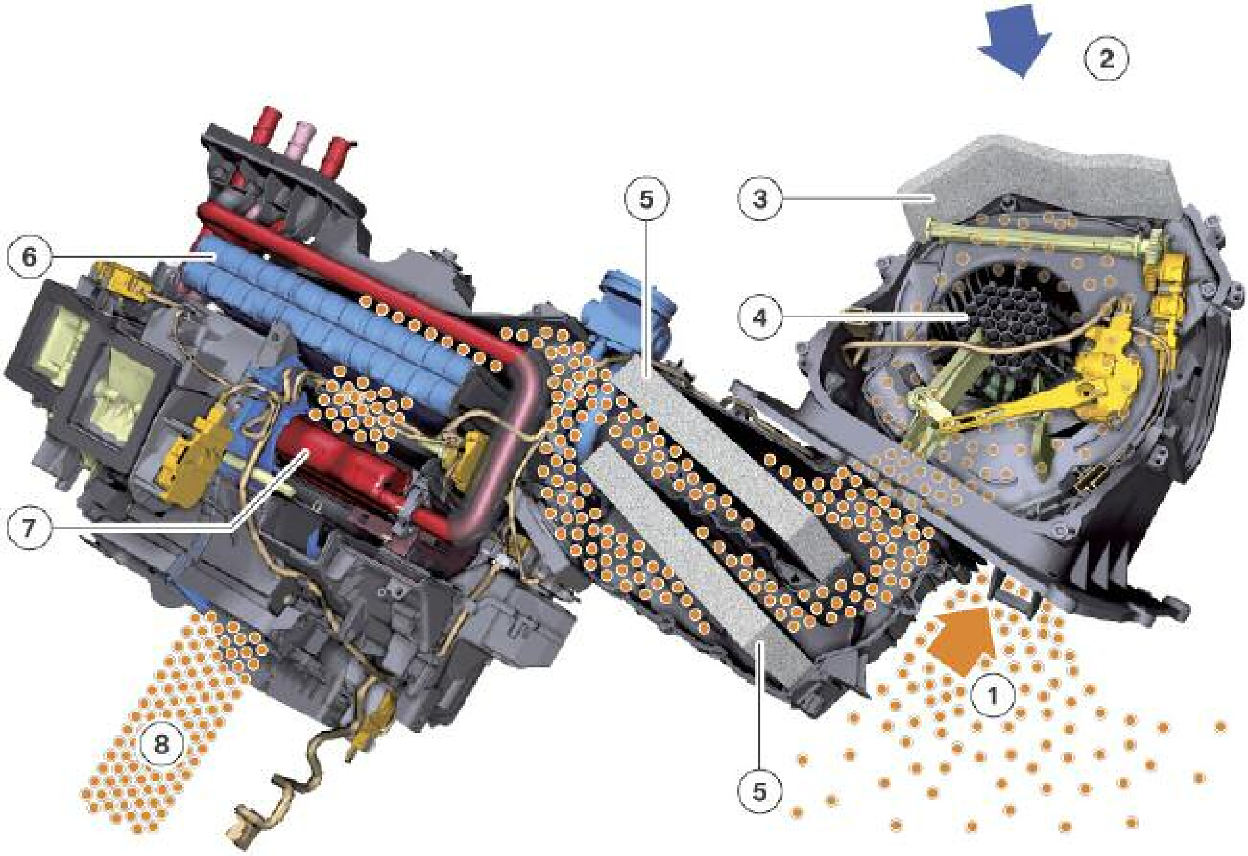
Fresh Air Intake



Top View of the Fresh Air Intake Path in the IHKA Housing on F01/F02

Index	Explanation	Index	Explanation
1	Fresh air intake via coarse filter to climate control fan	5	Two combination filters (activated charcoal)
2	Recirculated-air intake	6	Evaporator
3	Coarse filter in fan-motor housing	7	Heater core
4	Climate control system fan	8	Air outlet to air ducts and passenger compartment

Recirculated Air Intake



Top View of the Re-circulated Air Intake Path in the IHKA Housing on F01/F02

Index	Explanation	Index	Explanation
1	Re-circulated air intake from passenger compartment through opening in engine compartment bulkhead	5	Two combination filters (activated charcoal)
2	Fresh air intake	6	Evaporator
3	Coarse filter in fan-motor housing	7	Heater matrix
4	Climate control system fan	8	Air outlet to air ducts and passenger compartment

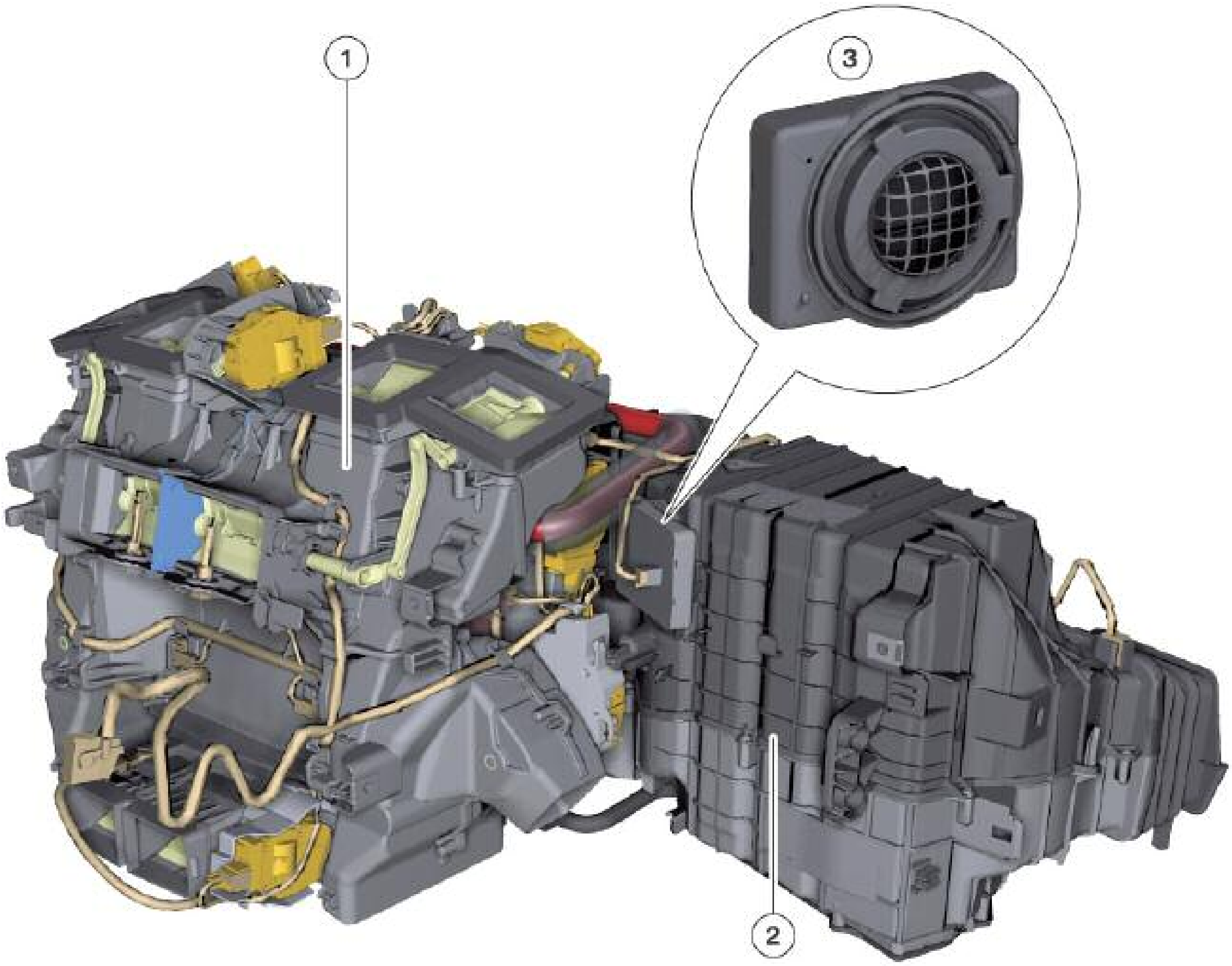
Air Ionizer

The air Ionizer used in the F01/F02 is the latest technical innovation in the area of heating and air conditioning.

The air ionizer is positioned upstream of the evaporator and it is activated as necessary when the vehicle is stationary.

By partial ionization of the air the formation of bacteria on the evaporator surface and the associated odor is prevented.

Air ionizer on F01/F02



Index	Explanation	Index	Explanation
1	F01/F02 climate-control unit	3	Air ionizer
2	Filter housing		

The air ionizer is a separate component which fits onto the climate-control unit with bayonet connection and is positioned in the air stream to the evaporator.

It essentially consists of a planar module, a flat ceramic plate which is covered by hard glass with printed electrical conductors located on the front and back of the component.

Air ionizer on F01/F02

Applying a high voltage generated internally in the ionizer partially ionizes the air.

The chemical reaction between the ionized air and the condensed water produces hydrogen peroxide in the evaporator housing, which kills bacteria and germs on the evaporator and thus prevents the formation of unpleasant odors that could enter the vehicle interior.

The IHKA decides when and whether to operate the air ionizer, based on the ambient and operating conditions of the climate control system.

The air ionizer is operated for a period of several minutes by a control signal from the IHKA.

Operation takes place as required only during the overrun period after Terminal 15 is turned OFF and the vehicle is locked.

The maximum power consumption of the unit is 850 mA.

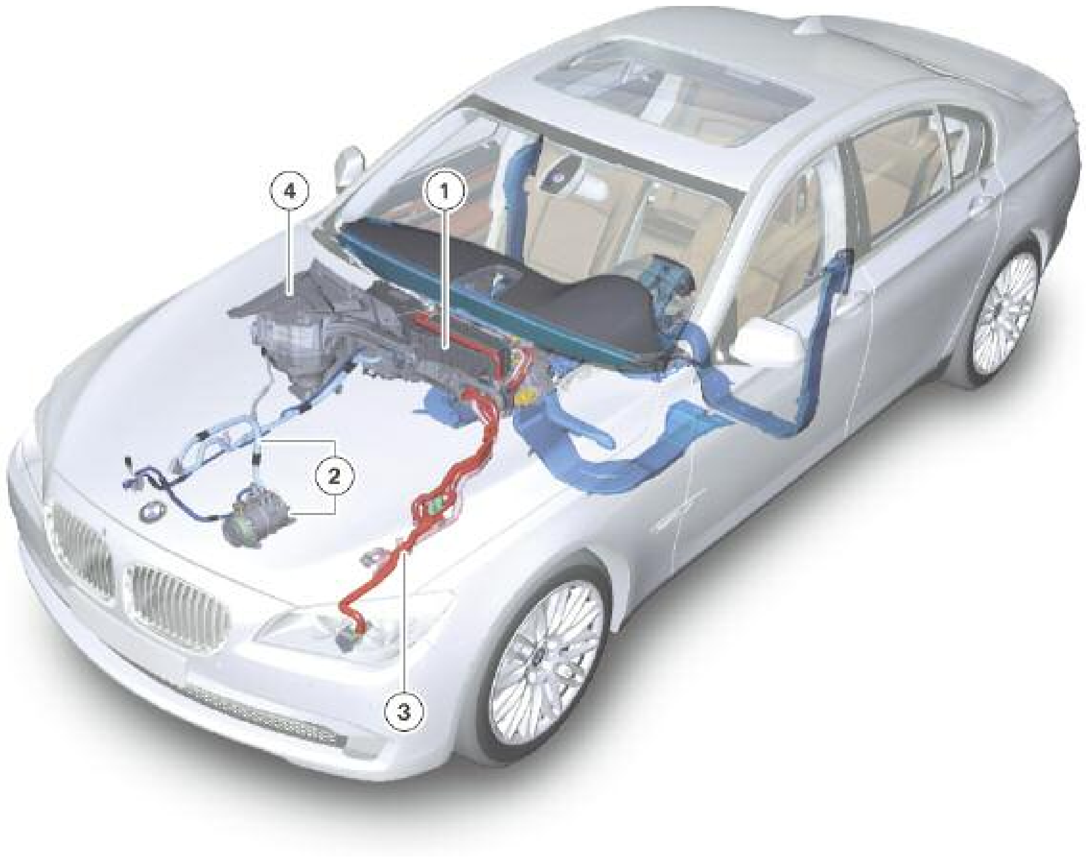
The power supply for operating the air ionizer is through a three-pin connector on the climate control wiring harness.

Communication with the IHKA control panel takes place by means of a control signal via a bidirectional cable connection.

IHKA Components

To optimize the system package, promote comfort and reduce noise level in the passenger compartment, the blower fan for the climate control system has now been placed in the engine compartment.

Main Components of the F01/F02 Climate Control System



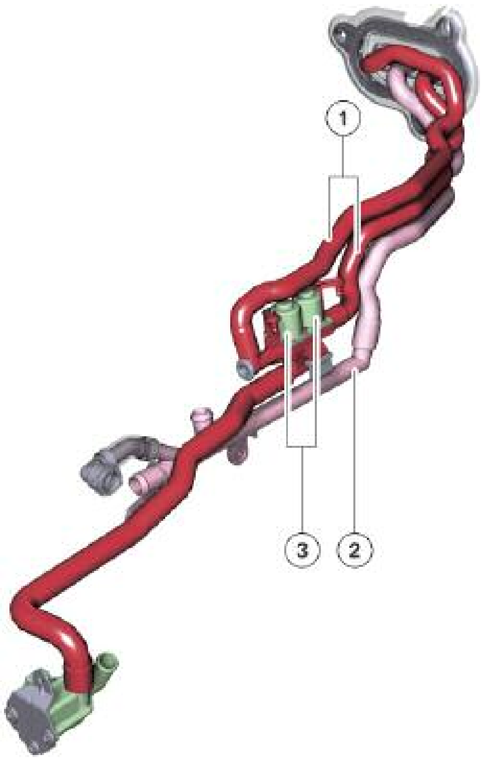
Index	Explanation	Index	Explanation
1	F01/F02 climate control system	3	Coolant pipes and double solenoid valves for the heater core
2	A/C compressor with intake and pressure lines	4	Fan for climate control system with fresh-air intake in engine compartment

Coolant Circuit of the Heating System

The F01/F02 IHKA system is a coolant regulated system. The coolant circuit uses a double solenoid heater control valve to control the temperature of the heater core.

Note: The N63 engine uses a mechanical water pump.

Index	Explanation
1	Flow pipes to heater matrix
2	Return pipe
3	Double solenoid valves for controlling the heater core temperature



Refrigerant Circuit

The refrigerant used on the F01/F02 is R134a.

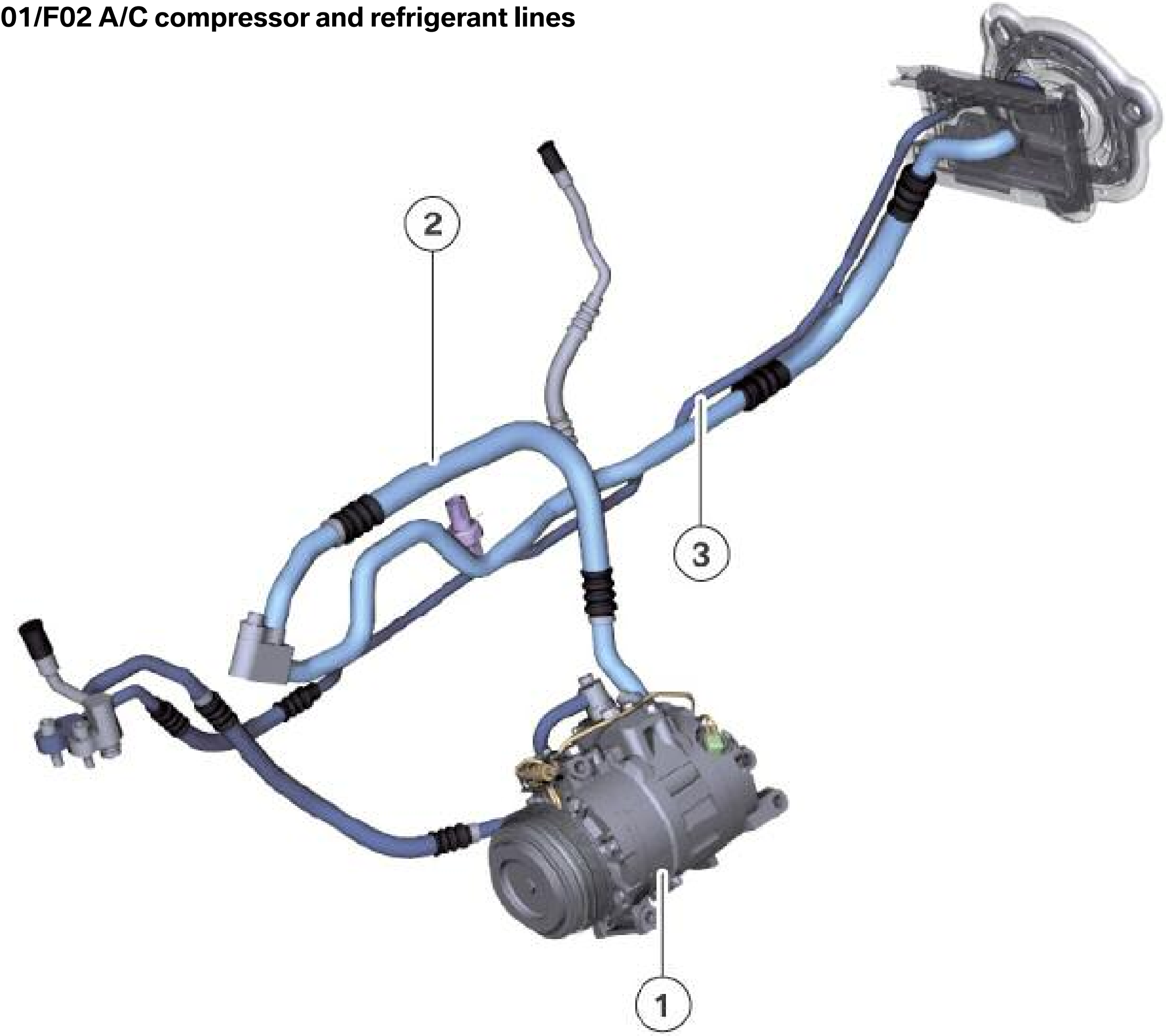
BAYERISCHE MOTOREN WERKE AG
MÜNCHEN. GERMANY
Füllmenge 810 ± 10g
Nur R134a(CF_3CH_2F)
ACHTUNG!
Schlauchleitungen der Klimaanlage stehen unter Druck.
Beim öffnen Sicherheitsvorschriften beachten!
AUTOMOTIVE AIR CONDITIONER
CONFORMS TO SAE J639
Charge 1.78 ± 0.02 lbs
ONLY R134a(CF_3CH_2F)
CAUTION!
Refrigerant lines of air conditioning system under pressure!
Observe safety regulations when opening! 6 920 708

Index	Explanation
1	Example of information plate in engine compartment of F01
2	Details of refrigerant and quantity used

Main AC Components

The A/C compressor location and refrigerant lines routing in engine compartment.

F01/F02 A/C compressor and refrigerant lines

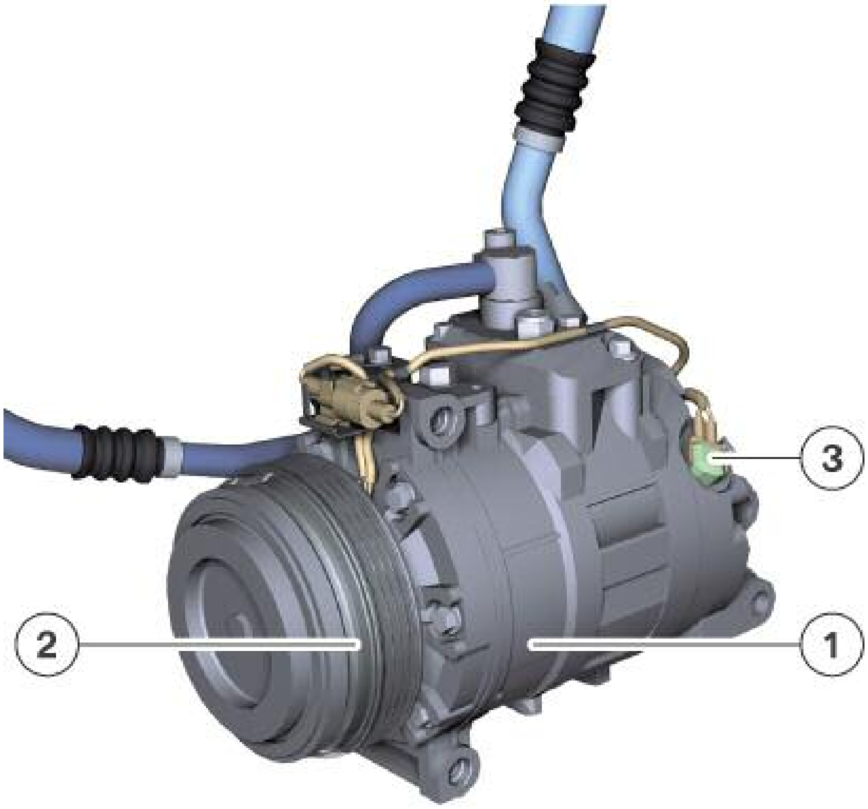


Index	Explanation	Index	Explanation
1	A/C compressor	3	Refrigerant circuit pressure line with pressure sensor
2	Refrigerant circuit intake line		

A/C Compressor

The system uses a variable displacement AC compressor with a magnetic clutch. Refrigerant pressure and flow are varied as the displacement of the compressor changes in response to the electronic control valve.

F01/F02 A/C Compressor

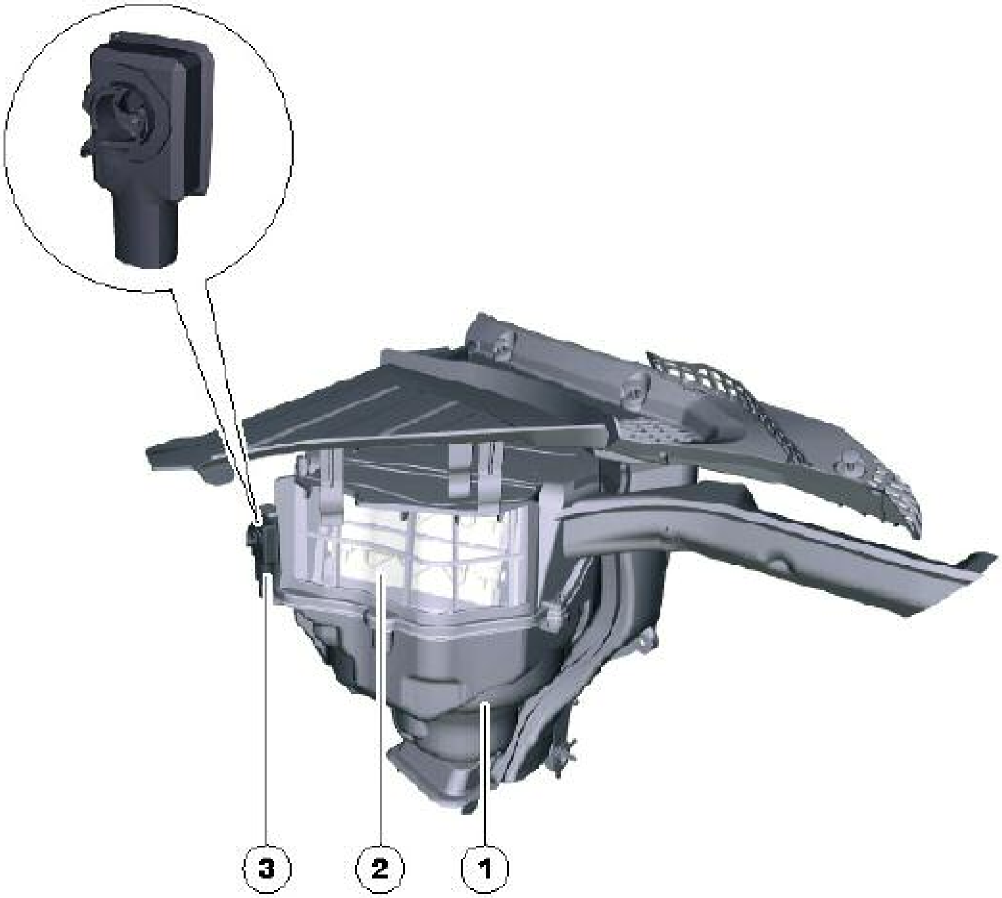


Index	Explanation	Index	Explanation
1	A/C compressor	3	Electronic control valve
2	A/C compressor magnetic clutch		

AUC Sensor

The AUC sensor is located next to the fresh air intake. The fresh air is drawn in through the cowl between windshield and hood and passes through a coarse filter in the climate control fan housing before entering the system.

Climate control system fan on F01/F02



Index	Explanation	Index	Explanation
1	Climate control system fan	3	AUC sensor
2	Coarse filter and fresh-air intake		

IHKA Front Control Unit Panel

The control panel and control unit of the climate control system on the F01/F02 is incorporated in the audio systems control panel.

The driver and front passenger can select separate automatic programs.

In order to be able to cater for the different heating/air conditioning preferences the automatic mode on the F01/F02 climate control offers a choice of 5 different levels of intensity for the automatic program.

Automatic mode is activated by pressing the AUTO button.

The intensity level is selected by repeatedly pressing the “Fan speed” rocker button when Automatic mode is active.

The “ALL” button can be used to synchronize the temperature, AUTO mode intensity or air flow rate and airflow distribution settings for all 4 zones with the settings for the driver.

The Residual feature is similar to the E70 in that it is operated by pressing the HIGH side of the driver’s fan speed button.

Some of the possible control scenarios on the control panels of the climate control systems are illustrated below.

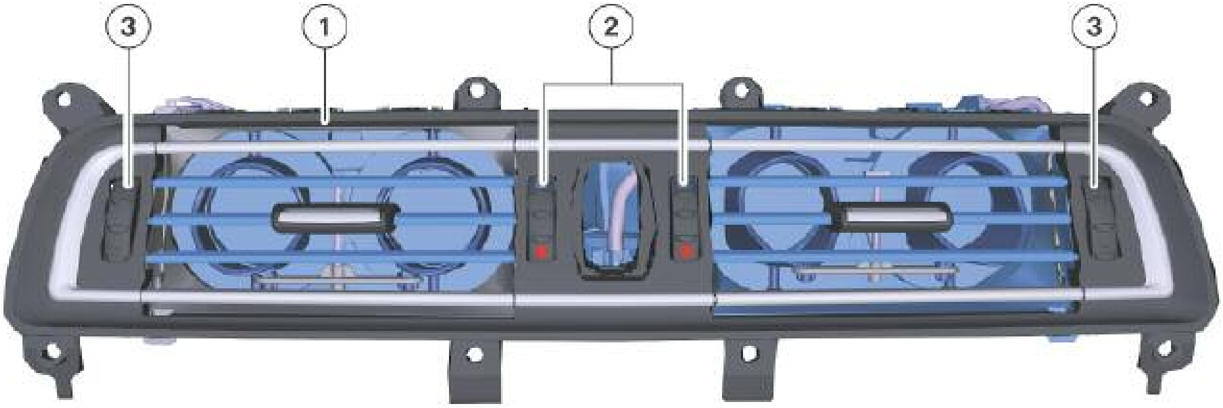
Control scenarios on control panels of F01/F02 climate control systems

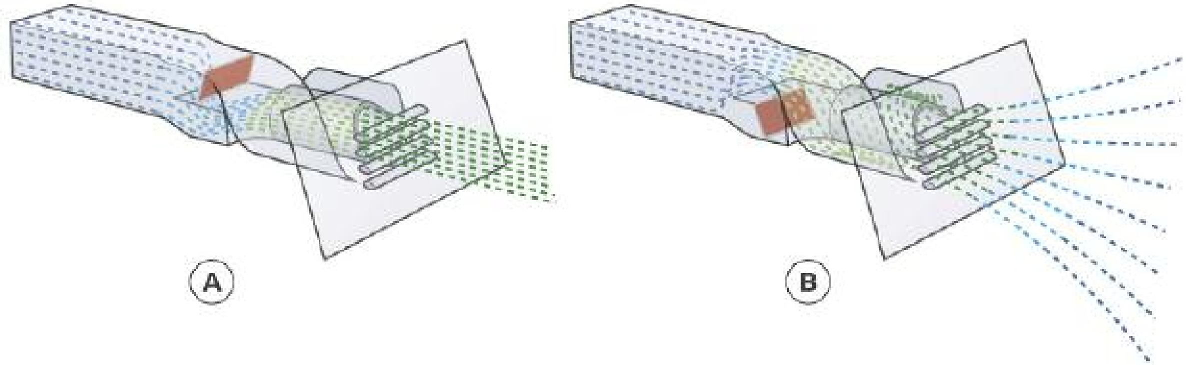
Index	Explanation	Index	Explanation
1	IHKA control panel, Automatic mode for driver and front passenger	3	IHKA control panel, Automatic mode for driver, climate control off for front passenger
2	IHKA control panel, Automatic mode for driver, manual mode for front passenger		

Front Center Air Vent

The front center air vent has a variable airflow focus feature that allows the airflow to be individually varied between spot-focussed and diffused mode settings.

Front center air vent with variable airflow focus on F01/F02





Index	Explanation	Index	Explanation
1	Front center fresh-air vent	A	Spot-focussed airflow setting
2	Front center airflow stratification controls	B	Diffused airflow setting
3	Spot/diffuser airflow adjusters		

Front center air vent with variable airflow focus on F01/F02

Index	Explanation	Index	Explanation
1	Left/right airflow stratification potentiometer and illumination	3	Left/right limit switch
2	Left/right adjuster illumination		

Left/right Side Air Vent

Index	Explanation
1	Adjuster and illumination
2	Limit switch

Left/right side air vent on F01/F02

Left/right B-pillar Air Vent

Index	Explanation
1	Adjuster and illumination

Left/right B-pillar air vent on F01/F02

FKA Rear Control Unit Panel

The 4-zone system has four control points for individually adjusting the climate control settings.

The rear passengers can adjust the temperature separately for the left and right sides.

The automatic program with its 5 intensity settings can also be selected in the rear seats.

As for the front seats, the intensity level in automatic mode for the rear passengers is selected and set by pressing the fan rocker button.

Index	Explanation	Index	Explanation
1	Control panel for FKA climate control set to automatic mode	2	Control panel for FKA climate control set to manual mode

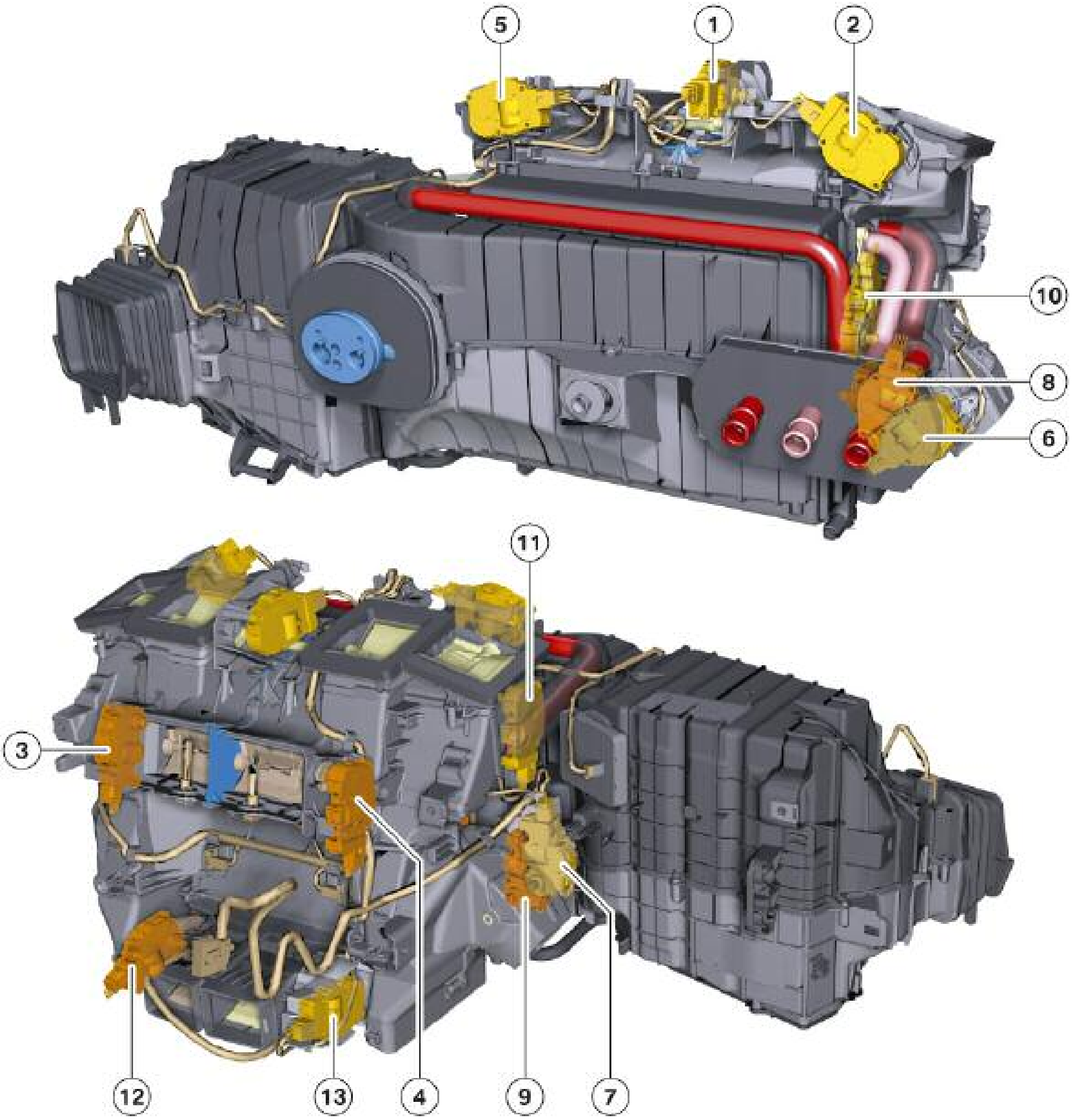
Rear Center Air Vent

Index	Explanation	Index	Explanation
1	Rear center air vent left/right airflow stratification potentiometer	3	Temperature sensor
2	Adjuster with illumination		

IHKA Stepper Motors

The IHKA 4 zone has a total of 15 stepper motors for automatic airflow distribution.

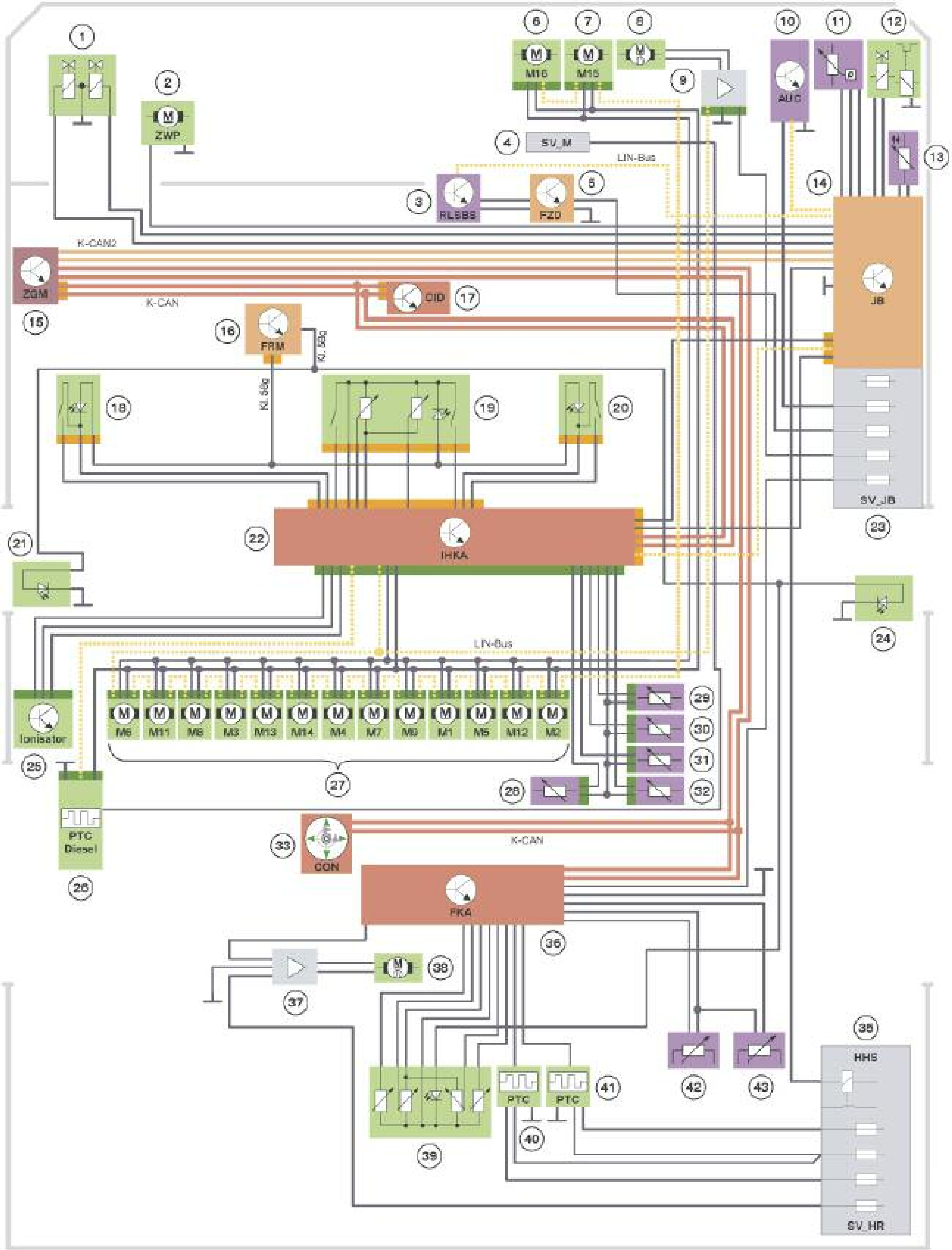
IHKA Stepper Motor Locations



IHKA Stepper Motors Location Legend

Index	Explanation
1	Stepper motor for defroster
2	Stepper motor for left outer air vent
3	Stepper motor for left center air vent
4	Stepper motor for right center air vent
5	Stepper motor for right outer air vent
6	Stepper motor for left front footwell
7	Stepper motor for right front footwell
8	Stepper motor for left rear footwell
9	Stepper motor for right rear footwell
10	Stepper motor for left front stratified airflow
11	Stepper motor for right front stratified airflow
12	Stepper motor for left rear stratified airflow
13	Stepper motor for right rear stratified airflow
14	Stepper motor for recirculated air (on fan motor housing)
15	Stepper motor for fresh/ram air (on fan motor housing)

IHKA (4 Zone) Circuit Diagram



Index	Explanation
1	Double solenoid valves for coolant supply to heater matrix, left/right
2	Electric auxiliary water pump (ZWP)
3	IHKA 4 zone: rain/light/solar/condensation sensor (RLBSS)
4	Not for US
5	Roof Function Center (FZD)
6	Servo motor for fresh air/ram air on air fan in engine compartment
7	Servo motor for recirculated air on air fan in engine compartment
8	Fresh air/recirculated air fan motor
9	Output stage for fresh air/recirculated air fan motor
10	AUC sensor for automatic recirculated air control
11	High-pressure sensor for air conditioner refrigerant circuit
12	Air-conditioning compressor with magnetic clutch and control valve
13	Outside temperature sensor
14	Junction Box electronics (JB)
15	Central Gateway Module (ZGM)
16	Footwell module (FRM), Terminal 58g
17	Central Information Display (CID)
18	IHKA 4 zone: left side vent limit switch and illumination
19	IHKA front center air vent, left/right airflow stratification potentiometer, left/right limit switch and illumination
20	IHKA 4 zone: right side vent limit switch and illumination
21	Left B-pillar vent illumination
22	Heating and air conditioning system/audio control panel IHKA control panel and control unit with interior temperature sensor

Index	Explanation
23	Front power distribution box
24	Right B-pillar vent illumination
25	Air ionizer on climate-control unit
26	Not for US
27	Stepper motors for automatic airflow distribution on climate-control unit IHKA 4 zone: fifteen stepper motors
28	Air temperature sensor, front center left
29	Air temperature sensor, front center right
30	Left heater matrix temperature sensor
31	Right heater matrix temperature sensor
32	Evaporator temperature sensor
33	Controller
34	Not for US
35	Rear right power distribution box with HHS relay
36	IHKA FKA control panel and control unit with interior temperature sensor
37	IHKA 4 zone: output stage for FKA center-console fan
38	IHKA 4 zone: FKA center-console fan
39	IHKA rear center air vent, left/right airflow stratification potentiometer, left/right temperature sensor and adjuster illumination
40	IHKA w/ FKA: PTC heater element in rear left footwell vent duct
41	IHKA w/ FKA: PTC heater element in rear right footwell vent duct
42	IHKA w/ FKA: temperature sensor in rear left footwell vent duct
43	IHKA w/FKA: temperature sensor in rear right footwell vent duct

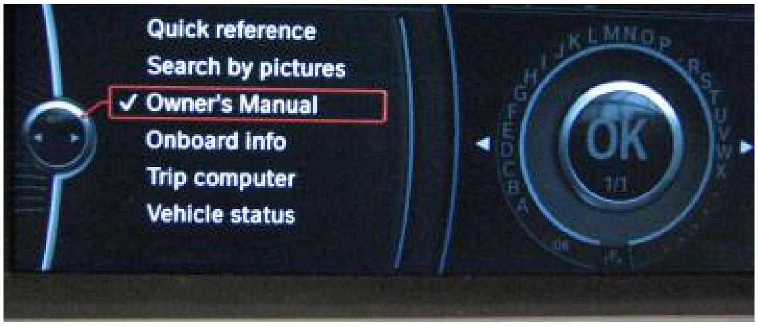
The F01/F02 introduces the interactive vehicle owner's manual.

It provides extensive information on system operation, function, configuration and performance.

The information can be accessed via the main menu.

- Main menu > (1)
  - Vehicle info > (2)
    - Owner's Manual > (3)
      - Keyword search > (4)
        - Climate Control > (5)

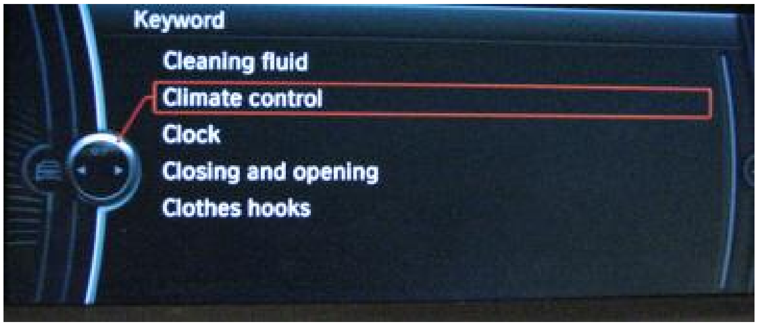
Interactive Owner's Manual on F01/F02



Extensive information is provided on the subject of air conditioning/climate control.

- Keyword search > (1)
    - Climate control (2)
        - Automatic climate control > (3)
            - Climate control functions in detail > (4)

Interactive Owner's Manual on F01/F02 climate control functions



Keyword

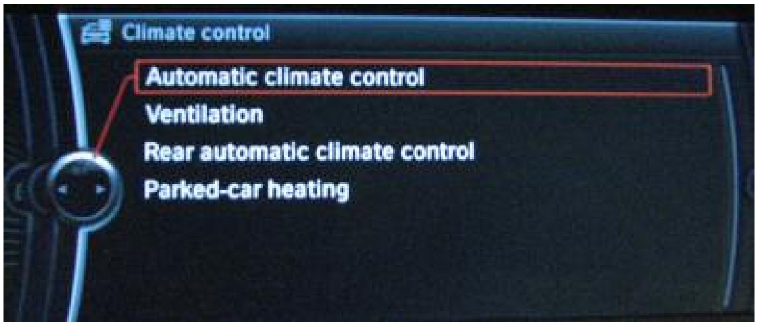
Cleaning fluid

Climate control

Clock

Closing and opening

Clothes hooks



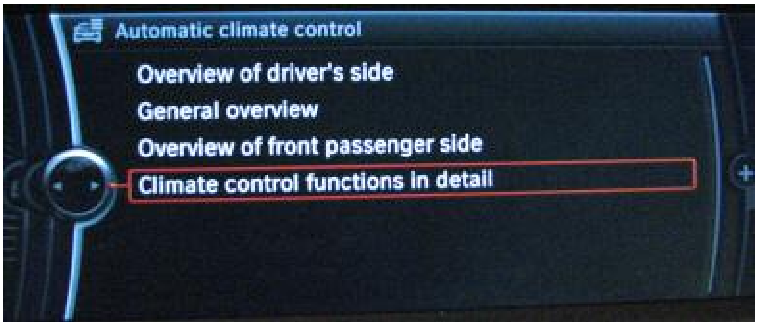
Climate control

Automatic climate control

Ventilation

Rear automatic climate control

Parked-car heating



Automatic climate control

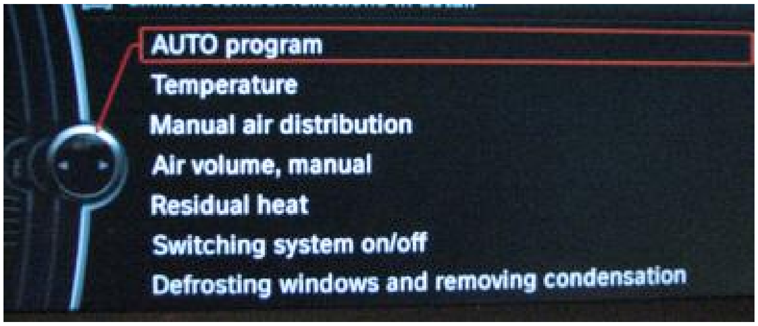
Overview of driver's side

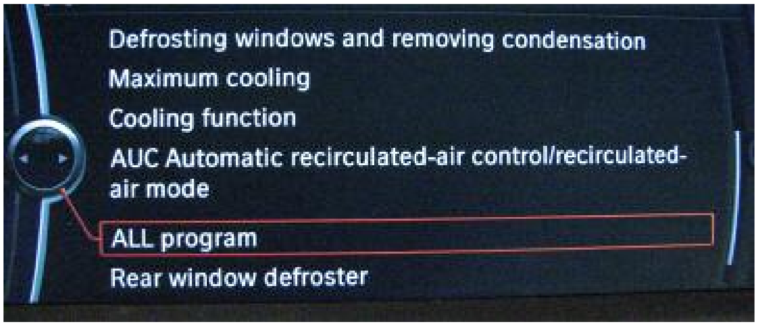
General overview

Overview of front passenger side

Climate control functions in detail

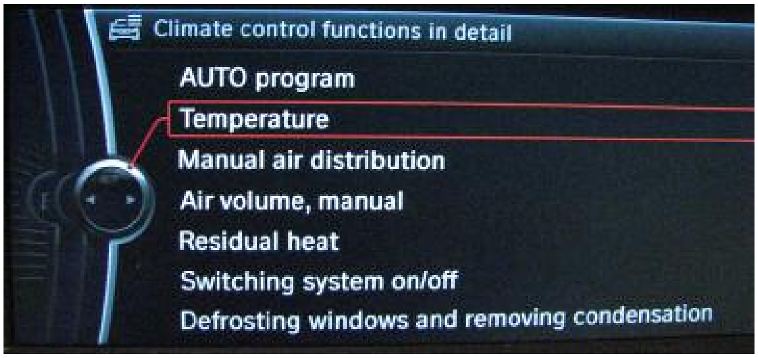
Interactive Owner's Manual on F01/F02 climate control functions





Index	Explanation	Index	Explanation
1	Climate control functions in detail	3	ALL program
2	AUTO program		

Interactive Owner’s Manual on F01/F02 climate control functions



Climate control functions in detail

AUTO program

Temperature

Manual air distribution

Air volume, manual

Residual heat

Switching system on/off

Defrosting windows and removing condensation

Climate control functions in detail

- Press the button on the right: increase intensity

The selected intensity is shown on the display of the automatic climate control.

Temperature

Turn the wheel to set the desired temperature. The automatic climate control achieves this temperature as quickly as possible, if necessary with

Index	Explanation	Index	Explanation
1	Climate control functions in detail	3	Adjusting temperature
2	Temperature		

- Main menu > (1)
  - Settings > (2)
    - Air conditioning > (3)
      - Rear air conditioning > (4)

Accessing air conditioning settings from main menu

Service Information

The following charts show the different systems/user functions and components used in the climate control systems of the F01/F02.

System Functions	IHKA/ FKA
IHKA Control Unit	X
FKA Control Unit	X
HKA Control Unit	
Control and adjustment points	4
Temperature zones	4
Air flow rate zones	4
Airflow distribution zones	4
AUTO programs with 5 intensity levels	3
Front Airflow stratification	2
Rear Airflow stratification	2
Air ionizer for evaporator disinfection	X

User functions	IHKA/ FKA
Variable airflow focus	X
Fresh air/recirculated air function, AUC	X
Cold start interlock	X
Start anti-misting	X
Anti-misting	X
Defrost	X
Max heating	X
Max cooling	X
Max A/C	X
Solar compensation	X
Residual heat	X
ALL function, 4 zones	X
OFF function	X
Rear OFF function	X
A/C compressor function manual cut-out	X

Sensor system	IHKA/ FKA
Front interior temperature sensor (IHKA)	X
Rear interior temperature sensor (FKA)	X
Evaporator temperature sensor	1
Refrigerant pressure sensor junction box electronics, JB	X
Heater matrix temperature sensor	2
Air outlet temperature sensor	6
AUC sensor, JB	X
Solar sensor	X
Condensation sensor	X

Table of Contents

F01 Passive Safety Systems

Subject **Page**

Initial Print Date: 01/09 Revision Date:

Passive Safety Systems

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the ACSM3 system of the F01/F02
- Describe the function of the ACSM3 system of the F01/F02
- Identify the components of the ACSM3 system of the F01/F02

Introduction

The F01/F02 passive safety system aims towards the objectives and characteristics of the E65/E66. The passive safety system fulfils all legislative requirements.

Extensive measures were taken on the body and on the occupants safety and protection systems. The passive safety system includes not only the restraint systems, but also a special body structure which offers a defined crash performance. In the event of an accident, the forces introduced are reduced in a defined manner and therefore have less on an impact on the occupants.

The restraint systems ensure that the risk of injury is further reduced.

The third generation ACSM is used as the central airbag control unit for the passive safety system on the F01/F02. It differs from the previous crash safety modules in having a sensor system placed in position.

The ACSM III provides up to 32 ignition outputs.

BMW safety concept with safety passenger cell and airbag systems in the example of an E60

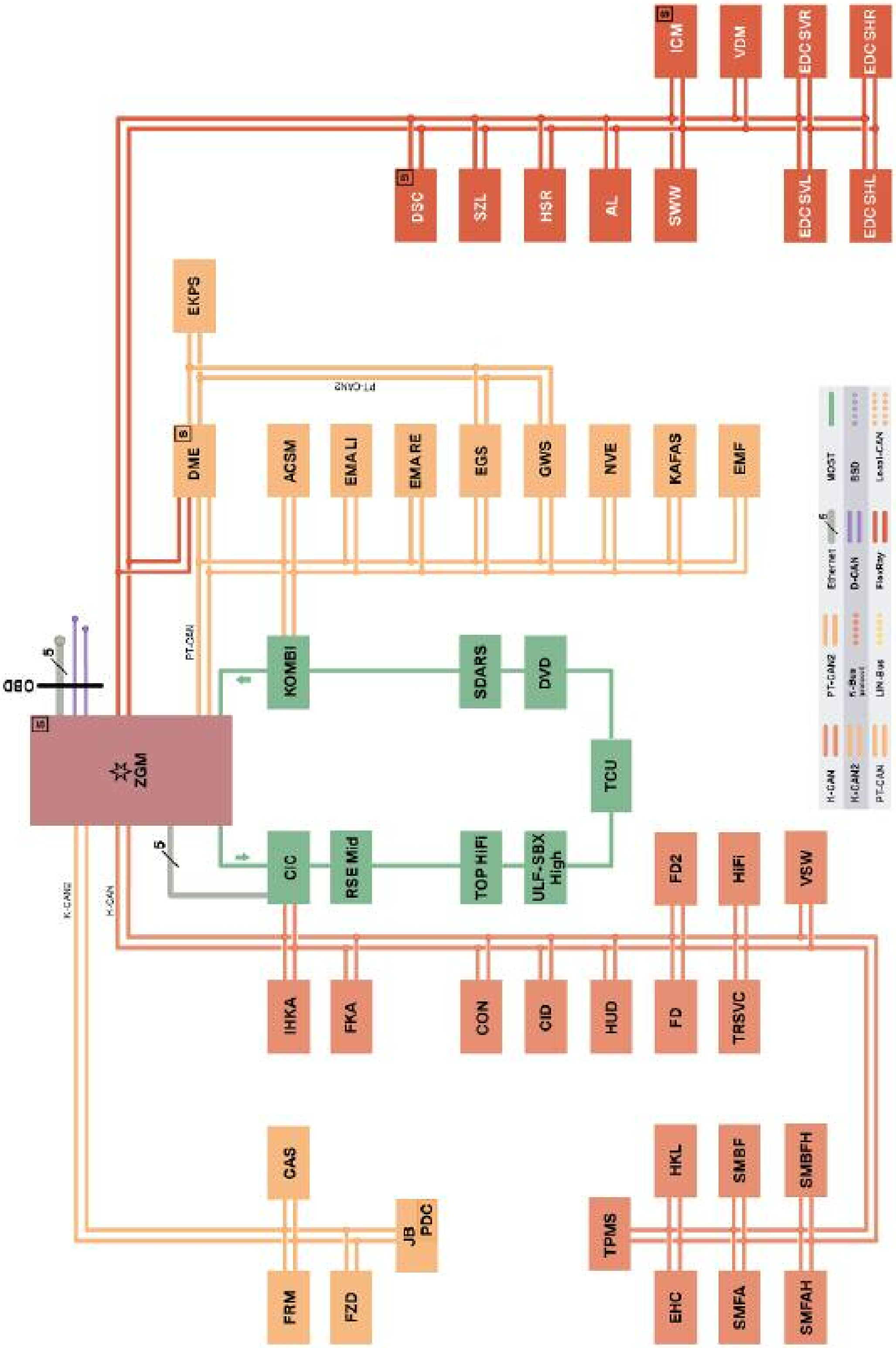
Model Overview

The passive safety system ACSM, the replacement system to the byteflight, is already used on the following models.

Model series	Model	Used as of	Variant
E60	5 Series Saloon	09/2005	ACSM 1
E61	5 Series Touring	09/2005	ACSM 1
E63	6 Series Coupé	09/2005	ACSM 1
E64	6 Series Convertible	09/2005	ACSM 1
E85	Z4 Roadster	01/2006	ACSM 1
E86	Z4 Coupé	05/2006	ACSM 1
E88	1 Series Convertible	04/2008	ACSM 2
E70	X5 SAV	11/2006	ACSM 2
E71	X6 SAC	04/2008	ACSM 2
E93	3 Series Convertible	03/2007	ACSM 2
F01	7 Series Saloon	11/2008	ACSM 3
F02	7 Series Saloon long version	11/2008	ACSM 3

System Overview

F01/F02 Bus System Overview



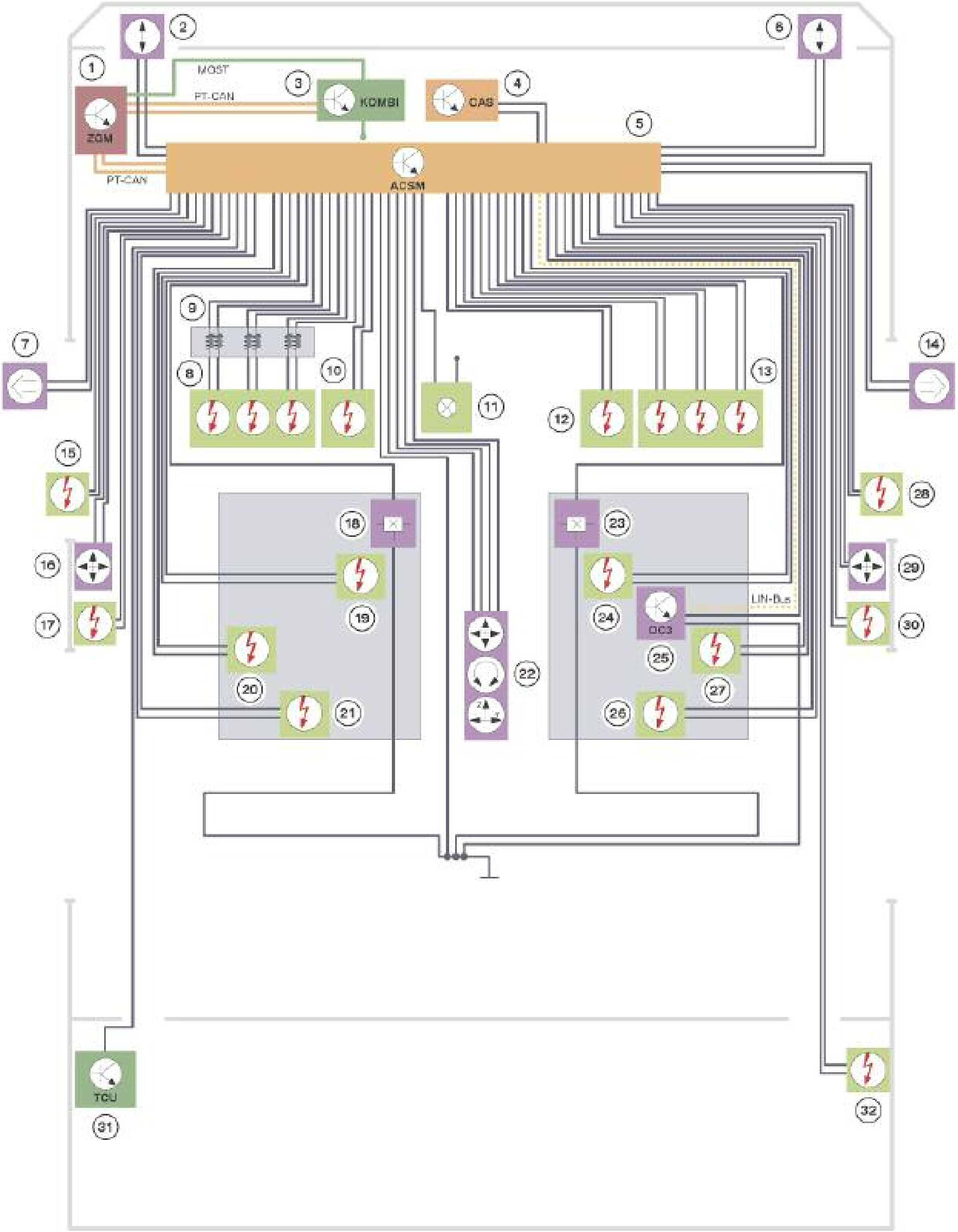
Legend for F01/F02 Bus System Overview

Index	Explanation
ACSM	Crash Safety Module (Advanced Crash Safety Module)
AL	Active steering system
CAS	Car Access System
CIC	Car Information Computer
CID	Central information display
CON	Controller
DME	Digital Motor Electronics
DSC	Dynamic Stability Control
DVD	DVD changer
EDC SHL	Electronic damper control, rear left satellite
EDC SHR	Electronic damper control, rear right satellite
EDC SVL	Electronic damper control, front left satellite
EDC SVR	Electronic damper control, front right satellite
EGS	Electronic transmission control
EHC	Electronic ride-height control
EKPS	Electrical fuel pump control
EMA LI	Electrically motorized reel, left, (seat belt)
EMA RE	Electrically motorized reel, right, (seat belt)
EMF	Electromechanical parking brake
FD	Rear compartment display
FD2	Rear display 2
FKA	Rear compartment heating/air conditioning system
FLA	High-beam assistant
FRM	Footwell module
FZD	Roof functions Center
GWS	Gear selector lever
HiFi	HiFi amplifier
HKL	Luggage compartment lid lift
HSR	Rear-axle drift angle control
HUD	Head-up display
ICM	Integrated Chassis Management
IHKA	Integrated automatic heating/air conditioning
JBE	Junction box electronics
KAFAS	Camera-based driver assistance systems
KOMBI	Instrument cluster
NVE	Night Vision electronics
PDC	Park Distance Control
TPMS	Tire Pressure Monitoring System

Legend for F01/F02 Bus System Overview (cont.)

Index	Explanation
OBD	Diagnosis socket
RSE-Mid	Rear seat entertainment
SDARS	Satellite tuner
SMBF	Passenger's seat module
SMBFH	Rear passenger seat module
SMFA	Driver's seat module
SMFAH	Rear module on driver' seat side
SWW	Lane change warning
SZL	Steering column switch cluster
TCU	Telematics control unit
TOP-HIFI	Top-HiFi system
TRSVC	Control unit for rear view camera and Side View (Top Rear Side View Camera)
ULF-SBX High	Interface box - high (USB / audio interface)
VDM	Vertical dynamics management (central control unit for electronic damper control)
VSW	Video switch
ZGM	Central gateway module

ACSM3 System Circuit Diagram



Index	Explanation
1	Central gateway module
2	Up-Front sensor, left
3	Instrument cluster
4	Car Access System
5	Crash safety module
6	Up-Front sensor, right
7	Door pressure sensor, left
8	Front airbag, driver
9	Coil spring for airbag
10	Knee airbag, driver
11	Passenger Airbag OFF light
12	Knee airbag, passenger
13	Front airbag, passenger
14	Door pressure sensor, right
15	Head airbag, left
16	B-pillar sensor, left
17	Adaptive belt force limiter, driver
18	Belt contact, driver
19	Seat belt pretensioner, driver
20	Side airbag, driver's side
21	Active head restraint, driver
22	Central sensor with rollover detection
23	Belt contact, passenger
24	Seat belt pretensioner, front passenger
25	OC3 mat
26	Active head restraint, passenger
27	Side airbag, passenger side
28	Head airbag, right
29	B-pillar sensor, right
30	Adaptive belt force limiter, passenger
31	Telematics Control Unit for emergency call
32	Safety battery terminal

System Functions

The function of the ACSM is to permanently evaluate all sensor signals in order to detect a crash situation. As a result of the sensor signals and their evaluation, the Crash Safety Module identifies the direction of the crash and the severity of the impact.

Also included is information on the occupants and whether they have their seat belts fastened or not. From this information, measures are taken to selectively trigger the necessary restraint systems.

The crash safety module monitors the system itself and indicates that the system is ready for operation when the airbag warning lamp (AWL) goes out.

If a fault occurs during operation, this is stored in a fault memory, which can then be read out for diagnostic purposes.

If a crash situation is detected, this is communicated to the other users in the bus-system network by way of a bus signal. The relevant control units respond to this signal by executing their own activities according to the severity of the crash.

The activities include:

- Opening the central-locking system
- Activating the hazard warning flashers
- Switching on the interior lighting
- Deactivating the fuel pump
- Switching off the auxiliary heating
- Automatic emergency call.

A function of ACSM is the seat belt reminder function, which uses optical and acoustic signals to remind the driver and front passenger to fasten their seat belts.

The functions of the ACSM are divided into:

- Crash-relevant functions
- System monitoring functions
- Additional comfort functions.

Crash-relevant Functions

The Crash Safety Module must fulfill the following crash-relevant functions:

- Evaluating the sensor signals
- Crash and rollover detection
- Determining the triggering times and order
- Triggering the output stages of the firing circuits
- Output of a crash telegram for other users in the bus system network
- Crash documentation
- Emergency call functions.

Evaluating the Sensor Signals

The sensors serve to detect and verify front-end, side-on and rear-end impact as well as a rollover.

The sensor signals are transmitted straight to the crash safety module and are evaluated there.

Crash and Rollover Detection

In addition to the longitudinal acceleration sensor and lateral acceleration sensor the central sensor also incorporates rollover detection. Rollover detection consists of a rate of yaw sensor and two low-g sensors. One low-g sensor measures in the Y direction, the second sensor in the Z direction.

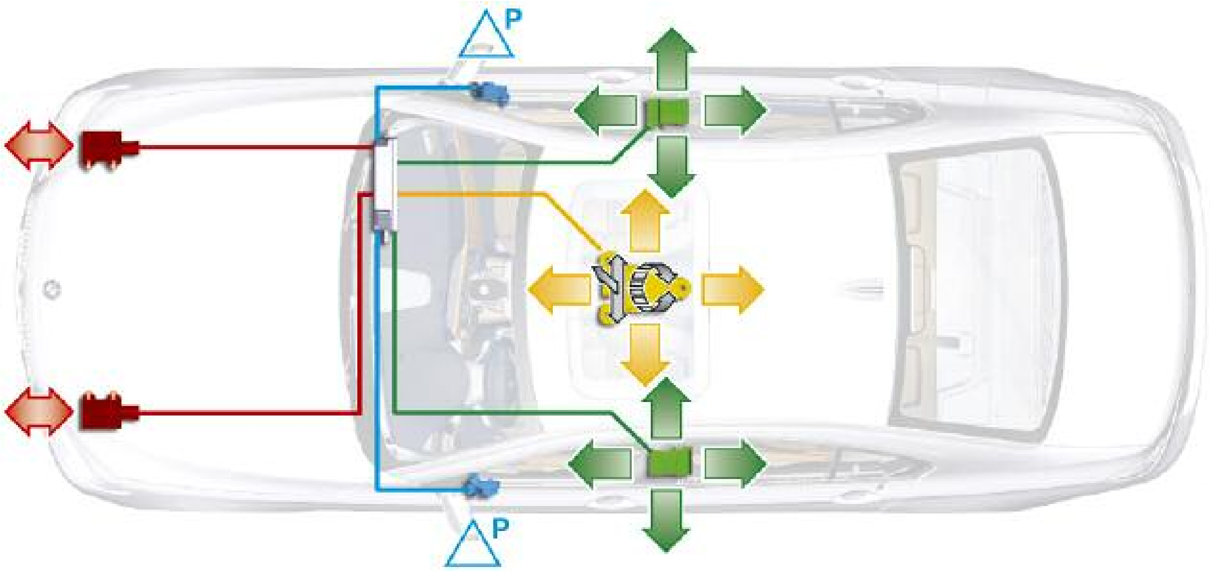
Additional airbag sensors are mounted in the B-pillars. These each consist of a longitudinal acceleration sensor and a transverse acceleration sensor.

Together with the transverse acceleration sensor in the central sensor, the transverse acceleration sensors serve to detect side-on crashes. Pressure sensors are also used in the front doors to detect side-on crashes.

Together with the longitudinal-acceleration sensor in the central sensor, the longitudinal-acceleration sensors serve to detect front-and rear-end crashes.

There are two airbag up-front sensors for front-end crash detection. They are located on the front area of the engine side members.

ACSM Sensor system



Detecting a crash and determining the triggering times and the order

The Crash Safety Module uses the values transmitted by the sensors to determine the direction and severity of the crash. The threshold values of two independent sensors must be exceeded in order to detect a crash. In the case of a front-end crash, for example, the relevant high acceleration values from the B-pillar satellite and from the longitudinal acceleration sensor must be detected in the crash safety module. Triggering the output stages of the firing circuits

Based on the acceleration values and crash severity and direction, an algorithm determines the triggering (firing) points and the order of the restraint systems to be activated.

A possible imminent rollover is also detected and the appropriate protection systems are activated.

Triggering the output stages of the firing circuits

The firing-circuit output stages are only triggered if the airbag algorithm detects that the threshold has been exceeded via different sensors, e.g. the airbag sensor in the B-pillar and the central sensor.

The crash safety module is powered by the Car Access System 4 (CAS4) using terminal 30b. At terminal 30b the crash safety module is in energy-saving mode, which means it is active at the bus and can also transmit the belt status to the EMA controller. Airbag functionality is blocked and only ready for operation at terminal 15 on completion of the system self-test.

The firing capacitors, which also serve as an energy reserve, are charged up by a switching controller. These capacitors make the firing energy available in the event of a crash. If the voltage supply is interrupted during a crash, the firing capacitors serve briefly as an energy reserve.

The output stages of the firing circuits consist of a high-side and a low-side power circuit-breaker. The high-side power circuit-breaker controls the firing voltage, while the low-side power circuit-breaker switches to ground. The output stages of the firing circuits are controlled by the microprocessor.

The high-side and low-side power circuit-breakers also serve the purpose of checking the firing circuits during the system self-test.

Output of Crash Telegram

In the event of a collision involving triggering of the restraint systems, the Crash Safety Module sends a crash telegram to the users in the bus-system network. Parallel to this, the TCU is informed via a direct single-wire line to transmit an emergency call.

As a result, the respective control units perform the following functions depending on the crash severity:

Function	Control Unit
Switch off electric fuel pump	Digital Motor Electronics DME
Switch off the auxiliary heating	Integrated automatic heating and air conditioning system IHKA (Not for US)
Release central locking	Junction box electronics JBE
Switch on hazard warning lights	Footwell module FRM
Switch on interior lights	Footwell module FRM
Transmit emergency call (only when airbag triggered)	Telematics Control Unit TCU

Crash Entries

In the event of a collision where one or more actuators are triggered, a crash entry is stored in a non-erasable memory. After three crash entries, a non-erasable fault entry is stored in the fault memory with the instruction to replace the crash safety module.

Note: The three crash entries could also be stored during the course of an accident. Each crash entry is assigned a system time.

The electronic control unit remains capable of firing even after three crash entries.
The crash entries cannot be erased and serve the purpose of subsequent device diagnosis.
A maximum of three crash entries can be stored. The control unit must then be replaced.

Emergency Call Functions

The emergency call functions are country-dependent and are available to customers in countries with BMW ASSIST infrastructure. This means an appropriate service provider with a call Center must be available. Another precondition for being able to make an emergency call is the availability of a telephone network.

With BMW ASSIST, the customer has a manual and an automatic emergency call as well as other functions.

A manual and an automatic emergency call function is provided as standard. Furthermore, the driver has the option of activating a breakdown call. Irrespective of whether the customer orders a telephone or not, each vehicle is equipped with a telematics control unit TCU, a telephone antenna, an emergency antenna, a handsfree kit and a GPS antenna for determining position.

■ Manual emergency call

The manual emergency call is intended for customers to request help quickly if they are present when an accident occurs without being involved themselves.

The emergency-call button is located in the roof function Center. The emergency call button is connected directly to the TCU.

Pressing the emergency-call buttons establishes a voice connection with the relevant country provider. The voice connection is indicated by a flashing LED in the switch.

■ Automatic emergency call

The crash safety module sends a crash telegram to the TCU in the event of an accident of corresponding crash severity. The TCU places an emergency call, which at the same time contains the location of the vehicle.

Parallel to this, attempts are made to set up a voice connection with the vehicle occupants to obtain more information on the accident (severity of the accident, number of injured) so that further rescue operations can be initiated.

System Monitoring Functions

The Crash Safety Module must execute the following system monitoring functions:

- System self-test (pre-drive check)
- Indication of system operability
- Cyclic monitoring
- Fault indication and fault code storage
- Fault output (diagnosis)
- Seat belt reminder function
- Deactivation of the front passenger front airbag, the knee airbag and side airbag in via the seat-occupancy detector.

System Self-test (Pre-drive check)

ACSM performs a system self-test as from terminal 15. The airbag warning lamp is activated for approximately 5 seconds during the system self-test.

When the system self-test is concluded and no fault has been found, the airbag warning lamp goes out and the system is ready for operation.

Indication of System Operability

ACSM system operability is indicated by the airbag warning lamp (AWL) going out in the instrument cluster.

Airbag warning lamp

Cyclic Monitoring

Once the system self-test has been successfully concluded and the system is ready for operation, a cyclic monitoring procedure is performed for fault monitoring purposes. Cyclic monitoring serves the purpose of internal diagnosis of the ECU and the overall airbag system. Cyclic monitoring is carried out for as long as the system is at terminal 15.

Fault Indication and Fault Code Storage

The crash safety module has a non-volatile fault memory. The airbag warning lamp indicates any entry in the fault memory.

A distinction is made between internal and external faults when entering the fault code.

Events such as triggering of an airbag or seat belt pretensioner are also stored in the fault memory.

Note: The entry of a triggered restraint system in the fault memory does not mean that the restraint system was defective in the crash situation, rather it only means that the restrain system is not available for further triggering.

Fault Output (Diagnosis)

With the aid of the ISTA diagnostic system, the fault memory can be read out via the diagnostic interface. After rectifying the faults or after replacing the triggered components, the fault memory can be cleared with the diagnosis command “Clear fault memory”.

Note: The cleared fault code memory entries are transferred to the past events memory. A maximum of 15 faults can be stored in the past events memory. When another entry is added, the first entry is deleted. The past events memory is set up as a ring memory and can only be read out by the development department. The past events memory is not available to the Service department.

Deactivating the Front Passenger Airbag

US law requires that specified child seats tested to specifications with a child roughly one year old on the front passenger seat be automatically detected and the passenger airbags be deactivated.

In order to meet legislative requirements, the OC3 mat (Occupant Classification OC) was developed.

■ OC3 Mat

The OC3 mat (Occupant Classification) detects a child seat specified in accordance with NHTSA and which is occupied on the basis of the pressure per unit area and disables the passenger airbag.

The OC3 mat consists of conductors in a pressure-sensitive resistance grid, so-called FSR elements (Force Sensitive Resistance). The conductors are connected to the electronic evaluation unit.

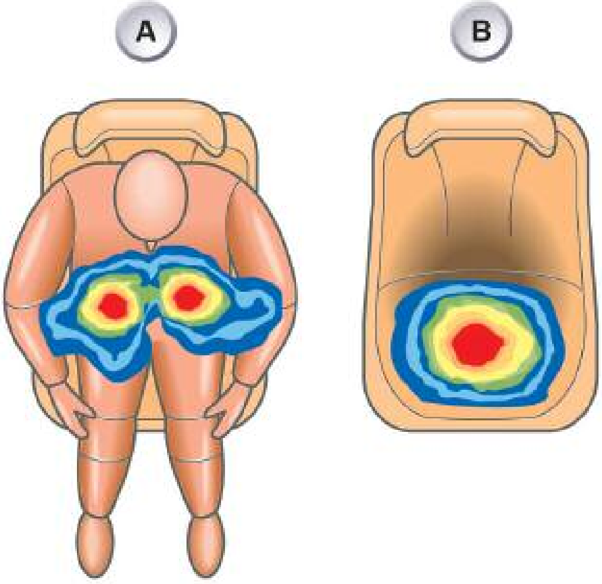
The FSR elements are wired in such a way that they can be sampled individually. When the mechanical load on a sensor element increases electrical resistance decreases and the measurement current changes accordingly.

OC3 Mat

By analysing the signals from the individual sensors, the analyzer can map the occupancy of the seat surface and identify local concentrations of weight. The relationship between the areas and the load points indicates whether there is a person or a child seat holding a small child present.

The electronic evaluation unit of the OC3 mat sends a telegram via the LIN-bus to the Crash Safety Module.

The front passenger airbags (front and side airbags) are disabled when a child seat with small child is detected. The crash safety module activates the passenger airbag OFF indicator lamp in the roof function Center.



Example of various surface imprints

Index	Explanation
A	Surface imprint of a person
B	Surface imprint of a child seat

Passenger Airbag OFF light

The passenger airbag OFF light in the roof console comes on when the child restraint system has detected a small child on the front passenger’s seat. Furthermore, the passenger airbag OFF lamp lights up when the seat is not occupied by a person.

The brightness of this light is controlled by automatic regulation of the display lighting.

Note: The Passenger Airbag OFF light is activated if the OC3 mat detects a child seat with a child approximately one-year old or if the front passenger seat is not occupied.

Electric Motor Driven Reel

Debuting in the F01/F02, an electric motor driven reel (EMA) is used for the seat belt. The electric motor driven reel is paired with the multifunction seat.

The electric motor driven reel reduces seat belt slack when fastening the seat belt using low retracting force as soon as the doors are closed. Removing the belt slack ensures that the seat belt fits the driver or front passenger. Thus better restraining action can be provided in the event of a crash.

Another advantage of the electric motor driven reel is the pre-tensions to the occupants before a possible accident with increased retracting force, thus also reducing the incidence of slipping out of the belt and the risk of submarining.

The dynamic driving control sensors in the ICM (Integrated Chassis Management) record data such as longitudinal acceleration and lateral acceleration, yaw rate, etc. The ICM passes on the data via the PT-CAN to the two EMA control units. The DSC also delivers information such as speed and brake pressure. The ACSM sends a message about the status of the belt contact to the two EMA control units.

From this data, the EMA control units calculate whether there is a critical driving situation, e.g. vehicle oversteer and as a result activates the electric motor, which pretensions the seat belt.

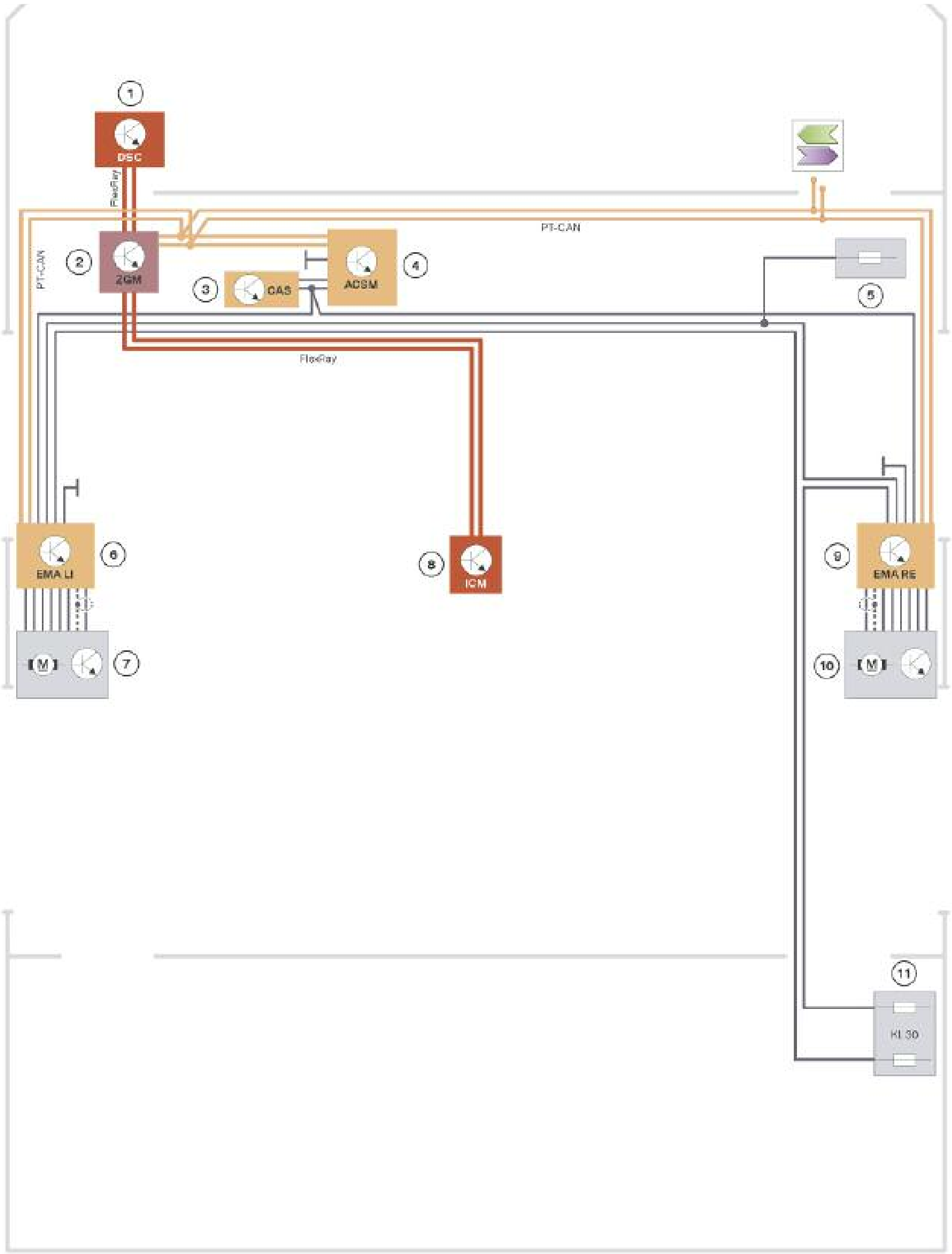
If there is now an accident with corresponding severity, the belt tensioner is also triggered and the seat belt fastened securely to the occupants.

The pre-tensions of the seat belt can reduce the force on the occupants in the event of an accident.

Index	Explanation
1	EMA control unit
2	Electric motor
3	Automatic reel
4	EMA drive unit

Seat belt with electric motor driven reel

System Circuit Diagram for Electric Motor Driven Reel



Index	Explanation
1	Dynamic stability control DSC
2	Central gateway module (ZGM)
3	Car Access System (CAS)
4	Crash safety module (ACSM)
5	Junction Box
6	Control unit, electric motor driven reel, left
7	Electric motor driven reel, left
8	Integrated Chassis Management
9	Control unit, electric motor driven reel, right
10	Electric motor driven reel, right
11	Luggage compartment junction box

Bus signals

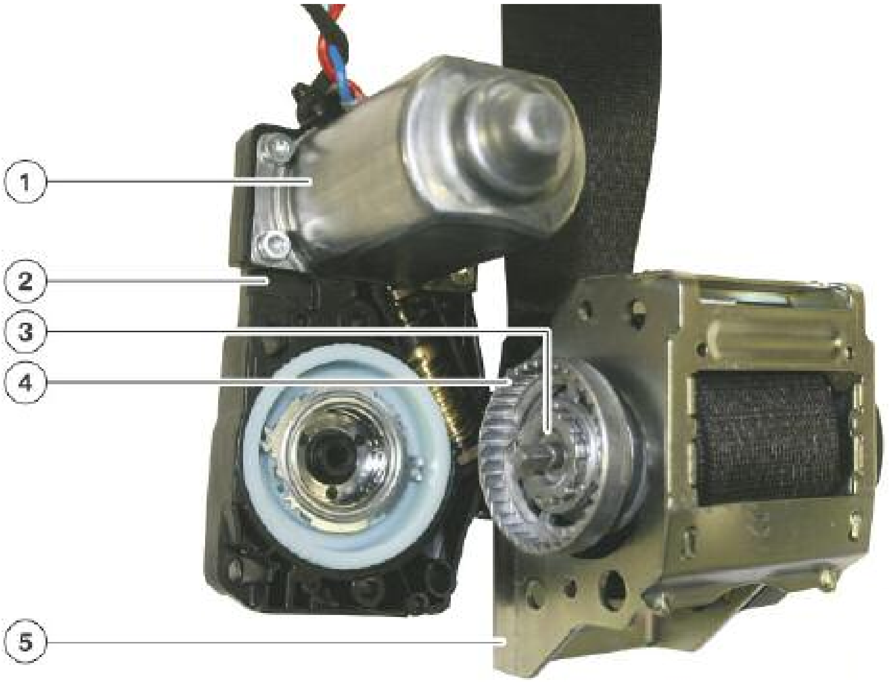
In/out	Information	Source/sink	Function
In	Terminal control	CAS > EMA LE/ EMA RI	Status terminal 30b
In	Vehicle speed	DSC > EMA LE/ EMA RI	Vehicle speed
In	Braking torque	DSC > EMA LE/ EMA RI	Emergency braking detection
In	Yaw speed	ICM > EMA LE/ EMA RI	Detection of skidding tilt
In	Steering angle effective at the front axle	ICM > EMA LE/ EMA RI	Steering effort
In	Longitudinal acceleration	ICM > EMA LE/ EMA RI	Acceleration
In	Lateral acceleration	ICM > EMA LE/ EMA RI	Lateral acceleration
In	Accelerator pedal angle	DME > EMA LI/ EMA RE	Driver power request
In	Belt contact status	ACSM > EMA LE/ EMA RI	Information whether the seat belt is fastened
In	Door contact	FRM > EMA LE/ EMA RI	Information whether the doors are closed

Design and Function of the Electric Motor Driven Reel

The electric motor driven reel is an extension of the functions of the existing automatic reel. The F01/F02 front automatic seat belt reels are also equipped with a pyrotechnic devices that operate the adaptive force limiters, as on E65/E66. The adaptive force limiters work independently from the (EMA) electric motor driven reels.

The electric motor driven reel essentially consists of an electric motor, a drive unit and a coupling, which establishes the connection to the automatic reel.

Components of the electric motor driven reel



Index	Explanation	Index	Explanation
1	Electric motor	4	Ring gear
2	Drive unit	5	Automatic reel
3	Belt shaft		

■ Electric motor driven reel, not working

The following image shows the design of the drive unit in detail (A). The locking pawls are retracted.

Image (B) shows the drive unit with ring gear. The ring gear and the belt shaft can rotate freely. The seat belt can be pulled out or rolled up.

Drive unit with separate components (A) and freely rotatable ring gear (B)

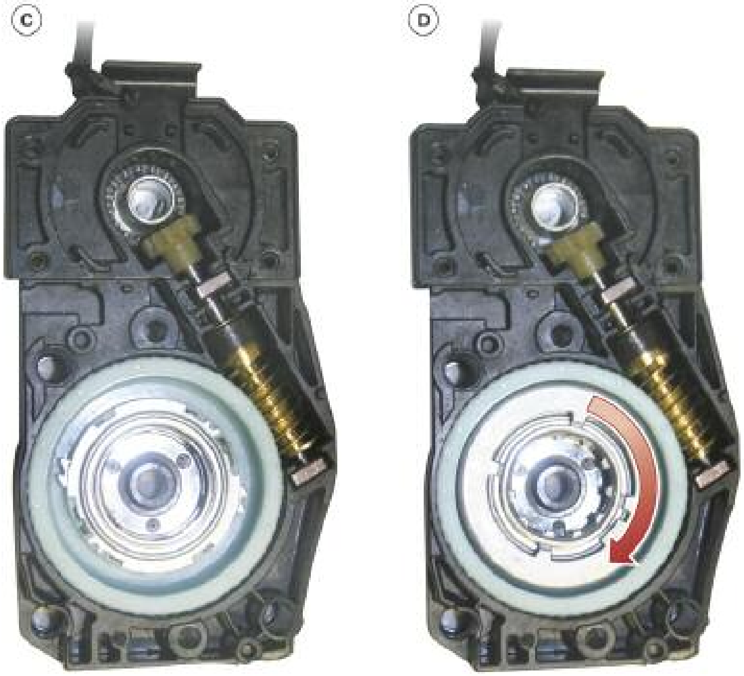
Index	Explanation	Index	Explanation
1	Drive gear for the electric motor	3	Worm gear
2	Drive gear for the drive shaft	4	Drive wheel with coupling

Electric motor driven reel in operation

When the driver or front passenger fastens their seat belt or there is a critical driving situation in terms of driving dynamics, the electric motor is activated and moves the drive shaft using the worm gear.

The worm gear turns the drive wheel with the coupling. The locking pawls move out and engage in the ring gear (C).

The ring gear, which is located on the belt shaft, drives the belt shaft (D). The seat belt is rolled up on the belt shaft and thereby shortened. This tensions the seat belt to the occupants.



Locking pawls move out (C) and the ring gear turns the belt shaft (D).

Driver Airbag

In conjunction with the seat belt, the driver's front airbag is designed to reduce the risk of serious injury to the driver's head or thorax during a head-on collision. The front airbag for the driver's side is located in the hub cushion of the steering wheel. The driver front airbag is equipped with a gas generator.

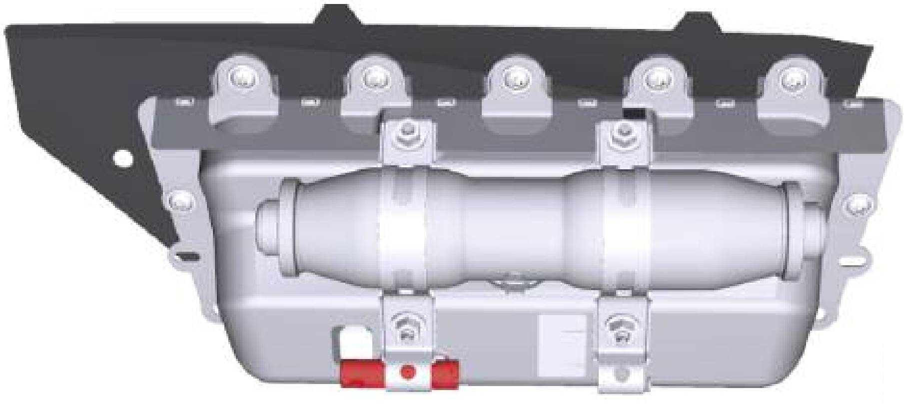
The airbag is triggered depending on the severity of the crash.

Driver airbag

Front Passenger Airbag

In conjunction with the seat belt, the front passenger front airbag, just as the driver front airbag, is designed to reduce the risk of serious injury to the passenger's head or thorax during a head-on collision. The front passenger front airbag is located under the dashboard.

Inflation of the front passenger airbag breaks the dashboard at defined points and opens two flaps, which are connected to the dashboard by means of fabric tapes. The passenger airbag opens in the direction of the windshield. The passenger airbag emerges in an upward direction and is supported on the windshield and on the instrument panel.



Front passenger airbag with pyrotechnically activated vent valve

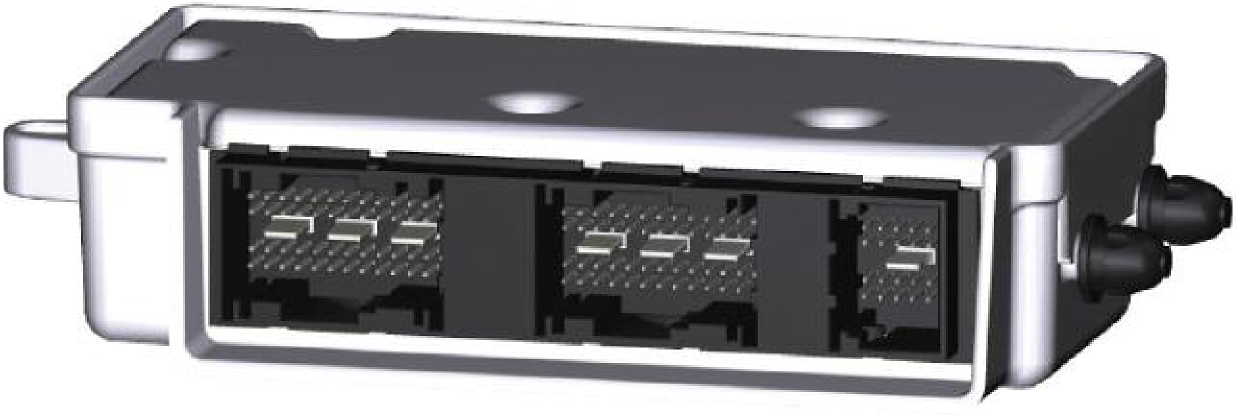
Note: The F01/F02 uses driver and passenger airbags with pyrotechnically activated vent valves which are explained under the "Actuators" section of this training material.

Crash Safety Module

The crash safety module in US vehicles is identical to vehicles for the rest of the world. It is adapted to the law and country-specific requirements by programming and coding.

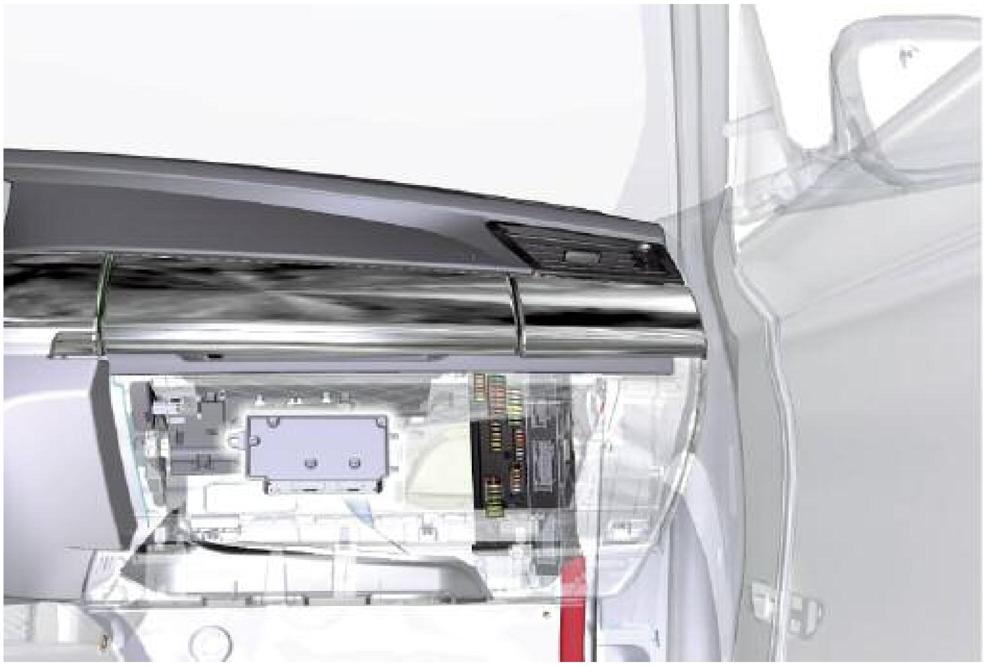
With ACSM3 Crash Safety Module is now integrated into the PT-CAN.

There are no sensors located in the crash safety module.



Crash safety module

The crash safety module has a new installation location for the F01/F02 is behind the glove compartment.



Crash safety module installation location

Sensors and Switches

All of the following sensors and switches were used on the previous ACSM systems with the exception of the Central Sensor, its functions where integrated inside the crash safety module:

- Central sensor
- Up-front sensor
- OC3 mat
- B-pillar sensor
- Door pressure sensor
- Seat belt buckle switches
- Emergency call button

Central Sensor

The central sensor is located centrally in the vehicle on the transmission tunnel.

In addition to the longitudinal acceleration sensor and lateral acceleration sensor, the central sensor has also been extended to incorporate rollover detection.

The longitudinal and lateral acceleration sensors detect positive and negative vehicle acceleration in a measuring range of 0-100 g. The longitudinal and lateral acceleration sensors detect acceleration in the event of a head-on, side or rear-end collision.

Rollover Detection

Rollover detection is provided by a rate of yaw sensor and two additional low-g sensors. The low-g sensors act in Y and Z directions.

There are different factors which can cause a car to overturn or roll over.

The most common causes are:

- The car hits a ramp (e.g. a crash barrier) on one side or the vehicle tilts due to the terrain. The car rotates about its longitudinal axis as a result of the high angular velocity.
- The car skids sideways off the road surface and its wheels become buried in soft soil. The kinetic energy could be sufficient to upend and overturn the car.
- The car skids sideways off the road into the kerb and is upended.

The crucial factors which determine whether the car overturns are not just the angle of rotation but also the angular velocity or angular acceleration at which the car is set into the roll. All these vehicle movements can also occur after a front-end, side-on or rear-end crash.

The two Low-g sensors have a small measuring range of 0-2 g and can therefore detect small accelerations and decelerations with great accuracy.

For example, when the vehicle skids sideways off the road surface and buries itself with its wheels in soft ground.

The sensors provide a voltage as measured variable. This voltage is a measure for the acceleration and is converted directly into digital signals in the sensor. The digital values are sent to the crash safety module for evaluation. The crash safety module evaluates the signals from the two Low-g sensors and the rate of yaw sensor. The results are compared with the stored algorithm. If the processor detects that a rollover situation is imminent, the seat belt pretensioners and the head airbags are triggered.

The sensor cluster is connected via a four-wire lead. A current interface which transfers a special report is used so that for the five sensors, this saves on six leads. This interface is also used for the other airbag sensors, so that, here too, savings can be made on leads and thereby weight.

Digital data transmission by means of current interface

The recorded acceleration values of the micro-mechanical acceleration sensors are converted in an ASIC (Application Specific Integrated Circuit) into digital signals. With the aid of a data telegram, the digital signals are transmitted unidirectionally to the Crash Safety Module.

The signals are transmitted via a current interface, which supplies the electronic circuitry with voltage.

The electronic circuitry receives a voltage level of approximately 5-10 mA via the current interface. The level rises at a step of 20 mA when a data telegram is transmitted so that only two lines per measurement channel are required.

The transmitted data is evaluated in the crash safety module.

Up-Front sensor

The airbag up-front sensors in the front area of the side member on the left and right sides serve to detect a head-on collision. They deliver additional information on the progress and severity of the collision to the crash safety module.

Each airbag up-front sensor consists of an acceleration sensor for recording the deceleration, a signal conditioner and an ASIC for data transmission.

The measured values are sent in the form of a data telegram to the crash safety module and are used in the calculation of the algorithm.

OC3 Mat

US legislation stipulates that the use of a child restraint system tested by NHTSA and holding a small child on the front passenger seat must be detected automatically and the front passenger airbag disabled.

The OC3 mat can detect an occupied child seat tested in accordance with the regulation (NHTSA FMVSS 208) on the basis of the pressure per unit area and disable the passenger airbag (front and side airbag). The passenger airbag OFF light comes on when a child restraint system tested in accordance with NHTSA and holding a small child was detected on the front passenger's seat.

Note: NHTSA FMVSS 208 stands for National Highway Traffic Safety Administration Federal Motor Vehicle Safety Standard 208

B-Pillar Sensor

The B-pillar airbag sensor consists of a longitudinal acceleration sensor and a transverse acceleration sensor.

The acceleration sensors measure both the acceleration and the deceleration in the X and Y directions. The resultant from the X and Y signals is the definitive factor in determining the direction of the impact.

The B-pillar airbag sensors serve the purpose of detecting head-on, side and rear-end collisions.

The B-pillar airbag sensors on the left and right are of identical design and are allocated by way of mechanical coding during installation.

Door Pressure Sensor

The airbag sensors in the front doors serve the purpose of verifying the plausibility of the acceleration signals from the B-pillar airbag sensors and the central sensor during side crash detection.

The airbag sensors are situated in the inner panels of the front doors and measure the increase in pressure in the event of a side-on impact.

In the event of a side-on impact with the door, the outer door panel is pressed inward, thus reducing the inner door space and increasing the pressure. This change in pressure is measured by the airbag sensors.

The airbag sensor also includes an electronic module, in addition to the pressure sensor, which digitizes the pressure values and transmits them cyclically to the Crash Safety Module. The data is transmitted in the same way as the B-pillar airbag sensors.

The pressure values are evaluated in the crash safety module.

Seat Belt Buckle Switches

The seat-belt buckle switches signal whether the seat belts are fastened or not. The signals from the seat belt buckle switches are transmitted to the Crash Safety Module and are used for triggering the required restraint systems and for the seat belt reminder function.

The seat belt buckle switch is located in the seat belt buckles of the driver's and front passenger's seat.

The seat-belt buckle switch is designed as a two-wire Hall-effect switch. The crash safety module powers the Hall switch via a current interface. The current intake of the switch varies depending on whether the seat belt is fastened or not. The seat belt buckle switch is permanently monitored as from terminal R "ON".

Actuators

The crash safety module is used in to control the following actuators:

- Adaptive driver airbag
- Adaptive front passenger airbag
- Driver/front-passenger side knee airbag
- Curtain (head) airbags, left and right
- Side airbag, integrated in the left and right front seats
- Front seat belt pre-tensioner, front left and right
- Automatic seat belt tensioner with adaptive force limiter
- Active head restraint, front left and right
- Safety battery terminal

The following warning lamps are additionally activated:

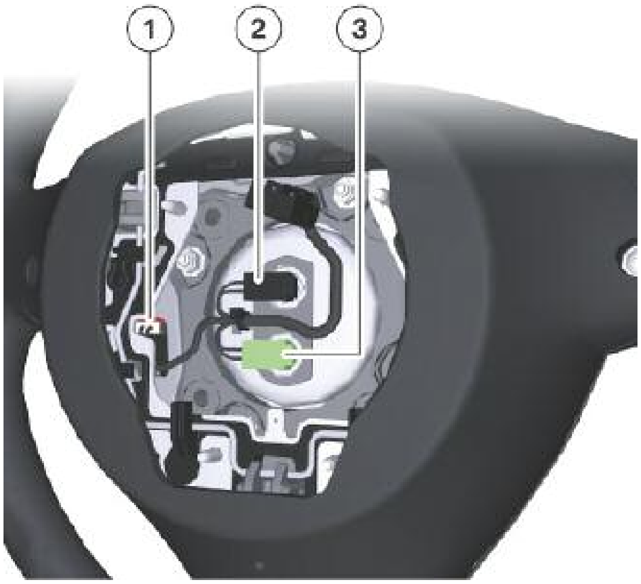
- Airbag warning lamp AWL
- Seat belt mannikin
- Passenger Airbag OFF light (POL)

Adaptive Driver Airbag, with Active Vent

Index	Explanation
1	Gas generator with exhaust vents
2	Actuator for vent valve

Driver airbag without airbag

Driver airbag, rear, without retaining plate



Index	Explanation
1	Connection of the squib for The active vent valve
2	Connection of the squib for the first stage
3	Connection of the squib for the second stage

Vent Valve

Airbags with pyrotechnically activated vent valve are used for the first time in a BMW vehicle on the F01/F02.

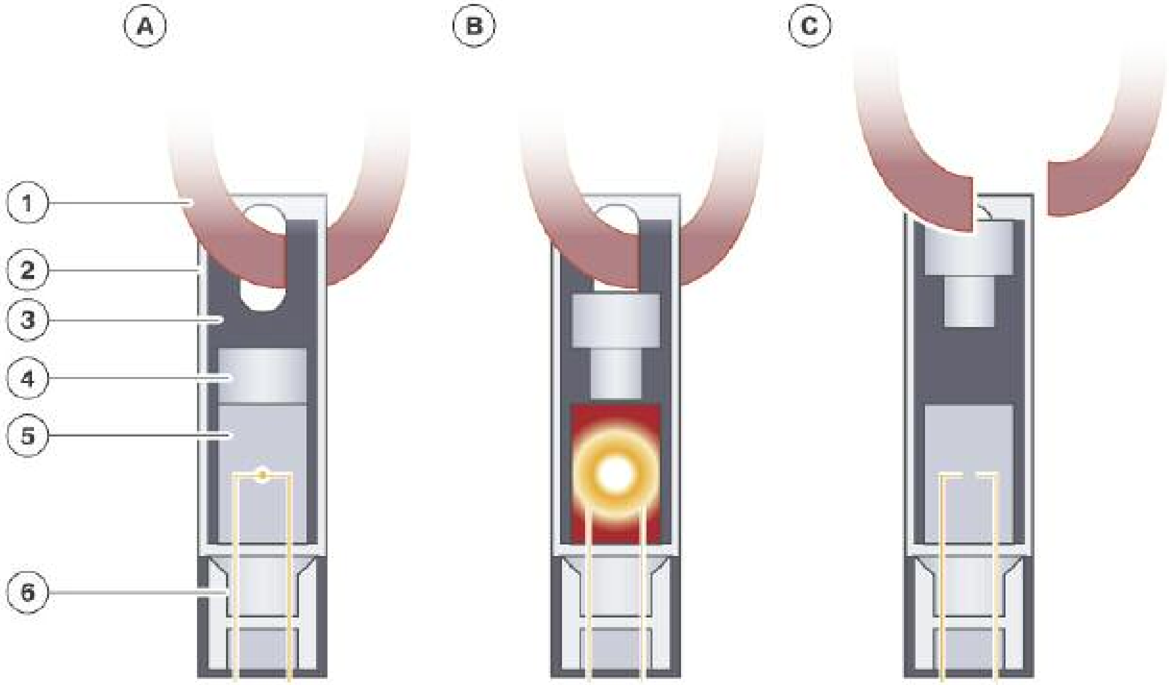
This measure serves to adapt the hardness of the airbag in possible accident scenarios with small persons or persons sitting close to the steering wheel.

On the basis of the crash severity, belt status and seat position information, the crash safety module decides whether the vent valve is activated or not.

The vent valve is an exhaust vent incorporated into the airbag, which is closed by an arrester band. The arrester band ends in a cylinder, in which there is a blade. In the event of triggering, the blade is pushed in the cylinder by the pyrotechnical actuator and the arrester band is cut through.

Due to the airbag inner pressure, the exhaust vent opens outwards and the hardness of the airbag is controlled by the gas venting.

Activation of the active vent valve



Index	Explanation	Index	Explanation
A	Vent valve is closed by arrester band	3	Cylinder
B	Squib triggered, blade is deployed	4	Piston with blade
C	Blade cuts through retaining strap and vent valve opens	5	Squib
1	Retaining strap	6	Squib connection
2	Housing		

The active vent valve is normally activated for smaller, lighter occupants.

If the system, (due to the seat position) detects a heavy occupant, a reduction of the airbag pressure is not desirable.

In this case, the active vent valve remains closed and is activated at a later stage for disposal firing, when the occupant is no longer in contact with the airbag.

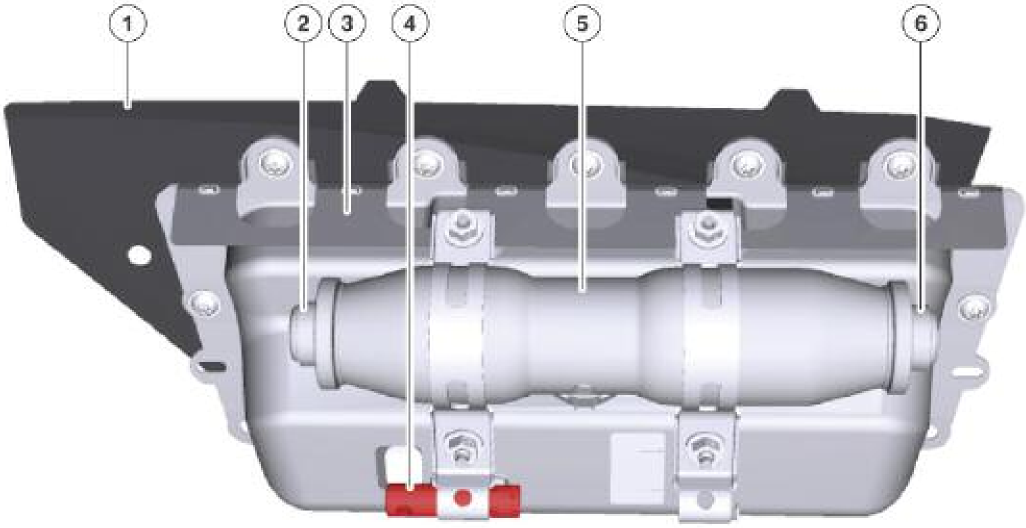
Vent valve remains closed

Normally heavy occupant

Vent valve is opened

Small, light occupant

Adaptive front passenger airbag with active vent valve



Front passenger airbag, two-stage with vent valve

Index	Explanation	Index	Explanation
1	Cover for airbag	4	Actuator for active vent valve
2	First stage squib	5	Inflator assembly
3	Airbag housing	6	Second stage squib

Knee Airbags

The knee airbags on the driver's side and front-passenger side are designed to control the forward movement of the occupant in the event of a head-on impact.

In the event of a collision in which the driver or front passenger are not wearing seat belts, the knee airbag provides support to protect the knees. This initiates a controlled forward displacement of the upper body, which is cushioned by the deployment on the corresponding airbag.

A knee airbag on the driver and front passenger side are standard equipment for the F01/F02.

The knee airbag is designed as a single-stage airbag with inflator assembly. The volume is approximately 20 liters/ 5.2 Gallons.

The gas generator is triggered in the event of a crash of sufficient severity and the resulting gas fills the airbag.

When occupant's knees make contact with the airbag, the load is distributed over the area of the airbag, thus supporting the occupant.

The knee support results in a controlled forward displacement of the upper body that is taken up and absorbed by the airbag.

The knee airbag on the driver's side is located below the steering column in the footwell trim while the knee airbag on the passenger side is located in the footwell trim.

F01/F02 driver's side knee airbag,

Knee airbag in operation

Note: The driver and front passenger knee airbags are also triggered by occupants wearing seat belts, though at a higher crash severity than if the seat belts are not fastened.

F01/F02 passengers side knee airbag

Curtain/Head Airbag

On the F01/F02, the curtain airbag for the driver and front passenger side is used as head airbag.

The head airbag extends from the A-pillar to the C-pillar and covers the entire side section at the level of the side windows.

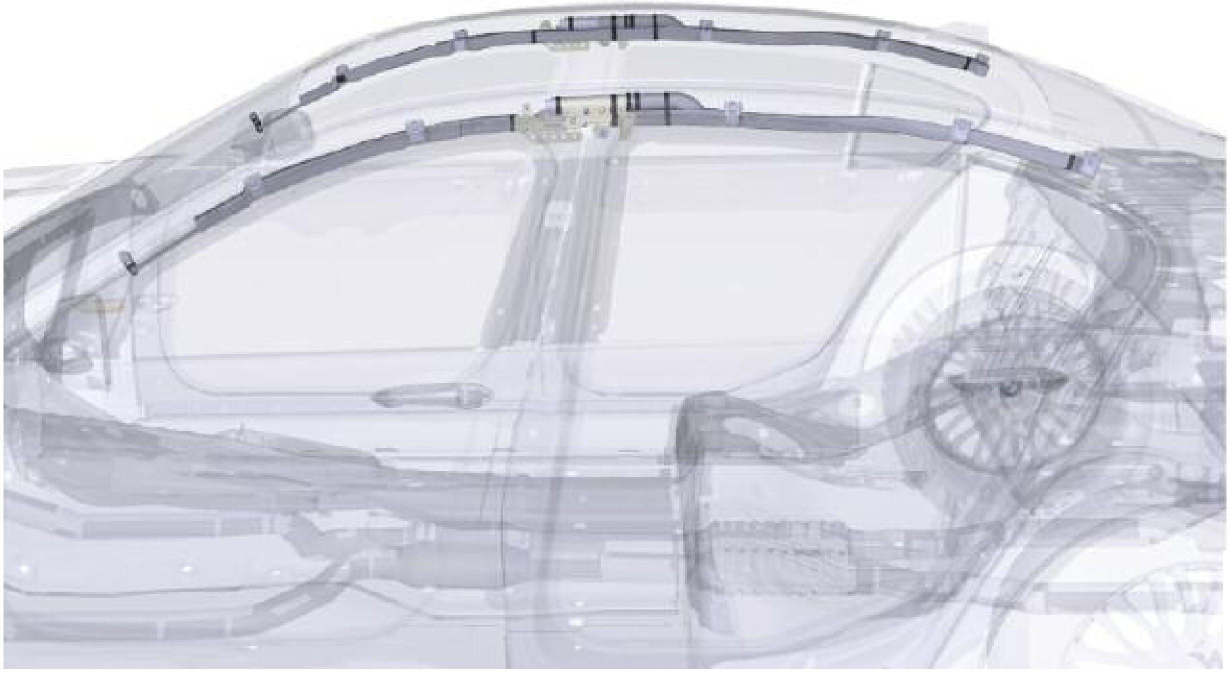
It deploys between the occupants, windows and pillar trim panels.

The system features:

- Extended coverage for front and rear windows.
- Reduction of the risk of glass splinters and objects entering the vehicle.
- Optimized coverage even for different sizes of occupant.

The curtain airbag is housed folded up in the roof frame. It consists of the inflator assembly and the curtain.

In the event of a side impact or of a rollover, the inflator assembly is triggered and a valve to the pressure tank is opened. The stored gas flows through the gas lance into the curtain.



Installation location of the curtain airbags on the F01/F02

The head airbag is set in the correct position by its mounting on the A-pillar and on the C-pillar. In addition, the curtain deploys between the side windows, pillar trim panels and the occupants.

The structural strength and stability is preserved for several seconds by the closed system.

In connection with the side airbag in the front seat, it provides optimum protection for the occupants in the event of side impact.

The head airbag reduces the movement of the head and other occupant extremities towards the outside during a side impact. This results in lower neck shear forces as well as bending moments in the cervical vertebrae. It additionally prevents direct contact with the side structure or the obstacle thus reducing the risk of head injuries.

Seat-integrated Side Airbag

The seat-integrated side airbags are mounted on the F01/F02 for the purpose of achieving optimum interior functionality, an appealing design while satisfying high safety requirements.

The side airbags are folded, together with the inflator assembly (gas generator) in a plastic housing. The airbag module is secured into the backrest and concealed by the rear panel.

The side airbag is triggered in response to a sufficiently strong impact from the side. The side airbag emerges between the seat backrest and the rear panel and inflates between the door and occupant.

The air cushion between the door and occupant provides controlled impact damping and therefore reduces the load on the occupant.

Side airbag (1) integrated in the seat

Note: It is important that no additional seat covers are fitted as they would greatly impair or even immobilize the airbag function.

Seat Belt Pretensioner

The task of the pyrotechnical seat belt tensioner is to minimize the seat belt slack in the pelvis and shoulder areas in the event of a crash, thereby improving the restraining action.

The seat belt catch pretensioners are located on the driver's and front passenger seats. The seat belt catch tensioners are triggered in the event of a head-on or rear-end crash and on vehicles with rollover sensor in the event of a rollover.

In the event of a crash of sufficient severity, the squibs in the seat belt catch tensioner are triggered by the crash safety module. The seat belt buckle is connected by means of a steel cable to the piston in the tensioning tube. If the squib is triggered, gas pressure is created, which moves the piston in the tensioning tube. At this, the seat belt buckle is pulled down by the cable and the seat belt is tensioned.

Seat belt pretensioner

Index	Explanation
1	Seat belt buckle switch
2	Connection for the squib
3	Tensioning tube with piston

Automatic seat belt tensioner with adaptive force limiter

The belt force limiter on the F01/F02 works according to the same principle as on the one used on the E65/E66.

For the driver and front passenger, an automatic reel with adaptive force limitation is mounted. With the aid of a gas generator, there is a changeover from a high to a low power level during the impact, in order to reduce the restraining forces.

With optimally tuning in connection with the airbag, the kinetic energy of the occupant is more uniformly reduced over the duration of the impact. Thus lower occupant stress values are achieved.

F01/F02 adaptive belt force limiter

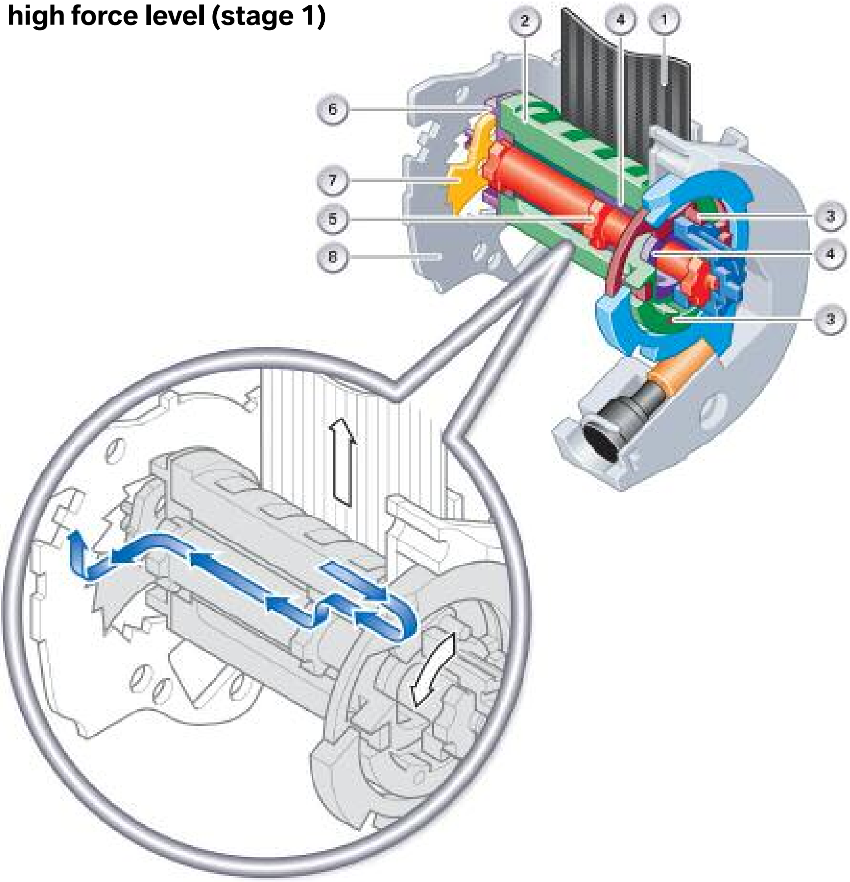
The adaptive force limitation is based on a two-step torsion bar (step shaft). The torsion bar consists of the two head ends at left and right, the step and the central head.

The belt force is transmitted through the seat belt webbing to the belt reel. The belt roller is joined to a sleeve, in which the torque bar is fitted. There is a shaft ring with locking pawls on the sleeve. The locking pawls transmit the torque to the torsion bar.

In the first stage, the belt force is transmitted from the seat belt strap on the belt roller via the locking pawls to the central head of the torsion bar. If the belt roller is rotated relative to the fixed torsion bar, the force is transmitted to the thicker part of the torsion bar. The high force level is thus set.

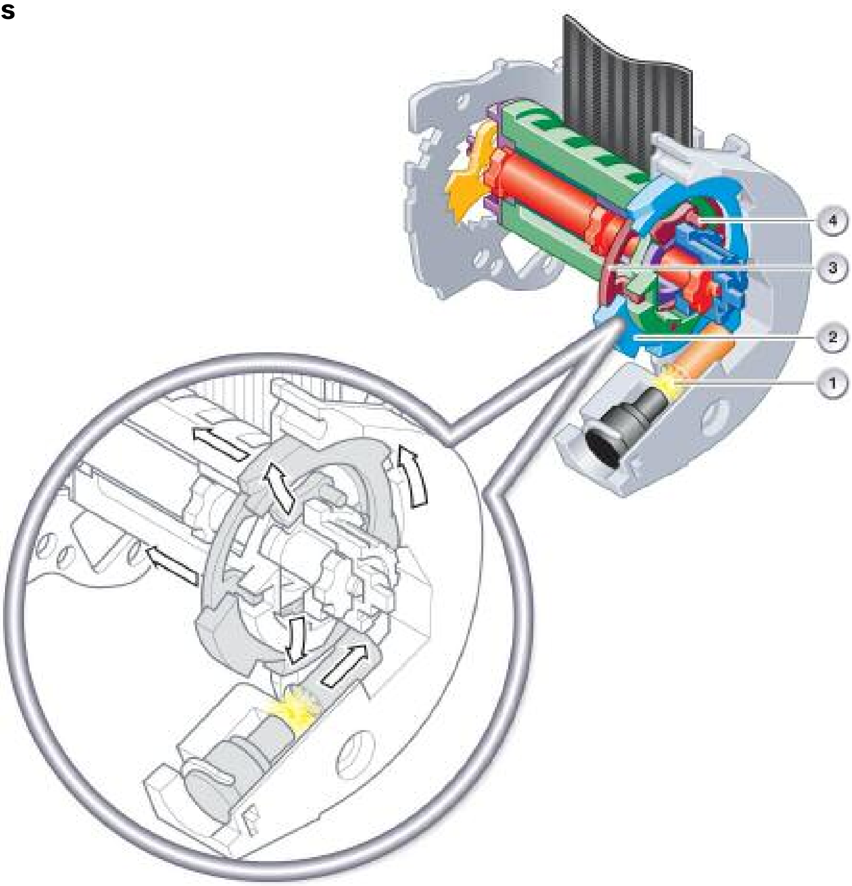
In the event of an impact with corresponding severity, the gas generator is ignited and a piston driven out which rotates the ratchet ring, thus moving the shaft ring axially.

Force flow with high force level (stage 1)



Index	Explanation	Index	Explanation
1	Seat belt webbing	5	Torsion bar (central head)
2	Belt roller	6	Sleeve
3	Locking pawls	7	Locking pawl
4	Sleeve	8	Housing

Ignition process

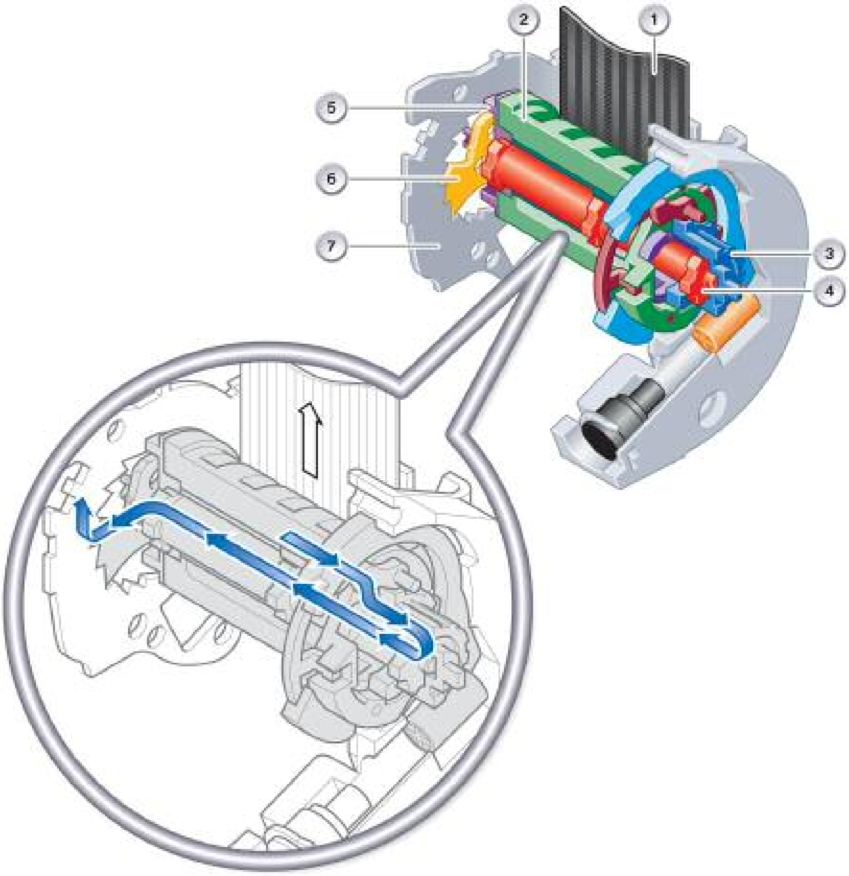


Index	Explanation	Index	Explanation
1	Ignition	3	Shaft ring
2	Ratchet ring	4	Locking pawls

The locking pawls are now no longer held by the sleeve. Therefore no more torque acts on the center head of the torsion bar.

The belt force is now introduced into the step shaft via the right-hand head end, and thus passes through the complete torsion bar. Because of the smaller diameter of the right-hand side, the torsion bar is rotated further, and thus the force is degraded to a lower level.

Force flow with lower force level (stage 2)



Index	Explanation	Index	Explanation
1	Seat belt webbing	5	Sleeve
2	Belt roller	6	Locking pawls
3	Connecting sleeve	7	Housing
4	Torsion bar		

Active Head Restraint

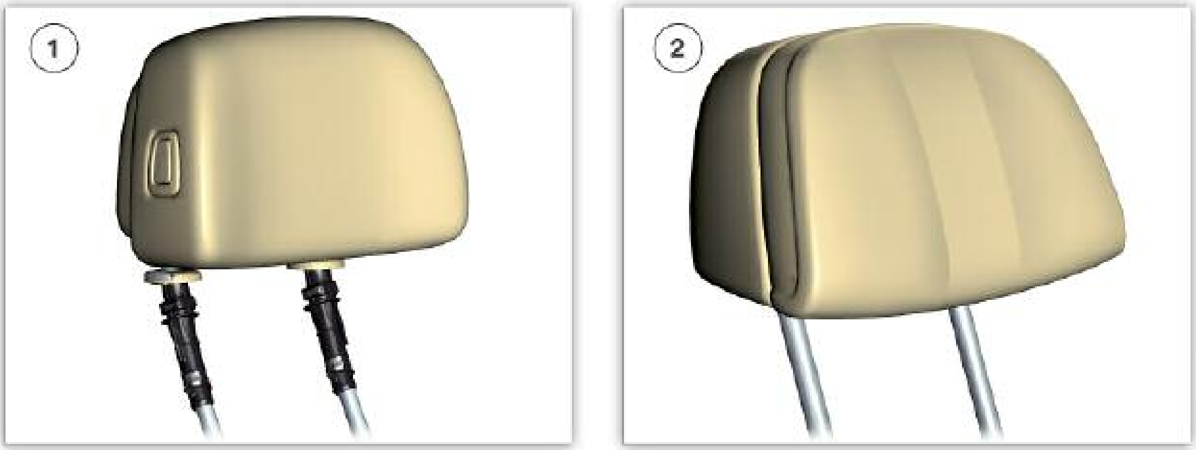
Used on previous BMW vehicles since 09/2007, Active head restraint are now installed on the F01/F02.

This is the version with pyrotechnical actuator and spring elements for adjustment.

There are two versions of active head restraints, depending on the seat option installed.

The memory seat (1) is designed for manual headrest adjustment.

In order to offer as much convenience as possible, the front section of the head restraint can be pulled forward or pushed backward approximately 30 mm. It is a two-stage adjustment. This allows for three different positions for the head restraint depth adjustment.



(1): Manually adjustable head restraint on the memory seat.
(2): Fixed head restraint on the multifunction seat

On the multi-function seat, (2) the headrest is adjusted by means of the headrest adjustment.

The active head restraint reduces the load on the cervical vertebrae in the event of a rear-end collision by reducing the distance between the head and the head restraint before the occupant moves backwards. This reduces the risk of injury to the cervical vertebrae.

In the event of a rear-end impact, the front section of the head restraint, driven by a spring, is moved towards the front by up to 60 mm within a very short space of time. Even before the head is jerked backwards due to the rear-end impact, the active head restraint reduces the distance to the head. The reduced distance contributes to increasing the stabilizing and securing function of the head restraints.

Triggering in the event of a rear-end collision

The crash safety module detects via sensors whether a rear-end collision has occurred.

If there is an appropriately severe crash, the active head restraints are triggered. This can even occur in the case of a slight rear-end collision.

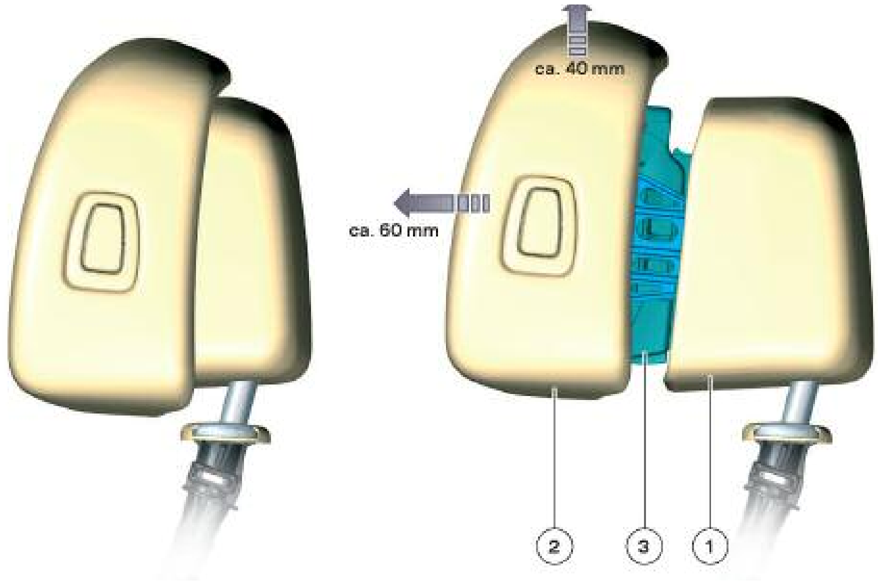
If the crash safety module detects a massive rear-end collision, other safety components, such as e.g. the belt tensioner and the safety battery terminal are also activated.

The crash safety module deploys the active head restraint, by igniting the head restraint actuator squib. The actuator releases the head restraint spring force by activating the release plate. This enables the front section of the head restraint to be moved towards the front by means of a spring.

The head restraint drive springs are only locked again once the pyro-actuator has been replaced.

Note: If the active head restraints have been triggered, the pyro-actuators must be replaced in the workshop. For more information please refer to the repair instructions available in ISTA and TIS.

Active head restraint, left, normal position, Active head restraint, right, after triggering

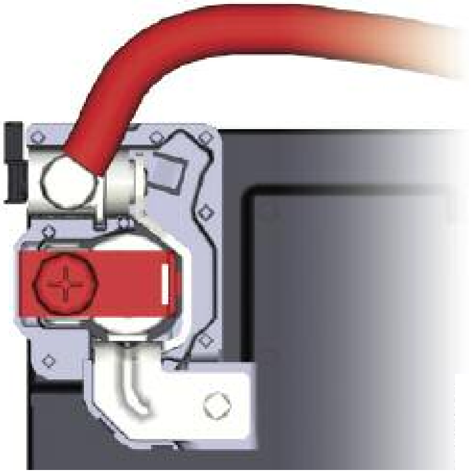


Index	Explanation	Index	Explanation
1	Head restraint support	3	Head restraint drive
2	Front section of the head restraint		

Safety Battery Terminal

The safety battery terminal is triggered at different thresholds when the Crash Safety Module detects a front-end, side-on or rear-end crash of sufficient severity. The connection between battery and starter/ alternator cable is then separated by pyrotechnical teams. The safety battery terminal is located directly at the positive terminal of the battery.

Despite the safety battery terminal being pressed off, it is guaranteed that all consumers relevant to safety such as hazard warning lights, interior lighting and telephone will continue to be supplied with voltage.



Safety battery terminal

Airbag Warning Lamp

The airbag warning lamp (AWL) is located in the instrument cluster. ACSM system operability is indicated by the AWL lighting up and then going out in during the predrive check. The AWL is controlled by means of a signal from the ACSM to the instrument cluster on the PT-CAN. The instrument cluster receives a signal on a cyclical basis. If the signal fails to materialize, the AWL is activated.

Airbag warning lamp

Passenger Airbag OFF light

In the F01/F02, the passenger airbag OFF lamp is located at the front of the roof function center FZD next to the interior lights.

The Passenger Airbag OFF light is activated if the OC3 mat detects a child seat with a child approximately one-year old or if the front passenger seat is not occupied.

The brightness of the Passenger Airbag OFF light is regulated by the automatic display lighting.

Roof function center with passenger airbag OFF light

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F01 System Functions

Subject **Page**

Initial Print Date: 01/09 Revision Date:

System Functions

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Explain the method in which diagnostic data is captured by the control units
- Identify the components in the system where data is centrally stored
- Identify and explain the various modes of operation for the control units
- Explain the purpose and operation of the ethernet connection on the vehicle
- Explain Sweeping technology
- Explain the process necessary for updating navigation map data
- Identify and explain the need for increased security features for the data in the vehicle

Diagnostics Master

The Diagnostics Master function is a function distributed throughout the vehicle. It is divided into the following subfunctions:

- Time Master
  Includes the centralized specification of a system time for all control units in the vehicle, and the application as a time stamp for fault messages from control units.
- Centralized fault memory
  Includes the saving of fault and Check Control messages with centralized ambient conditions.
- Specification of the fault memory status
  Includes the centralized specification a fault memory block for network fault memory entries in specific situations as well as the evaluation/application of the block in the client control units.

One task is often divided over multiple computers in a computer network (this also includes control units with bus connections). It is important to specify the computer (or control unit) that has the main function. This control unit is then described as the main control unit or "master". All other computers (control units) are called “peripherals” or "secondary controllers".

Each subfunction of the diagnostics master includes a master portion and a secondary portion. The master portion is always implemented in a single control unit, but the secondary controller portion in all participating control units.

Subfunction	**Master**
Time master	KOMBI
Centralized storage of fault messages	ZGM
Specification of the fault memory status	Junction Box

Time Master

The Time Master is located in the instrument panel and cyclically transmits the system time to all other control units in the vehicle every second.

This system time is set to zero only once in the life cycle of the vehicle while in the factory at the end of the production process. The system time expresses the time in seconds that have passed since initialization in the factory.

The counter for the system time is not reset when the battery is disconnected or when the power to the instrument panel is switched off.

When the battery is disconnected the time value is actually initially lost, but it is updated when the power supply is again available. This is achieved by reading the last value stored in the non-volatile memory (EEPROM), increasing it by one time unit, and applying it in the Time Master as a new system time. The counter for the system time can map a time of approximately 136 years.

The system time is received by all control units, and used it as a time stamp when fault messages are stored.

To allow retention of the system time even after replacement of the instrument panel, it is stored redundantly in the CAS similar to the mileage reading.

Centralized Fault Memory

This subfunction has the task of centralized storage of fault and Check Control messages in addition to the local fault memories for each of the control units and the storage of CC messages in the instrument panel. The central gateway module (ZGM) is the master for this function and it is also called the Diagnostics Master.

Whenever faults occur, all control units locally save the fault along with at least the two mandatory environmental conditions of kilometer reading and system time. A new function is that the control units additionally signal the fault code and the system time at which the fault occurred (time stamp) to the Diagnostics Master (ZGM).

The fault memory concept and fault memory process of the control units have not been changed by the additional reporting to the Diagnostics Master. This means a control unit "very normally" makes a self-defined fault memory entry. The local fault memory entry remains untouched in the local fault memory of the secondary control unit.

The Diagnostics Master then additionally centrally stores the fault code and a fixed set of 26 ambient conditions at the same time that it indicated in the time stamp.

The ambient conditions stored on the fault message by the Diagnostics Master include different information on the global status of the vehicle such as the:

- Standard time
- Vehicle system voltage
- Outside temperature
- Terminal status
- Kilometer reading
- Vehicle driving speed

The central fault memory in the ZGM has a size of 18 kB. Between 250 and 1000 fault events and Check Control messages can be stored centrally in the ZGM dependent upon how many faults occur simultaneously. When the fault memory is full no new faults or Check Control messages are stored. The fault and Check Control messages in the central fault memory can then only be deleted via the BMW diagnostic system.

Each fault code and each Check Control message is accepted up to 10 times. Without this limit, a constantly occurring fault would very quickly fill the entire central fault memory.

These ten entries are sufficient for analysis of the fault.

All central fault memory entries are lost when the ZGM is replaced.

Note: Primary fault analysis continues to be performed by using the fault memory entries in each of the control units. The data from the central fault memory of the Diagnostics Master serve to supplement and allow a more precise diagnosis. Functions for using this data are integrated in the new workshop system.

Advantages:

Previously (without Diagnostics Master), only the kilometer reading and system time (mandatory environmental conditions) and possibly a few additional ambient conditions could be found in the local fault memories.

The ZGM stores 26 additional ambient data items for each fault memory entry from each of the control units.

Additionally, up to 10 time instances at which the fault occurred are recorded in the ZGM for a fault code.

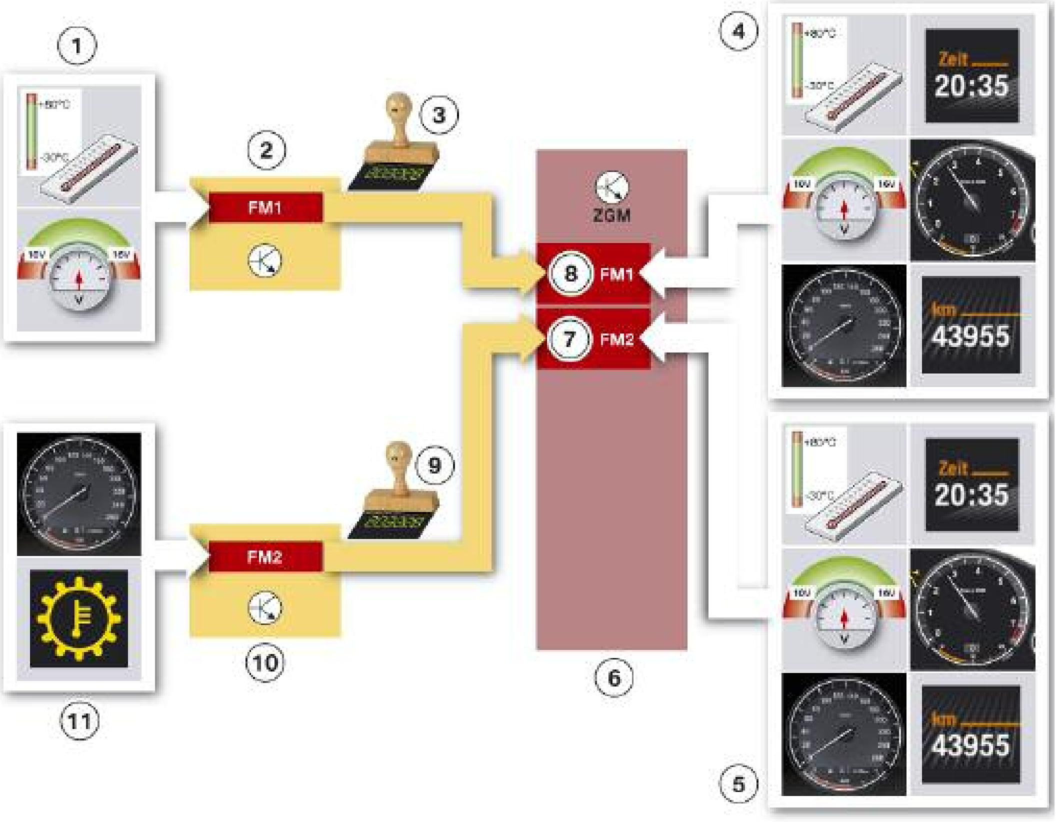
The time stamp with second-precision permits a statement upon the time sequence of fault events, which was previously not possible based solely upon the kilometer reading. For the first time it is possible to the name the cause and effect with greater clarity for distributed functions, e.g. the control unit that firstly entered a fault, the control unit that in consequence only entered a fault as a reaction, etc.

The Check Control messages at the time of the fault are also stored in the Diagnostics Master and are also provided with the 26 ambient conditions. "Customer complaints" can be assigned better to a vehicle situation because of the Check Control messages and above all also corresponding fault memory entries.

These measures have made a more precise diagnosis possible.

Note: Up to 55 fault codes (also without time stamp or ambient conditions as is currently the case) can still be stored In the CAS and in the identification sensor of the F01/F02.

Storage of faults in the F01/F02



Index	Explanation	Index	Explanation
1	Two local ambient conditions for fault 1	7	Fault message 2 (FM2)
2	Fault 1 and 2 local ambient conditions are stored in the fault memory of the control unit	8	Fault message 1 (FM1)
3	Fault message 1 (FM1) and the "time stamp" are sent to the Diagnostics Master	9	Fault message 2 (FM2) and the "time stamp" are sent to the Diagnostics Master
4	Central ambient conditions at the time when fault 1 occurred	10	Fault 2 and 2 local ambient conditions are stored in the fault memory of the control unit
5	Ambient conditions at the time when fault 2 occurred	11	Two local ambient conditions for fault
6	Diagnostics Master in the ZGM		

Specification of the Fault Memory Status (pseudo fault reduction)

In certain vehicle operating situations invalid fault memory entries (pseudo faults) are made as the control units do not behave synchronously in these situations. The critical operating situations occur during:

- Wake-up of the vehicle
- Start of the combustion engine
- Under/Overvoltage

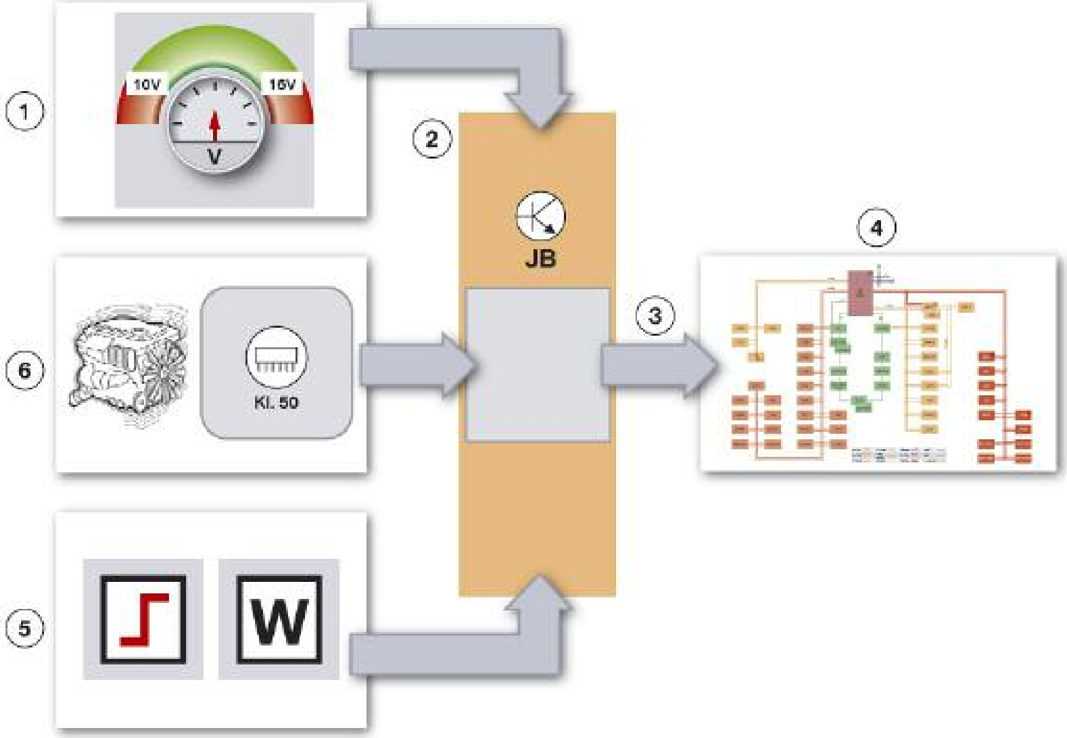
To prevent pseudo faults in these operating situations, a centrally communicated signal forbids specific faults from being entered in the local fault memories of the control units.

These will simultaneously actively prevent these faults being signalled to the master of the "storage system context" function and from being entered in the central fault memory.

The fault memory block is not only effective for network fault memory entries, however not for control units-fault memory entries.

The fault memory entries for control units relevant for exhaust gas and safety are not affected by this function and they will always be written.

Saving of faults is prevented under certain circumstances



Index	Explanation
1	Under/Overvoltage block condition: 10.5 V < U < 16 V Unblock condition: U > 11 V or U < 15.5 V
2	Junction Box (master for the subfunction specification of fault memory status)
3	Bus message "status - block fault memory"
4	All control units
5	Wake-up of the vehicle Block condition: wake-up signal Unblock condition: three seconds after wake-up signal tw > 3 s
6	Engine start (Terminal 50) block condition: Terminal 50 active

Vehicle Status Management

Vehicle status management is a system function with the task of implementing standardized system behavior in different operating conditions for all future BMW vehicles.

For instance, the different switch-on behavior of the radio. To switch on the radio in the E65, the START-STOP button must be pressed (Terminal R is switched on). In the E90, on the other hand, the radio can also be switched on without inserting the key's remote control into the insertion slot.

The vehicle status management system calculates a single vehicle status from the terminal status, vehicle movement, battery condition and status of the combustion engine. This status is then used to define when a customer function or a group of customer functions (e.g. all entertainment functions) has to be available.

Furthermore, the vehicle status management system controls the operating mode the vehicle or specific modules are in. Those functions that are to be available in a mode are controlled.

Example: No radio operation while in the transportation mode.

Distinction is drawn between the following operating states:

- Standby
- Basic control mode
- Ready to drive
- Engine start
- Driving

A further vehicle status management task is the simultaneous start up and shut down of the on-board communication network.

F01 on the production line

Start up and Shut Down of the Onboard Communication Network

The vehicle status management system describes the start up and shut down of the onboard communication network. In addition to general requirements, that are binding for all control units, the cascading, wake-up and sleep memories are defined.

Cascading

The cascading function ensures that all buses in the vehicle electrical and bus systems startup in coordination and shut down or "sleep" simultaneously. This function is made possible by a master function of the central gateway module (ZGM) that specifies whether the vehicle electrical and bus systems may sleep. This master function controls the secondary control units, each of which is responsible for the start-up and sleep for one bus. Secondary controllers are located in the following control units:

- ZGM (for K-CAN, K-CAN2, PTCAN, FlexRay and MOST)
- DME (for the PT-CAN2)

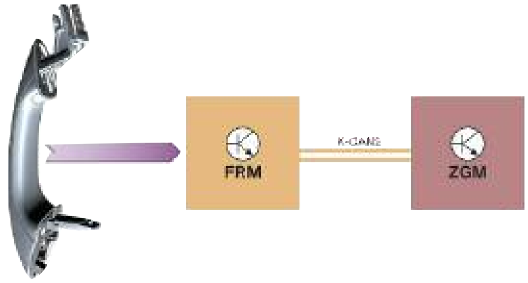
Wake-up and Sleep Memory

In the event that the vehicle should not correctly wake-up or sleep, this often results in an increased power requirement for the complete vehicle, which may cause an empty battery and therefore a broken-down vehicle.

With the wake-up and sleep memory, the vehicle status management makes functions available for detection of faulty wake-up and sleep processes and initiation of countermeasures. For this purpose, the vehicle status management system has firstly recorded all possible reasons that could allow a control unit to wake-up the vehicle. When such a reason exists, the waking control unit must signal this reason to the wake-up and sleep memory that is contained in the ZGM.

Should a faulty wake-up exist, it is logged in the ZGM (fault memory entry that includes also the waking control unit and the wake-up reason as ambient conditions). The time and current kilometer reading are always saved as further ambient conditions. In this instance, the ZGM initiates countermeasures by transmitting the diagnostic command "powerdown". Should faulty wake-up events continue to occur after this, a reset of terminal 30F and then a permanent switch-off of terminal 30F is required. Just as with wake-up, faults may also occur for sleep. For such a fault, the wake-up and sleep memory creates a fault memory entry and initiates the same measures as for faulty wake-up.

All control units that may wake-up the vehicle are defined and assigned an identification number (hexadecimal number). Two seconds after each control unit has completed the wake-up process it transmits the bus message "wake-up registration FZM" to the ZGM and notifies the reason for the wake-up.



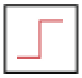
Example:

Wake-up by opening the driver's door FRM transmits the following message two seconds after the wake-up:

- Message ID: 0x5F2 (identification number for FRM)
- Byte 0: 0x27 (bus message "wake-up registration FZM")
- Byte 1: 0x72 (identification number FRM)
- Byte 2: 0x10 (Wake-up cause "door contact, front left")

Wake-up of the Vehicle
The bus overview of the F01/F02 with wake-authorized and wake-capable control units is shown below.

Wake-authorized control units may wake-up the vehicle electrical and bus systems.


The wake-authorized control units are shown on the bus diagram on the following page by a rising-edge symbol.

The wake-authorized control units include:

- K-CAN2: FRM, FZD, JB,
- K-CAN: IHKA
- MOST: RSE High, ULF-SBX High, ULFSBX and TCU

Wake-capable control units are woken up via a wake-up line.

W The wake-capable control units are identified with a "W". These control units are woken up via a wake-up line.

These include:

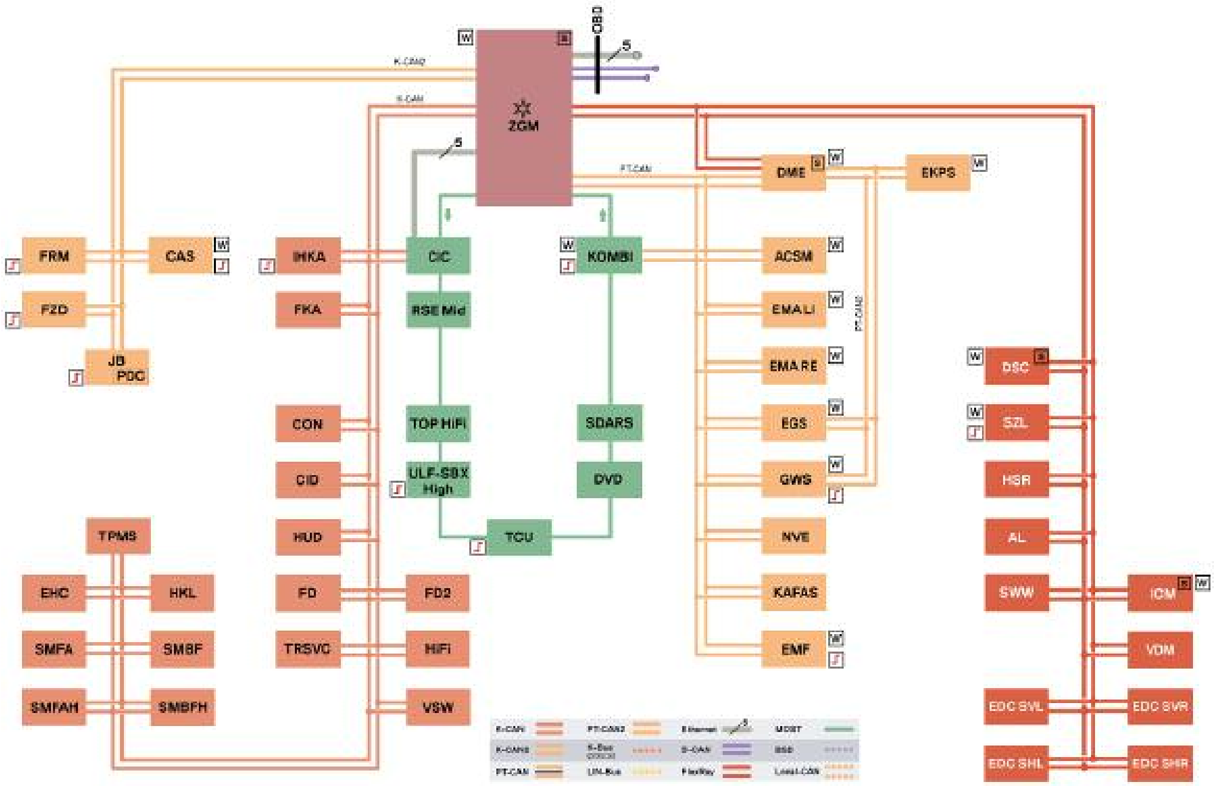
- ZGM
- PT-CAN: DME, ACSM, EMA LI, EMA RE, EGS
- FlexRay: DSC and ICM

Additionally, there is a group of control units that are “wake-authorized” as well as wake capable:

- K-CAN2: CAS
- MOST: Kombi
- PT-CAN: GWS and EMF
- FlexRay: SZL

The remaining control units are then woken up via the bus systems or via switching on the power supply.

Bus overview F01/F02 with wake-authorized/capable control units



Index	Explanation	Index	Explanation
ACSM	Advanced Crash Safety Module	DVD	Digital Video Disc
AL	Active Steering	EDC SHL	Electronic Damping Control (Satellite rear left)
CAS	Car Access System (CAS 4)	EDC SHR	Electronic Damping Control (Satellite rear right)
CIC	Car Information Computer	EDC SVL	Electronic Damping Control (Satellite front left)
CID	Central Information Display	EDC SVR	Electronic Damping Control (Satellite front right)
CON	Controller	EGS	Electronic Transmission Control
DME	Digital Motor Electronics	EHC	Electronic Height Control
DSC	Dynamic Stability Control	EKPS	Electric Fuel Pump

Index	Explanation	Index	Explanation
EMA LI	Electrically motorized reel, left	NVE	Night Vision Electronics
EMA RE	Electrically motorized reel, right	PDC	Park Distance Control
EMF	Electromechanical Parking Brake	OBD	On Board Diagnostic Connector
FD	Rear Display, left	RSE	Rear Seat Entertainment (Mid)
FD2	Rear Display 2, right	SDARS	Satellite Radio
FKA	Rear compartment, heating/air conditioning	SMBF	Seat module, passenger
FLA	High Beam Assistant	SMBFH	Seat module, passenger rear
FRM	Footwell Module	SMFA	Seat module, driver
FZD	Roof Functions Center	SMFAH	Seat module, driver side rear
GWS	Gear Selector Lever	SWW	Lane Change Warning (Active Blind Spot Detection)
HiFi	HiFi Amplifier	SZL	Steering column switch cluster
HKL	Trunk Lid lift	TCU	Telematics Control Unit
HSR	Rear axle drift angle control (Rear Steering Control Module)	TOP-HIFI	TOP-HiFi Amplifier
HUD	Head-up Display	TPMS	Tire Pressure Monitoring System
ICM	Integrated Chassis Management	TRSVC	Top Rear Side View Camera Module for rear/side view cam
IHKA	Integrated Heating and Air Conditioning, automatic	ULF-SBX High	Interface Box, high version
JB	Junction Box Electronics	VDM	Vertical Dynamics Management
KAFAS	Camera-assisted Driver Assistance Systems	VSW	Video Switch
KOMBI	Instrument Cluster	ZGM	Central Gateway Module

Calculation of the Vehicle Status and Control of Vehicle Functions

The vehicle status management system calculates a single vehicle status from the terminal status, vehicle movement, battery condition and status of the combustion engine. This status is then used to describe when a customer function or a group of customer functions (e.g. all entertainment functions) has to be available.

For instance, all functions for geometric adaptation are to be available in the basic control mode/stationary operation statuses. The operating states defined through vehicle status management are summarized in the following table:

Operating State	Identifying Feature	Function
Driving	Engine running	Active steering
Engine start	Starter motor running	Radio mute
Ready to drive	Engine OFF, driver present, ignition switched ON	This is where those functions are activated that are required for the driving mode, e.g. Park Distance Control, air-conditioning system, passive safety systems
Basic control mode	Engine OFF, driver present, ignition switched OFF	Radio, seat adjustment
Standby	Driver's absence identified by: • Secure vehicle, or • Non-initiation of driver interaction for 30 minutes.	Functions that have to exist when the driver is absent, e.g. DWA, CAS (read-in remote control)

Control of Operating Modes

Those functions that are to be available in an operating mode are defined (e.g. no radio operation in transportation mode) via the vehicle status management system. There are three operating modes: manufacture, transportation, flash, which are abbreviated in German as FeTraFla mode.

FeTraFla mode replaces the former manufacture, transportation, workshop or FeTraWe mode. Workshop mode has rarely been used to date and has been replaced by flash mode.

Flash mode offers the advantage that communication between the control units is reduced to a minimum during programming, and therefore higher data transfer rates are achieved from the BMW Programming system into the vehicle. Additionally, the control units are notified that programming is taking place.

This prevents the control units from going into emergency operation (e.g. the windscreen wiper does not start).

Flash mode is activated via a diagnostic command. The control units permanently save this mode. This has the advantage that the control units still know that they are in flash mode after a reset. In earlier vehicles a reset often had the consequence that a control unit had interrupted communication and this had consequently caused a flash termination.

It is also possible to use the "extended operating modes" to further subdivide a mode in order, for instance, to suppress or activate functions only at specific conveyor belt sections during manufacture.

Ethernet Access

The increasing number and complexity of functions in the vehicle cause a constantly increasing rise in the number of control units and consequently the data volume in the vehicle. When these data are to be updated the vehicles must be programmed over the BMW programming system. The number of BMW vehicles that can be programmed has constantly increased since the introduction of the E65 in 2001.

The challenge facing the Service Department is the programming of ever increasing data in increasing numbers of vehicles.

In order to accelerate the programming procedure in the workshop, an Ethernet access has been integrated in the diagnostic socket of the F01/F02 in addition to the OBD access (D-CAN).

It is Fast Ethernet compliant with IEE802.3 2005 100 base TX.

This standardized interface provides a centralized, standardized access in the vehicle. This access permits IP-based communication with the vehicle.

The vehicle is therefore uniquely identifiable as a communication partner in an IP-based network, and BMW diagnosis and programming systems can be used in the workshop for the data exchange with the vehicle.

Note: The previously used MOST direct access is not installed in the F01/F02.

What is Ethernet?

Ethernet is a cabled data network technology for local area networks (LANs). It facilitates the data exchange in the form of data frames between all devices (computers, printers, etc.) connected in a local network (LAN). Earlier the LAN only extended over one building.

Today the Ethernet technology uses fiber glass or radio to also connect devices over long distances.

Ethernet was invented over 30 years ago. A protocol was used as a transmission protocol that was in use at that time for radio-based networks.

Consequently the name Ether, that had been assumed historically to be the medium for propagation of radio waves.

In an Ethernet network, the users in the common cable network transmit messages via high-frequency signals.

Each network user has a unique 48-bit key that is called the MAC address. This ensures that all systems in an Ethernet have different addresses.

MAC is an acronym for Media Access Control.

The MAC address is required because a commonly used medium (network) can not be used simultaneously by multiple computers without data collisions, and therefore communication faults or data losses occur in the short or long term.

Different data transfer speeds were defined during development of Ethernet. Since 1995 the 100 Mbits/s standard has been used and it is called Fast Ethernet.

In the F01/F02, Fast Ethernet compliant with standard IEEE 802.3 2005 100 base TX with 100 Mbits/s data transfer rate is used.

100 Mbit/s Ethernet is also used today as the LAN connection for PCs.

Ethernet connection for a PC

In addition to a higher data rate, the 100 Mbits/s Ethernet offers the following advantages:

- All BMW dealers have an Ethernet infrastructure
- Ethernet is future-proof
- Standard IT technologies can be used inside and outside of the vehicle
- Ethernet allows a cable length of 100 m (cable length today in workshop = 10 m)

Ethernet Port

As there were enough free pins in the diagnostic socket it was possible to integrate the Ethernet port in this socket.

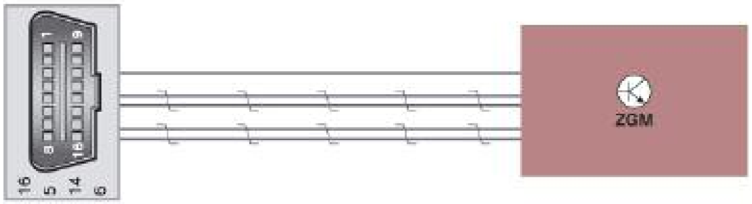
This installation location is the optimal solution for the vehicle access. The further advantage lies in that D-CAN as well as Ethernet can be connected to BMW diagnostic and programming systems via one connection (ICOM A).

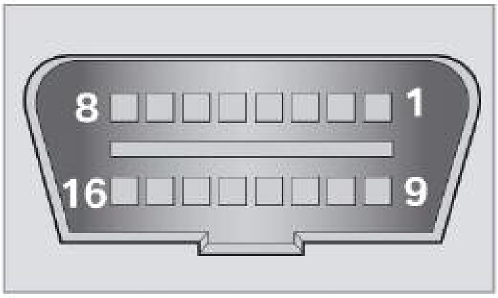
Five pins are used for the Ethernet port in the diagnostic socket.

These five lines are routed from the diagnostic socket to the central gateway module (ZGM).

One of the five lines transmits the activation signal. The remaining four lines are twisted pair and are used for data transmission.

Ethernet connection between the diagnostic socket and ZGM





Index	Explanation	Index	Explanation
1	Not assigned	9	Engine speed
2	Not assigned	10	Not assigned
3	Ethernet Rx+	11	Ethernet Rx-
4	Terminal 31	12	Ethernet Tx+
5	Terminal 31	13	Ethernet Tx-
6	D-CAN High	14	D-CAN Low
7	Not assigned	15	Not assigned
8	Ethernet activation	16	Terminal 30F

Activation of the Ethernet Access

The Ethernet access is switched off in normal operation. It must be activated prior to every usage and then deactivated after it has been used.

Upon connection of the ICOM A, the activation line (Pin 8) is connected to terminal 30B (Pin 16) and this activates the Ethernet access.

The Ethernet module in the ZGM receives the signal (voltage level of terminal 30B) via the activation line. When the ICOM A is disconnected from the diagnostic socket the Ethernet access is deactivated. When the customer is in driving mode the Ethernet access is always deactivated.

Each user in an Ethernet is assigned an identification number that is unique throughout the world, the MAC address (Media Access Control). A user in a network is uniquely identifiable via the MAC address. The MAC address of the vehicle is located in the ZGM and can not be changed.

The VIN (Vehicle Identification Number) identifies the vehicle to the BMW programming system. Before communication with the vehicle can take place, just the same as for a computer network in the office it is necessary for each device in an IP-based network to have received a logical identification, called the IP address. The IP address is only unique in the respective network segment (subnetwork) and it can be assigned dynamically or statically.

After activation of the Ethernet connection and establishment of the physical connection the central gateway module is assigned the IP address from the ICOM A. Through a special process, the so-called "vehicle identification", the IP address, VIN and MAC are exchanged between the BMW diagnosis or programming systems and the ZGM. This allows unique identification of the vehicle in the workshop network and therefore a communication connection can also be established.

The function of an IP address in a network corresponds to a phone number in the telephone network. Assignment of this IP address is performed per DHCP (Dynamic Host Configuration Protocol). This is a process for automatic allocation of IP addresses to new end devices in a network. Merely the automatic reference to IP address must be set on the end device.

It must be possible to assign the IP address dynamically (DHCP server) for operation in a changing workshop network infrastructure.

The vehicle should adapt to the network and not the network to the vehicle. After disconnection of the ICOM A the assigned IP address is released upon expiry of the time set in the DHCP server.

Data enters into the vehicle and is distributed in the vehicle via the Ethernet access over the central gateway module.

The Ethernet connection does not have any effect upon the operation and time response of the D-CAN connection.

Note: Simultaneous operation of the D-CAN and Ethernet access must be prevented, as this makes collisions of diagnostics commands within the vehicle probable and therefore communication via both accesses can become faulty.

Vehicle Connection to the BMW Shop Network

An example of connection of the F01/F02 to the BMW workshop network is shown in the diagram below.

An IP address is automatically assigned to the vehicle after connection of the ICOM A. This allows unique identification of the vehicle (the ZGM) in the BMW workshop network, and a communication connection is established.

Authentication must be completed, and a signature is necessary for writing (programming) data into the vehicle. As opposed to this, it is possible to read (diagnosis) data immediately after a data line has been connected to the vehicle. The authentication and signature prevent third parties from changing data records and memory values.

Programming is carried out using the Software Service Station and ISTA-P.

The ICOM A must always be connected to the workshop network over LAN cable to allow programming to be carried out.

Programming is always performed over the Ethernet access. Only the diagnosis and no programming is performed over D-CAN.

The connection to the vehicle must be retained until programming has been fully completed. The ZGM assumes the gateway function and distributes data over the buses to the other control units.

Definitions

- **Authentication**

Authentic from the Greek work "authentikos" = valid, real, credible.

Authentication = confirmation of authenticity

To authenticate = to make valid, make credible.

Nowadays the conformation of authenticity is often stated in connection with rights of use e.g. for PCs or access to buildings.

- **Authentification**

The process of proving the identity (authenticity) upon request.

For instance, check of the user password by the PC system.

An example to clarify authentification, authentication and authorization:

A user wants to log on to his PC. He authenticates himself.

The PC system wants to check whether the user is entitled to log on to the system:
It authentifies.

After it has completed the check, the PC grants access: It authorizes the user.

- **Digital Signature**

= Digital acceptance

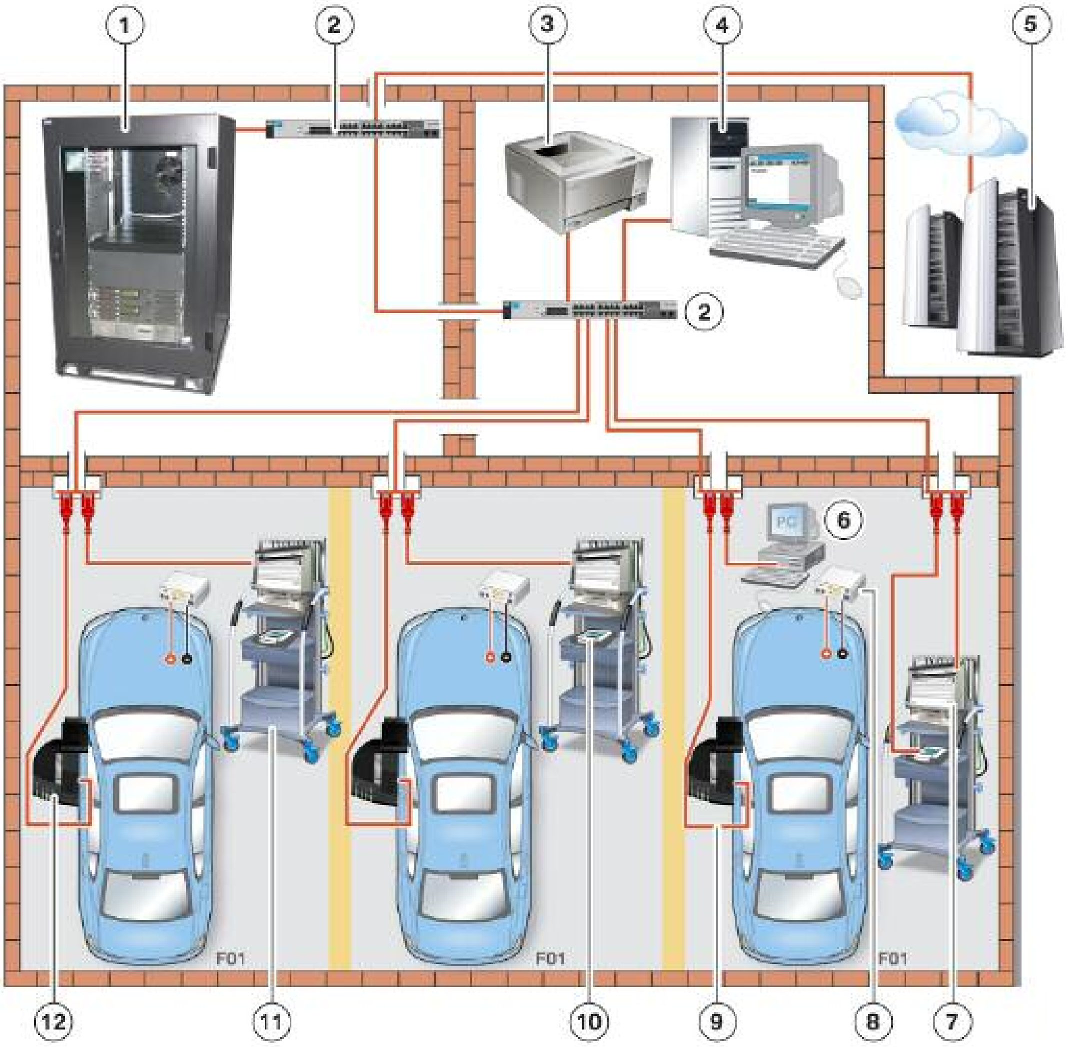
From the Latin "Signum" the sign.

A digital signature in an encryption procedure with the purpose of ensuring the trustworthiness of a person.

In this case, the authorship and affiliation of data to a specific person is checked.

Simultaneously the completeness, genuineness and intactness of the signed electronic data are checked.

Vehicle Connection to the BMW Shop Network



Index	Explanation	Index	Explanation
1	Integrated Service Information Server (ISIS1)	7	Integrated Service Information Display (ISID)
2	Gigabit switch	8	Battery charger
3	Printer	9	LAN cable
4	Integrated Software Service Station (ISSS)	10	Integrated Measurement Interface Box (IMIB)
5	BMW Group server	11	Workshop trolley
6	Workshop PC	12	Integrated Communication Optical Module (ICOM A)

Vehicle Configuration Management

The vehicle configuration management system (VCM) is a system function and has the primary task of centralized storage of data structures in the vehicle. The VCM integrated in the central gateway module ZGM as a system function.

The vehicle order and the I-levels in addition to the security are stored in the CAS. This ensures that the information can be restored after the ZGM has been replaced. The information stored in the vehicle configuration management system can be called by diagnostic commands upon request from the diagnosis system or internal vehicle system functions.

This means that the current vehicle configuration is saved centrally at precisely one place and a consistent information status is assured. This configuration knowledge only needs to be maintained at only one place. As this information is stored in the vehicle it is available at all times to all systems outside of the vehicle (diagnosis, programming) and the systems inside of the vehicle (system functions).

A further primary task of the vehicle configuration management system is the query, cyclic or upon request, of the configuration of the currently installed control units, and to use this to generate an equipment installation table that represents the current status, SVT-current. A comparison between SVT-nominal and SVT-current then takes place in order to determine whether the configuration installed in the vehicle is the same as the configuration that the vehicle should have. A fault memory entry is saved in the VCM if this reveals any discrepancies.

Additionally, upon request the vehicle configuration management system generates lists of control units that have specific characteristics.

Finally, the vehicle configuration management system has the task of determining those control units that have different serial numbers since a reference time (writing of SVT nominal).

The Service Department can use this to determine those control units that have been replaced since this time.

After replacement or changes to hardware or software, for instance, it is much easier to reestablish a consistent and working status for the vehicle electrical and bus systems.

Furthermore, the required configuration must not be maintained by each system function itself. This produces savings in component development as well as in system integration and logistics as compared to previous systems. Additionally, faults due to inconsistent configuration information are prevented.

Deviations from the specified configuration (SVT-nominal) and the current configuration (SVT-current) queried by the control units are identified.

Data Storage

The vehicle configuration management system provides detailed information on the hardware and software installation status of the vehicle. To the outside, the VCM makes available that, and only that, which is relevant for its users. Direct access to internal structures is prohibited and is instead achieved via defined interfaces.

The vehicle configuration management system administers the following data for all electrical components in the vehicle:

- Specified equipment installation table (SVT-nominal)
- Vehicle order (FA)
- Vehicle profile (FP) and
- I-levels

Equipment Installation Table (SVT)

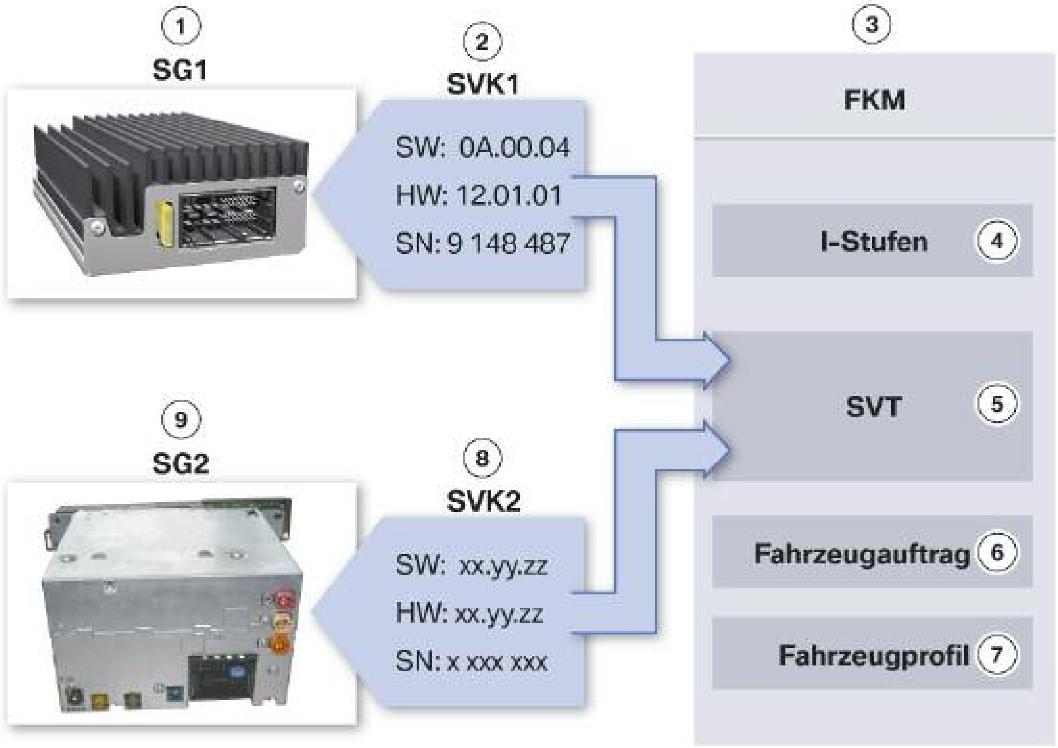
The equipment installation table (SVT) contains all equipment installation identification lists (SVK) of all users installed in the vehicle electrical and bus systems.

The equipment installation identification list (SVK) is a list of all components (software and hardware). The component is not to be confused with the control unit as a control unit may be made up of several units. For instance, a CCC comprises several software units such as: user interface (BO), antennas (ANT), audio system controller (ASK), gateway (GW) as well as the hardware unit.

The vehicle configuration management system checks the current configuration 10 seconds after the engine start. This creates the current-equipment installation table. The nominal configuration (SVT nominal) is also saved in the vehicle configuration management system. If discrepancies are determined between SVT current and SVT-nominal a fault memory entry is saved in the ZGM.

New nominal values are written into the VCM during vehicle programming and coding.

Storage of data by the vehicle configuration management system



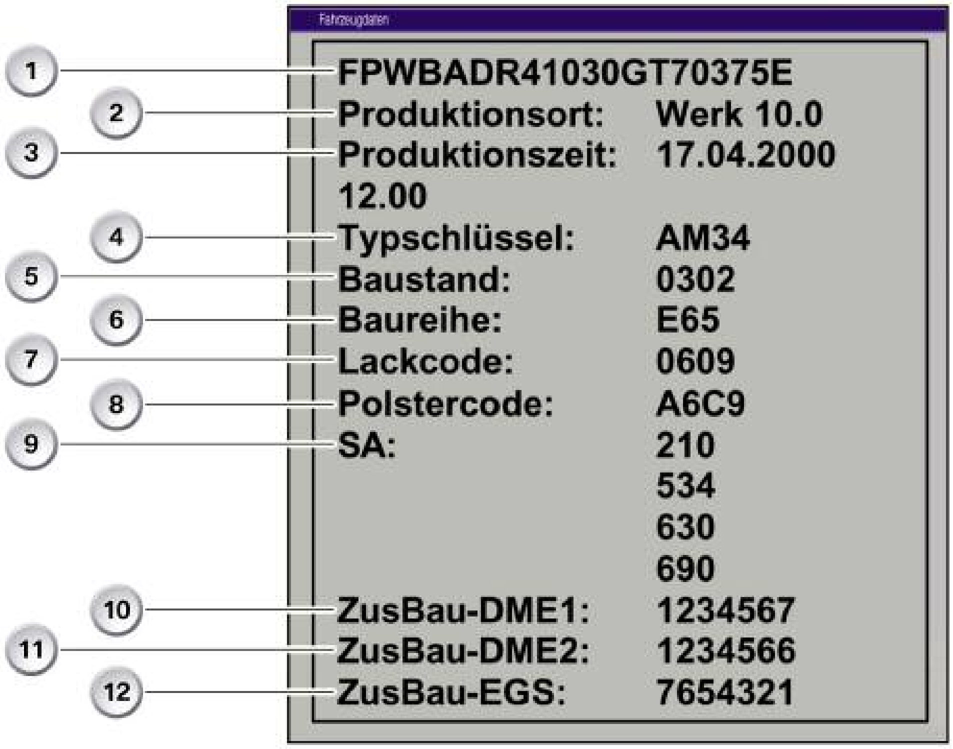
Index	Explanation
1	Control unit 1
2	Equipment installation identification list 1 (SVK1)
3	Data structure in the vehicle configuration management system
4	I-levels
5	Equipment installation table (SVT)
6	Vehicle order (FA)
7	Vehicle profile (FP)
8	Equipment installation identification list 2 (SVK2)
9	Control unit 2

Vehicle Order

The vehicle order contains all the important equipment features of the vehicle in addition to the type code.

The assembly numbers of the drive control units are stored in the vehicle during assembly and can no longer be changed. It is therefore possible at any time to identify which part numbers of the control units were allocated to the vehicle during production.

Vehicle order data



```
FPWBADR41030GT70375E
Produktionsort:     Werk 10.0
Produktionszeit:    17.04.2000
12.00
Typschlüssel:       AM34
Baustand:           0302
Baureihe:           E65
Lackcode:           0609
Polstercode:        A6C9
SA:                 210
                    534
                    630
                    690
ZusBau-DME1:        1234567
ZusBau-DME2:        1234566
ZusBau-EGS:         7654321
```

Index	Explanation	Index	Explanation
1	Vehicle identification number	7	Paint code
2	Production location	8	Upholstery code
3	Production time	9	Options (SA)
4	Type code	10	Assembly number DME-1
5	Build date	11	Assembly number DME-2
6	Model series	12	Assembly number 7654321

Vehicle Profile

The vehicle profile contains additional data that precisely describe the vehicle. In addition to the development model series and design they include, for instance, the gearbox type, engine, version etc.

Vehicle order data

Fahrzeugprofil

Entwicklungsbaureihe: F001
Batterieklasse: B080
Bauart: LIMOUSINE
Ländervariante: Deutschland
Lenkseite: LL
Sonderausstattung:
Treibstoff: BENZIN
Leistungsklasse: (185) UL
Motor: N63B44
Getriebetyp: AUTOMATIK
Zylinderzahl: 8
Hubraum: 44000CCM
Baustand: MAERZ_2008

Index	Explanation	Index	Explanation
1	Vehicle profile	8	Fuel
2	Development model series	9	Performance class
3	Battery class	10	Emgine
4	Design, e.g. Saloon	11	Gearbox type
5	National-market version	12	Number of cylinders
6	Steering side	13	Cubic capacity
7	Optional extra (SA)	14	Version

Initialization of the Vehicle Configuration Management System

Initialization of the VCM means the first writing of data. All data (SVT-nominal, vehicle order, vehicle profile and the I-levels) is written into the central gateway module through the initialization.

Initialization takes place in the factory and must always be performed when the ZGM is replaced.

Initialization is automatically performed by the programming system. Data from the vehicle order (FA) and I-levels on security are always stored in the CAS. The programming system firstly collects these data from the CAS and then writes them into the ZGM.

Reading and Writing of Data

The SVT-current, SVT-nominal, vehicle order, vehicle profile and the I-levels can be read out from the VCM via diagnosis. These data are written in the VCM during vehicle programming and coding. SVT nominal, FA, FP and I-levels can be written independently of each other.

For data security reasons, signatures are used in the data exchange between the diagnosis or programming systems and the VCM.

Example of Vehicle Configuration Management

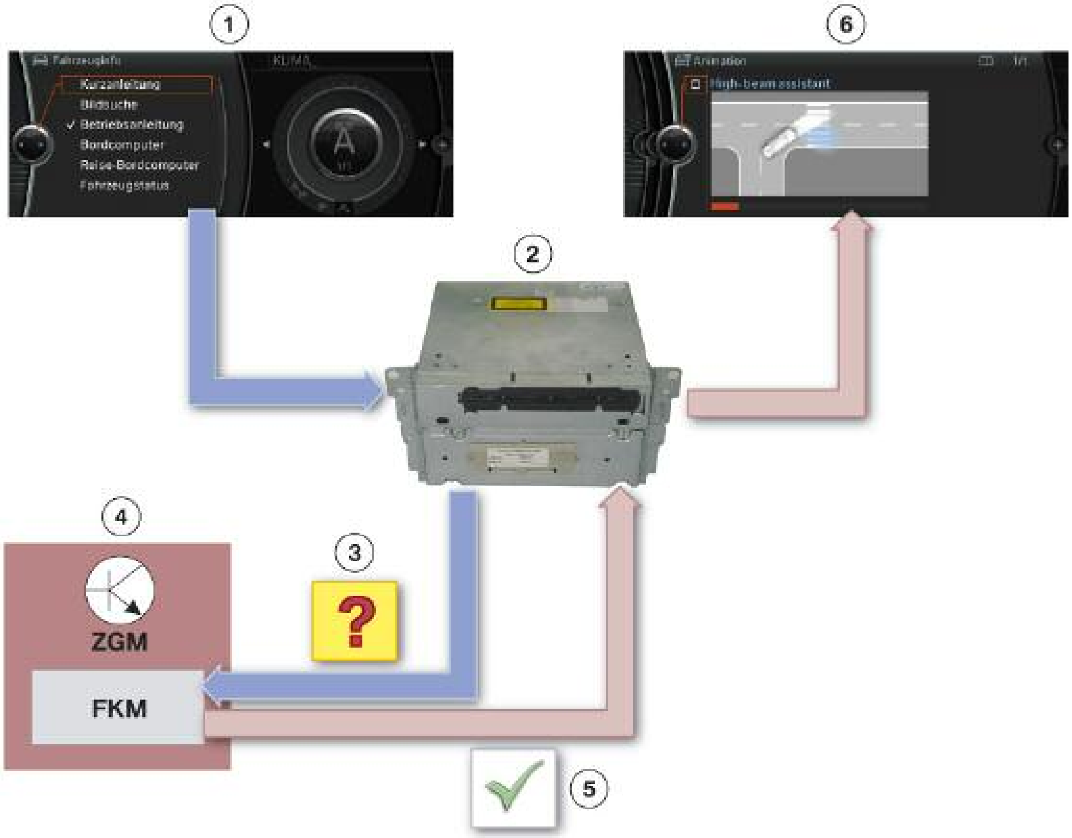
Upon request by other system functions (e.g. integrated Owner's Handbook), the VCM extracts a control units list, e.g. a list of all installed control units, from the SVT-current.

All the contents of the integrated Owner's Handbook are stored in the CIC, but only the vehicle-specific contents are shown. For instance, the CIC queries whether the high beam assistant is installed. If it is, the contents on the high-beam assistant are shown (graphic illustration on the next page).

Further system functions that revert to information from the VCM are, for instance:

- Personal profile (needs information on changes to the vehicle configuration).
- Diagnostics Master (needs list of the actively signalling control units).

Query to VCM on installed control units



Index	Explanation
1	Integrated Owner's Handbook is called up
2	CIC (queries the VCM on installed control units and makes vehicle-specific contents available)
3	Query to the VCM on installed control units e.g. high-beam assistant or KAFAS
4	VCM in the ZGM gives information on installed control units
5	The high-beam assistant or KAFAS is installed in this vehicle
6	The appropriate notes on this topic are shown in the CID

SWEEPING Technologies

SWEEPING technologies allows protection against copying, usage and manipulation of IT components and their software.

The abbreviation SWEEPING stands for **S**oftware **E**nabled **E**lectronics **P**latform for **I**nnovative **N**ext **G**eneration Technologies.

SWT is based upon an encryption process that uses a key specific to a vehicle and control unit, the activation code as it is called, to activate a software function or application for a control unit.

The activation code (Freischaltcodes - FSC) is input in the Service Department or by the customer.

This occurs either by an input in the controller or through the import from CD/DVD or USB stick as an import medium for the BMW programming system.

The activation code is then subsequently input in the respective vehicle via the BMW programming system.

The required software is operable only after input of the activation code.

Activation by Means of Activation Code

Introduction of SWT Hardware Activation

The first activation code for a BMW vehicle was used in March 2006 for activation of the night vision camera following a replacement.

The hardware component was activated and therefore made operable.

A legal requirement was the background for this. Strict conditions applied for the night vision camera that was developed especially for military purposes.

They could only be installed in registered vehicles. This allowed the vehicles with SA 611 (night vision) to be recorded and accounted for in strict conformity with license conditions.

Furthermore, usage of a FSC allowed clear allocation of the hardware component (night vision camera) to the vehicle in which it was installed.

An activation code for the night vision camera following a replacement was enclosed in the form of a CD. This so-called "subpart" had to be ordered by the parts technician over the EPC by giving the vehicle identification number.

The activation code located on the CD was requested by the BMW programming system during the programming. It was then transferred into the BMW programming system and imported into the vehicle.

If a FSC was not entered during programming or coding, it was not possible to activate BMW Night Vision. This was displayed after programming/coding by a Check Control message in the instrument panel.

Introduction of SWT Software Activation

In March 2007 the activation of single software components was commenced at BMW. This laid the foundation stone for the business model "software as a product".

It allowed functions already installed in the vehicle to be made usable for the customer and to activate them by means of an activation code.

This in turn created the opportunity to invoice software licenses individually with the supplier and only after its activation. In addition, copy protection was hugely improved by activation code activation, an asynchronous encryption method.

Activation of the Voice Recognition System in the CCC:

An activation code for the voice recognition system (SA 620) in connection with CCC (SA 609) became necessary when programming a vehicle from Progman V25.0, as the voice recognition system could no longer be used without this.

This applied for the retrofit of software for the voice recognition system as well as for replacement of the CCC.

Savings in license costs was the background, as invoicing could now be carried out with the software manufacturer separately for each vehicle instead of a general license.

When programming of the CCC (SA 609) was carried out on vehicles up to March 2007 fitted with the voice recognition system (SA 620) or voice recognition system preparation (SA 6UB), the BMW Programming system requested an activation code.

This activation code was located on a separate DVD or in the ASAP portal (only available in the ASAP portal after prior completion of an order).

On vehicles with a production date from March 2007 (I-level 07-03-5XX or higher) the activation code was contained in the CCC.

In the event of a hardware replacement for the CCC however, it is not possible to import the code from the SWT disc. The data does not exist on the CD.

The necessary code has to be ordered together with the replacement module via EPC and will be delivered via the ASAP portal (see page 126).

Note: Vehicles produced from 3/2007 require an activation code acquired from the ASAP portal.

SWEEPING Technologies in the F01/F02

From the F01/F02 the activation of software applications and function has been increasingly expanded.

It is now possible to activate the following applications or software functions via FSC:

- Software for voice recognition (SA 620)
- Navigation system application software (SA 609)
- Navigation system map data (activation code required from the second half of 2009)

The activation code for the software applications and software functions named above is loaded over the BMW programming system into the vehicle in nearly all cases. The CD is still necessary for activation of the camera for the night vision camera following a replacement.

Navigation system map data

Update of map data for the navigation system and input of the activation code

Since 09/2008 with introduction of the Car Information Computer, the navigation system map data is stored on a hard disk in the CIC.

Input of the map data is currently possible from the DVD drive and in later production vehicles over the programming system.

The activation code can also be entered over the programming system or via the controller of the iDrive system. An input aid (speller) is available in the iDrive display for this purpose.

This activation code along with the current navigation software (Navigation DVD) is handed to the customer when the customer purchases the map update.

When the order is placed for the activation code, the parts technician states the vehicle identification number of the vehicle for which the navigation map is to be updated.

A special activation code is consequently created in the BMW AG headquarters, in which the vehicle identification number becomes an element of the FSC.

This means the issued FSC and navigation DVD can only be used for the vehicle requested.

The initial filling of the hard disk integrated in the CIC with map data can, if this manufacturer has not already filled it, only be carried out over the BMW programming system.

For the update of map data, only the cash sale variant with activation code input via the speller is subsequently available.

Delivery Process of the Activation Codes Over ASAP

The majority of software functions and applications are not activated by customers, rather by BMW Service employees over the BMW programming system.

A special process was created for BMW employees to request the activation code from the BMW AG headquarters, to download it to the workshop PC and then to import it into the corresponding vehicle over the BMW programming system.

The part number for the activation code is available after input of the vehicle identification number in the EPC (Electronic Parts Catalog).

Upon request from the BMW Service employee, the parts technician orders the activation code over the appropriate Dealer Management System.

The activation code is now created in the BMW AG headquarters. It is normally available to the Service employee in the ASAP portal within a very short time.

Note: The delivery time for the activation code may be delayed for up to one workday due to country-specific circumstances and the world-wide time difference.

The activation code is now ready for download as a ZIP folder (content = 3 files) in the ASAP portal and is shown after input of the corresponding vehicle identification number.

This ZIP folder must be saved in a temporary directory for subsequent extraction of the contents.

These "unzipped" contents are now to be saved in on a CD/DVD or via the use of a USB stick as long as it has been formatted as a removable disc.

Note: No external USB hard drives will be supported.
Not all USB devices are compatible with the system.

Note: Cancellation of the activation code is only possible before the start of the download. Therefore, a check should be made before the download of whether the vehicle identification number of the customer's vehicle is correct. The activation code is invoiced when the download starts even though it has not been installed in the customer's vehicle.
Cancellation after the download is therefore no longer possible.

Input of the Activation Code into the BMW Programming System

The medium containing the three unzipped files is inserted into the ISSS so that the BMW programming system can access these FSC data.

After the import button has been pressed, follow the on screen instructions to complete the import process.

ISSS

Import of the activation code into the BMW programming system

Planned Expansion Stages

In the expansion stage of the BMW programming system planned for the future, the data import of the activation code is to happen automatically.

This would mean that after the request by the parts technician, the activation code, would be directly available to the BMW programming system after a short waiting time.

This process, called "SWT-Online", plays an important role particularly for repairs. Because after replacement of a Car Information Computer, for instance, work can be carried out on a repair without an activation code having to be ordered. It is made directly available to the BMW programming system by "SWT-Online".

However, it is still necessary to place an order over the parts technician and the Dealer Management System for software that has to be paid for, such as the voice input system.

"SWT-Online" or the ASAP portal can be selected afterwards as the delivery channel.

Cancellation of the activation code is however only possible over the ASAP portal.

The channel over the ASAP portal, with download onto the workshop PC and subsequent import into the BMW programming system, should therefore continue to be used as the backup-solution.

Should problems occur during the download or data import into the vehicle, technical support of the respective market should be contacted or a PuMA instance created.

Vehicle Security

History and Fundamentals

Vehicle security protects the vehicle electrical and bus systems against unauthorized manipulative external access.

The topic of vehicle security experienced its beginnings with the introduction of the E28.

On this 5 Series, an instrument panel with encoding connector (coding plug) was installed from 1980.

When a new instrument panel was installed, the encoding connector of the old one had to be used. If this was not done a manipulation dot lit up to indicate that the kilometer reading had been manipulated.

The kilometer reading was only reset to the correct reading with the old encoding connector. The manipulation dot was no longer displayed.

A new era in manipulation protection begins with introduction of the master security module (MSM) as a module in the central gateway module in the F01/F02 and the client security module (CSM) in some selected control units.

The basis for the requirement for the vehicle security system is formed by the growing amount of electronics and the interlinked networking installed in the vehicle.

Mention must also be made of the increase in driver-based services.

Threat Potential

As electronics increase in vehicles, the possibilities also increase of disrupting and infiltrating this sensitive system through manipulation, imitation of hardware and software, and tuning measures (blackbox tuning).

Data storage in the vehicle (e.g. Contacts menu) also means that adequate data protection must be provided.

Vehicle Security Measures

The measures below are carried out to be able to ensure vehicle security in the F01/F02:

- Periodic check of software signatures (signature = digital, electronic signature used for checking the completeness, genuineness and intactness of data)
- Individual stamping of control units on the vehicle in which they have been installed
- Cryptographic protection of the teleservice access
- Encryption of personal data
- Periodic checking of memory ranges.

Benefits for Customers

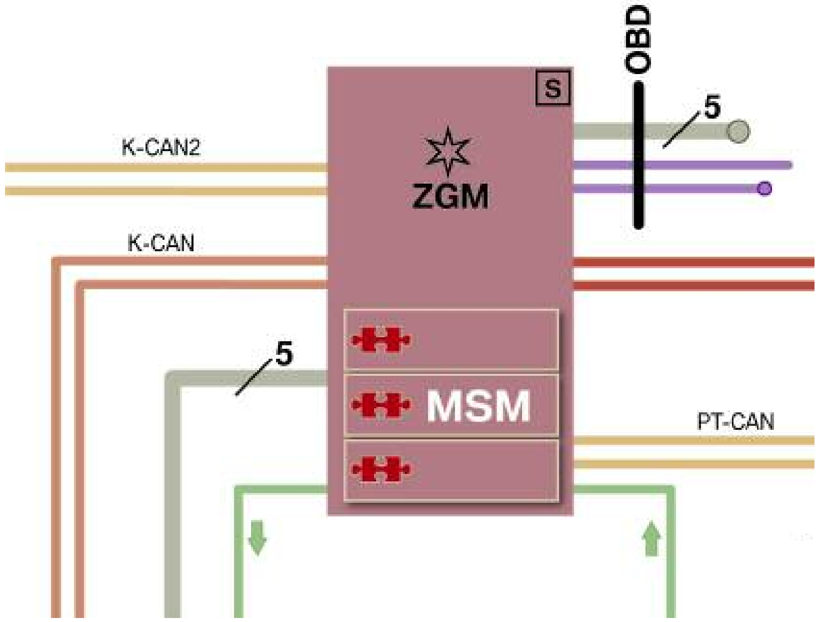
The vehicle security system actively protects the personal data of the customer and actively guards the vehicle electrical and bus systems against attempted manipulation from outside.

Benefits of the Vehicle Security System for the BMW Group and the BMW Brand

For the BMW Group, the vehicle security system contributes towards unjustified liability and to warranty costs not being accrued for manipulation.

Furthermore, vehicle security has the purpose of preventing vehicles damaged by manipulation giving a bad public image to the BMW brand and therefore damage to our reputation.

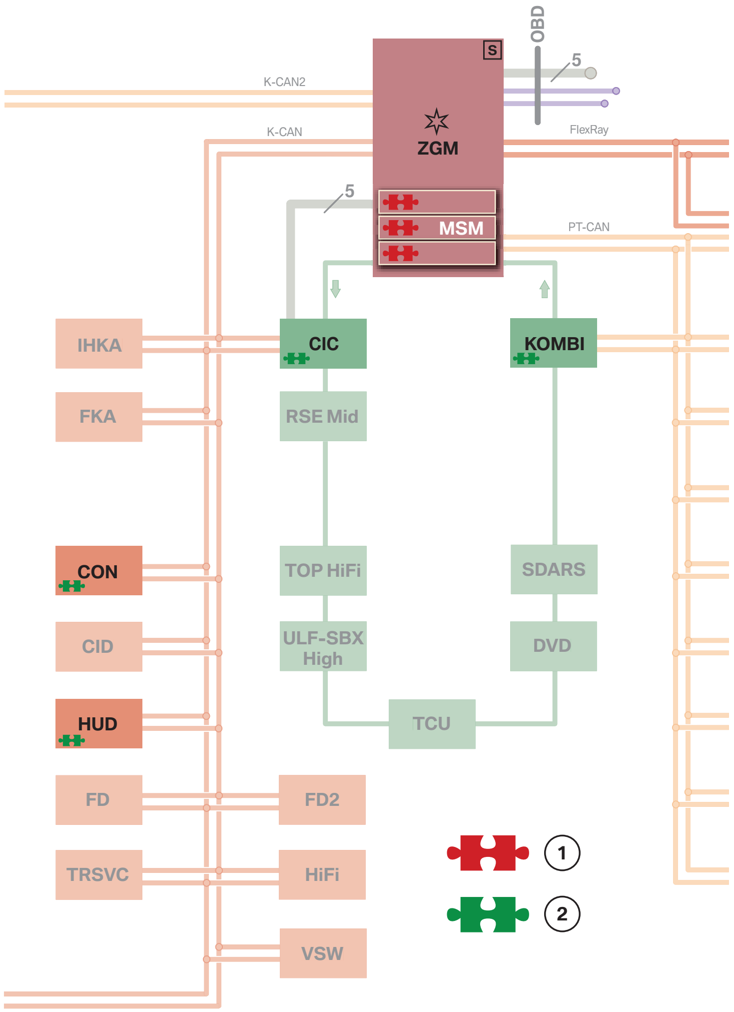
Master security module in the ZGM of the F01/F02



Secondly, the vehicle security system comprises the client security modules located in the control units below that are monitored by the master security module:

- CIC - Car Information Computer
- KOMBI - Instrument Cluster
- HUD - Head-up Display
- CON - Controller

Overview of the MSM and the individual client security modules



Index	Explanation
1	Master security module in the central gateway module
2	Client security module in the individual control units

Vehicle Security Operating Principle

The master security module periodically transmits queries to the individual client security modules.

Any faults and discrepancies are documented and notified to the BMW AG headquarters during transmission of the FASTA data via Jetstream during a service visit.

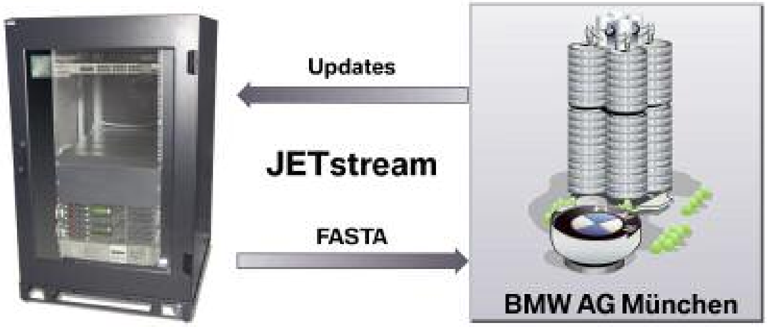
It is not possible for Service Department employees to use BMW diagnosis systems for accessing the information regarding manipulation stored in the control unit.

Possible faults and discrepancies in the vehicle security system are:

- A control unit was replaced without authority.
- A control unit was manipulated through a change of software or data status.
- Communication to the MSM was interrupted or manipulated for a control unit with a CSM.

Preservation of Function in the Vehicle Security System

Any manipulation found in the vehicle security system must not have a negative impact of functions relevant for security within the vehicle electrical and bus systems.



Data transmission via JETstream

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Integrated Service Technical Application - Programming

Subject **Page**

Integrated Service System Application - Programming (ISTA/P)

Model: All Models

Production: All

OBJECTIVES

After completion of this module you will be able to:

- Explain how to convert an SSS into an ISSS
- Navigate through the various ISTA/P menus
- Successfully code/program a BMW Group Vehicle
- Understand the reports generated by ISTA/P

Introduction

Reasons for introduction of the new programming system

Due to the constantly growing complexity and ongoing development of functions over the life of vehicles, adaptation of the software on the control units is unavoidable.

The launch of the F01 brings with it a new generation of vehicles which have not only new functions but also a new control unit architecture and a new electrical system configuration.

In order to ensure that those technologies can be supported by the dealer organization today and in the future, a new workshop system is being introduced alongside them.

The new workshop system incorporates an extensive workshop network with a central server for data storage and provision of the applications. It also introduces new hardware components for diagnosis and programming.

The existing programming system, Progman, is being replaced by the Integrated Service Technical Application for Programming, ISTA/P.

ISTA/P contains the present vehicle field programming functions plus new functions and is thus designed for the future content and requirements of vehicle programming in the field.

New features when comparing ISTA/P with Progman

- Reduction and combination of input demands.
- Configurable measures plan viewable as a graphical chart or a table.
- Detailed display of control unit status.
- Automatic repetition of programming in the event of control unit programming or coding errors within the programming process.
- Importing of enabling codes/vehicle order from any location in the workshop provided there is access to the workshop system/ISTA/P.
- Measures plan can be subsequently extended and adapted.
- Programming takes place first followed by automatic coding of all control units.
- Proactive saving of customization and CBS data and re-importing into control units from F01 on.
- Saving of personal profile settings such as phone book or navigation destinations, depending on control units fitted.
- Generation of a control unit order list if hardware needs to be replaced.
- Session can be saved if parts are not immediately available.
- Display of the Progman or ISTA/P version that was last used to program the vehicle.
- Timely/faster updates.

Release Phases

The new programming system ISTA/P is to be introduced in several phases.

Phase 1

Phase 1 requires the transformation of the Software Service Station, SSS, into the Integrated Software Service Station, ISSS. This “Phase 1”, allows the ISSS to be integrated in the ISIS network.

The actual data/software (ISTA/P application) needed to program the vehicles is installed in the will be on the ISSS. Updates will be applied to the ISIS via Jetstream or from DVD and then passed on to the ISSS during the maintenance cycles (off-business hours).

ISTA/P is capable of programming and coding all models.

Initially, the interface and control for programming can only take place by using keyboard and mouse on the ISSS. Soon after, programming control can take place via each individual ISID in the workshop.

The ICOM A and the ICOM B will be used as vehicle interface for programming.
The ICOM B will be used exclusively for programming MOST control units.

From the introduction of the ethernet connection in the OBD2 interface, ICOM B will not be used. (example: F01/F02)

Illustration of Phase 1

Future Phases

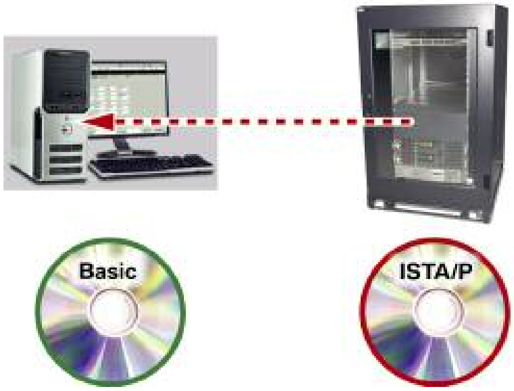
It is planned to integrate the programming system ISTA/P entirely in the ISIS workshop server. A precise timetable for integration of ISTA/P in ISIS has not yet been established.

Transforming an SSS into an ISSS

The technical requirements for conversion demand that the SSS is at least the 2nd generation (release 2). The 1st generation SSS can not be converted.

A starter pack containing the following items will be needed:

- ISSS - basic DVD (1 disc)
- ISIS - ISTA/P client (1 disc)
- ISIS ISTA/P data/software (2 disc)



First, the basic DVD is placed in the DVD drive on the SSS and the operating system installed on the SSS. In the process, the previous application, Progman, is completely deleted. From this point on, future, updates and installation of the ISTA/P application on the ISSS will take place exclusively via the ISIS.

The ISTA/P client and then application software are installed on the ISIS. The ISSS is updated/supplied with the application software by the ISIS via the network during the maintenance cycle.

Programming

As a fundamental rule, a vehicle may only be programmed in the following circumstances:

- If a diagnosis system test module instructs that programming is to be carried out.
- As part of a technical campaign.
- In the course of conversions or retrofits.
- If the BMW Group technical support (e.g. via PuMA) specifically instructs that a vehicle is to be programmed.

Similar to An important factor for error-free programming is proper preparation of the vehicle and observance of the instructions during programming. There are special requirements that may apply to individual vehicle models. The actions that are required for all models are described in the following pages.

Note: Programming must always be preceded by carrying out a diagnosis on the vehicle and making sure that there are no faults on the vehicle. Programming must not be started before faults in the vehicle electrical system are ruled out. Always refer to the latest bulletins and information on currently known issues involving software releases.

Preparatory Measures

	**Engine** Turn off engine, ignition key turned to terminal 0
	**Manual Gearbox/SMG/DKG** - Transmission in neutral - Parking brake applied
	**Automatic Transmission** - Transmission in position P - System temperature below 80°C
	**Parking Brake** On vehicles with electromechanical parking brake, apply the parking brake by means of the parking brake button, otherwise use the handbrake.
	**Electric Loads** All electric loads, lights and turn indicator switched off. Wiper/washer system switched off. Make sure that the wipers can move freely. The wipers may be activated during programming. On no account block the wipers.

	**Battery and Battery Charger** The battery should be sufficiently charged at the start of the programming procedure (>13 V). Connect a BMW-specified and approved battery charger and set to external power supply mode (FSV mode). Do not connect or disconnect the charger during programming. The electrical system voltage must not drop below 13 volts during the programming procedure.
	**Diagnosis** Carry out a vehicle test on the ISTA workshop system. Using the ISTA diagnosis system, rectify any problems before programming and delete stored fault codes.
	**Interfaces** Programming is performed exclusively via the ICOM devices. Any vehicle equipped with a MOST bus manufactured before the F01/F02, will require the use of an ICOM A and an ICOM B.
	**Programming** CKM data is automatically saved by ISTA/P and written back to the control unit after programming. The data status of the ISSS must always be up to date.

Programming of Control Units

The programming system ISTA/P ensures updating of the data statuses on all vehicles by automatically generating a measures plan that should be implemented on vehicles that are bound to an i-level status.

In this context, a distinction is made between three different options. Each of these options represents a change or adaptation to the software and functions. A distinction is made between three measures:

- Programming
- Coding
- Customizing

Programming

Programming (also known as flash programming) loads a new program or data in the control unit. A distinction can be made between control units with:

- Program status and
- Program and data status

The program status of the control unit corresponds to the operating system and controls the computer program in the control unit. The data status involves the characteristic maps and characteristic curves specific to the vehicle, engine and transmission. The ISTA/P programming application automatically takes that into account when programming the control unit concerned.

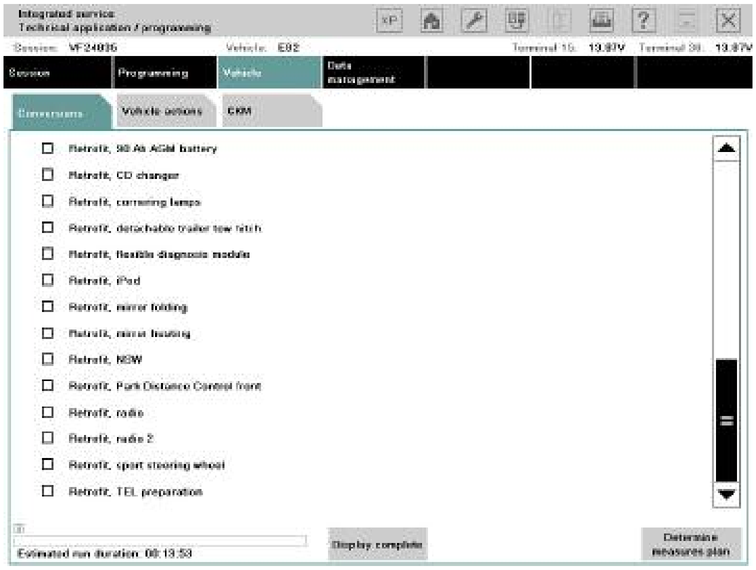
With ISTA/P, the control unit has been programmed, any necessary coding procedures are performed automatically.

Coding

Coding involves adapting the control units to the specific vehicle. That means that functions and data maps already in the control modules are enabled or activated in accordance with the vehicle order for the vehicle.

Customizing

On older vehicles, the car and key memory (CKM) option located under the Vehicle option is used to enter the customer-specific settings for the car and key memory functions on certain electrical systems.



Session: VF24036 Vehicle: E92 Terminal 15: 13.97V Terminal 30: 13.97V

- ☐ Retrofit, 90 Ah AGM battery
- ☐ Retrofit, CD changer
- ☐ Retrofit, cornering lamps
- ☐ Retrofit, detachable trailer tow hitch
- ☐ Retrofit, flexible diagnosis module
- ☐ Retrofit, iPod
- ☐ Retrofit, mirror folding
- ☐ Retrofit, mirror heating
- ☐ Retrofit, NSW
- ☐ Retrofit, Park Distance Control front
- ☐ Retrofit, radio
- ☐ Retrofit, radio 2
- ☐ Retrofit, sport steering wheel
- ☐ Retrofit, TEL preparation

Estimated run duration: 00:13:53

Personal Profile

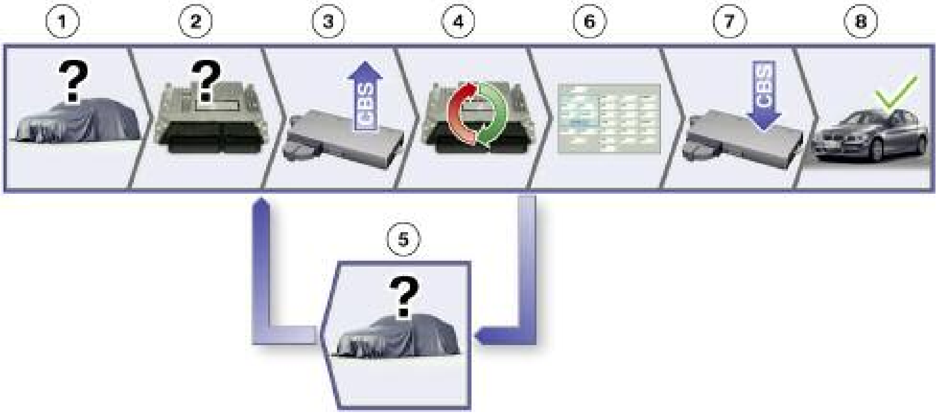
On vehicles with the Personal Profile function, the customization settings are entered directly by the customer. For such vehicles, there is no Customize button on the Vehicle menu.

Programming Process

The programming process consists of various procedures, some of which require manual intervention although most are automatic.

The individual procedures are illustrated here and described in detail below.

Programming process sequence



Index	Explanation
1	Identify vehicle and obtain read-out of control unit data
2	Produce and configure measures plan
3	Prepare for programming, export CBS/CKM data
4	Carry out repairs and replace control units where necessary
5	Re-check vehicle identification after repairs. Update measures plan.
6	Carry out programming
7	Carry out programming follow-up, import CBS/CKM data
8	Programming successfully completed.

Starting Programming

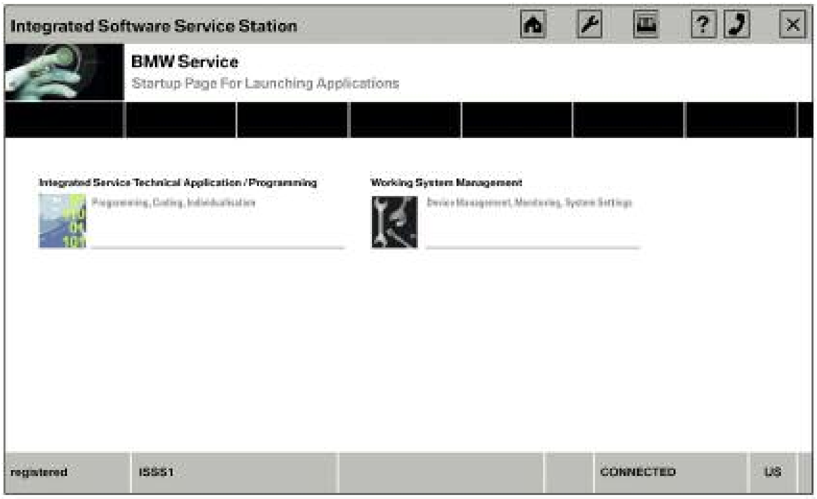
Essentially, ISTA/P is an independent external application that will run on the ISSS in Phase 1.

Although in a latter stage ISTA/P can be started from the ISID, it is entirely independent of the ISTA diagnosis application. That means that before programming can be started, diagnosis must be ended or interrupted.

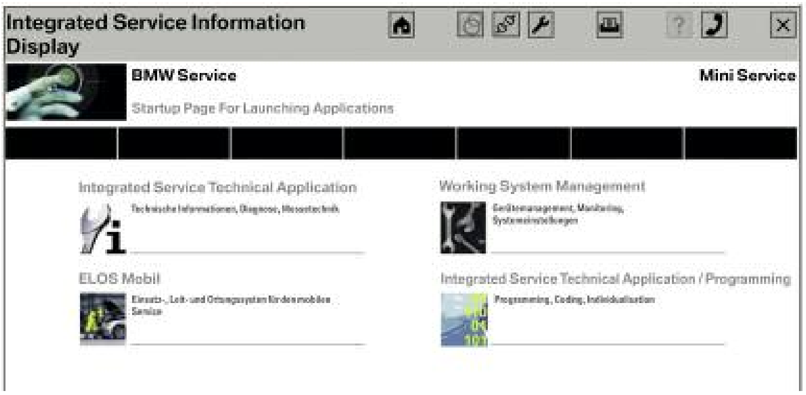
Starting and management of a new programming session can only be carried out by means of ISTA/P.

When ISTA/P is started, the user has a choice of three different actions:

- Cancel and exit ISTA/P
- Open an existing programming session
- Start a new programming session



Start screen on the ISSS Integrated Software Service Station



Start screen for ISID (not enabled initially)

Opening an Existing Programming Session

If the user decides to open an existing programming session, all the programming sessions currently in progress are listed and the user can select the session required.

On the toolbar there are various buttons for opening more menus.

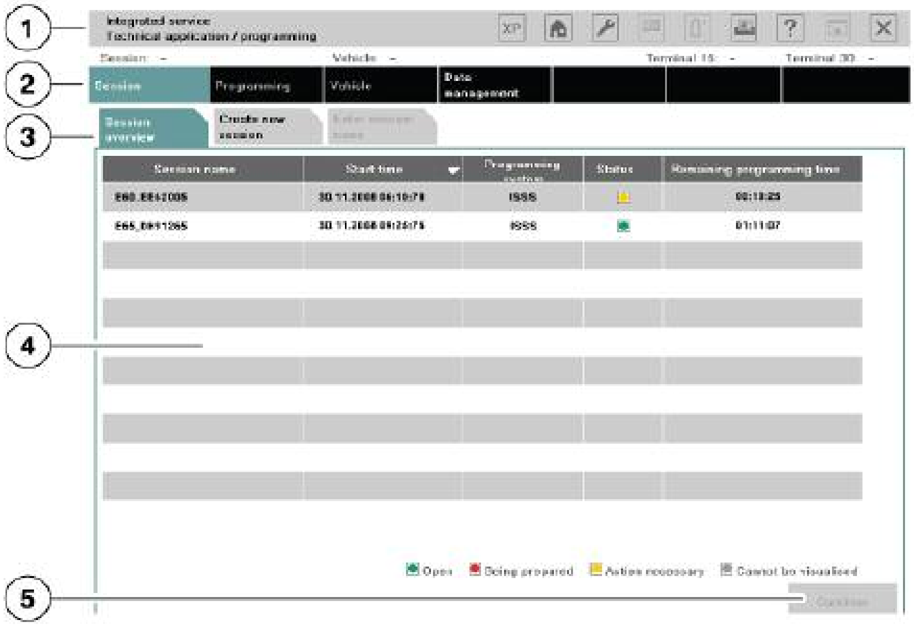
On the options bar, you can select the session or the vehicle that is to be programmed or the Integrated Software Service Station (ISSS) that is to be used for programming. Depending on the vehicles models connected, each ISSS can carry out up to five programming sessions at the same time.

On the function bar is the button for selecting the vehicle access method.

The information panel shows the details of the sessions or available ICOMs.

The control buttons are used to navigate through the programming process, e.g. the "Next" button takes you to the next screen.

List of current sessions

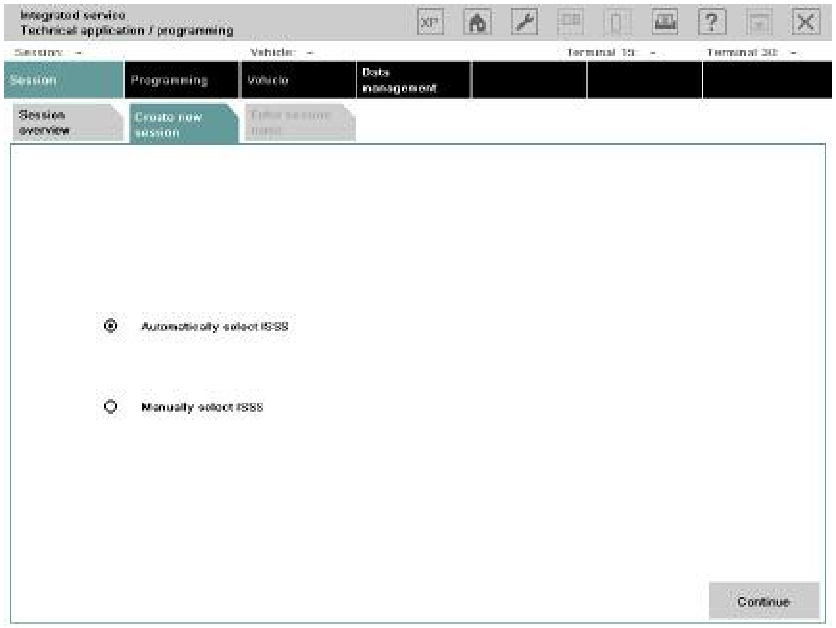


Index	Explanation
1	Toolbar
2	Options bar
3	Function bar
4	Information pane
5	Control buttons

Starting a New Programming Session

When a new programming session is to be started, the programming server on which the vehicle is to be programmed must first be selected.

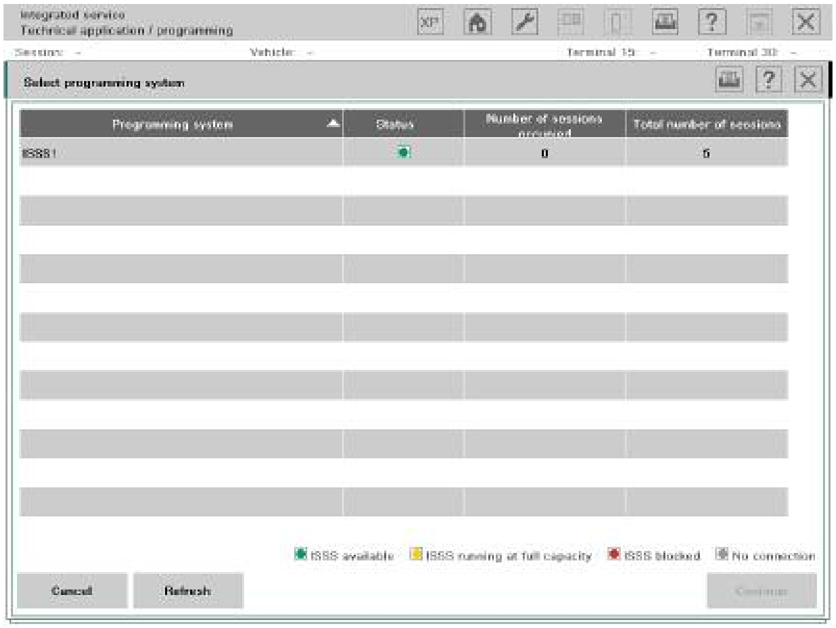
The ISSS used for the session can be selected manually or automatically. Because the ISSS can only program one F01 at a time or 5 other vehicles at a time, it is recommended that the automatic ISSS selection is carried out.



● Automatically select ISSS

○ Manually select ISSS

Selecting ISSS to be used for session

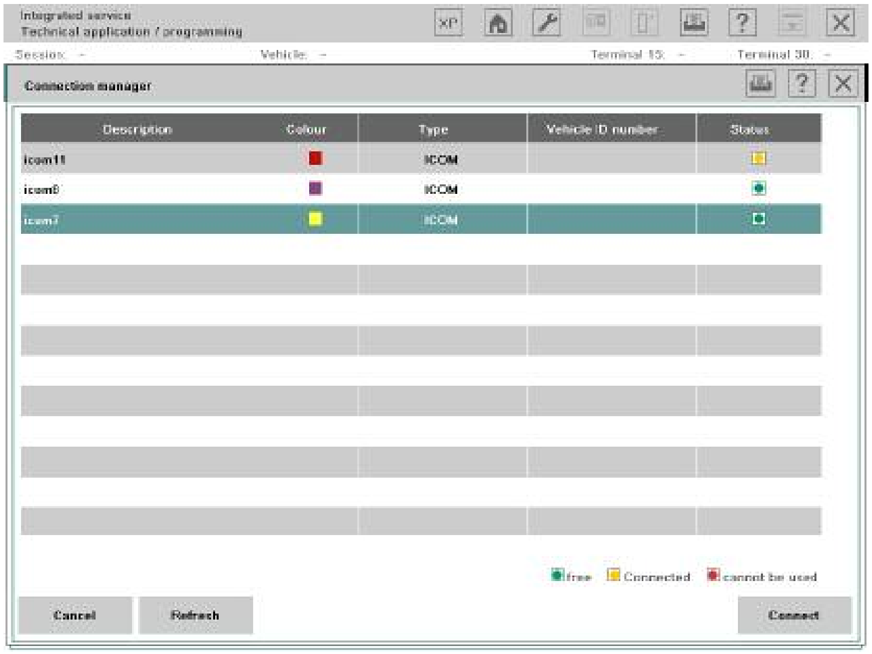


Programming system	Status	Number of sessions occupied	Total number of sessions
ISSS1	🟩	0	5

🟩 ISSS available 🟨 ISSS running at full capacity 🟥 ISSS blocked ▨ No connection

Selecting ISSS to be used for session

The connection manager on the ISIS establishes all the ICOMs that are available and displays the details. The user can select the desired ICOM or vehicle from the list displayed. ISTA/P then establishes the vehicle data. If that is not possible for any reason, the vehicle must be selected manually.



Session: –
Vehicle: –
Terminal 15: –
Terminal 30: –

Description	Colour	Type	Vehicle ID number	Status
icom11	🟥	ICOM		🟨
icom8	🟪	ICOM		🟩
icom7	🟨	ICOM		🟩

🟩 free 🟨 Connected 🟥 cannot be used

Selecting ICOM

The user then has the opportunity to give the session any individual name, but the system automatically enters the model of the vehicle along with the chassis number as an identifier (example: E60_EE12345).

Selecting Vehicle Interface

The same vehicle interfaces are used for programming with the new workshop system as for diagnosis.

From the F01 on, all control units can be programmed using only the ICOM **A**. Even though the F01/F02 is equipped with a MOST bus, ICOM **B** is not necessary due to the ethernet connection via the OBD2 connector.

For CAN-bus vehicles the ICOM A is used. MOST control units are programmed directly using the ICOM B. The ICOM B is connected to the ICOM A and the workshop network by a USB cable.

For older I-bus/K-bus vehicles with the round diagnosis connector, the ICOM C (C) is used in conjunction with the ICOM A.

Vehicle interfaces

Vehicle Access for MOST Bus

When programming vehicles with MOST bus from E65 to E9X, vehicle access is established as shown in the photograph below.

Vehicle access for programming MOST-bus vehicles

Vehicle Access for I-bus/K-bus Vehicles

On older vehicles without OBD II connection, programming is carried out via the round diagnosis connector in the engine compartment. That requires connecting the ICOM C to the ICOM A and to the workshop network.

Vehicle access for I-bus/K-bus vehicles

Vehicle Access from the F01/F02 on

All control units will be programmed exclusively using the ICOM A.

Identifying the vehicle and obtaining a read-out of control unit data

ISTA/P checks the vehicle electrical system, the central gateway and the vehicle-order control units (FRM/CAS/light module). The vehicle order is read and a consistency check carried out between the actual status and the required status.

If the central gateway does not respond, a software routine for restoring it to working order is attempted before the service technician is instructed to replace the ZGW.

First of all, the basic details of the vehicle are established such as VIN number, model, type code, etc.

Then, all control units fitted and the current I-level of the vehicle is determined. In addition, the programming system establishes, if possible, the software version last used to carry out servicing operations on the vehicle.

That makes it possible to avoid unnecessary programming if the vehicle already has the latest software version.

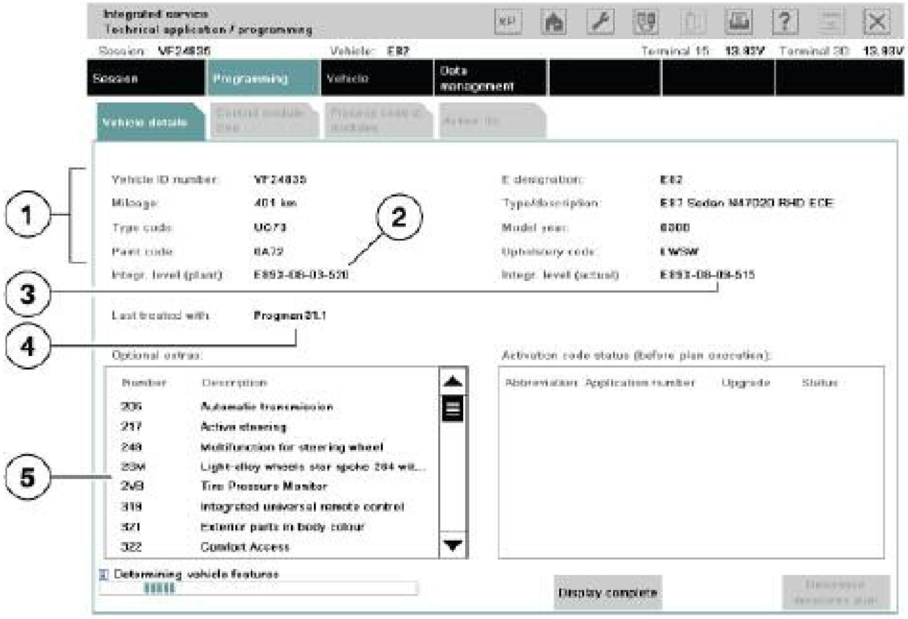
Afterwards, the details of the ex-works equipment options for the vehicle stored on the BMW programming system are retrieved.

Next, the control units identified and the equipment options fitted are compared (comparison of required vs. actual status).

For example, it is established whether the list of control units obtained actually matches those fitted on the vehicle and whether the level matches the current required status.

That ensures that all control units on the vehicle communicate properly with one another within the network. An I-level is a combination of networked control units validated and approved by BMW Development.

Establishing vehicle details



Session: VF24835 Vehicle: E82 Terminal 15: 13.93V Terminal 30: 13.93V

Vehicle ID number: VF24835
Mileage: 401 km
Type code: UC73
Paint code: 8A72
Integr. level (plant): E893-08-03-520
E designation: E82
Type/description: E87 Sedan N47020 RHD ECE
Model year: 0300
Upholstery code: EWSW
Integr. level (actual): E893-08-09-515
Last treated with: Progman 21.1

Optional extras:

Number	Description
206	Automatic transmission
217	Active steering
249	Multifunction for steering wheel
2SM	Light-alloy wheels star spoke 284 wit...
2VB	Tire Pressure Monitor
319	Integrated universal remote control
321	Exterior parts in body colour
322	Comfort Access

Activation code status (before plan execution):

Abbreviation	Application number	Upgrade	Status

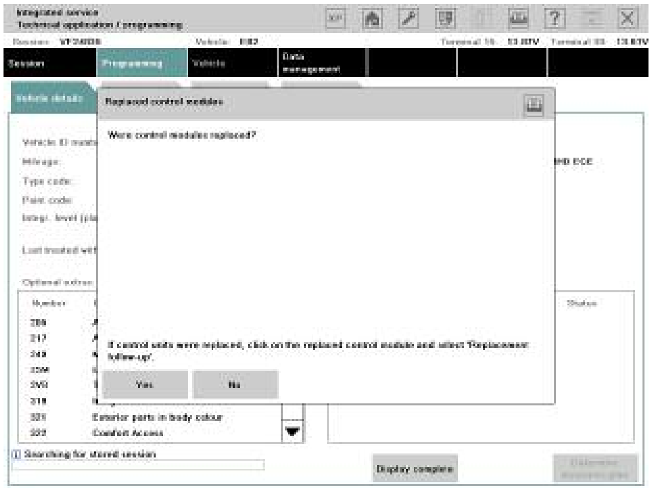
Determining vehicle features

Index	Explanation
1	Vehicle data
2	I-level with which the vehicle left the factory
3	Current I-level of the vehicle
4	System and version last used to program the vehicle
5	List of all optional equipment fitted on the vehicle

Producing and Configuring the Measures Plan

Before programming can be carried out, the measures plan is produced and can also be configured by the user. For example, it is now possible to program refits or conversions at the same time as the software update. The configuration for that is done now so that no further manual input is required later on during the programming sequence and it can then run automatically.

After the identification process, the user is asked if any control units have been replaced on the vehicle. If the answer is YES, ISTA/P checks whether an enabling code is required for the replaced control unit and, if so, requests it from the user if it has not already been entered on the system.



Were control modules replaced?

If control units were replaced, click on the replaced control module and select 'Replacement follow-up'.

Exterior parts in body colour

Comfort Access

Searching for stored session

Control unit replacement check

Associated customization data such as settings for the air conditioning are backed up and the action "Follow up control unit replacement" added to the list of actions.

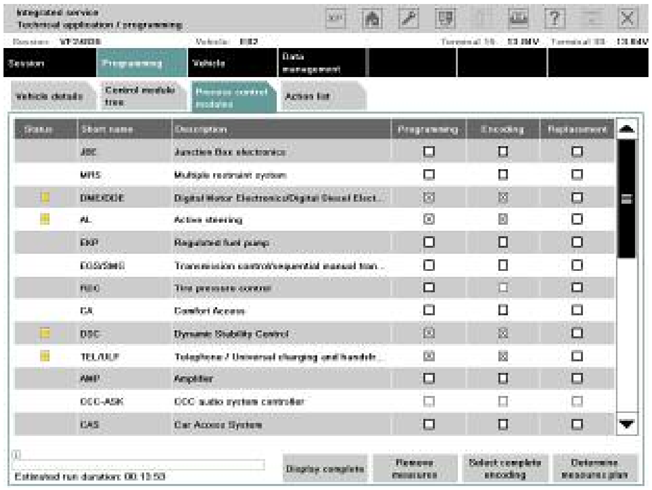
In general it is advisable to manually back up the customer's individual settings. If the control unit is defective, they can not be read and, therefore, can not be written back to the control unit after programming either.

The necessary actions, such as "Update control unit software", are established and added to the list of actions.

Then for the first time ISTA/P produces an measures plan based on the tasks in the list of actions at that point.

The user has the option of editing the measures plan. The user can add further actions to the measures plan but not remove them. The following actions can be added to the measures plan:

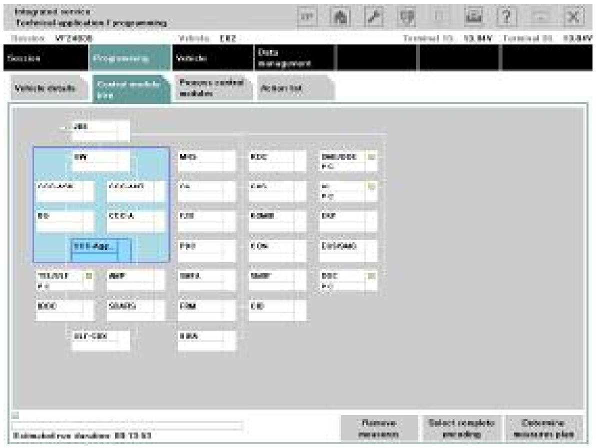
- Carry out conversion
- Prepare control unit replacement
- Program control unit
- Code control unit
- Set CKM data
- Enter enabling code
- Import vehicle order



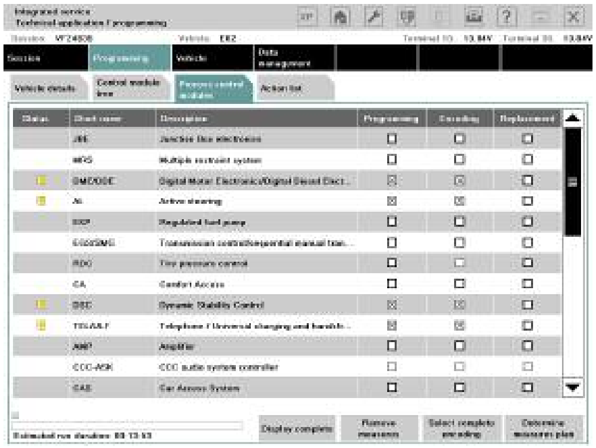
Status	Short name	Description	Programming	Encoding	Replacement
	JBE	Junction Box electronics	☐	☐	☐
	MRS	Multiple restraint system	☐	☐	☐
🟨	DME/DDE	Digital Motor Electronics/Digital Diesel Elect...	☒	☒	☐
🟨	AL	Active steering	☒	☒	☐
	EKP	Regulated fuel pump	☐	☐	☐
	EGS/SMG	Transmission control/sequential manual tran...	☐	☐	☐
	RDC	Tire pressure control	☐	☐	☐
	CA	Comfort Access	☐	☐	☐
🟨	DSC	Dynamic Stability Control	☒	☒	☐
🟨	TEL/ULF	Telephone / Universal charging and handsfr...	☒	☒	☐
	AMP	Amplifier	☐	☐	☐
	CCC-ASK	CCC audio system controller	☐	☐	☐
	CAS	Car Access System	☐	☐	☐

Estimated run duration: 00:13:53

Note: Required service functions such as initializations and clearing of fault codes are only indicated; they must be carried out on the ISTA diagnosis system.



Display of action plan as graphical chart



Measures plan shown as a table

The measures plan can be viewed as a graphical chart by pressing the button "Control unit tree" or as a table by pressing the button "Edit control units".

The measures plan can now be confirmed, rejected or cancelled.

The measures plan indicates which control units do not require any action - they are marked green.

The other control units, on which action is required, are marked yellow or red. The actions that are required are indicated by the letter(s) shown on the control unit. The letters stand for the following:

P = Program

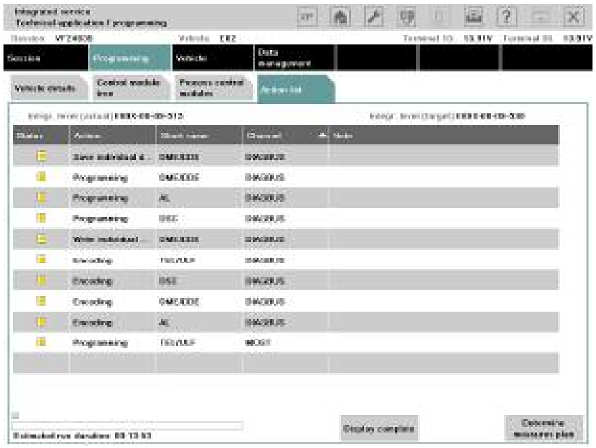
C = Code

I = Initialize

R = Replace

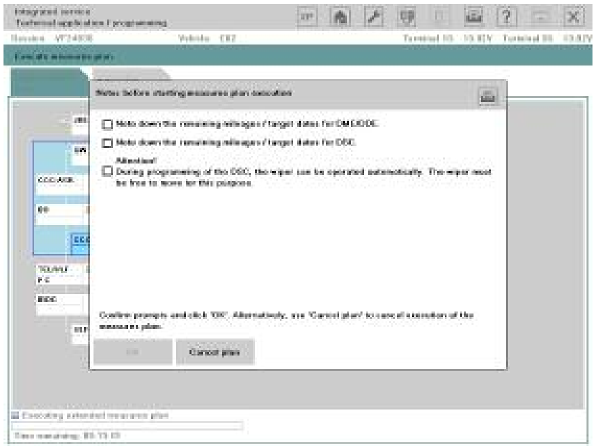
M = Mount (i.e. fit/install)

U = Unmount (i.e. remove).



Action list

The Action list contains all information relating to the control unit concerned and which via channel (D-CAN/MOST) it is programmed.



Guidance notes

Furthermore, additional guidance notes can be shown, e.g. on noting the remaining life of DME or conversion instructions for replacing control units.

Note: The guidance notes must be acknowledged by ticking the checkboxes and confirmed by clicking OK.

Preparing for Programming

After confirming the measures plan, the flash programmability of the control units is first checked and a notification message displayed if there is a problem. Then the customization data and the CBS data is read and backed up for rewriting later on.

If a control unit requires replacing, ISTA/P displays a message to the user indicating that the control unit should now be replaced.

After replacement is confirmed, the action "Follow up control unit replacement" is flagged for attention later on in the process.

ISTA/P then shows all required notifications, which must be acknowledged by the user before the actual programming starts.

That simultaneously starts the automatic programming process which requires no further interaction on the part of the user.

Note: As always, please keep in mind that the CAS is programmed first with the key removed. After successfully programmed, the ignition has to be switched on again.

Carrying Out Repair Tasks

If it was established in the process of identifying the vehicle that repair tasks are required, e.g. due to updating hardware or replacing a control unit, they are now carried out before the actual programming/coding process.

If the spare part is not available or the wrong part has been ordered, the session can be saved and ended at this point. As soon as the right part is available, the session can be retrieved and continued.

ISTA/P establishes from the measures plan which repair tasks are required and displays them. After successful completion of a repair task, the vehicle must be re-identified and any necessary software updates added to the measures plan.

In that way the possibility of inconsistencies on the vehicle after a repair is avoided. If a repair task fails, the programming process is cancelled.

Updating the Measures Plan

After a repair task has been carried out, ISTA/P performs the vehicle identification process again. If it identifies irregularities, e.g. that a control unit with an older I-level status has been fitted, appropriate actions are automatically set on the system or indicated to the user.

If there are irregularities, ISTA/P establishes which software updates are required based on compatibility management and adds them to the action plan. The measures plan is then updated and programming automatically started.

To prevent vehicles with inconsistencies being created, the user has no means of stopping the programming sequence.

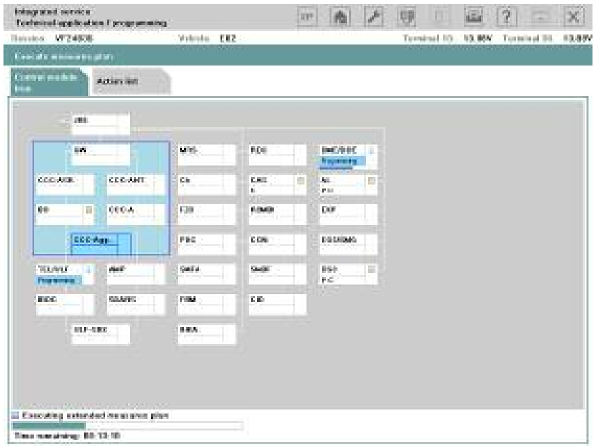
Carrying Out Programming

This stage of the process involves the programming and subsequent coding of the control units.

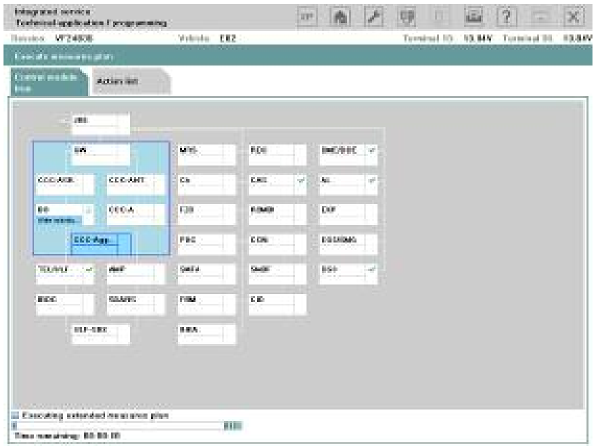
In the process of programming or coding a particular control unit, the system checks in each case whether the operation has succeeded before continuing with the programming of further control units. A particular version of ISTA/P distributes only one I-level. Programming of the vehicle as a whole (meaning all control units on the vehicle) is always performed to the latest I-level (target I-level).

The next step is to write the enabling codes to the relevant control units if required and modifying the vehicle order if conversions have been carried out. The programming of control units can also be performed simultaneously if they are on different bus systems, e.g. MOST and CAN.

The progress of the programming process is indicated by a progress bar.



Carrying out programming



View after completion of programming

If programming/coding/initialization has been completed successfully, there is a green tick by every control unit on which an action has been performed.

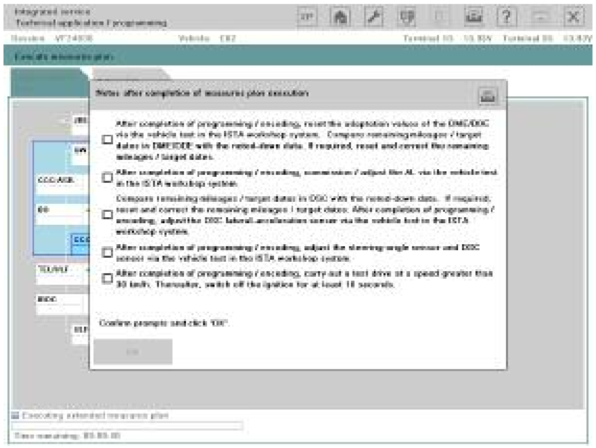
If an action has failed or not been completed, the control unit concerned is marked with a red X.

By clicking the control unit concerned, you can obtain information as to why programming failed.

Completing Programming Session

The last stage of the programming process is importing the customization, CBS and CKM data. The data is written back to the control units and checked. Afterwards, the automated initialization sequences are performed where required (electric windows/slide/tilt sunroof).

The automatic programming process is them complete. The initialization sequences that require user interaction are then carried out.



Notes on follow-up

After completion of the initialization sequences, ISTA/P establishes from the measures plan what service functions are required, e.g. setting steering angle. They are shown to the user. They have to be carried out as part of the diagnosis after programming. That is carried out by way of the vehicle test on the ISTA workshop system and afterwards all fault memories must be cleared.

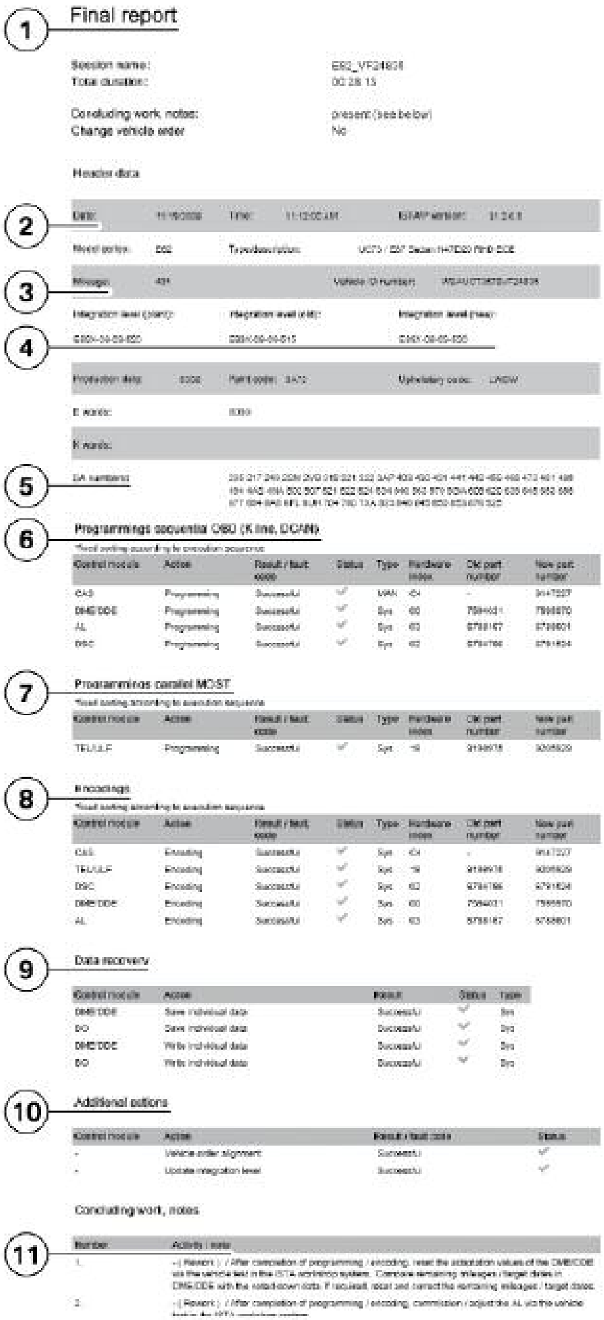
Finally, the actual status is checked once again and the final report produced. ISTA/P provides the user with the final report.

The user can print out the final report or else it is stored for a certain period on the ISIS.

The entire programming log is sent to BMW AG as part of the FASTA data. This allows BMW to retrace how the vehicle programming was carried out from the user actions, either for accounting purposes or if there is a subsequent fault.

Furthermore, that data is automatically analysed so that software errors can be detected at an early stage and suitable measures initiated. As a result, BMW is able to continuously monitor and improve software quality.

Final Report



Final report

Session name: E82_VF24828
Total duration: 00:28:15

Concluding work, notes: present (see below)
Change vehicle order No

Header data

Programmings sequential OBD (K line, DCAN)

Programmings parallel MOST

Encodings

Data recovery

Additional actions

Concluding work, notes

Index	Explanation
1	Final report
2	Current programming data: data, time, ISTA/P version
3	Vehicle data: mileage and VIN number
4	I-levels: factory, last, current
5	SA numbers
6	Programming actions indicating success or failure over MOST
7	Programming actions indicating success or failure over I/K bus
8	Coding actions indicating success or failure
9	Data saving actions indicating success or failure
10	Additional actions, e.g. whether updating of I-levels was successful or failed.
11	End notes