Reference Manual

E93
COMPLETE VEHICLE

Technical Training

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Introduction

Model: E93

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand dimensional changes of the E93
- Understand basic body construction of the E93
- Understand changes to seating on the E93

The 3 Series Convertible

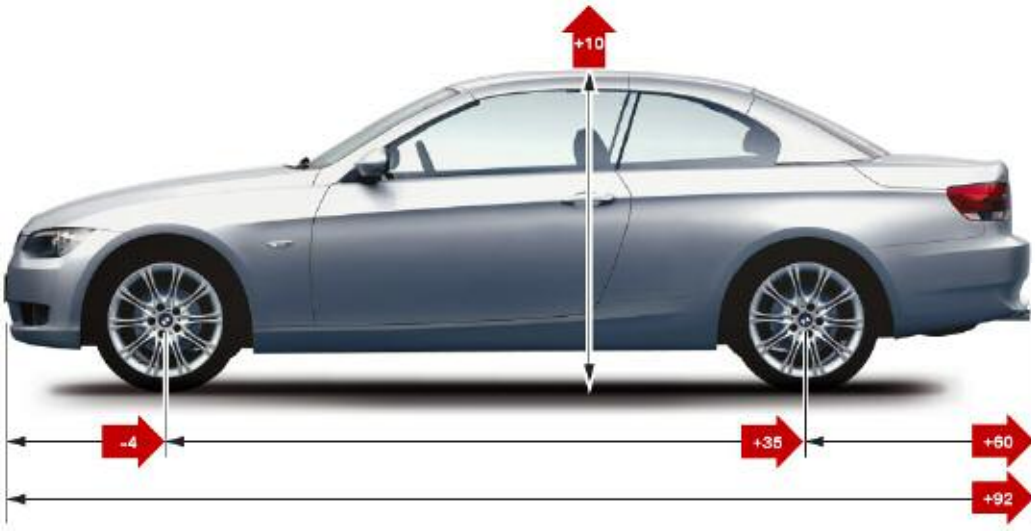
With the 3 Series Convertible, customers have always enjoyed the exhilarating feeling of driving with the top down.

The E93 consistently continues this line while adopting the sporty characteristics of the E92. This sport-orientated performance is reflected in the deep-drawn front and the wide, flat rear.

New engines, an even more rigid body with 19 Hz torsion frequency (torsional rigidity) and a sophisticated strut, chassis and suspension concept support the sports character.

Dimensions and Weight

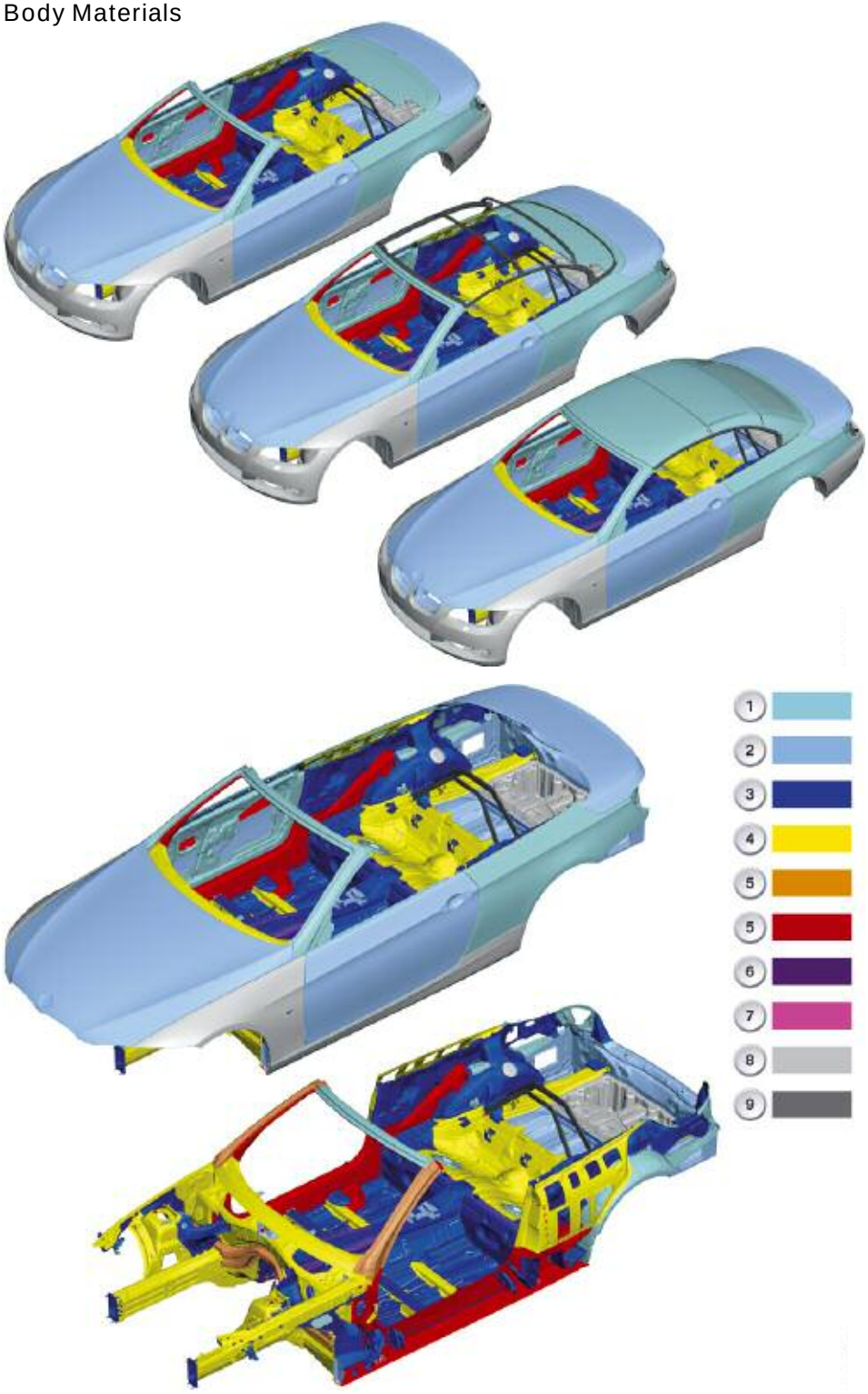
In terms of dimensions, the E93 is larger compared to the E46/C. The E93 is 4580 mm long, 1782 mm wide and 1384 mm high.The weight has also increased from 1565 kg (E46) to 1655 kg (E93).



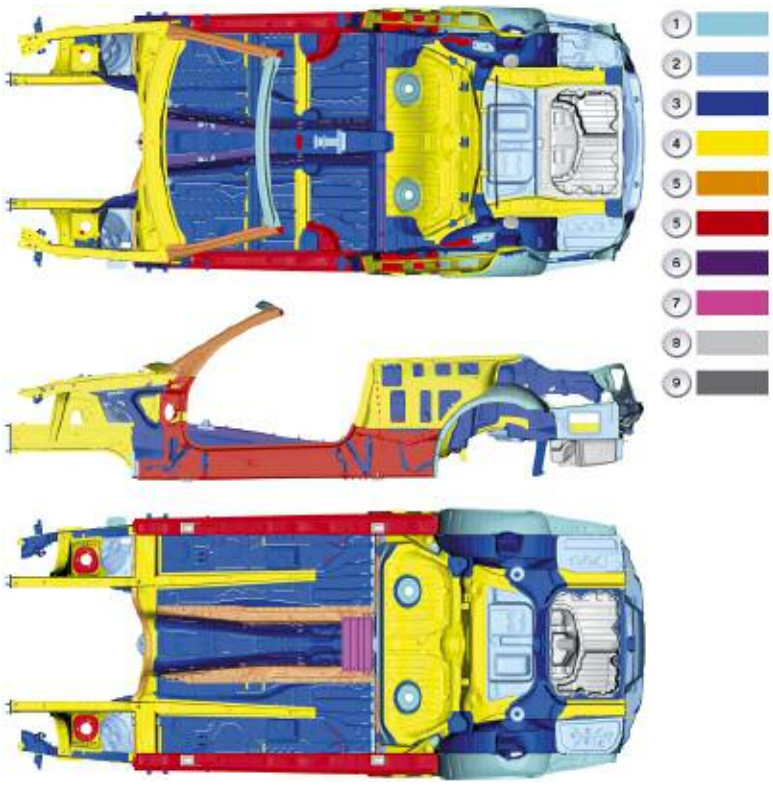
Bodyshell

By using high-strength materials, the philosophy of lightweight body construction has been consistently realized in the E93.

E93 Use of Body Materials

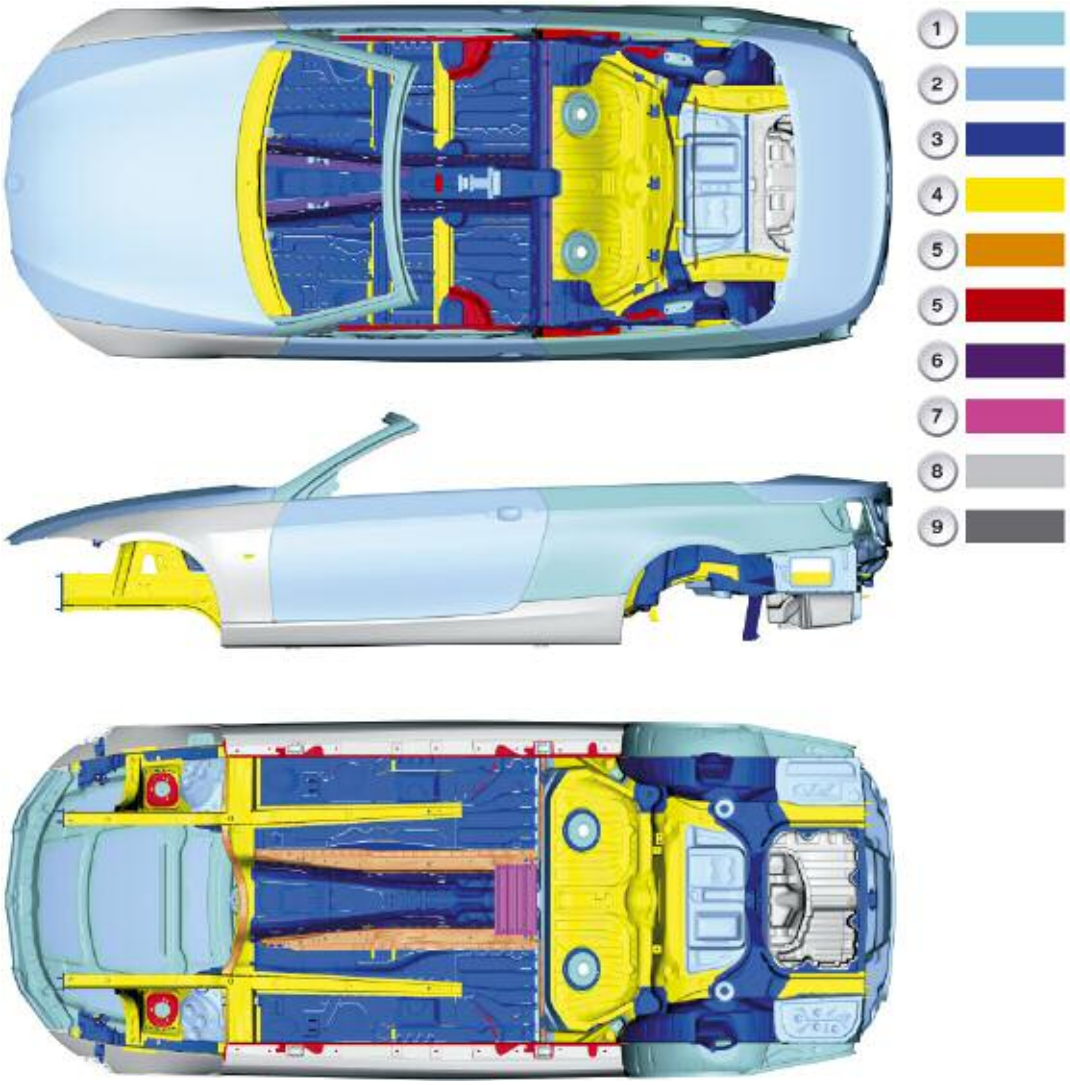


E93 Use of Body Materials



Index	Explanation	Index	Explanation
1	DC 03/04	6	HC 600 c/HD 680 C/HC 680 C
2	HC 180 BD/HC 220 BD	7	22 Mn B5, Docol 1000 DP
3	HC260 BD/HC 300 BD	8	Plastics
4	HC 400 TD/HC 380 LAD	9	Other
5	HC 420 LAD		

E93 Use of Body Materials



Index	Explanation	Index	Explanation
1	DC 03/04	6	HC 600 c/HD 680 C/HC 680 C
2	HC 180 BD/HC 220 BD	7	22 Mn B5, Docol 1000 DP
3	HC260 BD/HC 300 BD	8	Plastics
4	HC 400 TD/HC 380 LAD	9	Other
5	HC 420 LAD		

Higher dynamic forces are introduced into the body structure while driving due to the runflat tires and harder suspension setup in the E93 compared to the E46/C. Consequently, the rigidity targets have been raised even further compared to the E46/C.

Torsional Rigidity	E46/C	E93
Dynamic	17.5 Hz	19 Hz
Static	11500 Nm/°	14500 Nm/°

The sill represents the decisive load path from the front end to the rear end. A horizontal flange is used between the inner and outer sill shell in order to optimally utilize the available package space for bending and torsional rigidity. The sill is reinforced with transverse bulkheads.

To effectively absorb stress and strain, the outer skin panel of the sill is designed as a flexibly rolled sheet metal component with wall thickness varying between 2.00 mm and 3.00 mm. The greatest wall thickness is at the nodes for the A and B-pillars.

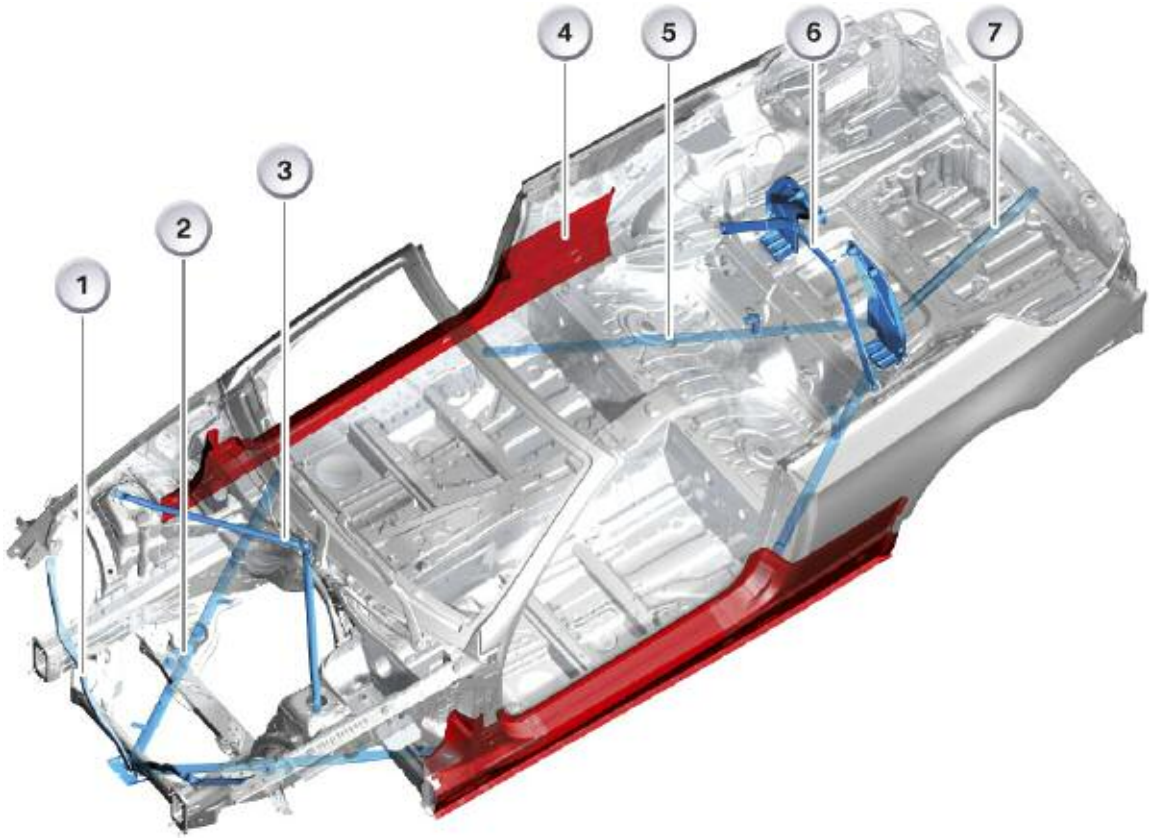
With minimum weight, the partition is an assembled module that provides a large, customer-friendly load space. Also in this area, the main load paths run via struts.

Strut Concept

A strut concept is employed with the aim of increasing the body rigidity, consisting of:

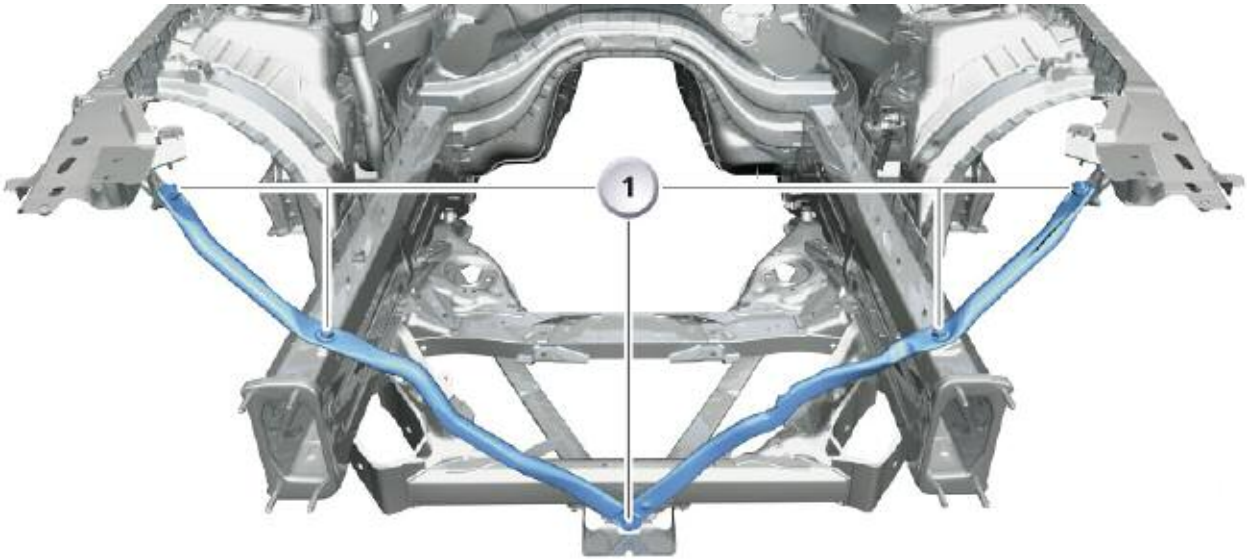
- Front end struts
- Spring strut tower - bulkhead - struts
- Front axle subframe - struts
- Tension struts at rear
- Strut in rollover protection system

The cross section of the sill has been additionally increased compared to the E92.



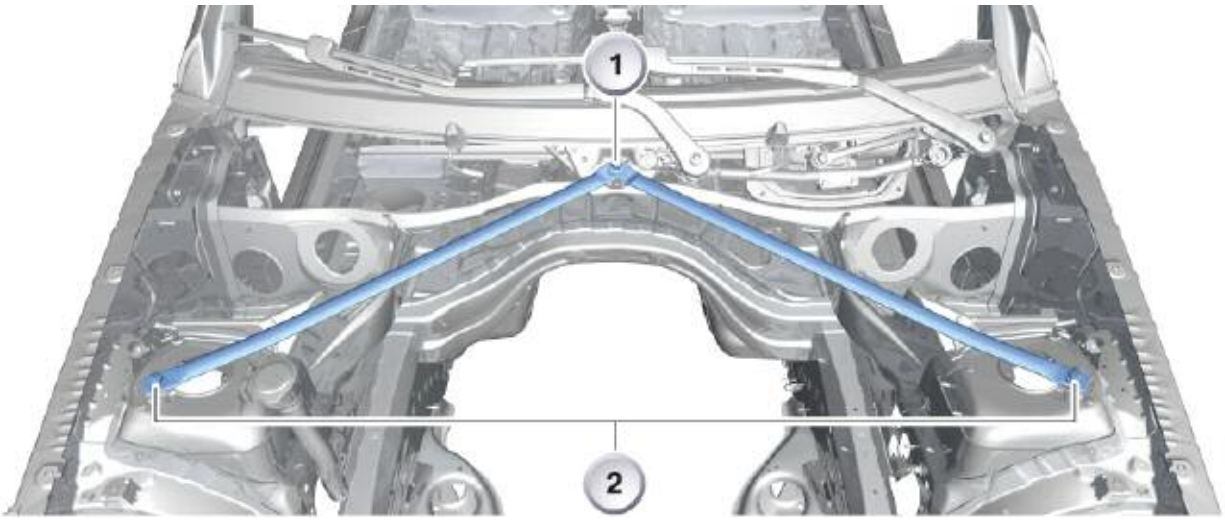
Index	Explanation	Index	Explanation
1	Diagonal strut, engine compartment	5	Underbody strut
2	Front axle subframe struts	6	Strut in rollover protection system
3	Spring tower strut	7	Tension strut
4	Sill		

Diagonal Strut, Engine Compartment



Index	Explanation
1	Mounting points of diagonal strut

Spring Tower Strut



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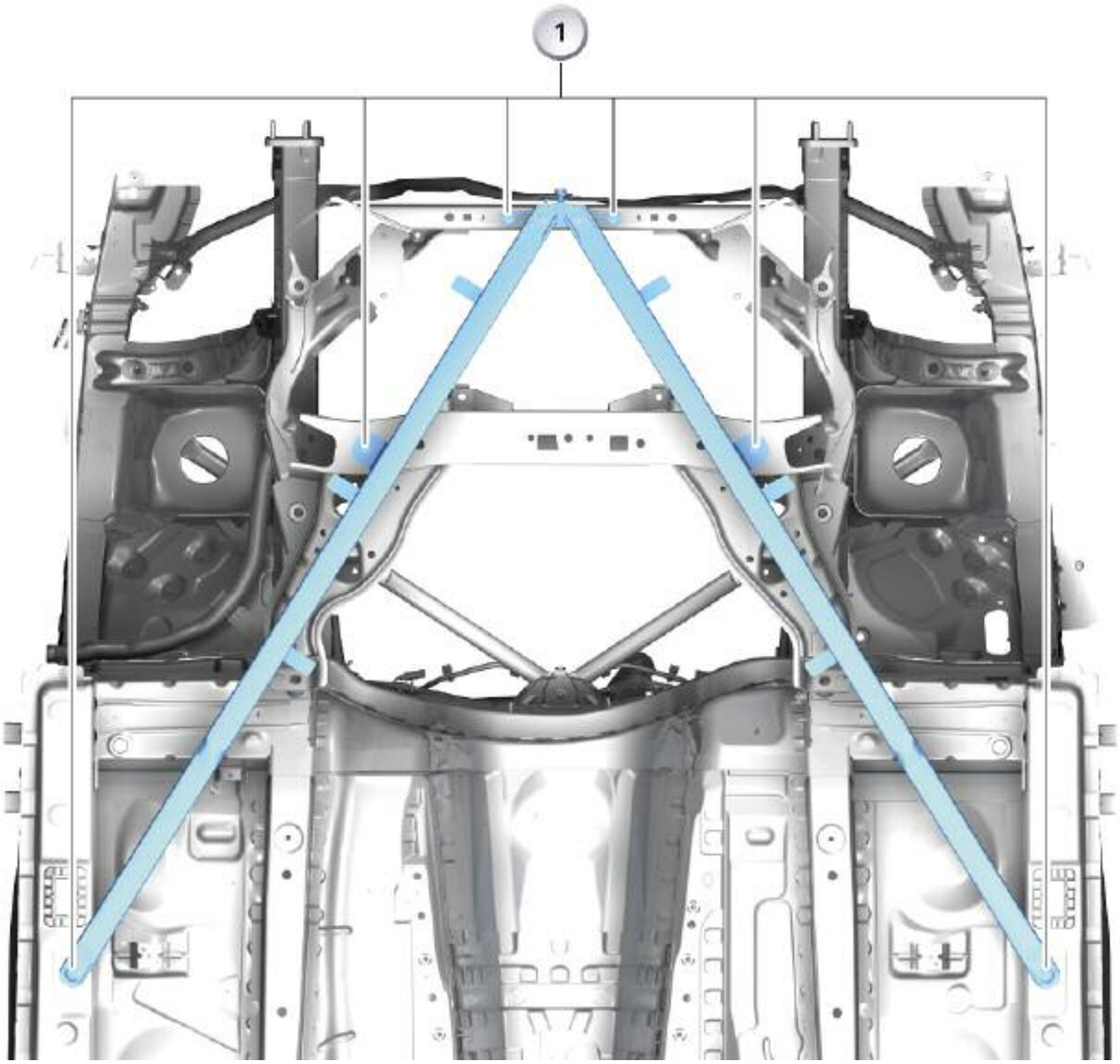
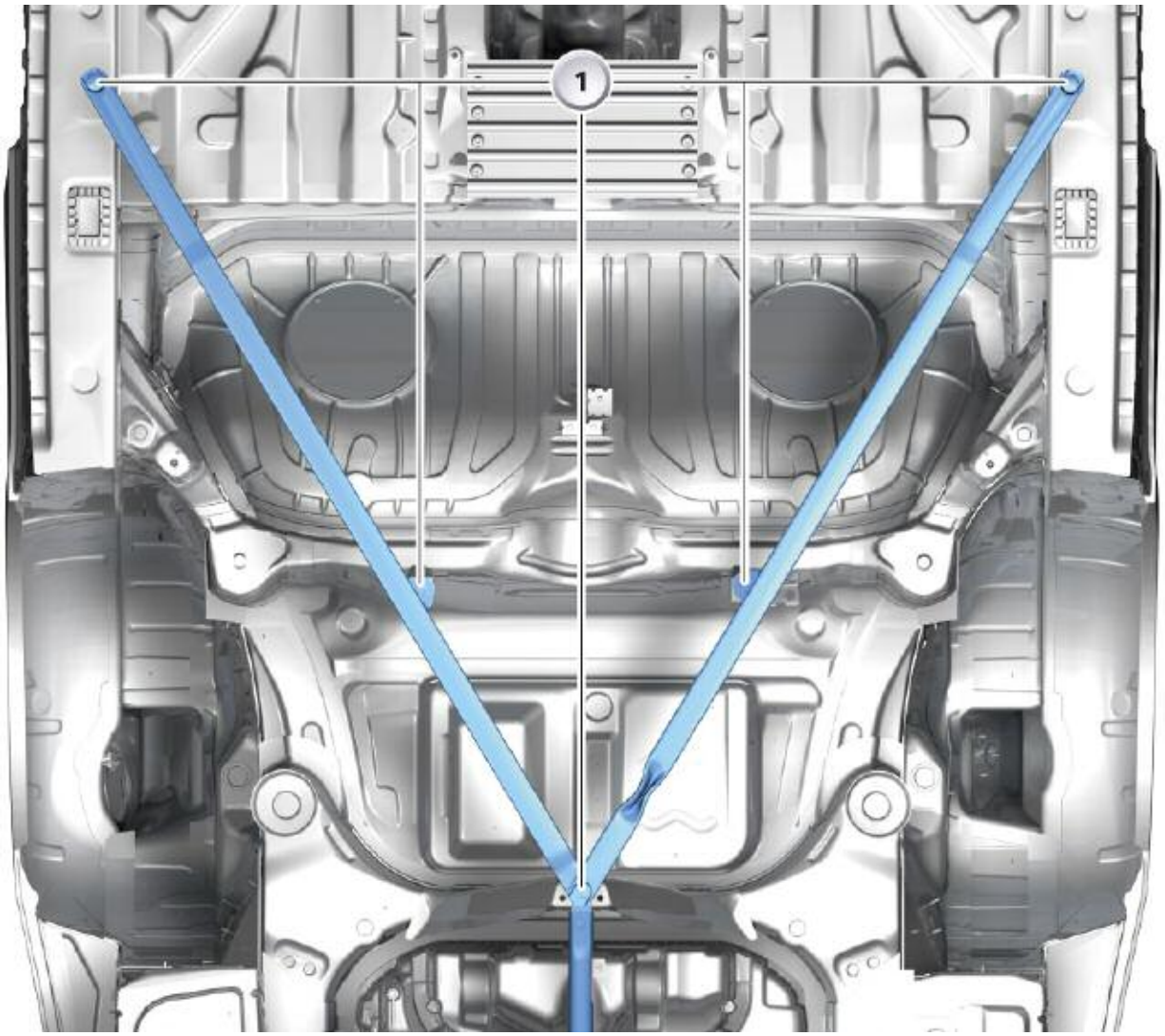
Underbody Struts



Index	Explanation
1	Mounting points of underbody strut, front



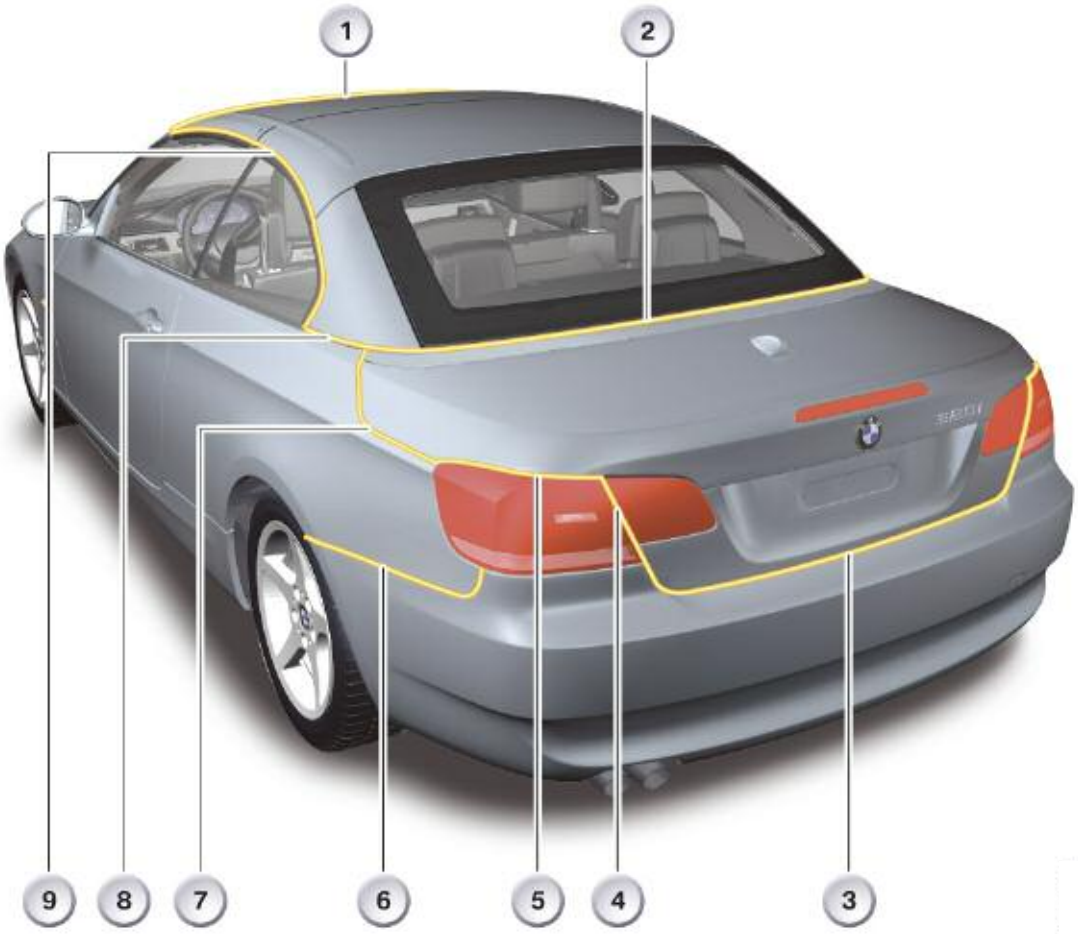
Index	Explanation
1	Mounting points of underbody strut, rear

Aerodynamics

The outstanding aerodynamic qualities of the 3 Series Coupé have been transferred to the 3 Series Convertible. Ultimately, a drag coefficient cx = 0.29 was realized on the 325i.

Joint Reduction

The size of the joint gaps has been reduced on the E93.



Index	Explanation	Index	Explanation
1	5.0 +/- 0.1 mm	6	2.5 +/- 0.6 mm
2	4.0 +/- 1.0 mm (previously 6.0 +/- 1.2 mm)	7	3.8 +/- 0.9 mm (previously 5.0 +/- 1.9 mm)
3	4.2 +/- 0.7 mm (previously 5.2 +/- 0.7 mm)	8	4.0 +/- 1.2 mm (previously 6.0 +/- 1.2 mm)
4	3.8 +/- 1.0 mm (previously 3.8 +/- 2.8 mm)	9	Trim strip offset
5	4.2 +/- 1.2 mm (previously 5.0 +/- 1.2 mm)		

Side Panel

The side panel of the E93 is made from thermoplastic material. It is common part from the E92.

The advantage of a plastic side panel is the weight reduction of approximately 3 kg compared to a side panel made from steel.

Minor bumps are absorbed.

Doors

From a workshop point of view, the doors of the E93 are the same as the doors of the E92. All assembly and installation work corresponds to that of the E92.

The doors of the E93 are also based on a lightweight steel construction. The anti-corrosion concept with a 2C PVC seal is the same as on the E92.

Important Body Equipment

- Retractable three-piece hardtop (see reference material "Retractable hardtop E93")
- Folding rear seat backrest with storage compartment
- Concealed antennas
- Easy-load luggage compartment
- Wind deflector with new functionality
- Multifunctional ski bag with larger through-load width (380 mm instead of 250 mm)

Partition Module

The partition module consists of the aluminum cross member section with nodes and corresponding struts as well as the rollover protection system.

The partition module additionally contains the control units for the Convertible top module (CTM), park distance control (PDC), Passive Go and rollover control (ROC).

Seats

A special feature of the front seats in the E93 is the seat-integrated seat belt system. This system is known from the E46 and E64. A new feature of the leather trim finish is so-called cool leather, i.e. sun reflective technology.

This technology involves a change in physical properties by introducing modified color pigments in the leather, thus achieving a clearly noticeable temperature difference of up to 20°C (on black leather).

The folding rear seat backrest is a new development in the E93.

Ski Bag

The considerably larger ski bag provides the option of storing skis, snowboards as well as a golf bag.

The volume of the luggage compartment is 350 liters and 210 liters with the top down. The front cover of the ski bag is hinged such that it can be opened even when the backrest is in the upright position. In this position, a restricted through-load opening can be used while simultaneously carrying four persons.

The full cross section of the through-load area can be used when the backrest is folded down. The front cover can be detached by means of an adapter system so as to increase the loading cross section even further.

Item	Dimension
Loading width	405 mm
Loading height	263 mm
Ski bag length	1300 mm
Ski bag volume	approximately 0.13 m^3

Rear Bag

The rear bag has been specially developed for the E93 for the purpose of transporting items of luggage, clothing and other items in a clean and dry condition and to protect them from nosy-parkers when the top is down.

The bag is fixed to the vehicle so that it and the contents remain secure even during sudden braking. It fits conveniently under the wind deflector.

Accident Repairs

The following procedures must be complied with in the event of accident damage in the vicinity of the retractable hardtop:

Accident Damage: Replacing boot lid

Procedure - Check kinematic rear end module, support tube and coupling locks and main mount of roof module, including Convertible top compartment lid for damage and replace as required.

Accident Damage: Replacing rear apron

Procedure - Remove and install rear end module for retractable hardtop to perform welding jobs (accessibility of welding tong at weld).

Check both main mounts, support tube and coupling locks when removed for damage and replace as required.

Accident Damage: Replacing rear left or right frame side member

Procedure - Remove and install rear end module for retractable hardtop to perform welding jobs (accessibility of welding tong at weld).

Check both main mounts, support tube and coupling locks when removed for damage and replace as required.

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Electronic Systems

Model: E93

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Identify changes to bus system on the E93
- Understand changes and additions to Information and Communication Systems
- Understand changes to the Climate Control System
- Understand changes to the Passive Safety System

E93 Electronic Systems

The vehicle electrical system and the scope of electrical/electronic systems are largely identical to those of the E92 Coupe.

Adaptations and modifications have been implemented in individual systems in view of the different body structures of the closed Coupe and the open Convertible.

This publication describes changes and modifications that result in an expansion or modification to the corresponding function.

The system descriptions are subdivided into following areas:

- Vehicle systems network
- Energy management
  – Terminal control
- General vehicle electrical system
  – Exterior lighting
  – Interior lighting
  – Central locking system
  – Anti-theft alarm system
  – Seats with rear compartment easy entry
  – Changes in control units
  – Power windows
- Air conditioning system
  – Convertible mode
- Information and communication technology
  – CCC function keys
  – Interface box SBX
  – Antenna systems
  – Locations of IKT control units
- Passive safety
  – Crash-reinforced bodyshell
  – Advanced crash and safety management
  – Rollover protection systems
  – Seat-integrated side airbag
  – Knee airbag US

Bus Network

The vehicle systems network US differs in that it features other systems provided specifically for the USA and Canada.

Since no diesel vehicles are currently offered in the USA, the corresponding control units have been omitted on the PT-CAN and BSD.

Changes in K-CAN

A new feature is the Convertible top module (CTM) which is connected to the K-CAN for the purpose of controlling the retractable hardtop.

The ACSM 2 is used as the passive safety system which contains the sensors for the rollover protection system.

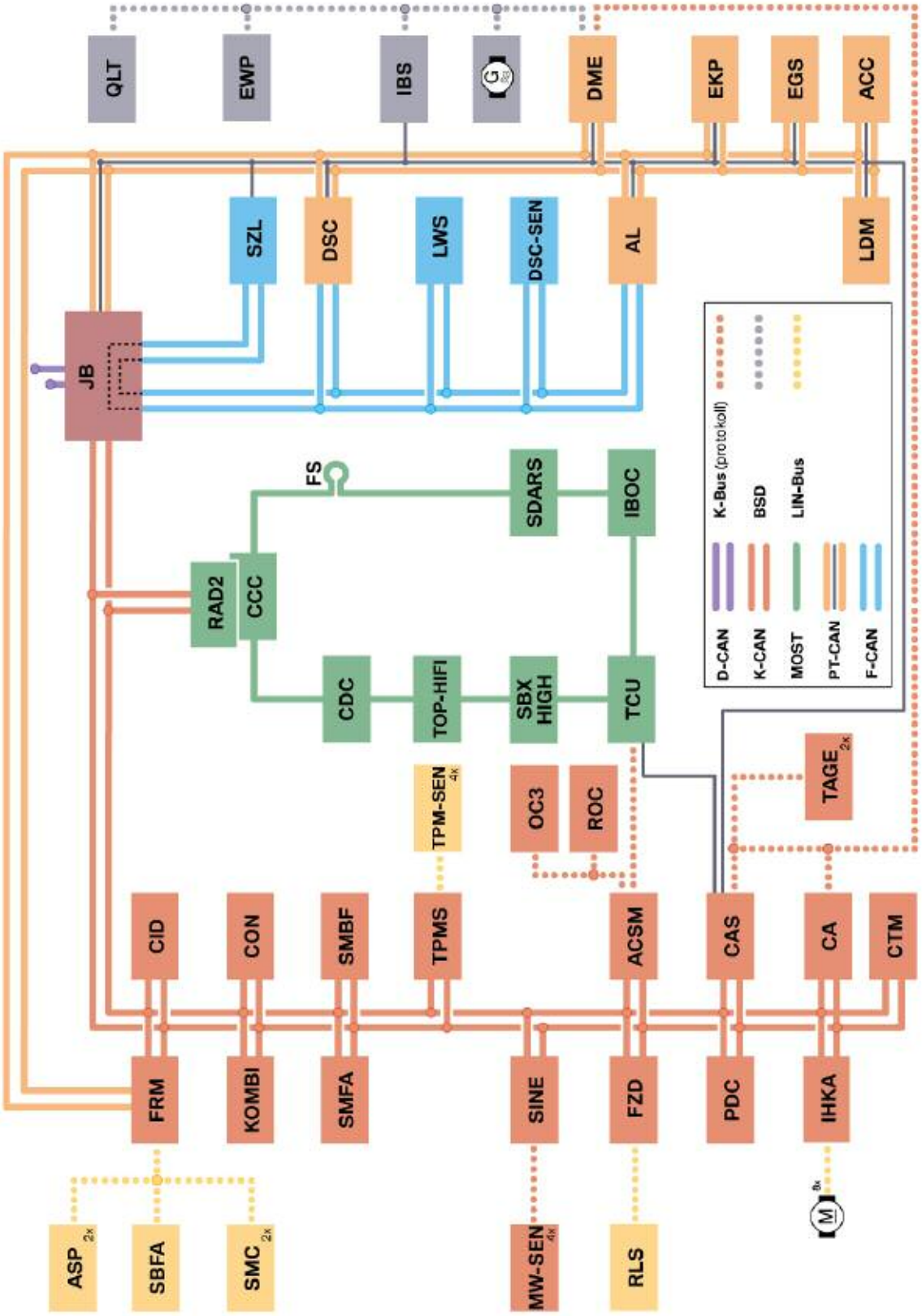
The SINE of the anti-theft alarm system DWA is no longer looped through the roof functions module FZD but rather connected directly to the K-CAN.

The RDC (TPMS) is a tire pressure monitoring system that replaces the tire failure indicator RPA in US vehicles to conform to legal requirements.

Changes in LIN-bus

Two control units for the seat belt extender on the driver's and passenger's side have been dropped from the LIN-bus as the seat belt in the Convertible is located directly in the seat.

E93 Bus Overview



Energy Management

As in the current models, an energy management system is also used on the BMW 3 Series Convertible to ensure a balanced energy supply in the vehicle.

The energy management functions are integrated in the power management system that is implemented in the form of software in the engine control module (DME).

The power management, the components and the various functions of the system differ depending on the equipment configuration of the vehicle.

Two energy management control systems are installed:

- Basic Power Management BPM
- Advanced Power Management APM

On vehicles equipped with advanced power management modifications have been made in the terminal shut-down system through relay 30g and 30g f.

Advanced Power Management

Advanced power management (APM) is used on vehicles featuring following options:

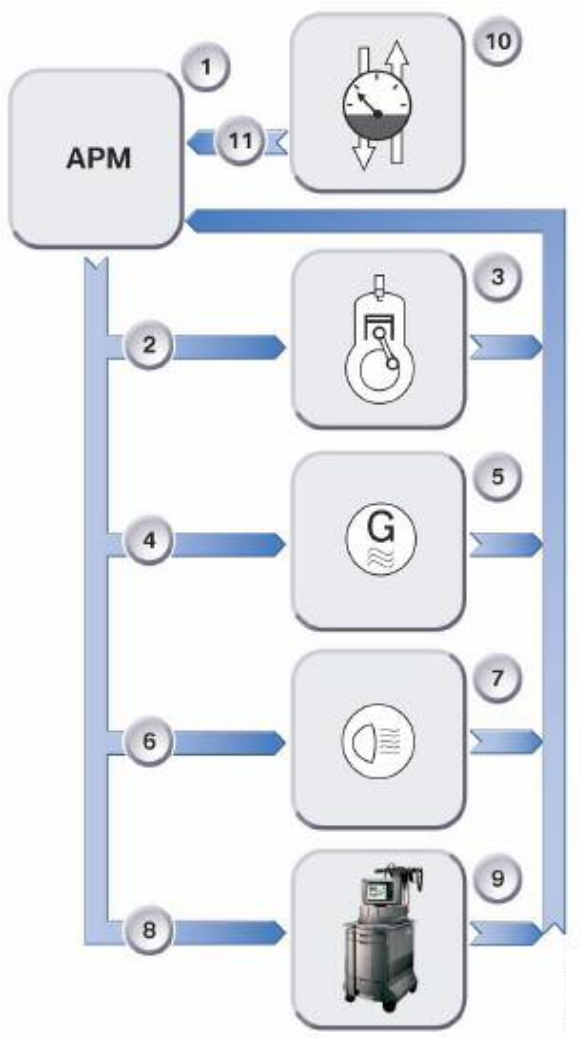
- Comfort access
- Multi-audio system controller
- Car communication computer
- Telephone US/telephone preparation US

The advanced power management has been expanded by the intelligent battery sensor IBS. In addition to the change in the idle speed and the specified charging voltage target value, the system includes the following functions that differ from the BPM.

Expanded APM Functions

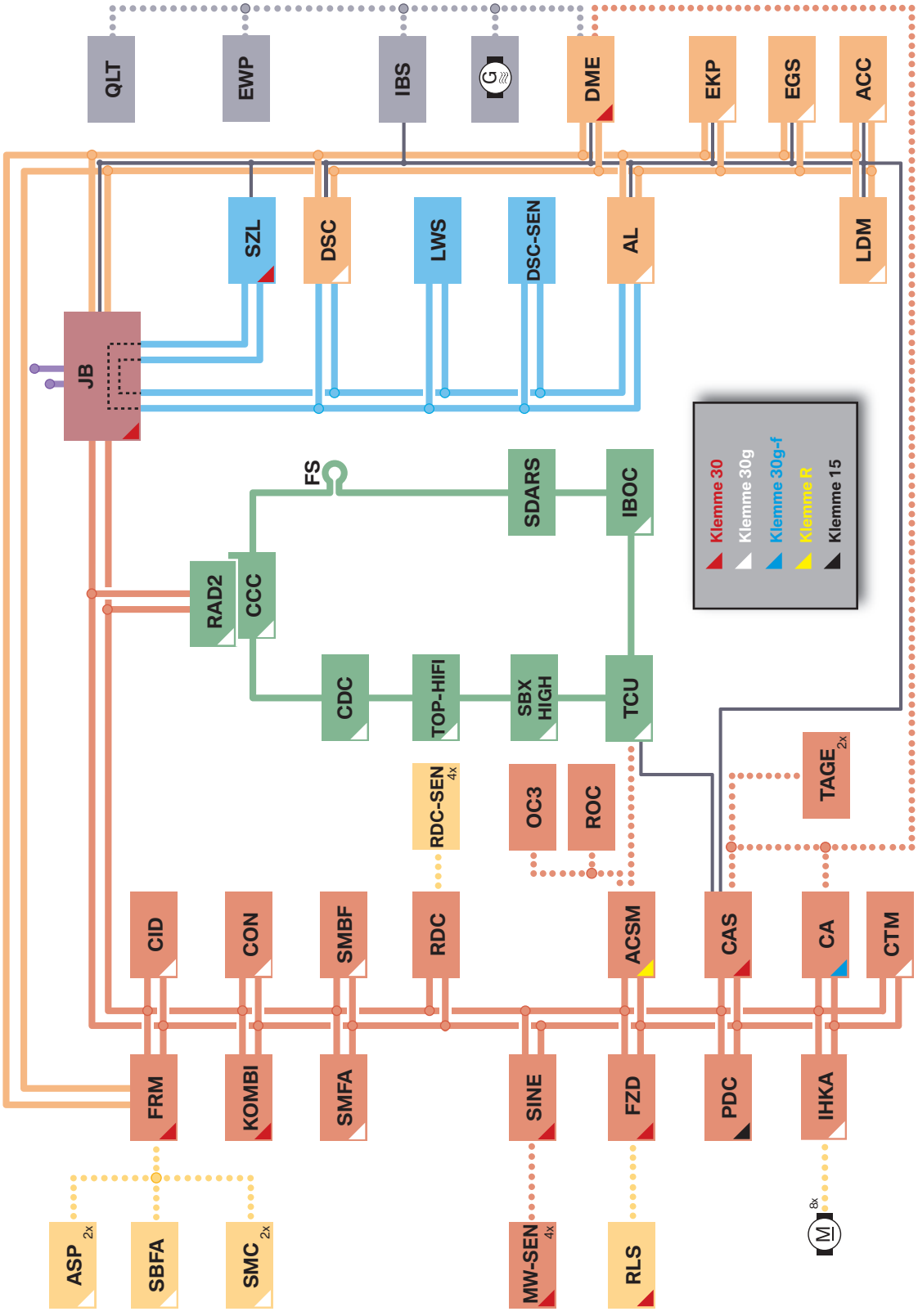
- Electric load reduction
- Electric load shut-down
- Systems network diagnosis
- Battery diagnosis

APM Control Circuit



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

E93 Bus Overview (with Terminal Status)



Terminal Shut-down Identification

To provide clear identification of the terminal shut-down function, the control units are identified with colored triangles. The identification and assignment to the individual terminals is shown in the legend on the opposing page.

Electric Load Shut-down Terminal 30g Relay

Time-dependent shut-down - The E93 is equipped with a terminal 30g relay for switching off the power supply to most control units. Most convenience electric loads such as the radio are switched off after 30 minutes by terminal 30g in order to maintain the starting capability of the battery.

The after-running time is extended to 60 minutes if a telephone is installed in the vehicle. The terminal 30g relay is activated by the car access system.

Electric Load Shut-down Terminal 30g_f Relay

Fault-dependent shut-down - The terminal 30g_f relay is additionally installed in the junction box of the E93 only when one of the following equipment options is ordered:

- Comfort access
- M-Audio system controller
- Car communication computer
- Telephone US/telephone preparation US

The terminal 30g_f relay is a bistable relay and is always in the ON state under normal conditions. It switches off the connected control units only in the case of fault. The switching status is retained even when no power is applied.

The terminal 30g_f relay is activated by the junction box control unit and switches off the connected electric loads if a fault occurs. The calculations required for activating the terminal 30g_f relay take place in the DME and in the junction box. The following activities are monitored in the junction box:

- Unauthorized wake-ups within the bus system
- Sleep mode preventers (control units that constantly keep the bus systems active)

The battery values are constantly read out and evaluated in the engine control unit. The relay is also switched off when the starting capability limit of the vehicle battery is reached.

Control Units (connected to terminal 30)

Due to their functionality, some control units cannot be switched off and must remain connected to KL30. The following chart shows the control modules connected to KL30 and the reasons why this is needed.

Index	Explanation
JB	Because of master functionality
FRM	Because of legally required hazard warning function
FZD	Because of the connection of the DWA components
SINE	Because of DWA functionality
CAS	Because of the “unlock vehicle” function
SZL	Because of the steering angle sensor data (volatile)
DME	Because of power management
EPS	Because of high current consumption
Kombi	Because of the data saving function (mileage reading)

Control Units (connected to terminal R and 15)

Control units that have only one functionality connected to terminal R or 15 can be switched off directly.

The ACSM2 control unit is connected to terminal R. The high beam assistant and park distance control are connected to terminal 15.

General Vehicle Electrical System

The general vehicle electrical system includes the following:

- Exterior lighting
- Interior lighting
- Central locking system
- Anti-theft alarm system
- Roof functions module
- Seat with rear easy-entry
- Changes in control units
- Power windows

Exterior Lighting

No changes have been made to the exterior lighting of the E93 Convertible compared to the E92 Coupe. The E93 Convertible is equipped as standard with bi-xenon lights.

Adaptive headlights are optionally available in connection with the turn signal or direction indicator light.

The E93 Convertible is equipped as standard with the daytime driving light function that is realized by the corona rings. The E93 Convertible also features the welcome light function.

Note: Important note on tail lights - In the event of a defective bulb in the tail lights, after removal, the bulb carrier must be fitted in the tail light housing otherwise the function of the new bulb cannot be checked due to the lack of ground connection.

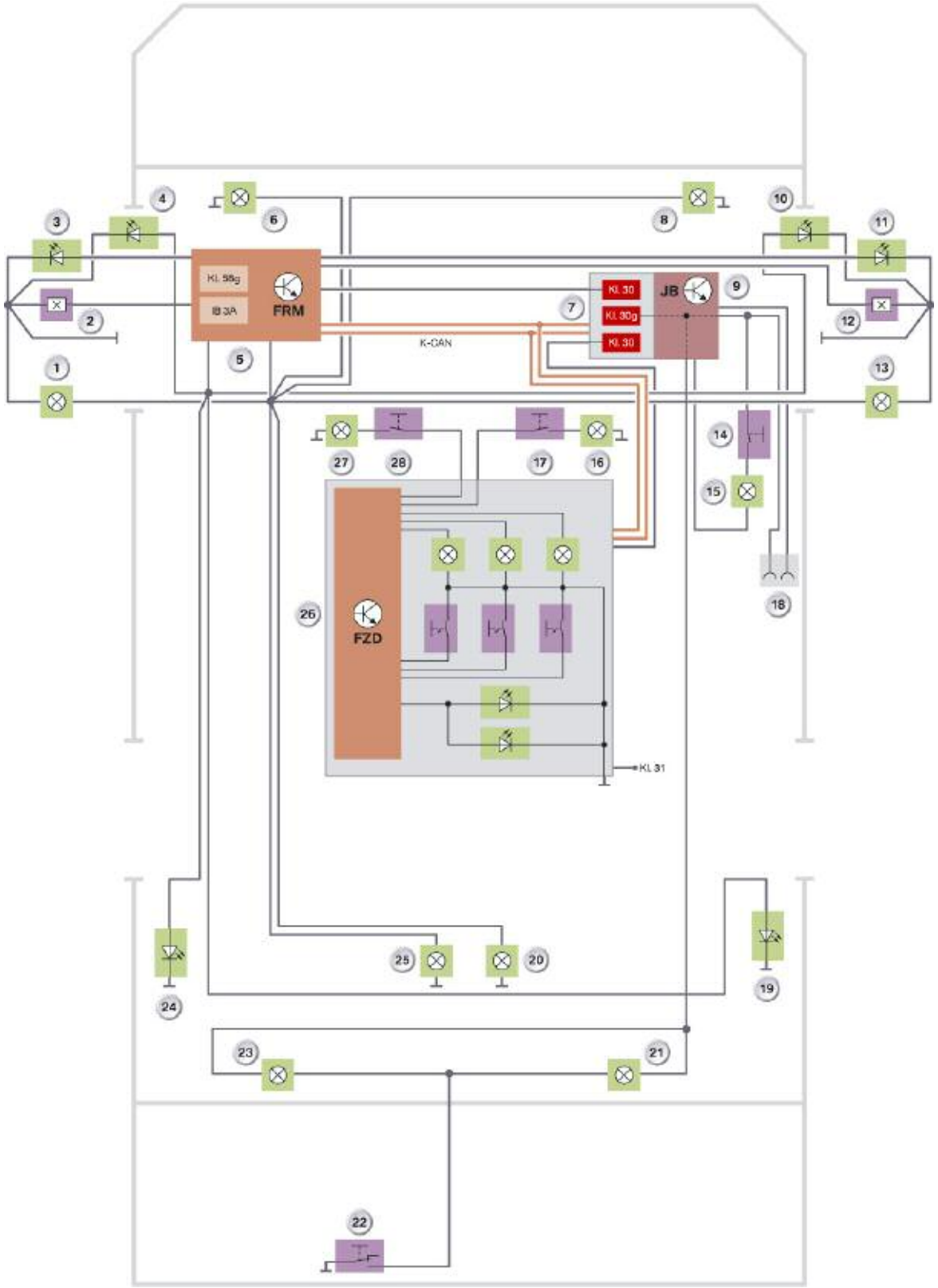
Interior Lighting

The interior lighting system of the E93 Convertible was adopted from the E92 with ambient interior lighting in the door and side trim panels.

For this reason, the general functions and the components of the interior lighting system will not be described in detail again here. The following minor changes have been made to the optional interior lights package:

- No rear interior light in the roof
- The central luggage compartment light has been replaced by two lights at the rear left and right

E93 Interior Light Schematic



Legend for E93 Interior Light Schematic

Index	Explanation	Index	Explanation
1	Exit light, left	15	Glove compartment lighting
2	Door contact, left	16	Vanity mirror light right
3	Courtesy lighting, left	17	Switch for vanity mirror light, right
4	Fiber optic cable for left door linear lighting	18	Charging socket
5	Footwell module	19	Side panel linear lighting, right
6	Footwell light, front left	20	Rear compartment footwell light, right
7	Power distribution box, junction box	21	Luggage compartment light, rear right
8	Footwell light, front right	22	Interior button for boot lid
9	Junction box electronics	23	Luggage compartment light, rear left
10	Fiber optic cable for right door linear lighting	24	Side panel linear lighting, left
11	Courtesy lighting, right	25	Rear compartment footwell light, left
12	Door contact, right	26	Roof functions module with front interior light
13	Exit light, right	27	Vanity mirror light, left
14	Glove compartment switch	28	Switch for vanity mirror light

Central Locking System

The central locking system has been adapted to the specific requirements of the Convertible. In addition to the basic functions of locking the doors, lids and flaps, two further functions have been added:

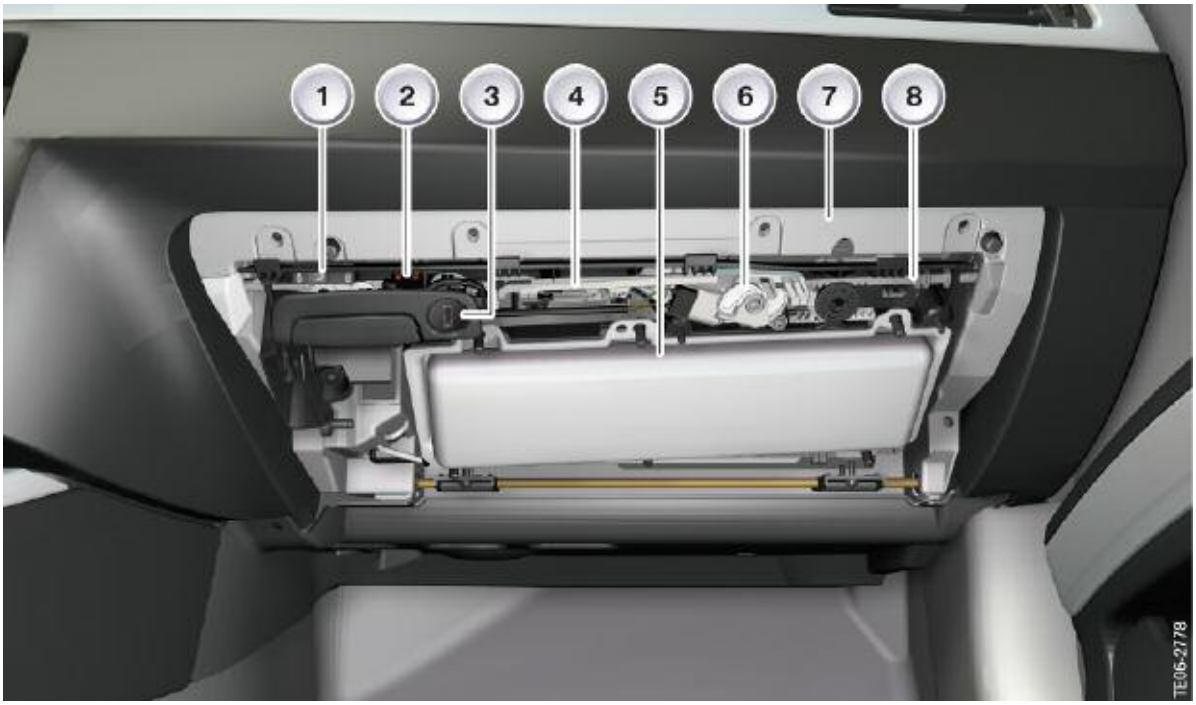
- automatic locking and opening of the glove compartment
- and the locking of the storage compartment in the center console.

These functions are necessary for the purpose of providing a safe place to store objects with the hardtop open.

Glove Compartment Locking

The glove compartment is unlocked by electrical means. The reason for this is that a knee airbag is installed in US vehicles. The knee airbag is located in the lid to the glove compartment.

The opener is located on the left on the glove compartment lid. The lid must be locked on both sides to ensure the resulting forces can be transmitted in the event of the knee airbag triggering.



Index	Explanation	Index	Explanation
1	Hotel switch	5	Knee airbag, front passenger
2	Microswitch, open	6	Unlocking motor with actuating cam
3	Lock with emergency release	7	Glove compartment housing
4	Locking rod, left	8	Locking rod, right

Opening Glove Compartment

The opener is raised slightly to open the glove compartment. A microswitch sends a signal to the junction box which, in turn, activates an actuator motor in the glove compartment. The actuator motor with the gear mechanism pulls back the two locking rods so that the glove compartment lid can be opened.

The power supply to the actuator motor is cut after a short time and the locking rods extend again.

Closing Glove Compartment

The ends of the locking rods are beveled. When closing the lid, the rods are pressed against a spring. When the lid is closed, the spring force pushes the locking rods back into the lock openings thus locking the glove compartment lid.

Locking Glove Compartment

The hotel switch is located in the glove compartment. The hotel switch can prevent unauthorized opening of the boot lid. For this purpose, the glove compartment is locked with the mechanical key at the lock barrel.

Emergency Release of Glove Compartment

In the event of the battery discharging or being defective, the glove compartment can be opened with the mechanical key.

Locking Function of Storage Compartment in Center Console

The storage compartment, in which the mobile phone is kept (depending on equipment variant) contains an actuator motor which locks the storage compartment. This actuator motor is driven directly by the junction box when central arrest is activated.

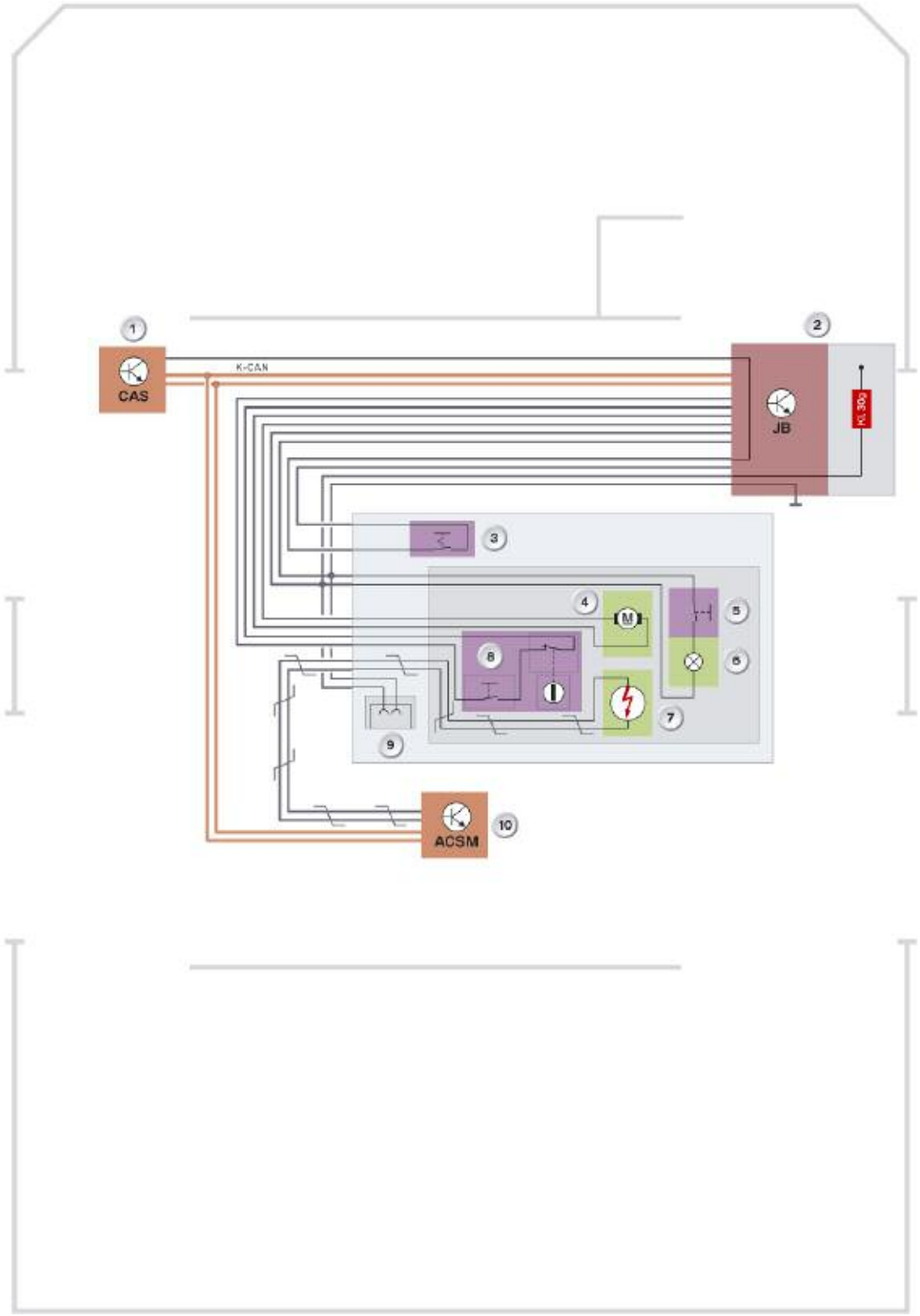
Emergency Release

The storage compartment in the center console can be released by means of a pull cable (1) in the event of the battery discharging or being defective.

For this purpose, the cover must be removed from the rear compartment air outlet, followed by removal of the air outlet.

The storage compartment can then be released by pulling the loop of the pull cable.

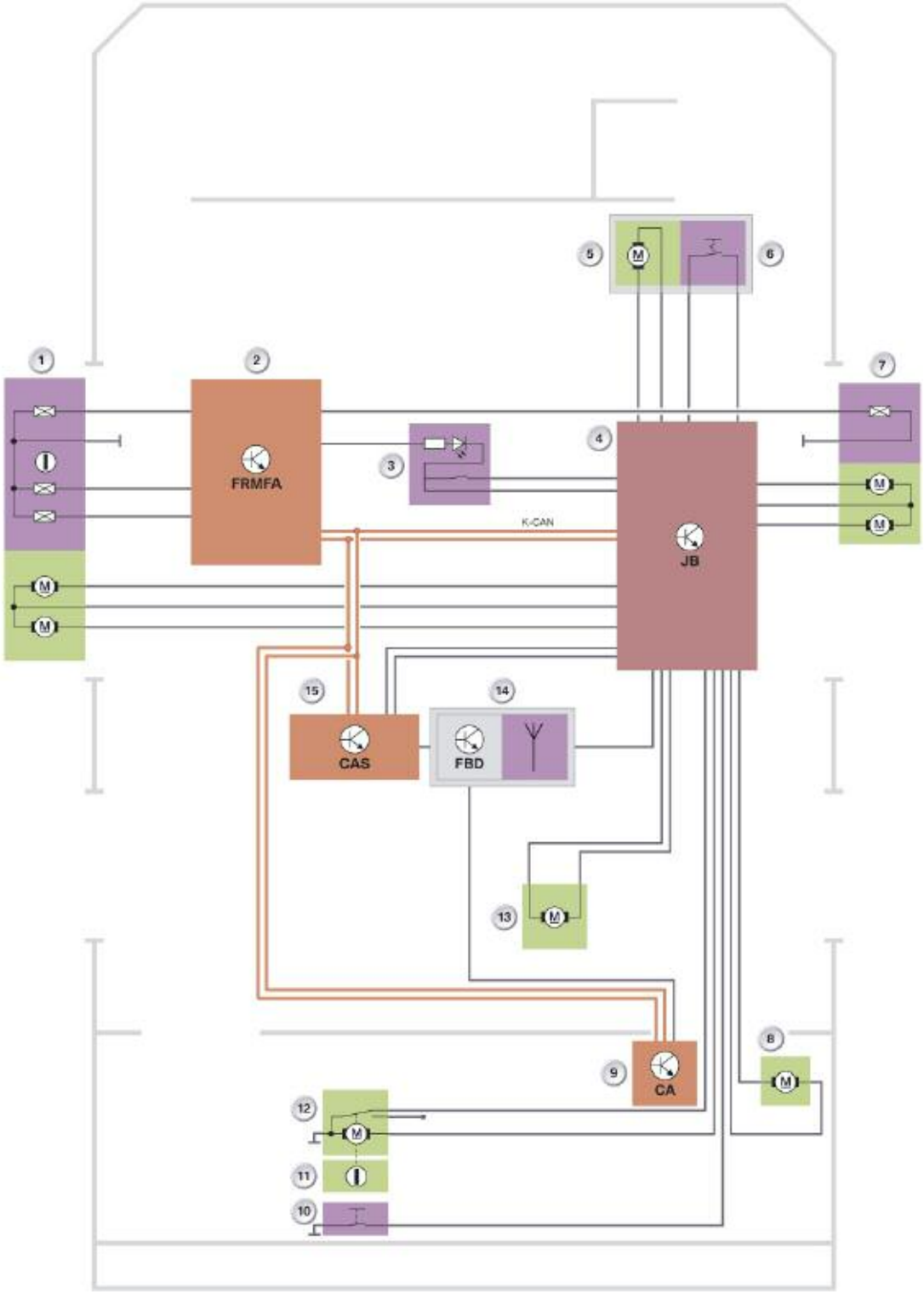
Glove Compartment Schematic



Legend for Glove Compartment Schematic

Index	Explanation
1	CAS
2	Junction Box
3	Hotel Switch
4	Unlocking motor
5	Switch for glove compartment lighting
6	Glove compartment lighting
7	Passenger’s side knee airbag ad glove compartment lid
8	Glove compartment lock with release button
9	Charging socket for flashlight
10	ACSM control unit

Central Locking Schematic



Legend for Central Locking Schematic

Index	Explanation
1	Driver’s door with actuator, door contact and door lock with Hall sensors
2	Footwell module
3	Central lock button
4	Junction box
5	Glove compartment actuator motor
6	Hotel switch
7	Passenger’s door with actuator and door contact
8	Actuator for fuel filler flap
9	Comfort access control unit
10	Trunk lid button
11	Trunk lid lock
12	Trunk lid actuator
13	Center console actuator
14	Interior rear view mirror with remote control receiver
15	Car Access System (CAS)

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Anti-theft Alarm System

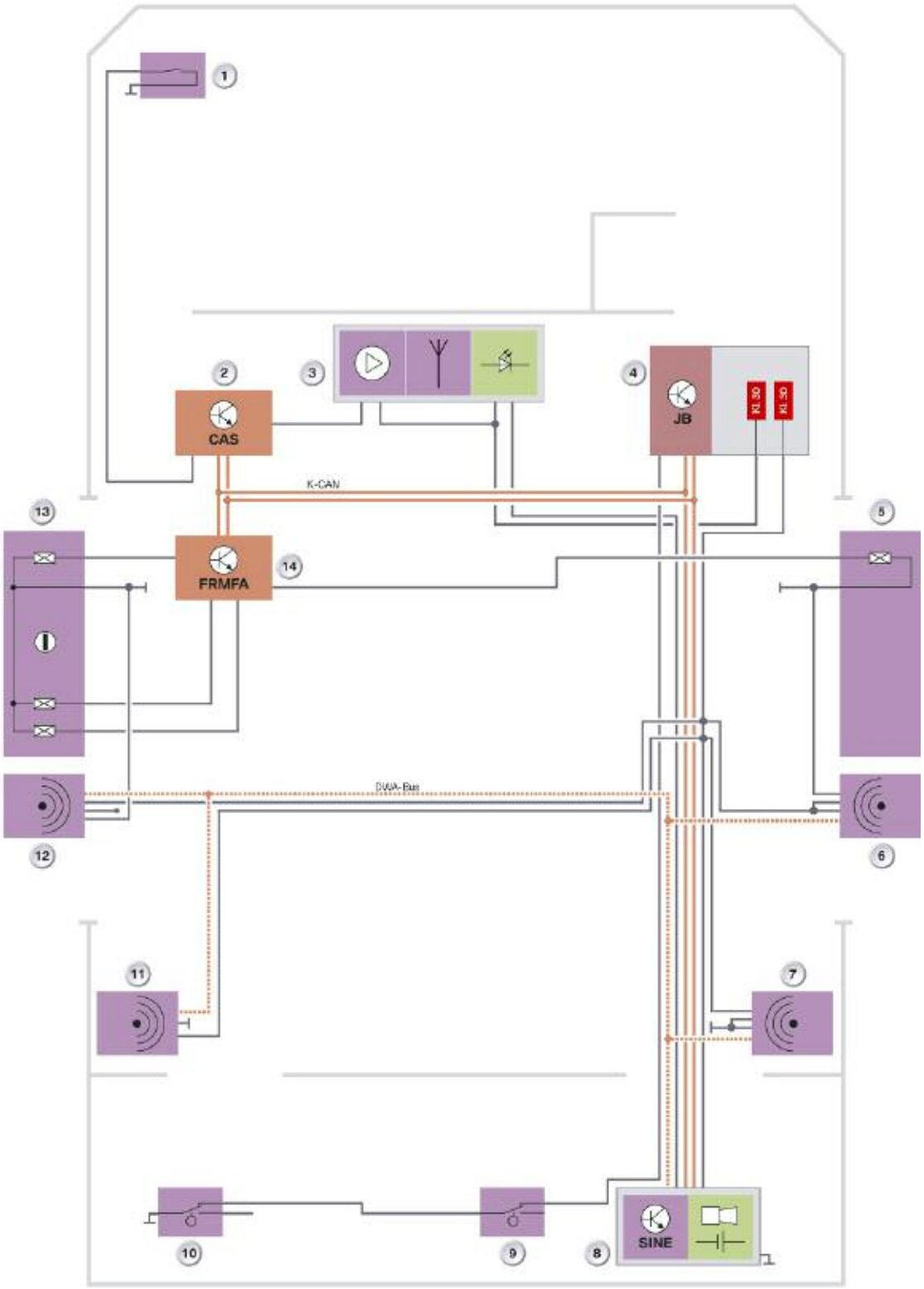
The anti-theft alarm system in the E93 Convertible is identical to that in the 3 Series Sedan in terms of its basic functions and operating mode. There are differences in the interior monitoring function and connection to the system network.

Microwave sensors, as in the E64 Convertible, are used for the interior monitoring system instead of ultrasonic sensors. The microwave sensors facilitate monitoring of the vehicle interior also when the convertible top is down.

The microwave sensors have a semicircular radiation characteristic. By strategic placement in the vehicle, the entire interior can be monitored without the microwave sensors radiating outside the vehicle.

Four microwave sensors are used on the E93 Convertible for the purpose of monitoring the interior. The microwave sensors are connected via the DWA bus to the SINE (siren with tilt alarm sensor). The DWA bus is a sub bus based on the K-bus. SINE is the master control unit and is connected directly to the KCAN. The entire control of the anti-theft alarm system is located in the SINE.

Anti-Theft System Schematic



Legend for Anti-Theft System Schematic

Index	Explanation
1	Hood contact
2	Car Access System
3	Interior rear-view mirror with remote control receiver and DWA LED
4	Junction box
5	Passenger’s door contact
6	Microwave sensor, front right
7	Microwave sensor, rear right
8	Siren with tilt alarm sensor
9	Boot lid contact, right
10	Boot lid contact, left
11	Microwave sensor, rear left
12	Microwave sensor, front left
13	Driver’s door contact
14	Footwell module (FRM)

Power Seats with Easy Entry Function

Special seats with a seat-integrated seat belt system as in the E46/E64 are installed in the E93 Convertible. The electrically adjustable seats (comfort and sport) are equipped with a rear compartment easy-entry function to facilitate entry in the rear compartment.

For this purpose, an adjustment switch is provided on the upper end of the backrest in order to move the seat forward and backward at double the speed via the seat forward/backward adjustment function.

When entering the rear compartment, the customer can move the seat forward with the adjustment switch. By mechanically releasing the seat backrest, it can be additionally tilted forward to create sufficient space for convenient entry.

Index	Explanation
1	Switch for rear compartment easy entry
2	Backrest release lever

At the same time, the headrest is retracted so that the backrest can be completely folded down and does not come in contact with the sun visor. Retraction of the headrest depends on the position of the seat. The headrest is not retracted if the seat position is set in the area approximately 8-10 cm from the rear end stop as there is sufficient space to fully fold down the backrest in this position.

Following entry, the backrest is folded back, the headrest automatically returns to its previous position and the seat can be moved back using the adjustment switch. The position of the headrest is detected by a Hall sensor on the headrest adjustment motor.

The seat moves back and assumes the previous position. The previous position is also determined by means of a Hall sensor on the seat forward/backward adjustment motor. The signals from the Hall sensors are read into the driver or passenger seat module and correspondingly evaluated. The front passenger seat module has no memory function.

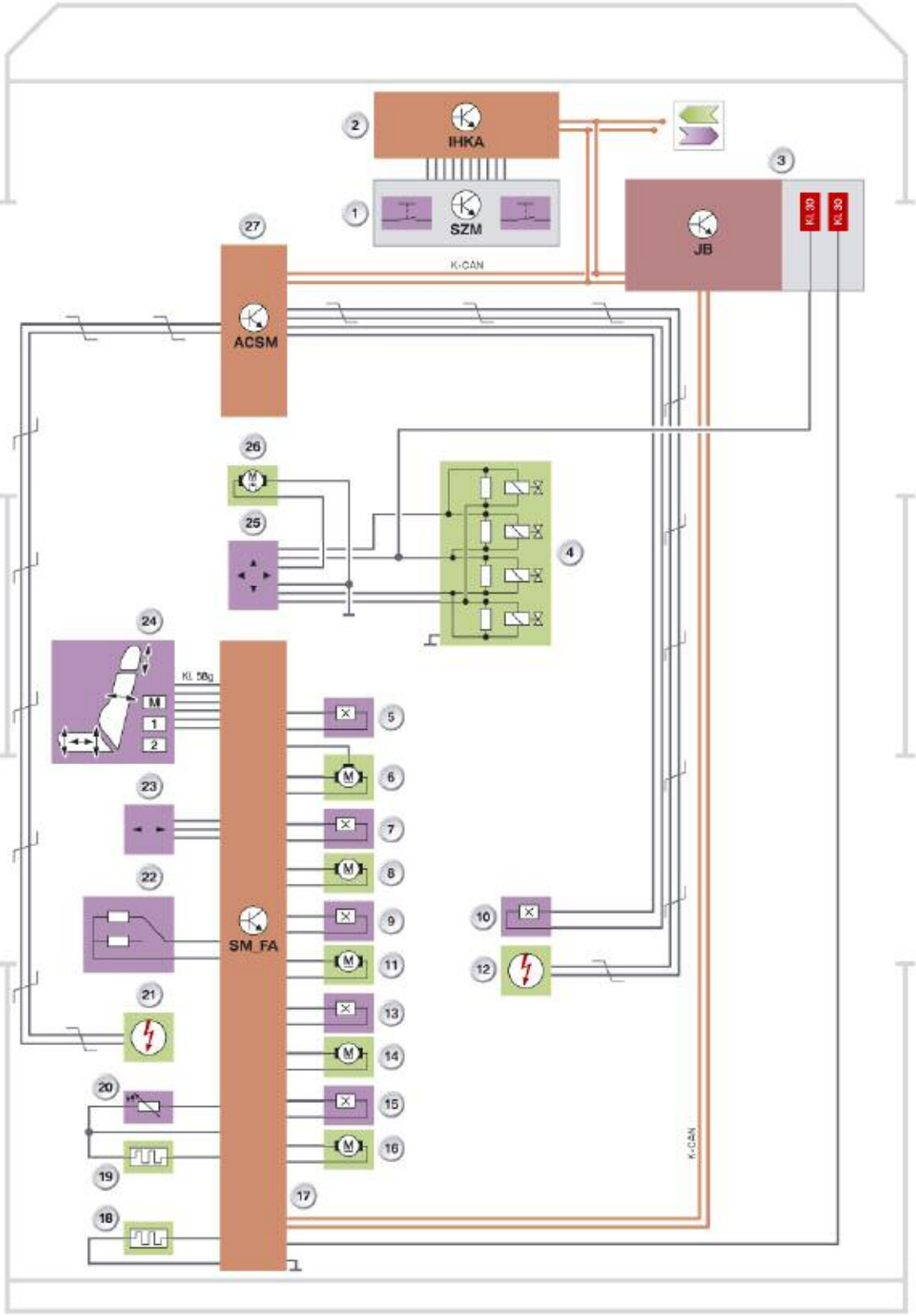
A new feature of the seat in the Convertible is the integration of the side airbag in the backrest. The use of the SGS seat with integrated seat belt system makes it necessary to monitor the backrest lock. If the backrest were not locked correctly, there would be the danger of the occupant moving forward with the backrest without any restraint effect. This would be equivalent to the occupant not wearing a seat belt.

For this reason, the backrests on the driver and front passenger seats are monitored to ensure they are locked correctly. The driver/passenger seat modules monitor the position with Hall sensors in the backrest. The information is sent to the crash safety module via the K-CAN link. The information is used in the calculation of the triggering algorithm.

A backrest that is not locked correctly would have the same effect on the triggering characteristics as an occupant not wearing a seat belt.

If the backrests are not locked correctly, the driver/passenger seat module generates check control messages which are sent via the K-CAN to the instrument cluster and the central information display.

Driver's Seat Schematic



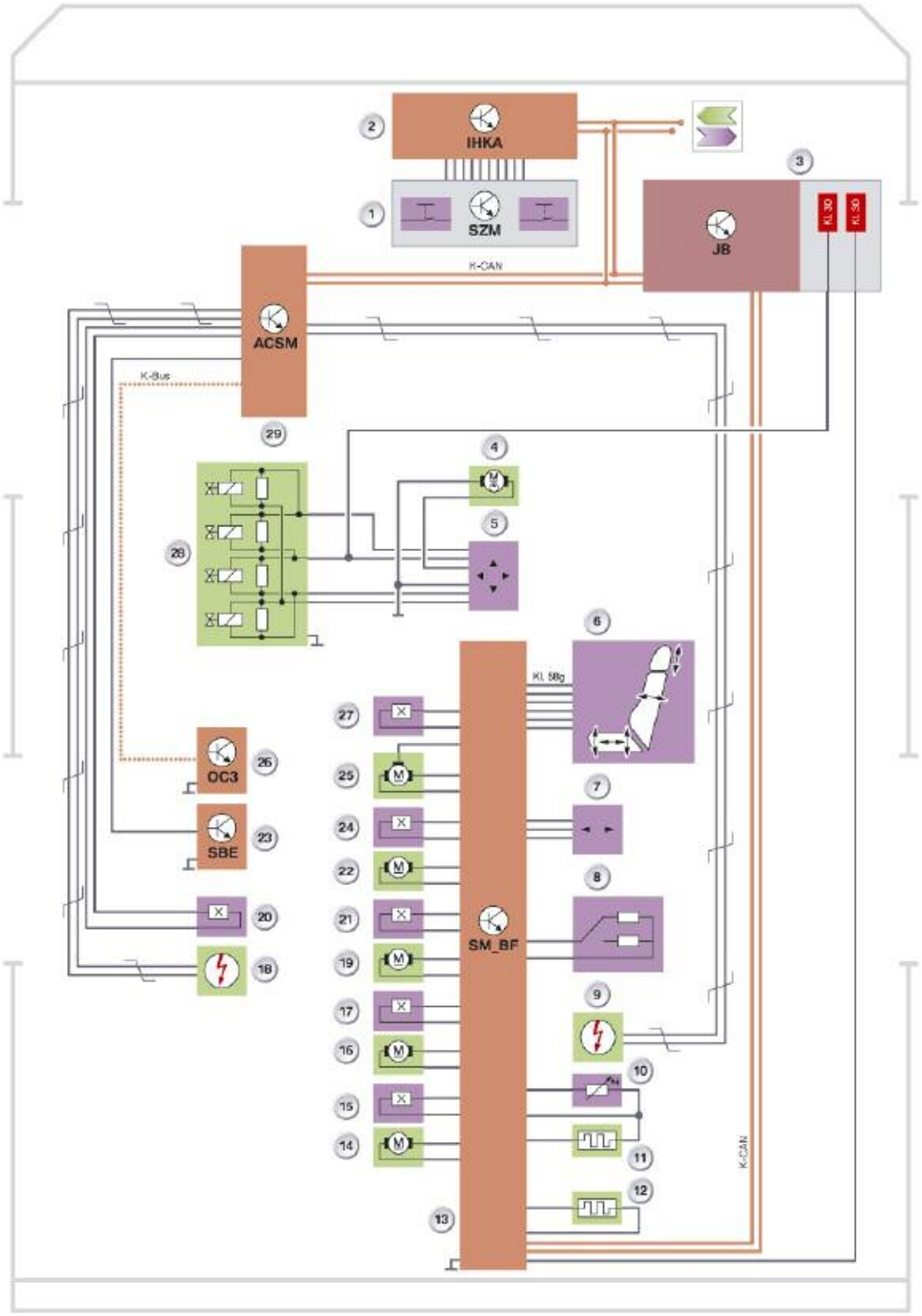
Legend for Driver's Seat Schematic

Index	Explanation	Index	Explanation
1	Center console switch cluster with seat heating buttons	15	Position, headrest height adjustment
2	IHKA	16	Motor, headrest height adjustment
3	Junction box	17	Driver's seat module
4	Pressure control valves for lumbar support adjustment	18	Backrest heating
5	Position, seat forward/backward adjustment	19	Seat cushion heating
6	2-stage motor for seat forward/backward adjustment	20	Seat heating temperature sensor
7	Position, seat height adjustment	21	Side airbag, driver
8	Motor, seat height adjustment	22	Backrest locking contact
9	Seat tilt position	23	Rear compartment easy entry switch
10	Seat belt buckle position	24	Seat adjustment switch with memory buttons
11	Motor for seat angle adjustment	25	Lumbar support button
12	Seat belt pre-tensioner	26	Motor for lumbar support adjustment
13	Backrest tilt position	27	ACSM control unit
14	Motor for seat backrest angle adjustment		

Signals

Input	Information	Source/to	Function
In	Terminal control (KL15)	CAS3> Driver's seat module	Status, KL15
In	Terminal status (KL50)	CAS3> Driver's seat module	Electric load shutdown
Out	Electric load output	Energy management (DME)	Power reduction depending on charge balance
Out	Backrest lock	Driver/passenger's seat module >ACSM	Triggering algorithm
Out	Backrest lock	Driver's/passenger's seat module > KOMBI > CID	Check control message

Passenger's Seat Schematic



Legend for Passenger's Seat Schematic

Index	Explanation	Index	Explanation
1	IHKA	16	Motor for seat backrest angle adjustment
2	Center console switch cluster	17	Backrest tilt position
3	Junction box	18	Seat belt pre-tensioner, front passenger
4	Motor for lumbar support adjustment	19	Motor for seat angle adjustment
5	Lumbar support button	20	Seat belt buckle position switch
6	Switch for seat settings	21	Seat tilt position
7	Rear compartment easy entry switch	22	Motor, seat height adjustment
8	Backrest locking contact	23	Not for US Market
9	Side airbag, front passenger	24	Position, seat height adjustment
10	Seat heating temperature sensor	25	2-stage motor for seat forward/backward adjustment
11	Seat cushion heating	26	Seat Occupancy Detector (OC-3)
12	Backrest heating	27	Position, seat forward/backward adjustment
13	Passenger's seat module	28	Pressure control valves for lumbar support adjustment
14	Motor, headrest height adjustment	29	ACSM control unit
15	Position, headrest height adjustment		

Signals

Input	Information	Source/to	Function
In	Terminal control (KL15)	CAS3> Driver's seat module	Status, KL15
In	Terminal status (KL50)	CAS3> Driver's seat module	Electric load shutdown
Out	Electric load output	Energy management (DME)	Power reduction depending on charge balance
Out	Backrest lock	Driver/passenger's seat module >ACSM	Triggering algorithm
Out	Backrest lock	Driver's/passenger's seat module > KOMBI > CID	Check control message

Changes to Control Units

Due to the various mechanical and electrical changes on the E93, some control modules have been modified or moved from their familiar locations. Brief explanations of these changes are in the following pages.

Roof Functions Module (FZD)

The roof functions module has been adapted in terms of its functionality and geometric form to the specific requirements of the E93 Convertible.

The following functions have been adopted:

- Interior lights, reading light and top light
- Connection of the electrochromic interior rear/view mirror and transmission of values on the K-CAN
- Connection of rain/lights sensor via LIN
- Gateway function LIN > K-CAN
- Connection of the condensation sensor and transmission on the K-CAN
- Emergency call button (option)
- Passenger airbag OFF light (option)

The following functions have been dropped:

- Connection of interior lights at rear
- Ultrasonic interior movement detector
- Operation and actuation of slide/tilt sunroof
- Microphones for hands-free and voice input

On the E93 Convertible, the microphones for hands-free and voice input are located on the steering column trim panel.

FZD Location on E93

Location of microphones for phone and voice input

Junction Box

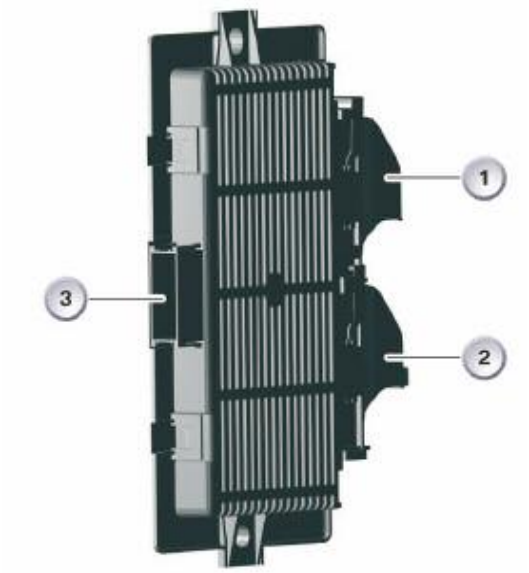
The functions of the junction box have been included to drive the actuators for the glove compartment and storage compartment in the center console.

The gateway function has been adapted to accommodate the D-CAN. At present, all other models are still equipped with the previous diagnosis interface (K-LINE 115 kbit/s).

Footwell Module

As the master control unit for the power windows, the footwell module is responsible for evaluation of the central power window switch. The central power window switch in the Convertible makes it possible to open and close all four side windows simultaneously.

A further function is the extended travel range of the power windows as on the E46/E64 Convertible. The extended travel range function of the power windows is activated when the retractable hardtop is lowered. All side windows are lowered almost fully during this operation to ensure smooth opening.



Index	Explanation
1	51-pin harness connector, main harness
2	51-pin harness connector, main harness
3	26-pin connector, dashboard

Car Access System (CAS3)

The comfort functions of the retractable hardtop have been added to the car access system.

Index	Explanation
1	42-pin connector, main harness
2	14-pin connector, ribbon cable

Power Windows

The E93 Convertible is equipped as standard with power windows at the front and rear. In addition to the individual power window buttons, the switch cluster on the driver's side contains a central button (1), with which all windows can be lowered simultaneously.

As a standard feature on BMW Convertibles, the side windows are frame-less. The windows must enter the door seal by several millimeters in order to avoid leaks and wind noise.

The door windows must be lowered by approximately 15 mm to ensure the doors can be opened and closed without applying any effort.

Automatic Climate Control

The E93 Convertible is available with the following heating/air conditioning systems:

- Integrated automatic climate control (IHKA)

The E93 Convertible with its retractable hardtop combines two vehicles in one. It is a Coupe when closed and a Convertible when open, a fact taken into account by the automatic climate control to create pleasant and comfortable heating/ventilation conditions.

This characteristic makes it possible for an individual climate control program for both states. The software automatically initiates the automatic climate control program when it detects that the hardtop is down.

Trials and customer surveys have shown that the previous air conditioning systems set up for Sedans or Coupes were not ideal for a Convertible with the top down.
The temperature and blower output stage had to be constantly readjusted for the purpose of ensuring pleasant interior conditions.

All control parameters are adapted to the requirements of driving with the top down when the hardtop is lowered.

Convertible mode requires no additional sensors. The IHKA control unit was programmed with corresponding software that takes these specific parameters into account.

Convertible Mode Setting

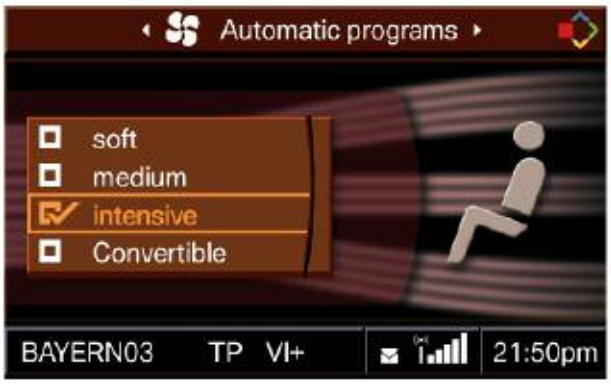
Convertible mode is available only in vehicles equipped with the optional fully automatic climate control (IHKA).

Convertible mode is activated by opening the retractable hardtop. The IHKA receives the corresponding information on the status of the hardtop from the Convertible top module (CTM).

Convertible mode is always active on vehicles with no central information display (CID). On vehicles with central information display, the Convertible Mode box in the "Automatic Program" menu must first be activated. This activation is possibly only with the hardtop open and is set to active as part of initial programming.

Note: If Convertible mode is not activated, the selected automatic program (soft, medium, intensive) is activated when the hardtop is opened.

Settings with Hard Top Down



Settings with Hard Top Up

All other program settings are deactivated (grey) if Convertible mode is activated with the hardtop lowered. The other program settings can be selected if Convertible mode is not activated with the hardtop lowered.

Convertible mode cannot be selected when the hardtop is closed. Convertible mode that has already been selected is correspondingly indicated, however, it is not active when the hardtop is closed (grey) and can also not be changed.

Convertible Mode Control

The aim of Convertible mode is to create an automatic climate control program that makes it unnecessary to continually make manual adjustments while driving.

When driving with the top down, the occupants consciously expose themselves to the solar radiation and outside temperature at changing driving speeds. These parameters have a decisive influence on the climate in the vehicle interior and must therefore be taken into consideration in the control concept.

The spatial separation of the interior is cancelled when the hardtop is opened thus drastically reducing the influence of the interior temperature sensor. The temperature control for the vent outlet temperature is strongly orientated on the outside temperature.

The sun's intensity has a great influence on the climate in the vehicle interior when driving with the top down. Therefore, changes in conditions such as cloudless, cloudy or daytime/night-time are included via the solar sensor to a greater extent in the temperature control than when the hardtop is up.

Unlike when the vehicle is closed, the ventilation outlets become the dominant air distribution level when the hardtop is down and are therefore always fully opened while, to achieve a comfort balance, the footwell outlets must always be restricted as soon as the operating temperature of the engine necessary for heating is reached.

Measures for keeping the windscreen/windows clear are not necessary when driving with the top down, therefore the defrost outlets always remain closed.

The driver sets the required temperature at the temperature control. Depending on the outside temperature, sun's intensity and vehicle speed, the required interior climate is maintained by the supply of correspondingly temperature-controlled air. The most comfortable conditions are achieved with the side windows closed and a wind deflector additionally installed.

The ram pressure compensation that serves the purpose of keeping the air throughput constant when the vehicle is closed is cancelled in Convertible mode. The blower output Is additionally increased based on the vehicle speed in order to maintain a constant air flow about the occupants.

The increasing air volume essentially shields the occupants from increasing turbulence at higher vehicle speeds. The occupants subjectively notice no difference in temperature conditions.

The AUC function is also active in Convertible mode up to a speed of 45 MPH. It is deactivated at higher speeds. This is intended to ensure that no pollutants are blown into the interior of the vehicle via the air conditioning outlets when driving at low speeds, e.g. in urban or stop-and-go traffic. The best effect is achieved with the side windows closed.

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Information and Communication Technology

Several changes have been made to the iDrive in connection with the launch of the E93 Convertible as from 03/07. In addition to the visual changes to the user interface in the form of different fonts and colors the operating philosophy of the Setup menu has been correspondingly adapted. Eight favorites buttons have been included for convenience in operation.

Corresponding software adaptations have also been implemented. Some of the new features are dependent on the optional equipment configuration, e.g. menu for light settings.

Changes in the Setup Menu

The individual user settings can be selected in the Setup menu. As on the other models with CCC as from 09/2006, an additional menu bar has been included in the Setup menu.

The following menu items can be selected in the menu bar:

- Screen OFF
- Information sources
- Settings

Further settings are linked to each menu item. The available menu items depend on the equipment configuration. A new pairing assistant for linking the Bluetooth telephone to the vehicle is provided under the Bluetooth menu item.

Favorites Button for CCC / MASK

Eight additional favorites button have been added to the two options navigation system Business with MASK and navigation system Professional CCC.

The following functions can be stored under the favorites buttons for quick access:

- Radio stations
- Navigation destinations
- Stored telephone numbers/names
- CD/DVD player
- CD changer
- MP3

Note: The freely selectable favorites buttons in the multifunction steering wheel are assigned as before.

The eight favorite buttons are accommodated in the front panel under the upper CD/DVD player. The buttons can be assigned with functions from the entertainment, telephone and navigation menus.

Six buttons are freely programmable for CCC and two buttons are assigned to FM/AM and MODE.

In addition to the pressure sensor element, the buttons contain a capacitive sensor that shows the assignment status of the button when touched in the info bar of the central information display.

A button is simply pressed for longer than 2 seconds to assign a function to it.

Navigation with CCC

Index	Explanation	Index	Explanation
1	Slot in DVD player	5	Eject button, CD player
2	Favorites buttons	6	Rocker switch for station selection, CD
3	Rotary push button	7	Eject button, DVD player
4	Slot in CD player		

Interface Box (High)

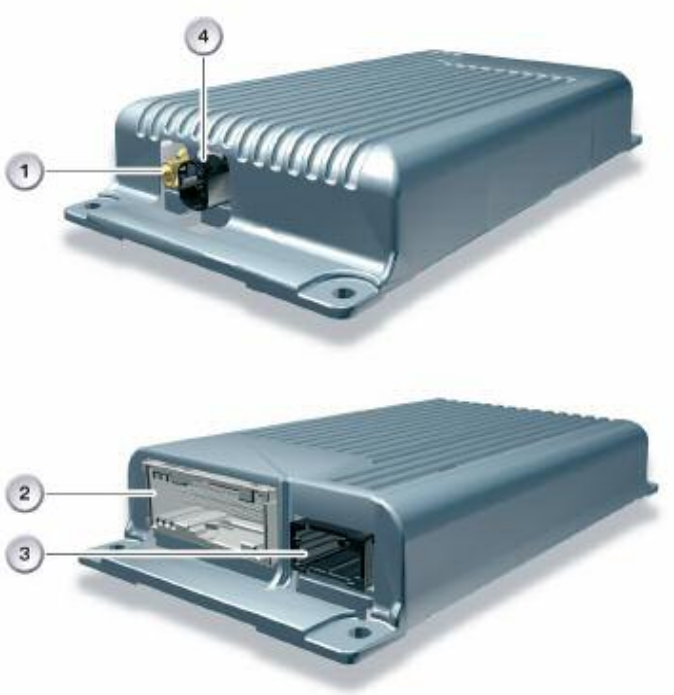
The US vehicle will receive a high variant of the interface box, the SBX High contains following functions:

- Pairing of customer mobile phone to the vehicle via Bluetooth interface
- Voice-activated control of the telephone or expanded voice-activated control in connection with the Assist/Bluetooth option
- Connection of USB/audio interface for USB storage media.

The USB/audio interface can be ordered through the option SA 6FL. The USB interface is located in the immediate vicinity of the 3.5 mm audio jack (AUX-IN). Audio files stored on USB mass storage media can be played in the vehicle via the USB/audio interface.

USB mass storage media that support one of the following standards be connected:

- USB Mass Storage Class
- Apple iPod as from 4th generation.



Index	Explanation
1	Bluetooth signal
2	54-pin connection
3	MOST connection
4	USB connection

Antenna Systems

Since the standard locations for antennas on the roof or in the fixed rear window are not available on the E93 Convertible, the various antenna systems are distributed and integrated in the vehicle. Antennas are required for the following systems:

- Radio
- Digital receivers
- Navigation
- Telephone and telematics
- Remote control

With the exception of the SDARS antenna, the E93 Convertible has no visible antennas. The Convertible does not even have the standard rod antenna, a feature contributing to the harmonious appearance of the exterior.

AM/FM Antennas

Four FM antennas (FM1-FM4) and one AM antenna that are switched via an FM antenna diversity function are used for radio reception in the E93 Convertible.

Index	Explanation
1	FM1 Antenna
2	AM Antenna
3	FM3 Antenna
4	FM2 Antenna
5	FM4 Antenna

Different antennas are used when the hardtop is closed or lowered. When closed, the AM, FM1 and FM3 antennas in the rear window are used as in a Coupe. The antenna amplifier and the rejector circuit for the rear window defogger are located on the left C-pillar. There is only a rejector circuit on the right-hand C-pillar.

The E93 Convertible has many information and communication antennas all of which, except for one, are concealed. Only the SDARS antenna on US vehicles is located on the rear lid as this requires a direct reception path to the satellites. The antenna systems are divided into radio, digital receiver, telephone, navigation and remote control.

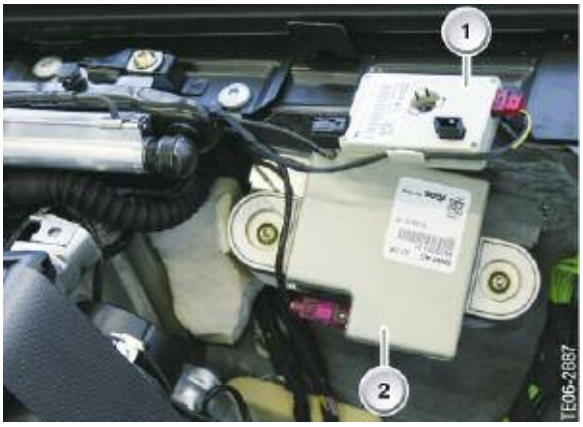
The FM2 and FM4 antennas are located behind the rear bumper panel. The antenna amplifiers for the FM2 and FM4 antennas are located in the antenna diversity module on the rear left in the luggage compartment.

Index	Explanation
1	FM4 Antenna
2	FM2 Antenna

AM and FM1 Antenna, Left

When the hardtop is lowered, the rear window is folded in the luggage compartment so that reception via the antennas is no longer possible. For this reason, a further AM and FM1 antenna is located in the left side trim panel at the rear.

AM and FM1 antenna in LH trim panel

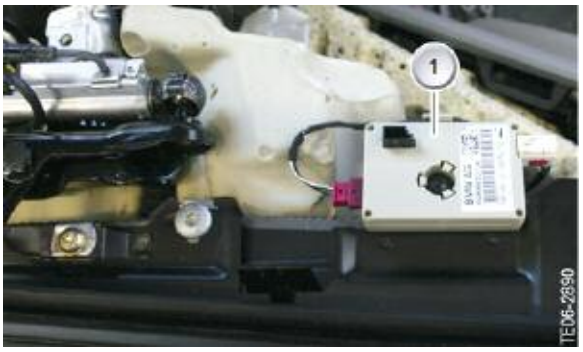


Index	Explanation
1	Antenna amplifier, left
2	Emergency antenna

FM3 Antenna, Right

The FM3 antenna is located in the right side trim panel at the rear. Each antenna has its own antenna amplifier. A total of four antenna amplifiers are installed. The received and amplified signal (RF signal) is then sent to the FM antenna diversity module on the rear left in the luggage compartment.

FM3 antenna in RH trim panel



Index	Explanation
1	Antenna amplifier, right

FM Antenna Diversity

The E93 Convertible features a four FM antenna diversity system that is made up of the following antennas:

- FM1 and FM3 antenna in the rear window
- FM1 and FM3 antenna in the side trim panel
- FM2 and FM4 antenna in the rear bumper
- Antenna amplifier on the C-pillar
- Antenna amplifier on the left and right shoulder (trim)
- Antenna amplifier in diversity module.

Antenna diversity module

Index	Explanation	Index	Explanation
1	FM2 and FM4 antenna input	5	RF signals, rear window
2	Power supply for external antenna amplifiers and input, KL30g	6	RF signal of FM3
3	Signal from CTM and Radio ON	7	RF signal of AM/FM1
4	RF signal for radio navigation	8	Changeover voltage/diagnosis

The switchover between the antennas in the rear window and side trim panels takes place by means of a signal from the Convertible top module CTM.

The sequence of FM antenna diversity is not defined as on previous models. On the E93, the reception quality and field strength of all antennas are checked and stored in a memory.

The next best FM antenna in the list is selected if the signal quality of the radio station received at the active antenna is insufficient in terms of quality and field strength.
The antennas are evaluated and the list updated at the same time as the switchover between the individual antennas.

Changeover takes place in such a way that no interruption is heard. The high frequency signal (RF) of the active FM antenna is routed from the antenna diversity module via a coaxial cable to the tuner for the radio or navigation system. The signal is de-modulate in the tuner and output via the speakers as an audio signal.

The radio or navigation system detects whether a diversity module is installed and generates the changeover voltage (Us) necessary for diversity operation and the intermediate frequency signal (IF).

The IF is evaluated by the electronic circuitry in the diversity module and is a copy of the radio station currently heard on the fixed frequency of 10.7 MHz.

The changeover between AM/FM1 reception and diagnosis mode takes place with the aid of the changeover voltage. This voltage is generated by the radio and used in the diversity module for evaluation purposes.

Diversity mode is active at 2.5 volts (Us = 2.5 V). AM mode is active or the FM1 antenna selected at 0 Volts (Us = 0 V). Diagnosis mode is active at 5 Volts (Us = 5 V).

Up to three signals can be transmitted simultaneously on the coaxial cable:

- RF signal (e.g. 87.5 - 108 MHz) from diversity module to radio
- Control voltage (Us) from radio to diversity module
- Intermediate frequency (IF = 10.7 MHz) from radio to diversity module as basis for assessing the quality of the RF signal.

Mutual influencing is not possible due to the different frequencies. The frequency of the antenna diversity module is 87.5-108 MHz.

Note: No antenna diversity is provided for SW, MW and LW reception as there is only one AM antenna.

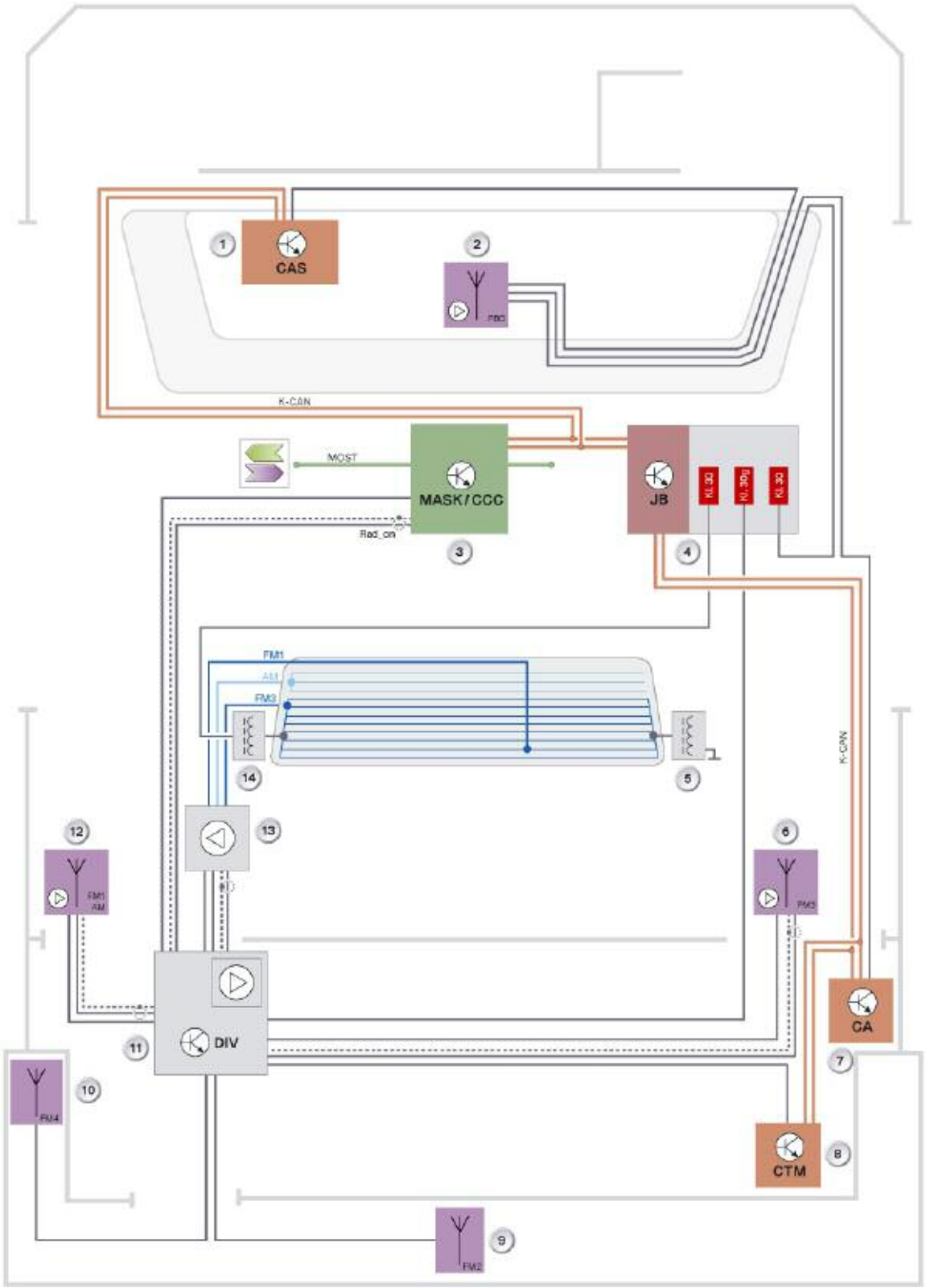
Satellite Antenna

The SDARS uses the “shark fin” antenna on the rear trunk lid area.

IBOC

The terrestrial In Band on Channel (IBOC) uses the FM antennas for digital reception.

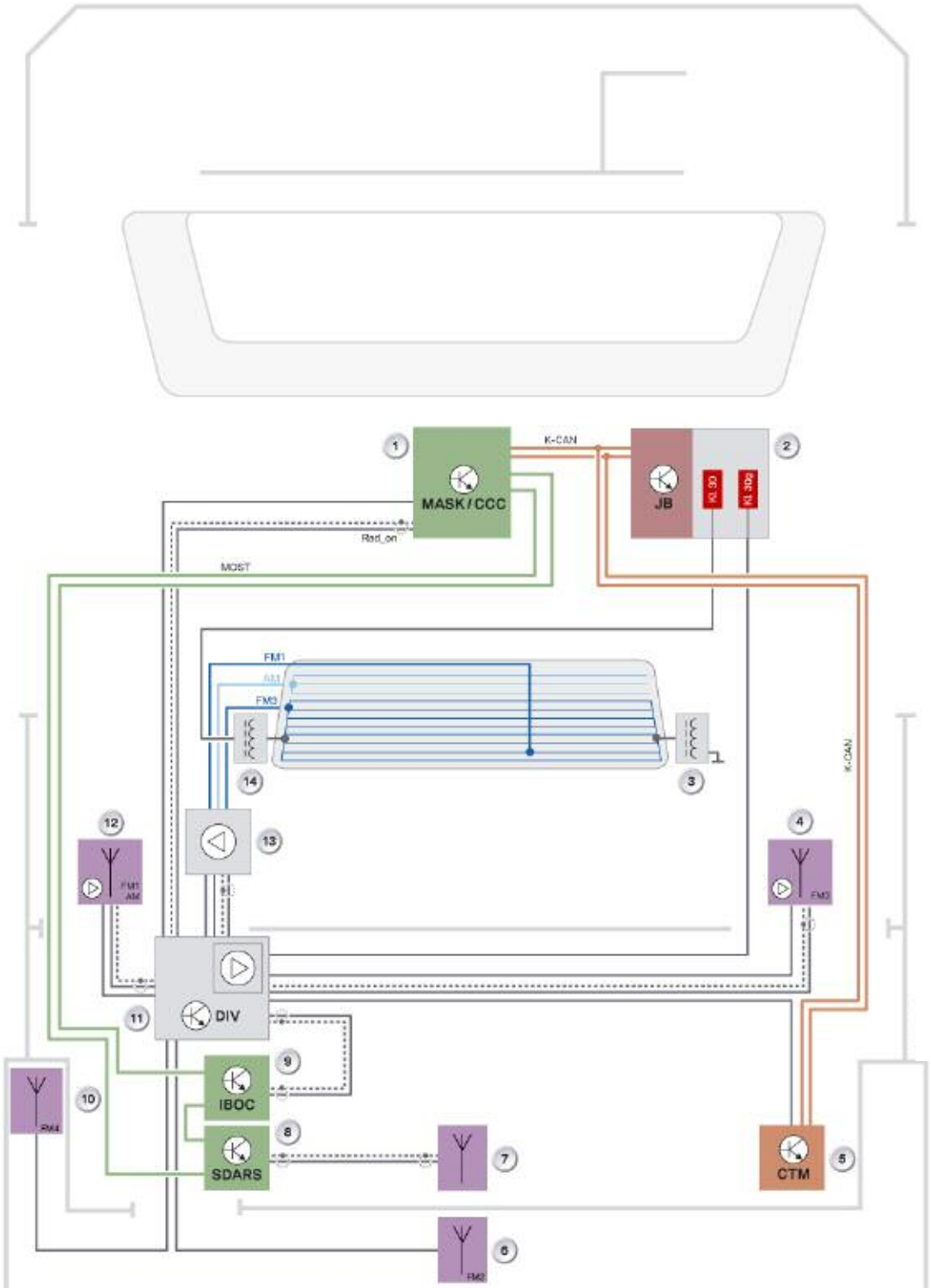
AM/FM Antenna Schematic



Legend for AM/FM Antenna Schematic

Index	Explanation
1	Car Access System
2	Remote control receiver in interior rear view mirror
3	CCC
4	Junction box
5	Rejector circuit, negative
6	FM3 antenna with amplifier in right hand shoulder trim
7	Comfort Access
8	Convertible Top Module
9	FM2 antenna in bumper
10	FM4 antenna in bumper
11	FM antenna diversity module
12	AM/FM1 antenna with amplifier in left hand shoulder trim
13	AM/FM antenna amplifier in rear window
14	Rejector circuit, positive

IBOC and SDARS Schematic



Legend for IBOC and SDARS Schematic

Index	Explanation
1	CCC
2	Junction box
3	Rejector circuit, negative
4	FM3 antenna with amplifier in right hand shoulder trim
5	CTM
6	FM2 antenna in bumper
7	SDARS antenna on rear lid (shark fin)
8	SDARS receiver (satellite tuner)
9	IBOC receiver
10	FM4 antenna in bumper
11	FM antenna diversity module
12	AM/FM1 antenna with amplifier in left hand shoulder trim
13	AM/FM antenna amplifier in rear window
14	Rejector circuit, positive

Antennas for Telephone and Telematics

The following antennas are required for telephone and telematics functions:

- Telephone antenna
- Telematics antenna
- SOS antenna
- GPS antenna
- Bluetooth antenna for internal communication

Telephone Antenna

The telephone antenna is located under the side panel on the front left. This position is possible as the side panels on the E93 Convertible are made of plastic.
The telephone antenna is routed directly to the eject box in the center console.

Telematics Antenna

The telematics antenna (1) is located on the rear bumper under the left tail light.
On vehicles equipped with the Assist, the telematics antenna is connected directly to the telematics control unit TCU and is used solely for data transmission relating to telematics functions.

SOS Antenna

The SOS antenna (2) is activated if the emergency call function is no longer possible via the telematics antenna after an accident. The SOS antenna is installed under the side trim panel on the rear left.

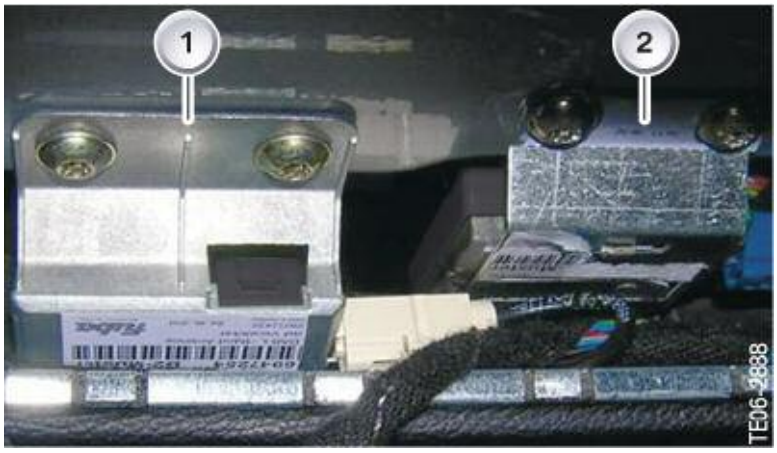
Bluetooth Antenna

The Bluetooth antenna (1) is used for internal transmission of data between the mobile phone and vehicle.
The antenna is located in the left footwell trim panel.

GPS Antenna

A GPS antenna (2) is necessary for the telematics function - Automatic emergency call with location -. On vehicles with CCC navigation system, the GPS antenna is routed directly to the navigation computer. The TCU receives the position data via the MOST.

The GPS antenna is connected directly to the TCU on vehicles with no navigation system but with radio Professional and telematics functions. In this case, the TCU determines the location. The GPS antenna is located behind the roof functions module in the roof frame.



Index	Explanation
1	Not for US Market
2	GPS Antenna

Arrangement of IKT Control Modules

Index	Explanation
1	Telematics control module (TCU)
2	IBOC tuner
3	Hifi or Top Hifi amplifier
4	CD Changer
5	Auxiliary fan for SDARS
6	Satellite tuner

NOTES PAGE

Passive Safety Systems

In the same way as the Sedan, the E93 Convertible offers vehicle safety at the highest level for all occupants as well as in all crash situations. Numerous reinforcements have been implemented in the body for the purpose of conforming to worldwide stipulations relating to a uniform body.

The loads and stresses that occur in the case of a crash are counteracted by a reinforced floor assembly and a reinforced bulkhead with high-strength A-pillars. The reinforced floor assembly is required particularly in the area of the front seats in order to direct the forces that are exerted in the event of a crash by the seat integrated seat belt systems into the floor assembly.

The sills were reinforced specifically for the Convertible in order to be able to absorb the forces in the event of a side crash and to direct them to the opposite side of the impact.

The roof frame in the area of the windscreen has been reinforced and forms the rollover protection system together with the roll bars integrated in the partition module.

In the event of a crash, in which the vehicle rolls over, the roll bars extend in milliseconds and, together with the roof frame, form an adequate survival space for the occupants.

The E93 Convertible is equipped with a passive safety system with rollover protection. In the event of a crash, in which the vehicle rolls over, the roll bars extend automatically and, together with the windscreen frame form an adequate survival space for the occupants.

The rollover sensor system is integrated in the crash safety module. The actuators are triggered by the ROC control unit. In the event of a side crash, an enlarged side airbag located in the backrest protects the thorax and head of the occupants.

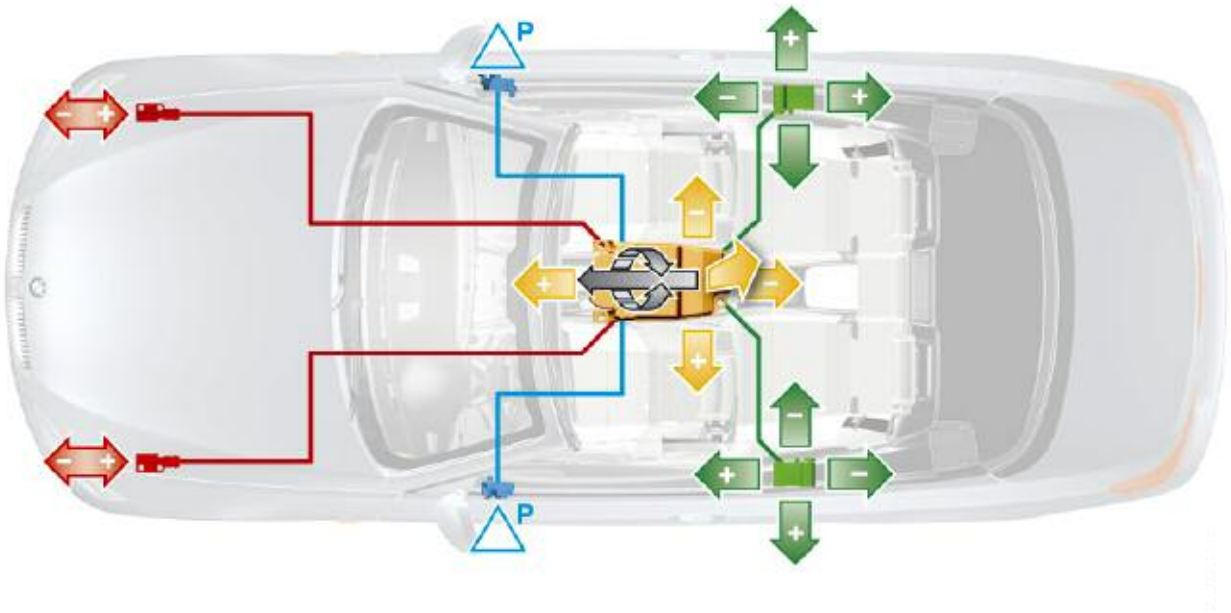
Advanced Crash and Safety Management

The E93 Convertible is equipped with the second generation advanced crash and safety management system (ACSM2). In terms of its scope of functions, the ACSM2 is identical to the ACSM in the E64 Convertible.

The ACSM2 differs from the ACSM in that the supplier is different and it features additional interfaces for future function expansions. The first generation ACSM is supplied by Autoliv while the second generation ACSM is supplied by BOSCH.

The task of Advanced Crash and Safety Management is to evaluate permanently all the sensor signals in order to identify 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.

The crash safety module incorporates a longitudinal acceleration sensor and a transverse acceleration sensor. The sensors serve to detect and verify front-end, side-on and rear-end crashes.



In the E93 Convertible the crash safety module has additional sensors for rollover detection.

Satellites are also integrated in the B-pillars. The satellites each consist of a longitudinal acceleration sensor and a transverse acceleration sensor.

Together with the transverse acceleration sensor in the crash safety module, the transverse acceleration sensors serve to detect side-on crashes. Door pressure sensors are additionally installed in the front doors for the purpose of detecting side crashes.

Together with the longitudinal acceleration sensor in the crash safety module, the longitudinal acceleration sensors serve to detect front and rear-end crashes.

The acceleration sensors measure the positive acceleration (+) and the negative acceleration (- / 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.

US vehicles have additional up-front sensors for front-end crash detection.

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.

In order to ensure ACSM operational availability at all times, the system monitors itself and indicates that it 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.

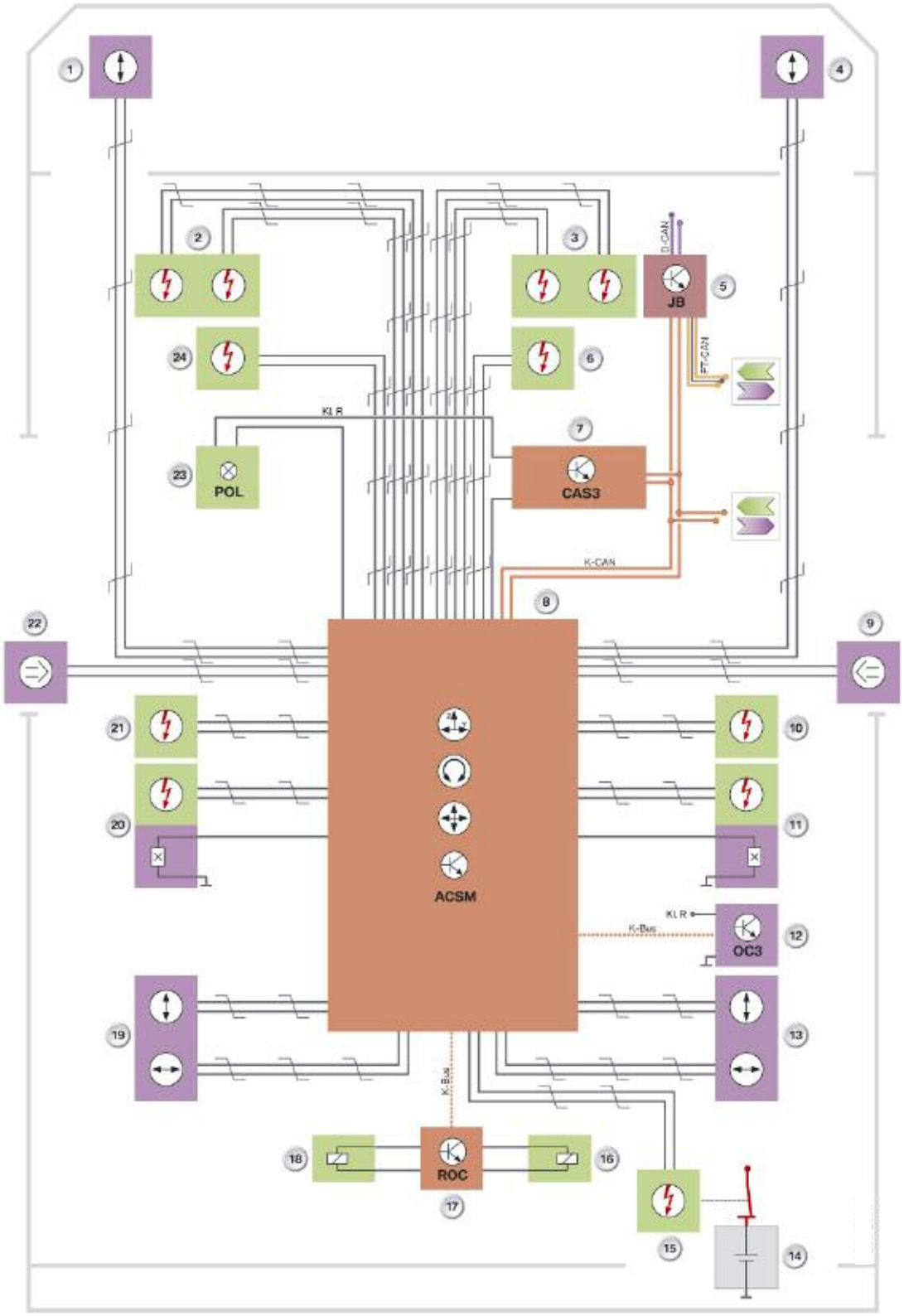
In the event of a crash, this is communicated to the other users in the bus-system network by way of a bus telegram. The relevant control units respond to this telegram by executing their own activities.

These activities include:

- Opening the central-locking system
- Activating the hazard warning flashers
- Switching on the interior lights
- Deactivating the fuel pump
- Switching off the alternator
- Automatic emergency call.

NOTES PAGE

ACSM 2 Schematic



Legend for ACSM 2 Schematic

Index	Explanation	Index	Explanation
1	Up front sensor, left	13	B-pillar satellite, right
2	Driver's airbag	14	Battery
3	Front passenger airbag	15	Safety battery terminal
4	Up front sensor, right	16	Actuator, right roll bar
5	Junction box	17	Rollover controller
6	Knee airbag passenger's side	18	Actuator, left roll bar
7	CAS 3	19	B-pillar satellite
8	Crash Safety Module (ACSM 2)	20	Seat belt pre-tensioner and seat belt buckle switch, driver's side
9	Door pressure sensor, passenger's side	21	Side airbag, driver's side
10	Side airbag, passenger's side	22	Door pressure sensor, driver's side
11	Seat belt pre-tensioner and seat belt buckle switch, passenger's side	23	Passenger Airbag OFF lamp
12	OC-3 mat	24	Knee airbag, driver's side

Signals on the PT-CAN

Input	Information	Source	Function
Out	Crash Telegram	ACSM2>JB>EKP module	Shut down fuel pump
Out	Crash Telegram	ACSM2>JB>DME	Shut down alternator

Signals on the K-CAN

Input	Information	Source	Function
Out	Crash Telegram	ACSM2 > CAS 3	Open central locking
Out	Crash Telegram	ACSM 2 > FRM	Activate hazard warning lights
Out	Crash Telegram	ACSM 2 > FRM	Switch on interior lights

E93 Convertible Rollover Protection System

The rollover protection system is of vital importance to the passive safety of the E93 Convertible. The rollover protection system helps to maintain a sufficient survival space for the occupants in the event of the car overturning or rolling over.

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. The car rotates about its longitudinal axis as a result of the high angular velocity.
- The car skids sideways off the road surface and buries itself with its wheels in the soft soil. The kinetic energy could be sufficient to upend and overturn the car.
- The car skids sideways off the road into the curb and is upended.

The crucial factors which determine whether the car overturns are not just the angle but also the angular velocity 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 rollover protection system consists of two extendable roll bars which are housed in the partition module behind the two rear seats.

Rollover Detection

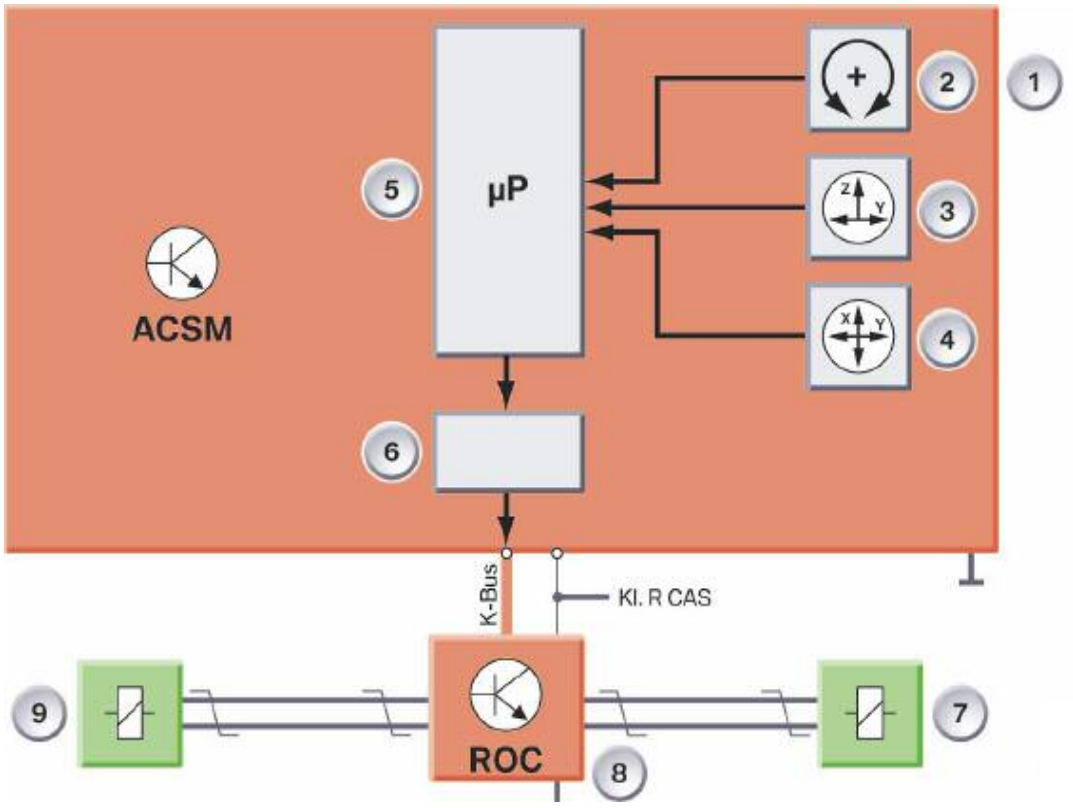
The E93 Convertible has a special sensor system in the crash and safety module ACSM2 for the purpose of detecting rollover situations. In addition of the two sensors (4) for longitudinal (X-axis) and transverse acceleration (Y-axis), there is a rotation rate sensor (2) and a Low-g sensor (3) for the Z-axis and for the Y-axis.

The longitudinal and transverse acceleration sensors (4) register the positive and negative vehicle acceleration in a range from 0-100 g. They serve to detect heavy accelerations and decelerations in a crash.

The two Low-g sensors (3) 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 processor for evaluation.

The processor evaluates the signals from the longitudinal and transverse acceleration sensors and the two Low-g sensors. The rotation rate sensor is also included in the calculation. The results are compared with the stored algorithm. When the processor detects that a rollover is imminent, it sends two telegrams within a defined timeframe to the ROC control unit with the instruction to trigger the actuators.



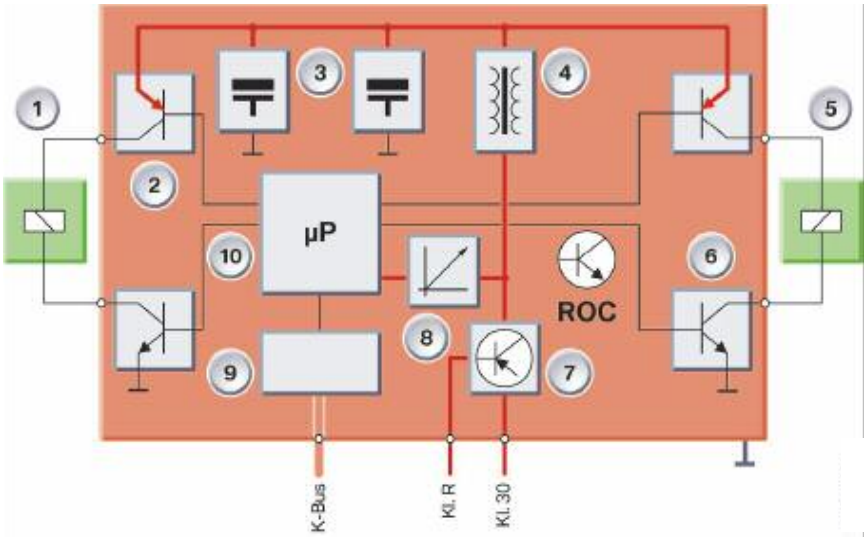
Index	Explanation	Index	Explanation
1	Crash Safety Module (ACSM 2)	6	K-bus interface
2	Rotation rate sensor	7	Actuator, right
3	Low g-sensors (Z/Y axis)	8	ROC control unit
4	Longitudinal and transverse acceleration sensors	9	Actuator, left
5	Microprocessor		

Triggering the Roll Bars

The ROC control unit is supplied with load current via terminal 30. Terminal R ON is applied as the switching signal and enables the power circuit-breaker (7). In this way, the voltage regulator (8), the microprocessor (10) and the switching controller (4) are supplied with voltage. The switching controller transforms the voltage into 35 V and charges up the two firing capacitors (3).

When the processor in the crash safety module detects an imminent rollover, it sends two telegrams within a defined time window via the K-bus.

The first telegram instructs the ROC control unit to make itself ready for firing (arming telegram). The ROC control unit incorporates two firing capacitors (3) connected in parallel for providing the firing energy. Each actuator has one high-side and one low-side power circuit-breaker.



Index	Explanation	Index	Explanation
1	Actuator, left	6	Low-side power circuit breaker
2	High-side power circuit breaker	7	Power circuit breaker
3	Firing capacitors	8	Voltage regulator
4	Switching controller	9	K-bus interface
5	Actuator, right	10	Microprocessor

The second telegram contains the firing command (firing telegram). The low-side power circuit-breakers (6) are connected to ground and the two high-side power circuit breakers (2) are switched through. The ROC control unit now discharges the two firing capacitors and the two actuators are supplied with voltage.

During normal operation, the roll bars are inserted in the cassettes in the partition module. They are pre-tensioned in the direction of their extension by a spring and held in place by a lock on the actuator.

The ROC control unit activates the two actuators via the output stages. Each actuator consists of a single-acting solenoid with a lock for disengaging and engaging its roll bar. The solenoid actuates the lock and releases the spring-loaded roll bar.

The locking pawls on the roll bar press the toothed rack back mechanically as the bar extends. When the protection bar is extended, the locking pawls are supported on the tooth strip. When the car is in the overturned position, the force is transmitted via the locking pawls on the roll bars to the toothed rack.

The rollover protection system may be triggered as follows:

- Automatically when an imminent rollover situation is detected
- By a defined crash severity in a front-end, side-on or rear-end crash
- Via the diagnostic interface
- By a mechanical emergency release mechanism.

In order to return the triggered roll bar back into its initial position, it is necessary to press the toothed strap back so that the bar can be pushed in.

Triggering the Rollover Protection System (via diagnosis equipment)

To check the function of the rollover protection system, it is necessary to trigger the system using the diagnostic equipment. The output stages of the actuators are activated here with the aid of a test module.

It is absolutely essential to observe the following safety precautions:

- Open the hardtop otherwise the rear window will be damaged
- Make sure no-one is situated in the immediate vicinity of the roll bars.

Mechanical Emergency Release

The rollover protection system should be triggered if it has to be removed for repair work. If this cannot be done electrically, e.g. for repair work following an accident, the system must be triggered mechanically in order to avoid the risk of injury.

Follow the procedure set out below:

- Open the hardtop otherwise the rear window will be damaged
- Remove rear seat
- Remove partition panel
- Remove control units under the roll bar cassette
- Remove control unit carrier
- Use a hook (Ø 3 mm) to reach the actuator
- The actuator has an opening in the middle, by means of which the roll bar can be triggered using the hook.

System Components

Advanced crash and safety management in the E93 Convertible essentially comprises the following components:

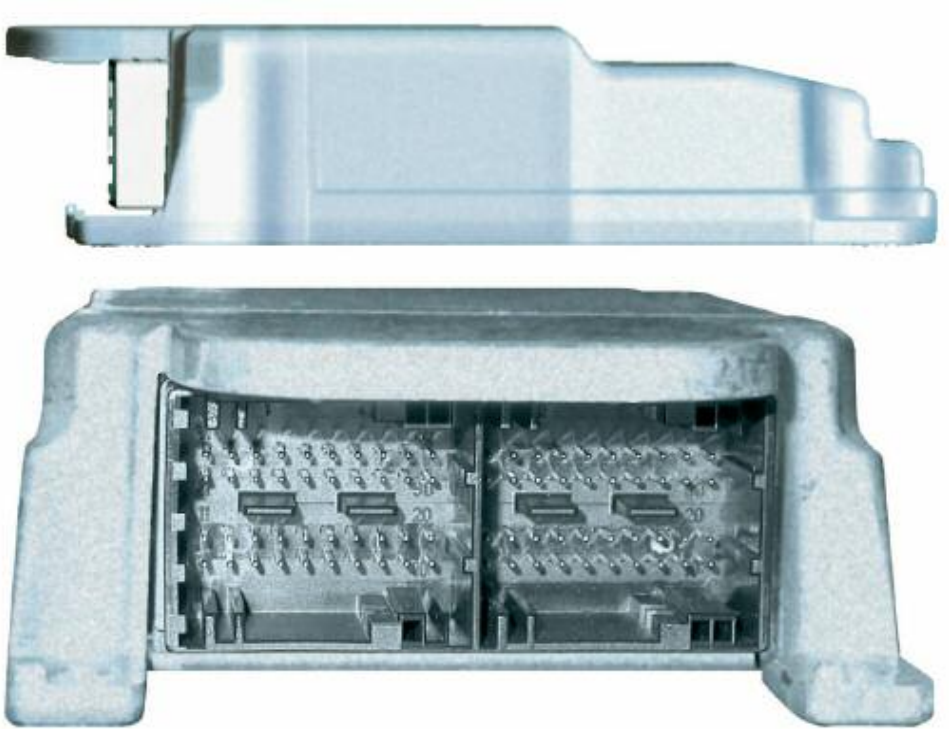
- Crash safety module ACSM2
- ROC control unit
- Sensors and switches
  - Up-front sensors (US only)
  - Door pressure sensors
  - B-pillar satellites
  - Seat occupancy mat US (OC3)
  - Seat belt buckle switch
  - Airbag switch
  - Emergency call button
- Actuators
  - Driver's airbag, two-stage
  - Passenger's airbag, two-stage
  - Knee airbag, driver/passenger (US only)
  - Side airbag, driver/passenger
  - Seat belt pre-tensioner, driver/passenger
  - Safety battery terminal
  - Roll bar, left/right
- Warning lights
  - Airbag warning light AWL
  - Seat belt mannikin
  - Passenger Airbag OFF lamp

Crash Safety Module

The crash safety module is located centrally on the transmission tunnel in the vehicle. The crash safety module consists of a diecast housing with integrated plug cover.

It contains two acceleration sensors offset at an angle of 90°. These acceleration sensors measure the longitudinal acceleration and transverse acceleration of the vehicle.

A rotation rate sensor as well as a Low-g sensor for transverse acceleration (Y direction) and a Low-g sensor for Z-direction are additionally integrated for detecting rollover situations.



Crash Safety Module (ACSM 2)

ROC Control Unit

In the E93 Convertible, advanced crash and safety management is equipped with an additional ROC control unit (rollover controller). The ROC control unit is connected via a K-bus to the crash safety module.

The task of the ROC control unit is to activate the actuators of the rollover protection system in the event of an imminent rollover situation.

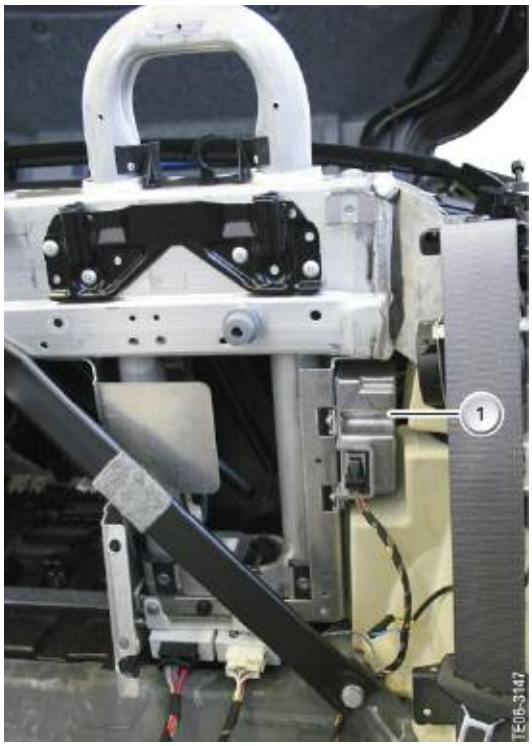
Rollover detection takes place in the crash safety module. Two telegrams are sent to the ROC control unit when the threshold values are reached.

The ROC control unit is mounted on the carrier structure of the rollover protection systems behind the rear right seat.

There are a few particulars to be borne in mind in relation to diagnosis for the ROC control unit.

The ROC (1) control module is not directly diagnosis-compatible. The ROC control unit monitors itself internally. The two circuits for the actuators are also monitored by the ROC.

In the event of a fault, the ROC transmits the fault to the ACSM2 crash safety module, where the fault is stored in the fault memory. ACSM2 activates the airbag warning lamp in the instrument cluster.



Airbag Systems

In addition to the known two-stage driver's and passenger's airbag, newly designed side airbags are used in the E93. The side airbags are integrated in the backrest of the SGS seat.

The side airbags have a larger volume compared to the airbags previously used. The side airbag develops between the seat and door in the event of side impact of sufficient severity. Due to the increased volume, the occupant's thorax and head are additionally protected.

Side airbag on E93

Design features of the E93 Convertible include the pronounced inclination of the windscreen with the windscreen cowl panel extending further towards the rear. Knee airbags are additionally fitted in US vehicles to conform to US legal requirements for protecting occupants not wearing seat belts.

The knee airbags substantially reduce displacement of the pelvis and initiate upper body rotation earlier in the event of an accident, thus preventing occupant contact with the sun visor on the windscreen cowl panel. When the ACSM 2 detects that the front passenger seat is not occupied, the knee airbag on the passenger's side will not be triggered in the event of a crash.

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Retractable Hardtop

Model: E93

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Explain the operation of the Retractable Hardtop on the E93
- Describe the distinguishing features of the Retractable Hardtop on the E93
- Identify the different components found on the E93 Retractable Hardtop
- Understand each component’s function in the operation of the Retractable Hardtop

Introduction

Spring 2007 will see the market launch of the new BMW 3 Series E93 Convertible. It is the first to offer a retractable hardtop in lightweight steel construction. The three-part roof design with a fully automatic opening and closing mechanism allows the roof to be opened or closed in less than 25 seconds.

The retractable hardtop of the new BMW 3 Series Convertible provides good rear visibility, even when closed. The glass surface area of the rear window is significantly larger than that of the predecessor model. This makes driving maneuvers such as changing lanes, turning or parking considerably more pleasant.

Other advantages of the retractable hardtop are:

- Greater preservation of value
- Improved protection against damage and theft
- Optimized year-round suitability
- Sound insulation performance at high speeds (up to 270 km/h, 167mph) compared to that of a Coupe.

In addition, the folding height of the retractable hardtop (about 170cm/67in) is low enough to allow it to be opened and closed in garages.

The three steel roof section plates are engineered for optimum weight and rigidity. The trunk lid is also made of steel for rigidity reasons.

The movement sequence of the retractable hardtop is driven by a central hydraulic system with 8 hydraulic cylinders. The movement sequence is also supported by 6 gas pressure dampers. The hydraulic system is controlled via the Convertible Top Module (CTM) and is built into a recess in the luggage compartment floor.

A central electric motor in the front roof panel locks the entire retractable hardtop system. It is locked at the cowl panel and the center roof panel by means of a linkage mechanism. The roof panels are interlocked using drive cables (similar to a sunroof drive) or flexible thrust cables.

The trunk lid is locked using the Soft Close Automatic (SCA) feature, which comes standard.

The retractable hardtop is opened and closed using the button in the middle of the center console. The retractable hardtop can also be opened using the remote control. The luggage compartment divider must be closed before the opening and closing process can be started.

The retractable hardtop can be stopped in any position during the opening/closing sequence. Pressing the operating button or remote control again continues the opening or closing process.

The retractable hardtop cannot be opened or closed while driving.

Weight:

- Roof module: about 98kg or 216lb (approx. 43kg or 95lb. more than soft top)
- Rear module: about 48 kg
- Complete scope of delivery with trunk lid attachments (lights, SCA etc.) approx. 147kg or 324lb

System Overview

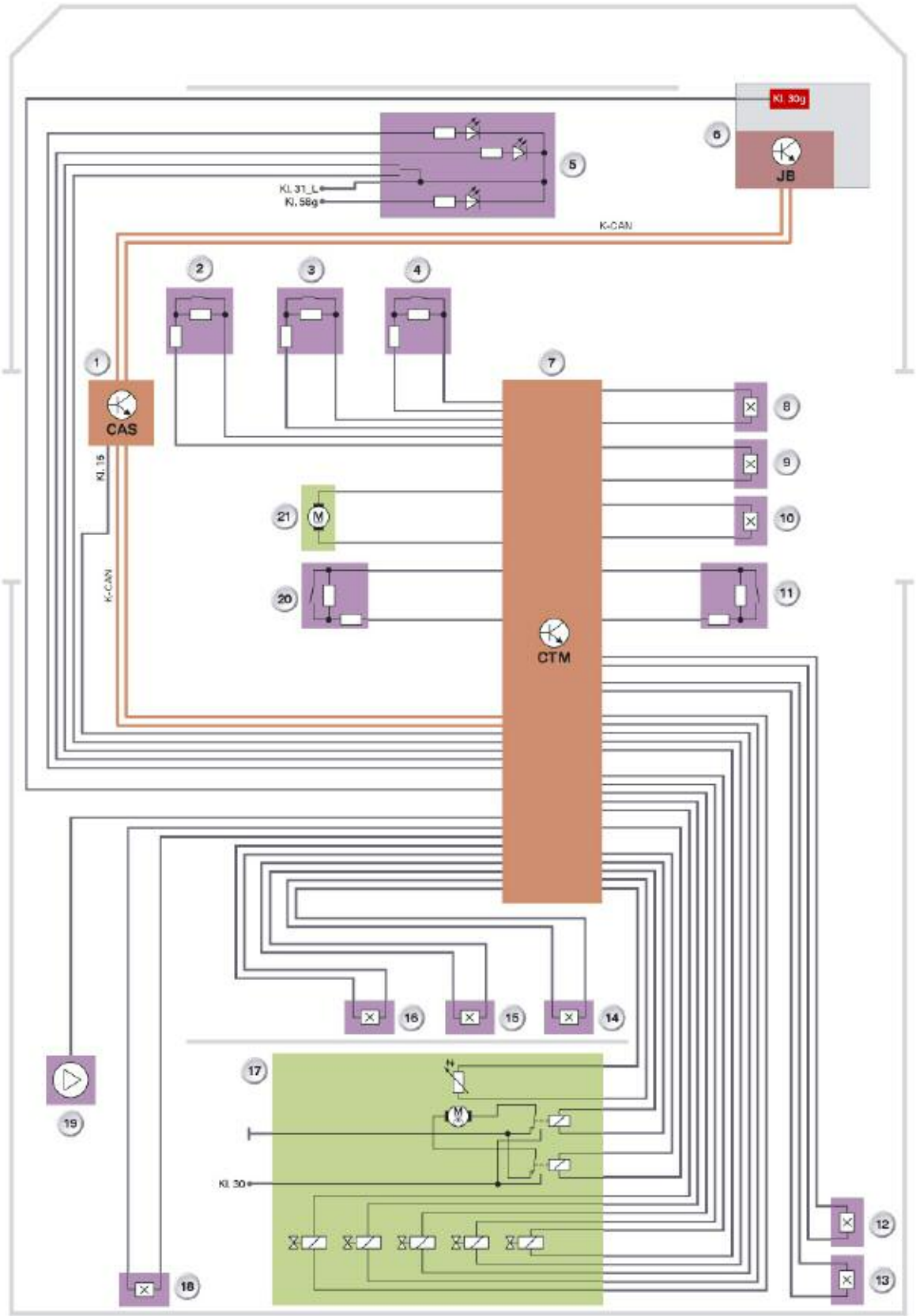
Conditions for Operation

The retractable hardtop can be opened and closed using the button in the center console only if the following conditions are met:

Important!!!

- Terminal R activated
- Outside temperature above -12°C (10°F)
- Trunk lid closed
- Vehicle not moving (driving speed 0 mph)
- Luggage compartment divider in lowest position
- Lateral inclination of the vehicle < 8°
- Power windows initialized.
- Battery voltage > 9.5 V
- Fewer than five successive opening/closing operations
- Temperature of the hydraulic fluid
  - For opening: max. 90°C, 194°F
  - For closing: max. 105°C, 221°F

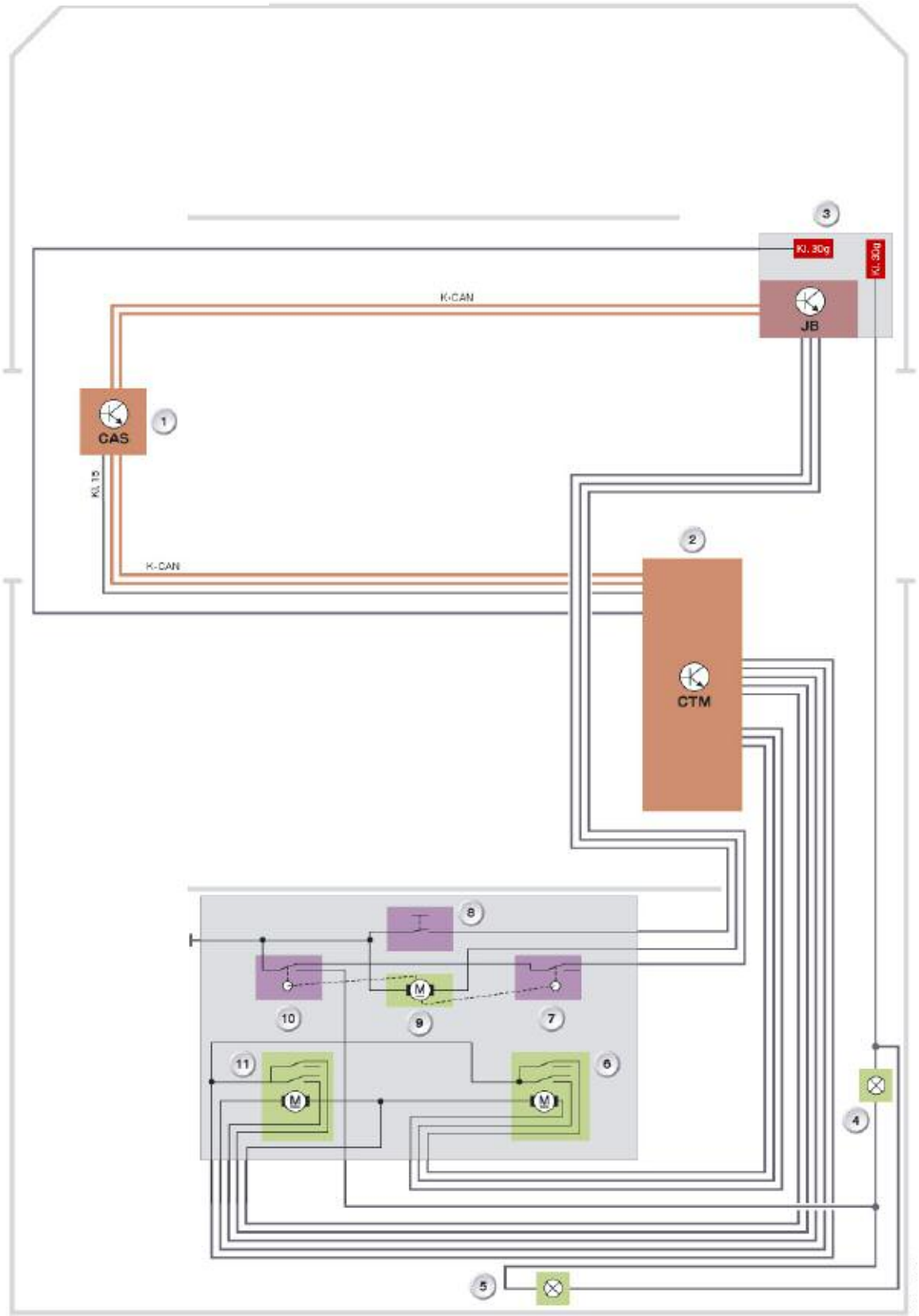
Convertible Top Module CTM



Convertible Top Module CTM Legend

index	Explanation	Index	Explanation
1	Car Access System (CAS)	12	"Rear module open" Hall sensor
2	"Cowl panel reached" microswitch	13	"Rear module almost closed" Hall sensor
3	"Catch hook locked" microswitch	14	"Roof package stowed" Hall sensor
4	"Catch hook unlocked" microswitch	15	"Rear module closed" Hall sensor
5	Operating button for retractable hardtop.	16	"Roof package extended" Hall sensor
6	Junction-box ECU	17	Hydraulic unit
7	Convertible top module (CTM)	18	"Luggage compartment divider" Hall sensor
8	"Open roof panels" Hall sensor	19	Diversity aerial
9	"Close roof panels" Hall sensor	20	"Left closure" microswitch
10	"Closure open" Hall sensor	21	Electric motor for fastener on cowl panel and interlocking of roof panels
11	"Right closure closed" microswitch		

Soft Close Automatic (SCA)



Soft Close Automatic (SCA) Legend

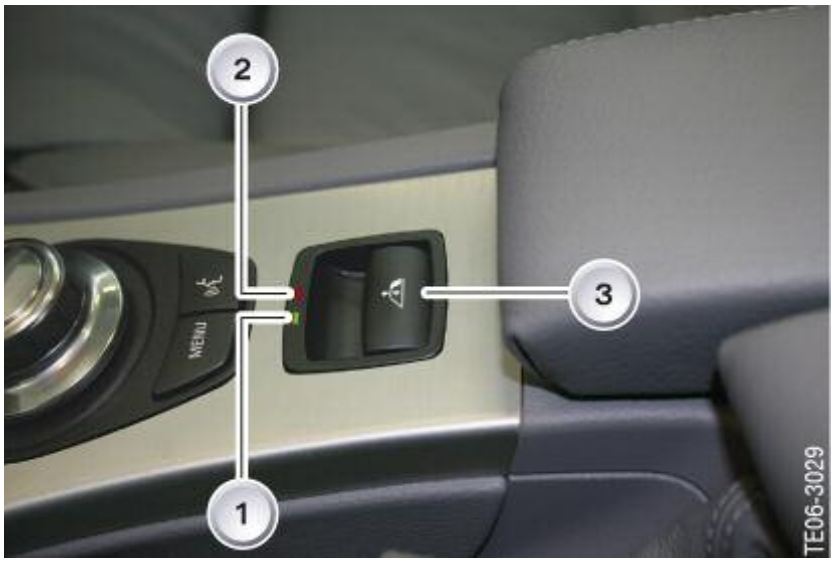
Index	Explanation	Index	Explanation
1	Car Access System (CAS)	7	Right Trunk lid lock
2	Convertible top module (CTM)	8	Rear hatch button
3	Junction box (JB)	9	"Trunk lid lock" electric motor
4	Trunk lid lamp	10	Left trunk lid lock
5	Luggage compartment light	11	Left Soft Close Automatic electric motor
6	Right Soft Close Automatic electric motor		

K-CAN Signals for the Convertible Top Module

In/out	Signal	Source	Function
In	Outside temperature	Instrument cluster	Hardtop cannot be operated at temperatures below -12 °C
In	Vehicle road speed	DSC wheel speed sensor	Hardtop cannot be operated at speeds > 0 km/h
In	Trunk lid position	Junction box	Hardtop cannot be operated with trunk lid open
In	Power window status	Footwell module	Hardtop cannot be operated if the power windows are not initialized
In	Vehicle tilt	DSC	Retractable hardtop cannot be operated if the vehicle tilt >8°.

Functions

Standard Operation



Index	Explanation
1	Green LED
2	Red LED
3	Button

The standard means of operating the retractable hardtop is by actuating the button in the center console. The movement of the hardtop is carried out as long as the button is actuated. The operating principle of the button is similar to that of the power windows.

- Pushing the button opens the hardtop; pulling the button closes it.
- The green LED in the button lights up while the hardtop is moving.
- If the button is released while the hardtop is moving, (the movement of the hardtop, the rear module or the side windows is immediately interrupted).The red LED then flashes in the button. The hardtop movement can be resumed by pressing the button again. The movement of the side windows can be resumed within 10 seconds.
- If one of the conditions is not met, the red LED is lit continuously.

Note: On early production E93 vehicles, the switch operation is different, Pushing the button closes the hardtop; pulling the button opens it.

Opening Sequence

When the button in the center console is pushed, the conditions for opening the hard-top are checked by the Convertible Top Module (CTM). After the check is successfully completed, the green LED on the switch goes on:

- The side windows are lowered.
- Then, the front roof panel is lowered and the roof sections are unlocked from each other.
- When the hydraulic system is activated, the lock fastener Mechanism “closure”, connecting the rear roof section and rear module to the body) is unlocked.
- The 3 roof sections are now positioned one on top of each other to form the “roof package”
- Then, the “rear module” is opened and the roof package is stowed in the trunk.
- The stowed roof module is then locked in place.
- The rear module is then closed and locked.
- Finally, the side windows move back up.

Closing Sequence

The closing procedure of the hardtop is the reverse of the opening. When the button in the center console is pulled, the conditions for closing the hardtop are checked by the Convertible Top Module (CTM). After the check is successfully completed, the green LED lights up and:

- The side windows are lowered if necessary.
- The rear module is then unlocked and opened. Simultaneously, the roof package is unlocked.
- Once the rear module is opened all the way, it is held in this position while the roof package is extended.
- When the roof package has reached the end position, the rear module is closed, locked by the “closure”, (to align all parts in closed position) then unlocked again.
- The roof sections are then moved apart until the front roof panel reaches the top of the cowl panel.
- The roof sections can now be interlocked as the front roof panel is locked to the cowl panel.
- Finally, the rear roof panel and rear module are locked to the body.
- The green LED in the button goes out.
- If the button remains pressed, the side windows are raised.

Convenience Functions

The retractable hardtop can also be operated using the remote control or using the mechanical key and door lock. For vehicles with the Comfort Access, the hardtop can be opened and closed using the ID sensor.

Convenience Opening Via Remote/ID Transmitter

The same pre-conditions apply for convenience opening of the hardtop using the remote control/ID Transmitter as for standard operation. The only difference is that terminal R does not need to be enabled and that the remote control/I D transmitter is within the reception range of the vehicle (4m or 13 ft)

The hardtop is opened by pressing and holding down the button on the remote control/ID Transmitter for unlocking the vehicle. If, during the opening process, a button of the second remote control/ID Transmitter is pressed, the opening process is immediately interrupted.

Convenience Closing Via Remote/ID Transmitter

Convenience closing of the hardtop via ID Transmitter is possible for vehicles with the Comfort Access.

The same pre-conditions apply for convenience closing of the hardtop using remote control/ID Transmitter as for standard operation.

The ID Transmitter must be within the reception range of the Comfort Access antenna (4m or 13ft). The hardtop is closed by pressing and holding down the button on the remote control/ID transmitter for locking the vehicle. If, during the closing operation, a button of the second remote control/ID Transmitter is pressed, the closing operation is immediately interrupted. If the ID Transmitter is in the slot, convenience closing is not possible.

Note: Convenience closing using the remote control is not possible on vehicles with out Comfort Access

Convenience Functions Via Door Lock

The hardtop can also be opened and closed using the mechanical key. During the opening or closing process, the vehicle user has all movements and hazardous situations in his or her field of vision. To do so, the mechanical key in the lock cylinder of the driver's door must be turned and held in the "unlock vehicle" or "lock vehicle" direction.

Mechanical key in the lock cylinder

Note: For vehicles with the Comfort Access, convenience closing via the outer door handle electronics is not possible

Convenience Loading/Unloading

The new convenience loading and unloading function allows quick access to the luggage compartment when the roof is open in order to load large items of luggage. The same pre-conditions apply for convenience loading and unloading as for operation via remote control/ID Transmitter.

The convenience loading and unloading function is activated as follows:

- Briefly press the trunk lid button.
- Then, press and hold down the trunk lid button (no more than one second may pass between when the trunk lid button is released and when it is pressed again)

Retractable hardtop and trunk lid in position for convenience loading

- First, the rear module is unlocked and opened all the way.
- Then, the roof pack is lifted from the luggage compartment to the intermediate position.
- Next, the rear module is closed and locked.
- Finally, the trunk lid is unlocked using the Soft Close Automatic feature and opened slightly.
- The luggage compartment divider can be pivoted upward manually. This enlarges the access to the luggage compartment so that it can be loaded conveniently without the need to close the hardtop all the way.
- After the luggage compartment is loaded, the hardtop can be opened using the remote control or opened or closed using the ID Transmitter (for vehicles with Comfort Access).

Note: "Open roof", "Close roof" and "Convenience loading" via remote control/ID Transmitter are only possible with Comfort Access Option.

Soft Close Automatic (SCA)

For convenient closing of the trunk lid, the Soft Close Automatic is installed as standard. It consists of two Soft Close Automatic drives that lock the trunk lid to the rear module carrier on the left and right. This increases the stability of the trunk area.

Opening the Trunk Lid

When the trunk lid is opened using the trunk lid button, a microswitch is actuated and its status is read by the junction box JB. The JB sends a message to the CAS via K-CAN. After the check is successfully completed, the CAS sends the release and the JB triggers the drive for unlocking the trunk lid. The drive actuates the release catch; the left and right trunk lid locks are unlocked via the control cables.

The JB transmits the status of the trunk lid (unlocked) on K-CAN, and the CTM receives it. The CTM then triggers the start-up of the SCA drives, which then move to standby position and are available for a closing operation or to support a closing operation.

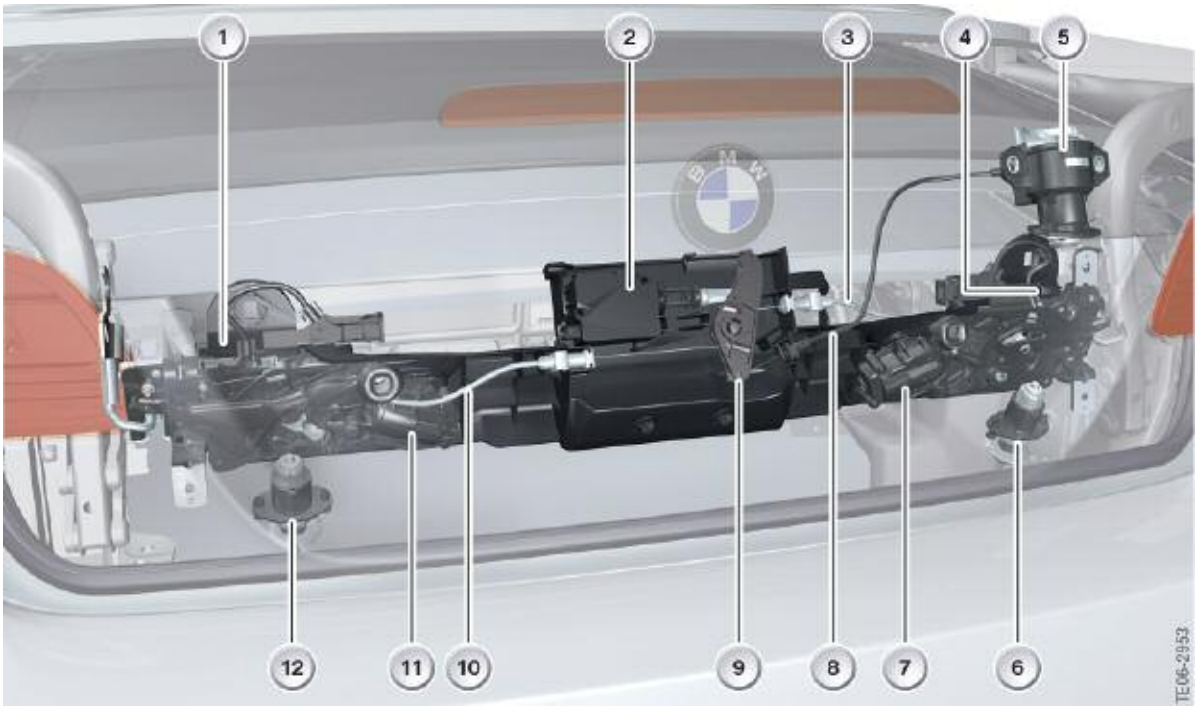
Closing the Trunk Lid

When the trunk lid is closed, the SCA drives are in standby position. When the left and right trunk lid locks have reached the locking clips, two microswitches are actuated and their status is read in by the CTM. The CTM then triggers both SCA drives (one on each SCA drive) until two other microswitches signal the "trunk lid locked" status to the CTM.

Manually closing the trunk lid would make closing via the Soft Close Automatic drive unnecessary. However, because it must be ensured that the trunk lid is really closed, the Soft Close Automatic drive is actuated nonetheless. The end position of the SCA drives in the "Unlocked" status is signalled to the CTM by two additional microswitches.

Non-repeat Lock

Each Soft Close Automatic drive has a non repeat lock to prevent overheating of the Soft Close Automatic drive. It allows up to 20 actuations of the Soft Close Automatic drive. Afterwards, the Soft Close Automatic drive is electrically disabled for approx. 2 minutes.



Index	Explanation	Index	Explanation
1	"Left trunk lid lock" microswitch	7	"Right Soft Close Automatic" drive
2	Drive for central locking of the trunk lid	8	Control cable for mechanical unlocking of the trunk lid
3	Control cable for unlocking the right trunk lid lock	9	Release lever
4	"Right trunk lid lock" microswitch	10	Control cable for unlocking the left trunk lid lock
5	Locking cylinder of the trunk lid	11	"Left Soft Close Automatic" drive
6	Right stop buffer	12	Left stop buffer

System Components

Mechanical Components

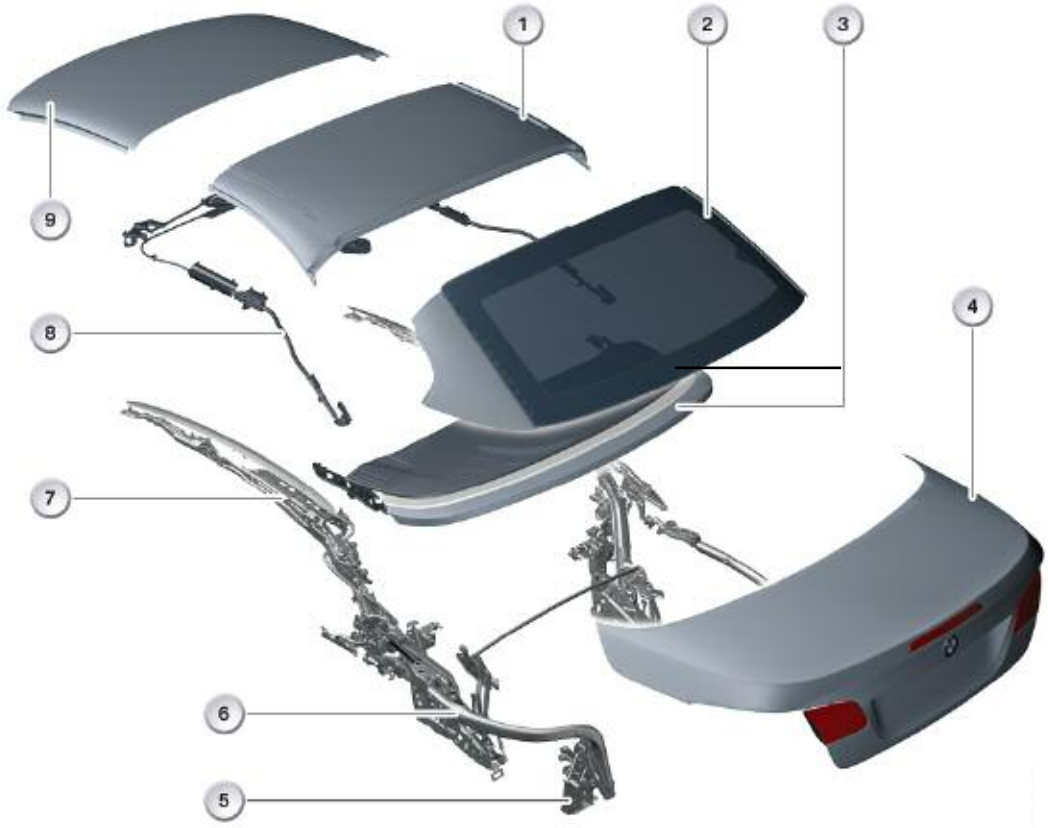
The retractable hardtop is a roof system in steel construction.

This system withstands speeds up to 270 km/h (167mph) and has a sophisticated water management system for draining remaining water when the roof is extended or retracted.

AM/FM antennas are integrated into the bonded rear window.

The retractable hardtop is designed as a three-part roof system. The hardtop roof panels are made of steel in a classic sandwich construction and are engineered for optimum weight and rigidity.

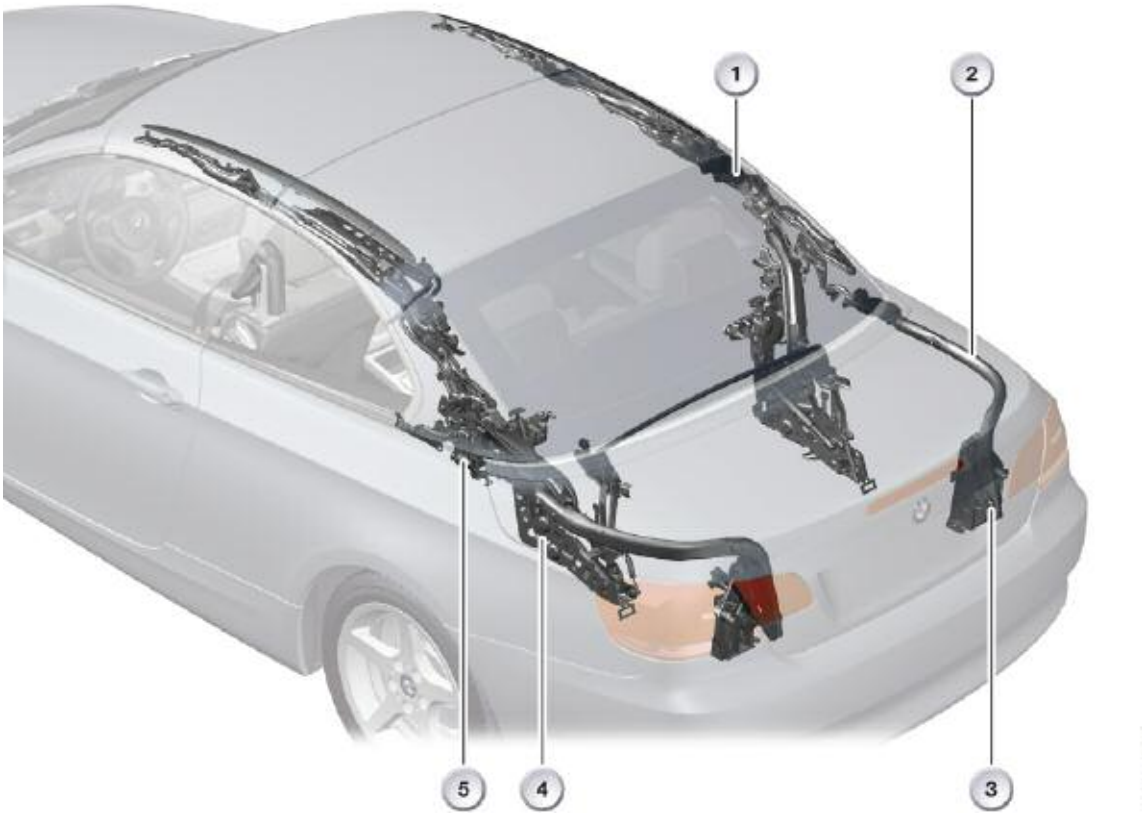
A central hydraulic system located in the luggage compartment floor operates the kinematic movement of 8 hydraulic cylinders in the overall system.



Index	Explanation	Index	Explanation
1	Center roof panel	6	Rear module linkage
2	Rear roof panel	7	Roof module linkage
3	Hardtop lid	8	Locking mechanism
4	Trunk lid	9	Front roof panel
5	Rear module mount		

- Fully automatic opening and closing is possible using the button in the center console or the mechanical door lock.
- The roof can also be operated (but only opened) using the remote control.
- For vehicles with the Comfort Access option,the retractable hardtop can be both opened and closed using the ID Transmitter.
- The hardtop can be operated only if the vehicle is not moving and the outside temperature is above -12°C (10°F).
- The opening/closing operation is completed in about 23 seconds.

Mechanism of the E93 retractable hardtop



Index	Explanation	Index	Explanation
1	Roof mechanism	4	Roof module main mount
2	Rear mechanism carrier bar	5	“Closure” locks the roof module, rear module and body together.
3	Rear module main mount		

Roof Module

The roof module consists of 3 roof sections, linkage, main mount and the hydraulics.

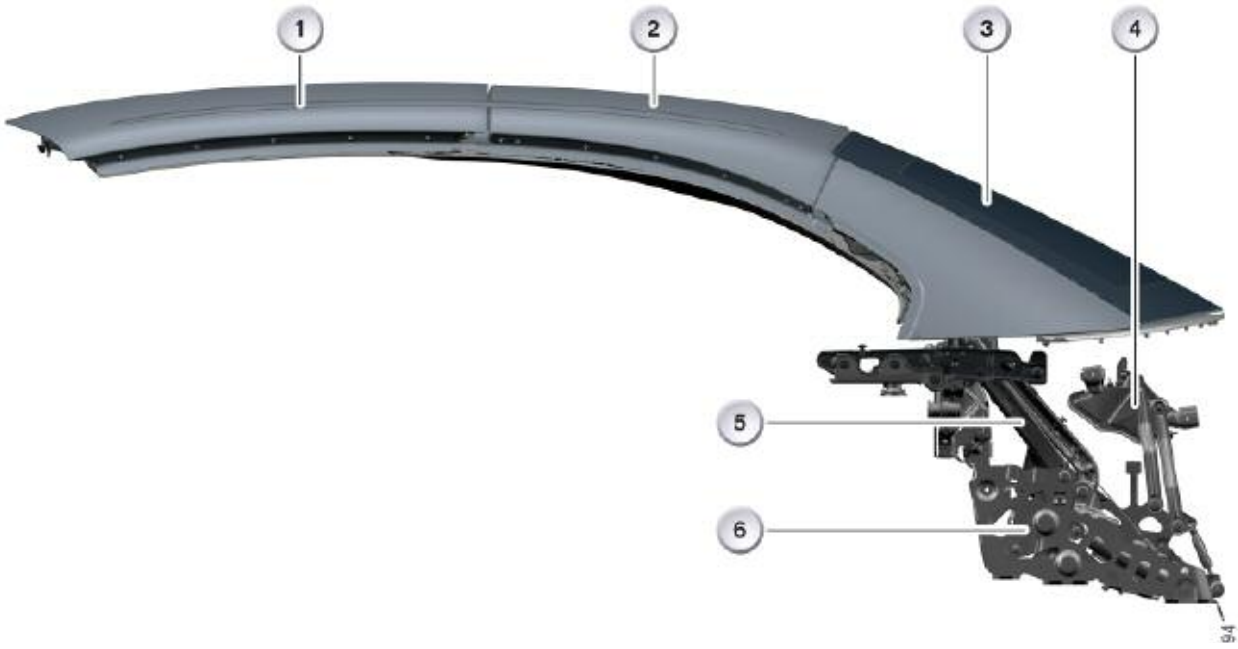
The movement sequence of the retractable hardtop is driven by a central hydraulic system with hydraulic 8-cylinder activation, with an additional 2 gas pressure dampers in the main mount.

A total of 8 hydraulic cylinders and 6 gas pressure dampers are used in the retractable hardtop. The hydraulic system is controlled via the Convertible Top Module (CTM) and is built into a multifunctional tray in the luggage compartment floor.

A central electric motor in the front roof section serves to lock the entire retractable hardtop system. The roof sections are interlocked using drive cable tubes, similar to a sunroof drive.

The roof module weighs about 98kg (216lb) (about 94lb more than a soft top)

E93 Roof Module



Index	Explanation	Index	Explanation
1	Front roof panel	4	Holder for luggage compartment divider
2	Center roof panel	5	Linkage
3	Rear roof panel	6	Main mount

Rear Module

The trunk lid and hardtop lid are integrated into the rear module. The rear module is fastened to the body using a supporting bar structure with main mount.

The rear module weighs about 48 kg. (106lb). The trunk lid is equipped with Soft Close Automatic.

Index	Explanation	Index	Explanation
1	Opening hinges for linkage (main pillars)	6	Wiring harness
2	Hardtop lid	7	Rear module linkage
3	Trunk lid	8	Trunk lid damper
4	Tail lights	9	Trunk lid linkage
5	Rear module main mount		

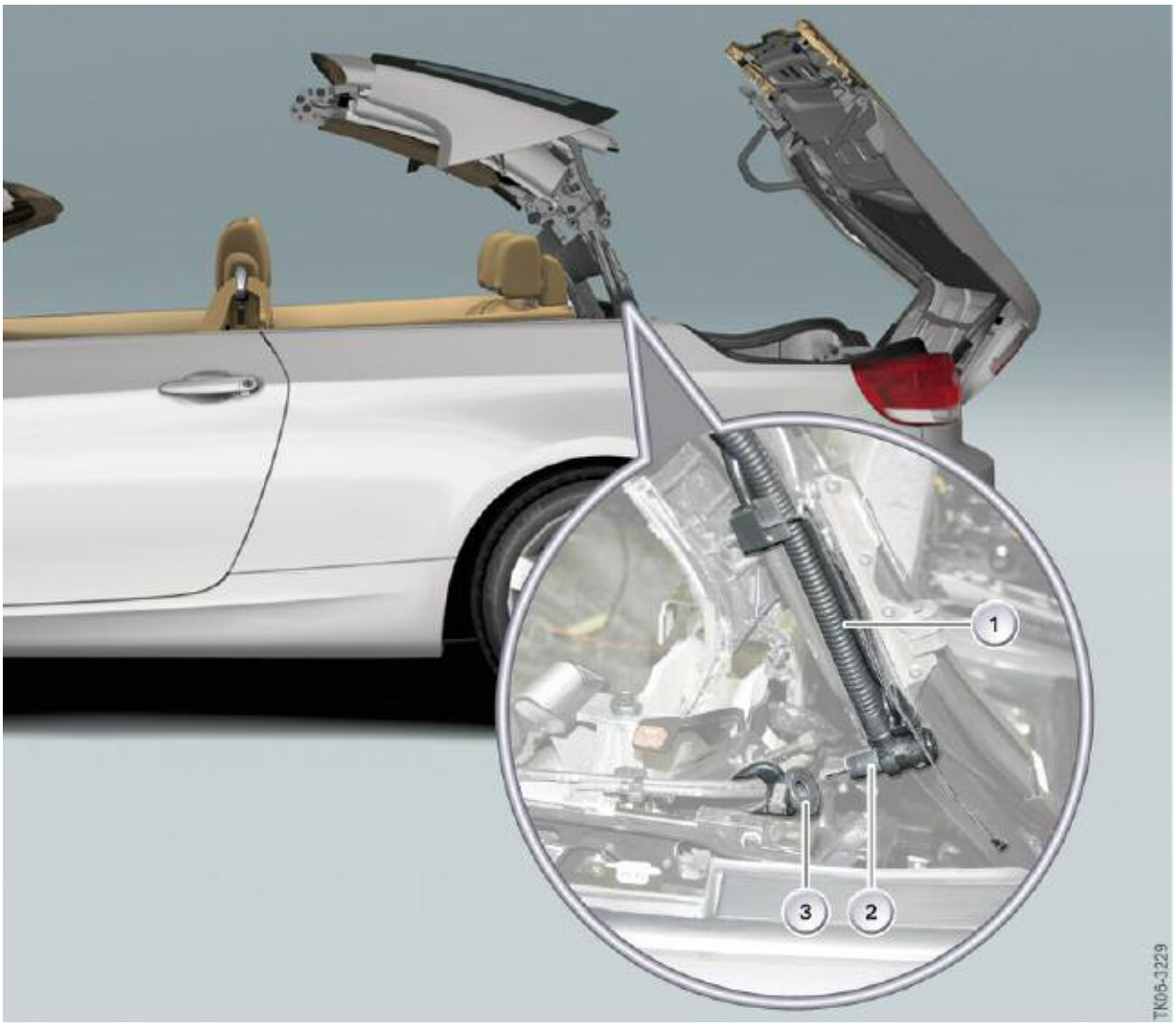
Water Management

The water flows from the roof channel into a water drain through a duct system with valve on the main guide bar.

When the retractable hardtop is stowed while wet, any remaining water droplets are collected in the side storage trays and the channel in the trunk sill panel, where they can evaporate. This provides items of luggage with maximum protection from remaining water.

Index	Explanation	Index	Explanation
1	Left storage tray	3	Right stowage tray
2	trunk sill panel channel		

Water Drains



Index	Explanation	Index	Explanation
1	Water hose	3	Water drain
2	Water valve		

Electrical Components

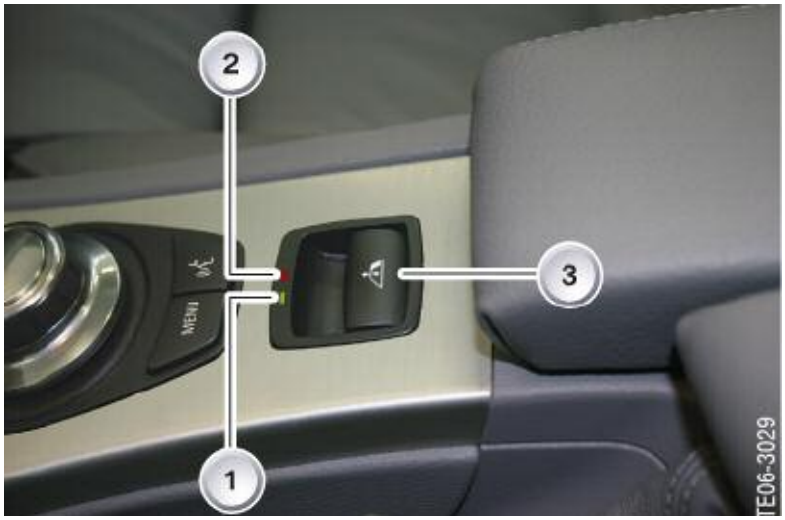
Button

The button is installed in the center console between the controller and armrest. It is secured by four screws in the console decor panel.

- The retractable hardtop and side windows are opened by pushing the button and holding it in that position.
- The retractable hardtop and side windows are closed by pulling the button and holding it down.

Note: On early production E93 vehicles, the switch operation is different, Pushing the button closes the hardtop; pulling the button opens it.

Index	Explanation
1	Green LED
2	Red LED
3	Button

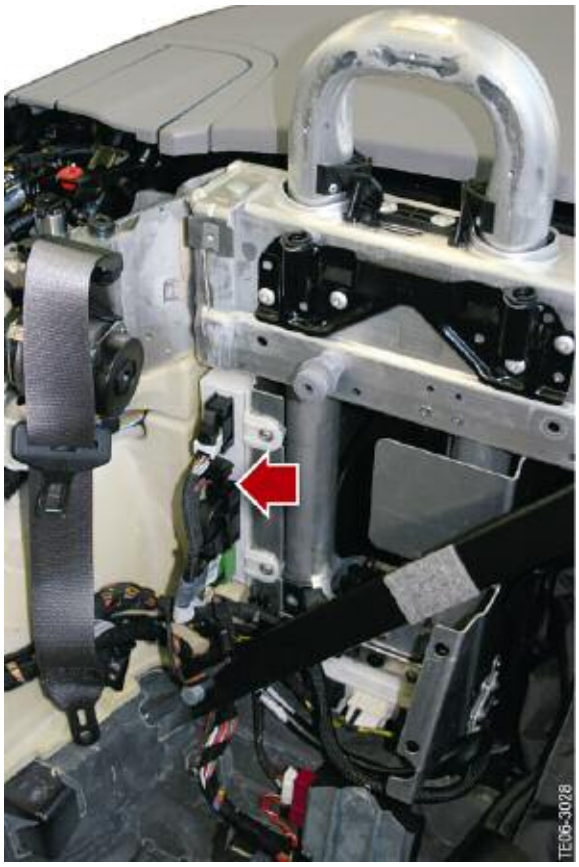


If the button is released while the hardtop is moving, then the movement of the retractable hardtop, the rear module or the side windows is immediately interrupted. The hardtop movement can be resumed by actuating the switch again. It has two contacts that are switched to ground and that are closed alternatively. The function display on the button has two LEDs (red and green).

- The green LED in the button lights up during the opening/closing operation.
- The blinking red LED indicates that a system operation has been interrupted in mid movement, as the movement resumes the green LED lights up again until the operation is complete.
- The solid red LED signals incorrect operation or hazardous situations by one or more of the preconditions for operation have not been met. For example, the hardtop cannot be opened if the luggage compartment divider is not in the lower position or ambient temperature is below 10°F. In this case, the red LED is lit continuously.The CTM detects the status of the button.

Convertible Top Module (CTM)

The (CTM) is the central electronic control module for all functions of the retractable hardtop. The location of the CTM is to the right of the compartment divider. The CTM controls the retractable hardtop, the rear module and the Soft Close Automatic feature.



Power is supplied to the CTM by the junction box with terminal 30g.

There is an additional power supply to the CTM via terminal 15 of the Car Access System (CAS) so that in certain cases of malfunction, such as an interrupted supply from the junction box, adequate diagnostics and communication with the diagnostic tester are possible.

The CTM controls the electric motor for the interlocking of the roof panels and of the front roof panel to the cowl panel. In addition, it controls the hydraulic pump and the 8 hydraulic cylinders via 5 valves in the hydraulic unit.

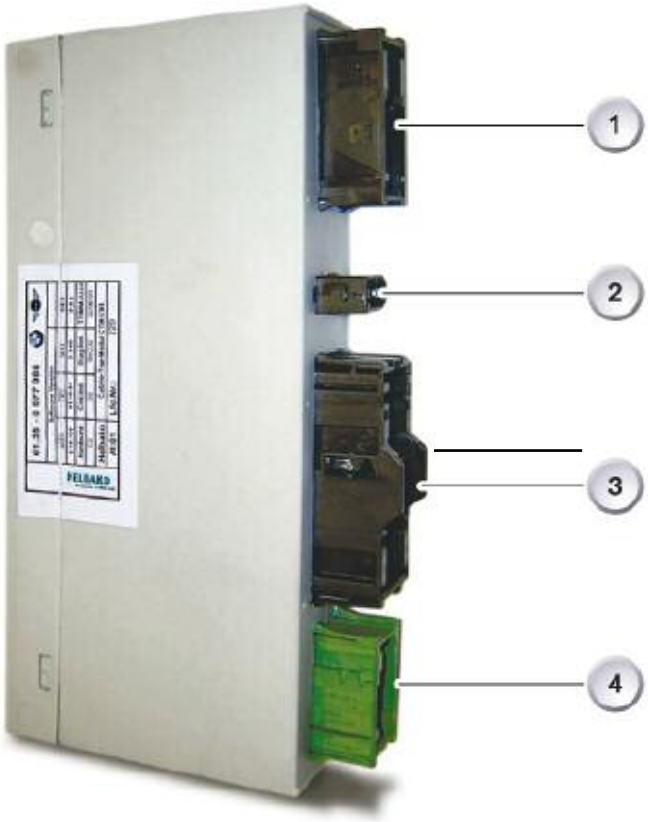
During the hardtop and rear module movements, the respective position is detected by 9 Hall sensors and 5 microswitches in the cowl panel, hardtop and rear module and forwarded to the CTM via the respective wiring harness. Each of them signals whether a certain status has been reached and whether the CTM can initiate the next phase. The current supply of the microswitches/Hall sensors is provided by the CTM. The CTM also reads in the status of the button.

The CTM is connected to other control modules via the K-CAN. For example, information about the outside temperature, driving speed and status of the trunk lid is received via K-CAN. When the hardtop is opened or closed, the CTM sends the request to lower the side windows to the FRM.

In certain critical situations, the CTM triggers introductions that are easily understandable to the customer in the instrument cluster as check control messages and text messages in the CID. A list of check control messages is provided in the "Service information" section of this Product Information.

Depending on whether the roof is closed or open, the CTM transmits a signal to the antenna diversity module for it to select best antenna to maintain proper reception.

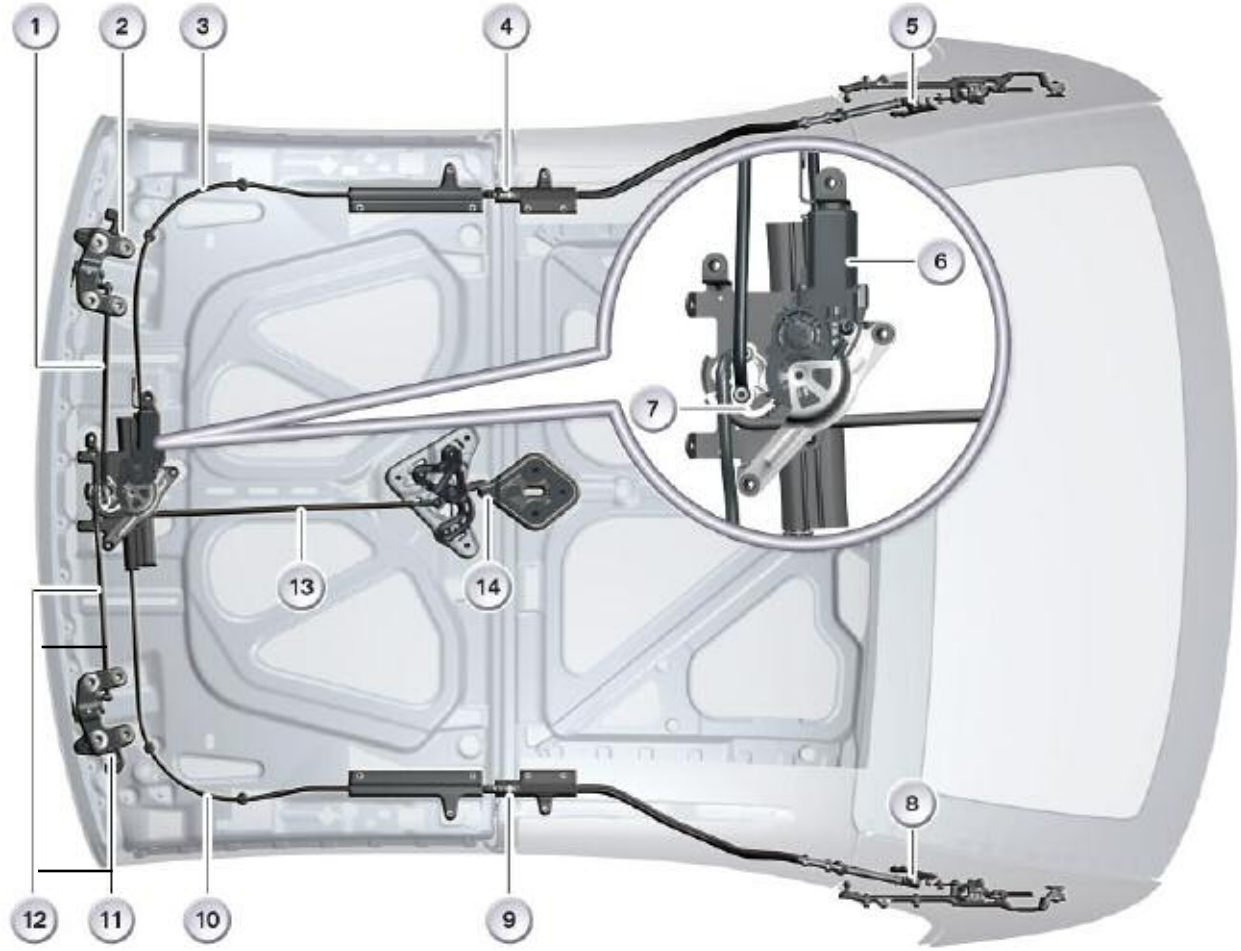
CTM Control Module



Index	Explanation
1	26-pin connector for Hall sensors and microswitches; 18-pin connector for hydraulic control module
2	2-pin connector for electric motor
3	41-pin connector for power supply, SCA, button, Hall sensors, microswitches and KCAN
4	18-pin connector for hydraulic control module

Hardtop Locking Mechanism

The roof sections of the hardtop are interlocked. In addition, the front roof panel is locked at the cowl panel via two catch hooks. The electric motor installed in the center of the front roof section serves as the drive. The electric motor is activated directly by the CTM.



Index	Explanation	Index	Explanation
1	Connecting rod for right catch hook	8	Locking bolt (pin) for center roof panel to rear left roof panel
2	Right catch hook	9	Locking bolt (pin) for front center roof panel to center left roof panel
3	Right drive cable	10	Left drive cable
4	Locking bolt (pin) for front center roof panel to center right roof panel	11	Left catch hook
5	Locking bolt (pin) for center roof panel to rear right roof panel	12	Connecting rod for left catch hook
6	Electric motor	13	Connecting rod for locking hook
7	Control disk	14	Locking hook

Roof Sections Locking Sequence

When the front roof panel has reached the cowl panel, the electric motor is activated. The left and right drive cables are driven via the gear on the electric motor (in a manner similar to the sliding/tilt sunroof). The ends of the drive cables have locking bolts (pins) that are pushed from the front roof panel into the center roof panel and thus lock these roof sections together. Simultaneously these locking bolts press against springloaded elements in the center roof panel then act on flexible rods, that push a second set of locking bolts (pins) to secure roof panels 2 and 3.

While the drive cables are operated, the connecting rods are simultaneously activated via the control disk. The force is transmitted from the gear wheel of the electric motor to the connecting rods via the splines on the control disk. The left and right connecting rods separate, and the front roof panel is locked to the cowl panel via the catch hooks. The locking hook, which locks the front roof panel to the center roof panel, is also driven via the center connecting rod.

The roof panels are unlocked by reversing this operation. The end positions of the electric motor are detected by two microswitches and forwarded to the CTM.

Locking of the Roof Package

To prevent damage to the roof package when stowed, such as when driving over pot-holes, etc., the front roof section is locked in the luggage compartment. Locking the front roof panel secures the entire roof package in place, which also prevents noises (such as squeaks, groaning or rattles).

When the roof sections have been stowed in the luggage compartment, the electric motor is activated. The catch hooks are locked to the base plates via the catch hooks. In addition, the locking bolts (driven by the drive cables) move into the guides. Thus the front roof panel is securely locked in the luggage compartment.

Locking of the roof panels in the rear

Index	Explanation	Index	Explanation
1	Left catch hook	4	Right locking bolt(pin)
2	Right catch hook	5	Left locking bolt(pin)
3	Electric motor		

Overview of E93 Retractable Hardtop Sensors

Legend on the following pages 33 - 36

Microswitches and Hall Sensors

The various positions of the retractable hardtop and the rear module are detected via 9 Hall sensors and 5 microswitches and sent to the CTM. All Hall sensors and microswitches are supplied with voltage by the CTM and are capable of diagnostics.

"Cowl panel reached" Microswitch (1)

- This microswitch is built into the left cowl panel on the vehicle.The CTM evaluates the signal of the microswitch. When the guide pin of the front roof panel has reached the cowl panel, the microswitch is closed. Beginning at this position, the electric motor is activated and the roof sections are locked.

"Catch hooks locked" Microswitch (2)

- This microswitch is installed on the left below the electric motor for hardtop locking mechanism.The contacts of the microswitch are opened if the catch hooks are locked all the way.The CTM reads in the status of the microswitch.The catch hooks can be locked both at the cowl panel and at the base plate in the luggage compartment. When the hardtop is closed all the way, the contacts of the microswitch are open. The CTM receives a "High" signal. When the hardtop is opened, the catch hooks are unlocked and the contacts of the microswitch are closed. After the roof package is stowed in the luggage compartment, the catch hooks at the base plate are locked and the contacts of the microswitch are opened.

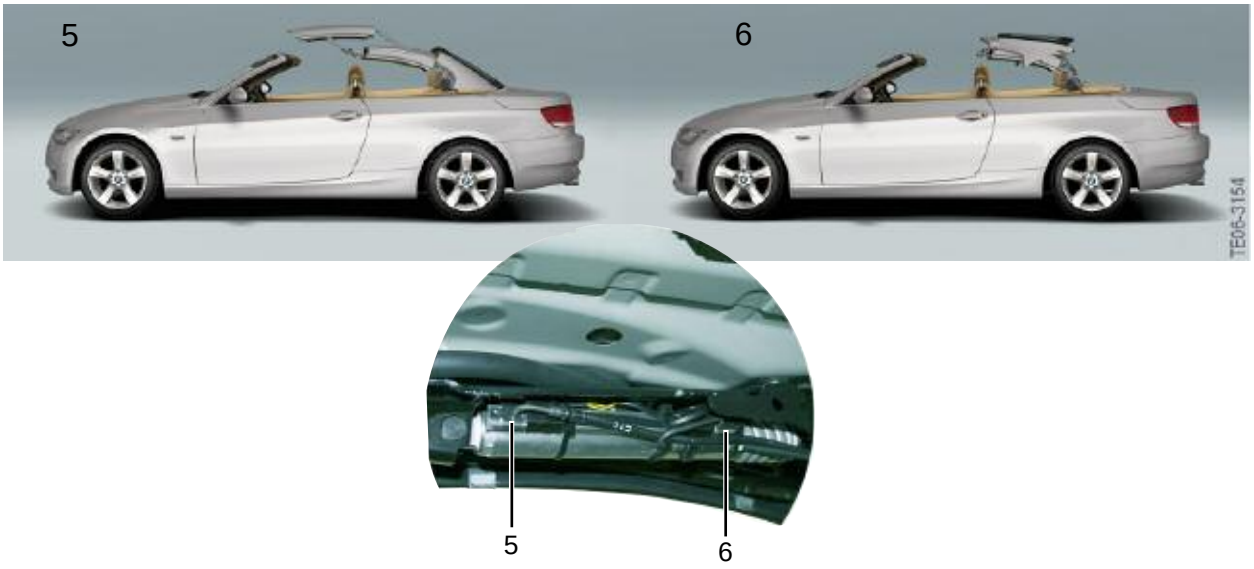
"Catch hooks unlocked" Microswitch (3)

- This microswitch is installed on the right below the electric motor for hardtop locking. The contacts of this microswitch are opened if the catch hooks at the cowl panel are locked all the way. The status of the microswitch is read in by the CTM. When a High signal is received by the CTM, the opening of the of the catch hooks of the hardtop is complete. Furthermore, the locking of the front roof panel to the center roof section and the interlocking of all three roof sections are separated. If the roof panels are subsequently lifted above each other and are stowed in the luggage compartment, the contacts of the microswitch remain open. Only when the catch hooks begin to lock are the contacts of the microswitch closed again.

"Roof panels partially open/partially closed" Hall Sensor (5-6)

Two Hall sensors are installed on the right roof panel cylinder and detect the movement of the piston in the roof panel cylinder. If the piston is extended, a signal is sent from the "Roof panels partially open" Hall sensor to the CTM. In this position, the roof sections are positioned completely above each other and can now be stowed in the luggage compartment. The "Roof panels partially closed" Hall sensor sends a signal to the CTM when the piston in the roof panel cylinder is almost completely retracted. From this position, the hardtop closes more slowly until it reaches the cowl panel (indirect pressure-sensitive finger guard system).

Left: Roof panels partially closed, right: Roof panels partially opened



"Right closure open" Hall Sensor (7)

This Hall sensor is located on the right closure cylinder. It transmits a signal to the CTM when the piston of the closure cylinder is fully extended. In this position, the lock of the rear module and the rear roof panel to the body is disengaged.

"Left/right closure closed" Microswitch (8 and 15)

One microswitch is on both the left and right closure cylinder. These microswitches transmit a signal to the CTM when the closure is locked.

"Rear module closed" Hall Sensor (9)

This Hall sensor is installed on the right of the divider module. It transmits a signal to the CTM when the rear module has reached the bottom position. The rear module has a bow that changes the voltage in the Hall sensor when it reaches the end position.

"Roof package stowed" Hall Sensor (10)

This Hall sensor is installed on the right base plate in the luggage compartment. It transmits a signal to the CTM when the guide pin of the front roof panel has reached the guide in the base plate. Beginning at this position, the drive for the hardtop lock can be activated and the rear module can be closed.

"Rear module opened/rear module almost closed" Hall Sensor (11-12)

Two Hall sensors are installed on the right rear module cylinder and detect the movement of the piston in the rear module cylinder. If the piston is extended, a signal is sent from the top "Rear module open" Hall sensor to the CTM. In this position, the rear module is completely open and the roof panel package can be stowed in or lifted out of the luggage compartment. The lower "Rear module almost closed" Hall sensor sends a signal to the CTM when the piston in the rear module cylinder is almost completely extended. From this position, the rear module closes more slowly until it reaches the end position.

Left: Rear module opened, right: Rear module almost closed

“Luggage compartment divider” Hall Sensor (13)

The Hall sensor for the luggage compartment divider signals that the luggage compartment divider is in the bottom position and thus that an important function condition is met. If this signal is missing, the hardtop cannot be actuated.

The Hall sensor is installed on the left rear module mount on the vehicle.

Index	Explanation
1	Luggage compartment divider
2	Installation location of the Hall sensor for the luggage compartment divider

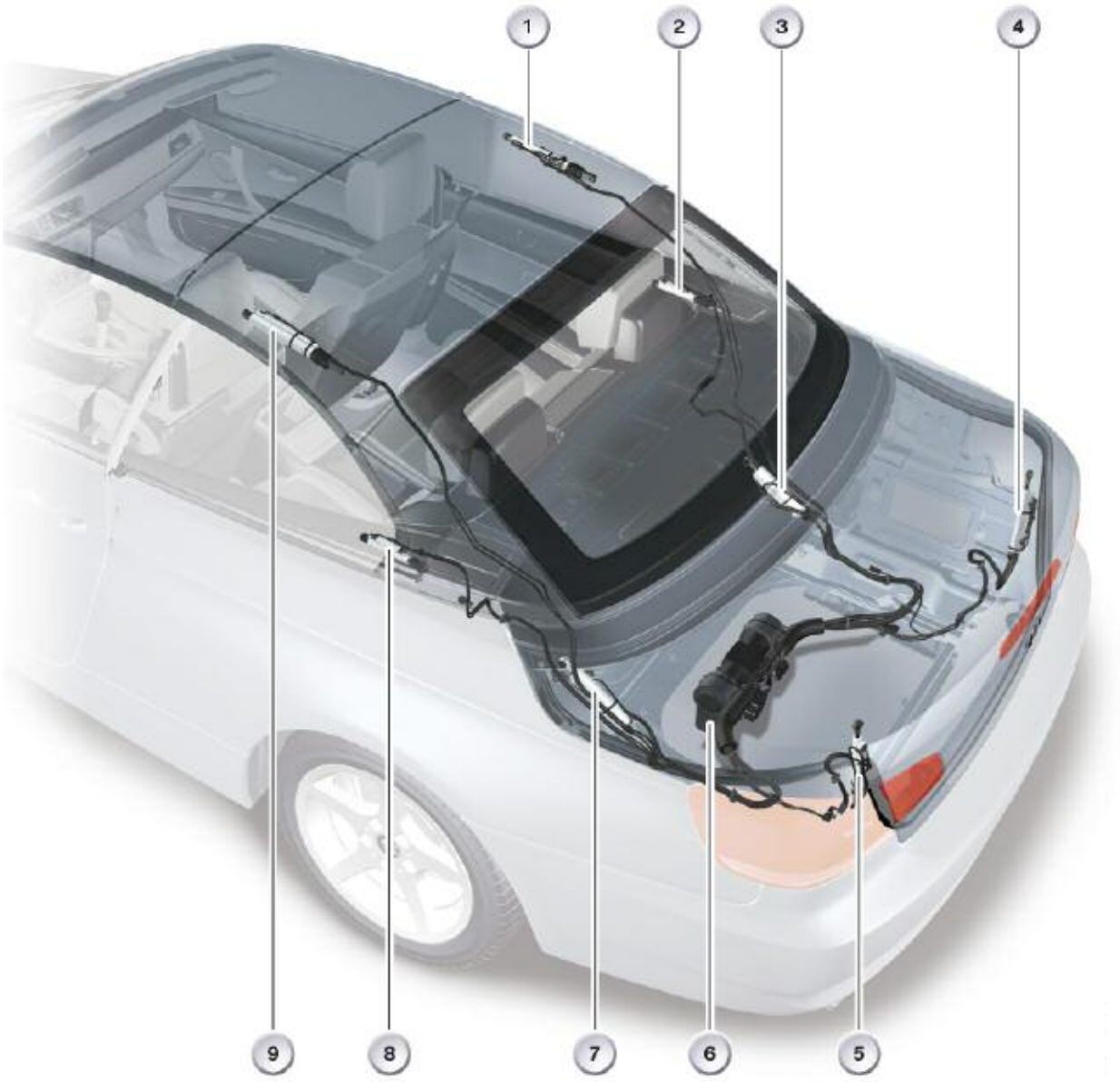
"Roof package extended" Hall sensor (14)

A Hall sensor is installed on the right rear pillar cylinder that sends a signal to the CTM when the piston in the rear pillar cylinder is extended. When the rear pillar cylinders are retracted, the roof panels are lifted.

Roof package extended

Hydraulic Components

Overview of the Hydraulic Components



Index	Explanation	Index	Explanation
1	Right roof panel cylinder	6	Hydraulic assembly
2	Right closure cylinder	7	Left main pillar cylinder
3	Right main pillar cylinder	8	Left closure cylinder
4	Right rear module cylinder	9	Left roof panel cylinder
5	Left rear module cylinder		

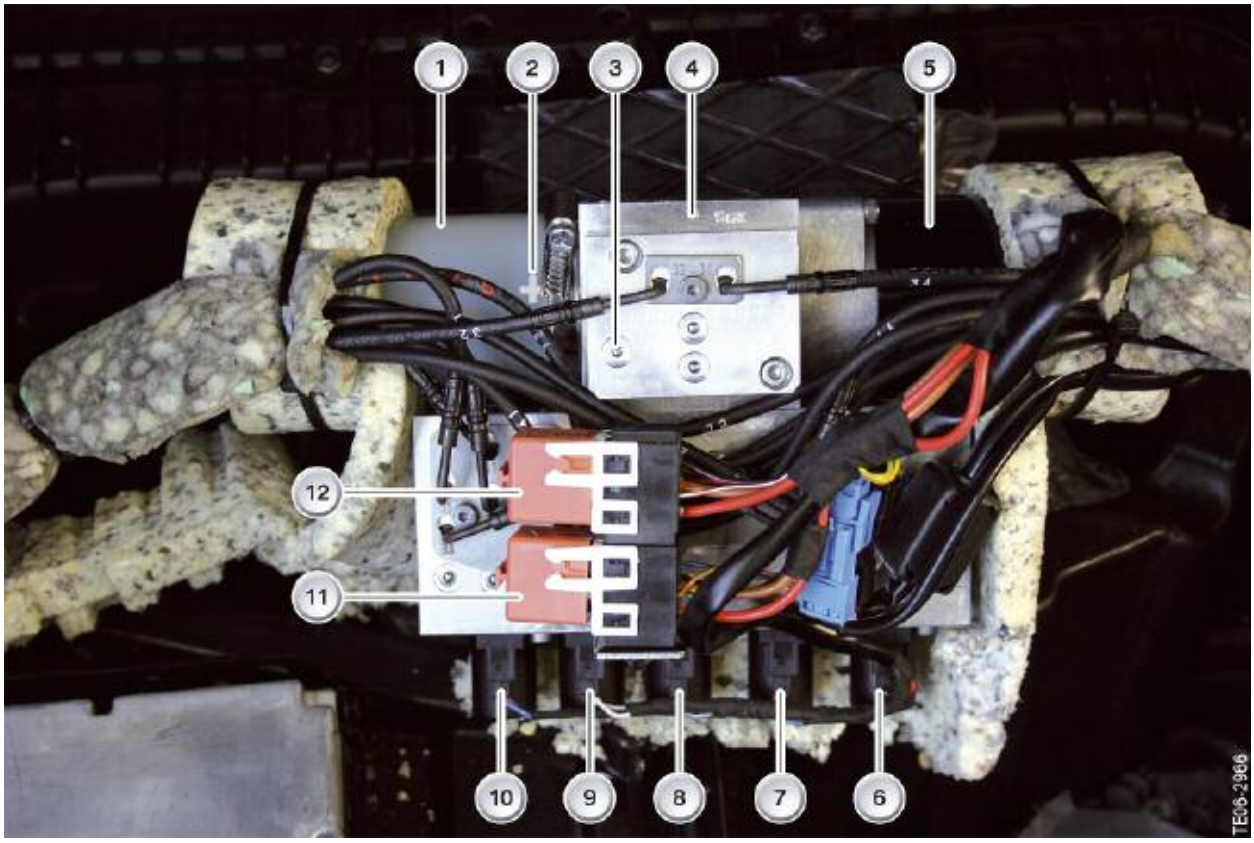
Hydraulic Overview

The retractable hardtop and the rear module are driven hydraulically. The hydraulic system consists of 8 hydraulic cylinders that are supplied with pressure by the hydraulic system via the hydraulic lines. The cylinders are always activated in pairs. The hydraulic assembly is installed in a recess in the luggage compartment floor. Four cylinders are required for the movement of the hardtop:

- Two roof panel cylinders and two rear pillar cylinders.
- The rear module is opened and closed by two rear module cylinders.
- Two closures are responsible for locking/unlocking the rear roof panel and the rear module.

Hydraulic Unit

Hydraulic Assembly in the Luggage Compartment Cavity



(See table on next page.)

Hydraulic Assembly Legend

Index	Explanation	Index	Explanation
1	Reservoir for hydraulic fluid	7	Valve 3
2	Fill level mark	8	Valve 5
3	Bleed screw for emergency actuation	9	Valve 4
4	Hydraulic pump	10	Valve 2
5	Pump motor	11	Relay for anticlockwise operation
6	Valve 1	12	Relay for clockwise operation

The movement direction of the hardtop and rear module are determined by corresponding valve positions and by reversing the direction of rotation of the pump. The hydraulic pump in the hydraulic unit is driven by an electric motor that operates in two directions of rotation. Both rotation directions are implemented with a relay switch.

The pump motor and the five hydraulic valves are activated by the CTM. The power consumption of the electric motor is about 40A (safeguarded by a 50A fuse). The hydraulic pump generates an operating pressure of 150 to 200bar.

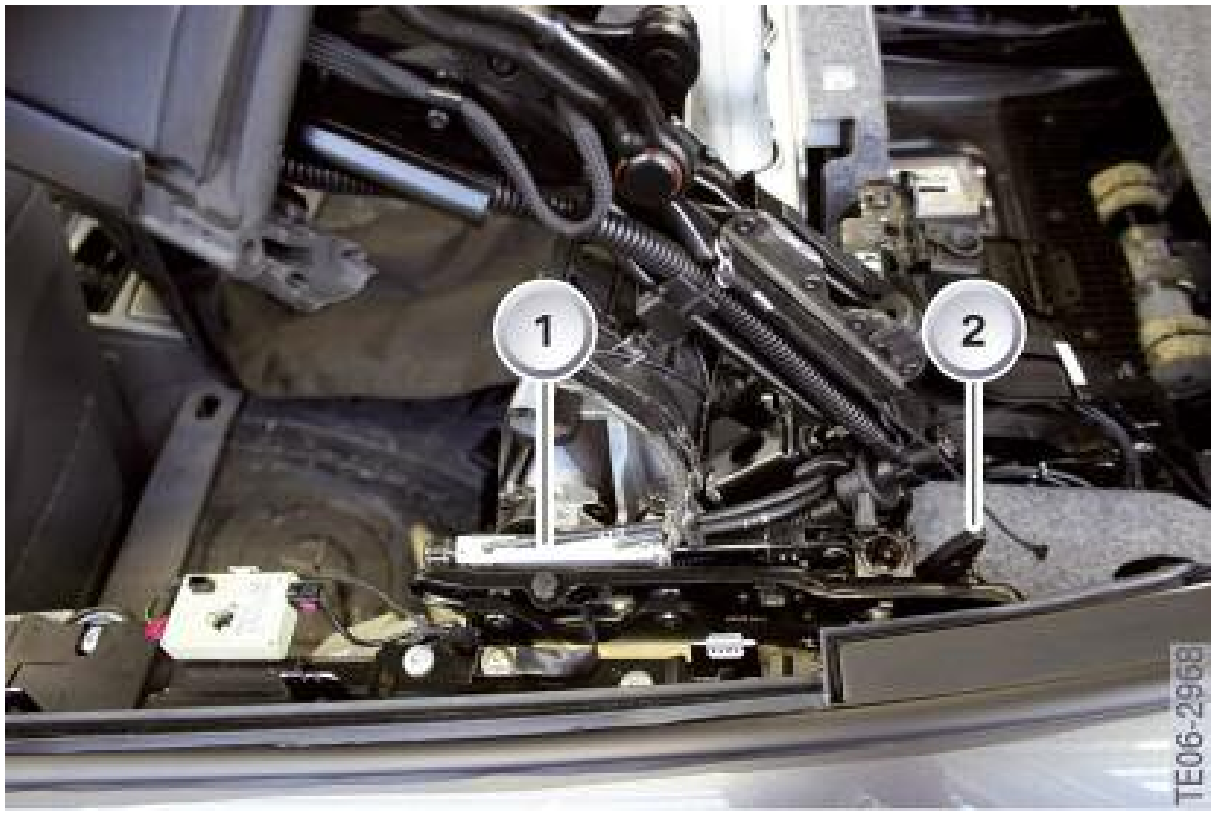
To prevent the pump motor from overheating if the hardtop is operated frequently, the temperature of the pump motor is measured using an NTC resistor. The NTC resistor is connected to the CTM via two wires with a floating ground. An open circuit causes an entry in the fault code memory, but does not prevent the hardtop from moving. Two temperature values are particularly important. The lower of these is around 90°C (194°F) and serves as an "early warning". If this temperature is exceeded, any hardtop movement that has already begun is continued until it has safely come to an end. If the temperature reaches 105°C (221°F), the hardtop movement is stopped immediately. It cannot be resumed until the temperature falls back below 90°C.

- If the hardtop movement is interrupted, the hardtop remains in the hold position. The pressure in the hydraulic system is maintained at all times and is not shut off.
- In case of an emergency actuation of the hardtop, the bleed screw on the hydraulic pump must be released.
- The hydraulic fluid does not need to be changed (lifetime).
- If the hydraulic fluid needs to be refilled due to leaks ensure that the approved hydraulic fluid is used. Add hydraulic fluid only up to the mark on the reservoir.
- If a lot of noise is heard while the hardtop is actuated, the hardtop must be opened and closed a few times in succession to allow the system to bleed.
- The hydraulic system is automatically bled in the reservoir.

Closure Cylinders

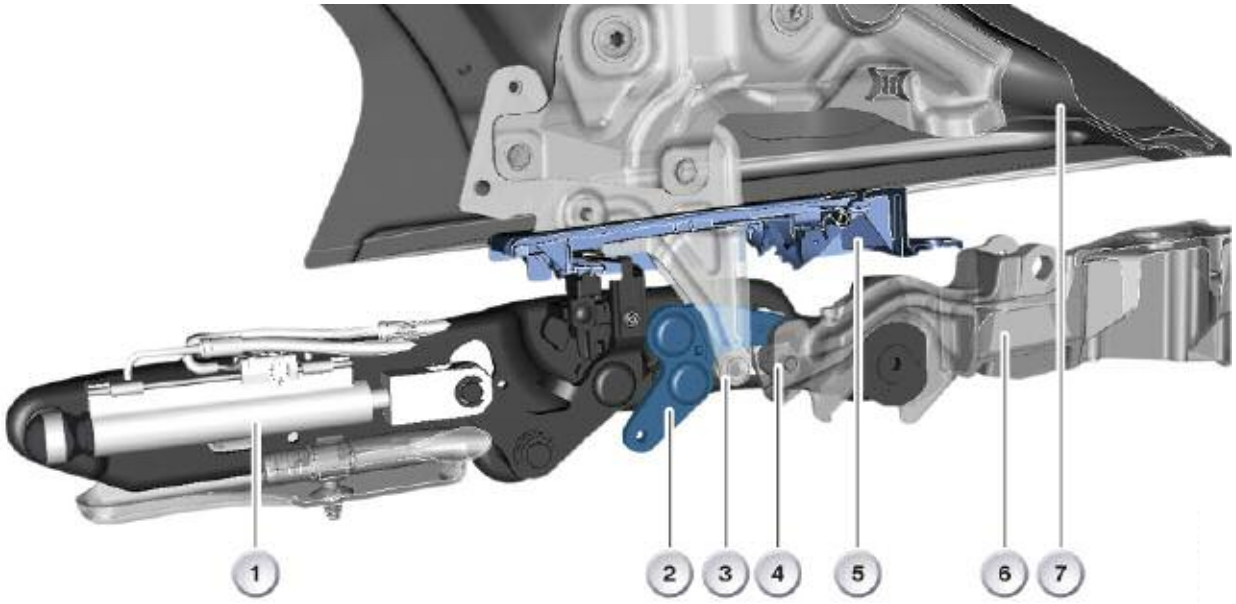
The closure cylinders lock the rear roof panel and rear module to the body. Before the hardtop can be opened, the rear roof panel must be unlocked. It is unlocked by extending the piston. A Hall sensor is installed on the right cylinder that detects the position of the extended piston. Since the cylinders are de-pressurized if the hydraulic pump is not activated, they are engaged while locked or activated via dead center.

The locking is signaled to the CTM by two microswitches (one on each of the two closure cylinders). When the hardtop is closed, after the roof package is extended and the rear module is closed, the closure cylinders are retracted in order to push the rear module all the way into the lower position. Then, the closures open and are not closed until the roof panels are interlocked and locked to the cowl panel. The rear roof panel and the rear module are locked to the body by closing the closures.



Index	Explanation
1	Closure cylinder
2	Lock hook

Closure



Index	Explanation	Index	Explanation
1	Closure cylinder	5	Outlet flaps for main pillars
2	Lock hook	6	Rear module mechanism
3	Rear roof panel locking roller	7	Rear roof panel
4	Rear module locking roller		

Roof Panel Cylinders

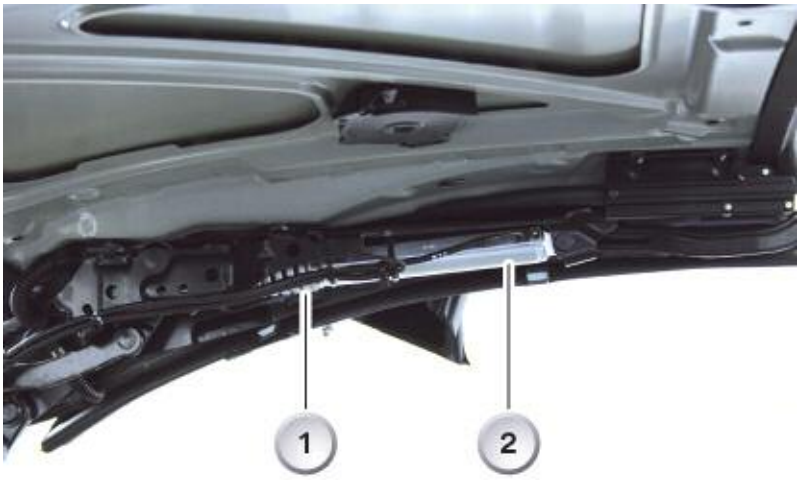
The movement of the roof sections is carried out using two roof panel cylinders. The actuation direction of the roof panel cylinders depends on the rotation direction of the hydraulic pump.

- When the pistons have retracted into the roof, the hardtop is closed.
- When the roof panel cylinders are pressurized on the piston side, the pistons are extended and move the roof panels above each other via the roof panel control arms.
- Two Hall sensors are installed on the right roof panel cylinder and detect the position of the piston.

- When the roof panel cylinders are pressurized on the rod side, the pistons are retracted and the roof panels separate.
- When the Hall sensor detects the position of the retracting piston, the pressure in the cylinder is reduced.

In addition, the spring on the roof panel cylinder acts counter to the movement direction. The reason for this is that the front roof panel moves into the front cowl very slowly, resulting in a harmonious hardtop movement. The slow movement also minimizes the risk of becoming trapped.

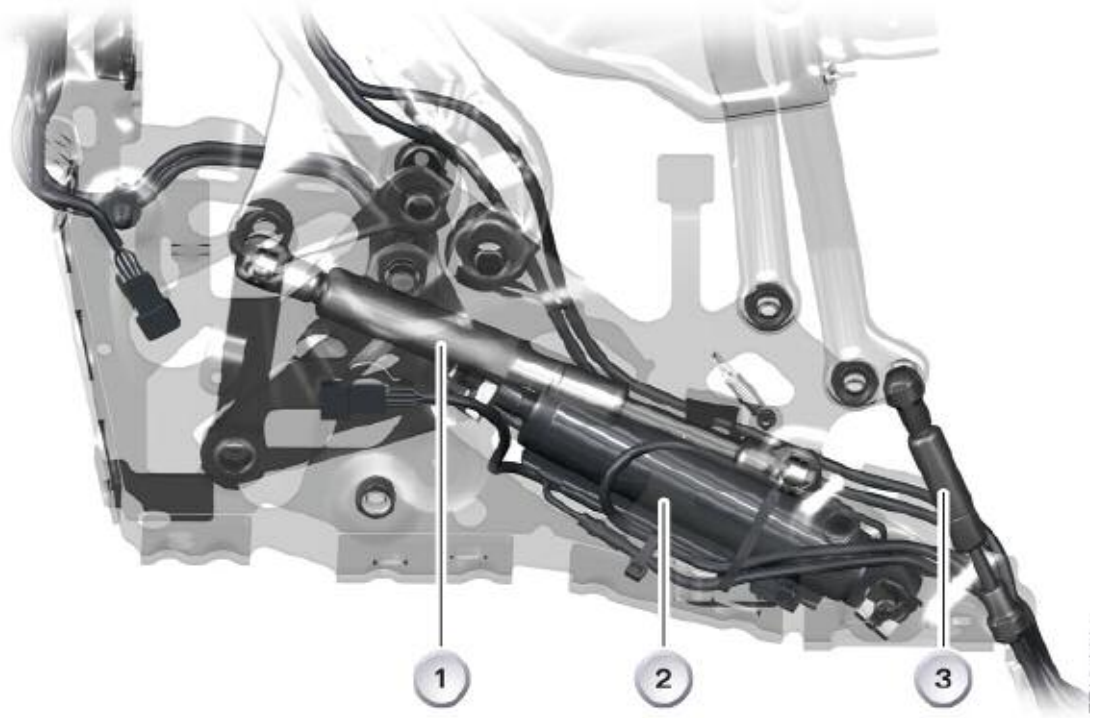
Left roof panel cylinder



Index	Explanation
1	Spring for mechanically damping the roof panel movement
2	Roof panel cylinder

Main Pillar Cylinders

The main pillar cylinders serve to stow the roof package in the luggage compartment and to lift it out of the luggage compartment. When the rear pillar cylinders are retracted, the roof package is lifted. The roof package is stowed by extending the main pillar cylinders. A Hall sensor is installed on the right main pillar cylinder that signals the "Roof panels extended" position to the CTM. The uniform movement of the roof package is supported by 2 gas pressure dampers in the main mount.



Index	Explanation	Index	Explanation
1	Gas pressure damper for main pillar	3	Gas pressure damper for luggage compartment divider
2	Main pillar cylinders		

Rear Module Cylinders

The rear module is opened and closed by the rear module cylinders. When the rear pillar cylinders are retracted, the rear module is closed. The rear module is opened by extending the pistons in the rear module cylinders. Two Hall sensors are installed on the right rear module cylinder. The upper Hall sensor detects the position of the opened rear module. The lower Hall sensor signals to the CTM that the rear module is almost closed. Beginning at this position, the pressure in the rear module cylinders is reduced and the rear module is slowly closed until it reaches the end position.

Rear module cylinders

Index	Explanation
1	Rear module cylinder
2	Rear module

Service Information

In certain situations, the hardtop cannot be opened or closed . To indicate these situations, corresponding messages are displayed in the instrument cluster as check control messages and as plain text in the Central Information Display. The check control messages are for support purposes and provide explanatory information for the red LED that lights up in the operating button in case of fault. As long as the CC messages are active, they are displayed every 5 seconds.

The following illustration provides an overview of possible messages

ID	Symbol	Cause/trigger	CC brief message	Additional text
401		Electrical/electronic defects (triggered when button is pressed)	Functional failure of roof system!	Roof system No roof movement possible. If the roof system is not locked, contact the nearest BMW Service.
416		Is triggered when the button is pressed.	Luggage compartment divider	Luggage compartment divider No roof movement possible. Move the luggage compartment divider into the required position; see the owner's handbook.
432			Roof hydraulic system too hot	Roof hydraulic system Roof hydraulic system too hot. Temporarily, only the closing function is available.
445		Roof movement is not allowed when vehicle is on an incline	Vehicle is on too much of an incline	Roof system Vehicle is on too much of an incline, no roof movement possible.
447		Safe end position was not detected (e. g. casing jammed, button released too soon, set in motion with roof not in end position)	Roof system not locked!	Roof system Locking not completed. Please check: Vehicle stationary? Roof movement locked? Then, press the button again.
19		Luggage compartment open	Luggage compartment open!	

Note: Due to the high current consumption of the retractable hardtop of up to 40A, the hardtop may be operated only when the battery charger is connected or the engine is running.

Adjusting the Retractable Hardtop

- When removing or installing the retractable hardtop, you must follow the repair instructions.
- Special tools and procedures to service the retractable hardtop are discussed in the Repair Instructions.
- Adjustment gauges are provided for the adjustment tasks during installation.

Service Shop Emergency Procedure

Emergency procedure for closing the hardtop in the case of a malfunction is only possible in the service shop by service employees (see Repair Instructions)

Note: An emergency procedure for operating the retractable hardtop by the customer is not provided nor possible.

Installing/removing the Retractable Hardtop

For installing/removing the retractable hardtop “Roof Package”, a workpiece carrier is used as a special tool.

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PAGE

Lane Departure Warning

Model: E60, E61
Production: From 3/2007 Production

Model: E63, E64
Production: From 9/2007 Production

OBJECTIVES

After completion of this module you will be able to:

- Explain the operation of the Lane Departure Warning System
- Identify the Components used in the Lane Departure Warning System
- Understand the operation of the camera

Introduction

The lane departure warning is available to order from 03/07 as option 5AD for the E60 and E61. The feature will be introduced in 09/07 on the E63 and E64.

Fatigue or inattentiveness on the road can cause a driver to unintentionally leave a lane. This could result in the vehicle driving into a lane with oncoming traffic or ditches at the side of the road.

BMW's lane departure warning is a driver assistance system designed to inform the driver in good time of unintentional course deviations by means of vibrations in the steering wheel intended to prompt the driver to make corrective steering movements.

The lane departure warning is a driver assistance system. The area in front of the vehicle is captured by a camera. This makes it possible for the roadway markings to the right and left of the current lane to be detected.

If the vehicle approaches a roadway marking in the absence of a turn indication, the driver is informed of the course deviation by steering wheel vibrations before the vehicle crosses the line.

The camera is fitted near the rear-view mirror behind the windscreen and its camera images to the control unit on a data line.

The control unit contains the software that determines the position of the vehicle in the lane from the camera images.

The lane departure warning is designed for operation on highways, major roads and well maintained country roads. A warning is issued if the system (current driving conditions within a specific time frame being equal) detects that the vehicle is crossing the roadside border line. The warning can be felt as a vibrating of the steering wheel.

The lane departure warning is switched on and off using a button on the steering wheel. 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 (last function mode).

The display indicating whether the lane departure warning is switched on or off is output by the instrument cluster or, optionally, by the head-up display. When the lane departure warning is switched on, there is an additional display indicating whether the system is primed or not.

Note: The system is only primed if it is switched on and has detected one or two roadside border lines with the vehicle travelling at a speed faster than 70 km/h.

Display and Control Concept

The lane departure warning is switched on and off using the button shown below on the multi-function steering wheel. The lane departure warning is switched on and off with each press of the button.

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 (last function mode).

Lane departure warning button E60/E61

Index	Explanation	Index	Explanation
1	Lane departure warning button	2	Vibration motor

The system function display in the instrument cluster can take the form of the states listed in the following table.

Displays in the instrument cluster	
Lane departure warning ON	**Left-hand, right-hand lane or both lanes detected and v > 70 km/h**
	
Display in the instrument cluster with ACC deactivated	
	 Note: If the vehicle has Active Cruise Control ACC, the lane departure warning display is combined with the ACC symbol.
Display in the instrument cluster with ACC activated	
	 Note: When the ACC display is shown depends on the driving situation.

The display of the states listed above is the same for the head-up display.

Displays in the head-up display	
Lane departure warning ON	
	Shown here without the ACC symbol.
Left-hand, right-hand lane detected or both lanes detected and v > 70 km/h	
	Shown here with the ACC symbol.

Note: There is an option to switch the lane departure warning display in the head-up display on or off on the Central Information Display using the controller.

The lane departure warning can be switched on as of terminal 15 ON. The system is available from a speed of 70 km/h. The lane departure warning will also be primed if lanes are detected. If the lane departure warning is switched on at speeds of under 70 km/h, a message will appear in the instrument cluster for 3 seconds indicating availability above a speed of 70 km/h.

Message indicating the availability of the lane departure warning.

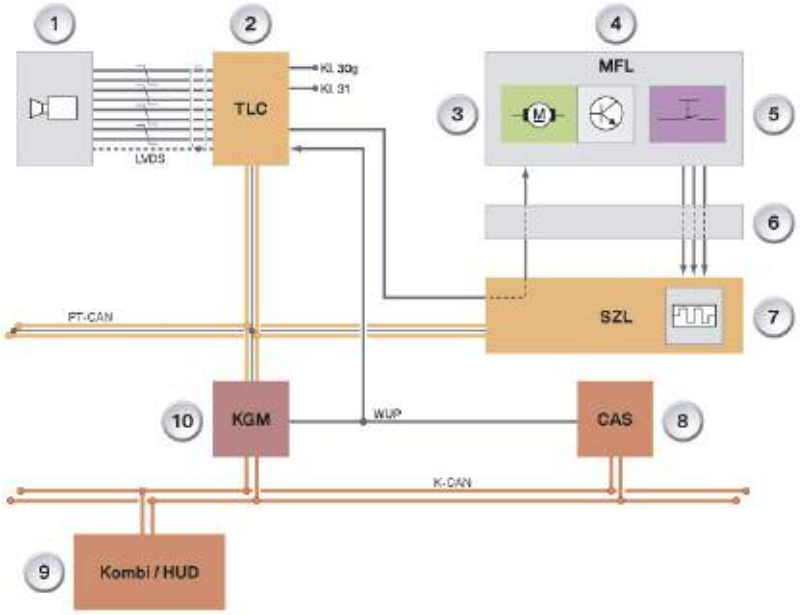
Head-up Display (HUD)

It is possible to activate or deactivate the lane departure warning display in the Head-up Display using the controller.

The activation option is located in the Head-up Display menu > Head-up Display display options. Select "ACC/lane departure warning" and confirm with the controller.

HUD menu > Head-up Display display options E60

Systems Overview



Index	Explanation	Index	Explanation
1	Lane departure warning camera	8	Car Access System
2	Lane departure warning control unit	9	Instrument cluster/head-up display
3	Vibration motor	10	Body gateway module
4	Multi-function steering wheel	K-CAN	Body CAN
5	Lane departure warning button	PT-CAN	Powertrain CAN
6	Volute spring cassette	W-UP	Wake-up
7	Steering column switch cluster		

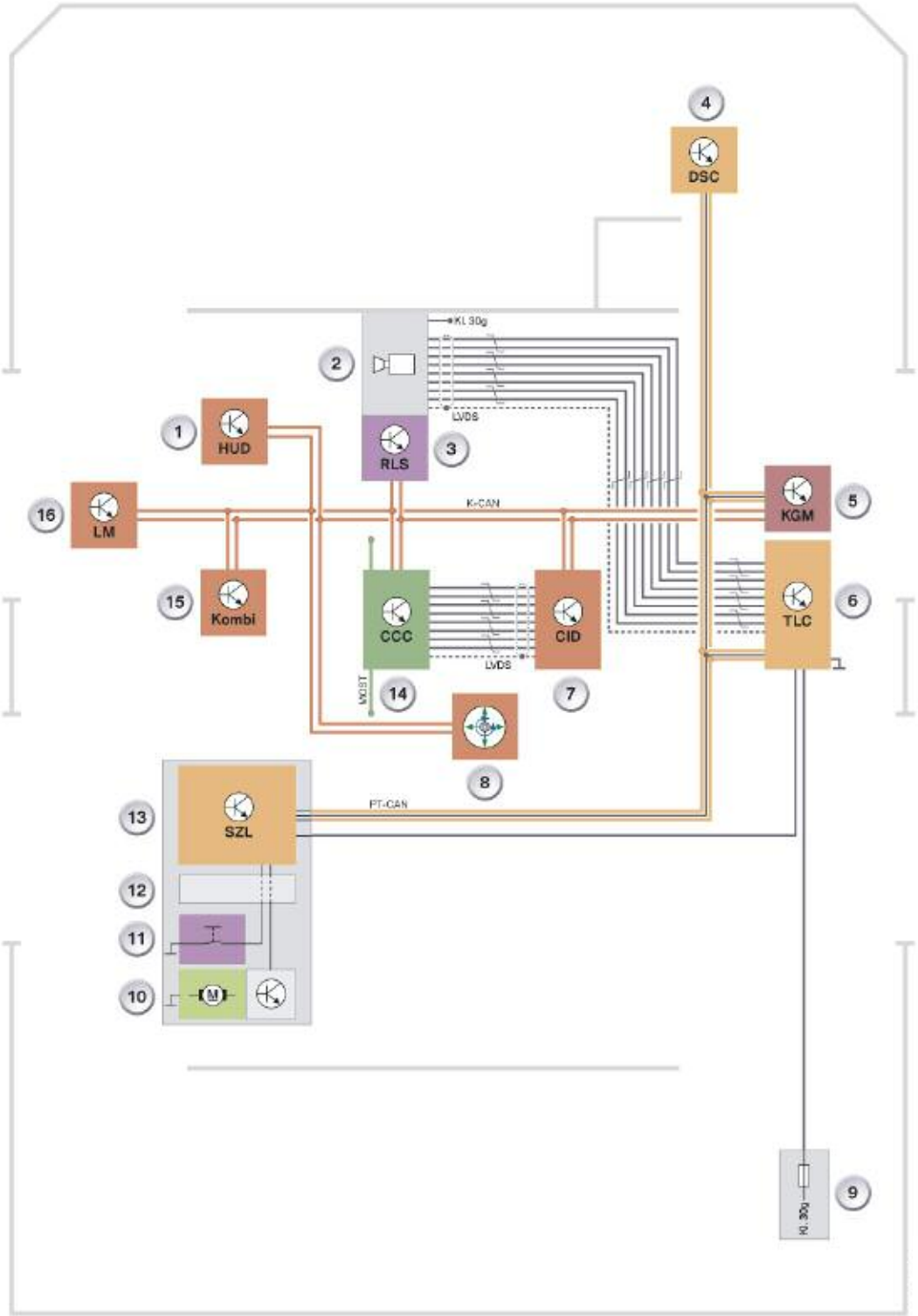
Lane departure warning system overview The lane departure warning system receives a number of input signals. The image data of camera (1) is evaluated in lane departure warning control unit (2) together with the other vehicle data that the control unit receives on the PT-CAN. The lane departure warning is realized from the combination of this data.

Instrument cluster (9) and head-up display (9) output the displays of the lane departure warning.

Electric motor (3) in multi-function steering wheel (4) produces the vibration of the steering wheel by means of an imbalance mass.

Body gateway module (10) transfers the PT-CAN messages from the lane departure warning control unit to the K-CAN and vice versa.

System Schematic Circuit Diagram



Index	Explanation	Index	Explanation
1	Head-up display HUD	12	Volute spring cassette
2	Lane departure warning camera	13	Steering column switch cluster SZL
3	Rain/light sensor RLS	14	Car Communication Computer CCC
4	Dynamic Stability Control (DSC)	15	Instrument cluster Kombi
5	Body gateway module	16	Light module LM
6	Lane departure warning control unit	K-CAN	Body CAN
7	Central Information Display CID	PT-CAN	Powertrain CAN
8	Controller	MOST	Media Oriented System Transport
9	Fuse in the rear distribution box	LVDS	Low Voltage Differential Signalling
10	Vibration motor	KL 30g	Terminal 30 switched
11	Lane departure warning button		

Camera (2) sends image data to lane departure warning control unit (6) on the LVDS data line.

The control unit receives vehicle data on the PT-CAN. The vehicle data includes the status of the turn signal steering column switch or the button for the lane departure warning, for example.

Instrument cluster (15) is able to display whether or not the lane departure warning system is switched on. The primed status or availability of the lane departure warning system is also displayed in the instrument cluster. Using controller (8), it is possible to select an option to have the information displayed in head-up display (1). The relevant menu appears in Central Information Display (7).

Functions

One Function, One Control Unit

The lane departure warning system receives a number of input signals.

Details of the input and output signals evaluated by the lane departure warning system are listed below.

Input and output signals

Input signal	Sensor control unit	Explanation
Steering wheel angle	Dynamic Stability Control steering column switch cluster steering angle sensor	Lane detection assistance
Brake pressure	Dynamic stability control	Brake pressure threshold as warning cancellation criterion
Road speed	Dynamic stability control	Lane detection assistance
Road speed	Instrument cluster	Control of the primed status display
Terminal status	Car Access System	Control of the operating states of the lane departure warning control unit
Vehicle identification number	Car Access System	Detection as to whether the control unit fitted and the camera match the vehicle
Engine status	Digital Motor Electronics/ Digital Diesel Electronics	Activation of the processor for image processing after the engine start
Lane departure warning button	Steering column switch cluster	System switch on/off
Direction indicator	Steering column switch cluster	Suppression of warnings in case of intentional lane departure
Wiper status	Steering column switch cluster	Support of lane detection by detection of when the windscreen wiper sweeps through the camera image
Battery voltage	Instrument cluster	Fault code memory
Kilometre reading	Instrument cluster	Fault code memory

Output signal	Sensor control unit	Explanation
Lane departure warning	Instrument cluster Head-up display	Display of status and primed status in the instrument cluster and head-up display
Check control message	Lane departure warning control unit	Request of the Check Control message

Lane Detection

The camera is fitted to the windscreen near the rear-view mirror. The camera captures the roadway up to approximately 40m to the front of the vehicle and up to approximately 5 m to the right and left.

Using image processing technology, the lane departure warning control unit looks for possible lane markings in the images captured by the camera.

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

From the detected lane markings, the lane departure warning is then calculated for the vehicle.

Roadway Markings

The roadway markings in the image may differ greatly depending on the type of road, environmental conditions or country. The system is able to detect various types of roadway marking in a number of situations.

Type of Roadway Marking	Explanation
	Broken Lines
	Unbroken Lines
	Double Lines
	Bott’s Dots
	“Car Pool” Lanes

Road Situations

The lane departure warning is able to handle various road situations.

Type of Roadway Marking	Explanation
	Roads with only a Center Line (edge of road on left-hand side not detected)
	Roads without Center Line
	Highway Exit
	Highway Access
	Turn-off

Type of Roadway Marking	Explanation
	Hatched Zones
	Short Breaks in the Marking

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Environmental Conditions

The lane departure warning functions under different environmental conditions.

Type of Roadway Marking	Explanation
	Rain/wet Asphalt
	Night
	Low-Level Sun
	Snow
	Fog

Type of Roadway Marking	Explanation
	Light Colored Asphalt
	Dark Asphalt
	Tar Seams on the Road
	Oncoming Vehicles

Physical Limitations

Systems functionality may be restricted under various road and environmental conditions due to physical limitations.

Type of Roadway Marking	Explanation
	Construction Sites
	On roads with worn, poorly visible or inadequately painted lane markings.
	On roads with colored or black lane markings
	On roads on which the lane markings are covered by water, dirt, snow or ice.
	On roads with sharp bends.

Type of Roadway Marking	Explanation
	On roads with no distinct lane markings
	On roadways that are too narrow
	If the vehicle comes too close to a vehicle in front that the camera is unable to see the lane markings within the detection range.
	If the view of the camera is blocked by dirt, snow, ice or other obstructions on the windscreen.
	In very poor weather conditions (rain, fog, snow, etc.)
	If intense light shines into the camera from the front or fades out the lane markings.

Availability of the Lane Departure Warning

The system is available when:

- No system fault is present.
- The lane departure warning system is calibrated correctly.
- The vehicle speed is above the activation threshold (see following table).
- At least one roadway marking has been detected by the system with sufficient certainty.
- The vehicle is not in a construction site area with several possible roadway markings.
- The vehicle is on a road with an average lane width of more than 2.5 m.

The speed threshold above which the lane departure warning can be available has been adapted to country-specific conditions. In the US the activation threshold is 45 mph and deactivation threshold is 42 mph.

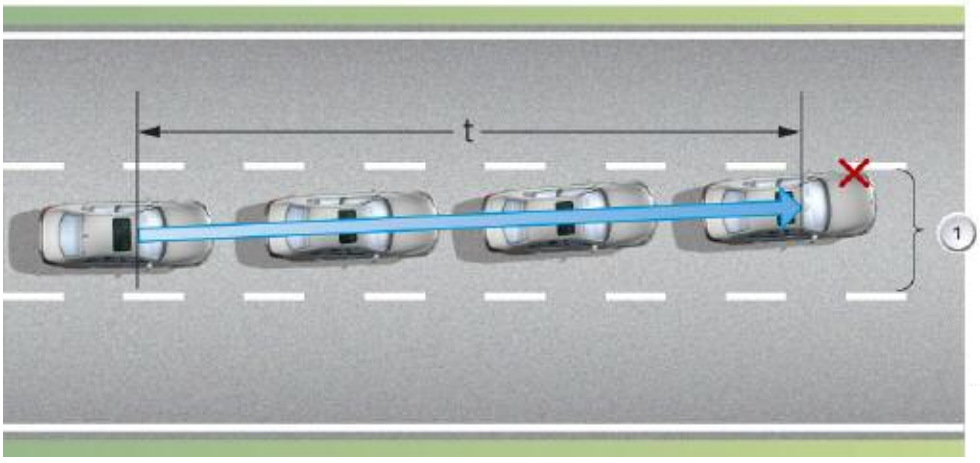
Warning Output

The lane departure warning function only outputs a warning to the driver if the system is switched on and available.

Warning Point

The system outputs the warning to the driver if the driver approaches a detected roadway marking. To do so, the system calculates the anticipated time (t) before the roadway marking is crossed. The warning is output in time before the vehicle crosses the marking.

Since warning situations may arise more frequently on narrow roads, the warning is output later by tendency on these kinds of road.



Warning output of the lane departure warning E60

Index	Explanation	Index	Explanation
1	Current Lane	t	Calculated time before point X

Warning Duration

The warning ends when:

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

Note: A warning is output only once on approach to a roadway marking. The warning lasts no more than 2.5 s. If the vehicle remains on the line, no new warning will be issued. 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.

Suppression of the Warning

A warning is suppressed despite the display of primed status if the following conditions exist on one side:

- Turn signal operated before the vehicle is driven towards the warning trigger.
- One-touch turn signal indicated on the side from which a warning would be triggered.

There is no warning suppression if the hazard warning flashers are switched on.

System Components

The most important components for the lane departure warning are:

- Lane departure warning control unit
- Lane departure warning camera
- Vibration motor in the multi-function steering wheel
- Windscreen
- Button
- Low Voltage Differential Signalling line
- Other control units
  - Steering column switch cluster SZL
  - Car Access System
  - Instrument cluster/head-up display
  - Body gateway module
- Other components
  - Mirror caps
  - Cable finisher
  - Headlining
  - Mirror base with high beam assistant

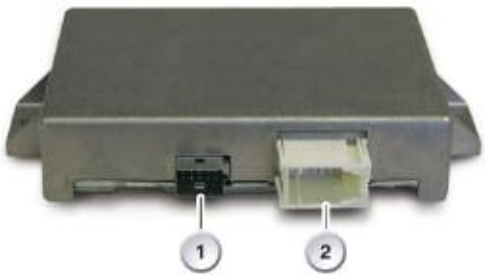
Component Overview (example of E61)

Index	Explanation
1	Lane departure warning button
2	Lane departure warning camera
3	Panorama glass sunroof control unit
4	Lane departure warning control unit
5	Control unit holder
6	CD changer
7	Body basic module
8	Body gateway module
9	Comfort Access

Lane Departure Warning Control Unit

The control unit is accommodated in a 2/3 shell-type housing. For EMC reasons, the housing is made entirely of aluminum. It has two connectors:

- 12-pin connection to the vehicle electrical system
- 10-pin connection to the LVDS line.



Index	Explanation
1	LVDS Connection
2	Vehicle Electrical System Connection

The control unit has two processors. One processor is for communicating with the vehicle electrical system on the PT-CAN. The second processor is used to calculate the lane departure warning.

The communication processor is activated as soon as terminal 30g is ON. Messages can now be sent and processed on the PT-CAN. The control unit itself is still in sleep mode.

From terminal 15 ON, the control unit reports to the vehicle electrical system on a cyclical basis. The control unit only becomes operational once the Engine running signal is present. This is because it is only at this point that the high-performance computer, whose responsibilities include image processing, is activated.

The high-performance computer evaluates the image data of the camera together with the other vehicle data that the control unit receives on the PT-CAN. The lane departure warning is realized from the combination of this data.

During operation of the wipe/wash system, the sweep of the wiper blades also takes them through the field of view of the lane departure warning's camera. For this reason, the control unit for the lane departure warning receives information about whether the wipe/wash system is switched on or off.

Installation Location

The control unit is secured by a bracket to the support tube above the glove compartment.

Overvoltage/Undervoltage Behavior

The voltage range in which the control unit operates is 9.0 V to 16.0 V.

Wake-up

The control unit for the lane departure warning is woken by the wake-up signal of the control units on the PT-CAN.

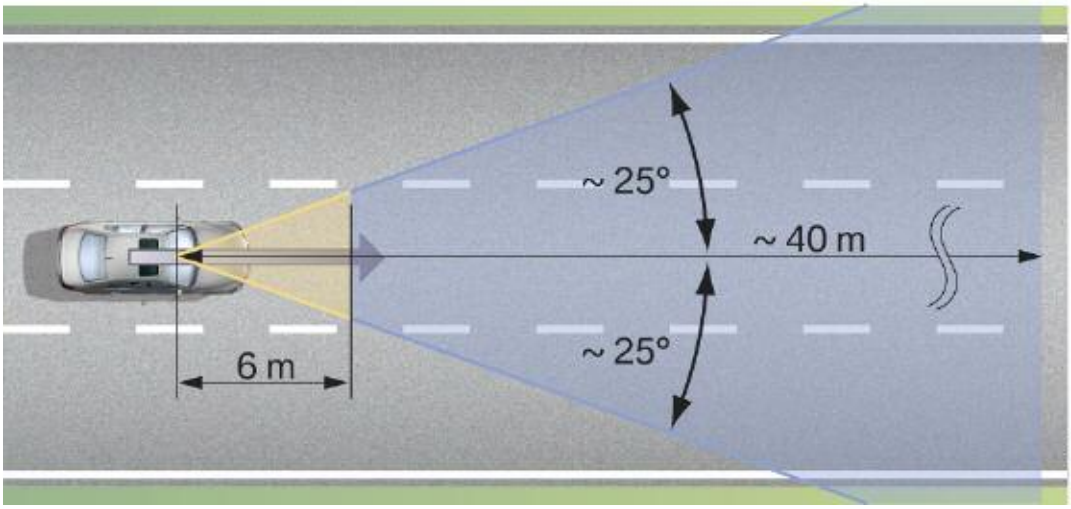
Sleep Mode

In sleep mode, the control unit is switched off.

Lane Departure Warning Camera

The camera is fitted behind the windscreen at the base of the rear-view mirror. The camera for the lane departure warning captures the surrounding area, and therefore the lane markings, to the front of the vehicle.

The camera's scope of detection ranges from approximately 4 m to 40 m ahead of the vehicle. The camera has a horizontal aperture angle of approximately 50°, and a vertical aperture angle of approximately 30°.



Detection range of the lane departure warning camera using the E60 as an example

The camera is a digital black/white CMOS camera. This means that the captured surroundings are output as a grayscale image.

Colored or Black Roadway Marking

Roadway markings Colored yellow, blue, red or black are also represented in grayscale. The grayscale image may stand out poorly, or not at all, from the grey road surface.

In unfavorable situations, this could mean that these lanes cannot be detected.

Note: If no lane is detected, the lane departure warning does not display primed status.

Lane detection with the eye

Lane detection with the camera

Camera Size

The graphic below illustrates the size of the camera by comparison with the vehicle's remote control.

Index	Explanation
1	Camera
2	Lens Shade
3	LVDS Connector

Camera Objective

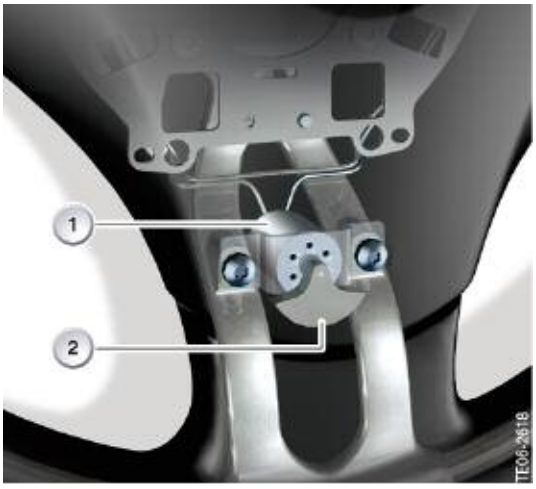
The camera objective has several glass lenses. They are coated to diminish or even fully eliminate scattered light and thereby increase the image quality of the camera.

Vibration Motor

The vibration motor and its electronics are fully integrated inside the steering wheel. The vibration motor is fitted in the six o'clock spoke of the steering wheel.

To generate the vibration, there is a small imbalance mass on the shaft of the vibration motor. The vibration motor is controlled directly by the control unit. The electronics in the steering wheel are used to convert the control voltage supplied by the control unit into the voltage value required by the motor and to provide its stabilization. The control voltage corresponds to the on-board voltage.

The motor with imbalance mass issues a warning if the vehicle threatens to leave the current lane by causing the steering wheel to vibrate.



Index	Explanation
1	Vibration Motor
2	Imbalance mass
3	LVDS Connector

Windscreen

The lane departure warning requires a windscreen matched to the system. The windscreen has a wider, black print that conceals the camera and a camera holder bonded on.

Button

The SZL records the requests input at the button and sends them to the lane departure warning control unit on the PT-CAN.

Other Control Units

Steering Column Switch Cluster

The vibration motor in the steering wheel is connected directly to the lane departure warning control unit by the SZL and the slip ring.

All steering wheels equipped with steering wheel heating LHZ require an SZL with steering wheel heating. These SZLs are compatible with the lane departure warning.

For steering wheels without LHZ, there is a special variant of the steering column switch cluster for the lane departure warning.

Car Access System

The CAS control unit controls the wake-up line and thus also the waking of the control unit for the lane departure warning.

Instrument Cluster/Head-up Display

The instrument cluster and the head-up display display the activation status when the lane departure warning is switched on.

Note: The message indicating availability of the lane departure warning is only displayed in the instrument cluster.

A corresponding Check Control message is displayed in the event of a fault anywhere in the lane departure warning system.

Body Gateway Module

The body gateway module transfers messages from the lane departure warning control unit (PT-CAN) to the K-CAN. The same applies in the opposite direction.

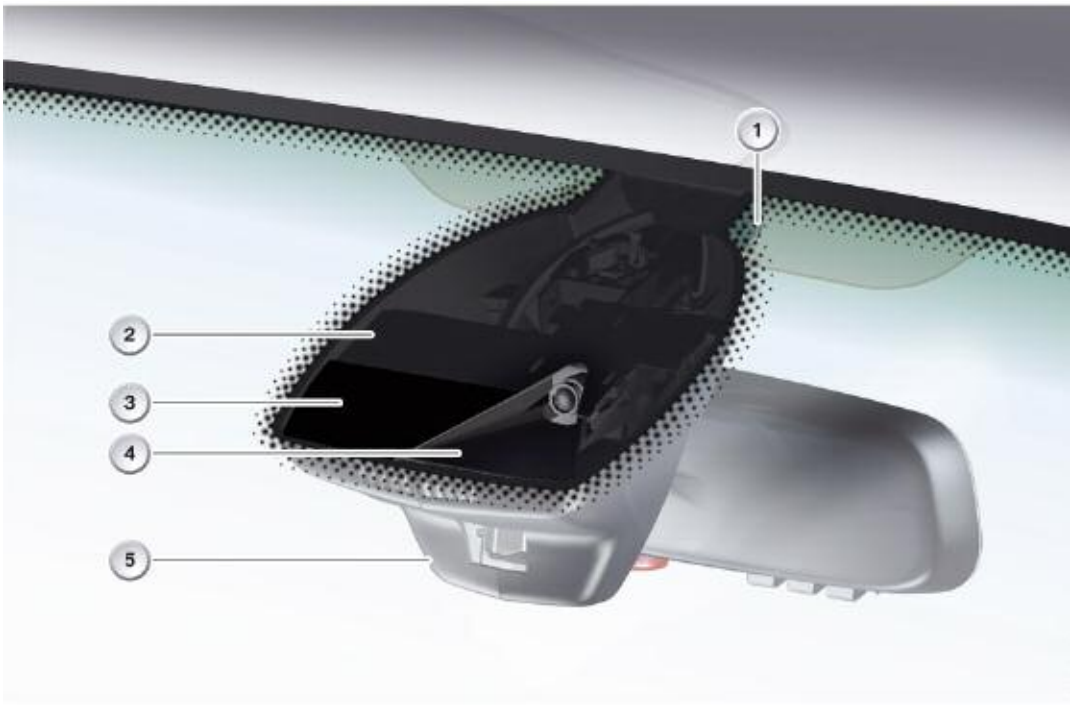
Other Components

Mirror Caps, Cable Finisher, Headlining

The lane departure warning system has wider mirror caps to conceal the camera, a cable finisher and a larger headlining cutout.

Mirror Base With High Beam Assistant

When fitted in combination with the high beam assistant (FLA), the system has a special mirror base for package reasons.



Index	Explanation
1	Headlining cutout with cable end
2	Rain/light sensor
3	Condensation sensor
4	Lane departure warning camera
5	Mirror caps/high beam assistant

Service Information

Calibration

If the system is to be able to calculate the distance to a given roadway marking, it must know the exact installation position of the camera on the one hand, and the camera's exact focal direction on the other.

Due to installation tolerances and tolerances inside the camera, the position of the camera's viewing angle may vary by several degrees.

The exact installation position of the camera and its installation angle are determined during calibration of the system and stored in the system.

In production, there is a dedicated calibration bench for this process that determines the measured variables by means of sample boards, which are arranged in a defined position relative to the vehicle.

Any replacement of the camera or windscreen requires a calibration of the system because the position of the camera and thus of the system sensor may have changed.

No calibration is required if the control unit is replaced. In this case, the calibration data stored in the camera is transferred to the control unit and stored there.

Each time the system is started, a check takes place to determine whether the system is calibrated and whether the system components are matched to each other and the vehicle. In this regard, the Vehicle Identification Number VIN stored in the control unit is compared with that of the vehicle's.

With this plausibility check, it can be determined whether the control unit is coded correctly and whether it belongs to the vehicle.

The VIN stored in the camera is then compared with the VIN stored in the control unit. If discrepancies are detected, the system detects that a camera requiring new calibration has been fitted and it outputs a corresponding fault code. For more details, please refer to the BMW diagnostic system or the repair instructions.

Note: A windscreen replacement cannot be detected by the system. In this case, the aftersales service organization is responsible for ensuring that the system is newly calibrated.

To have the system calibrated in the aftersales service organization, a diagnostics job is started. This diagnostics job investigates whether the camera is functional and has free line of sight. This is determined from the detection of movements in front of the camera. Free line of sight can be determined by having someone walk by in front of the camera, for example.

Calibration starts automatically on successful completion of this test step (good camera image). Calibration takes place during a calibration run, which can be carried out by the customer. In the event that the camera test failed, the calibration process is terminated and must be restarted after the possible interfering factors have been remedied.

A specially developed algorithm is used for calibrating the system during the calibration run. This algorithm scans the image for all straight edges and, from their orientation, determines the viewing angle of the camera.

The calibration algorithm works from a speed of 30 km/h. For evaluation purposes, it essentially uses images captured during straight-ahead travel. As soon as enough information has been recorded, the viewing angle is calculated and stored in the control unit.

This process generally takes a few minutes. In conditions of poor visibility, e.g. night, rain or winding roads, the calibration process may take up to 20 minutes.

The calibration run does not have to be completed during the first drive following the start of the diagnostics job. It is reset with each power cycle and restarted again until it has been successfully completed.

The system can be switched on and off during the calibration process. When the lane departure warning has been calibrated, the primed status display is shown when the lane departure warning is on. The conditions for this are:

- speed of over 70 km/h
- lane markings detected.

Following a replacement, e.g. of the control unit, the camera or the windscreen, it is necessary to recalibrate the lane departure warning.

The customer is notified by a Check Control message if the calibration process cannot be completed successfully after a net time of 7 minutes of straight-ahead travel at over 60 km/h.

The system then makes an automatic attempt to carry out calibration again. If this attempt under the conditions described above is unsuccessful, the system makes another attempt at calibration. A new Check Control message is only ever output after a power cycle following the first unsuccessful calibration attempt.

This process repeats itself until calibration has been successfully completed. If the calibration run does not complete successfully, the vehicle must be brought into the after-sales service organization. In the after-sales service organization, the calibration process can be terminated manually using a diagnostics job.

After the calibration process has been terminated, it must then be restarted once more.

Diagnosis

The control unit for the lane departure warning is compatible with diagnostics. The fault code memory can be read using the BMW diagnostic system.

For test purposes, there is an option for controlling the vibration motor or the camera, for example. You will find more detailed information in the BMW diagnostic system.

Check Control Message

Check control message	Description	Information in central information display
	Lane departure warning malfunction!	Lane departure warning malfunction! Please visit the nearest BMW Service.

The Check Control messages are output by the lane departure warning or the instrument cluster. If the control unit for the lane departure warning is faulty, it sends a request to have a Check Control message displayed.

If the signal from the lane departure warning drops out, the instrument cluster generates a Check Control message.

If a Check Control message is output, system availability is simply no longer displayed but the activation indication continues to be displayed in the instrument cluster or the head-up display, provided the system is activated.

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Initial Print Date: 04/07 Revision Date:

USB/Audio Interface

Model: E9x, E70, and E6x (except 7 Series)

Production: From 3/2007, 4/2007 (E70)

OBJECTIVES

After completion of this module you will be able to:

- Explain the operation of the USB Interface
- Identify the components used in the USB/Audio Interface

Introduction

Option SA 6FL, "USB/Audio interface", enables the sound systems in BMW vehicles to play audio files stored on mass storage devices with a USB (Universal Serial Bus) interface, e.g. USB memory sticks. A special iPod adapter cable is available for connecting an Apple iPod.

USB is a serial bus system used for quick and easy connection of terminal devices to computers.

The mass storage device can be accessed from the "Entertainment" menu on the iDrive.

The CID supports alphanumeric characters of the Roman character set. Other character sets cannot be correctly represented on the CID at present.

Operation is described in the owner's handbook for the vehicle.

USB/Audio Interface On iDrive

Index	Explanation
1	Selection of external audio source
2	Selection of mass storage device
3	Selection after sorting
4	Menu structure of mass storage device

USB mass storage devices that support the "USB Mass Storage Class" standard can be connected. That includes mass storage devices for playback of compressed audio files with a USB interface such as MP3 players, USB memory sticks, etc. The system also supports Apple iPods of the 4th generation or later, iPod nano and iPod mini if connected using the iPod adapter cable (special accessory).

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" appears.

When a USB mass storage device is connected, the contents of the device are read and the folder structure processed for display on the CID. In addition, 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.

Processing of the data takes some time. 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 not supported at present. MP3 players that carry the PlaysForSure logo use MTP and are therefore not supported. More information on the protocols used can be obtained from the operating instructions of the mass storage device concerned.

Note: Connecting mobile phones to the USB interface is not recommended. With certain mobile phones, Bluetooth is deactivated if they are connected to the vehicle through the USB interface. There is no USB socket on the Snap-in adapter.

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.

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). DRM is a method of protecting copyright and marketing rights relating to intellectual property in digital form.

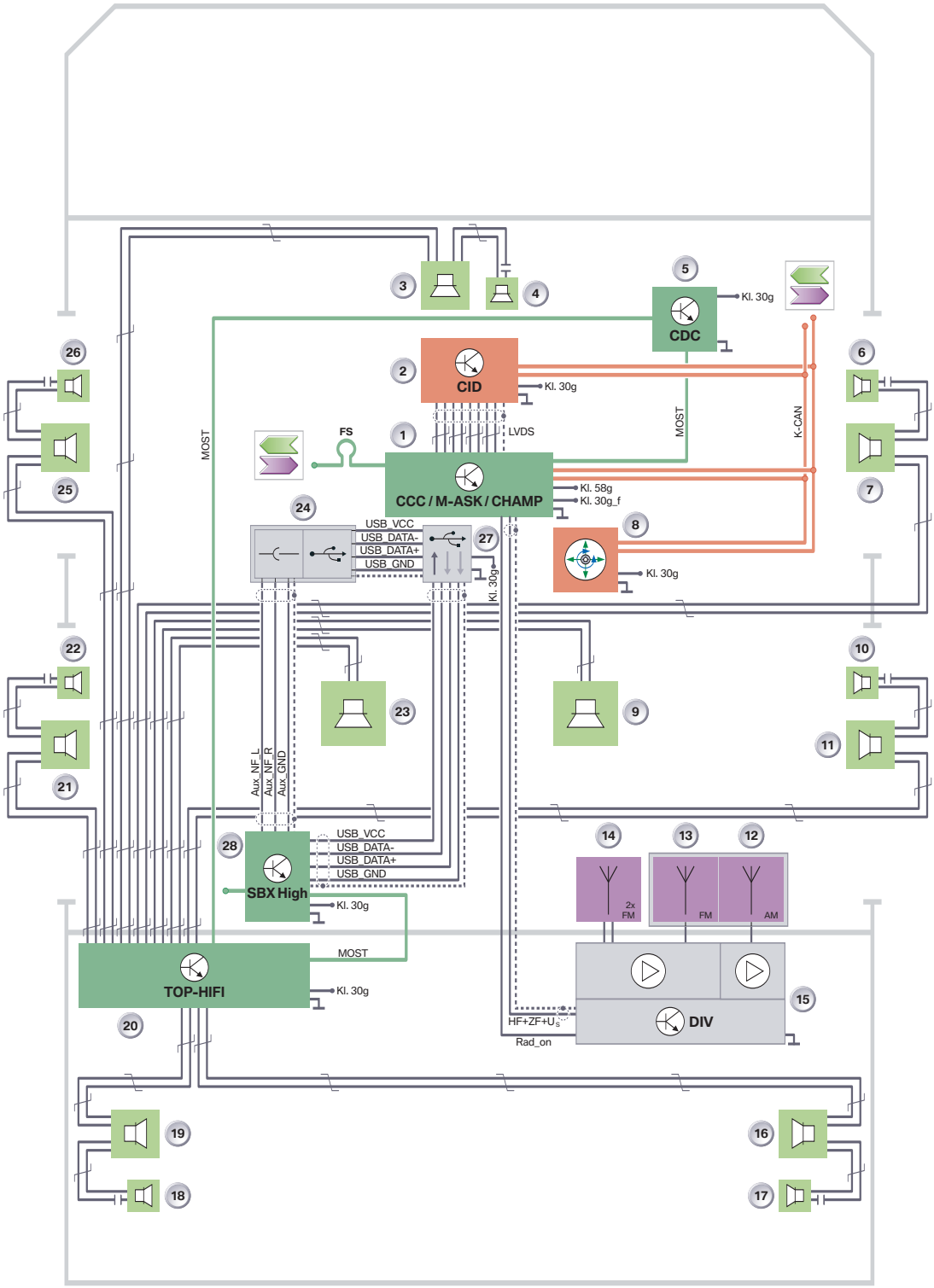
If music tracks acquired from Apple iTunes are to be played, the iPod must be connected by means of an adapter cable that simultaneously uses the jack socket and the USB. The adapter cable is available to order from BMW Parts Sales.

With the adapter 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 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 jack plug, the iDrive cannot be used to operate the device.

System Circuit Diagram



Index	Explanation	Index	Explanation
1	Head unit	15	Aerial amplifier with diversity module
2	Central information display	16	Mid-range speaker, D-pillar right
3	Mid-range speaker, front center	17	Tweeter, D-pillar right
4	Tweeter, front center	18	Tweeter, D-pillar left
5	CD changer	19	Mid-range speaker, D-pillar left
6	Tweeter, front right door	20	Top-HiFi amplifier
7	Mid-range speaker, front right door	21	Mid-range speaker, rear left door
8	Controller	22	Tweeter, rear left door
9	Central bass speaker, right	23	Central bass speaker, left
10	Tweeter, rear right door	24	Audio socket with USB interface
11	Mid-range speaker, rear right door	25	Mid-range speaker, front left door
12	Rear spoiler aerial (AM)	26	Tweeter, front left door
13	Rear spoiler aerial (FM1)	27	USB hub
14	Rear window aerials (FM2, FM3)	28	High interface box
LVDS	Low voltage differential signal	MOST	Media Oriented System Transport
Aux_NF	Audio input for additional audio sources	FS	MOST direct access
Rad_On	Control signal or power supply	US	Switching voltage
HF	High frequency signal	ZF	Intermediate frequency signal
USB_VCC	USB power supply	USB_DATA +	USB data positive
USB_GND	USB earth	USB_DATA -	USB data negative

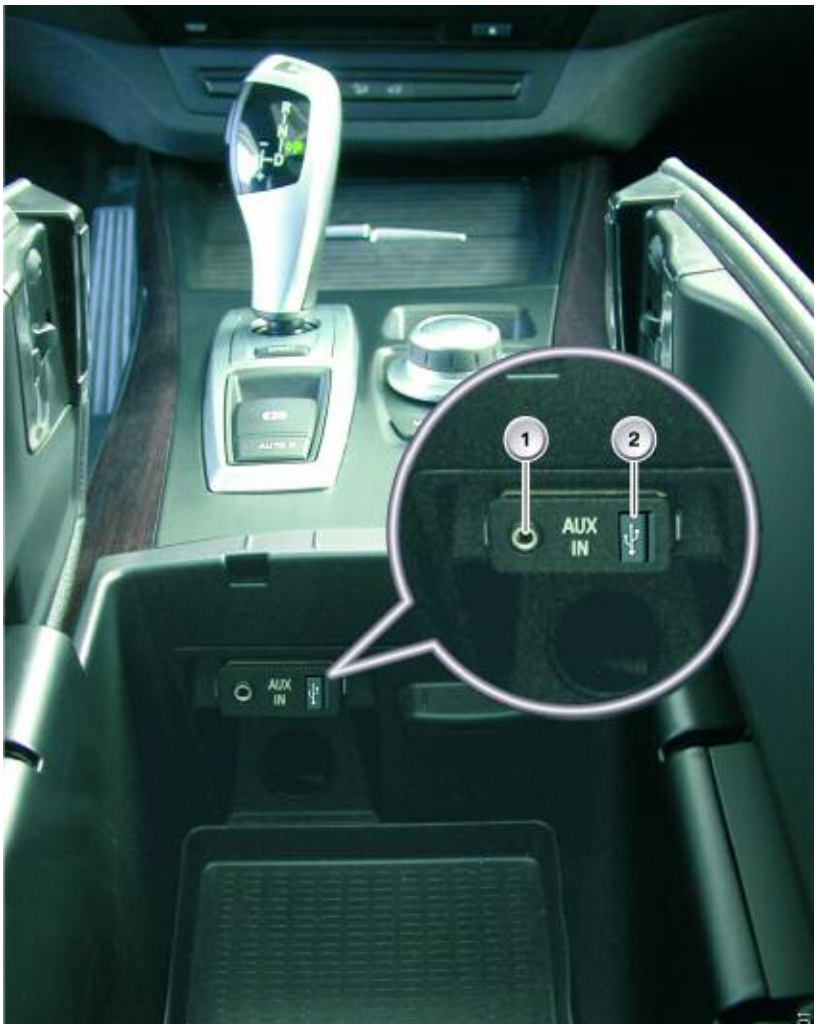
Components

Option SA 6FL, "USB/Audio interface" consists of the following components:

- High interface box (SBX High)
- USB hub
- Audio socket with USB interface
- Application software on the head unit.

The USB interface is on the center console and is protected by a slider mechanism.

To prevent earth loops, simultaneous use of the USB interface and the 12 V socket for charging the mass storage device is not recommended. Dependent 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.



Location of Audio Socket with USB Interface

Index	Explanation
1	Audio socket (3.5 mm jack)
2	USB interface

The High interface box (SBX High) performs the following tasks:

- USB connection for USB/audio interface
- Bluetooth signal connection for customer's mobile phone (dealt with in "E70 Telephone Systems" Product Information)
- Voice input system (dealt with in "Voice input and activation systems E70" Product Information)

The High interface box is always fitted if option SA 6FL, "USB/Audio interface", is fitted to the vehicle. It decodes the digital audio signals that are supplied via the USB interface. After decoding, the audio files are broadcast via the MOST. In addition, the analogue LF signals from the audio socket are also broadcast on the MOST.

Software (drivers) cannot be uploaded to the SBX High via the USB interface.

The SBX High supports USB 1.1 with the following specifications:

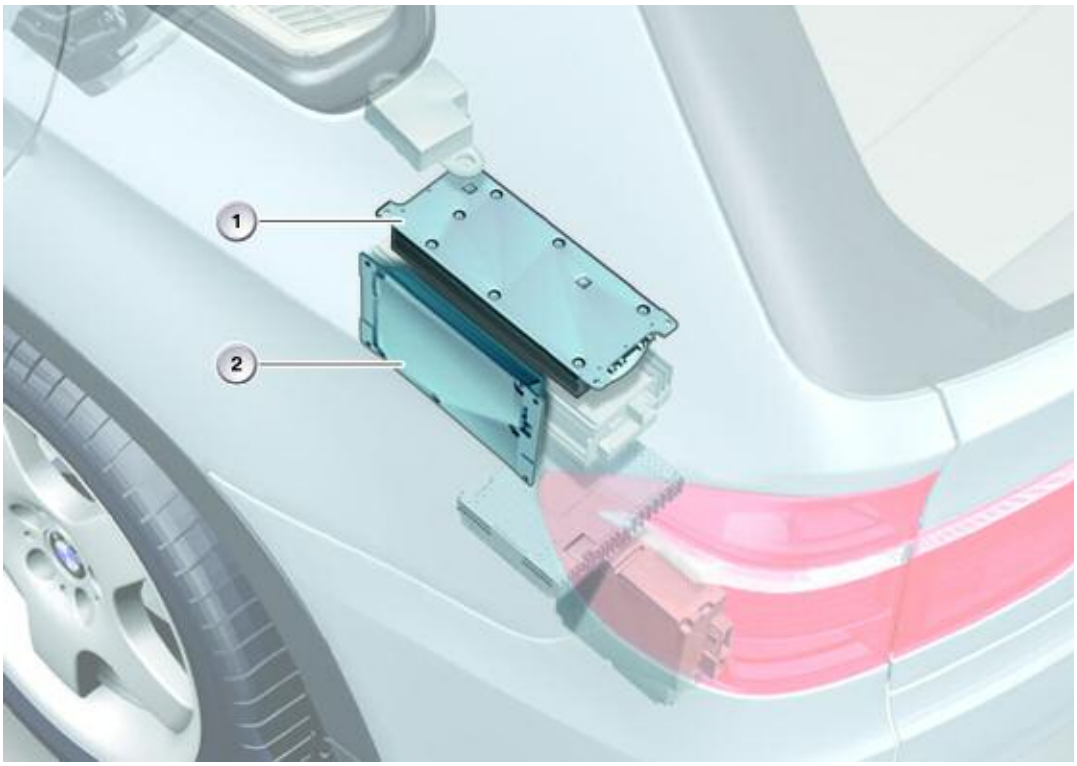
- Maximum data rate: 12 Mbit/s
- Voltage: 5 V
- Current: 500 mA.

The SBX High is located in the luggage compartment on the left-hand side.

SBX High Connections

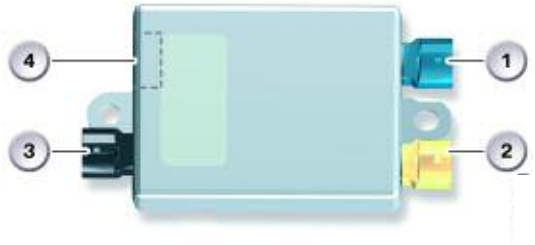
Index	Explanation
1	Bluetooth signal Connector color code: transparent
2	USB connection Connector color code: black

SBX High Location



Index	Explanation
1	Telematic Control Unit (TCU)
2	High interface box (SBX High)

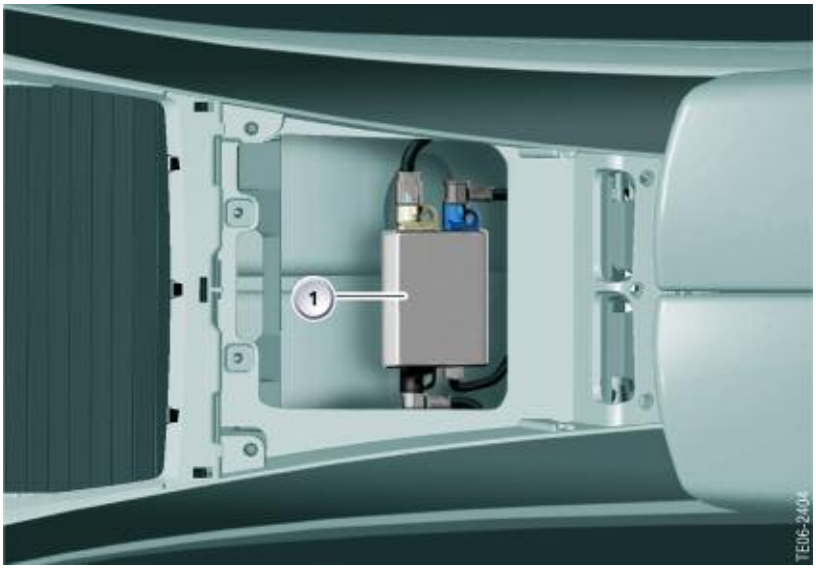
The USB hub allows multiple USB interfaces to be connected to the SBX High. The USB hub incorporates an active USB signal amplifier and is equipped with one USB input and two USB outputs. The second output is not used at present.



USB Hub

Index	Explanation
1	USB Interface - Blue
2	Not used at present - Transparent
3	SBX High - Black
4	Power Supply - Black

The USB hub is fitted underneath the center console. Its precise location depends on which version of the climate control system is fitted.



Location of USB hub on Vehicles without 4-zone Climate Control

Index	Explanation
1	USB Hub

Audio Jack

The audio socket is used for connecting an external audio source such as an MP3, cassette or CD player using a 3.5 mm jack plug. The audio socket (Aux In) without USB interface is standard equipment on the E70. It is located below the center armrest.
A 12 volt power socket is located in the immediate vicinity of the audio socket.

Service Information

Included with the option code 6FL (USB/Audio Interface) is a cable that is required to fully integrate an Apple iPod to the vehicle.

This cable allows the data files and incompatible audio files to be masked in the CID. Only compatible audio files will be displayed if this interface cable is used.

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Initial Print Date: 04/07 Revision Date:

IBOC Update

Model: E6x, E70, E9x

Production: From 3/2007 Production (4/2007 E70)

OBJECTIVES

After completion of this module you will be able to:

- Explain the operation of the HD Radio multicasting feature
- Identify the components utilized in a vehicle with RTTI and HD Radio

Introduction

In August 2005, BMW announced the first OEM availability of HD Radio technology in its 2006 7 Series models. BMW then followed up in November 2005 by extending the HD Radio option to drivers of its 2006 6 Series vehicles. This past June, the company announced that HD Radio would be offered in its 2007 5 Series models.

BMW continues to expand its pioneering position in providing high-quality audio systems by offering a factory-installed digital HD Radio receiver with FM multicasting capability. HD Radio technology is one of the most significant advances in radio broadcasting history, providing listeners with enhanced digital audio quality and clear, noise-free reception, as well as multicasting and on-screen text information. The HD Radio multicasting feature allows FM stations to broadcast multiple channels of digital programming simultaneously on a single frequency.

Of the more than 1,000 stations across the country broadcasting with HD Radio technology, more than 500 FM stations are offering a second (HD2) and, in many cases, a third (HD3) multicast channel.

For example, WAMU in Washington, DC, offers three channels: 88.5-1, a simulcast of its news/talk analog channel; 88.5-2, a simulcast of an innovative Baltimore music station not available in DC; and 88.5-3, bluegrass music.

These channels are free but can only be found on HD Radio receivers. As with all HD Radio programming, there are no fees or additional costs associated with multicast channels.

The number of HD Radio stations is growing daily and expected to exceed 3,000 within the next few years. A current list of HD Radio stations and multicast stations can be found at: www.hdradio.com.

HD Radio and RTTI

Until 3/2007 it was not possible to order a vehicle equipped with both RTTI and HD Radio together.

This was due to the fact that only one antenna connection was available. It was used for either of the two options.

In March 2007 production vehicles, an antenna splitter will become available that allows the antenna connection to be split. In this manner, both the HD Radio control unit and the CCC will have the FM signal that comes from the antenna amplifier diversity unit.

Components

Antenna Splitter

The antenna splitter is necessary in order to split the FM line output from the antenna amplifier/diversity unit.

It is mounted to the rear of the HD Radio control unit and is comprised of the electronics housing, and three connectors.

Principles of Operation

In order to utilize the multicasting option of the HD Radio, the HD Radio option must be set to on. This can be selected/performed from the settings menu under the sub-menu audio settings.

The multicasting option uses the the HD Radio technology to its fullest potential. A radio station can broadcast more than one radio program on the same frequency digitally while still broadcasting its primary radio station in analog format.

In order for the multicasting option to be selected, the HD Radio control unit has to be in the "digital" mode at the moment. In other words, the CID has to confirm that the HD Radio digital signal is being used at the moment. If the digital mode is not on/active, only the primary analog signal can be heard.

The best way to know if the radio is in the "digital" mode is to observe the HD icon/symbol in the CID.

In the illustration above, we can see that the radio is in the "digital" mode and that it is in WKTU-HD1. in order to select the WKTU-HD2, the forward seek button on the face panel of the head unit should be selected.

Note: Multicasting can only operate in the digital mode.
If the HD Radio control unit switches over to the analog mode (usually due to poor reception), the unit will revert back to the primary analog signal that is broadcast by the radio station (i.e HD1 will be played).
For a comprehensive listing of radio stations that are transmitting using multicasting technology please refer to www.ibiquitydigital.com.

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E60/E61 Model Update

Model: E60, E61

Production: From March 2007 Production

OBJECTIVES

After completion of this module you will be able to:

- Identify the changes made to the E60 and E61 as of March 2007 production

Introduction

At the change of model year in March 2007, there will be new systems in the E60 and E61.

These systems include, for example, the lane departure warning and active cruise control with stop & go function.

With the lane departure warning, BMW is providing a new assistance system.

The lane departure warning warns the driver to counter-steer in the event of unintentional lane changing. It does this by generating a vibration in the steering wheel. The system is designed for use on B-roads, A-roads and highways.

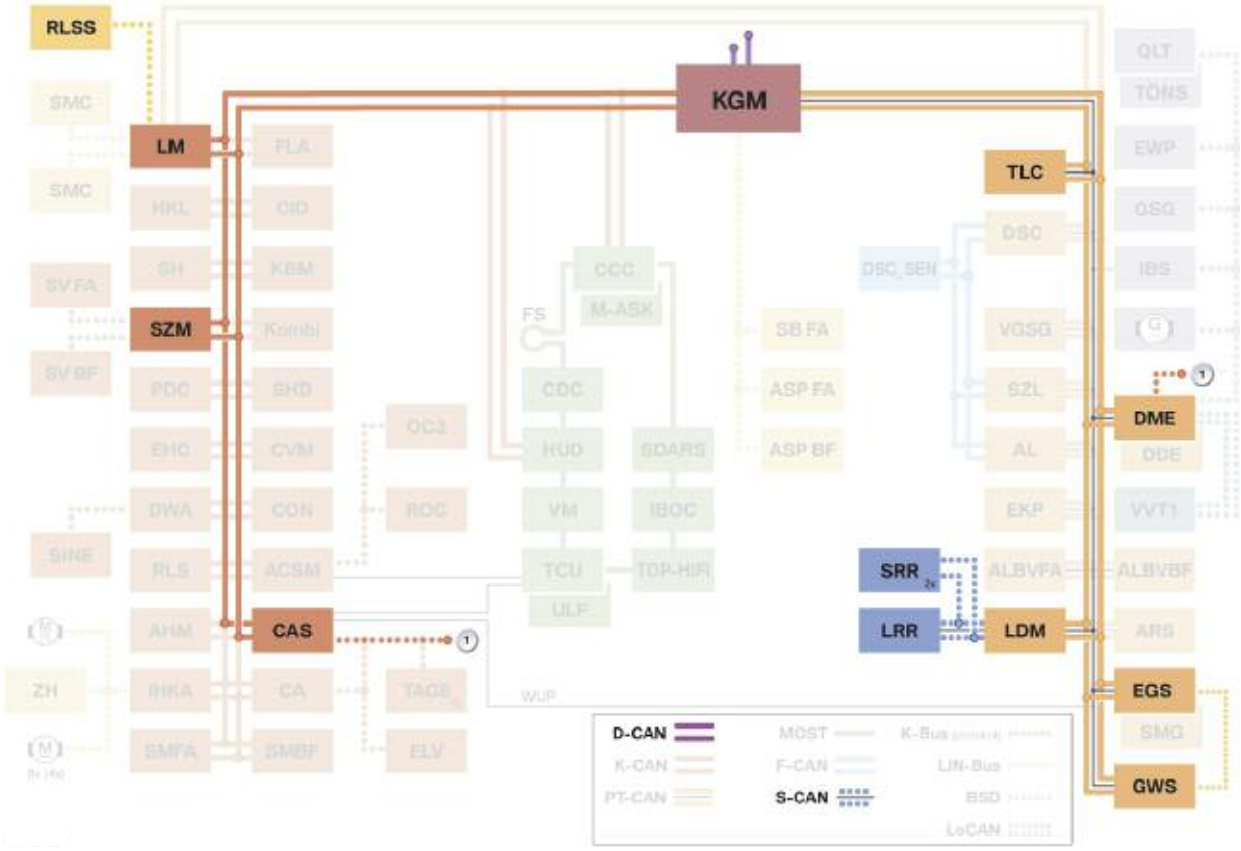
Active cruise control with stop & go function makes it easier to drive in heavy traffic. The system supports repeated pulling away and braking in slow traffic queues.

Other model year actions include:

- Car Access System with electronic immobilizer 4
- Rain/light solar sensor with LIN bus
- Two-part center console switch cluster and pop-up menus for seat auxiliary functions
- Welcome light
- Daytime driving light with corona rings
- Adaptive headlights with turn-off light
- Direction indicator based on light emitting diodes LED and additional side-marker lamps at rear as standard equipment
- Diagnostics on CAN on body gateway module.

Systems Overview

Bus Diagram



New control units are integrated in the bus system of the E60/E61. The modifications in the bus system are listed below in brief.

New Control Units

Lane Departure Warning (TLC)

The lane departure warning generates a warning when the driver accidentally changes lane. The warning should prompt the driver to counter-steer.

Gear Selector (GWS)

The control unit was first used with the E70 and is now also integrated in the E60/E61.

Longitudinal Dynamics Management (LDM)

LDM is used, amongst other things, for the "Active cruise control stop & go function" driver assistance system.

Car Access System (CAS)

The model year actions provide for the installation of the Car Access System 3 in the E60/E61.

The Car Access System 3 was first installed on the E92 and includes electronic immobilizers EWS 3 and EWS 4. Depending on the engine variant, EWS 3 or EWS 4 is operated by the Car Access System 3.

With EWS 4, the engine electronics are connected to the Car Access System 3 by a redundant data connection. The data connection is redundant to the PT-CAN and uses the K bus protocol.

New Components

Long Range Radar/Short Range Radar

Both components are for the newly installed active cruise control with stop & go function.

Center console switch cluster E60/E61 The center console switch cluster, which previously consisted of one switch bar, has been split into two switch blocks. One switch block is for the driver's side, and the other is for the front-passenger side. Between the switch blocks, there is an ashtray insert.

Rain/Light Solar Sensor

The installation of the rain/light solar sensor or rain/light sensor depends on the options. Thus, for example, only the rain/light sensor is fitted with the Japan specifications.

For vehicles with the head-up display option, it is not possible to install the rain/light solar sensor.

The above-mentioned options for the sensors result in the different connections via the LIN bus or K-CAN.

New Bus Systems

Sensor CAN

The sensor CAN S-CAN is a new bus system. The bus system is based on the PT-CAN. Therefore, the S-CAN works at the same speed as the PT-CAN and uses the PT-CAN protocol.

Diagnostics on CAN D-CAN

The body gateway module KGM now has a connection for the Diagnostics on CAN D-CAN. The connection of a D-CAN depends on the engine variant.

Principle of Operation

Car Access System 3

The Car Access System 3 CAS 3 includes the functions of Car Access System 2. A more detailed description of the Car Access System 3 is given in the following Product Information:

- "Electrical/Electronic Systems E92"
- "Car Access System E70".

Electronic immobilizer 4 EWS 4 can be used with Car Access System 3. The use of the electronic immobilizer 4 depends on the engine control system fitted. The following table specifies the engine variants and their relationship to the electronic immobilizer.

The Car Access System 3 CAS 3 includes the functions of Car Access System 2. A more detailed description of the Car Access System 3 is given in the following Product Information:

- "Electrical/Electronic Systems E92"
- "Car Access System E70".

Vehicle	Production Date (launch)	Engine	Engine Management	EWS 3	EWS 4
E60/E61	03/07	N52B30U0/N52B30OO N52B30O1/N52B30M1	MSV80		X
E60/E61	03/07	N53B25U1/N52B25O1	MSD80		X
E60/E61	03/07	N54B30U0	MSD80		X
E60/E61	03/07	N53B30U0/N53B30O0	MSD80		X
E60/E61	03/7	N62B40O1/N62B48O1	ME9.2.3	X	

Electronic immobilizer 4 EWS 4 can be used with Car Access System 3. The use of the electronic immobilizer 4 depends on the engine control system fitted. The following table specifies the engine variants and their relationship to the electronic immobilizer.

Rain/Light Solar Sensor

From 03/07 the E60/E61 will be fitted with the rain/light solar sensor. In addition, the LIN bus will be installed between the rain/light solar sensor and the light module.

The rain/light solar sensor is taken from the E70 and is adapted to the E60/E61. The light module requests the values from the rain/light solar sensor every 20 ms. In this way, it receives the request to activate or deactivate the driving light, for example.

Requests received by the light module from the solar sensor or rain sensor, are converted into K-CAN format. The light module sends the sensor signals via the K-CAN.

In this way, the body basic module receives the requests for automatic wiping and the air conditioning system receives requests for air distribution in the vehicle.

The rain/light solar sensor cannot be fitted on vehicles with the head-up display option.

Therefore, in this option, the rain/light sensor used to date is fitted. The rain/light sensor is connected via the K-CAN.

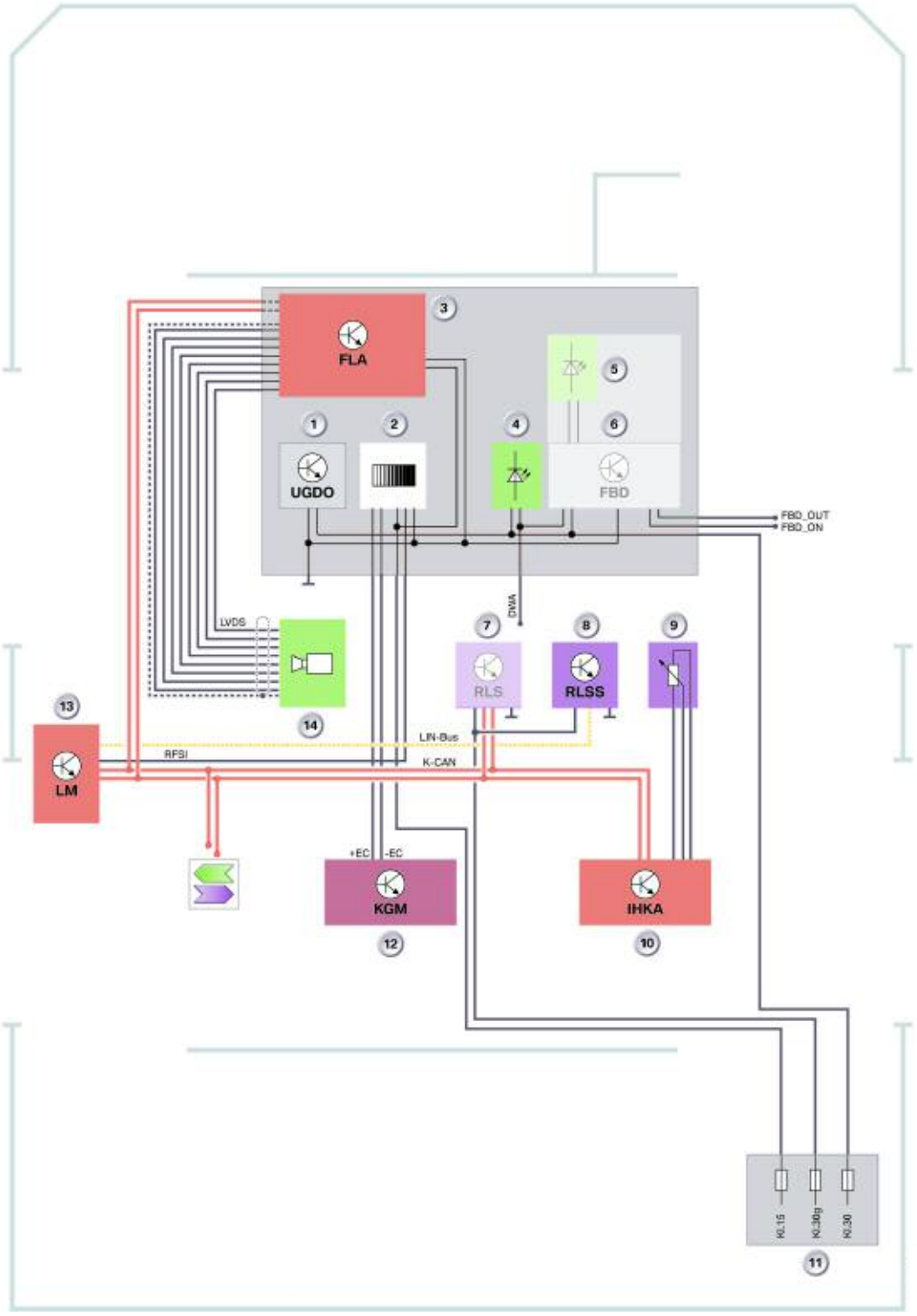
Both specifications are illustrated in the system circuit diagram on the next page.

Electrochromic Interior Mirror

The electrochromic interior mirror sends the request for lighting/dimming the outside mirror directly to the body basic module. The body basic module prompts lighting/dimming of the outside mirror.

The electrochromic interior mirror cannot be dimmed if reverse gear is engaged. Therefore, the light module sends the "RFSI" signal directly to the electrochromic interior mirror. This prevents the electrochromic interior mirror from dimming when reverse gear is engaged. This enables an optimal view to the rear via the interior mirror or the outside mirror.

System Circuit Diagram



Index	Explanation
1	Universal garage-door opener UGDO
2	Electrochromic interior mirror
3	High beam assistant FLA
4	Anti-theft alarm system LED
5	Anti-theft alarm system LED
6	Remote control receiver FBD
7	Rain/light sensor RLS
8	Rain/light solar sensor RLSS
9	Mist sensor
10	Integrated heating-air conditioning control IHKA
11	Luggage compartment electrical distribution box
12	Body gateway module KGM
13	Light module LM
14	High beam assistant image sensor
K-CAN	Body CAN
LIN-bus	Local Interconnect Network bus
LVDS	Low Voltage Differential Signalling
KL 15	Terminal 15
KL 30	Terminal 30
KL 30g	Terminal 30 switched
FBD	Remote control service
FBD_OUT	Remote control service OUT
FBD_ON	Remote control service ON
+EC	+ Electrochromic interior mirror
-EC	- Electrochromic interior mirror
RFSI	Reversing light signal

Modified Center Console Switch Cluster

The center console switch cluster SZM will be replaced by a two-part SZM from 03/07. This not only changes the visual aspect, but also the functionality of the buttons.

The SZM is available in single, double or triple row versions. The version depends on the number of buttons required.

In principle, the buttons for Dynamic Traction Control (DTC) or Park Distance Control (PDC) are located in the top row.

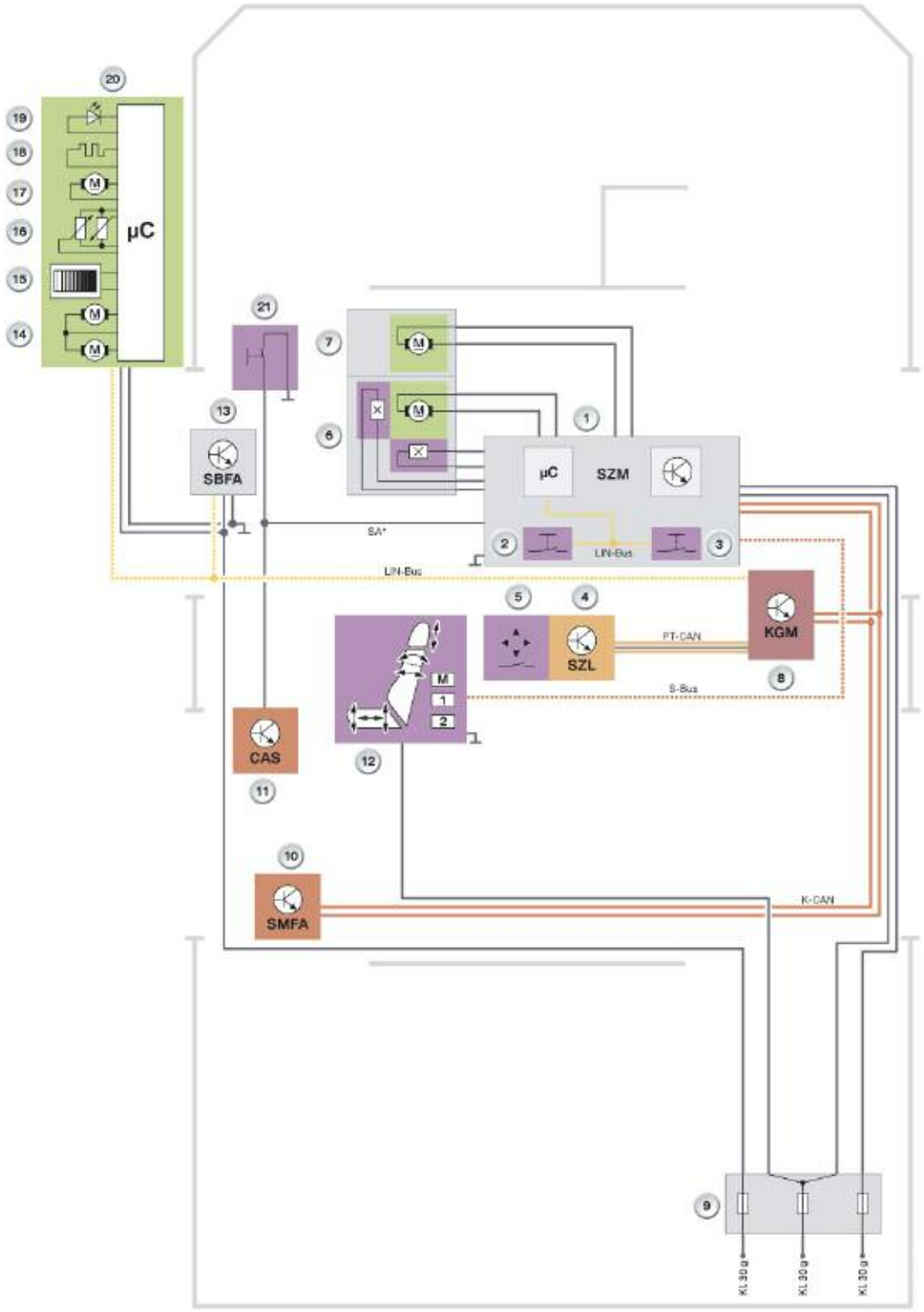
Previous and new center console switch

If, for example, Park Distance Control was not ordered, the button for unlocking the luggage area or tailgate will be located here instead.

Center Console Switch Cluster	Version
	Single-Row The single-row version means that only one button is integrated in the SZM on the front passenger and driver's side.
	Double-Row The double-row version means that two buttons are arranged one above the other on the front-passenger and driver's side. With the double-row version, the function display is shown via an LED on the button. • Active seat width adjustment • Seat heating. 1
	Triple-Row With the triple-row version, there are three buttons one above the other on the front passenger and driver's side. From the triple-row version, there is a "pop-up" menu in the Central Information Display for: • Active seat back width adjustment • Seat air conditioning • Seat heating. 1

NOTES PAGE

System Circuit Diagram



Index	Explanation
1	Center console switch cluster SZM
2	Button for driver's seat function
3	Button for front passenger seat function
4	Steering column switch cluster (SZL)
5	Steering column adjustment button
6	Driver's outside mirror
7	Mirror adjustment motors
8	Potentiometer memory position
9	Outside mirror heating
10	Mirror folding motor
11	Electrochromic outside mirror
12	Courtesy lighting
13	Boot lid push button
14	Body gateway module KGM
15	Luggage compartment electrical distribution box, left
16	Driver's seat module
17	Seat-adjustment switch
18	Car Access System CAS
K-CAN	Body CAN
PT-CAN	Powertrain CAN
LIN bus	Local Interconnect Network bus
KL 30g	Terminal 30 switched
KL 58g	Terminal 58 switched
Option*	Dependent on option

As for the triple-row version, it is only possible to display the function via the LED in the button.

This means that pressing the button (2 or 3) calls up the associated pop-up menu in the Central Information Display.

The individual activation stages of the specific function are shown in the Central Information Display.

Pop-up Menu

Depending on the option, pop-up menus can be displayed in the Central Information Display. The pop-up menus are dependent on the following auxiliary seat functions:

- Seat heating in conjunction with seat climate
- Seat heating in conjunction with active seat
- Seat heating in conjunction with seat climate and active seat
- Seat heating in conjunction with active seat back width adjustment
- Seat heating in conjunction with seat climate and active seat back width adjustment

Example of "Pop-up" Menu	Seat Function
	Seat Heating
	Seat Climate
	Active seat back width adjustment

Pressing the button for an auxiliary seat function causes this function to be activated. A pop-up menu appears in the Central Information Display. When the function is switched on, the highest setting for the activated function is shown first. By pressing the button again, you can shift through until the function is switched off or reactivated again.

The pop-up menu for the auxiliary seat functions fades to show Check Control messages for the time during which the Check Control messages are present.

It is still possible to shift through the seat function. The only indicator in this situation is the activation display via the LED on the button.

Note: If seat functions were stored before leaving the vehicle, they will still be active the next time the vehicle is started.

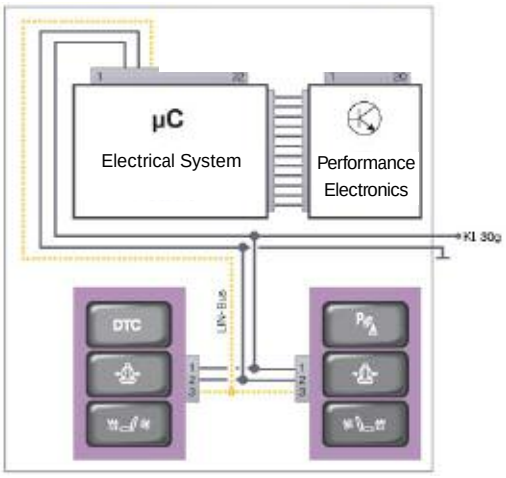
Center Console Switch Cluster Assembly

The center console switch cluster consists of an electrical system, performance electronics and the driver's and front-passenger side button blocks.

The performance electronics are connected via a 20-pin connector. The electrical system has a 32-pin connection. The two electrical systems communicate with each other via a 12-pin ribbon cable.

The electrical system is integrated in a 2/3 housing and the performance electronics are integrated in a 1/3 housing (module). Both modules are installed in the glove box device holder.

The electrical system, performance electronics and buttons are connected to terminal 30g.



Basic Assembly of the Steering Column Switch Cluster

Electrical System

The LIN bus of the SZM-electrical system only connects the SZM-button blocks.

The electrical system is responsible for analyzing the information from the following bus systems:

- Body-CAN K-CAN
- Seat bus S bus based on K bus protocol
- Local Interconnect Network bus LIN bus, only for internal connection in the center console switch cluster.

Performance Electronics

The performance electronics control the motors for steering-column adjustment and for the roller sunblind.

Steering Column Adjustment

The electrical system monitors the Hall sensors for the electric steering-column adjustment. Thus, the position of the steering column can be used for the steering column memory function, based on the Hall sensor pulses.

The request to activate the motors for steering column adjustment is received by the electrical system via the K-CAN. The electrical system forwards the request to the performance electronics, which activates the motors.

Note: The buttons for the steering-column adjustment are analyzed by the steering column switch cluster. The steering column switch cluster sends the request via the PT-CAN. The body-gateway-module converts the signal to the K-CAN.

Roller Sunblind E60

The request to activate the roller sunblind is received via the K-CAN. The electrical system analysis the request and the performance electronics activate the motor.

Note: The button for the roller sunblind is analyzed by the driver's switch block. The driver's switch block is connected to the body gateway module via the LIN bus. The body gateway module requests the status of the button cyclically from the driver's switch block.

In this way, the body-gateway-module receives the request to activate the roller sunblind and converts this to the K-CAN.

Buttons in the Center Console Switch Cluster

The buttons in the center console switch cluster are connected to the electrical system via the LIN bus. The electrical system sends the status of the buttons via the K-CAN.

In this way, the Park Distance Control can be activated or deactivated by pressing the PDC button, for example.

Trunk Push Button

For vehicles without optional equipment, the boot-lid push button is located on the A-pillar and is redundant in the center console switch cluster.

Components

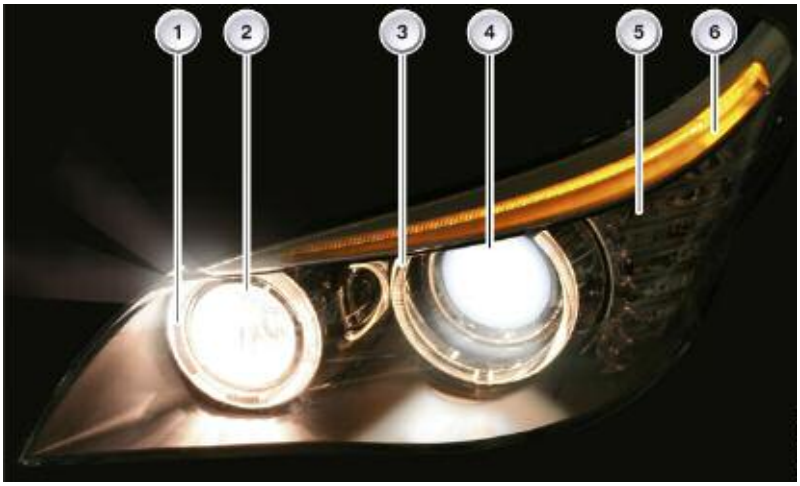
Exterior Lighting

In 03/07, the exterior lighting of the E60/E61 will have the following function additions:

- Welcome light
- Daytime driving light with corona rings (only with bi-xenon lights)
- Turn-off light (only with bi-xenon lights)
- Side-marker light at rear, as standard
- High beam assistant option 5AC can be deactivated via the light settings menu

For these additions, not only new headlights or rear lights are required, but also a new light module. The light module contains the abovementioned functions and the connection options. The pin assignment is to be taken from the BMW diagnostics system.

The external dimensions of the headlights and rear lights remain the same. The modifications are within the headlight or tail light, such as corona ring for the daytime driving light or direction indicator based on light emitting diodes LED in the rear light.



Index	Explanation
1	Parking light/daytime driving light
2	Turn-off light
3	Parking light/daytime driving light
4	Low-beam headlights/high-beam headlights
5	Direction indicator
6	Side-marker light

Welcome Light

The welcome light is activated for around 20 seconds when the vehicle is unlocked. In addition to the interior lighting, the following lights are also activated for the welcome light:

- Parking light, corona rings in parking light function
- Tail light bars, also the dimmed rear fog lights on the E60
- License plate light
- Courtesy lights
- Side-marker light
- Illumination of the instrument cluster as indicator lamp

Note: For the welcome light function, the light switch must be in the "low-beam headlights" or "automatic driving lights control" position.

The welcome light is activated as factory default. With the controller, the welcome light can be deactivated via the Central Information Display.

To do this you must select menu item:

"Settings" > "Vehicle/Tires" > "Light settings" > "Welcome light"

Confirm the desired setting by pressing the controller.

Daytime Driving Lights

The daytime driving light is available with halogen headlights or bi-xenon headlights as well as with adaptive headlights.

Halogen Headlight

With halogen headlights, the light switch must be in the "automatic driving lights control" position. With the daytime driving light, the driving light is used.

Bi-Xenon Headlights/Adaptive Headlights

The daytime driving light with corona rings is only available in conjunction with the bi-xenon headlights and adaptive headlights options. In the daytime driving light function, the corona rings of the headlights and the tail light bars of the rear lights are activated.

The principle for generating the daytime driving light with corona rings is taken from the E92. The light in the inside chamber of the main headlight is fed into the corona rings through optical fiber cables. Only one bulb per headlight is used for feeding light to the corona rings.

For the daytime driving light function, the light switch must be in the "light OFF" or "automatic driving lights control" position. The switch position is important, as the daytime driving light cannot be activated by the light module otherwise.

The corona rings are switched on from terminal 15 ON, with the corresponding light switch position. The bulb is actuated in pulse width modulation. Pulse width modulation makes it possible to realize the daytime driving light and parking light functions.

In the event of a defect in the daytime driving light or parking light, the following information is displayed or issued:

Check Control Message	Meaning	Messages in the Central Information Display
	Left parking light/daytime driving light failed.	Left parking light/daytime driving light. Left parking light/daytime driving light failed. Have checked by nearest BMW Service.
	Right parking light/daytime driving light failed.	Right parking light/daytime driving light. Right parking light/daytime driving light failed. Have checked by nearest BMW Service.

The daytime driving light function can be activated or deactivated via the Central Information Display using the controller.

To do this, you must select the menu option "Settings" > "Vehicle/Tires" > "Light settings" > "Daytime driving light". See also the Owner's Handbook.

Note: The daytime driving light is subject to statutory and country-specific regulations. These statutory and country-specific regulations must be complied with.

Cornering Lights

The cornering lights is integrated with the xenon light option. With the turn-off light, the areas in front of and beside the vehicle can be illuminated, in addition to the adaptive headlights.

The cornering lights has been integrated in the place of the former auxiliary high-beam light in the headlight.

A special reflector geometry and positioning of the H3-bulb makes it possible for the light to be beamed to the side.

The function of the turn-off light is taken from the E92. The function of the H3-bulb is monitored by the light module.

In the event of a defect in the turn-off light, the following information is displayed or issued:

Check Control Message	Meaning	Messages in the Central Information Display
	Left cornering lights failed.	Left cornering lights light. Left cornering lights failed. Have checked by nearest BMW Service.
	Right cornering lights failed.	Right cornering lights. Right cornering lights failed. Have checked by nearest BMW Service.

To activate the cornering lights, the adaptive headlights must first be switched on via the automatic driving lights control.

The cornering lights is not activated if the hazard warning lights or one-touch direction indicator function are in operation.

The cornering lights is not activated when the high-beam headlights or headlight flasher are activated. If the high-beam headlights or headlight flasher is switched off and the switch-on conditions are fulfilled, the cornering lights are activated.

Activation Conditions

The activation conditions for forwards travel are:

- 0 mph
- Steering angle approximately 40 - 70°
- Engine Running

The activation conditions for reverse travel are:

- Reverse gear selected
- Turn-off light on both sides

Deactivation Conditions

The turn-off light is switched off if none of the switch-on conditions is met:

- Adaptive headlights OFF and
  - Direction indicator OFF or
  - Steering angle reversed or
  - Reverse gear OFF.

In vehicles with Europe specifications, the turn-off light is also switched off when the high-beam headlights or headlight flasher are activated.

In addition, the turn-off light is switched off if one of the following parameters applies:

- Road speed
- Vehicle stationary
- Time out, time or temperature-related limitation
- Dynamism, vehicle drifting

The conditions are given in the following table:

Other Switch-off Conditions		
Road Speed	Switch-on Condition	Remark
70 km/h	Steering Column	When the vehicle is in motion
Stationary	Switch-on Condition	Remark
0 mph	Steering angle	5° - 10° reduced according to switch-on condition
Time out	Condition	Remark
> 4 seconds	FRAZ on, v= < 2 km/h steering angle 0°	Turning at traffic lights
Temperature Model	Steering movement and yaw rat have opposite directions	Headlight protection
Dynamism	Condition	Remark
Drifting	Steering movement and yaw rate have opposite directions	Adaptive headlights switch to straight-ahead position

Rear Light Cluster

A new feature here is the side-marker light integrated in the rear light cluster as standard on vehicles with Europe specifications.

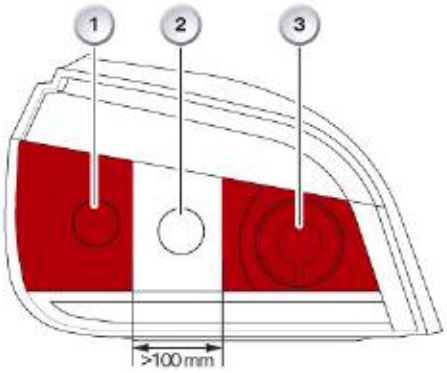
The direction indicators and the side-marker lights are shown in LEDs (light emitting diodes).

For the additional side-marker light, four LEDs are used on the E60 and two LEDs on the E61.

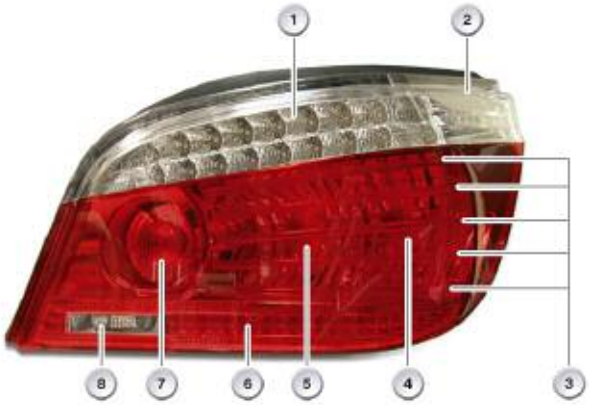
For the brake light (BL), the outer and inner chamber of the rear light cluster is used. For the brake-force display (BFD) function, the rear fog light NSL chamber is used. If the rear fog light is switched on, the brake-force display is not shown. The following table shows which lights are activated, according to the function.

Function	Activated Lights
BL Normal	BK1 + BL2
BL + BFD	BL1 + BL2 + BFD
BL + NSL	BL1 + NSL

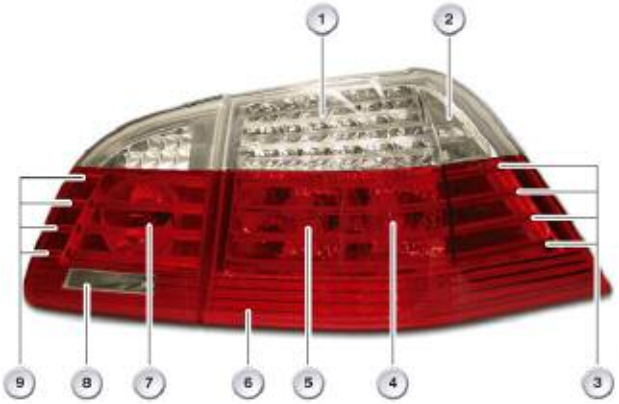
Note: When the rear fog light is ON, the inner chamber of the rear lights cluster is not used as the brake light (BL2). This is because a legally required distance of 100 mm is prescribed between the light surfaces of the brake light and the rear fog light.



Index	Explanation
1	Exterior chamber for brake light - BL1
2	Interior chamber for brake light - BL2
3	Rear fog light NSL/brake-force display - BFD
> 100 mm	Legally required distance between light surfaces of BL/NSL must be greater than 100 mm



Rear Light E60



Rear Light E61

Index	Explanation
1	Direction indicator (basic LED)
2	Side-marker light (LED)
3	Tail light bars (basic LED)
4	Brake light 1
5	Brake light 2
6	Reflector
7	Brake-force display
8	Reversing light
9	Tail light bars (basic LED)

Automatic Driving Lights Control

With the model year actions, the E60 and E61 also now have a rain/light solar sensor.

The rain/light solar sensor is connected to the light module via the LIN bus.

The requests to switch the driving light on or off are received by the light module via the LIN bus. The light module requests the status of the rain/light solar sensor cyclically from the LIN bus.

The rain/light solar sensor responds to the requests from the light module.

The light module converts the signals from the rain/light solar sensor to the K-CAN and vice versa. Thus, the light module is the gateway between the LIN bus and the K-CAN

Note: In vehicles with the head-up display, lane departure warning the previous rain/light sensor is used. The rain/light sensor is connected via the K-CAN.

Diagnostics Connection D-CAN

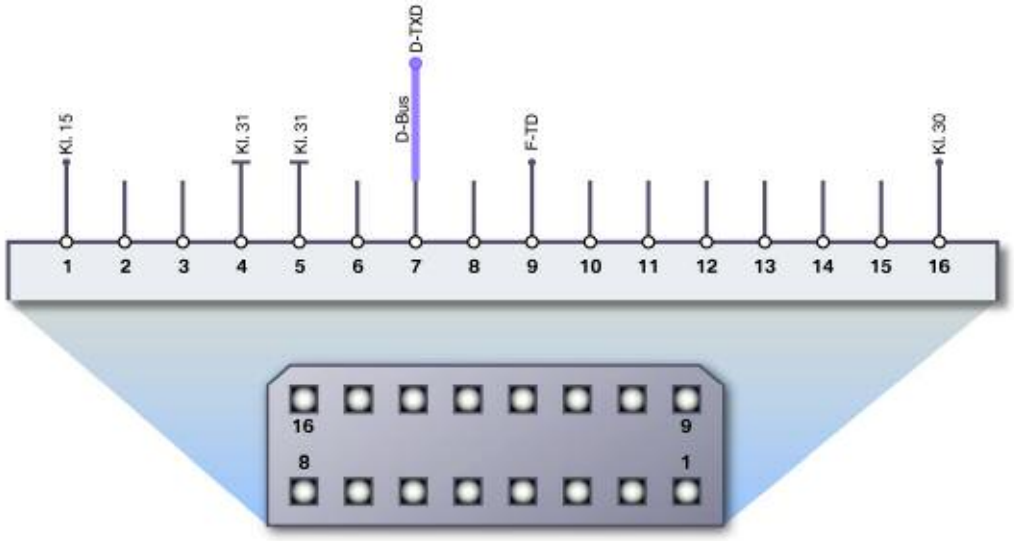
A new communication interface will be used for diagnostics in future.

D-CAN (Diagnostics on Controller Area Network) will replace the previous diagnostics interface world-wide. In this way, BMW has met the requirements of standard ISO 15765 (Diagnostics on CAN with KWP 2000 [Keyword Protocol 2000] or UDS [Unified Diagnostic Service]).

The D-CAN data-signalling rate is 500 kbit/s.

The background for the change-over is a new legal regulation in the USA, according to which all vehicles from model year 2008 must be fitted with a D-CAN. The transition phase began in September 2006.

The change-over to D-CAN in all ranges and model variants is planned for 3/2007 and 9/2007, depending on the type of engine installed.



Pin Assignments E60/E61

An OBD-tool or BMW diagnostics system is automatically detected and distinguished during data output. The second TXD interface (pin 8) is not necessary.

Center Console Switch Cluster

The center console switch cluster is now split into two. For servicing, it must be noted that the performance electronics and the electrical system are integrated in a single module. Both modules are installed in the glove box device holder.

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Longitudinal Dynamics Systems

Model: E60 & E61

Production: From 3/2007 Production

OBJECTIVES

After completion of this module you will be able to:

- Identify the changes made to the E60/E61 Longitudinal Dynamics Systems
- Explain the operation of the ACC Stop & Go Function
- Identify the components used in the ACC Stop & Go Function and where they are located

Introduction

Cruise Control with Braking Function

The cruise control with braking function on the E60/E61 LCI is identical in function to the system used on the E9x models. 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 desired speed in small or large increments, which is then set and maintained by the system by controlling power output and braking.

Accordingly it incorporates the following features:

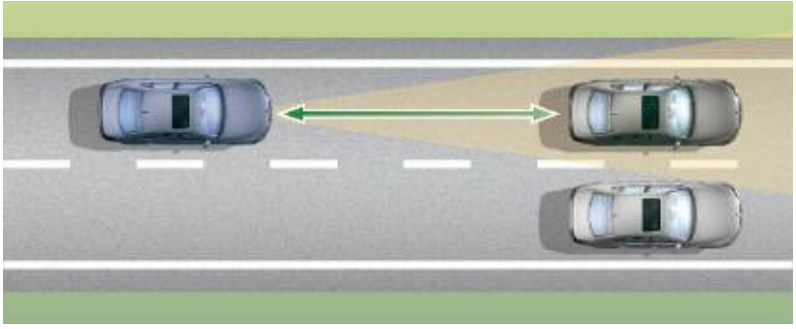
- Selection of desired speed in increments of 1 mph and 5 mph.
- Usable road-speed range of 20 mph to vehicle's maximum speed (max. 155 mph)
- Acceleration and deceleration of vehicle in two stages using the control lever
- Operation of brakes when travelling downhill and slowing down with DCC
- Modulation of longitudinal acceleration and road speed when cornering at high lateral acceleration levels.

Active Cruise Control with Stop & Go Function

Familiar ACC Function

The familiar Active Cruise Control (ACC) system keeps the car at a constant speed while there is no vehicle directly in front. It switches automatically to maintaining a safe distance as soon as its sensors detect a slower vehicle ahead in the same lane. Thus it relieves the burden on the driver not only on quiet roads but also in heavy traffic. ACC takes over the onerous task of repeated acceleration and braking in order to precisely control speed and distance from the vehicle in front. With ACC, this is only possible in moving traffic.

The driver can set the desired speed to between 15 and 110 mph. There are four possible settings for the desired distance.



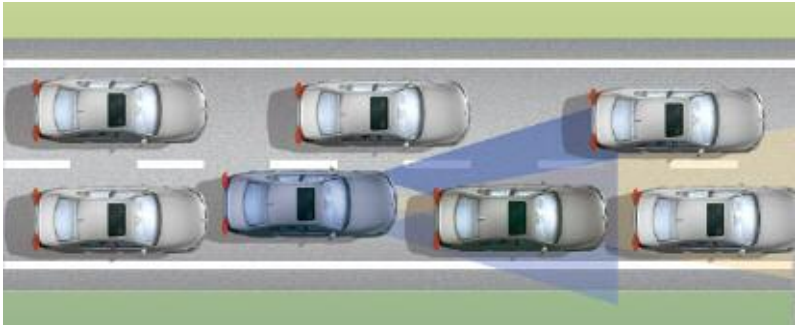
New ACC Stop & Go Function

The new Active Cruise Control with Stop & Go function (ACC Stop & Go) extends the usable range of ACC to low speeds right down to 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 start moving again, the driver has to acknowledge that indication by operating the control lever or accelerator pedal.

Only if the car is stationary for a very short time does the ACC Stop & Go automatically start the car moving again.

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 driver can set the desired speed to between 15 and 110 mph as with other systems. There are also four desired distance settings as with ACC.

Technically, the following challenges had to be overcome in order to implement ACC Stop & Go.

1. Detection of external environment directly in front of vehicle across full vehicle width.
   This is necessary in order to be able to reliably detect all road users at close proximity that are likely to be encountered at low speeds.
   Therefore, in addition to the familiar ACC sensor (long-range sensor), new sensors (close-range sensors) were developed.
2. Optimization of and development of new sensor data processing and control algorithms. At low speeds, other road users and you yourself use higher acceleration and deceleration rates.
   Accordingly, the system had to be designed so as to be able to cope with such dynamic traffic situations.

Adaptive Braking Assistance

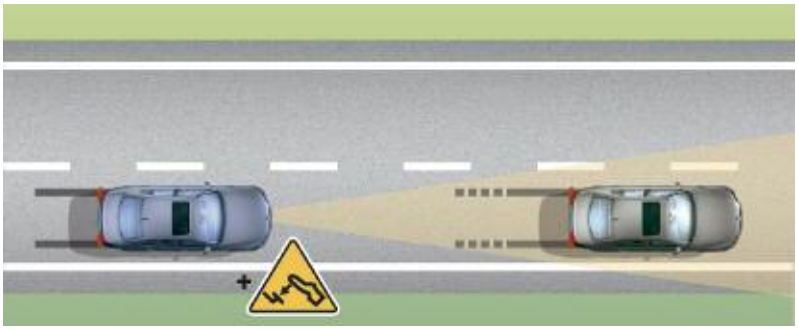
Whereas earlier driver assistance systems have only made use of information from the vehicle's external environment for convenience functions, Adaptive Braking Assistance (ABA) is the first system to utilize that information for safety functions.

On the basis of the object data supplied by the radar sensors and data relating to the vehicle's motion, an algorithm decides whether and to what degree one of the two constituent functions is to be activated:

- Priming of the braking system and
- Lowering the threshold for the Hydraulic Braking Assistance function.

Adaptive Braking Assistance works best in situations where the car is following another vehicle that suddenly performs an emergency braking operation. Its effect is to give the driver braking effect the moment the brake pedal is touched. In addition, the lowering of the threshold means that the Hydraulic Braking Assistance is triggered more easily.

The consequence is a shorter braking distance which may enable an accident to be avoided altogether or at least the impact speed to be reduced as much as possible.



System Overview

Component Locations

If a customer orders "Cruise control with braking function", no additional components are fitted on the vehicle as the function is integrated in the DSC control unit software.

Therefore, only the new sensors and control units for the option "Active Cruise Control with Stop & Go function" are presented here. They also include the essential components of the Adaptive Braking Assistance system.

Radar sensors for ACC Stop & Go, Front view

Index	Explanation
1	Long-range radar (LRR) sensor
2	Short-range radar (SRR) sensor, right
3	Short-range radar (SRR) sensor, left

The two short-range sensors are identical components that have the same part number.

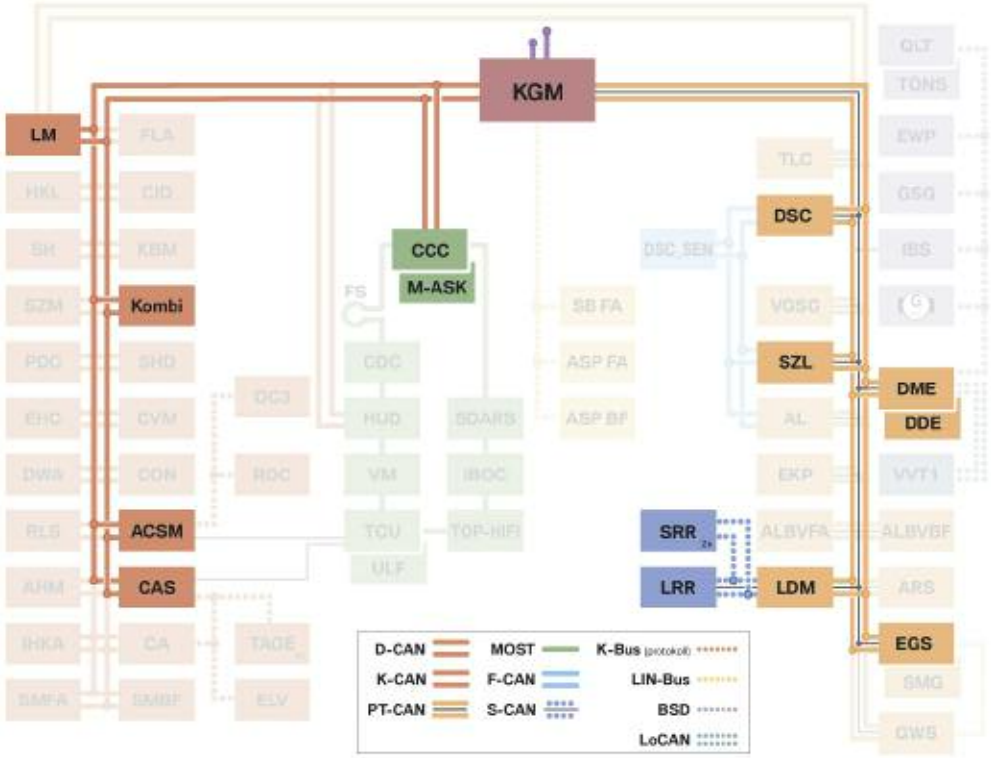
The view illustrated shows the front of the vehicle without the plastic bumper trim.

Note: The short-range sensors are fitted behind the bumper trim on the bumper crossmember. Therefore, they are only visible in this view and not with the bumper trim in place.

The location of the long-range sensor for the ACC Stop & Go is identical to that of the sensor for the familiar ACC system.

Electrical System Integration

Bus System Integration



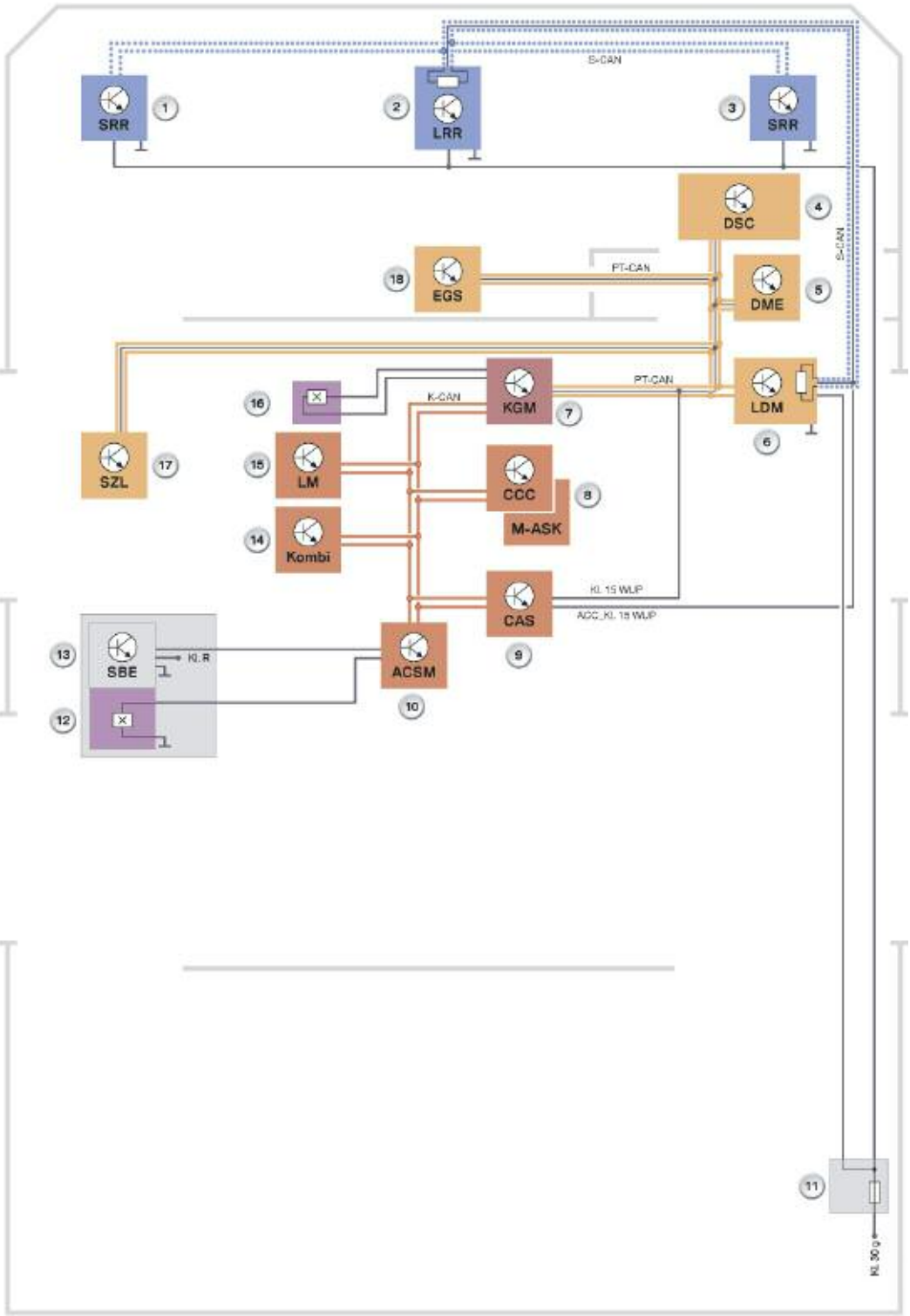
Index	Explanation	Index	Explanation
ACSM	Advanced Crash Safety Module	KOMBI	Instrument cluster
CAS	Car Access System	LDM	Longitudinal Dynamics Management
CCC	Car Communication Computer	LM	Lamp Module
DDE	Digital Diesel Electronics (ECU)	LRR	Long-range Radar Sensor
DME	Digital Engine Electronics (ECU)	M-ASK	Multi Audio System Controller
DSC	Dynamic Stability Control	SRR	Short-range Radar Sensor
EGS	Electronic Transmission Management	SZL	Steering Column Switch Cluster
KGM	Body Gateway Module		

The equipment option Active Cruise Control with Stop & Go function on the E60/E61 LCI brings with it the new Sensor CAN (abbreviated to S-CAN) bus system.

The S-CAN basically functions in the same way as the PT-CAN.

It has been introduced in order to be able to transfer the large volumes of data from the LRR and SRR radar sensors to the LDM control unit without affecting data communication between the other vehicle systems.

System Circuit Diagram fro ACC Stop & Go



Index	Explanation	Index	Explanation
1	SRR, left	10	ACSM control unit
2	LRR	11	Fuse in boot (power supply for LDM and radar sensors)
3	SRR, right	12	Belt buckle switch, driver's seat
4	DSC control unit	13	Seat occupancy detector, driver's seat
5	DME control unit	14	Instrument cluster
6	LDM control unit	15	Light module
7	KGM control unit	16	Door switch, driver's door
8	CCC/M-ASK control unit (navigation system)	17	Steering column switch cluster
9	CAS control unit	18	EGS control unit

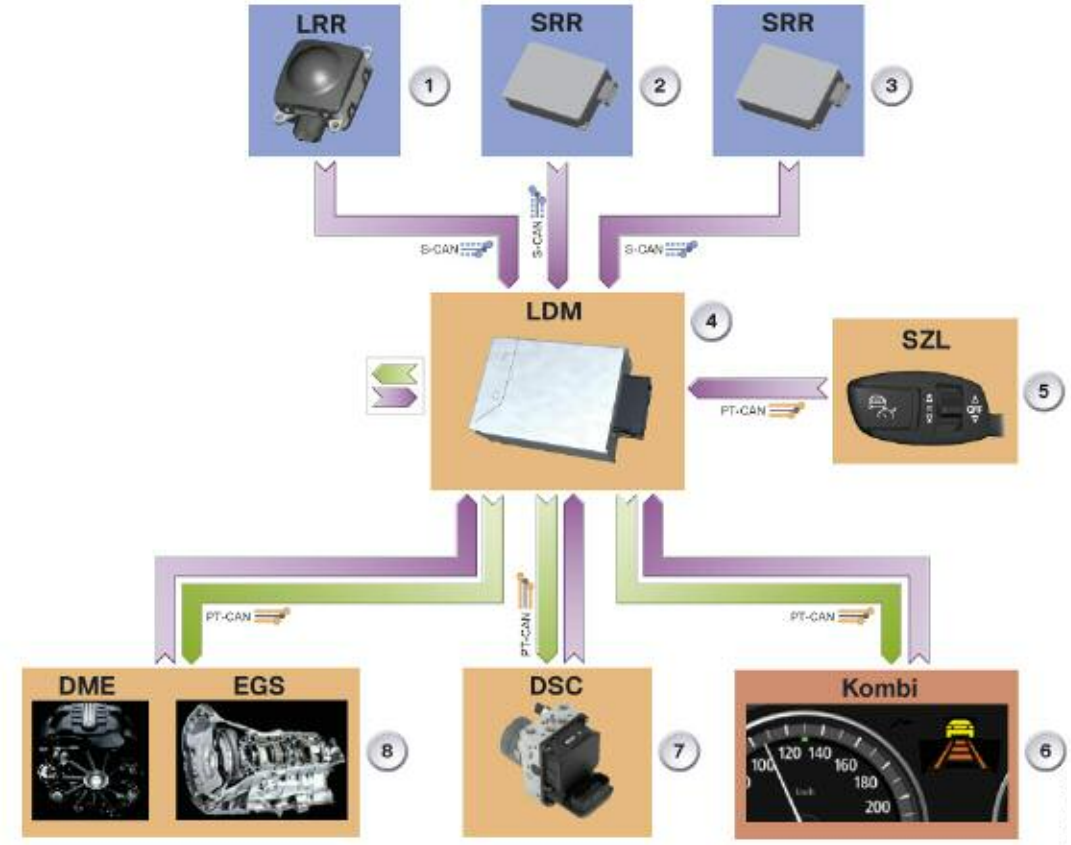
The new architecture for ACC Stop & Go illustrated here includes the LDM control unit, Sensor CAN and the short-range radar sensors as new components. It is being used for the first time on the E60/E61 LCI.

The characteristic feature of the previous architecture was that the ACC sensor was connected to the PT-CAN. That architecture remains in use for the cruise control on the E63/E64 for the time being.

For the purposes of comparison, the previous ACC architecture is illustrated below in the system circuit diagram.

Principles of Operation

Functional Integration



ACC Stop & Go is capable of performing gap modulation at speeds down to standstill (car is stopped). The car starts moving again on acknowledgement from the driver or automatically if only stationary for a very short period.

The control functions are integrated in the LDM control unit. The radar sensors provide information about the objects in front of the vehicle. Adaptive Braking Assistance uses information from the long-range radar sensor to detect emergency braking situations when following another vehicle. It makes it easier for the driver to obtain optimum braking effect by intervening in DSC functions.

Index	Component	Functions
1	Long Range Radar Sensor	• Detecting objects at long range, pre-processing object data, broadcasting list of objects on S-CAN (for ACC Stop & Go) • Detecting objects, pre-processing object data, calculating activation criteria and broadcasting request signals on S-CAN (for Adaptive Braking Assistance)
2	Short Range Sensor, Left	• Detecting objects at short range, pre-processing object data, broadcasting list of objects on S-CAN (for ACC Stop & Go)
3	Short Range Sensor, Right	• As short-range radar sensor, left
4	LDM control unit	• Analysis of objects and selection of relevant object (for ACC Stop & Go) • Interpretation of driver control signals and generation of display signals (for ACC Stop & Go) • Cruise control, gap modulation, and cornering speed modulation (for ACC Stop & Go) • Control of power transmission and brake actuators by output of required settings on PT-CAN (for ACC Stop & Go) • Gateway between S-CAN and PT-CAN (for diagnosis and flash-programming of long-range radar sensor) • Gateway between S-CAN and PT-CAN (for Adaptive Braking Assistance)
5	DCC/ACC control lever	• Generation of driver control signals (for DCC/ACC Stop & Go)
6	Instrument cluster	• Display of indications requested by LDM (for ACC Stop & Go) • Supply of signal for displayed speed (for ACC Stop & Go)
7	Brakes (DSC)	• Execution of braking levels specified by LDM when car is in motion and stationary (for ACC Stop & Go) • Execution of Adaptive Braking Assistance functions on instruction from LDM (priming of braking system and lowering of threshold for Hydraulic Braking Assistance) • Supply of signals relating to motion status of the car and brake pressure
8	Power transmission system consisting of engine and gearbox (DME and EGS)	• Execution of power output levels specified by LDM when car is in motion and stationary (for ACC Stop & Go) • Supply of signals indicating power transmission forces (for ACC Stop & Go)

In addition to the most important constituent parts of the system complex for ACC Stop & Go and Adaptive Braking Assistance as listed above, there are other functional groupings that are summarized below.

Other Signals to/from LDM (PT-CAN)			
In/Out	Information	Source/Recipient	Function
In	Road type, stretch of road	CCC > KGM > LDM	Adaptation of LDM control parameters according to navigation data
In	GPS location	CCC/M-ASK > KGM > LDM	Shutdown of short-range radar sensors in the vicinity of astronomical radio telescopes
In	Terminal status, engine running	CAS > KGM > LDM, DME > LDM	Activation condition for ACC/DCC
In	Automatic transmission selector position	EGS > LDM	Activation condition for ACC/DCC
In	Steering angle	SZL > LDM	Extrapolation of vehicle lane course (when stationary)
In	Driver's door open/closed	Door switch > KGM > LDM	Warning if driver is about to get out
In	Driver's seatbelt fastened/unfastened	Belt buckle switch > ACSM > KGM > LDM	Warning if driver is about to get out
In	Driver's seat occupied/unoccupied	Seat occupancy detector > ACSM > KGM > LDM	Warning if driver is about to get out
Out	Request for hazard warning flashers	LDM > KGM > LM	Warning if driver is about to get out
Out	Request for horn	LDM > SZL	Warning if driver is about to get out

Note: ACC Stop & Go and Adaptive Braking Assistance are highly integrated functions.

In the event of customer complaints, reports of failure or initially unexplained function behavior, the fault memories of the LDM and long-range radar sensor should be checked first and the programmed testing sequences followed if necessary.

If that does not identify the problem, all control units and sensors involved in the system complex must be manually checked.
A precise examination of the PT-CAN, S-CAN and K-CAN bus systems is particularly advisable in the event of signal or communication faults.

Cruise Control with Braking Function (DCC)

As this function was already familiar from the E9x models before being adopted on the E60/E61 LCI, only the most important details and new features are presented here.

Functions

Cruise Control

The cruise control calculates a required acceleration rate on the basis of the desired speed set by the driver and the vehicle's current actual speed. That acceleration rate may be positive, if the desired speed is greater than the actual speed, or negative if the reverse is the case.

Accelerating and Decelerating Using the Control Lever

The control lever allows the driver to do more than just set the desired speed. It also provides the "Easy Dynamics" function. If the control lever is pressed and held forwards or backwards, that is interpreted as a direct acceleration or deceleration command. The rate of acceleration or deceleration is dependent on whether the driver pushes the lever to the first or second position.

This mode takes precedence over cruise control.

Cornering Speed Modulation

Also known as "Lateral acceleration control", this function has the purpose of preventing the lateral acceleration rate when cornering from exceeding a comfortable level when cruise control is active.

The actual lateral acceleration is calculated from the road speed and the yaw rate. That figure is then compared to a threshold level, which is speed-dependent, with the purpose of achieving the following apparently contradictory aims:

- Avoiding irritating, over-restrictive intervention in situations where the driver would corner at higher lateral acceleration rates.
  Examples: at low speeds such as when on a mountain road or at high speeds on a highway.
  In those situations a higher threshold is applied.
- Intervening effectively and accordingly bringing about a clearly perceptible reduction in dynamic forces at typical trunk road speeds. That is when most drivers perceive too high lateral acceleration as unpleasant, which is why a lower threshold is applied for such situations.

The output variable from this function is also a required level for longitudinal acceleration.

Prioritizing Required Settings

From the required longitudinal acceleration rates calculated by the above control functions, the required setting that has the highest priority is selected according to the situation. When doing so, abrupt jumps when switching from one required setting to another are avoided by signal filtering.

Estimating Contributory Forces

In order to be able to put the prioritized longitudinal acceleration rate into effect by means of the actuators, an acceleration or deceleration rate must be calculated.

Example: when driving uphill, the engine power required to bring about a specific longitudinal acceleration rate is greater than would be required on the flat. If it is necessary to decelerate when going uphill, less braking force is required than on the flat.

In order to be able to correctly calculate the necessary forces, the precise figures would be required not only for the gradient but also for the mass of the vehicle, the rolling resistance, the wind resistance and a number of other accelerating or retarding forces.

Since there are no sensor systems for any of those contributory forces, an estimated figure is calculated by comparing the two following variables:

- the vehicle's actual motion variables and
- the vehicle's expected motion variables based on the power transmission and braking forces currently in effect.

The figure for the contributory force thus determined is included as an added quantity in the calculation of the required longitudinal acceleration rate.

Control of Actuators

In order to bring about the longitudinal acceleration calculated by the control functions and compensate for the contributory forces that are in effect, power transmission and/or braking forces must be initiated.

Accelerating the vehicle generally only involves specifying a required setting for the power transmission system consisting of engine and gearbox. (In the exceptional case of a steep descent, it may also be necessary to operate the brake to bring about a specific positive acceleration rate.)

If the vehicle is to be slowed down, the system first of all ascertains how great the possible retarding effect of the power transmission system (braking effect of engine and gearbox) is and signals it to the drivetrain control units (DME and EGS).

Only the remaining retarding force required is signalled as the required deceleration rate to the braking system control unit (DSC).

Note: If the brakes are noticeably applied in order to achieve the desired vehicle deceleration rate, the vehicle's brake lights are also switched on (legal requirement).

Operation and Display

Activation and Deactivation

The preconditions for operation for the DCC function must be satisfied before operation of the control lever by the driver can be acted upon as a request for activation.

Those preconditions for operation are:

- Vehicle's road speed must be within the permitted range (above 20 mph)
- Brake pedal must not be depressed
- A forward gear (manual gearbox) or Drive (automatic transmission) must be engaged
- Parking brake must not be on
- DSC must be switched on and no control intervention currently in progress
- There must be no system fault present

If any of those conditions is not met, activation is prevented despite any attempts by the driver to activate the function.

Conversely, if the function is active when any of those conditions ceases to be met, the function is deactivated.

Changing the Desired Speed

If the cruise control is already active, the driver can change the desired speed in increments of two different sizes by operating (pressing and immediately releasing) the control lever.

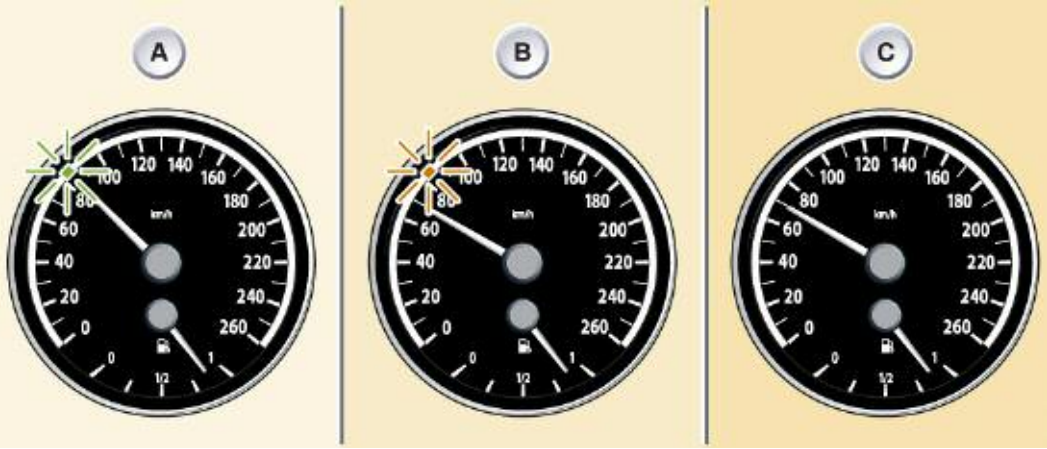
- Pressing the lever to the first position increases or decreases the desired speed by 1 mph.
- Pressing the lever to the second position increases or decreases the desired speed by 5 mph.

Pressing and holding the control lever sends a direct instruction for one of the two acceleration or deceleration rates (see the section "Control functions").

While the lever is held, the vehicle's actual speed changes due to the acceleration or deceleration rate applied. After operating the lever, the driver generally wants to continue at the resulting speed. Therefore, while the vehicle is accelerating or decelerating, the desired speed changes to match the actual speed.

The range of adjustment for the desired speed is between 20 and 155 mph for the DCC function.

The desired speed selected is permanently indicated by means of an illuminated mark on the perimeter of the speedometer.



Indication of Desired Speed on Speedometer Perimeter

Index	Explanation
A	The mark is colored green when the system is active. It then indicates the desired speed to which the system is working.
B	The mark shows orange when the system is inactive. It then indicates the desired speed last selected, which can be reactivated by the driver.
C	The mark is not visible if the system is inactive and has not been used since the engine was last started. In those circumstances, there is no stored desired speed that the driver could reactivate.

When the system is switched on or the desired speed changed, an additional indication is displayed: the new setting for the desired speed is shown in figures on the variable display panel of the instrument cluster.

This method of indication is also used if activation is not possible because the preconditions for operation are not satisfied. In that case, three lines are shown instead of the figures.

Monitoring Functions

All monitoring functions serve the two purposes of preventing the function from operating with incorrect input signals or parameters and also preventing critical dynamic handling conditions arising from system faults.

Symbol displayed on fault related failure of cruise control with braking function

For those reasons, all input signals, the operational status of the associated systems involved and the system's own control unit hardware are monitored. If a fault is detected, the control function is shut down or its activation prevented. In addition, an indication is given on the instrument cluster by means of a check control message.

Symbol displayed on deactivation of cruise control with braking function due to operation reconditions ceasing to be met

The failure message referred to above should not be confused with the message the driver receives when the system is deactivated due to the preconditions for operation ceasing to be met.

Active Cruise Control with Stop & Go Function

Even with its distinctly wider operating range, Active Cruise Control with Stop & Go function (ACC Stop & Go) remains a system intended to relieve the burden on but not replace the driver. The driver is and remains responsible for employing the system sensibly. The fact that the driver must continue to pay careful attention to the road traffic conditions is self-evident and is merely made easier by the system. Only in that way can the driver intervene promptly and in a controlled manner when ACC Stop & Go reaches its limits.

Information from the Vehicle's External Environment

Detecting Objects

Detecting other road users in front of the vehicle represents one of the most important functions of Active Cruise Control. With the introduction of the Stop & Go function, the system has to be capable of doing so not only at long range but also at short range right down to the area directly in front of the vehicle.

This is necessary because at low speeds, shorter gaps of only a few meters can be maintained (see the section "Gap modulation").

Consequently, that task cannot be performed by one radar sensor on its own. The familiar ACC sensor, now referred to as the long-range radar sensor, is supplemented by two additional short-range sensors.

In addition to the simple detection of objects, those sensors ascertain the position of objects on the x and y axes and their relative velocities in relation to the vehicle. From the relative speed, the sensors also compute the relative acceleration of the objects in relation to the vehicle. That figure is required for gap modulation.

Pre-processing Object Data

Initial processing of the object data (position and motion variables) is performed by the radar sensors themselves. They collate and track individual undefined objects over time in order to bridge detection gaps. They also pre-filter the object data.

The second processing stage takes place in the LDM control unit. The position data is first of all standardized and adjusted by the offset of the radar sensors from the vehicle's center axis (x axis).

The object data received from the different radar sensors then has to be merged because parts of the sensors' detection zones overlap.

That overlap occurs in the close-range zone in particular where objects are frequently detected by more than one sensor.

A further filtering process is then performed on the merged object data to take account of the special requirements of gap modulation.

Assessing Objects

In order to decide which object should used as the basis for gap modulation, an assessment rating is calculated for each object. The following two essential criteria are taken account of by the calculation:

1. The position and speed of the object relative to the vehicle.
   The closer the object is to the vehicle and/or the faster it is approaching the vehicle, the higher is its assessment rating.
2. Position of the object in the vehicle's lane.
   The radar sensors cannot identify the actual lane or the lane markings on the road. And the data from the camera based system that is used for the "lane departure warning" system is not available to the ACC at this stage. For that reason, the ACC Stop & Go, like the familiar ACC system, calculates a probable lane course ahead of the vehicle.

   While the vehicle is moving, it is based on variables that define the motion of the vehicle itself and the position of detected stationary objects.

   When the vehicle is stationary, the calculation is based primarily on analysis of the signal from the steering angle sensor. That means that steering wheel movements while the vehicle is stationary change the lane course calculated by the ACC Stop & Go and, consequently, the assessment of the objects detected.

The object with the highest assessment rating ultimately forms the basis on which gap modulation is performed.

In this processing phase, objects are also classified on the basis of their motion status. A distinction is made between moving and stationary objects. Special treatment is given to objects classified as stationary (since they were first detected).

Control Functions

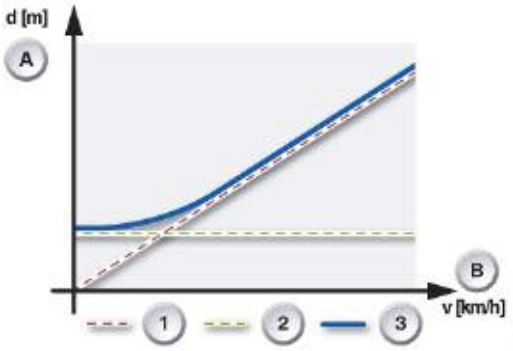
Cruise Control

The cruise control function on the ACC system basically operates in precisely the same way as on the DCC system.

Distance Control

Gap modulation is the core function of any ACC system. On the ACC Stop & Go system it is integrated in the LDM control unit. (As distinct from ACC on the E9x on which gap modulation is integrated in the ACC control unit.)

The driver can set the desired gap to one of four choices by means of a rocker on the control lever. On the basis of that desired gap setting, the ACC Stop & Go calculates the required distance from the vehicle in front.



Calculation of required gap for gap modulation by ACC Stop & Go

Index	Explanation
A	Required gap d in meters
B	Road speed v in kph
1	Required gap, in-motion component, proportional to road speed
2	Required gap, stationary component, constant
3	Resulting required gap from in-motion and stationary components

As with the familiar ACC system, the required gap when the vehicle is moving is proportional to the road speed (1).

At low speeds and when stationary, a second component is given greater weight by the ACC Stop & Go. This is a fixed quantity in meters (2). If this component were not taken into account, the required gap when stationary would be zero meters. Instead, this second component is used to set the desired gap when stationary (approx. 5 m).

The resulting required gap is calculated from the two components. They are differently weighted according to the vehicle's road speed.

The input data for the gap modulation function is the pre-processed object data relating to the object with the highest assessment rating.

In comparison with the previous ACC system, the new system had to meet additional requirements:

1. The maximum acceleration and deceleration rates for the ACC Stop & Go system have been increased compared with the ACC. The change was introduced for the low-speed range (below approximately 50 kph) as drivers uses greater rates themselves at those speeds but still perceive them as comfortable.

   Depending on the situation, the ACC Stop & Go accelerates at up to approximately 2 m/s^2 and decelerates at up to approximately 4 m/s^2.

   The increase was technically justifiable as, firstly, the additional short-range sensors have increased the reliability with which vehicles in front can be identified.
   And secondly, the projection of the lane course is also more reliable in the lower speed range, which is also why selection of the object on which control is based has also improved.

2. Traffic queue stability. In very heavy traffic moving at very slow speeds it is all the more important that following vehicles do not make successively greater changes to longitudinal dynamics (longitudinal acceleration) than the vehicle in front in each case. If that were to happen, at some point further along the queue a vehicle would be forced to make an emergency stop even though the first vehicle in the queue had only braked very slightly.

The ACC Stop & Go gap modulation function is designed in such a way that it reacts as soon as possible but not any more severely than the vehicle in front.

Cornering Speed Modulation

The cornering speed modulation function on the ACC Stop & Go is based on that of the DCC.

It has been extended to take account of the lateral limits of the radar sensor detection zones. If the bend being negotiated is so tight that objects can no longer be detected, it intervenes and prevents the vehicle accelerating.

Prioritizing Required Settings

Prioritization of the required settings on the ACC Stop & Go system is basically the same as on a DCC system. There is merely an additional specified control setting generated by the gap modulation function.

Estimating Contributory Forces

The estimation of contributory forces by the ACC Stop & Go is also based on the DCC system. Nevertheless, the fine detail required numerous optimizations because at slow speeds (under 20 mph) inaccuracies in the estimation of contributory forces are much more noticeable than at high speeds.

Greater accuracy of estimation combined with simultaneously quicker adaptation to changes in the contributory forces present was therefore necessary.

Control of Actuators

Apart from the situation when stationary, for which the data interface between the LDM and DSC has been extended, the control of actuators by the ACC Stop & Go is effected in the same way as by the DCC or ACC on the E9x.

Note: The brake lights are also switched on when the ACC Stop & Go brings the car to a stop.

Operation and Display

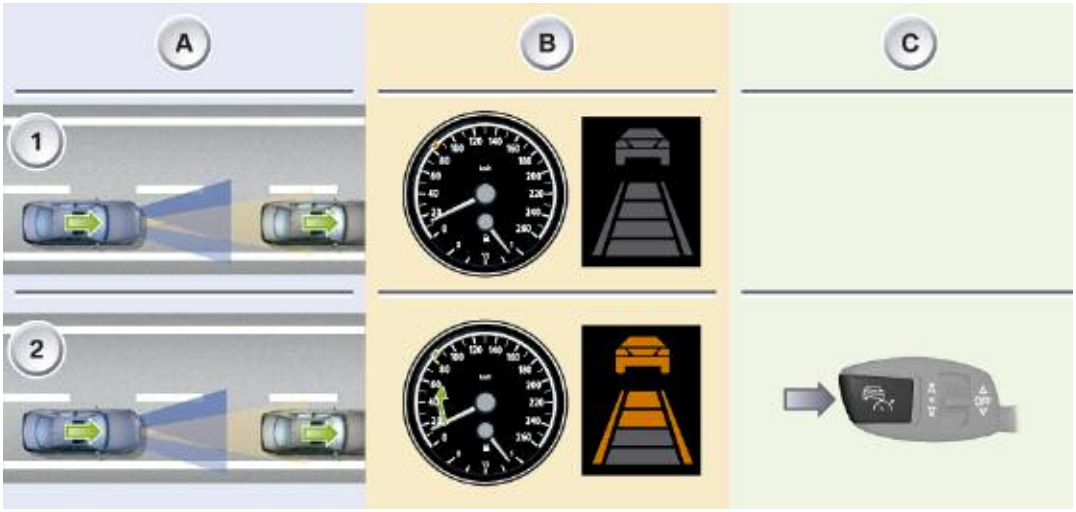
Activation and Deactivation

When the car is moving, the same conditions have to be met for the ACC Stop & Go system to be activated as for the familiar Active Cruise Control:

- Brake pedal must not be depressed
- Automatic transmission must be in Drive
- Parking brake must not be on
- DSC must be switched on and no control intervention currently in progress
- Radar sensors must be operational and not dirty
- There must be no system fault present

Activation when Moving

In contrast with the previous ACC system, ACC Stop & Go can be activated at speeds below 20 mph if a vehicle is detected ahead.



Activation of ACC Stop & Go when Moving

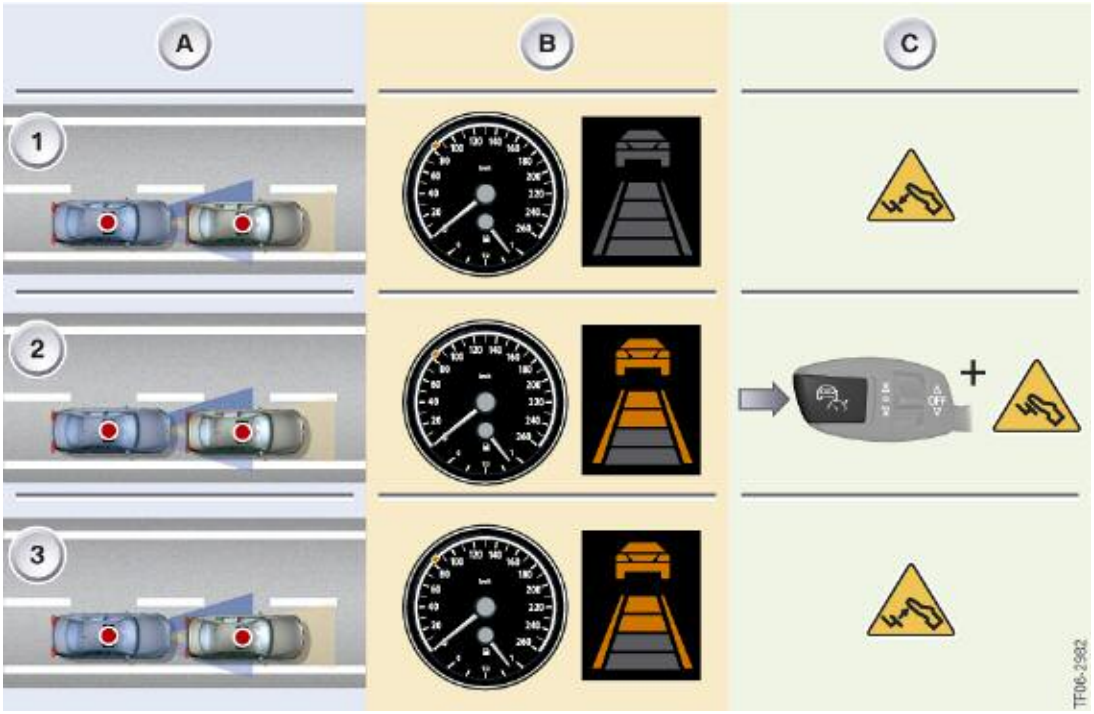
Index	Explanation
A	Road traffic situation
B	ACC indications on the instrument cluster
C	Control operations by driver
1	ACC Stop & Go is inactive. A desired speed has been stored from a previous activation (orange mark). Object and gap indications are off.
2	ACC Stop & Go is switched on by means of the Resume button. The desired speed mark changes color to green. The vehicle accelerates so as to either reach the desired speed or adjust the distance from the vehicle in front to the desired gap setting.

Activation when Stationary

If the driver wants to activate ACC Stop & Go when stationary, the same basic conditions must be met as when the vehicle is moving.

The following additional conditions must also be satisfied:

- The driver must be pressing the brake pedal to keep the vehicle stationary.
- There must be another stationary vehicle in front of the car.
- The driver's door must be closed and the driver must have the seat belt on.

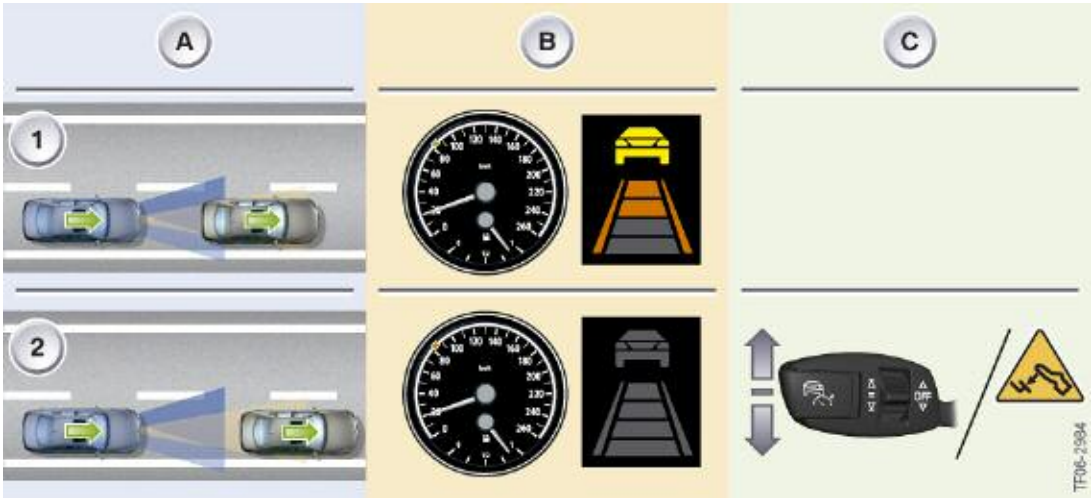


Activation of ACC Stop & Go when Stationary

Index	Explanation
A	Road traffic situation
B	ACC indications on the instrument cluster
C	Control operations by driver
1	ACC Stop & Go is inactive. A desired speed has been stored from a previous activation (orange mark). The object and gap indications are off. The driver is pressing the brake pedal to keep the vehicle stationary.
2	The driver continues to press the brake pedal while also pressing the resume button. This switches on the ACC Stop & Go. Object and gap indications are also switched on. The desired speed mark stays orange.
3	The driver releases the brake pedal. The active ACC Stop & Go system continues to keep the vehicle stationary by operating the brake. The desired speed mark stays orange to indicate that the ACC Stop & Go will not automatically move the car off (see the section "Stopping and moving off").

Deactivation when Moving

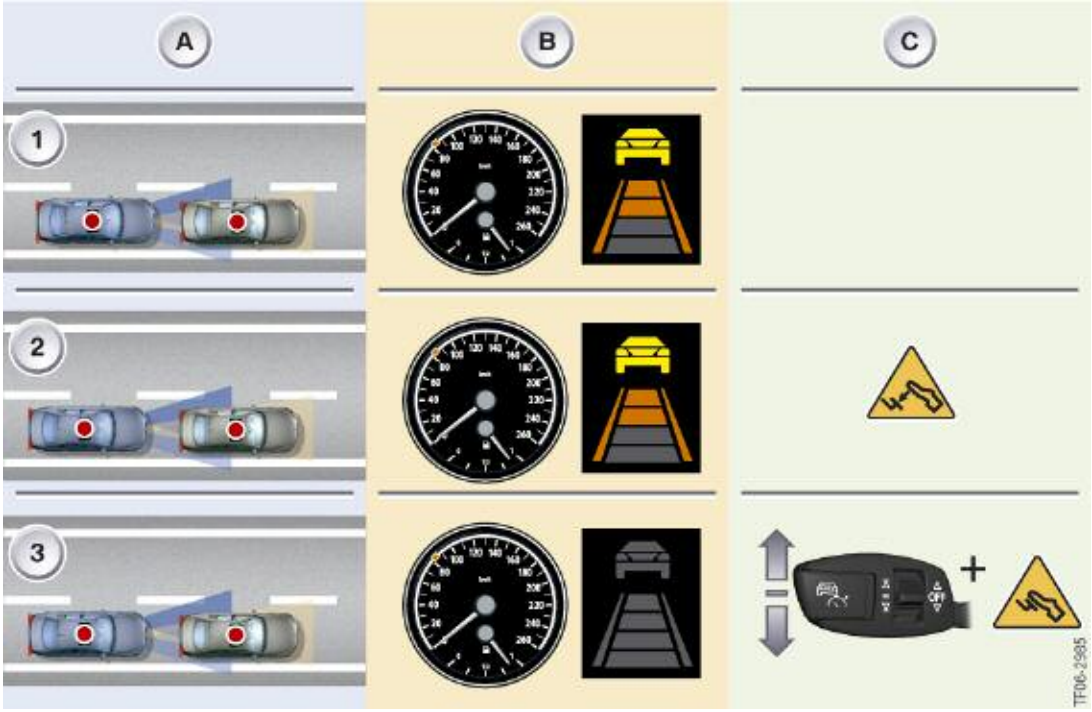
Deactivation of the ACC Stop & Go is effected by driver control operations that are more or less the reverse of those for activation.



Activation of ACC Stop & Go when Stationary

Index	Explanation
A	Road traffic situation
B	ACC indications on the instrument cluster
C	Control operations by driver
1	ACC Stop & Go is active. Object and gap indications are on. The desired speed mark is showing green.
2	The driver pushes the control lever up or down or presses the brake pedal to switch off the ACC Stop & Go. The object and gap indications are switched off. The desired speed mark changes color to orange thereby indicating that the last desired speed setting can be resumed.

Deactivation when Stationary



Deactivation of ACC Stop & Go when Stationary

Index	Explanation
A	Road traffic situation
B	ACC indications on the instrument cluster
C	Control operations by driver
1	ACC Stop & Go is active and holding the car stationary behind another stationary vehicle. Object and gap indications are on. The desired speed mark is showing orange.
2	The driver operates the brake pedal. ACC Stop & Go remains active, waiting for further control operations by the driver. If the driver were next to release the brake pedal, the ACC Stop & Go would remain active and keep the car stationary by operating the brakes. The indications would not change as a result of the brakes being operated.
3	As well as operating the brake pedal, the driver pushes the control lever up or down to switch off the ACC Stop & Go. The object and gap indications are switched off. The desired speed mark shows orange thereby indicating that the last desired speed setting can be resumed.

Changing the Desired Speed

The driver can change the desired speed for the ACC Stop & Go when the system is switched on in the same way as with the DCC.

The adjustment range for the desired speed setting is from 15 to 110 mph, as with the familiar ACC system.

Changing the Desired Gap

As with the familiar ACC system, the desired gap can be changed when the system is switched on by pressing and releasing the rocker on the control lever. The usual choice of four gap settings is offered and the selected setting is indicated by the bars below the object indication on the instrument cluster.

Changing the desired gap when the vehicle is moving produces an immediate perceptible vehicle response. It accelerates or slows down slightly to adjust the gap to the new setting.

Note: When the vehicle is stationary, changing the desired setting will not cause the vehicle to move off - it will neither move forwards to reduce the gap nor backwards to increase the gap.

Stopping and Moving Off

Although the "gap modulation" function basically operates at speeds down to zero (standstill), there are additional software functions that control the stopping and moving off sequences.

Their job is to operate the power transmission system and the brakes in such a way that the perception of the vehicle's Behavior by the driver and passengers is as comfortable as possible. In addition, the vehicle must not be allowed to roll backwards in the course of those operations.

Maximum driver assistance and relief would be offered by a Stop & Go function that automatically performed all operations from stopping to moving off again.

The function actually technically achieved is one that automatically stops the car but only automatically moves it off again if the car is only briefly stationary.

If the stationary period lasts longer than a few seconds, the ACC Stop & Go does not automatically move the vehicle off again.

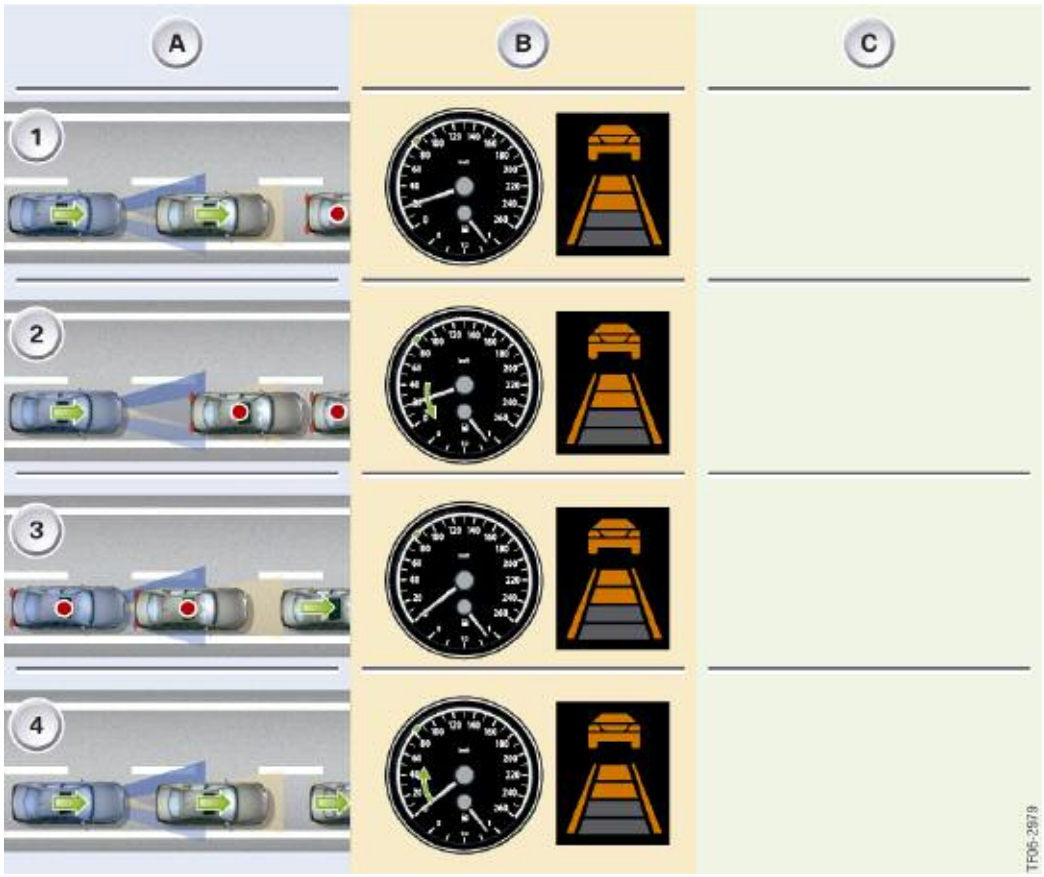
Instead, the ACC Stop & Go signals to the driver on the instrument cluster that it has detected a situation in which the vehicle can move forwards and only moves the vehicle off when the driver acknowledges that signal by a control operation.

Note: Requiring acknowledgement ensures that the driver is paying attention to the traffic situation again after an extended stationary period. Because even though the Active Cruise Control has been extended by the Stop & Go function, the driver remains responsible for driving the vehicle and making appropriate use of the assistance functions available.

For extended standstill phases, the ACC Stop & Go makes use of a Dynamic Stability Control function known as standstill management.

That function firstly ensures that the braking force necessary to stop the vehicle moving is increased as circumstances demand if the vehicle starts rolling when it shouldn't (longitudinal motion detection). In addition, standstill management observes whether there are interventions from the ABS system during the stopping sequence. If that is the case, skid detection, which reduces the braking force at each of the wheels in turn, is activated when the vehicle is "stationary". If any of the wheels starts rotating, the standstill management identifies that the vehicle is skidding. As a consequence, the ACC Stop & Go is switched off, the brakes are released on all wheels and the driver is informed by a check control message. Releasing the brakes makes the skidding vehicle steerable again. Of course, the driver still has the option of stopping the car again by operating the brakes if the road conditions allow.

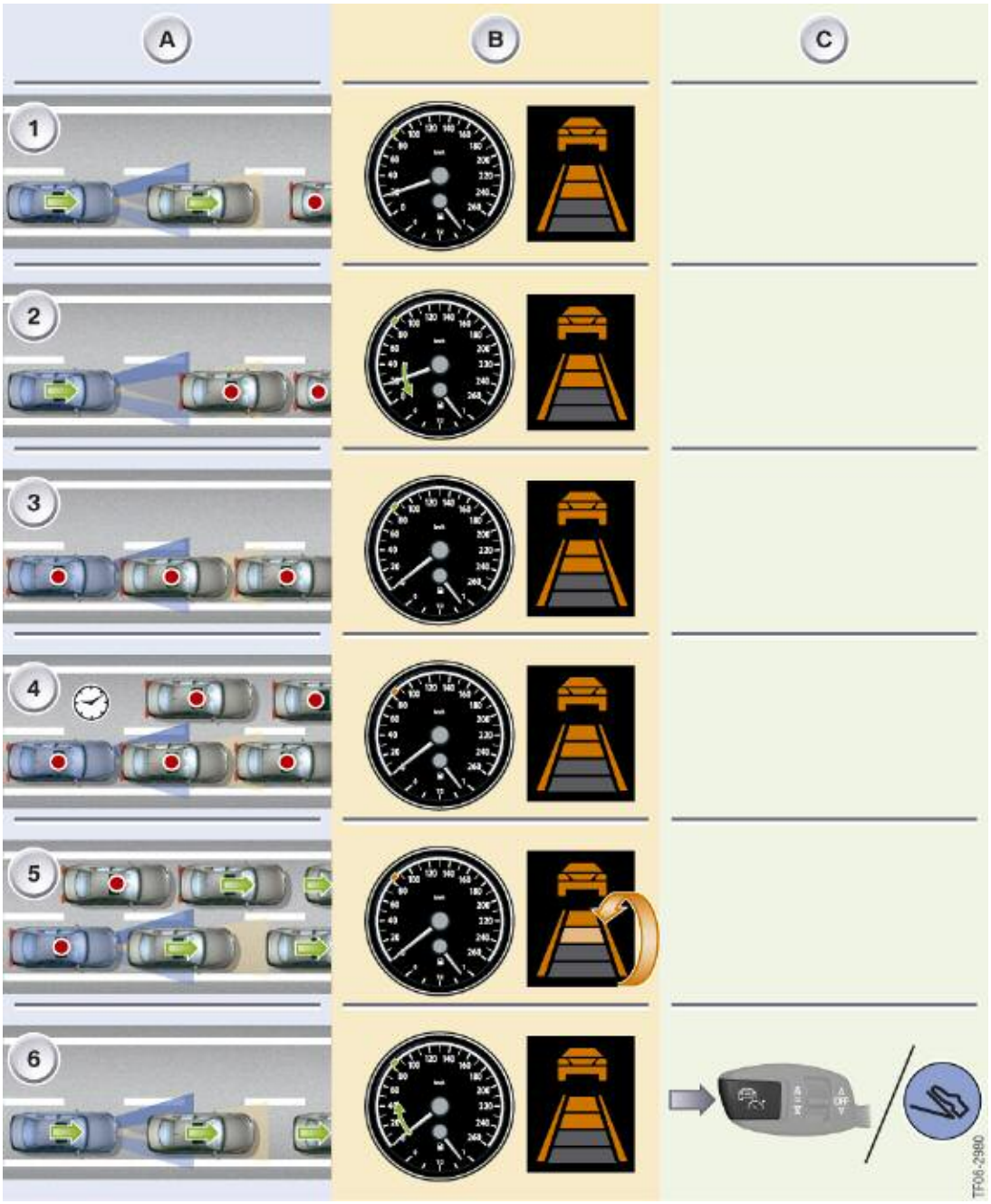
Automatic Moving-off Sequence



Stopping and Moving off Automatically with ACC Stop & Go

Index	Explanation
A	Road traffic situation
B	ACC indications on the instrument cluster
C	Control operations by driver (no control operations are required in this situation)
1	The vehicle with ACC Stop & Go is following another vehicle at a slow speed. Due to the short-range radar sensors, reliable detection remains possible at the resulting short distance between the vehicles.
2	The vehicle in front stops. The ACC Stop & Go vehicle automatically slows down by carefully controlled application of the brakes.
3	The ACC Stop & Go vehicle automatically comes to a halt. Once the vehicle is stationary, the brakes are applied in such a way that there is a certain amount of surplus braking force so as to ensure there is no undesirable movement of the vehicle. In the situation illustrated, the period of standstill is very short. The first vehicle in the queue has already started moving again.
4	The ACC Stop & Go detects that the vehicle in front has started moving again after a very short time and automatically starts the moving-off sequence. To do so, it gradually releases the brakes at the same time as increasing the transmission of power. As a result, the ACC Stop & Go smoothly starts the vehicle moving.

Moving-off Sequence with Driver Acknowledgement

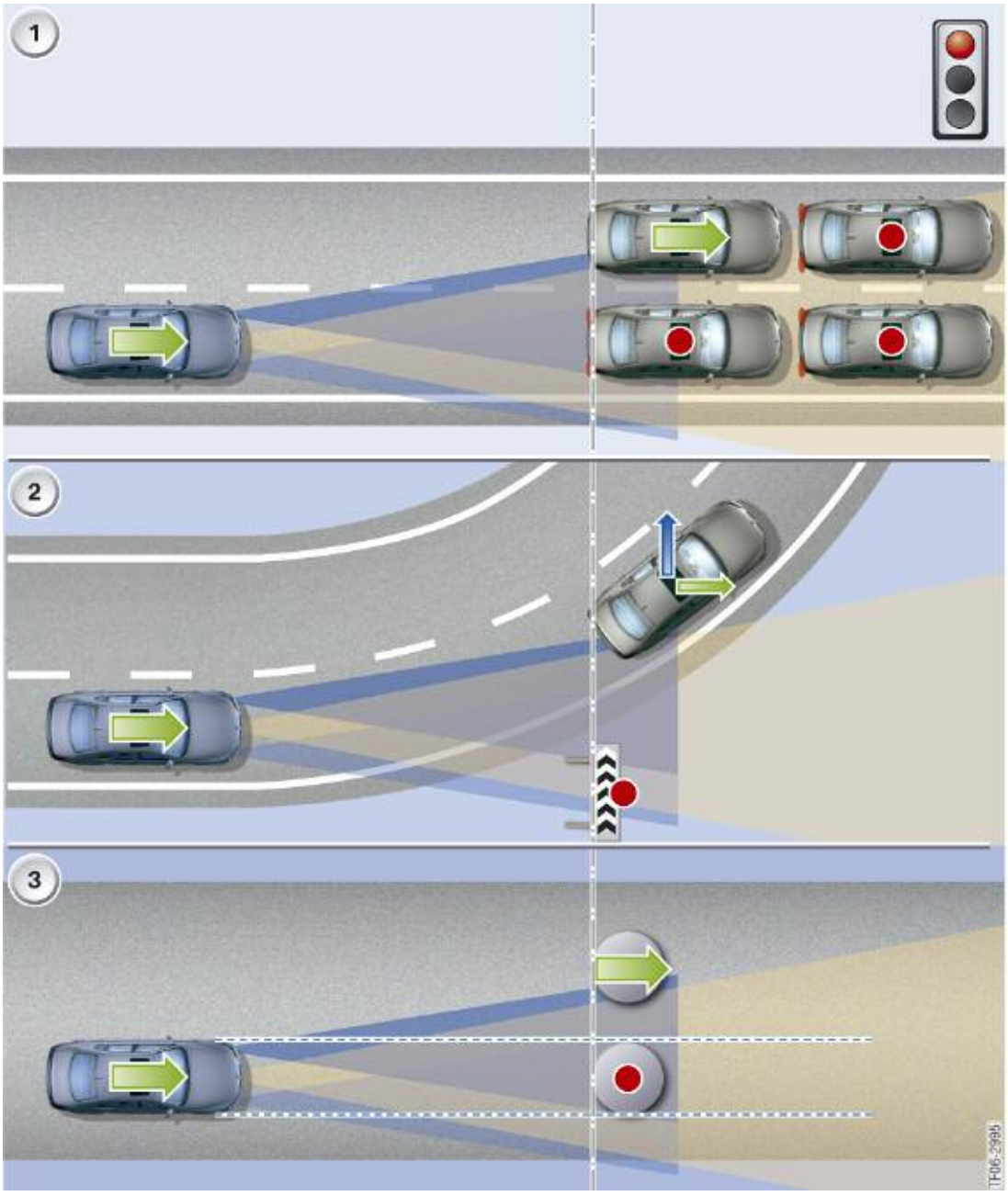


Stopping and Moving-off with Driver Acknowledgement

Index	Explanation
A	Road traffic situation
B	ACC indications on the instrument cluster
C	Control operations by driver
1	The vehicle with ACC Stop & Go is following another vehicle at a slow speed. Due to the short-range radar sensors, reliable detection remains possible at the resulting short distance between the vehicles.
2	The vehicle in front stops. The ACC Stop & Go vehicle automatically slows down by carefully controlled application of the brakes.
3	The ACC Stop & Go vehicle automatically comes to a halt. Once the vehicle is stationary, the brakes are applied in such a way that there is a certain amount of surplus braking force so as to ensure there is no undesirable movement of the vehicle.
4	In the situation illustrated, the traffic congestion increases and the standstill period is longer. The ACC Stop & Go and the DSC standstill management function make sure that the vehicle continues to be kept stationary. To signal to the driver that ACC Stop & Go will not automatically start the car moving, the desired speed mark changes color from green to orange. Object and gap indications remain on.
5	The traffic starts moving and the vehicles directly in front move off again. The ACC Stop & Go signals to the driver by means of rolling gap bars that it has detected a situation in which the vehicle can move off. But as long as the driver does not acknowledge the signal, the ACC Stop & Go continues to keep the vehicle stationary.
6	The driver acknowledges the moving-off signal from the ACC Stop & Go either by pressing the Resume button on the control lever or pressing the accelerator. The ACC Stop & Go then resumes the control function and follows the vehicle in front.

Response to Stationary Objects

Special treatment is given to stationary objects that have not been detected as moving (velocity equal to zero) since they were first identified.



Road Traffic Scenarios Involving Stationary Objects

Index	Explanation
1	Real road traffic scenario The vehicle with ACC Stop & Go approaches a stationary vehicle that has not been identified as moving at any point up to then. In this scenario, the driver wants the ACC Stop & Go to slow the car to a stop in response to the stationary object in front.
2	Real road traffic scenario From a straight section of road, the vehicle with ACC Stop & Go approaches a bend at the beginning of which there is a warning sign. That warning sign is similarly identified by the ACC Stop & Go as a stationary object. In this scenario, the driver does not expect the ACC Stop & Go to slow the car down in response to the stationary warning sign.
3	Road traffic scenario as seen by ACC Stop & Go The real road traffic scenarios (1) and (2) are indistinguishable to the ACC Stop & Go as the radar sensors merely provide information about the position and motion status of the objects detected. They do not provide any details of the type of object, which is why in both cases the ACC Stop & Go responds as in scenario (3).

A distinction can only be made between actual road users and other objects such as road signs or buildings if we assume that a road user must have been moving at some time.

That is precisely the assumption that cannot be made of stationary objects so that no reliable conclusion about their significance with regard to ACC response can be drawn either.

Note: To prevent the car slowing down inappropriately, for instance for road signs, ACC and ACC Stop & Go never respond to stationary objects. In other words, it does not even slow the vehicle down if it is approaching the end of a stationary queue of traffic at high speed.

However, the driver can activate the ACC Stop & Go function when the vehicle is stationary behind another stationary object. In that situation it is assumed that the driver would only activate the function when stationary behind another road user.

Instruction to Take Over Control

As with the familiar ACC, the ACC Stop & Go also has procedures for instructing the driver to take over control. A new algorithm has been developed to take account of the substantially more diverse and dynamic situations in the lower speed range and shorter distance zone. Development of a new algorithm also made it possible to improve the instruction to take over control in the higher speed range.

Now, rather than the ACC Stop & Go not informing the driver until it has reached the self-imposed limit for maximum deceleration when it can, therefore, no longer control the situation, the instruction to take over control is initiated if the motion data from the system's own vehicle and the vehicle in front demand a quick response from the driver (before the ACC Stop & Go has achieved the maximum deceleration). Reduction of the gap to below a minimum distance for an extended period has also been integrated as a third trigger criterion.

A feature that remains the same compared with the previous ACC is that the instruction to take over control is only issued when the ACC is switched on. The method of indication is also unchanged. It consists of a visual signal in the form of the red flashing object symbol and a two-tone audible beep signal.

Red flashing object symbol as instruction to take over control

Warning if Driver is About to Get Out

ACC Stop & Go uses the DSC hydraulics to reliably slow the vehicle to a halt and keep it stationary. However, the following general parameters and differences from other systems must be made clear:

- When the vehicle comes to a standstill in the course of ACC Stop & Go operation, this constitutes a transitional phase before the vehicle moves off again. ACC Stop & Go is, therefore, by no means a system for permanently parking the vehicle.
- Without a supply of electricity, the DSC hydraulics are unable to indefinitely maintain the braking force necessary to keep the vehicle stationary. The valves require a constant supply of electricity and the hydraulic pump also has to be brought into action if the pressure in a brake circuit threatens to drop. Under extreme circumstances, the DSC hydraulics may even become overheated. In such conditions, the standstill function has to be cancelled in order to protect the components from permanent damage.
- The only technical device on the vehicle designed to secure it against rolling away is the parking brake. Some BMW vehicles now have an electromechanical parking brake. It can be electronically operated if needed so as to automatically secure the vehicle against rolling away.

The E60/E61 LCI, however, continues to be fitted with a conventional hand operated parking brake.

Note: The driver is responsible for securing the vehicle against rolling away and remains so even with ACC Stop & Go fitted on the E60/E61 LCI.

This can be done by engaging Park on the automatic transmission but the parking brake should be applied as well.

As the use of the ACC Stop & Go driver assistance function may result in drivers becoming unaware of that responsibility, a multi-stage warning concept has been developed. It is designed to prevent sudden and unexpected cessation of the standstill function on the one hand while also insistently reminding the driver to carry out that responsibility.

Typical Warning Sequence if Driver is About to Get Out

Index	Explanation
A	Actions by driver that trigger warning stages
B	ACC indications on the instrument cluster
C	Road traffic situation or perceptible response of vehicle with ACC Stop & Go
0	No warning stage active ACC Stop & Go is switched on and automatically holding the car stationary behind another vehicle. That vehicle moves away after an extended standstill period.
1	Warning stage one is active The driver undoes the seatbelt or opens the driver's door. The belt buckle switch and the door switch generate signals when that happens. The driver may be intending to get out of the car. ACC Stop & Go remains active and continues to keep the vehicle stationary. The yellow warning symbol on the instrument cluster is accompanied by a single audible signal. In addition, a check control message warning that the vehicle could roll away is displayed. If the driver fastens the seat belt again and closes the driver's door, the warning is cancelled and the ACC Stop & Go continues to hold the vehicle stationary as before.
2	Warning stage two is active The driver has undone the seatbelt and opened the driver's door. The driver's intention to get out of the car is more definite. ACC Stop & Go switches itself off and releases the brakes. The vehicle starts to move. This alone raises the barrier to the driver getting out of the vehicle completely. The red warning symbol on the instrument cluster is accompanied by a repetitive audible signal. The check control message that is also displayed insistently informs the driver that the vehicle is now moving and it must be secured against rolling away. Even if the driver fastens the seat belt again and closes the driver's door, the ACC Stop & Go remains switched off. It can subsequently be reactivated by the driver.
3	Warning stage three is active As well as having undone the seat belt and opened the driver's door, the driver gets out. This is detected by the fact that the driver's seat is no longer occupied. The vehicle continues to move. In addition to the alerts inside the vehicle, the light module switches on the hazard warning flashers and the SZL sounds the horn repeatedly. Those alerts perceptible from outside the vehicle are intended to persuade the driver to get back in the car and secure it against rolling away.

In addition to the typical sequence described above, there are a number of other possible combinations of events that can trigger the individual warning stages.

Example: the driver undoes the seat belt and raises himself/herself from the seat. The driver's door is still closed.

Warning stage 2 is triggered. In this case too the vehicle will start to move because the ACC Stop & Go switches itself off!

Monitoring Functions

As is familiar from the Active Cruise Control on the E9x models, the LDM monitors the system complex to check that all constituent systems are operational, all input signals required for the function are present and correct and the control unit's own hardware is functioning properly.

That same concept has basically been adopted for the ACC Stop & Go system.

The new constituent systems have been incorporated into the monitoring concept.

Note: When troubleshooting it is important to include not only individual components but all systems involved in the extended system complex.

If a fault occurs, the function is completely shut down as with previous ACC systems. In addition, the driver is informed of the failure by an indication on the instrument cluster and a check control message. Reactivation is not possible until the fault has been eliminated.

Symbol displayed on fault related failure of Active Cruise Control with Stop & Go function

The failure message referred to above should not be confused with the message the driver receives when the system is deactivated due to the preconditions for operation ceasing to be met. Reactivation is possible once the preconditions for operation are satisfied again.

Symbol displayed on deactivation of ACC Stop & Go due to preconditions for operation ceasing to be met

In order to be able to offer the driver as wide a range of functions as possible for as long as possible, the following cases are given special treatment. Appropriate symbols and information in the check control message explain the circumstances to the driver in each case.

- If only the short-range radar sensors are sporadically non-operational, the ACC function is not shut down until the vehicle's speed drops below a threshold of approximately 20 mph. It is only at speeds below that threshold that the short-range radar sensors are indispensable for overall system function with the result that shutdown can be delayed until that point.
- If one or more radar sensors are sporadically unavailable, the ACC function is shut down but the driver can still switch to DCC mode so as to at least benefit from the assistance of that function.

This is option is particularly useful if the radar sensors are dirty or the vehicle is close to an astronomical radio telescope. This option is also possible if the radar sensors temporarily signal a fault status.

Adaptive Braking Assistance (ABA)

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 sub-functions of:

- priming the braking system and
- lowering the threshold for the Hydraulic Braking Assistance function

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.

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!

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.

Therefore, the LDM control unit acts as a gateway for that purpose from the S-CAN to the PT-CAN.

Note: Adaptive Braking Assistance is always active and does not have to be switched on separately by the driver.

Information from the Vehicle's External Environment

Detecting Objects

Adaptive Braking Assistance only takes account of objects detected by the long-range radar sensor. The short-range sensors would only increase the usable number of relevant objects by a very small margin. The reason for that is that Adaptive Braking Assistance is an anticipatory function that must be followed by a response on the part of the driver. The time thus required necessitates detection of an emergency braking situation as early as possible and, therefore, focussing primarily on objects that are relatively distant.

Pre-processing Object Data

The long-range radar sensor pre-processes the position and motion data of the objects detected more or less as it does for the ACC Stop & Go function. However, different parameters are used for filtering, for instance, in order to take account of the more dynamic nature of emergency braking situations.

Assessing Objects

Different assessment criteria are applied to the objects for the two constituent functions:

- For brake-system priming, only objects in the same lane as the vehicle are treated as relevant.
- For lowering the Hydraulic Braking Assistance threshold, objects in the same lane as the vehicle are treated as highly relevant but objects in adjacent lanes are also taken into account. Ultimately that means that the system is able to react more quickly if an object switches lanes from an adjacent lane to the same lane as the vehicle and in so doing precipitates an emergency braking situation.

In comparison with the ACC, there is a slightly longer confirmation period for the object situation with Adaptive Braking Assistance functions. The purpose of that is to reduce inappropriate reactions to detection errors.

Identifying and Reacting to Emergency Braking Situations

Criteria for an Emergency Braking Situation

Based on the motion data of the vehicle itself and the objects detected in the vehicle's external environment, a deceleration rate is calculated at which the driver would have to brake to avoid a collision (avoidance deceleration). That deceleration rate is compared with threshold levels that are stored in the memory of the long-range radar sensor, e.g. 3 m/s^2, 6m/s^2 and 8 m/s^2. If the computed deceleration rate is greater than one of those threshold levels, an output signal is sent to the Dynamic Stability Control to prime the braking system and/or lower the Hydraulic Braking Assistance response threshold.

Priming the Braking System

When the braking system is not primed, there is a small gap between the brake pads and the disc. This is intended and useful in uncritical situations for preventing noise and friction.

However, that gap means that when the brakes are applied, the pads have to complete a certain amount of free travel before they come onto contact with the discs. Only at the point where they come into contact with the discs does any retarding force come into play.

While that response characteristic is acceptable for normal braking operations, in an emergency braking situation it means losing valuable time/braking distance.

Note: When the braking system is primed, the brake pads are already in direct contact with the discs. Thus any degree of brake application results in an immediate braking effect.

DSC also attempts to detect situations in which brake priming is helpful. If the driver backs off the accelerator very abruptly, the DSC automatically activates the brake priming function.

However, this does have the disadvantage that no information about the road traffic situation in the vehicle's immediate environment goes into the decision to activate the function.

By incorporating the data supplied by the long-range radar sensor about the objects in front of the vehicle, brake system priming can be adapted much more effectively to the actual traffic situation. The result is that it can be activated much earlier on the basis of the radar sensor data, i.e. regardless of when and how quickly the driver takes his/her foot off the accelerator.

Brake system priming can only be switched on or off by the long-range radar sensor; other parameters (e.g. relating to the degree of priming) are controlled by the Dynamic Stability Control itself.

Priming is only maintained for a limited period from the point of activation. If the driver does not apply the brakes in that period, it is assumed the danger has passed and the braking system does not need to remain primed.

Even if brake priming were to be erroneously activated, there is no inconvenience to the driver whatsoever because the function does not produce any perceptible degree of deceleration.

Although the long-range radar sensor may request brake system priming by the DSC, it is the DSC that ultimately decides whether to implement the action.

Lowering the Threshold for the Hydraulic Braking Assistance Function

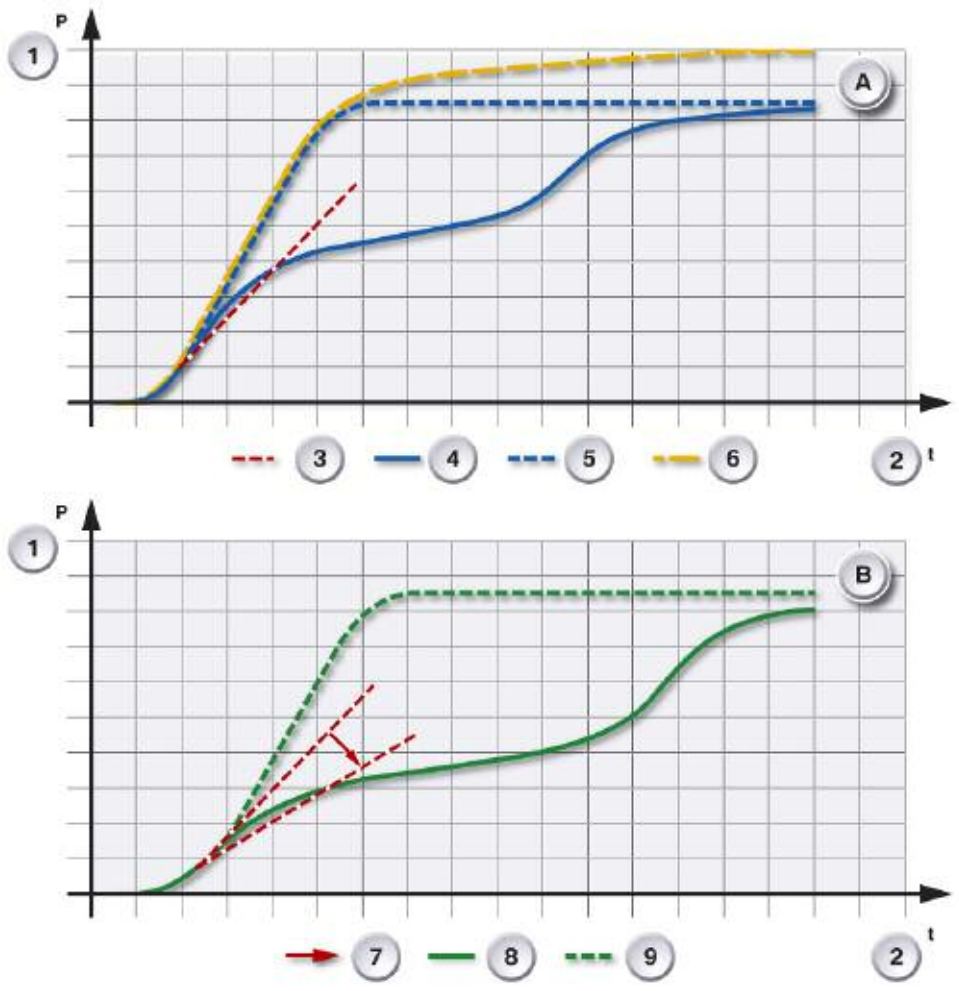
The Hydraulic Braking Assistance (HBA) function integrated in the DSC operates according to two basic response criteria. The driver must apply the brakes in such a way as to produce:

- a minimum brake system pressure and
- a minimum rate of brake system pressure increase.

The parameters are chosen so that, on the one hand, the HBA responds reliably in genuine emergency braking situations, but on the other, that inappropriate response is avoided.

Note: The new threshold lowering function only affects the second response criterion, the minimum rate of increase of brake system pressure.

If an emergency braking situation is detected, the response threshold is lowered in stages according to the calculated avoidance deceleration rate. The result is that the driver can trigger the HBA more easily, i.e. with a lower rate of brake system pressure increase.



Comparison of Response Thresholds for Hydraulic Braking Assistance (HBA)

Index	Explanation
A	Brake system pressure curves without threshold lowering
B	Brake system pressure curves with threshold lowering
1	Brake system pressure
2	Time
3	Standard threshold level (rate of increase of brake system pressure) above which the HBA is activated
4	Brake system pressure curve for a normal driver without HBA who brakes soon enough but not hard enough
5	Brake system pressure curve for a normal driver with HBA. Based on the rate of brake system pressure increase, the HBA detects that the driver intends to perform an emergency stop and with the aid of the DSC hydraulic pump increases the brake system pressure to a level that produces maximum braking effect
6	Brake system pressure curve for an experienced driver who brakes soon enough and hard enough in an emergency braking situation
7	Lowered threshold level (rate of increase of brake system pressure) above which the HBA is activated
8	Brake system pressure curve for a hesitantly braking driver who does not exceed the standard threshold for HBA activation. The HBA therefore does not respond even though the situation might be such that there is a risk of a collision. Thus valuable braking distance is lost because neither is the reaction fast enough nor is sufficient braking force developed.
9	Brake system pressure curve for a hesitantly braking driver. Even though the rate of brake system pressure increase is below the standard threshold, the HBA is still activated. The threshold level has been lowered because a potential collision situation has been detected on the basis of the data from the long-range radar sensor. As a result, even a hesitantly braking driver can trigger the HBA in an appropriate situation.

Whereas hesitantly braking drivers could not previously trigger the HBA, this function gives them the possibility of avoiding or at least reducing the severity of an accident in a potential collision situation with the aid of the HBA.

As threshold lowering only takes place if the long-range radar sensor actually detects a potential collision situation and, at the same time, the threshold for the minimum brake system pressure remains unchanged, inappropriate activation is avoided. If a driver should nevertheless inadvertently activate the HBA, the braking severity can be reduced by means of the familiar graduated response function. To do so, the driver merely has to reduce the amount of brake pedal travel.

HBA threshold lowering can not only be switched on or off by the long-range radar sensor, it can also be activated in degrees. Threshold lowering is only maintained for a certain period from the point of activation. If the driver does not apply the brakes in that period, it is assumed the danger has passed and the threshold can revert to normal.

Even though the long-range radar sensor may request threshold lowering, the DSC retains ultimate control over the decision to trigger the HBA.

Monitoring Functions

The monitoring concept for Adaptive Braking Assistance is shared between the following three areas.

1. Fault statuses in object detection and on the long-range sensor hardware are monitored by the sensor itself.
2. Communication faults on the S-CAN or PT-CAN are primarily monitored by the LDM control unit.
3. Faults on the DSC hydraulics or DSC electronic circuitry are monitored by the DSC itself.

Regardless of where a fault status is detected, the brake system priming and threshold lowering functions are not then carried out.

The fault status is recorded in the fault memory of the control unit that detects it.

Note: A message to the driver indicating failure of Adaptive Braking Assistance is not issued. The next time the car is taken for a service, the fault can be diagnosed and rectified by reading the fault memory.

Some faults result not only in the Adaptive Braking Assistance functions being unavailable but also the ACC Stop & Go function, for instance. A typical example of such a case is an electronic fault on the long-range radar sensor or the LDM control unit. In such circumstances the driver would be informed indirectly of the fault status by way of the ACC Stop & Go failure message.

System Components

Only the components that are either entirely new or the design and function of which has changed since previous applications are described at this point.

Those system components are:

- Long-range radar sensor
- Short-range radar sensors
- LDM control unit
- Sensor-CAN
- DSC control unit and hydraulic unit
- Sensor systems for detecting if the driver is about to get out of the car

Of course there are also changes to other system components such as the drivetrain or the instrument cluster in order to be able to implement the new longitudinal dynamics systems. However, they are not dealt with in this document.

Long-range Radar Sensor

Physical Differences

The long-range radar (LRR) sensor is outwardly identical with the familiar ACC II device supplied by Bosch. The ACC II device used previously on the E60 and other vehicles can be distinguished from the new ACC Stop & Go unit by means of the part number.

Index	Explanation
1	Position of screw for vertical adjustment
2	Position of fixed mounting
3	Position of screw for horizontal adjustment

Compared with the sensor previously used on the E60/E61, the positions of the adjusting screws and the fixed mounting screw have changed, see illustration.

Note: The adjustment procedure for the long-range radar sensor is unchanged. The diagnosis system takes account of the fact that the positions of the screws have changed and gives the correct instructions.

As the fixed mounting screw remains inaccessible from the outside as with the previous unit, the possibility of adjustment errors can be virtually excluded.

Electrical Differences

The long-range radar sensor on the E60/E61 LCI is no longer connected to the PT-CAN. Instead it is now connected to the new Sensor-CAN. Nevertheless, it can still be accessed via the diagnosis system as before because the LDM control unit relays diagnosis communication to and from the long-range radar sensor.

The power supply and connection to the wake-up lead are unchanged from the familiar arrangement.

Note: A terminal resistor for the S-CAN is accommodated in the long-range radar sensor.
LRR sensor and LDM control unit are supplied by the CAS control unit using a separate wake-up lead that is electrically isolated from the normal wake-up lead. This arrangement was chosen because the long-range radar sensor is fitted in an accident prone area (front end of vehicle).

If the wake-up lead of the LRR sensor were damaged in an accident (e.g. causing a short to earth), this arrangement limits the consequences for other control units.

See also system circuit diagram in the System overview section.

An additional wiring harness which carries the power supply and the Sensor-CAN both the to the long-range radar sensor and the short-range radar sensors has been added between the vehicle wiring harness and the long-range radar sensor.

If no short-range radar sensors are fitted (e.g. in Japan due to lack of radio transmissions approval), the additional wiring harness is missing and the long-range radar sensor is connected directly to the vehicle wiring harness. Even where in such cases the Stop & Go function is not available and the familiar Active Cruise Control is used instead, the architecture using long-range radar sensor and LDM control unit remains the same.

Modified Range of Functions

The ACC II units used up to now on BMW vehicles perform both sensor and control functions. In the ACC Stop & Go system complex by contrast, the long-range radar sensor now primarily performs only sensor functions, i.e. it detects vehicles ahead, measures their distance and motion variables and pre-processes that data. Subsequent processing and control functions are performed by the LDM control unit.

Accordingly, the data interface between the long-range radar sensor and the LDM control unit consists of a list of the objects detected and the associated data relating to their position and motion status.

New functions that have been added are the assessment of objects and computation of the activation criteria for the Adaptive Braking Assistance functions. The long-range radar sensor issues request signals to the LDM control unit. They are transmitted via the SCAN and indicate whether brake system priming and/or HBA threshold lowering are to be activated.

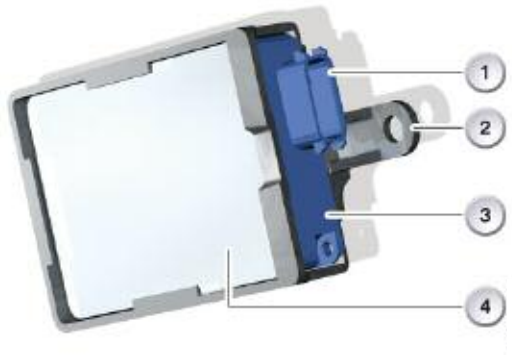
The algorithm integrated in the long-range radar sensor for detecting maladjustment has been optimized to the extent that it continues to be computed even if the maladjustment cut-off threshold has been exceeded. Thus if the algorithm has at any time erroneously initiated a shutdown (e.g. due to the lens being partially obscured), it can still "relearn" the correct setting afterwards.

Short-range Radar Sensors

Principle of Operation

The fundamental measurement method of the short-range radar sensors is significantly different from that of the long-range radar sensor, as the table below illustrates.

Characteristic	Long-range Radar Sensor	Short-range Radar Sensors
Modulation method	FMCW - (frequency modulated continuous wave)	PD - (pulse doubler)
Mid-range transmission frequency	76.5 GHz	24 GHz
Distance measurement	Based on frequency deviation	Based on pulse propagation time
Measurement of relative speed	Based on frequency shift - (Doppler effect)	Based on phase difference measurement (Doppler effect)
Angle measurement	Ratio calculation based on amplitudes of the radar lobes	Ratio calculation based on two measured variables (sum and differential signals)
Transmission power	< 5 mW (average) 10 mW - (maximum)	approximately 0.08 mW (average) approximately 100 mW (single pulse)



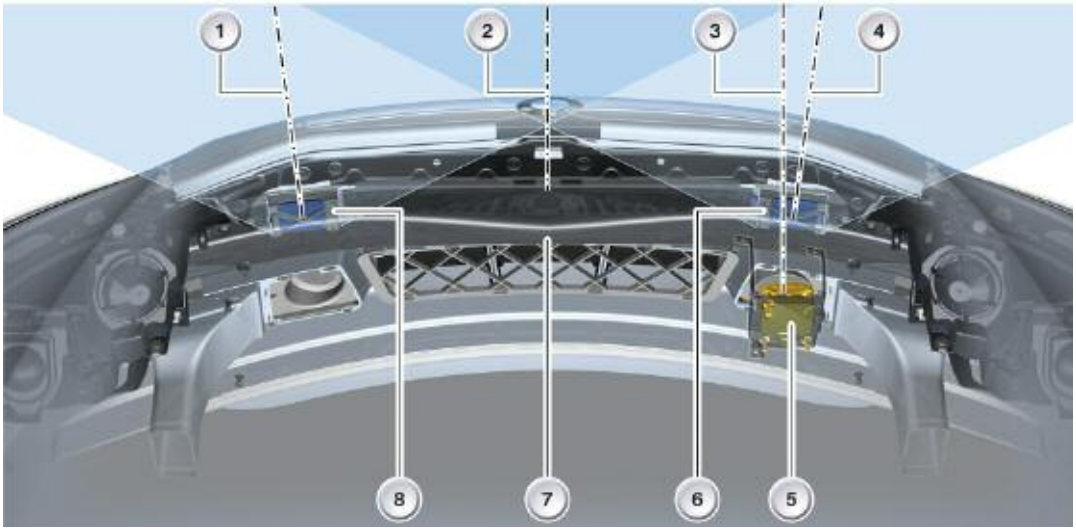
Index	Explanation
1	Connector
2	Plastic bracket
3	Plastic sensor casing
4	Aerial cover

Short-range Radar Sensor for ACC Stop & Go

Note: If short-range radar sensors are replaced, it is important to ensure that the connector faces towards the vehicle.

Fitting of Short-range Radar Sensors

Two identical short-range radar sensors are fitted for the ACC Stop & Go function. They are mounted on the front bumper crossmember by means of an additional plastic bracket.



Fitted Location of Radar Sensors for ACC Stop & Go, Rear Overhead View

Index	Explanation
1	Center axis of left short-range radar sensor
2	Vehicle x-axis
3	Center axis of long-range radar sensor
4	Center axis of right short-range radar sensor
5	Long-range radar sensor and bracket
6	Right short-range radar sensor with bracket
7	Bumper cross-member
8	Left short-range radar sensor with bracket

The center axes of the short-range radar sensors (1 and 4) are angled outwards relative to the vehicle's x-axis (2).

Two different versions of the front bumper trim are fitted depending on whether or not the vehicle has the M aerodynamics package. This affects the fitting location of the short-range radar sensors and the angle at which their center axis points outwards.

That means that a vehicle cannot simply converted to the M aerodynamics package (or vice versa) without additional adjustments.

The following additional operations are required and are described in detail in the Repair Instructions:

- Replacement of black impact absorbers, which have a special cut-out for the short-range radar sensors (to match new bumper trim)
- Replacement of brackets for short-range radar sensors (different fitting location requires different bracket design)
- Coding the vehicle, and specifically the LDM control unit, to take account of the new equipment configuration with/without M aerodynamics package
- Commissioning the LDM control unit and short-range radar sensors using the diagnosis system. In the process, the new fitted position is recorded in the memory.

In contrast with the long-range radar sensor, the aerials and lenses of the short-range radar sensors are flat.

Functions of the Short-range Radar Sensors in the System Complex

Like the long-range radar sensor, the primary function of the short-range radar sensors is to detect objects in front of the vehicle and compute their position and motion data.

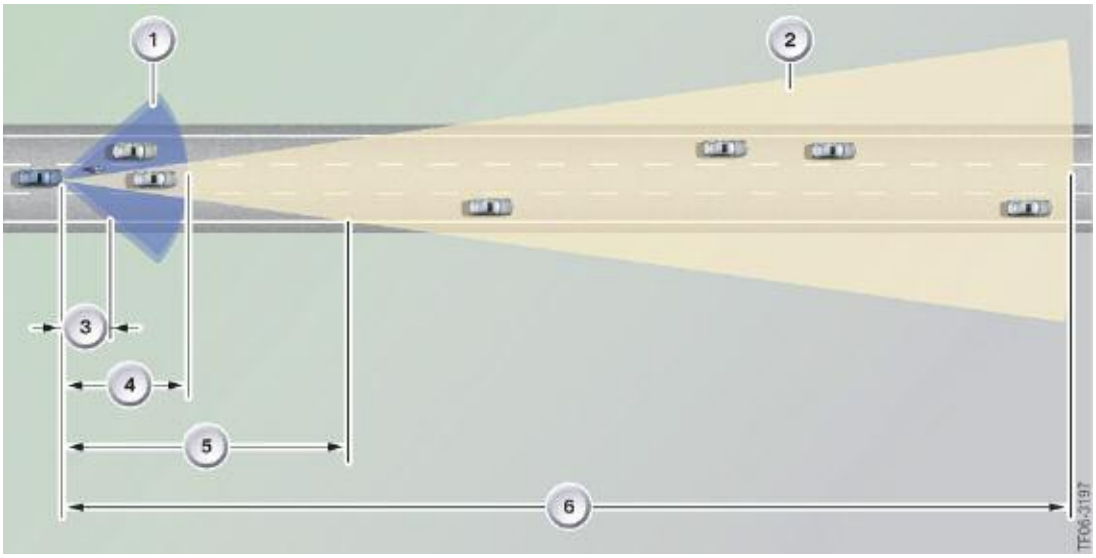
The object data from the short-range radar sensors is used only for the ACC Stop & Go function and not for the Adaptive Braking Assistance functions.

The short-range radar sensors have a significantly different detection range than the long-range radar sensor.

Characteristic	Explanation	Short Range Radar
Range	At least 120 m, up to 150 m	At least 10 m, up to 20 m
Horizontal angular width of beam	+/-8°	+/-40°
Vertical angular width of beam	Approximately 4°	Approximately 20°

The figures quoted for range vary according to the type of object being detected. A pedestrian, for instance, can not be detected as far away as a car. They reflect the radar beam to differing degrees.

The illustration below shows clearly why the large horizontal beam width is required by the short-range radar sensors. In the area directly in front of the vehicle, the detection range of the long-range radar sensor is a long way short of covering the width of the car let alone the width of the lane. However, precisely that is what is required in order to be able to stop reliably behind cars driving off-center or motorcycles.



Scale drawing of detection ranges of the radar sensors used for ACC Stop & Go

Index	Explanation
1	Detection range of short-range radar sensors
2	Detection range of long-range radar sensor
3	Distance from which short-range radar sensors detect objects across full width of three lanes (approximately 4.5 m)
4	Range of short-range radar sensors (here assumed to be 15 m)
5	Distance from which long-range radar sensor detects objects across full width of three lanes (approximately 40 m)
6	Range of long-range radar sensor (here assumed to be 120 m)

Electrical Integration in the Vehicle

The short-range radar sensors are supplied with power from Terminal 30g. They are not connected to the wake-up line. Instead, they are woken by the LDM control unit by means of appropriate messages on the S-CAN. The two short-range radar sensors also use the S-CAN to each supply a list of object data to the LDM control unit.

In the wiring loom, pin no. 5 is applied to earth for the left sensor and pin no. 6 for the right sensor. The other pin in each case is left unconnected. In that way the identical right and left sensors can identify which side of the vehicle they are fitted on and take it into account when computing the object data.

Note: The short-range radar sensors are intelligent sensors which monitor their own operational capability. They record any fault statuses that may arise, although they cannot be accessed directly by the diagnosis system for diagnosis/programming. Instead, the LDM control unit copies the details of faults reported by the short-range radar sensors to its own fault memory.

Self-diagnosis and Types of Fault

In the cases listed below, short-range radar sensor monitoring functions respond because reliable function is no longer possible. This results in shutdown of the ACC Stop & Go function.

As the problems in such cases are not always genuine faults that necessitate repair action, they are described briefly at this point.

Dirty Short-range Radar Sensors

The short-range radar sensors cannot reliably detect objects if there is a layer of snow, slush or ice over their aerials. Neither their aerial covers nor the bumper trim are heated.

Therefore, there are situations in which the heated lens of the long-range radar sensor is clear but the areas around the short-range radar sensors are covered in snow.

Index	Explanation
1	Area of bumper trim in front of the short-range radar sensors completely covered in snow
2	Lens of long-range radar sensor only partially snow-covered due to heating

In order to maintain the greatest possible availability of the ACC Stop & Go function, detection of dirt on the short-range radar sensors does not necessarily immediately result in shutdown. Only if the vehicle is travelling at a low speed (slower than approximately 30 kph) at that point is shutdown immediate.

At substantially higher road speeds, the function is maintained on the basis of the data from the long-range radar sensor.

Shutdown due to dirty short-range radar sensors is indicated to the driver by a notification in the check control message issued at the same time.

Note: No fault memory entry is recorded for dirty short-range radar sensors.

External Interference Affecting Radar Signal Analysis

Other automobile manufacturers also use radar sensors for driver assistance functions.

The radar signals emitted by those sensors can interfere with the signal analysis by 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.

Note: Such instances of interference are recorded in the fault memory that can be read from the LDM control unit by the diagnosis system. 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 Faults

The following events can cause temporary faults on the short-range radar sensors that are summarized under a single fault memory entry:

- Communication fault on S-CAN
- Power supply voltage too high or too low
- Temperature of short-range radar sensors too high

The procedure according to the diagnosis system testing sequence should be followed.

When doing so, the connectors on the short-range radar sensors and the wiring loom should be checked in particular.

Control Unit Faults

If there is a control unit fault on one of the short-range radar sensors, it can be rectified by replacing the defective sensor.

After fitting the new short-range radar sensor, the commissioning sequence as specified by the diagnosis system must be completed.

This resets some adapted settings in the LDM control unit memory that apply to the sensor that has been replaced.

Sensor Out of Adjustment

As with the long-range radar sensor, the short-range radar sensors in conjunction with the LDM control unit can detect maladjustment resulting from 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 rectify the fault, the procedure described in the next section must be followed.

Adjustment and Repair

Adjustment of the short-range radar sensors during production or in the course of servicing is not provided for. It can be dispensed with for the following reasons:

- The horizontal fitting tolerance for the short-range radar sensors is considerably greater than for the long-range radar sensor. It is +/-2° (compared with 0.25° for the long-range radar sensor).
- The accuracy of fit of the bumper crossmember is sufficient for the sensors to be within the required fitting tolerance.
- The short-range radar sensors and LDM control unit have a correction algorithm that detects maladjustment of the sensors and compensates appropriately. Due to the wide horizontal detection range of the short-range radar sensors, there is a greater possible degree of compensation for imprecise adjustment than with the long-range radar sensor.

Accident

If a vehicle with ACC Stop & Go suffers accident damage to the front end, it is entirely possible that the permissible fitting tolerance will be exceeded. The scenarios and associated repair actions set out below should be distinguished.

1. Scenario: there is no visible damage, the customer makes no mention of an accident.
   Possible cause is that on the production line or in the course of previous repairs, the commissioning sequence was not correctly carried out.

   Action: carry out the commissioning sequence for the short-range radar sensors again using the diagnosis system. In the process, the correct fitted position is recorded in the memory and the maladjustment figure reset.

2. Scenario: bumper trim is scratched and/or marginally misshapen (visible dent).

   Action: The area of the trim in front of the short-range radar sensors must not be painted more than twice.
   Nor must dents be repaired by applying additional plastic material in that area. Instead, the trim must be removed and the short-range radar sensors behind it checked for damage.
   If the dent is directly in front of the short-range radar sensor, impairment of function must be expected. If the customer complains of problems, the bumper trim should be replaced.

3. Scenario: bumper trim or entire vehicle front end is clearly out of shape.

   Action: the bumper trim must be removed and replaced if there is visible damage directly in front of the short-range radar sensors.
   In addition, the bumper cross-member should be checked for damage. If it is more than approx. 5 mm out of position, the bumper cross-member must also be replaced. In that case, it is advisable to check the engine sub-frame members for damage as well. Repair of the engine sub-frame may then also be necessary. Only in that way can the correct position of the bumper cross-member and, therefore, of the short-range radar sensors be reinstated.

The repair measures have only been briefly summarized at this point and are described in detail in the Repair Instructions.

After any of the work described here that may involve the alignment of the short-range radar sensors, the commissioning sequence must be carried out using the diagnosis system.

Note: Care must be taken in the course of any repair work that the bumper trim is refitted correctly. No force should be applied as otherwise the intended design clearance between trim and short-range radar sensor casings will not be guaranteed.

If the vehicle concerned is fitted with PDC, the electrical wiring to the ultrasonic sensors must be refitted correctly. On no account must the wires be left hanging loose in front of the aerial cover of a short-range radar sensor because otherwise the sensor function could be severely impaired.

LDM Control Unit

Design and Electrical Characteristics

Like the radar sensors, the LDM control unit is only fitted on the vehicle if it is ordered with the option Active Cruise Control with Stop & Go function.

An LDM control unit was previously introduced on E9x models. The same basic concept has been adopted for the ACC Stop & Go function. As before, it contains two micro-processors with different primary tasks:

- functional tasks
- safety monitoring functions.

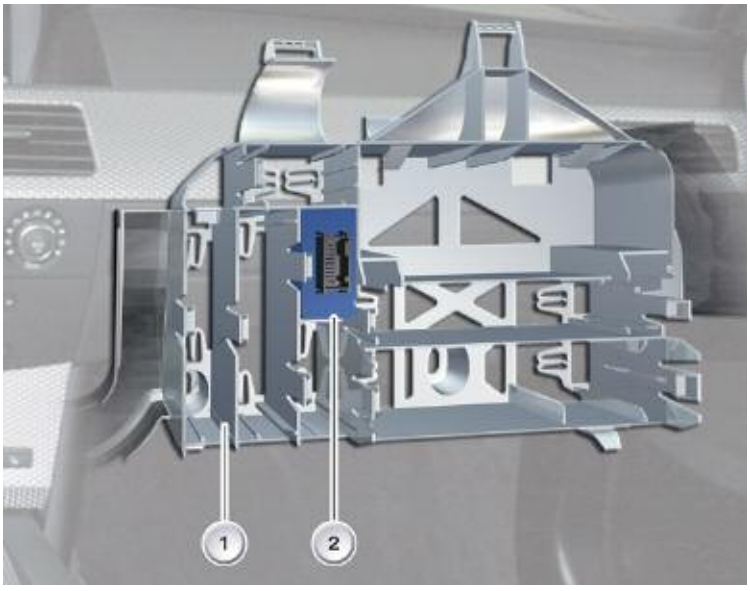
The processing and memory capacity of the processors has been increased in order to be able to implement the more extensive functionality.

As on E9x models, the new LDM control unit for the E60/E61 LCI contains only control electronics and no sensors or power electronics. All input signals from sensors are received via the PT-CAN and S-CAN bus systems. The LDM controls all actuators via the PT-CAN.

Note: The LDM control unit contains one of the terminal resistors for the S-CAN.

Location

The LDM control unit is on the equipment mounting bracket near to the glove box.



Location of LDM Control Unit on E60/E61 LCI

Index	Explanation
1	Glove box equipment mounting bracket
2	LDM control unit

Functions within System Complex

The LDM control unit represents the central processing unit for the ACC Stop & Go function and performs the following constituent functions:

- Merging of object data supplied by the radar sensors
- Assessment of objects detected and selection of the relevant object for gap modulation
- Analysis of driver control signals and generation of display signals
- Control of speed and distance from the vehicle in front
- Generation and output of the required settings to the power transmission and braking system actuators via the PT-CAN
- Monitoring of all input signals, its own control unit hardware and vehicle behavior for faults or implausible conditions

For the Adaptive Braking Assistance functions, the LDM control unit acts primarily as a gateway.

- The signals from the long-range radar sensor are transferred from the S-CAN to the PT-CAN. Those are the signals that the long-range radar sensor produces in order to activate the brake system priming and HBA threshold lowering functions.
- The DSC indicates by means of signals on the PT-CAN that it is operational and supplies signals that describe the motion status of the vehicle. The LDM control unit transfers those signals from the PT-CAN to the S-CAN so that they can be received from there by the long-range radar sensor.

Note: The gateway function on the part of the LDM control unit is also required to be able to access the long-range radar sensor using the diagnosis system.

Behavior in the Event of Faults

The LDM control unit responds differently according to the type of monitoring function triggered by the fault. This also has consequences in terms of the fault memory entries and troubleshooting, which is why a brief description is given here.

- Short-range radar sensor faults are recorded in the LDM control unit memory because the short-range radar sensors are not accessible by the diagnosis system.
- Long-range radar sensor faults are stored in the sensor's own fault memory. The LDM control unit records a fault that refers to the long-range radar sensor.
- The LDM always records fault memory entries referring to other control units if the LDM itself is not the cause of the fault. An implausible input signal or another control unit not being operational are possible causes of that type of fault memory entry. In such cases, the testing sequences applicable to the fault memory entries on the control units to which the LDM refers should be followed.
  Replacing the LDM control unit will by no means cure a fault of this type.
- Most monitoring functions on the LDM operate in such a way that the function and system complex are shut down normally in the event of a fault. The associated fault cause is then also recorded in the LDM control unit's fault memory.
- There is an exceptional case in which normal shutdown can not be carried out: if the microprocessor that performs the safety monitoring functions has to disconnect the LDM control unit from the PT-CAN. This only happens if no other shutdown action is effective and at the same time an irregular LDM output is detected on the PT-CAN. In that case, all of the LDM's associated control units (e.g. DME, DSC and instrument cluster) register a communication fault with the LDM.

Troubleshooting should always proceed according to the diagnosis-system testing sequences. If the LDM control unit has to be replaced, the replacement unit fitted must be:

- coded
- commissioned

This allows for such tasks as entering the fitted positions of the short-range radar sensors in the memory and resetting the adaptation settings to their initial values.

Sensor-CAN

The new Sensor-CAN (S-CAN for short) connects:

- the LDM control unit
- the long-range radar sensor
- and the short-range radar sensors.

The introduction of this new bus system was necessary in order to be able to transmit the large volumes of data from the radar sensors to the LDM control unit. The volume of data is so great because the radar sensors send extensive lists of data about the objects detected to the LDM control unit. That amount of data would have exceeded the available capacity on the existing bus systems.

The electrical characteristics are largely the same as the PT-CAN and feature:

- Data transmission rate of 500 kBit/s
- Two-core cable
- Two terminal resistors of 120 Ω each (in long-range radar sensor and LDM control unit)
- Separate wake-up line for long-range radar sensor and LDM control unit (electrically isolated from wake-up line used for the other control units).

DSC Control Unit and Hydraulic Unit

On vehicles with ACC Stop &Go, the DSC unit performs the function of:

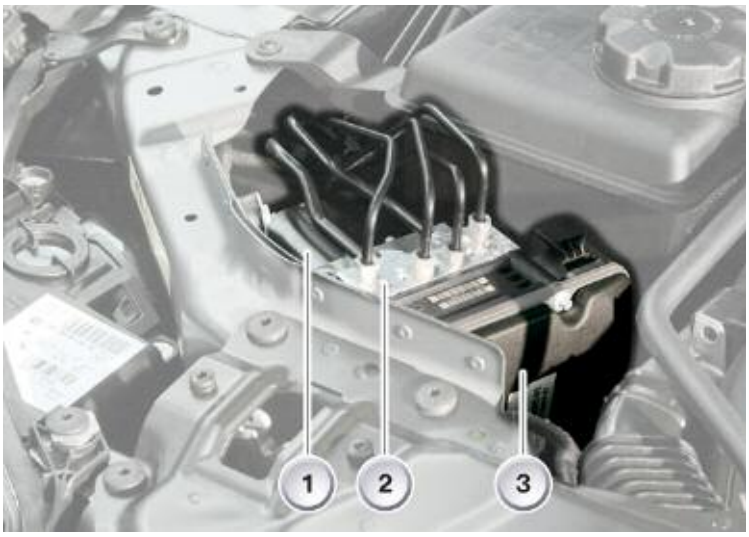
- an actuator (execution of braking requests from LDM and Adaptive Braking Assistance) and
- a signal supplier (supplying information about the motion status of the vehicle).

On vehicles with DCC, the DSC control unit also performs the task of computing the DCC control algorithms.

On the E60/E61 LCI, the DSC unit technology has been taken over from the E70. That technology was the fundamental prerequisite for the ability to implement the ACC Stop & Go function at all. It is only with that technology that it is possible to:

- very sensitively,
- dynamically and
- quietly increase brake system pressure as is required for ACC Stop & Go.

The DSC unit is located in the engine compartment on the right at the front between the right headlight and the coolant expansion tank - see illustration below.



DSC unit on E60/E61 LCI

Index	Explanation
1	Electrically operated hydraulic pump
2	Valve block
3	DSC control unit

Driver’s Seat Status Sensor

In order that ACC Stop & Go can issue a warning if the driver is about to get out of the car, the following sensor signals are used:

- Door switch, driver's door
- Belt buckle switch, driver's seat
- Seat occupancy detector, driver's seat

They are made available to the LDM control unit on the PT-CAN. The transmitting control units are:

- Body Gateway Module (KGM) for the door switch signal
- Crash Safety Module (ACSM) for the belt buckle switch and seat occupancy detector signals. These signals have to be transferred from the K-CAN to the PT-CAN by the KGM.

The door-switch and belt-buckle switch signals were already available on the vehicle before the introduction of ACC Stop & Go.

The seat occupancy detector in the driver's seat was introduced on the E60/E61 LCI for ACC Stop & Go.

These three signals have thus been used firstly to be able to warn the driver as soon as possible, and secondly to increase the reliability of the warning. None of the signals on their own would have been able to provide the reliability demanded.

Service Information

Important!!! Points for Servicing and Repairs

Cruise Control with Braking Function

- Vehicles with the option "Cruise control with braking function" do not have an LDM control unit. The function is integrated entirely in the DSC control unit.

Active Cruise Control with Stop & Go Function

- ACC Stop & Go and Adaptive Braking Assistance are highly integrated functions. In the event of customer complaints, reports of failure or initially unexplained function Behavior, the fault memories of the LDM and long-range radar sensor should be checked first and the programmed testing sequences followed if necessary.

  If that does not identify the problem, all control units and sensors involved in the system complex must be manually checked. A precise examination of the PT-CAN, S-CAN and K-CAN bus systems is particularly advisable in the event of signal or communication faults.
- If the brakes are noticeably applied in order to achieve the desired vehicle deceleration rate, the vehicle's brake lights are also switched on (legal requirement). The brake lights are also switched on when the ACC Stop & Go brings the car to a stop.
- The driver can also set the desired speed and desired gap while the vehicle is being held stationary by the ACC Stop & Go. However, the new settings do not take effect until the vehicle is moving.
- In order that stopping and moving off are performed smoothly and without the vehicle rolling backwards, the power and brakes are applied gradually and simultaneously. Such system Behavior is intended absolutely comparable with that of the driver when performing a hill start using the hand brake and the accelerator.
- Requiring acknowledgement ensures that the driver is paying attention to the traffic situation again after an extended stationary period. Because even though the Active Cruise Control has been extended by the Stop & Go function, the driver remains responsible for driving the vehicle and making appropriate use of the assistance functions available.
- To prevent the car slowing down inappropriately, for instance for road signs, ACC and ACC Stop & Go never respond to stationary objects. In other words, it does not even slow the vehicle down if it is approaching the end of a stationary queue of traffic at high speed.
- When the ACC Stop & Go is operating in DCC mode there is no gap modulation function whatsoever and no instruction to take over control is issued!

- ACC Stop & Go is not a system for permanently stopping or parking the car. The driver is responsible for securing the vehicle against rolling away before leaving it. The parking brake and the automatic transmission Park setting are the means provided for that purpose.

Adaptive Braking Assistance

- Adaptive Braking Assistance is always active and does not have to be switched on separately by the driver.
- Adaptive Braking Assistance never initiates an emergency stop of its own accord. With the aid of information from the long-range radar sensor it detects situations in which emergency braking is necessary. In such cases, it then assists the driver when he/she applies the brakes.
- A message to the driver indicating failure of Adaptive Braking Assistance is not issued.

  The next time the car is taken for a service, the fault can be diagnosed and rectified by reading the fault memory.

Long-range Radar Sensor

- The location of the long-range sensor for the ACC Stop & Go is identical to that of the sensor for the familiar ACC system.
- A terminal resistor for the S-CAN is accommodated in the long-range radar sensor.
- The adjustment procedure for the long-range radar sensor is unchanged. The diagnosis system takes account of the fact that the positions of the screws have changed and gives the correct instructions.

Short-range Radar Sensor

- The short-range sensors are fitted behind the front bumper trim on the bumper crossmember. Therefore, they are not visible from the outside unless the bumper trim is removed.
- If short-range radar sensors are replaced, it is important to ensure that the connector faces towards the vehicle.
- The short-range radar sensors are intelligent sensors which monitor their own operational capability. They record any fault statuses that may arise, although they cannot be accessed directly by the diagnosis system. Instead, the LDM control unit copies the details of faults reported by the short-range radar sensors to its own fault memory.
- The short-range radar sensors cannot be programmed either.
- No fault memory entry is recorded for dirty short-range radar sensors.

- Interference from radar sensors on other cars affecting the short-range radar sensors is recorded as a fault in the fault memory.

  However, there is no repair action that can be taken. Instead, the customer should be informed of the cause of the fault (external interference).

- If a vehicle with ACC Stop & Go suffers accident damage to the front end, it is entirely possible that the permissible fitting tolerance will be exceeded. The scenarios and associated repair actions set out below should be distinguished.

  - Scenario: there is no visible damage, the customer makes no mention of an accident. Possible cause is that on the production line or in the course of previous repairs, the commissioning sequence was not correctly carried out.
    Action: carry out the commissioning sequence for the short-range radar sensors again using the diagnosis system. In the process, the correct fitted position is recorded in the memory and the maladjustment figure reset.

  - Scenario: bumper trim is scratched and/or marginally misshapen (visible dent).
    Action: The area of the trim in front of the short-range radar sensors must not be painted more than twice. Nor must dents be repaired by applying additional plastic material in that area. Instead, the trim must be removed and the short-range radar sensors behind it checked for damage.
    If the dent is directly in front of the short-range radar sensor, impairment of function must be expected. If the customer complains of problems, the bumper trim should be replaced.

  - Scenario: bumper trim or entire vehicle front end is clearly out of shape.
    Action: the bumper trim must be removed and replaced if there is visible damage directly in front of the short-range radar sensors. In addition, the bumper cross-member should be checked for damage. If it is more than approx. 5 mm out of position, the bumper cross-member must also be replaced. In that case, it is advisable to check the engine sub-frame members for damage as well. Repair of the engine sub-frame may then also be necessary. Only in that way can the correct position of the bumper cross-member and, therefore, of the short-range radar sensors be reinstated.

- Care must be taken in the course of any repair work that the bumper trim is refitted correctly. No force should be applied as otherwise the intended design clearance between trim and short-range radar sensor casings will not be guaranteed.

- If the vehicle concerned is fitted with PDC, the electrical wiring to the ultrasonic sensors must be refitted correctly. On no account must the wires be left hanging loose in front of the aerial cover of a short-range radar sensor because otherwise the sensor function could be severely impaired.

LDM Control Unit

The LDM control unit contains one of the terminal resistors for the S-CAN.

The gateway function on the part of the LDM control unit is also required to be able to access the long-range radar sensor using the diagnosis system.

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Initial Print Date: 04/07 Revision Date: 05/07

M Model Updates

Model: E60 M5 & E63/E64 M6

Production: From 3/2007 Production

OBJECTIVES

After completion of this module you will be able to:

- Understand and be able to explain the automatic soft close function
- Identify and locate the components used in the soft close function
- Explain the benefits of using diplexers/crossovers in the audio system
- Identify and locate the components used in the BMW Enhanced Premium Sound System.

Automatic Soft Close Function

Introduction

The E60 M5 and E63/E64 M6 will be equipped with the automatic soft close function on the doors as option 323 and will be available from March 2007 production.

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 are no longer a single unit, as was previously the case. The automatic soft close function drive is separate and controls the door lock by way of a bowden 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.

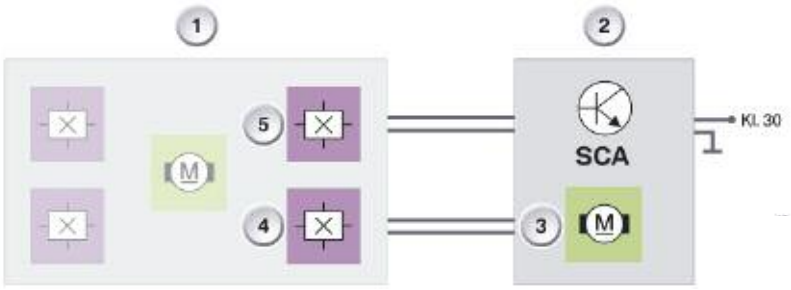
If the automatic soft close option is ordered, it is installed on all the doors on the vehicle.

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.

Principles of Operation

The automatic soft close function is an independent (stand-alone) function. The only connection to the car's electrical system is terminal 30g and the earth connection. The automatic soft close function is ready for use from "terminal 30g ON".

Automatic Soft Close Function Circuit Diagram



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		

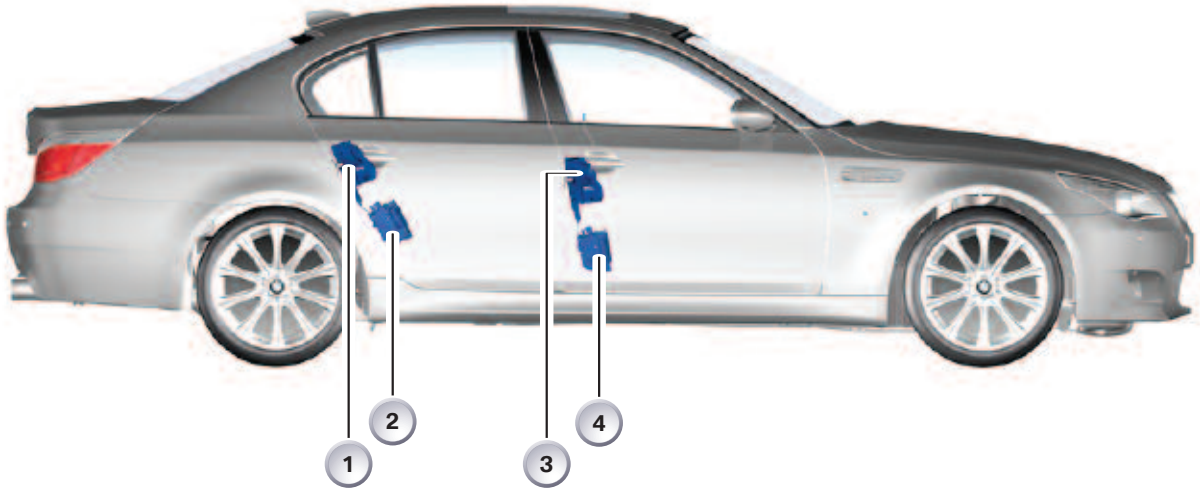
The electronics for controlling and monitoring the function are located in the automatic soft close function drive.

The sensors for the automatic soft close function are Hall sensors and are found in the lock. 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.

The automatic soft close function analysis the status of the Hall sensors. The automatic soft close function drives are activated or moved back to their starting position, depending on their current status.

The automatic soft close function drive is connected to lock by way of a Bowden cable and a 4 wire cable.

Automatic Soft Close Function Drive Locations



Index	Explanation	Index	Explanation
1	Lock for driver's side rear door	3	Lock for driver's side door
2	Drive for automatic soft close function in driver's side rear door	4	Drive for automatic soft close function in driver's side 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 function drive 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. Control over the automatic soft close function drive is then withdrawn and the automatic soft close function drive moves to the 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. Since it must, however, be ensured that the door is truly locked, the automatic soft close function drive is nevertheless still operated for safety reasons.

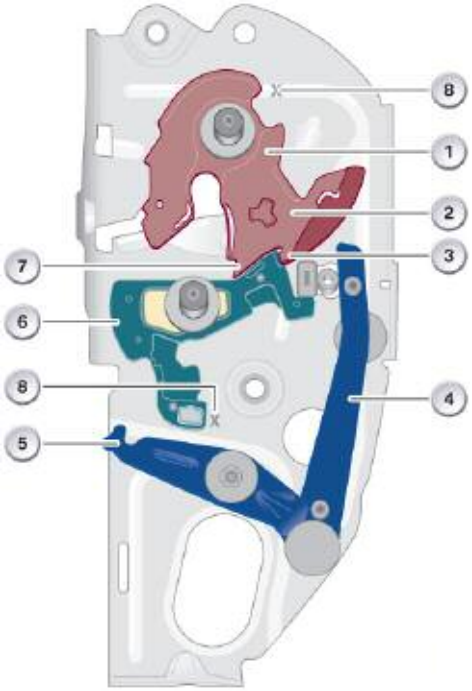
The electronics in the automatic soft close function drive detect the slamming of the door by the fact that the Hall sensors in the locking pawl and the rotary striker have changed their status within a brief period.

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.

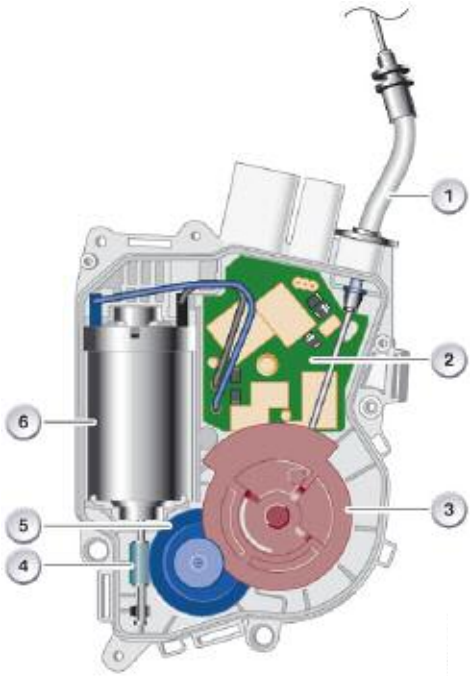
Design of the Lock and Drive



Index	Explanation
1	Rotary striker
2	Rotary striker pull pawl
3	Advance detent tooth for rotary striker
4	Drive pawl
5	Automatic soft close function drive actuating lever
6	Locking pawl
7	Rotary striker main detent tooth
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



Index	Explanation
1	Bowden cable
2	Control electronics
3	Bowden cable drive wheel
4	Drive worm
5	Idler gear
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

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. Only the lock and the automatic soft close function drive can only be ordered as a spare part together.

Note: There is no diagnostic function for the automatic soft close function drive in the diagnostics system. Retrofitting the automatic soft close function is only possible with great effort and is thus not foreseen.

BMW Enhanced Premium Sound System

The BMW Enhanced Premium Sound System (SA 752) positioned over the Top-HiFi system will be offered in the vehicles of the E60 M5, E63 M6 model series as from March 2007.

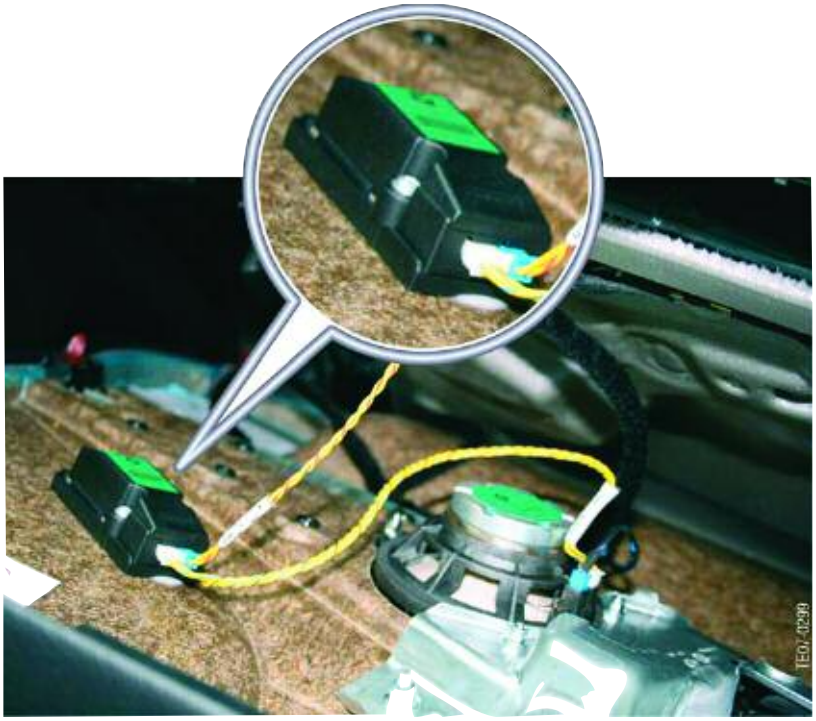
The sound system consists of 16 speakers (7x tweeter, 7x mid-range speaker, 2x central bass supplied by LPG) in connection with the high-end audio amplifier manufactured by Lear).

The 4 speakers in the rear window shelf will not be installed on the E64 M6 convertible. This model will receive only 12 speakers.

The systems differ in terms of the speakers and their installation locations. A special feature of the BMW Enhanced Premium Sound System (SA 752) is the frequency diplexers/crossovers (supplied by LPG) installed in the two front doors.

They separate the high and medium range much more accurately and with better sound results than when using an individual capacitor as in the Top-HiFi system; SA 677.

Due to space limitations, the frequency diplexers/crossovers are installed only in the front doors. A capacitor is used as the frequency diplexer for all other mid-range speakers and tweeters.



Frequency Diplexer/Crossover in the front door