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# General Vehicle Electrical

**Model: E90**

**Production: From Start of Production**

# OBJECTIVES

After completion of this module you will be able to:

- Explain distributed functions
- Diagnose the various electrical systems
- Discuss the operational signal paths of the various systems
- Identify the key control modules for each system

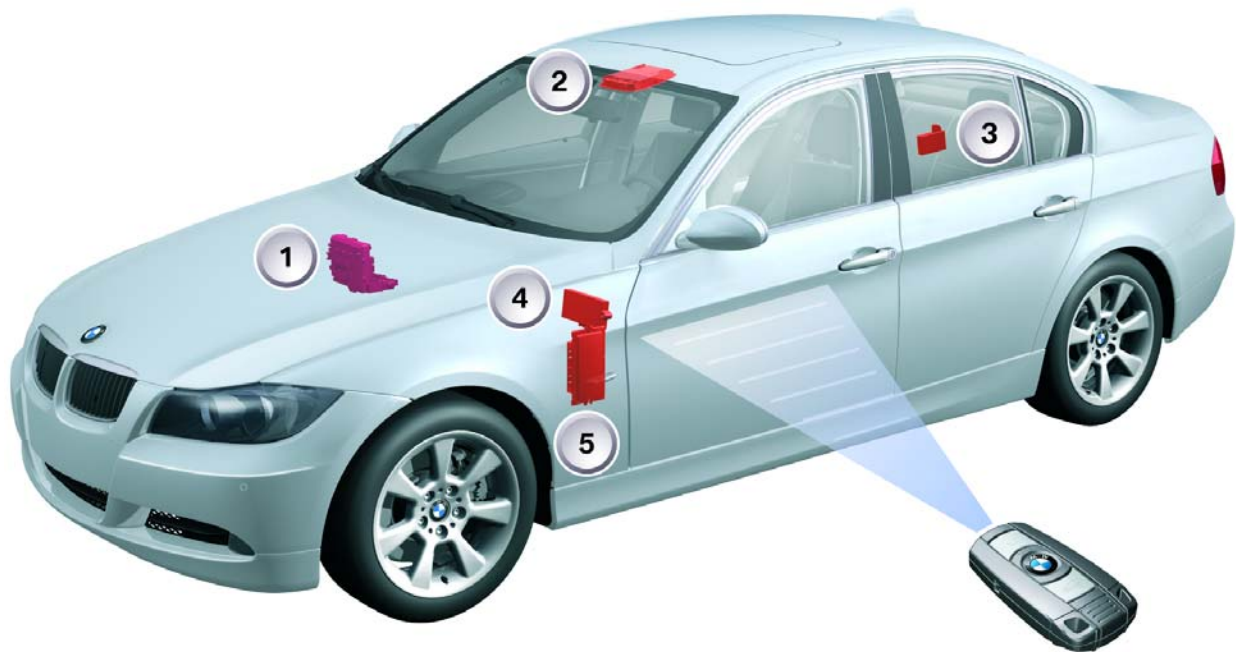
# Introduction

With the new 3 Series multiple control modules will be involved in the operation of a system, similar to the “distributed functions” approach which has been successfully implemented on the E60, E63/64, E65 & E66. With the launch of the E90, the distributed function concept will be continued and further developed.

The associated optimization of the wiring/cabling through fewer interfaces is also an important aspect when evaluating cost reduction and assembly time.

For diagnosis, on the other hand, the concept of "distributed functions" signifies a new challenge. In terms of the control module, it is no longer apparent what functions it initiates.

In the E90 there are several systems (i.e. Central Locking, Power Windows and Interior Lighting) whose functions are distributed over the following control modules:



Index	Explanation	Index	Explanation
1	Junction Box (JB) & Junction Box Elect (JBE)	4	Car Access System 2 (CAS2)
2	Roof Functions Center (FZD)	5	Footwell Module (FRM)
3	Comfort Access (CA)		



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To get a better understanding of the concept of “distributed functions” using the Central Locking System as an example.

To date (E46), the "Central Locking" function was located primarily in the General Module (GM) or, on the E60 in the Basic Body Module (KBM) and the door modules.

The "Central Locking" function in the E90 is distributed over several control modules (Car Access System, Junction Box Electronics Control Module & Footwell Module). Distributing functions over several control module offers the advantage that sensors and actuators are connected directly to a control module in the vicinity of their installed location, which result is shorter cable connections. By interlinking the control modules, it is possible to exchange sensor data between them.

The primary control modules for the systems in the E90 are:

- Junction Box Electronics Control Module (JBE)
- Car Access 2 (CAS2)
- Footwell Module (FRM)
- Roof Function Center (FZD)

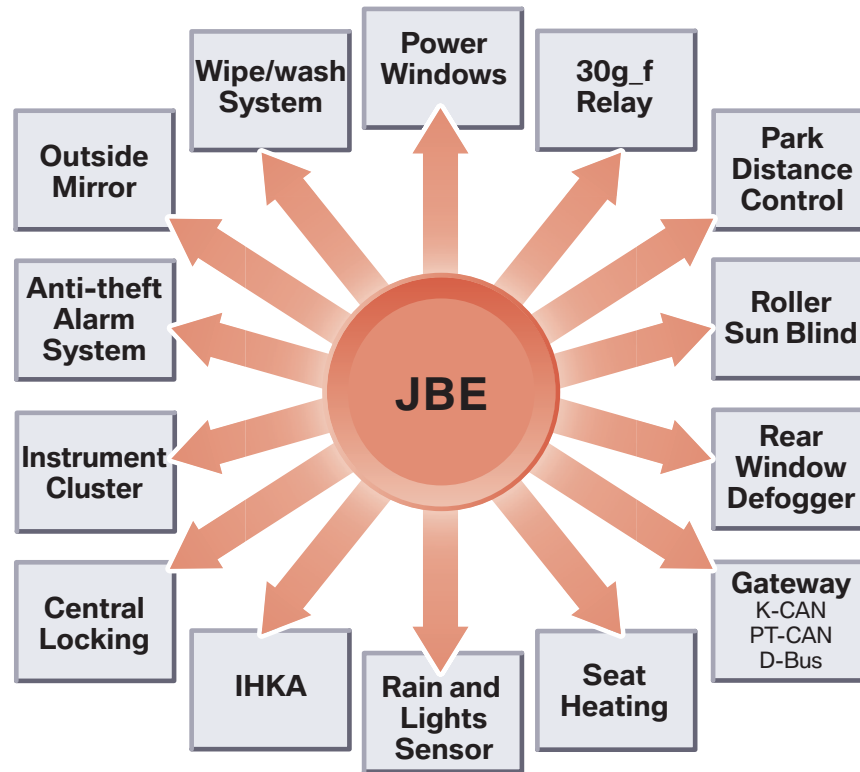
The distributed functions concept is used/identified in the following General Vehicle Electrical Systems:

- Central Locking (ZV)
- Comfort Access (CA)
- Interior Lighting (IB)
- Power Windows (FH)
- Slide/tilt Sunroof (SHD)
- Anti-theft Alarm System (DWA)
- Electronic Steering Lock (ELV)
- Wiper Washer System
- Park Distance Control (PDC)
- Vehicle Exterior Lighting
- Adaptive Headlight Control
- Steering Column Switch Cluster (SZL)
- Outside Mirror
- Power Seats
- Rear Sun Shade

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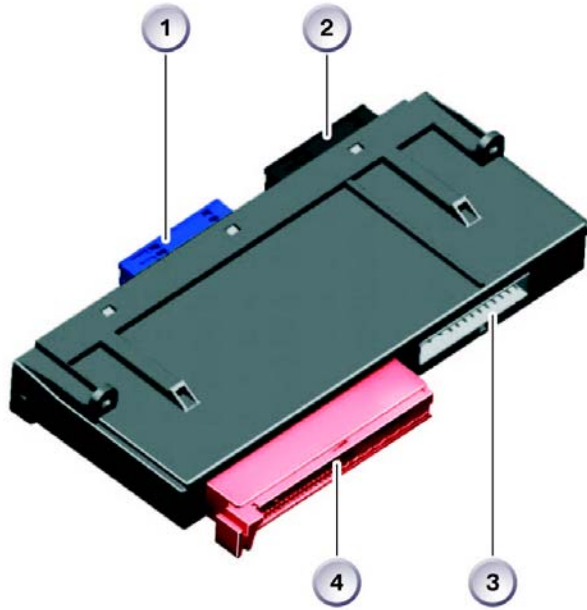
## Primary Control Modules

### Functions of Junction Box Electronics Control Module



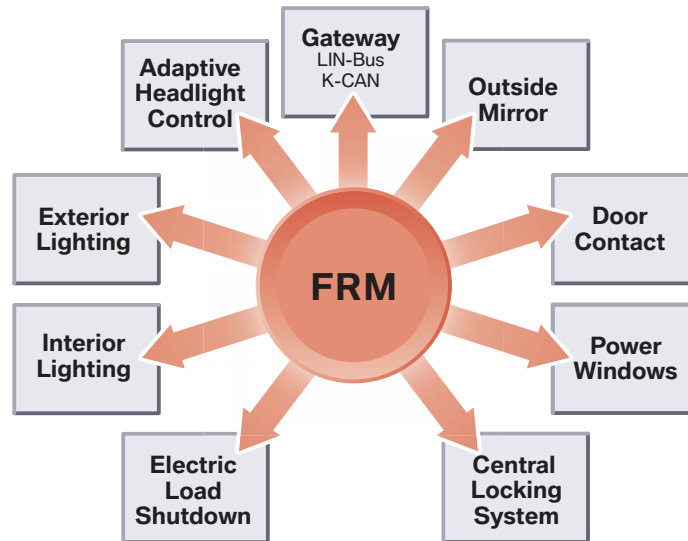
The Junction Box Electronics Control Module (JBE) serves as:

- Gateway Module for vehicle Bus System (provides a pass-through function for F-CAN)
- Evaluator & transmitter of sensor data for Kombi such as Engine Coolant Level, Washer Fluid Level, Fuel Level, Hand Brake Contact (evaluated data is transmitted on to the Instrument Cluster)
- Evaluator & transmitter of sensor data for IHKA such as Automatic Recirculation Air Control, Coolant Pressure (evaluated data is transmitted on to the IHKA module)
- Activator of Compressor Valve and Rear Window Defogger (activation control data is transmitted from IHKA module)
- Controller of Wipe/Wash functions, Heated Washer Jets, Seat Heating, Mirror Heating, Water Valve, Relay 30g\_f, Rear Power Windows, Rear Window Sun Shade
- Locking & Unlocking of complete vehicle
- Pass-through for Outside Temp Sensor



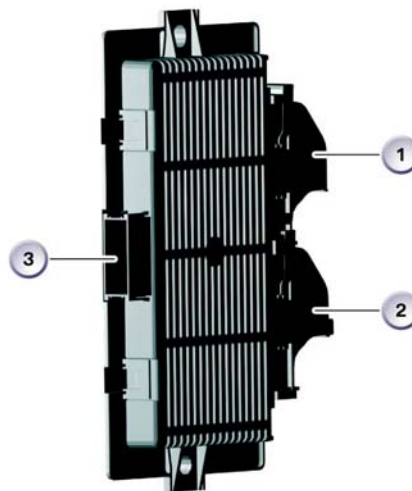
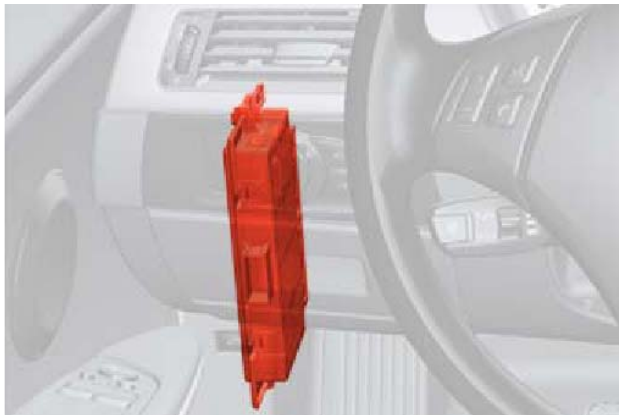
Index	Explanation	Index	Explanation
1	Connection to Main Wiring Harness (54-pin)	3	Direct contact to Power Distribution Box (23-pin)
2	Connection to Instrument Cluster (54-pin)	4	Connection to Main Wiring Harness (47-pin)

## Functions of Footwell Module



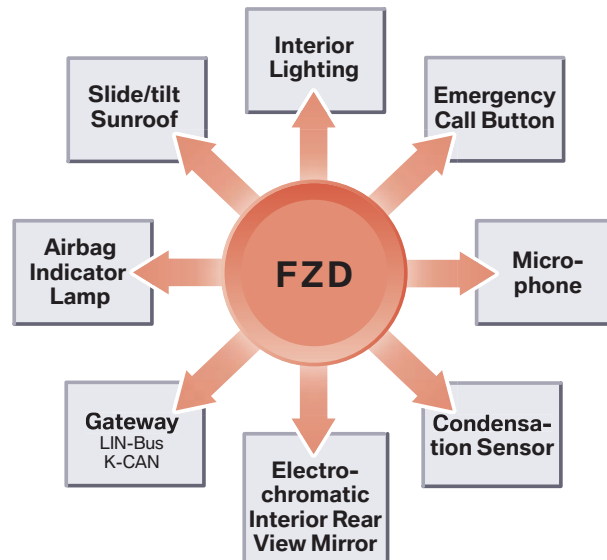
The Footwell Module (FRM) serves as:

- Gateway Module for communication between devices connected to the LIN Bus and K-CAN (Outside Mirror & Drivers Switch Cluster).
- Evaluator of data from Door Contacts and Door Lock Cylinders
- Activator/controller of all Exterior Lights, Adaptive Headlights,
- Controller of Front Power Windows, Electric Load Shut-down
- Activation of Power Window Anti-Trap
- Stores the Vehicle Order information



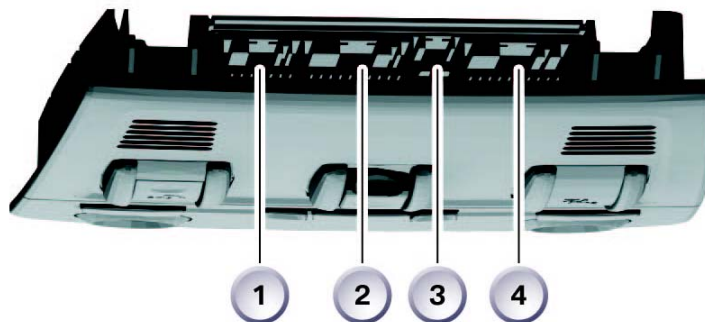
Index	Explanation	Index	Explanation
1	Connection to Main Wiring Harness (51-pin)	3	Connection to Instrument Cluster (46-pin)
2	Connection to Main Wiring Harness (51-pin)	4	

## Functions of Roof Function Center



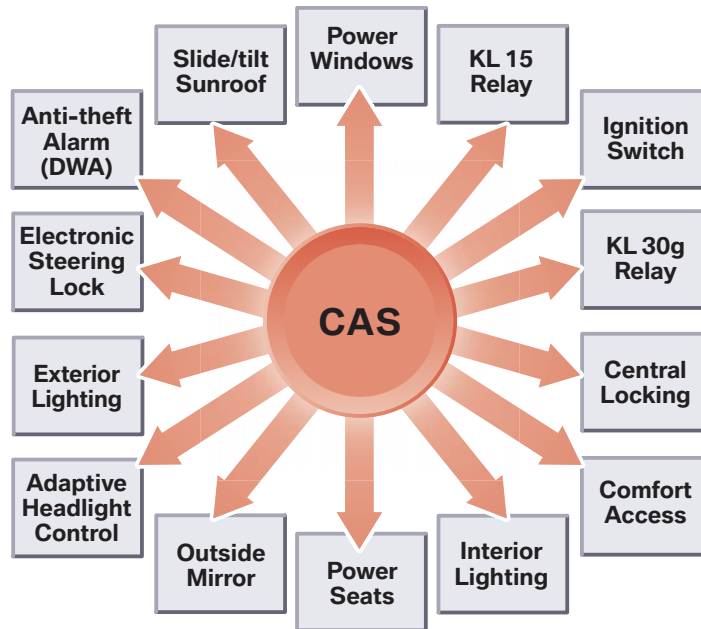
The Roof Function Center (FZD) serves as:

- Controller of Sunroof Functions
- Gateway for Rain Light Sensor (Data transmitted from RLS to FZD via LIN Bus then transmitted via K-CAN from FZD to other modules)
- Evaluator of data from Condensation sensor and calculates relative humidity (data is transmitted via K-CAN to IHKA)
- Evaluator of data from Interior Electrochromatic Rear View Mirror (data from mirror is converted and transmitted to FRM via K-CAN, FRM dips the outside mirrors)
- Supplies power to Universal Garage Door opener
- Activation/Controller of Vanity Mirror lighting, Map/Reading and Interior Light
- Integration point for Passenger Airbag light, Microphone, and Emergency call button



Index	Explanation	Index	Explanation
1	Connection to Main Wiring Harness (20-pin)	3	Connection to Main Wiring Harness (4-pin)
2	Connection to Interior Rear View Mirror (20-pin)	4	Connection to Rear Interior Lighting (20-pin)

## Functions of Car Access System



The Car Access System 2 (CAS2) serves as:

- Ignition Switch/Terminal control
- Master controller for Central Locking, Comfort Access, Power Windows and Sunroof (issues enable command)
- Actuator/Controller of Electronic Steering Lock
- “Key” validation device and Electronic Vehicle Immobilization
- Redundant data storage device for Vehicle Order
- Storage point for Condition Based Service (CBS) data
- Control of KL15 and KL 30g relays



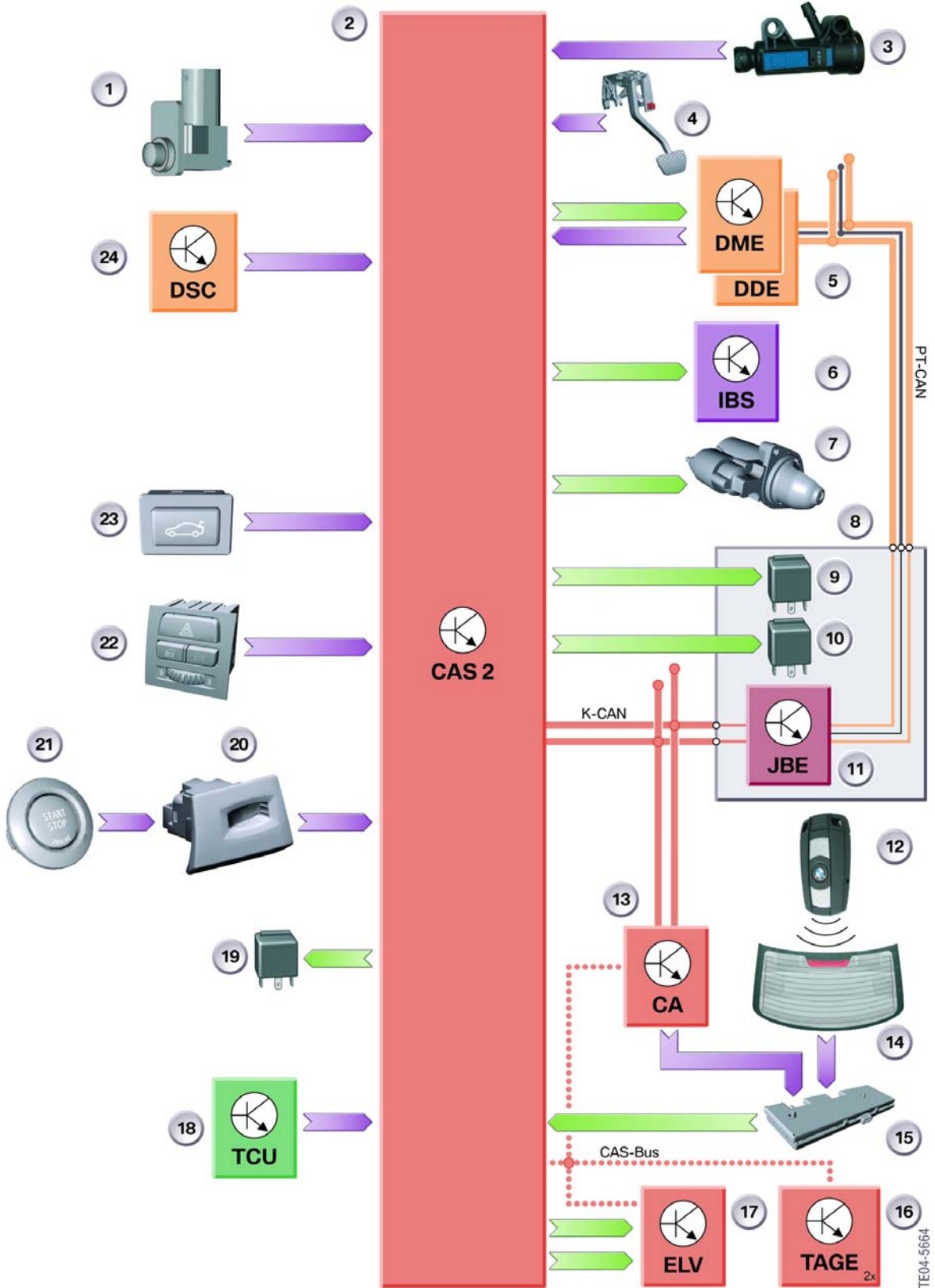
Index	Explanation	Index	Explanation
1	Connection to Wiring Harness (42-pin)	2	Ribbon Cable Connector (14-pin)

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NOTES

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# Car Access System 2 - Input/Output



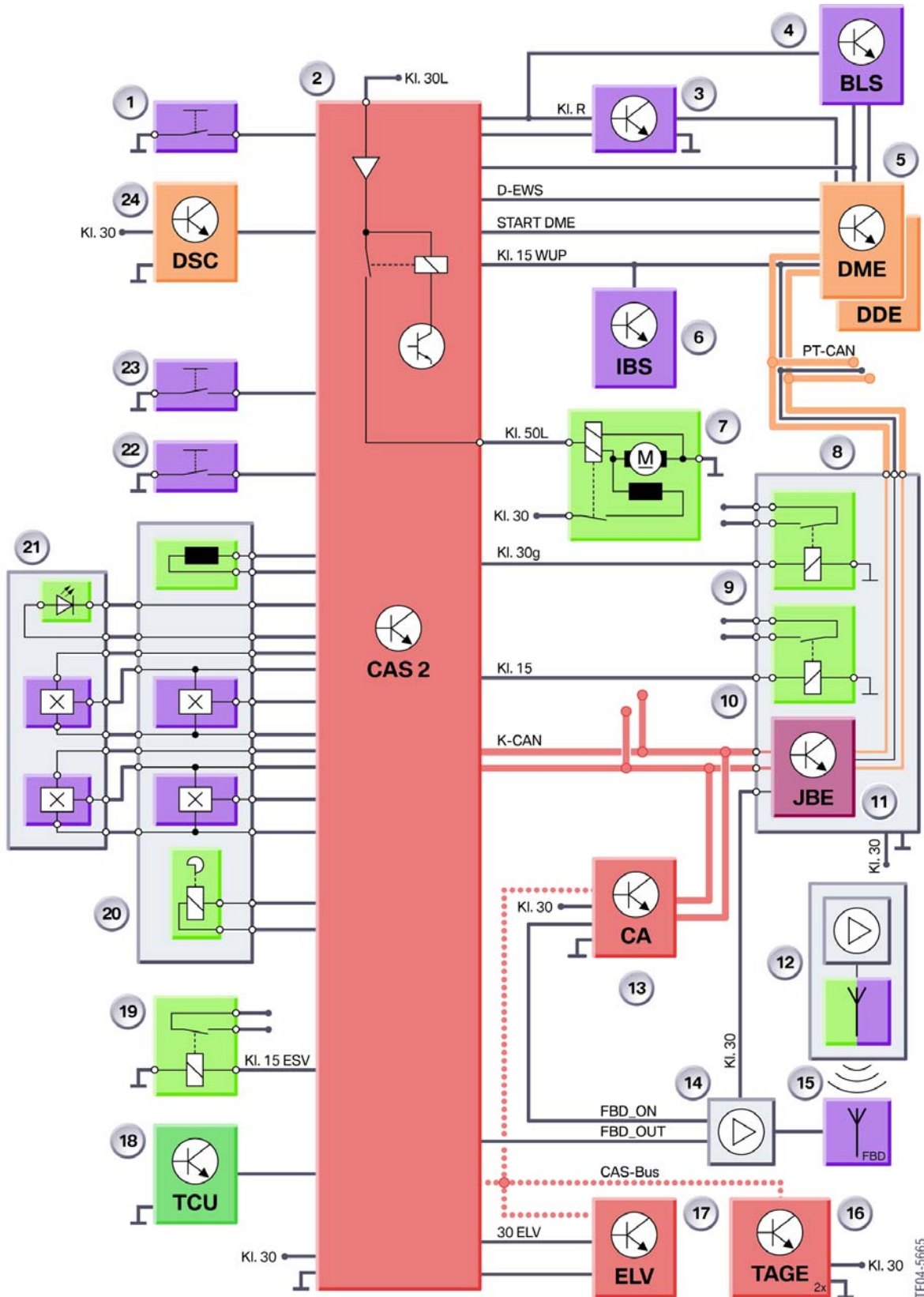
TE04-5664



## Legend for Car Access System 2

Index	Explanation	Index	Explanation
1	Hood Contact Switch	22	Center-Lock Button
2	Car Access System 2 CAS 2	23	Truck Lid Button, Interior
3	Clutch Switch	24	Dynamic Stability Control (DSC)
4	Brake Light Switch BLS	KI. R	Terminal R
5	Digital Motor Electronics DME/ECM	KI. 15	Terminal 15
6	Intelligent Battery Sensor (IBS)	KI. 15 WUP	Terminal 15, Wake-up
7	Starter	KI. 15 ESV	Terminal 15, Fuel Injectors
8	Junction Box (JB)	KI. 30	Terminal 30
9	Terminal 30g Relay	KI. 30g	Terminal 30, Switched
10	Terminal 15, Load-Shedding Relay	KI. 30L	Terminal 30, Load
11	Junction Box Electronics Control Module (JBE)	KI. 50	Terminal 50
12	Identification Transmitter	CAS-Bus/K-Bus	K-Bus Protocol
13	Comfort Access (CA)	K-CAN	Body CAN
14	Remote Control Receiver	PT-CAN	Powertrain CAN
15	Rear window antenna	EWS	Electronic Vehicle Immobilizer Signal
16	Electronic Outer Door Handle Module TAGE	START-DME	Start, Digital Motor Electronics
17	Electric Steering Lock (ELV)	30 ELV	Positive Supply ELV
18	Telematics Control Unit TCU	FBD	Remote Control Services
19	Relay, Fuel Injectors	FBD ON	Remote Control Services ON
20	Holder	FBD OUT	Remote Control Services OUT
21	START/STOP Button		
22	Side airbag, front right		

# Car Access System 2 - Circuit Diagram



TE04-5665

## Legend for Car Access System 2

Index	Explanation	Index	Explanation
1	Hood Contact Switch	22	Center-Lock Button
2	Car Access System 2 CAS 2	23	Truck Lid Button, Interior
3	Clutch Switch	24	Dynamic Stability Control (DSC)
4	Brake Light Switch BLS	KI. R	Terminal R
5	Digital Motor Electronics DME/ECM	KI. 15	Terminal 15
6	Intelligent Battery Sensor (IBS)	KI. 15 WUP	Terminal 15, Wake-up
7	Starter	KI. 15 ESV	Terminal 15, Fuel Injectors
8	Junction Box (JB)	KI. 30	Terminal 30
9	Terminal 30g Relay	KI. 30g	Terminal 30, Switched
10	Terminal 15, Load-Shedding Relay	KI. 30L	Terminal 30, Load
11	Junction Box Electronics Control Module (JBE)	KI. 50	Terminal 50
12	Identification Transmitter	CAS-Bus/K-Bus	K-Bus Protocol
13	Comfort Access (CA)	K-CAN	Body CAN
14	Remote Control Receiver	PT-CAN	Powertrain CAN
15	Rear window antenna	EWS	Electronic Vehicle Immobilizer Signal
16	Electronic Outer Door Handle Module TAGE	START-DME	Start, Digital Motor Electronics
17	Electric Steering Lock (ELV)	30 ELV	Positive Supply ELV
18	Telematics Control Unit TCU	FBD	Remote Control Services
19	Relay, Fuel Injectors	FBD ON	Remote Control Services ON
20	Holder	FBD OUT	Remote Control Services OUT
21	START/STOP Button		
22	Side airbag, front right		

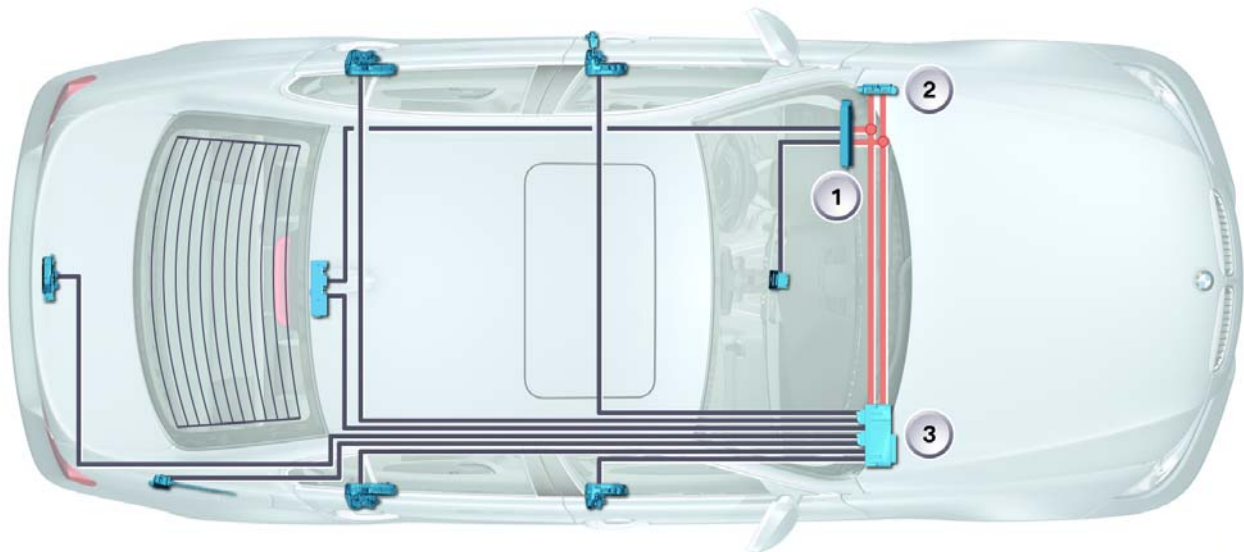
# Central Locking

On the E90, all doors as well as the trunk lid and fuel filler flap are integrated into the Central Locking System.

The central locking can be operated via the following components:

- Remote control/identification transmitter
- Driver's door lock barrel (door lock)
- Center-lock button
- Electronic outer door handle module (TAGE) in connection with comfort access

## Control Modules for Central Locking Function



Index	Explanation	Index	Explanation
1	Car Access System 2 (CAS2)	3	Junction Box (JB)
2	Footwell Module (FRM)		

---

## **Car Access System 2 (CAS2)**

As soon as the CAS2 receives the lock/unlock signal from the remote control receiver, it checks whether the identification transmitter is valid and belongs to the vehicle. Only if the check/authentication, which takes a few milliseconds, is successful will the CAS2 forward the request to activate the central locking.

The CAS2, serves as the master control module for the central locking system, as it issues the enable signal to activate a lock/unlock function. An enable status signal is transmitted to the JBE from CAS2 via K-CAN.

*Signal Path: Remote control to remote receiver to CAS2; or  
Central lock button input to CAS2;  
Enable signal from CAS2 to JBE via K-CAN (if all doors are closed)  
Door status signal from FRM to JBE via K-CAN then JBE via K-Can to CAS2*

**Example:** *The request to lock the vehicle, is not executed while the driver's door is open.*

## **Junction Box Electronics Control Module (JBE)**

The Junction Box Electronics Control Module is responsible for implementing the lock/unlock operation for the entire vehicle, as it contains the lock/unlock relays which in turn drive the respective lock/unlock motors.

The following central locking relays are activated by JBE:

- Driver's door
- Rear doors
- Front passenger's door
- Fuel filler flap

The central locking function for the trunk lid is activated directly via a power output stage.

*Signal Path: Enable signal from CAS2 to JBE via K-CAN; JBE activates lock/unlock function via direct activation of relay(s)*

## **Footwell Module (FRM)**

The Footwell Module (FRM) monitors the hall sensors of the door contacts to determine if a door is open or closed. CAS2 indirectly obtains the door status information and uses the information to determine if an enable signal is to be provided to the JBE.

*Signal Path: Door contact signals input to FRM; Door status signal from FRM to JBE via K-CAN then forwarded from JBE via K-Can to CAS2.*

## Unlocking/Locking the Vehicle

The central locking system can be activated only when the driver's door is closed.

The vehicle unlocking/locking procedure is initiated by the following system components:

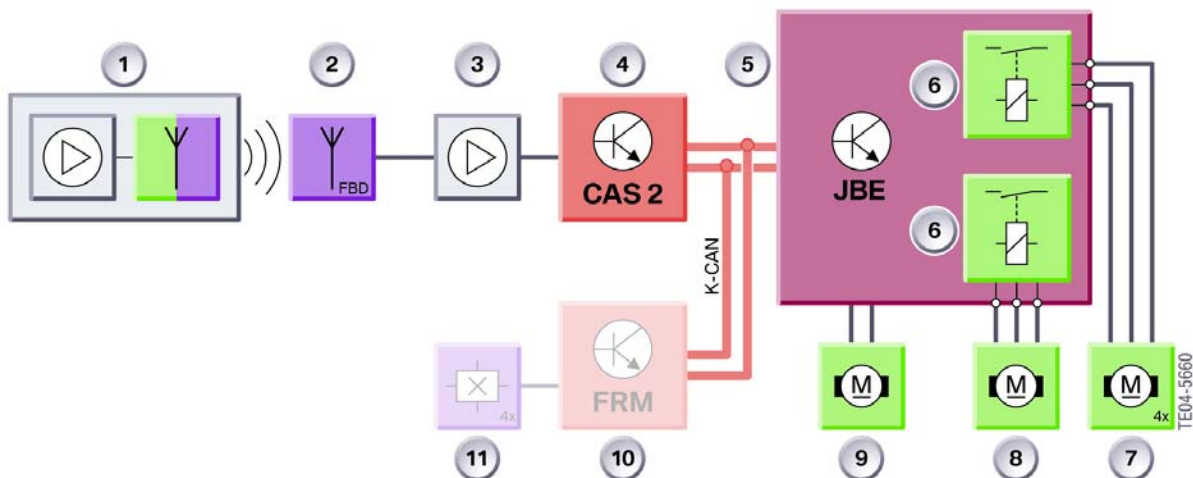
- Remote control/identification transmitter
- Center-lock button
- Mechanical key/spare key

**Note: The identification transmitter is incorporated with the remote control function and is used solely for Comfort Access. The vehicle activates the identification transmitter by way of a radio signal from the Comfort Access System. This makes it possible to unlock the vehicle without actively using the identification transmitter.**

The central locking system activates the following system components:

- Central locking, driver's and front passenger's door
- Central locking, rear doors
- Central locking, fuel tank
- Central locking, trunk lid

**Example:** If the vehicle is unlocked using identification transmitter/remote control the unlocking procedures is as shown below .



Index	Explanation	Index	Explanation
1	Identification Transmitter	7	Central Locking, rear side driver's door, passenger doors, fuel filler flap
2	Rear Window Antenna	8	Central Locking, Driver's Door
3	Remote Control Receiver	9	Central Locking, Trunk Lid
4	Car Access System (CAS2)	10	Footwell Module FRM
5	Junction Box Electronics Control Module (JBE)	11	Door Contacts
6	Relay for Central Locking		

---

## **Unlocking Procedure**

As soon as the unlock button on the identification transmitter is pressed, the signal initially reaches the rear window antenna followed by the remote control receiver. The remote control receiver is located in the diversity module and forwards the signal to the CAS2. The signal from the identification transmitter is verified in the CAS2. If the signal is recognized as valid, the JBE is enabled for the purpose of unlocking the central locking drive units. The JBE now activates the relay to trigger the vehicle unlocking procedure.

## **Locking Procedure**

The vehicle can be locked only after the Footwell Module has evaluated the door contacts and the CAS2 signals that the doors are closed.

## **Using Identification Transmitter**

The identification transmitter sends out a coded signal as soon as the unlock or lock button is pressed.

The signal from the identification transmitter is demodulated and conditioned in the remote control receiver. This signal is then made available to the car access system 2.

All central locking drive units assume the "lock" position during the vehicle locking procedure. The central locking drive units in the doors additionally assume the "central arrest" position.

On conclusion of the central arrest procedure, the locking buttons in the doors are mechanically separated from the central locking drive system. The vehicle can then no longer be unlocked using the locking buttons in the doors.

The trunk lid can also be opened separately with the identification transmitter.

## **Center-Lock Button**

The vehicle can be locked/unlocked with the center-lock button. The CAS 2 receives a high signal (battery voltage approx. 12 V) when the center-lock button is not pressed. The high signal changes to a low signal (approx. 0 V) as soon as the center-lock button is pressed.

The CAS 2 evaluates the change from the high signal to the low signal and locks/unlocks the vehicle. The signal from the center-lock button is looped through the Junction Box Electronics Control Module.

## **Mechanical Key/Spare Key**

The footwell module evaluates the Hall sensors for the lock barrel in the driver's door. The CAS2 is informed of the change in status via the K-CAN.

The CAS2 enables the vehicle unlocking/locking procedure. The JBE initiates the vehicle unlocking/locking procedure.

---

## **Locking Button on Vehicle Doors**

All four doors can be locked mechanically, by using the separate locking buttons.

If the button on the door is depressed, then the inner door handle of the door to be unlocked must be pulled twice to unlock the vehicle door.

In this situation the Junction Box Electronics Control Module does not activate the central locking.

## **Opening the Trunk Lid**

The trunk lid can be unlocked via the remote control, the identification transmitter, the outer or inner trunk lid release button.

### **Opening with Remote Control/Identification Transmitter**

The trunk lid is opened with the remote control/identification transmitter by pressing on the trunk lid symbol. The trunk lid opens irrespective of whether the vehicle is locked or not.

The motor in the lock of the trunk lid is activated via a power output stage in the JBE in order to open the trunk lid.

### **Opening with the Outer Trunk Lid Button**

As soon as the vehicle is unlocked, the trunk lid can be opened by pressing the outer trunk lid button.

The microswitch switches to ground when the outer trunk lid button is pressed.

The JBE monitors the microswitch. The trunk lid is unlocked and opened when the signal from the microswitch goes to low.

### **Opening with the Inner Trunk Lid Button**

As soon as the vehicle is unlocked, the trunk lid can be opened by pressing the inner trunk lid button.

The inner trunk lid button is installed on the A-pillar on the driver's side. It switches to ground. The microswitch is routed directly to the CAS2. As soon as the signal of the microswitch goes to low, the CAS2 sends this status to the JBE. In turn, the JBE activates the motor in the lock of the trunk lid.



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## Special Functions

### Automatic Locking (Personal Profile)

The vehicle is locked automatically when driving at a speed in excess of 16 km/h. The speed signal is made available by the DSC module.

The vehicle is unlocked in connection with Comfort Access (CA) as soon as terminal 15 is switched off.

On vehicles without Comfort Access (CA), the unlocking procedure is triggered by removing the remote control from its holder.

### Selective Unlocking

With corresponding coding, the vehicle can also be unlocked selectively. In this case, the driver's door is initially unlocked. The rest of the vehicle is unlocked in response to a renewed unlock request.

### Unlocking After an Accident

A locked central locking system is unlocked as soon as the CAS2 receives a crash message from the Multiple Restraint System 5 (MRS5).

On receiving the crash signal, the center-lock button and the remote control receiver are inhibited for the central locking functions. The center-lock button and the remote control receiver are enabled again only after the a change in terminal R OFF/terminal R ON.

## Location of Control Modules



Index	Explanation	Index	Explanation
1	Footwell Module (FRM)	3	Junction Box (JB)
2	Car Access System 2 (CAS2)		

### Footwell Module (FRM)

The footwell module is located in the left hand A-pillar. It evaluates the status of the door contacts and reads the Hall sensor signals from the lock barrel in the driver's door and transfers the information via the Junction Box Electronics Control Module to the Car Access System 2.

### Car Access System 2 (CAS2)

The Car Access System 2 is installed to the left of the steering column. The CAS2 assumes the master function for the Central Locking System, it has the exclusive system authorization and is simply supported by the other control modules.

### Junction Box Electronics Control Module (JBE)

The Junction Box Electronics Control Module is integrated in the front power distribution box. The JBE contains the relays for activating the central locking drive modules. The trunk lid is operated via a power output stage. The signals from the outer trunk lid button and center-lock button are also sent to the JBE and transferred to the CAS2.

The remote control receiver is powered by the Junction Box Electronics Control Module.

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## Components of Central Locking System

### Controls

Central locking can be operated from the following controls:

- Remote control
- Identification transmitter
- Center-lock button
- Driver's door lock barrel

#### ■ Remote Control

Each vehicle is delivered with one spare key and two remote control units. The adapter for the spare key is located in the glove compartment.

**Note: A third remote control for the vehicle is optionally available. This remote control can be ordered through Spare Parts.**

The remote control has three buttons for operating the central locking system.

There is a rechargeable battery in the remote control that is charged by means of a transponder coil in the remote control holder.

The mechanical key is integrated in the remote control.



Index	Explanation	Index	Explanation
1	Unlock / convenient open button	3	Button for OPEN trunk lid
2	Lock / convenient close button	4	Mechanical key

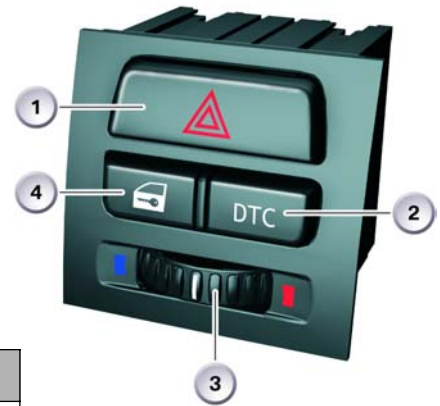


Index	Explanation
1	Mechanical Key
2	Spare Key
3	Remote Control

### Center-Lock Button

The center-lock button is installed in the instrument panel in the center of the outlet nozzle.

A new feature is that the center-lock button forms one component together with the hazard warning switch, the button for dynamic stability control and the stratification potentiometer.



Index	Explanation	Index	Explanation
1	Hazard Warning Flasher Button	3	Stratification Potentiometer
2	Dynamic Stability Control Button	4	Central Lock Button

### Driver's Door Lock Barrel

The lock barrel is connected mechanically via a linkage to the door lock. Hall sensors for the lock barrel are integrated in the door lock.

The footwell module evaluates the signals from the Hall sensors for locking/unlocking purposes.

### Central Locking Drive Units

A central locking drive unit consists of an electric drive unit and the unlocking/locking mechanism.

### Central Locking Drive Units in the Doors

The central locking drive units in the doors are equipped with two motors to facilitate the unlocking/locking and central arrest functions of the vehicle.

Central arrest means that the locking button in the doors is separated mechanically from the central locking drive unit. As a result, the vehicle cannot be opened by pulling the locking button. The Hall sensor for the door contact is additionally integrated in the central locking drive unit.

### ■ Central Locking Drive Units for Truck Lid and Fuel Filler Flap

The central locking drive units for the truck lid and fuel filler flap are each equipped with a motor for unlocking/locking purposes.

### ■ Manually Release for Fuel Filler Flap

The fuel filler flap can be unlocked manually in the event of an electrical defect. The release device is located in the luggage compartment on the right behind the luggage compartment cover.

1. Remove cover
2. Pull green knob with fuel pump symbol.

### ■ Lock Barrel, Trunk Lid

The trunk lid can be unlocked via the lock barrel using the mechanical key or spare key. This a pure mechanical unlocking function and triggers no response in the central locking.

### ■ Emergency Trunk Lid Release

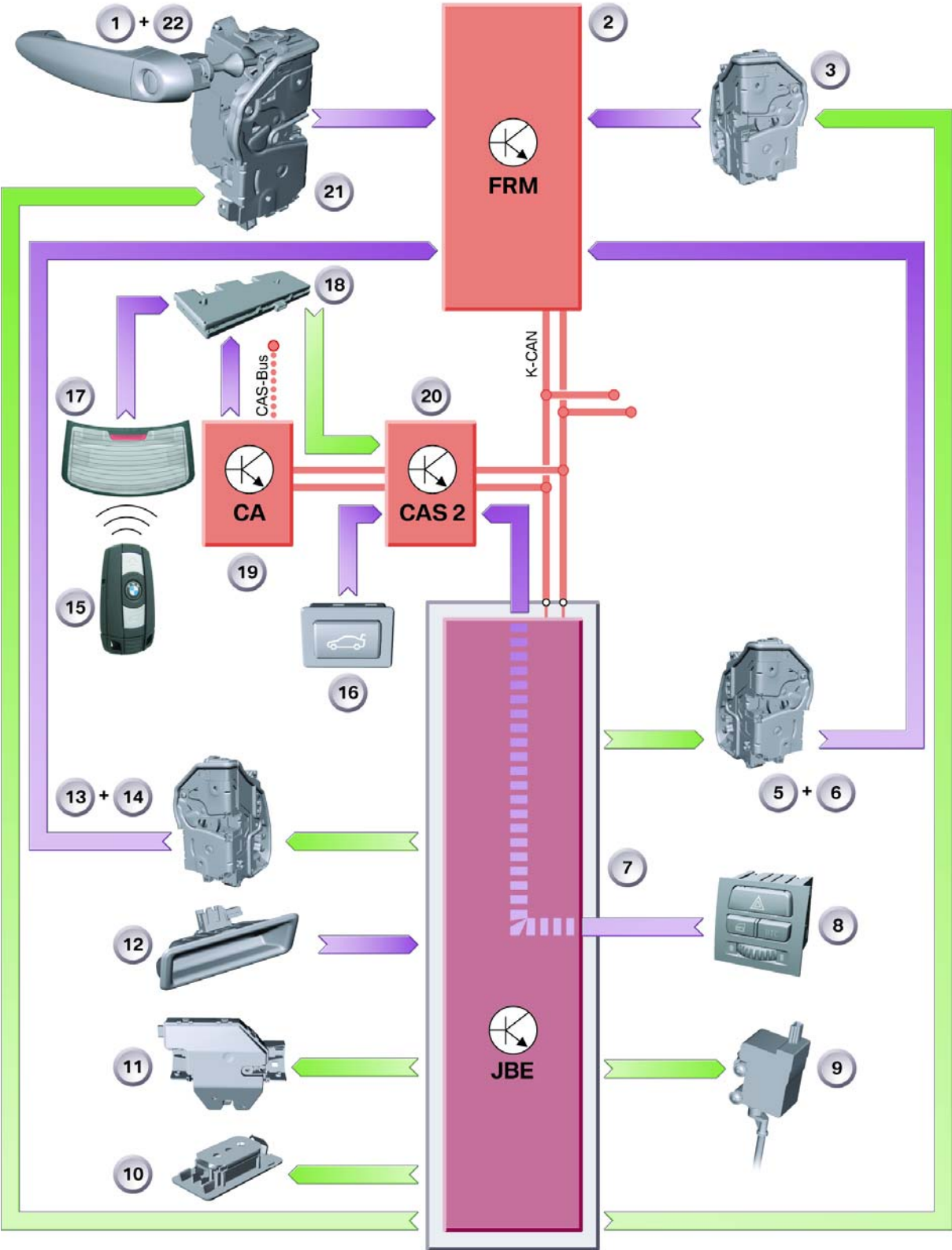
The emergency release for the trunk lid is integrated in the luggage compartment. The central locking of the trunk lid is released by pulling the pull handle for the emergency release.



Index	Explanation	Index	Explanation
1	Pull handle for emergency release	4	Cylinder barrel in trunk lid
2	Bowden cable for emergency release	5	Central locking, trunk lid
3	Bowden cable for cylinder barrel in trunk lid		

A detailed description of the truck lid emergency release facility is provided in the E90 Owner's Manual.

# Central Locking - Inputs/Outputs

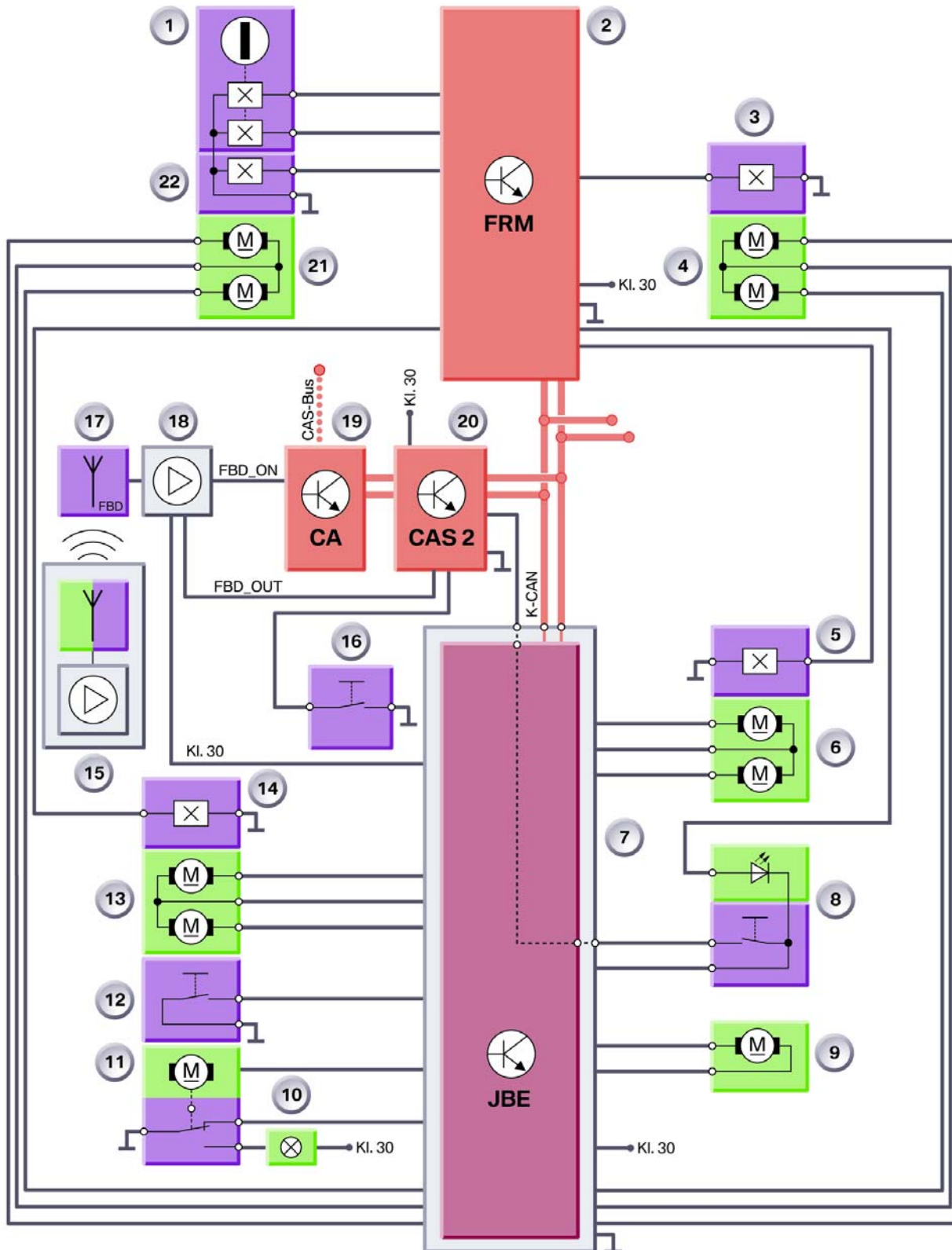


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## Legend for Central Locking

Index	Explanation	Index	Explanation
1	Lock barrel, driver's door	15	Identification transmitter
2	Footwell module FRM	16	Interior button for truck lid
3	Door contact, passenger's door	17	Rear window antenna
4	Central locking, passenger's door	18	Remote control receiver
5	Door contact, rear passenger's side	19	Comfort access CA
6	Central locking, rear passenger's side	20	Car access system 2 CAS 2
7	Junction Box Electronics Control Module (JBE)	21	Central locking, driver's door
8	Center-lock button	22	Door contact, driver's door
9	Central locking, fuel filler flap	K-CAN	Bodyshell CAN
10	Luggage compartment light	KI. 30	Terminal 30
11	Central locking, truck lid	CAS-Bus//K-Bus	K-Bus Protocol
12	Button, truck lid, exterior	FBD	Remote control services
13	Central locking, rear driver's side	FBD ON	Remote control services ON
14	Door contact, rear driver's side	FBD OUT	Remote control services OUT

# Central Locking - Circuit Diagram





## Legend for Central Locking

Index	Explanation	Index	Explanation
1	Lock barrel, driver's door	15	Identification transmitter
2	Footwell module FRM	16	Interior button for truck lid
3	Door contact, passenger's door	17	Rear window antenna
4	Central locking, passenger's door	18	Remote control receiver
5	Door contact, rear passenger's side	19	Comfort access CA
6	Central locking, rear passenger's side	20	Car access system 2 CAS 2
7	Junction Box Electronics Control Module (JBE)	21	Central locking, driver's door
8	Center-lock button	22	Door contact, driver's door
9	Central locking, fuel filler flap	K-CAN	Bodyshell CAN
10	Luggage compartment light	KI. 30	Terminal 30
11	Central locking, truck lid	CAS-Bus//K-Bus	K-Bus Protocol
12	Button, truck lid, exterior	FBD	Remote control services
13	Central locking, rear driver's side	FBD ON	Remote control services ON
14	Door contact, rear driver's side	FBD OUT	Remote control services OUT



## Classroom Exercise - Review Questions

1. What control modules are involved in activating/deactivating central locking?

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2. What modules directly controls/activates the relays for lock/unlocking the vehicle?

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3. What module provides information regarding the status of the door contacts?

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4. How many remote controls are available?

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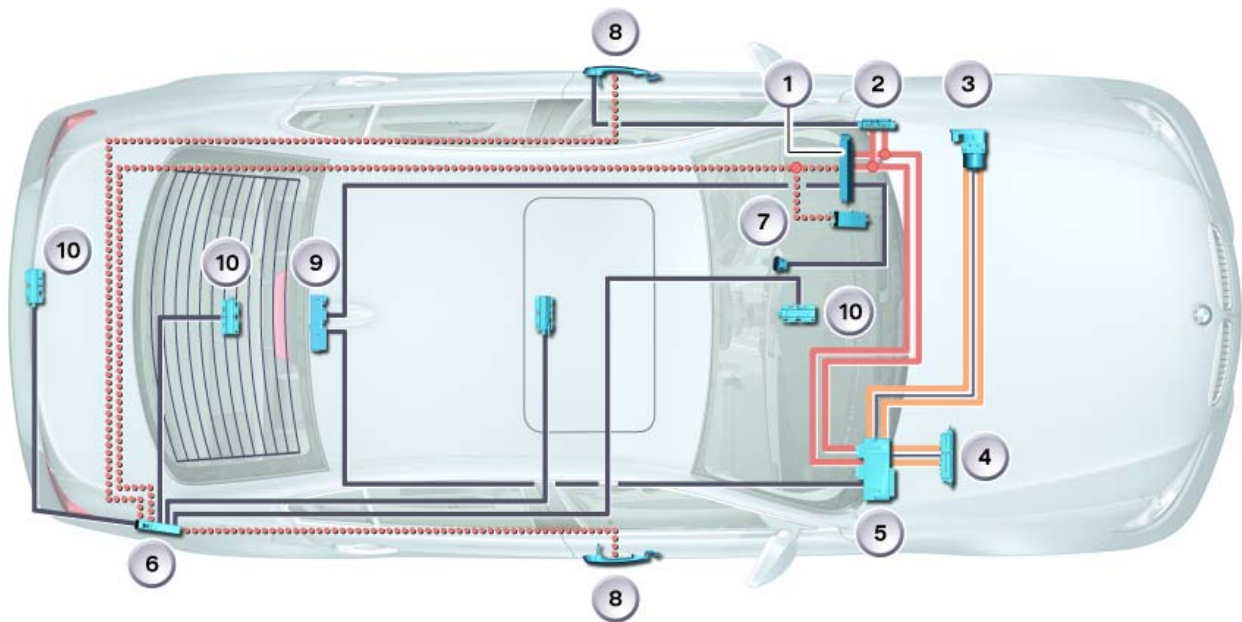
# Comfort Access

Comfort Access (SA 322) is offered as an option for the E90.

"Comfort Access" is a passive access system. This means the vehicle is unlocked by grasping the outer door handle, provided the identification transmitter is located within a radius of no more than approx. .5 - 1.5 m from the vehicle.

With Comfort Access it is sufficient for the driver to simply carry the identification transmitter on his/her person in order to open or start the vehicle. "Keyless" access to the vehicle was implemented for the first time on the E65 and has been adapted for the E90.

As with many of these systems the operation/functions are distributed among several different control modules. Comfort Access utilizes the same modules that are utilized for the Central Locking function plus two more.



Index	Explanation	Index	Explanation
1	Car Access System (CAS 2)	6	Comfort Access (CA)
2	Footwell Module (FRM)	7	Electric Steering Lock (ELV)
3	Dynamic Stability Control (DSC)	8	Electric Outer Door Handle Module (TAGE)
4	Digital Motor Electronics (DME/ECM)	9	Remote Control Receiver
5	Junction Box Electronics Control Module (JBE)	10	Antennas

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## Control Modules for Comfort Access Function

### Car Access System 2 (CAS2)

As soon as the CAS2 receives a request signal it must verify if a valid ID Transmitter is located with range of the antenna. CAS2 requires that the antenna in the area of the request transmit a request for validation to the ID Transmitter.

The ID transmitter transmits a signal to the remote control receiver, which in turn forwards the signal to the CAS2 where the signal is checked to be valid and belonging to the vehicle. Only if the check/authentication, which takes a few milliseconds, is successful will the CAS2 forward the request to activate the specific function.

The CAS2, serves as the master control module for the central locking system, as it issues the enable signal to activate a lock/unlock function. An enable status signal is transmitted to the JBE from CAS2 via K-CAN.

### Junction Box Electronics Control Module (JBE)

The Junction Box Electronics Control Module is responsible for implementing the lock/unlock operation for the entire vehicle, as it contains the lock/unlock relays which in turn drive the respective lock/unlock motors.

The following central locking relays are activated by JBE:

- Driver's door
- Rear doors
- Front passenger's door
- Fuel filler flap

The central locking function for the trunk lid is activated directly via a power output stage.

*Signal Path: Enable signal from CAS2 to JBE via K-CAN; JBE activates lock/unlock function via direct activation of relay(s)*

### Footwell Module (FRM)

The Footwell Module (FRM) monitors the hall sensors of the door contacts to determine if a door is open or closed. CAS2 indirectly obtains the door status information and uses the information to determine if an enable signal is to be provided to the JBE.

*Signal Path: Door contact signals input to FRM; Door status signal from FRM to JBE via K-CAN then forwarded from JBE via K-Can to CAS2.*

### Comfort Access Control Module

The Comfort Access Module controls/activates the antennas located on the exterior and interior of the vehicle, plus reads/transfers the data received from the Electronic Outer Door Handle Module to the CAS2.

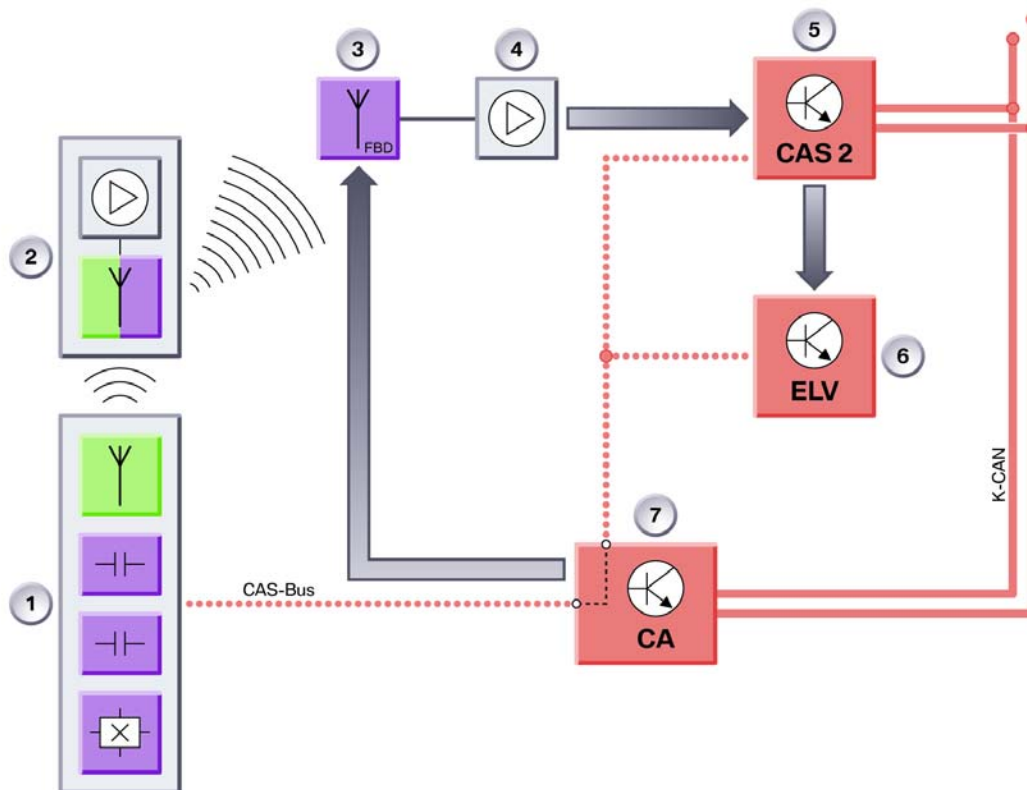
## Electronic Outer Door Handle Module (TAGE)

The Electronic Outer Door Handle Module (TAGE) transmits door handle status data via CAS BUS(K-BUS) to the Comfort Access module, which in turn forwards the data to CAS2. Information from the door handle that is transmitted is primarily related to changes at the capacitive sensors and hall sensors integrated into the door handle.

## Functions of Comfort Access

The main advantages of Comfort Access (CA) are:

- Passive Entry - Unlocking the vehicle without actively using the ID transmitter
- Passive Go -Starting engine without inserting the ID transmitter into its holder
- Passive Exit - Locking authorization without actively using the ID transmitter



Index	Explanation	Index	Explanation
1	Electronic Outer Door Handle Module (TAGE)	6	Electric Steering Column Lock (ELV)
2	Identification Transmitter/Remote	7	Comfort Access (CA)
3	Rear Window Antenna		
4	Remote Control Receiver	CAS-Bus/K-Bus	K-Bus protocol
5	Car Access System 2 (CAS 2)	K-CAN	Body Bus

**Note: In connection with the comfort access system, the vehicle must activate the identification transmitter by means of a radio signal so that the transmitter is registered with the vehicle (authentication).**

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## Passive Entry

Passive entry enables access to the vehicle without operating the Identification Transmitter/Remote Control.

**Note: The vehicle cannot be woken and opened without a valid ID transmitter being present within a .5-1.5 m radius from a specific external antenna.**

The vehicle in sleep mode is woken with the presence of a valid ID transmitter/remote control and activation of the Comfort Access System is started by grasping the outer door handle.

### ■ Unlocking

The capacitive sensor in the Electronic Outer Door Handle Module (TAGE) recognizes that the handle has been grasped and activates the transmit antenna. The transmit antenna sends a 125 kHz signal to the identification transmitter. In turn, the identification transmitter sends a 315 MHz high frequency signal to the remote control receiver, which contains the authentication request.

The CAS2 checks the authentication of the identification transmitter.

Following successful authentication, the CAS2 issues the enable signal to unlock the vehicle and initiates the vehicle unlocking procedure. The JBE executes the unlocking procedure.

**Note: At this point the steering is not yet unlocked.**

### ■ Opening Trunk Lid

An authentication check also takes place before opening the trunk lid, an identification transmitter must be located within the rear area of the vehicle.

After successful authentication, the trunk lid can be unlocked and opened with the outer trunk lid button.

## Passive Go

The passive go function makes it possible to start the vehicle without the ID transmitter being inserted in its holder.

**Note: The vehicle cannot be started without a valid ID transmitter being located in the interior of the vehicle.**

### ■ Issuing Start Enable

After the door has been opened, the CAS2 starts the check after 3 s to establish whether there is a valid ID transmitter in the vehicle. The CAS2 instructs the Comfort Access control module to again send out the identifier for a valid ID transmitter.

The Comfort Access Module sends the request via the interior antennas.

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The identification transmitter replies with a code via the high frequency link (315 MHz) to the remote control receiver. This code contains data for the electronic vehicle immobilizer.

The car access system 2 issues the enable to start the engine for the DME/DDE and the electric steering lock is unlocked.

### **Passive Exit**

The passive exit function makes it possible to lock the vehicle without actively using the ID transmitter/remote control.

**Note: The vehicle cannot be unlocked without a valid identification transmitter within a .5-1.5 m radius from a specific external antenna.**

### **■ Locking Procedure**

After the vehicle door has been closed, the locking procedure is started by touching the recognition point/area on the outer door handle. The electronic outer door handle module sends the request to lock the vehicle via the K-Bus to the Comfort Access System.

Based on the exterior and/or interior antennas, the Comfort Access System checks where the ID transmitter is located. The ID transmitter is instructed to send an authentication signal. In turn, the identification sensor sends encrypted data via the high frequency link to the remote control receiver.

The CAS2 checks whether the ID transmitter is valid. Upon successful completion of the check, the CAS2 issues the enable signal to lock the drive units and initiates the steering locking procedure.

The JBE activates the central locking drive units.

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## Special Comfort Access Functions

The Comfort Access System additionally features special functions that are determined by the actions of the vehicle user such as:

### ■ ID Transmitters Remain in Vehicle

If an ID transmitter remains in the vehicle interior, by checking via the interior antennas, the car access system 2 recognizes whether there is a valid identification transmitter in the vehicle interior.

If a valid identification transmitter is detected in the vehicle interior and the vehicle is locked by means of another valid identification transmitter, the identification transmitter located in the vehicle interior is set to "invalid".

For the Comfort Access System, this identification transmitter is considered as no longer belonging to the vehicle until the vehicle is unlocked again.

### ■ ID Transmitter Remains in Trunk

If an ID transmitter is in luggage compartment, upon closing the trunk lid, it is immediately opened (automatically).

If there is an identification transmitter in the luggage compartment of the locked vehicle with the trunk lid open. An audible and visual signal draws the customer's attention to the fact that the identification transmitter has been left in the luggage compartment.

On request from the CAS2, the Comfort Access control module starts the check via the interior antennas. The valid identification transmitter in the luggage compartment is recognized via the luggage compartment antenna. Consequently, the CAS2 does not issue the enable signal to lock the trunk lid.

The trunk lid cannot be closed before the ID transmitter has been removed and is located outside the luggage compartment.

**Note: An ID transmitter can be locked in the truck if a second valid ID transmitter is identified as being on the exterior of the vehicle within the radius of the bumper antenna or if the valet function is active.**

### ■ Engine Start Disable

The engine cannot be started if the identification transmitter is located in the luggage compartment of the unlocked vehicle.

**Note: The CAS2 issues the enable signal for starting the engine only when a valid identification transmitter has been detected in the vehicle interior.**



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### ■ **Starting Engine without ID Transmitter**

The function makes it possible to start the vehicle within 10 s after "engine OFF" without detecting the identification transmitter. This function is intended for cases where the identification transmitter is not detected due to high frequency interference, as an example.

### ■ **Check Control Message, Terminal 15**

The Comfort Access System enables terminal selection without the ID transmitter being inserted in its holder. It is possible that terminal 15 is selected by pressing the START-STOP button. A corresponding check control message is shown in the instrument cluster after the door is opened. An audible signal also sounds.

**Note: The battery may be discharged if the driver ignores the warnings and locks the vehicle.**

### ■ **Unintentional Wake-up Function**

The sensors are subject to a check procedure in order to avoid waking the electronic outer door handle module by touching the outer door handle without a valid identification transmitter.

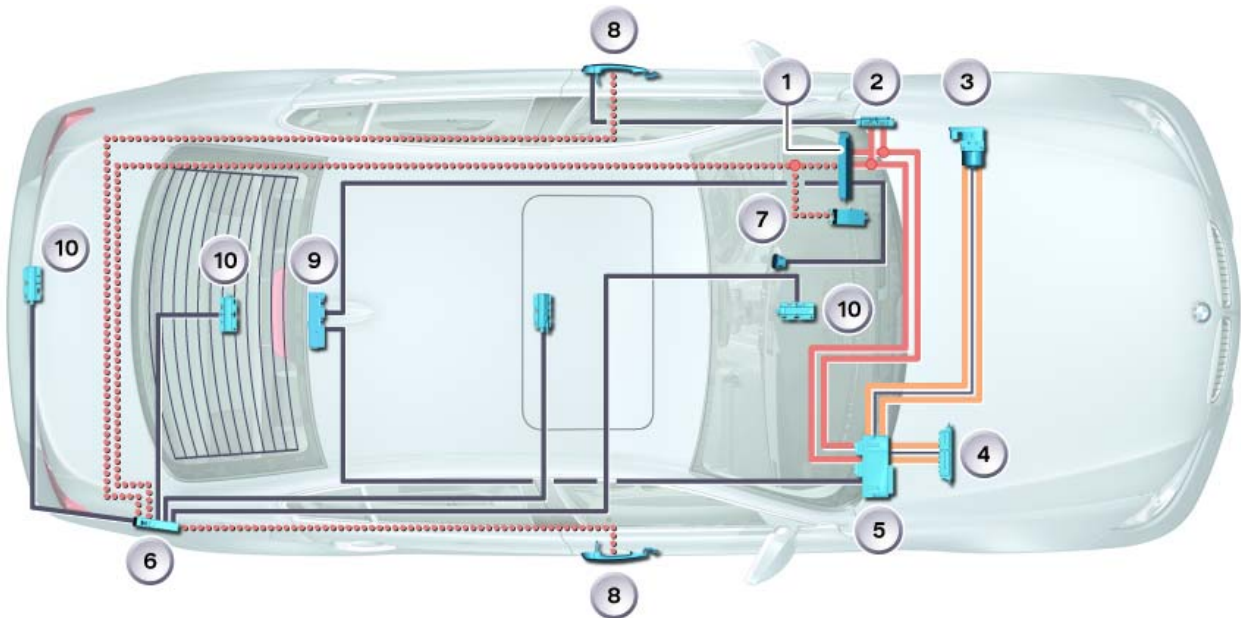
The identification transmitter is requested to send an authentication signal. If no valid ID transmitter is detected, the electronic outer door handle module receives this information from the CAS2. In this case, the electronic outer door handle module remains inactive until a valid identification transmitter is detected.

### ■ **Locking with Engine Running**

The vehicle can also be unlocked with the engine running if the engine was started with passive go. When leaving the vehicle, the ID transmitter must also be taken and the vehicle locked from the outside.

## Components of Comfort Access System

The following graphic shows all components of the Comfort Access System with the respective control modules and control components.



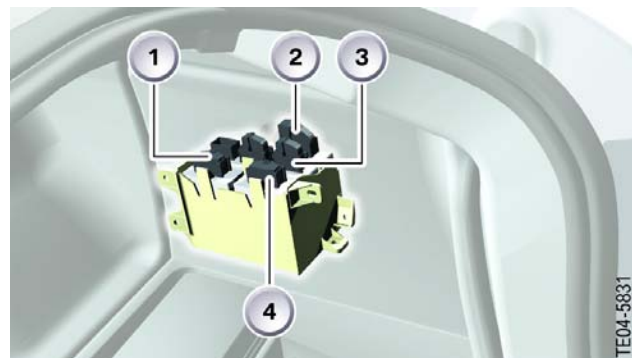
Index	Explanation	Index	Explanation
1	Car Access System (CAS 2)	6	Comfort Access (CA)
2	Footwell Module (FRM)	7	Electric Steering Lock (ELV)
3	Dynamic Stability Control (DSC)	8	Electric Outer Door Handle Module (TAGE)
4	Digital Motor Electronics (DME/ECM)	9	Remote Control Receiver
5	Junction Box Electronics Control Module (JBE)	10	Antennas

### Comfort Access Control Module

In addition to providing Central Locking functions, the option SA 322 Comfort Access is installed to facilitate Passive Entry, Passive Go and Passive Exit functions.

The Comfort Access control module is located at the right rear of the luggage compartment.

The Comfort Access Module controls/activates the antennas located on the exterior and interior of the vehicle, plus reads/transfers the data received from the Electronic Outer Door Handle Module to the CAS2.



Index	Explanation
1	N/A
2	Comfort Access Module (CA)
3	Park Distance Control Module (PDC)
4	N/A

## Identification Transmitter

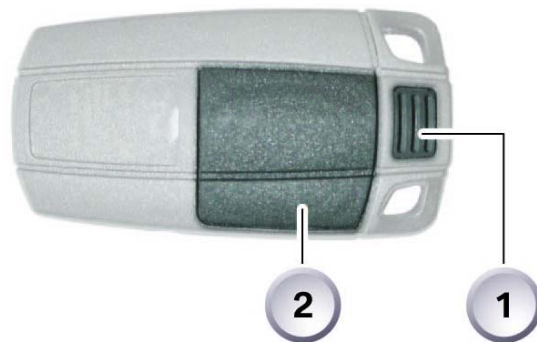
The identification transmitter for Comfort Access must be actuated by means of a coded 125 kHz radio signal that is transmitted from the Electronic Outer Door Handle Module or exterior antenna. The coded 125 kHz radio signal enables the ID transmitter to transmit a coded 315 MHz high frequency validation signal that is received by the remote control receiver and forwarded to the CAS2, which determines if the ID Transmitter is valid and belongs to the vehicle.

The ID transmitter is exclusively responsible for use/operation of the Comfort Access System.

The ID transmitter does not need to be operated to enable access to the vehicle, it simply needs to be carried on the person that is accessing/operating the vehicle.

The ID transmitter for Comfort Access utilizes a replaceable battery, which is the identifiable difference when compared to the regular remote control that has an integrated rechargeable battery. The ID transmitter for Comfort Access does not need to be inserted in the holder in order to start the vehicle it just needs to be located in the interior of the vehicle in order to start the engine.

The service life of the battery in the ID Transmitter is about 2 years.



Index	Explanation
1	Unlock Button for Mechanical Key
2	Battery Compartment

## Voltage Monitoring

The ID Transmitter monitors its own battery voltage in two stages:

- First stage the ID Transmitter signals to the CAS2 that the battery is "flat" (discharged). In response, the CAS 2 generates a check control message. The check control message informs the customer that the battery needs to be changed.
- Second Stage if the battery is not changed, the voltage monitoring facility initiates a function which saves the data in the ID Transmitter is saved and then ID Transmitter is set/made "inoperable".

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## Antennas for Comfort Access

Six antennas are installed for the comfort access system. Three antennas are located in the exterior and three in the interior.

The antennas for the exterior and interior are inductive antennas and have a ferrite core which contributes to their compact size. This is of particular advantage for accommodating the antennas in the outer door handles.

The transmit frequency of the antennas is 125 kHz. All messages that are sent via the antennas are encrypted.

### ■ Locations of Exterior Antennas

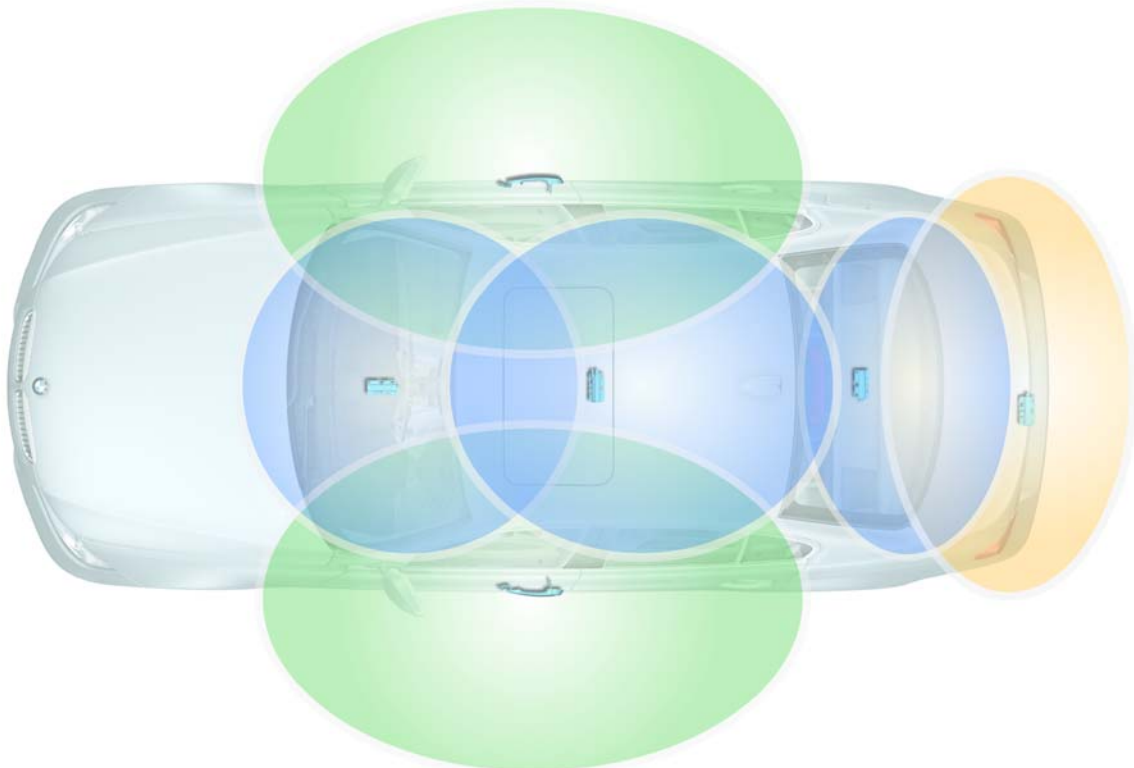
The exterior antennas are installed in the following locations on the E90:

- Door Handle, Driver's side
- Door Handle, Passenger's side
- Rear Bumper

### ■ Locations of Interior Antennas

The interior antennas are installed in the following locations on the E90:

- Passenger Compartment, Front
- Passenger Compartment, Centre
- Luggage Compartment



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### ■ **Antenna in Outer Door Handles**

The antenna in the outer door handles is an integral part of the electronic outer door handle module. The antenna characteristic is structured such that it covers the area about the vehicle doors.

### ■ **Antenna in Bumper**

The antenna in the rear bumper is of the same design as the interior antennas. It features a waterproof plug connection to ensure no water enters the antenna.

The antenna characteristic is structured such that it covers the rear area and enables access to the luggage compartment.

### ■ **Antennas for the Passenger Compartment**

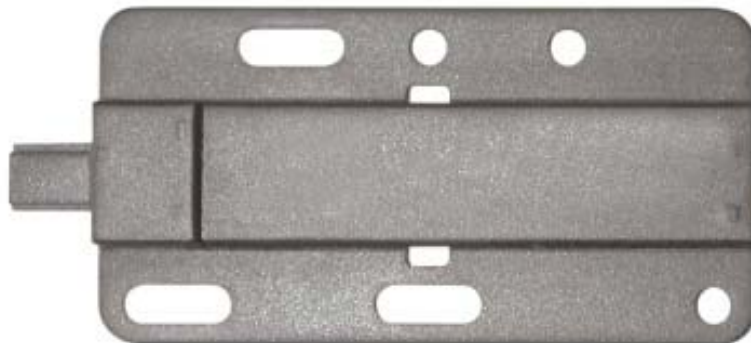
The antenna characteristic is spherical. The entire vehicle interior is covered by the two interior antennas.

The interior antennas are important for checking whether there is an identification transmitter located in the interior.

### ■ **Antenna for Luggage Compartment**

Due to its design, the luggage compartment acts as a "separate" area in the vehicle. This arrangement makes it easier for the comfort access system to identify the identification transmitter in the luggage compartment.

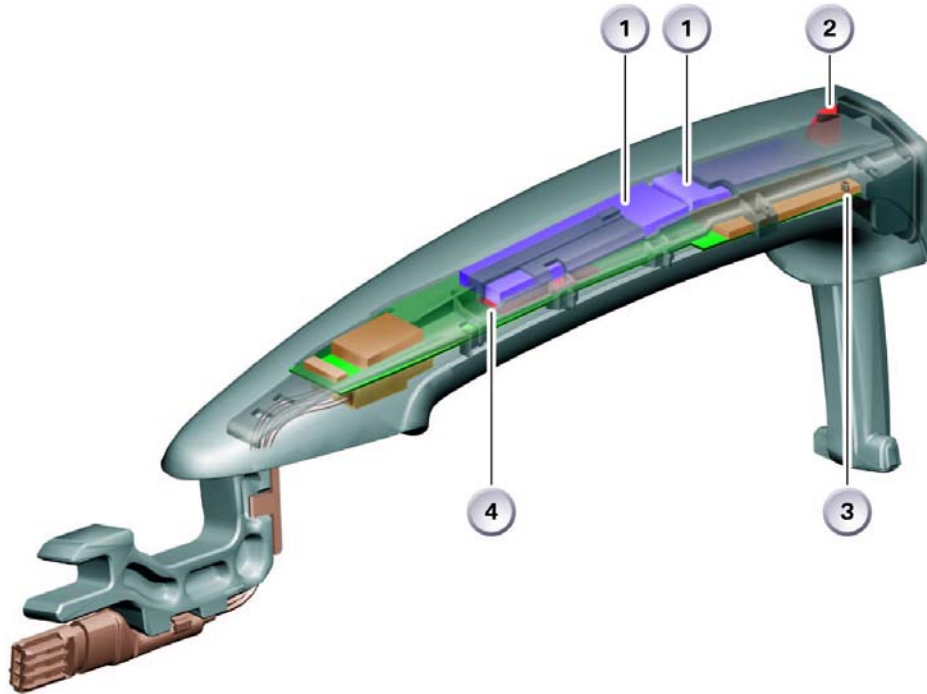
The luggage compartment antenna is of the same design as the interior antenna. The antenna characteristic is laid out such that it covers the entire luggage compartment.



**Interior Antenna**

## Electronic Outer Door Handle Module (TAGE)

The outer door handle contains the components of the Electronic Outer Door Handle Module (TAGE), which is connected to terminal 30 and operates within a voltage range from 9 V to 16 V.



Index	Explanation	Index	Explanation
1	Capacitive Sensor 1	3	Hall Sensor
2	Capacitive Sensor 2	4	Exterior Antenna

The electronic outer door handle module is connected to the vehicle via the K-Bus thus making available the information from the capacitive sensors and the Hall sensor.

### Design

The Electronic Outer Door Handle Module (TAGE) contains the following components:

- 3 sensors
  - Capacitive sensor 1 for unlocking the vehicle
  - Capacitive sensor 2 for locking the vehicle
  - A Hall sensor for pulling the outer door handle
- Inductive antenna for the exterior
- Electronic module for outer door handle and interface for CAS-bus.

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With the aid of 3 sensors, the TAGE module detects the status of the outer door handle. Each change in the status of the outer door handle module triggers on of the corresponding functions:

- Trigger pulse when a hand is moved around the outer door handle; capacitive sensor 1
- Unlock request by pulling the outer door handle; Hall sensor
- Lock request by touching the recognition point/area on the outer door handle; capacitive sensor 2

## **Sensors**

To protect the battery, the TAGE module switches off the capacitive sensors for the driver's side after the vehicle has been at rest for 192 hours. The capacitive sensors on the passenger's side are switched off after 72 hours.

### **Functional Principle of the Capacitive Sensor**

The capacitive sensor consists of three capacitor plates (electrodes). The dielectric is the air gap between the door handle and the body/door panel of the vehicle. One capacitor plate is the car body including the surrounding vehicle. The other two capacitor plates are located in the outer door handle.

The outer door handle is split in two parts with respect to the capacitor plates. One capacitor plate is in the outer door handle. The other capacitor plate is contained in the grooved area on the upper portion of the outer door handle. The functional principle of the capacitive sensor is based on a change in the electrical field between the capacitor plates, which results in a change in the capacitance of the capacitor. A change in capacitance occurs (increase) whenever a hand is placed between the body and the outer door handle (grabbing of the handle). The electronic circuitry in the outer door handle wakes up based on a defined change in capacitance, which is referred to as triggering.

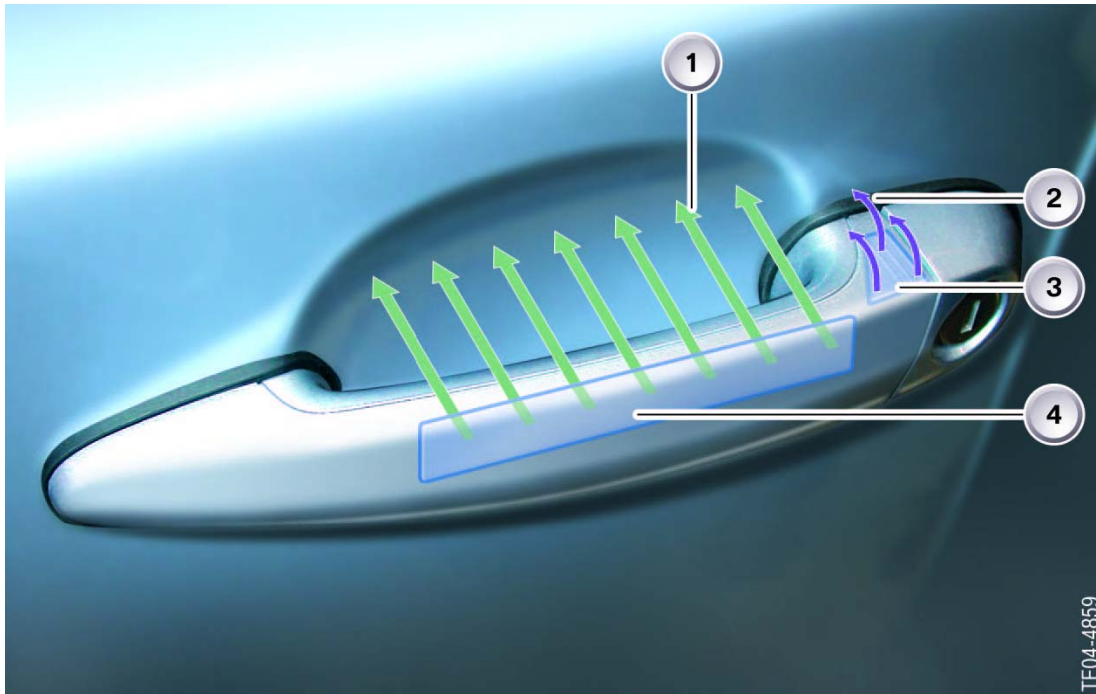
The capacitive sensor responds with a pulse only to fast changes in its capacitance. Changes in its environment such as slow soiling of the outer door handle or rain therefore have no influence on the function of the capacitive sensor.

When unlocking/locking the vehicle, the sensors are mutually blocked for a period of 2 sec., meaning that after locking, unlocking is inhibited for 2 sec and vice versa.

### **Capacitive Sensor 1**

Capacitive Sensor 1 is responsible for initiating the Unlock request by generating pulse when a hand is held between the "capacitor plates", door handle and door panel/body. The pulse wakes up the electronic circuitry in the TAGE. If the vehicle is in sleep mode, the TAGE will send a wake up request via K-Bus to the Comfort Access Module and CAS2. CAS2 will request that a signal be sent from the external antenna to the ID Transmitter asking for a validation signal. The Comfort Access module switches on the remote control receiver in order to receive the validation signal sent from the ID transmitter.





Index	Explanation	Index	Explanation
1	Electric field, capacitor 1	3	Capacitor plate, capacitive sensor 2
2	Electric field, capacitor 2	4	Capacitor plate, capacitive sensor 1

### Capacitive Sensor 2

A change in capacitance at sensor 2 is achieved by placing the thumb on the grooved area of the door handle. The change in capacitance generates a signal from sensor 2, resulting in the TAGE sending a lock request via the K-Bus (CAS-Bus) to the CAS2.

### Hall Sensor of the Outer Door Handle

The Hall sensor is redundant to the capacitive sensor 1. If the TAGE has switched off the capacitive sensors, the Hall sensor is still operational after 192 hours which allows the unlocking procedure to also be started via the Hall sensor.

The Hall sensor changes its status from low to high when the outer door handle is pulled. The TAGE monitors the status of the hall sensor and consequently detects whether access to the vehicle is requested.

The monitoring cycle takes place every 40 ms in order to save the vehicle battery. A signal is triggered when the sensor reaches a defined threshold. The electronic outer door handle module detects the signal and switches on the power supply of the Hall sensor for checking purposes.



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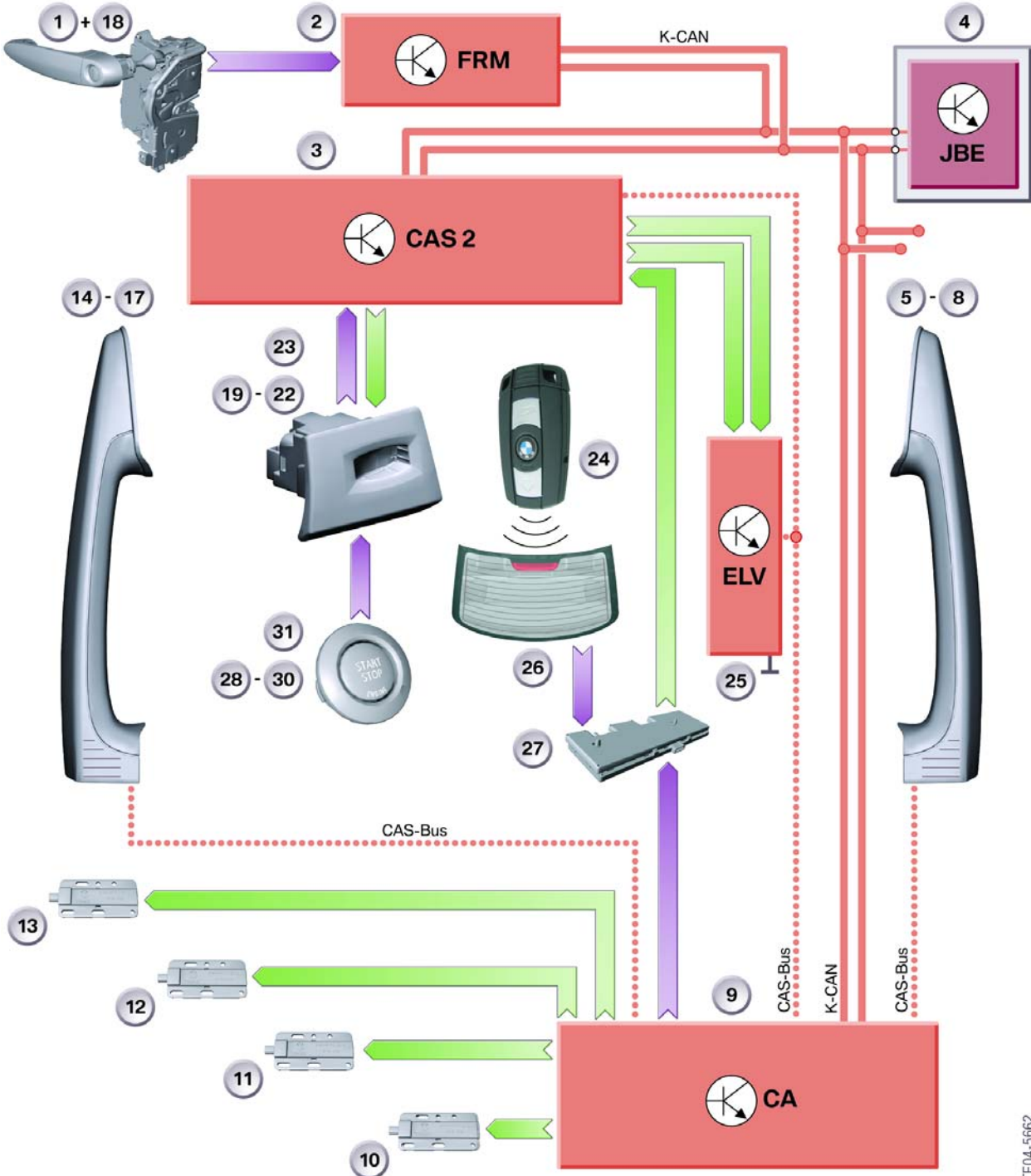
## Lock in Driver's Door & Front Passenger's Door

The capacitive sensor 1 initiates the vehicle unlocking procedure.

The lock in the driver's door and front passenger's door is equipped with an additional spring to ensure the vehicle can be opened fast enough. The spring exerts pretension on the central locking drive unit for the unlocking procedure. The door is already unlocked before an attempt is made to open it with the outer door handle.

**Note: If pulled very fast, however, it may be necessary to pull the outer door handle a second time in order to open the door.**

# Comfort Access - Input/Output

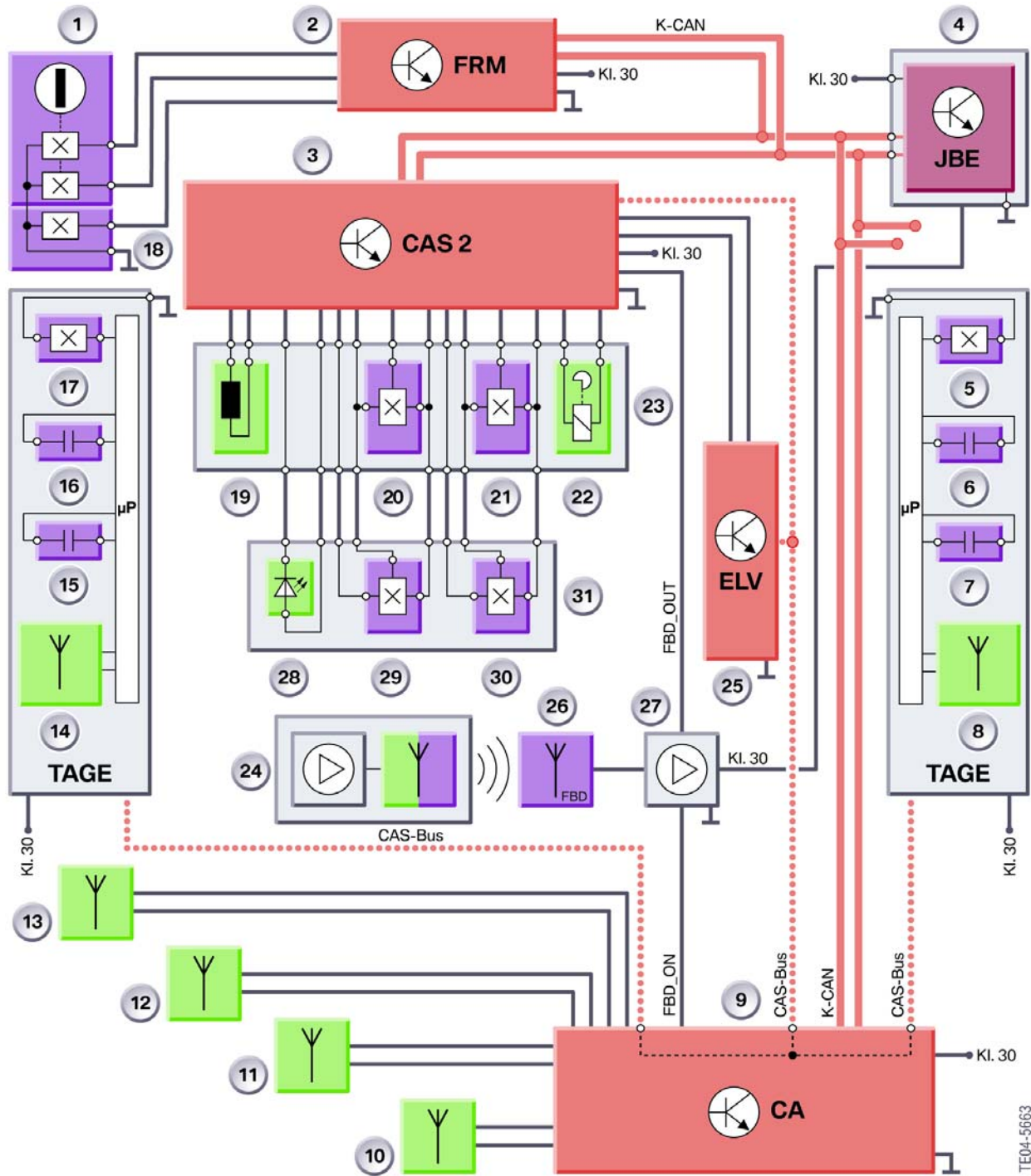


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## Legend for Comfort Access

Index	Explanation	Index	Explanation
1	Lock Barrel, Driver's Door	20	Hall Sensor, ID transmitter in Holder
2	Footwell Module (FRM)	21	Hall Sensor, ID transmitter in Holder
3	Car Access System 2 (CAS 2)	22	Identification Transmitter Locked in Holder
4	Junction Box Electronics Control Module (JBE)	23	Identification Transmitter Holder
5	TAGE Hall sensor, Front Passenger's Side	24	Identification Transmitter
6	TAGE Capacitive Sensor, Front Passenger's Side	25	Electric Steering Lock ELV
7	TAGE Capacitive Sensor, Front Passenger's Side	26	Rear Window Antenna
8	TAGE Antenna, Front Passenger's Side	27	Remote Control Receiver
9	Comfort Access (CA)	28	LED START/STOP Button
10	Exterior Antenna	29	Hall sensor, START/STOP Button
11	Luggage Compartment Antenna	30	Hall sensor, START/STOP Button
12	Interior Antenna, Rear	31	START/STOP button
13	Interior Antenna, Front	CAS-Bus/K-Bus	(K-bus protocol
14	TAGE Antenna, Driver's Side	K-CAN	Bodyshell CAN
15	TAGE Capacitive Sensor, Driver's Side	KI. 30	Terminal 30
16	TAGE Capacitive Sensor, Driver's Side	FBD	Remote Control Services
17	TAGE Hall sensor, Driver's Side	FBD ON	Remote Control Services ON
18	Door Contact	FBD OUT	Remote Control Services OUT
19	Transponder Coil		

# Comfort Access - Circuit Diagram



TE04-5663

## Legend for Comfort Access

Index	Explanation	Index	Explanation
1	Lock Barrel, Driver's Door	20	Hall Sensor, ID transmitter in Holder
2	Footwell Module (FRM)	21	Hall Sensor, ID transmitter in Holder
3	Car Access System 2 (CAS 2)	22	Identification Transmitter Locked in Holder
4	Junction Box Electronics Control Module (JBE)	23	Identification Transmitter Holder
5	TAGE Hall sensor, Front Passenger's Side	24	Identification Transmitter
6	TAGE Capacitive Sensor, Front Passenger's Side	25	Electric Steering Lock ELV
7	TAGE Capacitive Sensor, Front Passenger's Side	26	Rear Window Antenna
8	TAGE Antenna, Front Passenger's Side	27	Remote Control Receiver
9	Comfort Access (CA)	28	LED START/STOP Button
10	Exterior Antenna	29	Hall sensor, START/STOP Button
11	Luggage Compartment Antenna	30	Hall sensor, START/STOP Button
12	Interior Antenna, Rear	31	START/STOP button
13	Interior Antenna, Front	CAS-Bus/K-Bus	(K-bus protocol
14	TAGE Antenna, Driver's Side	K-CAN	Bodyshell CAN
15	TAGE Capacitive Sensor, Driver's Side	KI. 30	Terminal 30
16	TAGE Capacitive Sensor, Driver's Side	FBD	Remote Control Services
17	TAGE Hall sensor, Driver's Side	FBD ON	Remote Control Services ON
18	Door Contact	FBD OUT	Remote Control Services OUT
19	Transponder Coil		



## Classroom Exercise - Review Questions

1. What is Passive Entry? How does it work?

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2. What is Passive Go? How does it work?

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3. What is Passive Exit? How does it work?

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4. How many antennas are in the vehicle?

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5. Can the ID transmitter be locked in the trunk? If so, how?

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# Interior Lighting

The components installed with the interior lighting system for the E90 are:

- Interior Light with Interior Light Switch
- Interior Light with Interior Light Switch
- Reading Light with Reading Light Button, Driver and Passenger
- Top Light, Driver and Passenger
- Interior Light
- Interior Light with Interior Light Switch
- Reading Light with Reading Light Button, Driver and Passenger
- Top Light, Driver and Passenger
- Luggage Compartment Light
- Vanity Mirror Light, Driver and Passenger
- Footwell Lights, Driver and Passenger
- Courtesy Light, Driver and Passenger

## Control Modules for Interior Lighting

The "interior lighting" function is distributed over several control module that communicate with each other via the K-CAN.

- Footwell Module (FRM) is responsible for switching the interior lighting on & off.
- Roof Functions Center (FZD) is responsible for the interior lighting components in the roof area.
- Junction Box Electronics Control Module (JBE) is the interface to the luggage & glove compartment lighting.
- Car Access System 2 (CAS2) receives the unlock signal and sends the instructions through the footwell module to switch on the interior lighting.

The interaction of these three control units is described in more detail on the following pages.

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## Footwell Module (FRM)

All interior lighting outputs of the Footwell Module are pulse-modulated to ensure that the interior lighting functions are at a constant brightness level in the event of voltage fluctuations. The pulse width modulation is also used for the soft ON/OFF function.

The Footwell Module features the following functions for the interior lighting:

- Switching the interior lighting on/off
- Electric load shut-down after 16 minutes
- Instrument lighting, terminal 58g

### ■ Switching on the Interior Lighting

The footwell module receives numerous input signals that switch on the interior lighting. For instance, the input signals from the footwell module are read in directly or received via the K-CAN.

The input signals for the interior lighting are listed in the following.

Input Signals	From	Input Signals	From
Central Locking Signals	CAS2	Barrel Lock, Driver's Door	FRM
Crash Signal	MRS 5	Interior Light Switch	FRM/FZD
Door Contacts	FRM	Central Locking, Trunk Lid	JB

### ■ Switching-on Conditions

The interior lighting is switched on in response to one of the following conditions:

- Unlock via barrel lock in driver's door
- Unlock via remote control/identification transmitter
- Terminal R OFF when terminal 58g was ON
- Receiving crash signal
- Lock button on remote control/ ID transmitter pressed when the central locking has been in central arrest state for longer than 10 s
- Interior lighting button pressed.

### ■ Switching Off Interior Lighting

The FRM receives numerous signals to switch off the interior lighting via the K-CAN or are obtained indirectly by the FRM.



### ■ Switch-off Conditions

The interior lighting is switched off under the following conditions:

- Central locking in central arrest, all doors and the trunk lid are closed
- Terminal R OFF after 16 mins
- Interior lighting button pressed for longer than 3 s
- Terminal R ON with doors closed
- Terminal 58 ON and terminal R OFF.

The interior lighting is switched off if no door is opened within 20 s.

- The interior lighting is switched off if the vehicle is unlocked via the remote control/identification transmitter and no door is opened after 20 s.
- Terminal R OFF and a vehicle door is opened for longer than 1 min
- "Power down" via diagnosis

### ■ Electric Load Shutdown

By way of terminal R OFF, the interior lighting system is switched off by the FRM after 16 min. For this purpose, the Footwell Module sends the electric load shut-down information via the K-CAN.

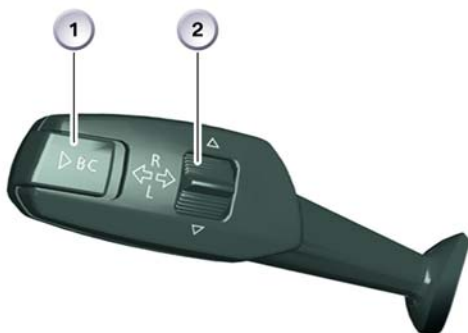
The Roof Functions Center (FZD) receives this information and switches off the interior lighting in the roof area.

The interior lights that are switched on directly by the FRM are also switched off.

### ■ Terminal 58g

The FRM makes available terminal 58g via the K-CAN. Terminal 58g is pulse width-modulated and features the following two brightness levels:

- The brightness level for the locator lighting can be set individually via the rocker switch on the column stalk.
- The brightness level for the function lighting is not dimmed and is switched on at full brightness.



Index	Explanation
1	On-board Computer Button
2	Rocker Switch

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## **Roof Functions Center (FZD)**

For the interior lighting system, the Roof Functions Center represents the interface to the Footwell Module since both control modules are connected to the K-CAN. For instance, the FZD can receive instructions to switch the interior lighting on or off via the K-CAN from the FRM. The FZD is the link to the rear interior lighting unit.

The interior lighting functions in the Roof Functions Center are:

- Switching the interior lighting on/off on request from the Footwell Module
- Reading the signals from the interior light buttons and transferring them to the Footwell Module

### **■ Terminal 58g**

The Roof Functions Center receives the terminal 58g signal from the Footwell Module via the K-CAN and activates the lighting in the buttons.

## **Junction Box Electronics Control Module (JBE)**

The JBE is responsible for switching the luggage compartment and glove compartment lighting on and off by providing the ground connection for the lighting system.

### **■ Luggage Compartment Lighting**

The status of the trunk lid contact changes when the trunk lid is opened manually or via the remote control/ID Transmitter, which causes the signal to go to a low level. The JBE evaluates this signal and switches on the luggage compartment lighting.

The status of the trunk lid contact switch changes when the trunk lid is closed again, this causes the signal to go to a high level and the JBE switches off the luggage compartment lighting.

The JBE also switches on the luggage compartment lighting when the trunk lid is opened from the inside by pressing the button on the A-pillar.

### **■ Glove Compartment Lighting**

Opening the glove compartment operates a microswitch that switches on the glove compartment lighting.

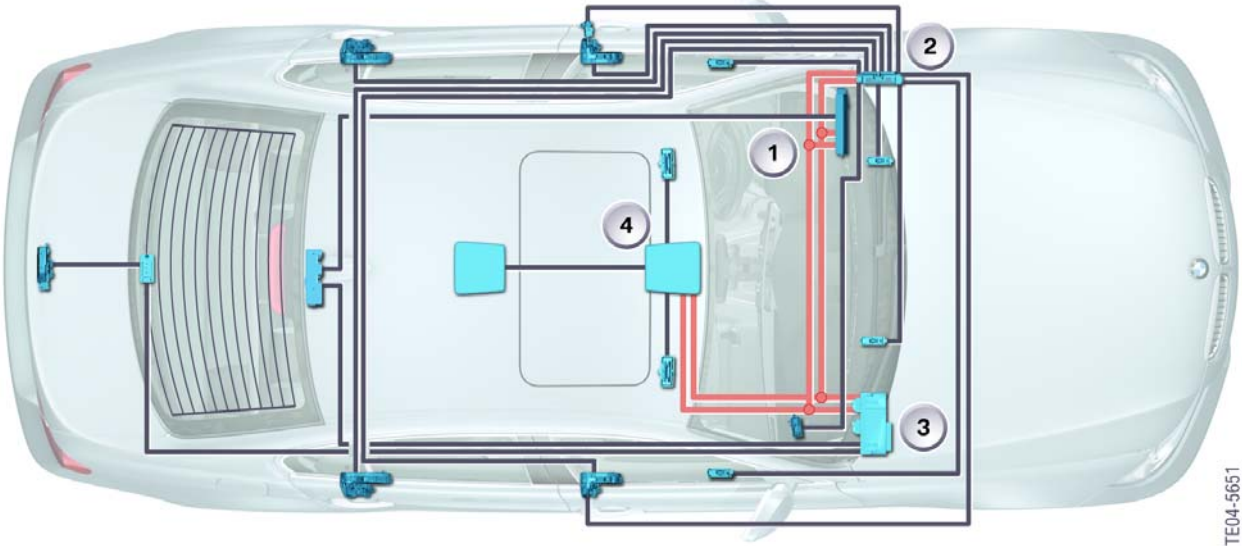
## **Car Access System 2 (CAS2)**

The CAS2, serves as the master control module for the Central Locking System and issues the enable signal to activate/deactivate central locking which in turn transmits a signal, via K-CAN, to the FRM requesting the illumination of the interior light.

As soon as the CAS2 receives a request to unlock/lock, the signal is checked whether it is valid and belongs to the vehicle. Only if the check is successful will the CAS2 forward the request to lock/unlock via JBE plus activate interior lighting via the FRM.

# Interior Lighting Components

The "interior lighting" function is distributed over several control units that communicate with each other via the K-CAN. .



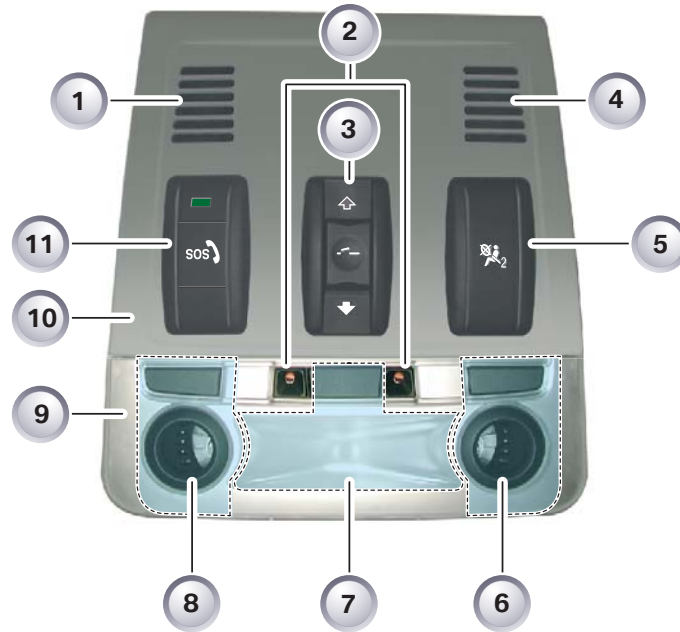
TE04-5651

Index	Explanation	Index	Explanation
1	Car Access System2 (CAS2)	3	Junction Box Electronics Control Module (JBE)
2	Footwell Module (FRM)	4	Roof Functions Center (FZD)

## Interior Lighting Unit, Front

The front interior lighting unit consists of:

- Reading lamp, driver's side with button
- Interior light with button
- Reading lamp, front passenger's side with button
- Top light.
- Emergency call button
- Passenger airbag OFF lamp
- Microphone
- Slide/tilt sunroof
- Color of roof area

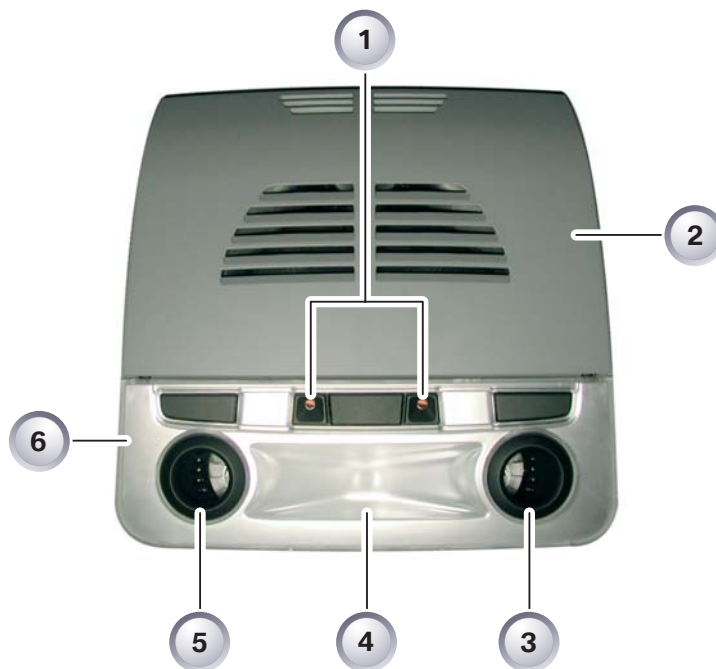


Index	Explanation
1	Telephone microphone, driver's side
2	Top light
3	Sunroof button
4	Passenger's side microphone for voice recognition system
5	Airbag indicator lamp
6	Reading lamp, front passenger's side with button
7	Interior light with button
8	Reading lamp, driver's side with button
9	Interior lighting unit
10	Cover
11	Emergency call button

## Interior Lighting Unit, Rear

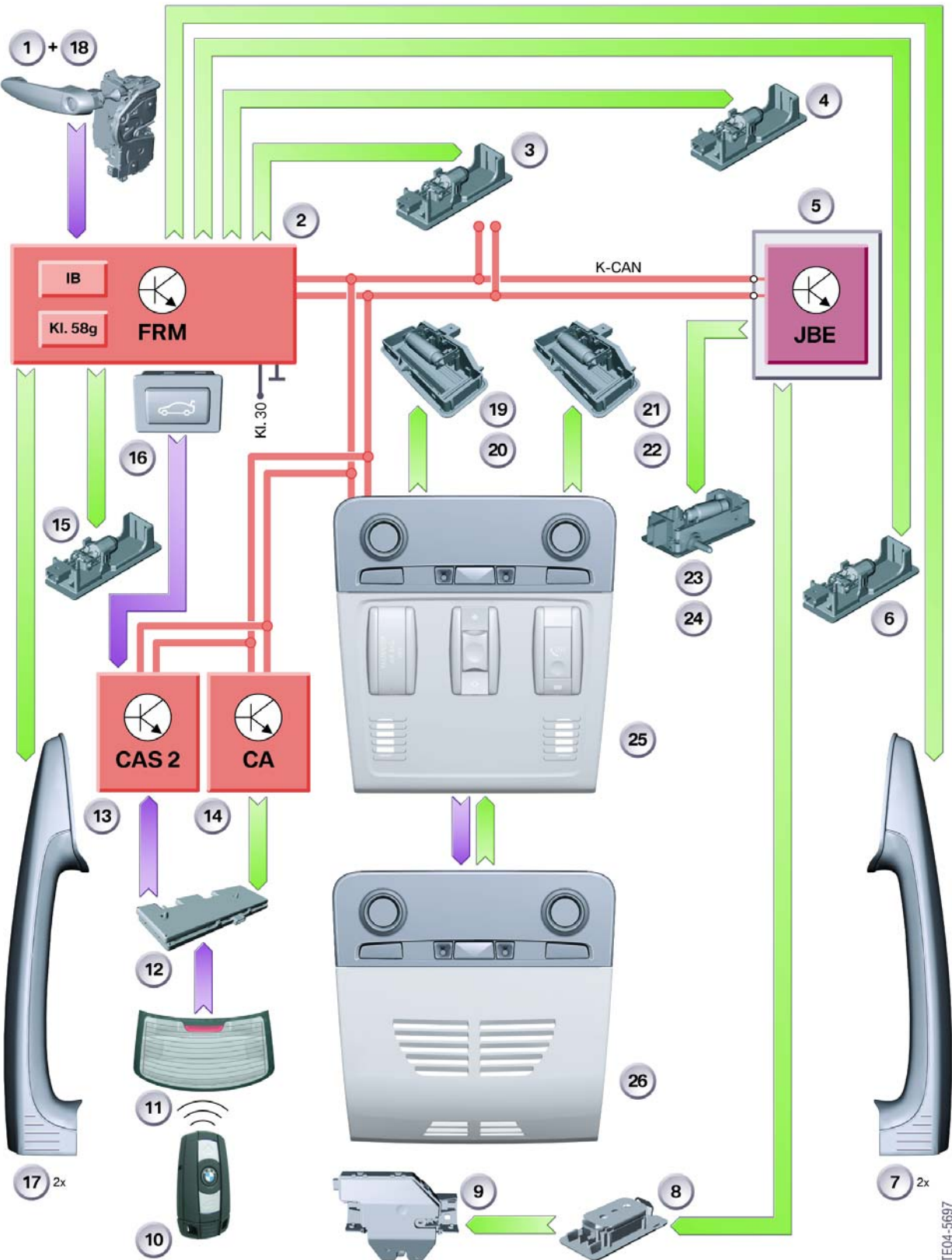
The rear interior lighting unit consists of:

- Reading lamp, rear left/right with button
- Interior light with button
- Top light
- Cover for ultrasonic interior protection (movement detector) on vehicles with DWA.



Index	Explanation
1	Top light
2	Cover for ultrasonic interior protection
3	Reading lamp, rear right
4	Rear interior light with button
5	Reading lamp, rear left
6	Interior lighting unit

# Interior Lighting - Input/Output (Option)

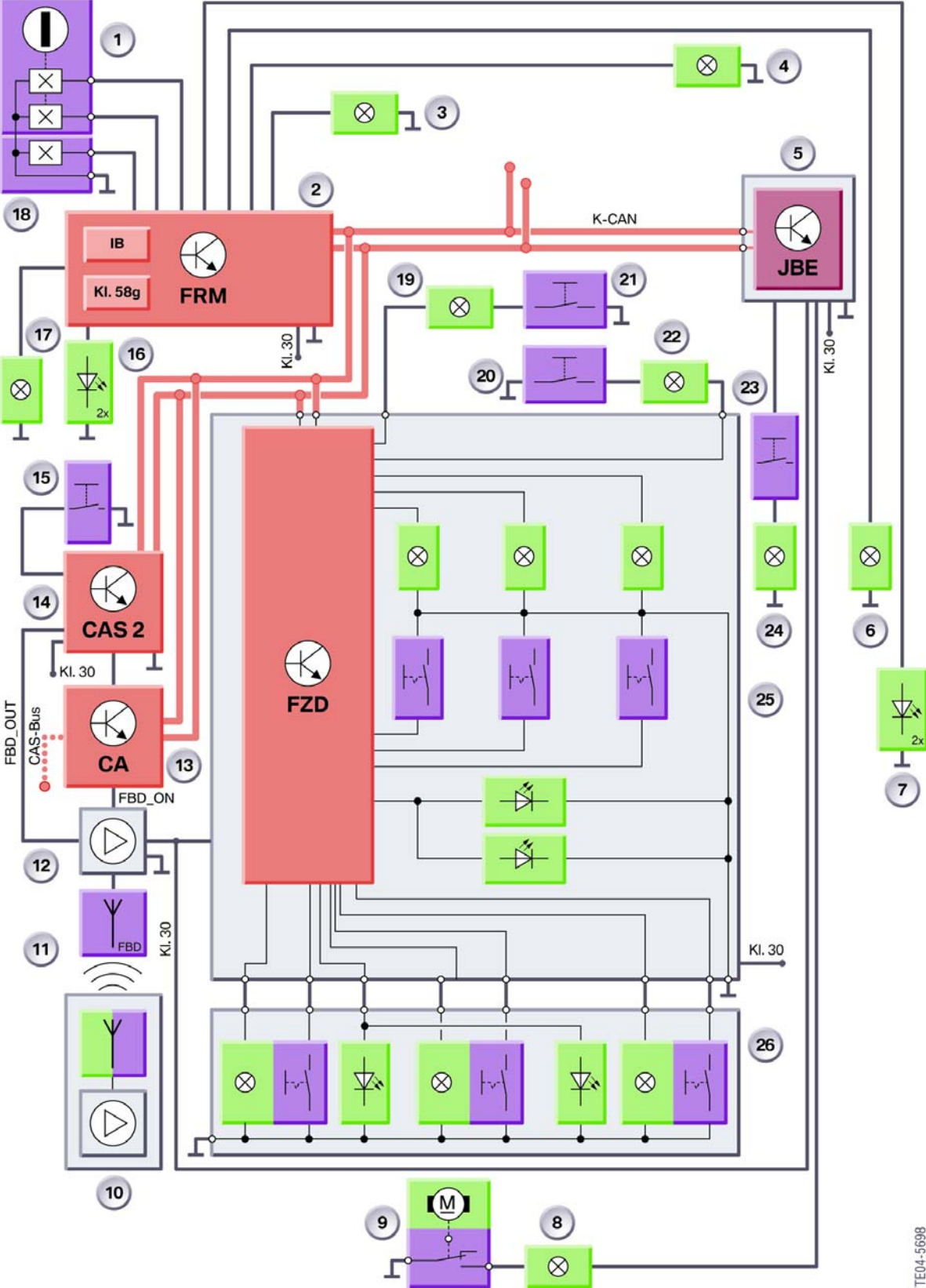


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### Legend for Interior Lighting (Option)

Index	Explanation	Index	Explanation
1	Driver's door lock barrel	18	Door contact
2	Footwell module FRM	19	Vanity mirror light, driver's side
3	Courtesy lighting, driver's side	20	Switch for vanity mirror light, driver's side
4	Courtesy lighting, front passenger's side	21	Vanity mirror light, passenger's side
5	Junction Box Electronics Control Module (JBE)	22	Switch for vanity mirror light, passenger's side
6	Footwell light, front passenger's side	23	Switch for glove compartment light
7	Exit light, passenger's side	24	Glove compartment light
8	Luggage compartment light	25	Roof functions center FZD with front interior light
9	Central locking, truck lid	26	Interior light, rear
10	Identification transmitter	K-CAN	Bodyshell CAN
11	Rear window antenna	KI. 30	Terminal 30
12	Remote control receiver	KI. 58g	Terminal 58g
13	Car access system 2 CAS 2	IB	Interior lighting control
14	Comfort access CA	FBD	Remote control services
15	Footwell light, driver's side	FBD ON	Remote control services ON
16	Interior button for truck lid	FBD OUT	Remote control services OUT
17	Exit light, driver's side	2 x	Courtesy light, front and rear

# Interior Lighting - Circuit Diagram (Option)





### Legend for Interior Lighting (Option)

Index	Explanation	Index	Explanation
1	Driver's door lock barrel	18	Door contact
2	Footwell module FRM	19	Vanity mirror light, driver's side
3	Courtesy lighting, driver's side	20	Switch for vanity mirror light, driver's side
4	Courtesy lighting, front passenger's side	21	Vanity mirror light, passenger's side
5	Junction Box Electronics Control Module (JBE)	22	Switch for vanity mirror light, passenger's side
6	Footwell light, front passenger's side	23	Switch for glove compartment light
7	Exit light, passenger's side	24	Glove compartment light
8	Luggage compartment light	25	Roof functions center FZD with front interior light
9	Central locking, truck lid	26	Interior light, rear
10	Identification transmitter	K-CAN	Bodyshell CAN
11	Rear window antenna	KI. 30	Terminal 30
12	Remote control receiver	KI. 58g	Terminal 58g
13	Car access system 2 CAS 2	IB	Interior lighting control
14	Comfort access CA	FBD	Remote control services
15	Footwell light, driver's side	FBD ON	Remote control services ON
16	Interior button for truck lid	FBD OUT	Remote control services OUT
17	Exit light, driver's side	2 x	Courtesy light, front and rear



## Classroom Exercise - Review Questions

1. What is the primary module for controlling the interior lighting functions?

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2. What lighting components does the FZD control?

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3. How long after the ignition is switched off are the interior lights shut down?

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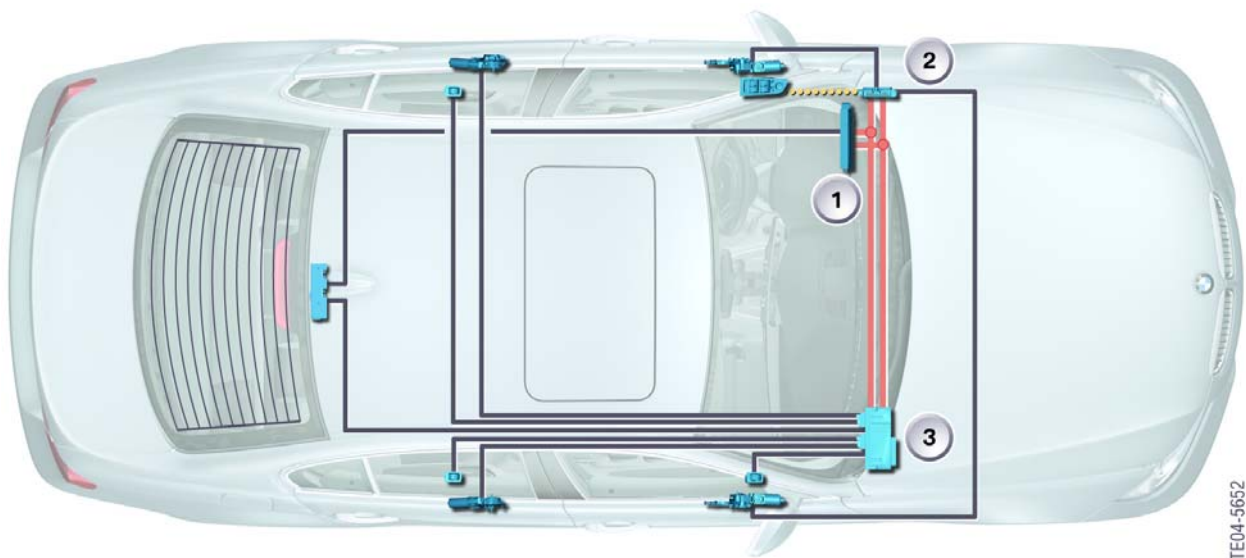
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# Power Windows

The Power Window functions available in the E90 are:

- Opening and closing
- Opening and closing with toll function
- Convenient opening and closing
- Indirect anti-trapping protection
- Panic mode
- Load shut-down at terminal 50
- Thermal protection of power window motors

## Control Modules for Power Windows



TE04-5652

Index	Explanation	Index	Explanation
1	Car Access System2 (CAS2)	3	Junction Box Electronics Control Module (JBE)
2	Footwell Module (FRM)	4	

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## **Car Access System 2 (CAS2)**

The car access system 2 is the master control module for opening and closing the windows.

## **Footwell Module (FRM)**

The relays for the power window motors for the driver's and passenger's side are installed in the Footwell Module.

## **Junction Box Electronics Control Module (JBE)**

The relays for the power window motors of the rear left/right doors are installed in the Junction Box Electronics Control Module.

## **Opening & Closing**

The Car Access System 2 is the central control function for electric opening and closing of the power windows. This means that the CAS2 issues the signal to enable the open and close function for the power windows. The FRM and the JBE activate the power window motors.

The FRM and the JBE monitor the motor speed of the respective power window motors. In this arrangement, the FRM or JBE can respond to overheating or possible blocking of the power window motors in the event of an object being trapped in the windows.

## **Opening and Closing**

The corresponding power window motor is activated in OPEN or CLOSE direction by pressing or pulling the power window switches to the first notch position. The power window motor is driven until the corresponding power window switch is released.

To ensure the power window is closed reliably, the power window motor is briefly driven to block status at the upper stop.

## **Opening and Closing with Toll Function**

The toll function is implemented for all power windows (window regulators). The corresponding power window motor is driven in OPEN or CLOSE direction by pressing or pulling a power window switch beyond the limit stop. The power window motor moves the window automatically until it is completely open or closed. Power window operation is stopped when the power window switch is pressed or pulled again.

**Examples:** The following examples illustrate the interaction of the individual components for the power windows function.

### Switch Cluster, Driver's Door

1. The signal is routed via the LIN-bus to the footwell module when the power window switch for the window in the driver's door or front passenger's door is operated. The footwell module drives the corresponding power window motor.
2. The signal is routed from the driver's door switch cluster via the LIN-bus to the footwell module when the power window switches for the windows in the rear doors are operated. The FRM sends the signal via the K-CAN to the JBE.

On receiving the signal, the Junction Box Electronics Control Module activates the corresponding power window motor.

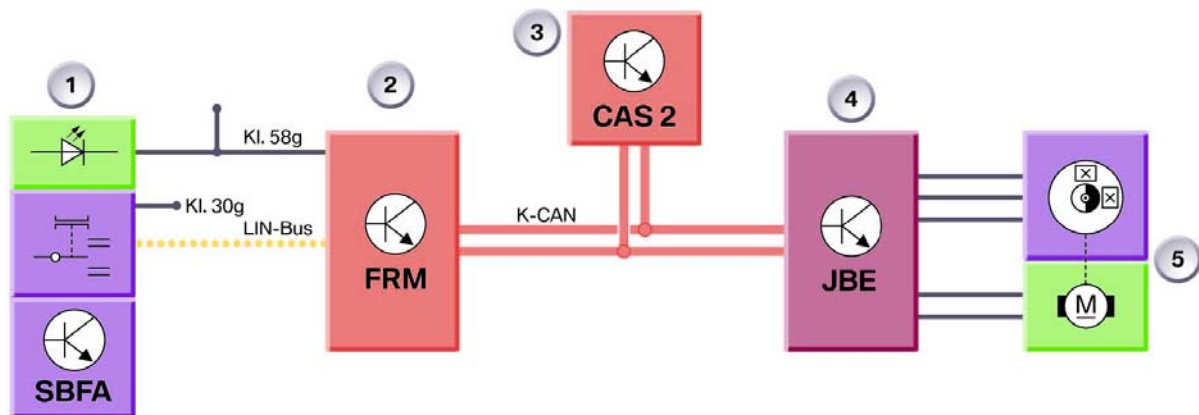
### Power window switch, front passenger's door

The signal is routed to the JBE when the power window switch in the front passenger's door is operated. The JBE sends the signal via the K-CAN to the footwell module. The FRM drives the power window motor.

### Power window switch, rear doors

The signal is routed to the JBE when the power window switches in the rear doors are operated. The JBE drives the power window motor.

By way of example, the opening and closing procedure for one of the rear windows is illustrated in the signal progression in the following graphic. The opening or closing function is initiated from the driver's door switch cluster.



Index	Explanation	Index	Explanation
1	Power Window Switch in Driver's Door switch cluster SBFA	LIN-Bus	Lin-Bus
2	Footwell Module (FRM)	K-CAN	Bodyshell CAN
3	Car Access System 2 (CAS 2)	KI. 30g	Terminal 30g
4	Junction Box Electronics Control Module (JBE)	KI. 58g	Terminal 58 g
5	Power Window Motor		

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## **Convenient Opening and Closing**

Convenient opening or closing can be performed with the remote control/ID transmitter via the door lock in the driver's door or the outer driver's/ passenger's door handle.

### **■ Convenient Opening with Remote Control**

The convenient opening function is initiated by unlocking the vehicle with the remote control and keeping the button pressed for longer than 5 s.

Initially, the front windows are opened, followed after a short time delay by the rear windows and the slide/tilt sunroof. If the fold in/out outside mirrors are optionally installed and the mirrors are folded in, the mirrors will be folded out at the same time the rear windows are opened.

The signal from the remote control is made available to the CAS2 via the remote control receiver.

The CAS2 issues the enable to operate the power windows and initiates the convenient opening function. The footwell module and the Junction Box Electronics Control Module correspondingly activate the power window motors.

### **■ Convenient Closing with Remote Control**

The convenient closing function is initiated after locking the vehicle with the remote control and keeping the button pressed for longer than 5 s. Initially, the slide/tilt sunroof is closed followed with a short time delay by the rear/front windows.

If the folding outside mirrors option is installed, the mirrors are folded in simultaneously as the rear windows are closed.

### **■ Convenient Opening and Closing via the Driver's Door Lock Barrel**

There are two Hall sensors installed in the door lock for the purpose of opening and closing the vehicle. The Hall sensors enable the FRM to detect the position of the mechanical key or of the spare key in the lock barrel.

The key must be turned to the open or close position to initiate the convenient opening and closing function. The convenient opening or closing function is initiated when the key is held in this position.

The FRM sends the request via the K-CAN. On conclusion of the corresponding check, the CAS2 initiates the convenient opening or closing procedure.

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### ■ Convenient Closing with Comfort Access

In connection with Comfort Access, the convenient closing function is triggered via the driver's/passenger's outer door handle.

It is sufficient to touch the sensitive area of the outer door handle in order to trigger the convenient closing function via the door handle. Convenient closing starts if the sensitive area is touched for longer than 5 seconds. The identification transmitter must be within an approx. 2 m radius of the vehicle.

**Note: Touching the outer door handle corresponds to pressing the lock button on the ID transmitter.**

### ■ Indirect Anti-Trapping Protection

Essentially, the indirect anti-trapping function does not prevent an object being trapped but rather it limits the trapping force to maximum 80 N. The power window motor is reversed on exceeding this trapping force.

The footwell module and the Junction Box Electronics Control Module monitor the activated power window motors. The indirect anti-trapping function of the front windows is activated by the footwell module. The indirect anti-trapping function of the rear windows is activated by the Junction Box Electronics Control Module.

The indirect anti-trapping function in the E90 is based on the evaluation of the hall pulses from the power window motors. The speed is derived from the Hall pulses of the power window motors. Speed fluctuations within certain ranges trigger the indirect anti-trapping function so that the windows are opened. Operation of the power window switches is ineffective while the windows are opened.

The window can only be operated in jolts if no operable anti-trapping function is detected as the result of defective Hall sensors. The power window (window regulator) is in emergency mode and must be reinitialized.

**Note: The initialization procedure is described in the Service Information.**

### ■ Panic Mode

Panic mode is triggered by overpulling - releasing - overpulling (overpulling = pulling beyond limit stop) the power window switches. It is necessary to release and overpull the switch again in order to deactivate the anti-trapping protection function, which is still active the first time the switch is overpulled.

Overpulling the power window switch the second time within 4 s closes the window with maximum force.

**Note: The indirect anti-trapping function is no longer active in this case. The window closes at the maximum closing force and does not reverse.**

---

### ■ **Load Shut-down, Terminal 50**

To protect the battery, operation of the power windows is interrupted during the vehicle start procedure.

The CAS2 revokes the enable for power window operation, in order to interrupt current operation of the power windows.

The signal is received by the FRM and JBE via the K-CAN. The power window switches must be pressed again following an interruption in operation. The corresponding function is not executed if the power windows are operated during the start procedure.

The enable for operation of the power windows is not issued until the start procedure has been completed.

### ■ **Thermal Protection of Power Window Motors**

The FRM and the JBE monitor the power window motor temperature. The motor temperature is determined based on the outside temperature, motor running time and the time the motor is stationary (not operative).

Each motor can be switched off individually to prevent the power window motors overheating during operation of the power windows (window regulators). The motor is then deactivated for a defined period of time.

The thermal protection function does not prevent the windows from being opened in the case of trapping. Once started, a power window function is not interrupted by the thermal protection facility.

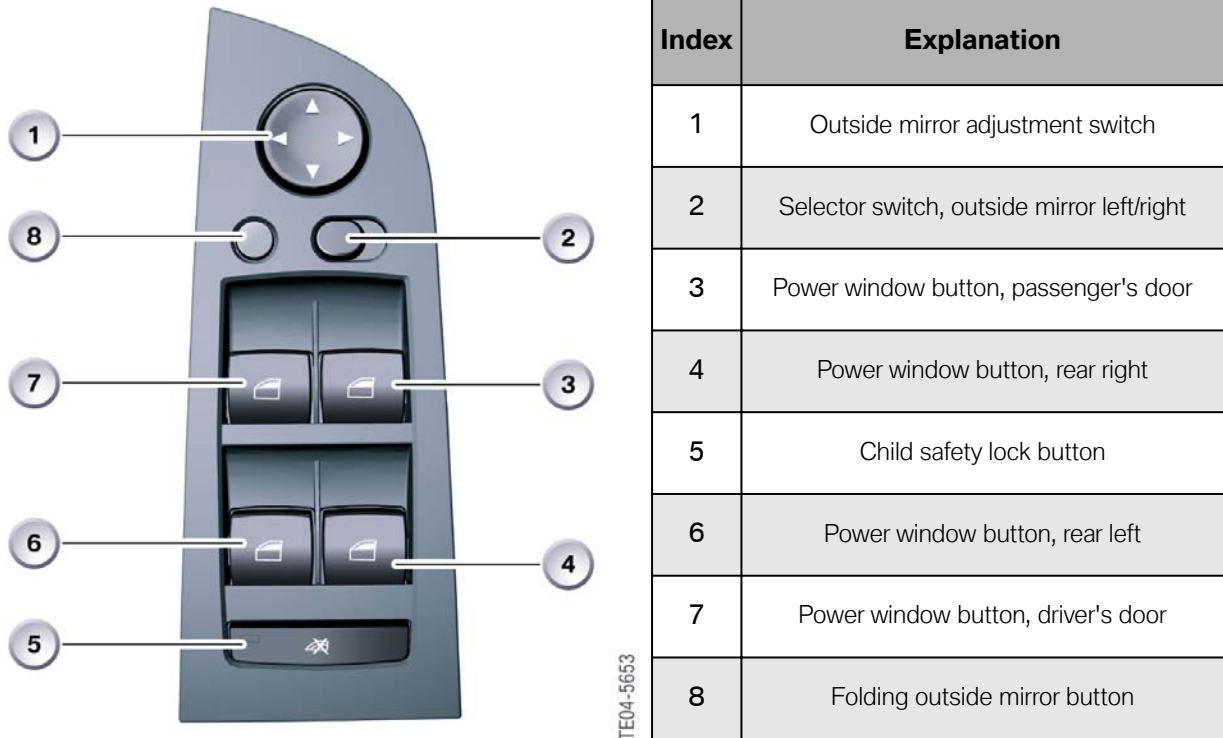
In panic mode the window can still be closed even when the thermal protection function is active.



## Controls

### Driver's Door Switch Cluster

The driver's door switch cluster is connected via the LIN-bus to the footwell module. The power window switches are resistance-coded and switched to ground.



### Signal Evaluation of the Power Window Switches

The signals of the power window switch in the driver's door are evaluated directly by the driver's door switch cluster and transferred to the footwell module via the LIN-bus.

The signals from the power window switches in the front passenger's door as well as the power window switches of the both rear doors are evaluated by the JBE.

Signal evaluation of the power switches is summarized in the following table.

	Driver's Door Switch Cluster				Door Switches		
	Driver's Side	Passenger's Side	Left Rear	Right Rear	Passenger's Side	Left Rear	Right Rear
Direct Link to	-----	-----	-----	-----	JBE	JBE	JBE
Connection via LIN-Bus to:	FRM	FRM	FRM	FRM	-----	-----	-----

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## Remote Control

The remote control or the ID transmitter can initiate the comfort opening/closing procedure for the power windows. The operating procedure is defined in the Owner's Handbook.

## Power Window Motors

The power window motors are equipped with Hall sensors that generate signals during motor operation, for the purpose of monitoring motor operation, and are evaluated by the FRM and JBE for the anti-trapping function.

## Initialization

### Initialization of Power Windows

The front and rear power windows can be initialized via the power window switches or the BMW diagnosis system.

**Note: The power windows can only be moved in small increments if not initialized.**

#### ■ Initialization via the Power Window Switches

The following procedure must be performed to initialize the system:

1. Completely close window by pulling the power window switch beyond the limit stop.
2. Briefly interrupt pulling/release the power window switch and then pull the switch upwards again for approx. 1 s.

#### ■ Initialization via the BMW Diagnostic Equipment

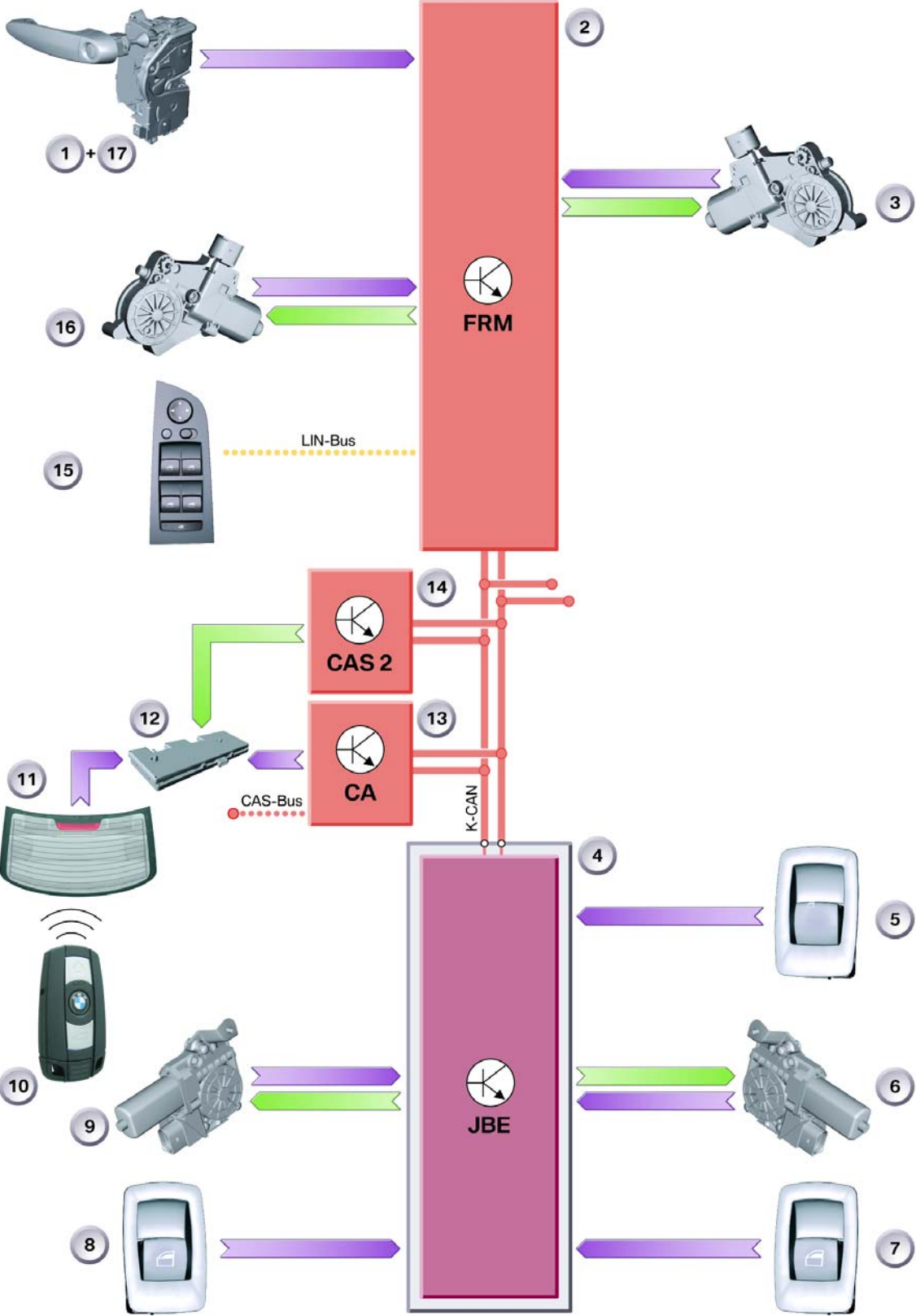
The power windows can be initialized as part of an initialization procedure using the BMW diagnostic equipment. A detailed description of the initialization procedure is provided in the BMW diagnosis system.

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NOTES

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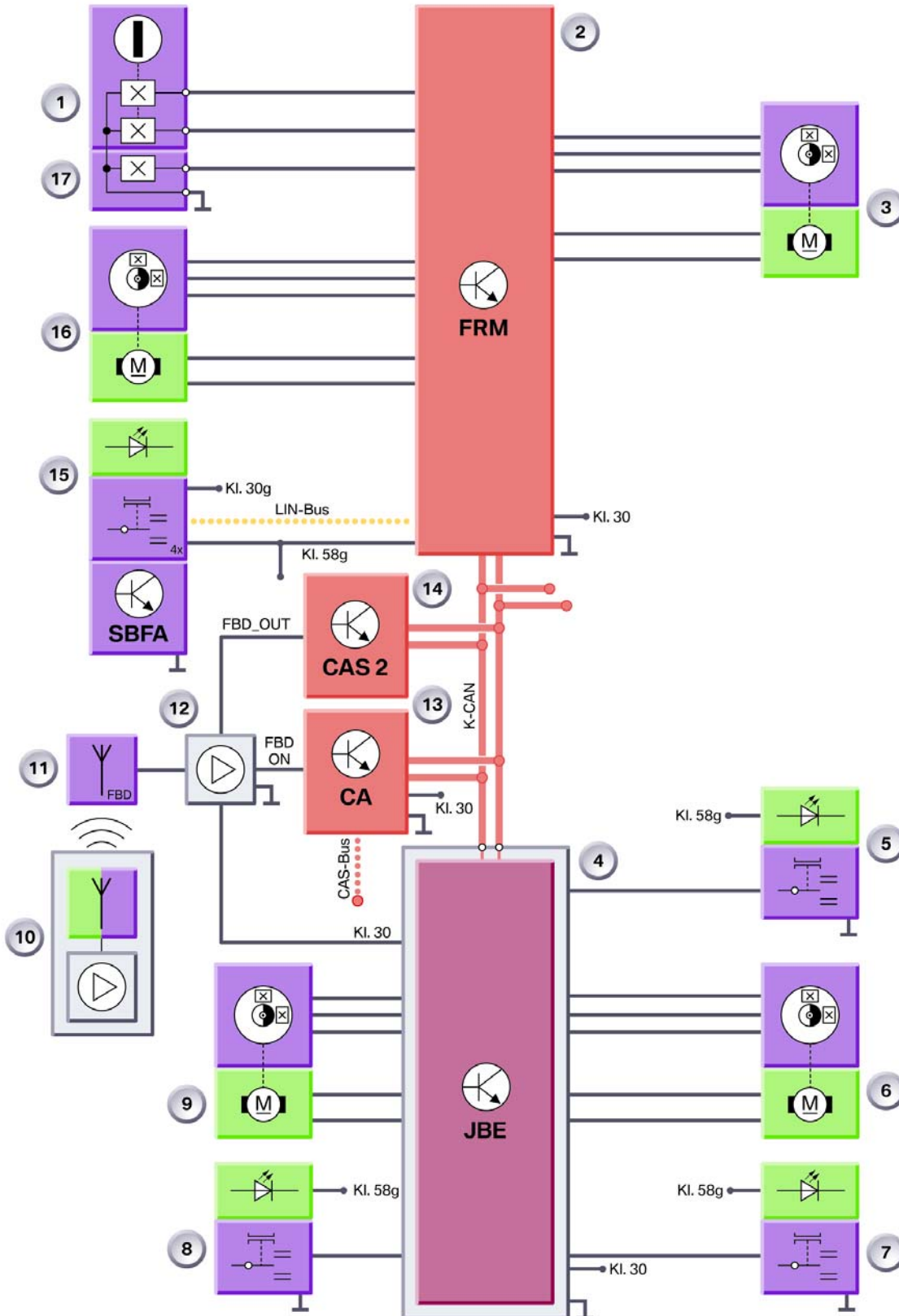
# Power Window - Input/Output



### Legend for Power Window - Circuit Diagram

Index	Explanation	Index	Explanation
1	Driver's door lock barrel	14	Car Access System 2 (CAS 2)
2	Footwell module (FRM)	15	Driver's door switch cluster (SBFA)
3	Power window motor with indirect anti-trapping function, passenger's side	16	Power window motor with indirect anti-trapping function, driver's side
4	Junction Box Electronics Control Module (JBE)	17	Door contact
5	Power window switch, front passenger's side	K-CAN	Bodyshell CAN
6	Power window motor with indirect anti-trapping function, rear right	KID.30	Terminal 30
7	Power window switch, rear right	KID.58g	Terminal 58g
8	Power window switch, rear right	LIN-Bus	Local interconnected network bus
9	Power window motor with indirect anti-trapping function, rear left	FBD	Remote control services
10	Remote control	FBD ON	Remote control services ON
11	Rear window antenna	FBD OUT	Remote control services OUT
12	Remote control receiver	CAS-Bus	K-Bus (K-Bus protocol)
13	Comfort Access (CA)		

# Power Window - Circuit Diagram



TE04-5700

### Legend for Power Window - Circuit Diagram

Index	Explanation	Index	Explanation
1	Driver's door lock barrel	14	Car Access System 2 (CAS 2)
2	Footwell module (FRM)	15	Driver's door switch cluster (SBFA)
3	Power window motor with indirect anti-trapping function, passenger's side	16	Power window motor with indirect anti-trapping function, driver's side
4	Junction Box Electronics Control Module (JBE)	17	Door contact
5	Power window switch, front passenger's side	K-CAN	Bodyshell CAN
6	Power window motor with indirect anti-trapping function, rear right	KID.30	Terminal 30
7	Power window switch, rear right	KID.58g	Terminal 58g
8	Power window switch, rear right	LIN-Bus	Local interconnected network bus
9	Power window motor with indirect anti-trapping function, rear left	FBD	Remote control services
10	Remote control	FBD ON	Remote control services ON
11	Rear window antenna	FBD OUT	Remote control services OUT
12	Remote control receiver	CAS-Bus	K-Bus (K-Bus protocol)
13	Comfort Access (CA)		



## Classroom Exercise - Review Questions

1. What module controls the relays for the driver and passenger windows?

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2. What module controls the relays for the rear windows?

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3. What is the role of the CAS2 module in the operation of the power windows?

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4. How is information from the driver's door switch cluster transferred to the FRM?

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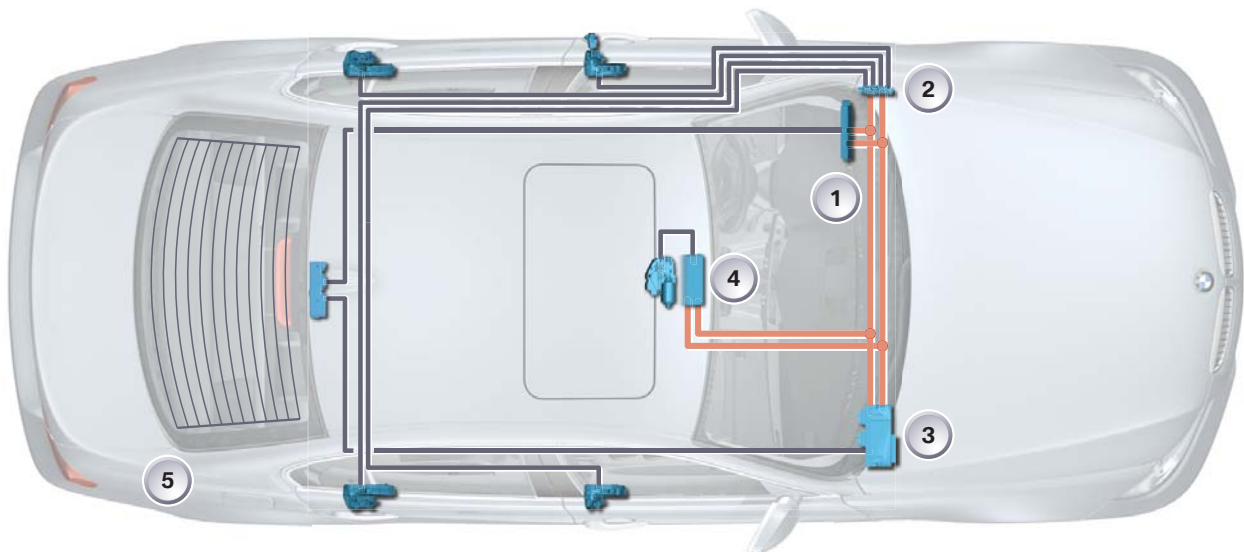
## Slide/Tilt Sunroof

The roof functions center receives signals from the other control units for the functions of the slide/tilt sunroof. The executing control unit is the roof functions center. On request, it drives the sunroof motor and simultaneously monitors the motor rotation.

The following sunroof functions are integrated in the FZD:

- Reading operating requests
  - Anti-trapping protection
  - Blocking protection
  - Thermal protection
- Panic mode
- Load cut-out during start procedure
- Terminal 58g
- Initialization

### Control Modules for Sunroof Operation



Index	Explanation	Index	Explanation
1	Car Access System2 (CAS2)	4	Roof Function Center (FZD)
2	Footwell Module (FRM)	5	Comfort Access (CA)
3	Junction Box Electronics Control Module (JBE)		

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## **Car Access System 2 (CAS2)**

The Car Access System 2 is the master control module for and issues the enable command for opening and closing the sunroof.

## **Footwell Module (FRM)**

The Footwell Module supplies input signals for the convenient opening/closing function and monitors the door contacts.

## **Roof Function Center (FZD)**

The Roof Functions Center (FZD) controls and monitors the slide/tilt sunroof motor, plus it contains the relays to drive the sunroof motor.

## **Comfort Access (CA)**

Comfort Access module (if installed) supplies input signals for the convenient opening/closing function.

### ■ **Operation**

The slide/tilt sunroof can be operated using the following controls:

- Slide/tilt sunroof button
- Remote control/identification transmitter
- Driver's door lock barrel
- Driver's/passenger's outer door handle with comfort access

### ■ **Slide/Tilt Sunroof Button**

The button for the slide/tilt sunroof is located in the roof functions center. When operated, the button sends a low signal to the electronic module that drives the sunroof motor corresponding to the button selection.

### ■ **Remote Control/ID Transmitter**

The convenient opening/closing function is initiated by pressing the button on the remote control/identification transmitter.

### ■ **Driver's Door Lock Barrel**

The convenient opening/closing function is triggered by turning and holding the mechanical key or the spare key in the open/ close position in the driver's door lock barrel.

### ■ **Outer Door Handle**

The convenient closing function can be triggered by touching the sensitive area of the outer door handle.

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## **Slide/tilt Sunroof Motor**

The FZD activates the integrated relays when it receives the request for the slide/tilt sunroof. The sunroof motor receives its voltage supply via the relays. The FZD monitors the relay contacts to ensure trouble-free control of the motor and therefore of the slide/tilt sunroof. In addition, the motor speed is calculated from the pulses of the Hall sensors and the direction of rotation of the corresponding motor.

The distance the slide/tilt sunroof must cover during the opening or closing procedure is defined in the FZD. The sunroof motor generates a certain number of pulses within this range and therefore recognizes the end positions of the slide/tilt sunroof.

### **■ Anti-trapping Protection**

The indirect anti-trapping function is determined on the basis of the power intake of the sunroof motor. The anti-trapping function is triggered if the closing force increases by 80 to 90 N and the sunroof is moved back by approx. 200 mm.

### **■ Blocking Protection**

The FZD detects blocking if the pulses from the Hall sensor fail for more than 500 ms during the opening or closing procedure, which results in the power supply to the motor being switched off.

### **■ Thermal Protection**

The thermal protection of the slide/tilt sunroof motor is calculated in the FZD. For this purpose there is a temperature sensor on the pc-board of the FZD which determines the ambient temperature.

The FZD calculates the current motor temperature based on the operating time of the sunroof motor. The warm-up and cool-down phases are stored based on a temperature model in the FZD. The current temperature is entered in the memory before the FZD assumes sleep mode. When the vehicle is restarted, the motor temperature is adjusted to the ambient temperature.

### **■ Panic Mode**

The slide/tilt sunroof is closed at maximum closing force in panic mode. Panic mode can be activated up to a vehicle speed of 16 km/h. Panic mode is triggered by pressing, releasing, again pressing and holding the sunroof button.

The anti-trapping function is not active.

### **■ Terminal 58g**

When the exterior lights are switched on, the FRM sends this information via the K-CAN. The FZD receives this information and adopts the set value for the instrument lighting.

The LED in the button for the slide/tilt sunroof is activated, pulse width-modulated by the FZD. This achieves a constant brightness of the LED even under fluctuating system voltage conditions.

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## Control

### Button for Slide/Tilt Sunroof

The button is located in the FZD and has 3 operating directions. (Open/Close/Tip-up)

### Slide/Tilt Sunroof Motor

The motor of the slide/tilt sunroof features 2 Hall sensors. The Hall sensors are located on the motor shaft and are offset by 90 degrees with respect to each other.

When the motor is running, this results in two offset Hall signals that are used to register the direction of rotation of the motor and for the anti-trapping protection function.

## Initialization

Initialization of the slide/tilt sunroof involves the following procedures that are necessary to ensure complete operation of the slide/tilt sunroof:

- Normalizing  
The normalizing procedure involves finding the mechanical end position at the limit stop of the "tilt" position. This position is stored and is used to calculate the remaining end positions of the slide/tilt sunroof.
- Learning the characteristic  
The learning procedure registers the closing force necessary for each direction of the slide/tilt sunroof and stores this value.

Complete functionality of the slide/tilt sunroof can be guaranteed only by full initialization. The initialization procedure can be initiated with the button for the slide/tilt sunroof or via the diagnosis system.

## Procedure

**Note: The control button must remain pressed during the entire initialization procedure. The initialization procedure must be repeated if the button is released.**

Initialization is performed as follows:

- Press and hold sunroof button in sunroof "tilt" direction
- After approx. 15 s, the initialization run starts in the "tilt" direction and stores the end position
- The slide/tilt sunroof is closed after 5 s in the "tilt" position
- The sunroof is then opened and the end position stored
- The sunroof is then closed and the end position stored

Time required for initialization approx. 120 s.

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### ■ **Interruption in Power Supply**

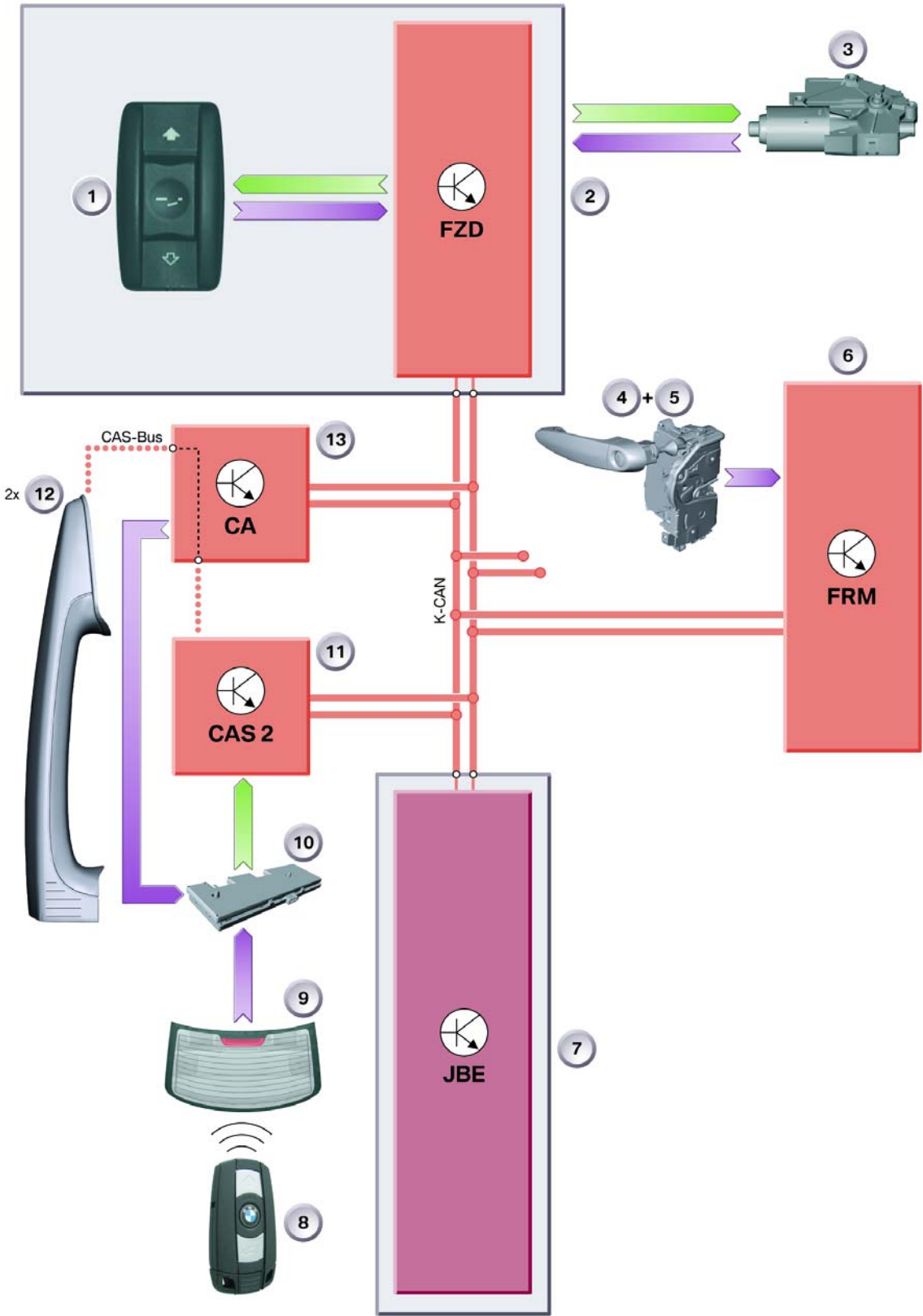
An interruption in the power supply does not require renewed “normalization”. If the power supply is interrupted during initialization the entire procedure is invalid and the system must be re-initialized.

### ■ **Deleting the Initialization**

The initialization is deleted under the following circumstances:

- Failure of the supply voltage during initialization
- Hall sensor fault detected
- Position implausible
- Certain instructions in the diagnosis
- Modified/changed vehicle coding
- Coding data faulty

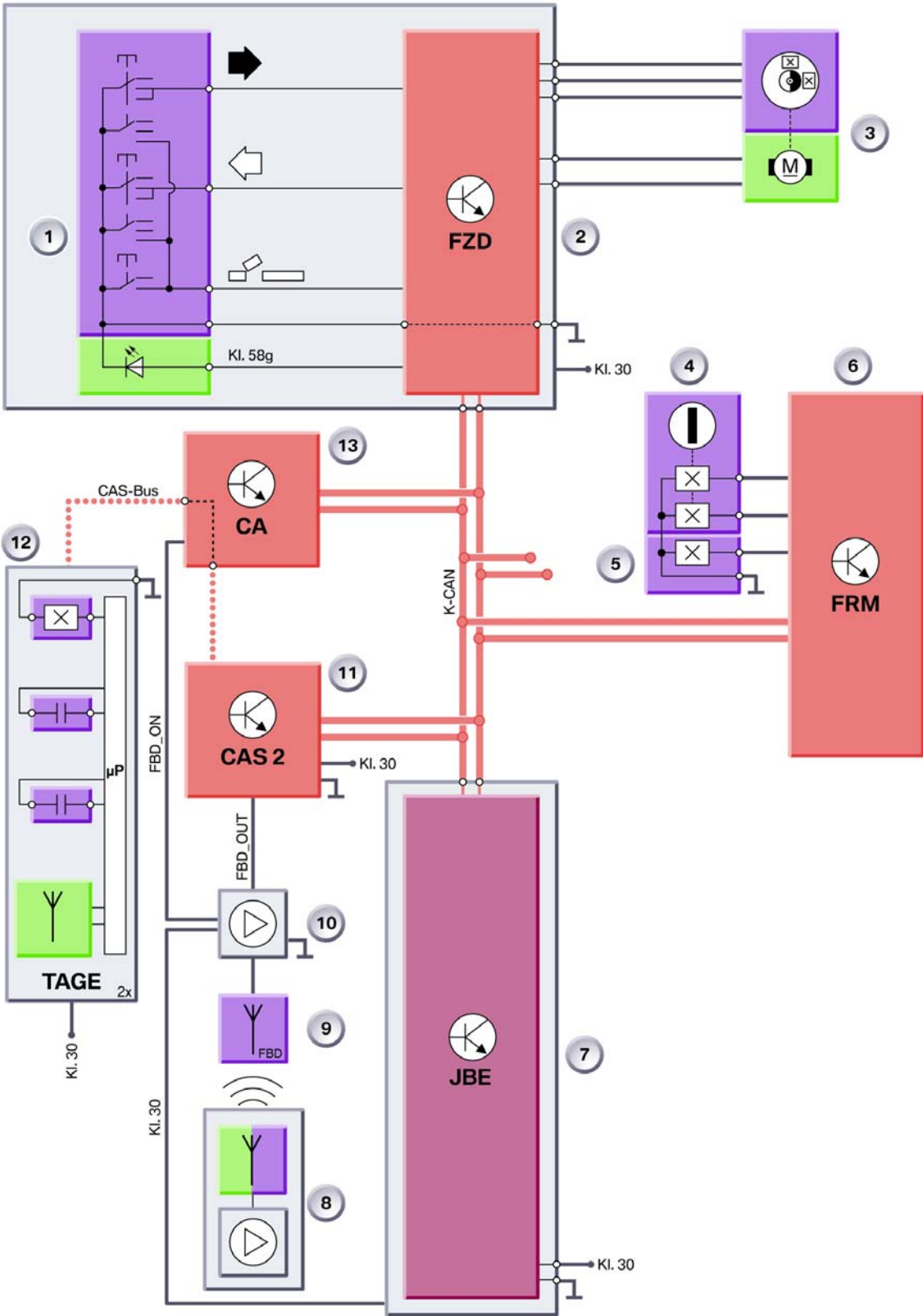
# Slide/Tilt Sunroof - Input/Output



### Legend for Slide/Tilt Sunroof

<b>Index</b>	<b>Explanation</b>	<b>Index</b>	<b>Explanation</b>
1	Button for Slide/Tilt Sunroof	11	Car Access System 2 (CAS2)
2	Roof Functions Center (FZD)	12	Electronic Outer Door Handle Module (TAGE)
3	Slide/tilt Sunroof Motor	13	Comfort Access (CA)
4	Driver's door lock barrel	K-CAN	Bodyshell CAN
5	Footwell Module (FRM)	Kl. 30	Terminal 30
6	Door Contact	Kl. 58g	Terminal 58g
7	Junction Box Electronics Control Module (JBE)	CAS-Bus/K-Bus	K-Bus Protocol
8	Identification Transmitter	FBD	Remote control services
9	Rear Window Antenna	FBD ON	Remote control services ON
10	Remote Control Receiver	FBD OUT	Remote control services OUT

# Slide/Tilt Sunroof - Circuit Diagram



TE04-5702



### Legend for Slide/Tilt Sunroof

<b>Index</b>	<b>Explanation</b>	<b>Index</b>	<b>Explanation</b>
1	Button for Slide/Tilt Sunroof	11	Car Access System 2 (CAS2)
2	Roof Functions Center (FZD)	12	Electronic Outer Door Handle Module (TAGE)
3	Slide/tilt Sunroof Motor	13	Comfort Access (CA)
4	Driver's door lock barrel	K-CAN	Bodyshell CAN
5	Footwell Module (FRM)	Kl. 30	Terminal 30
6	Door Contact	Kl. 58g	Terminal 58g
7	Junction Box Electronics Control Module (JBE)	CAS-Bus/K-Bus	K-Bus Protocol
8	Identification Transmitter	FBD	Remote control services
9	Rear Window Antenna	FBD ON	Remote control services ON
10	Remote Control Receiver	FBD OUT	Remote control services OUT



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## Classroom Exercise - Review Questions

1. What module controls the operation of the slide/tilt sunroof motor?

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2. What function does the FRM provide in the operation of the sunroof?

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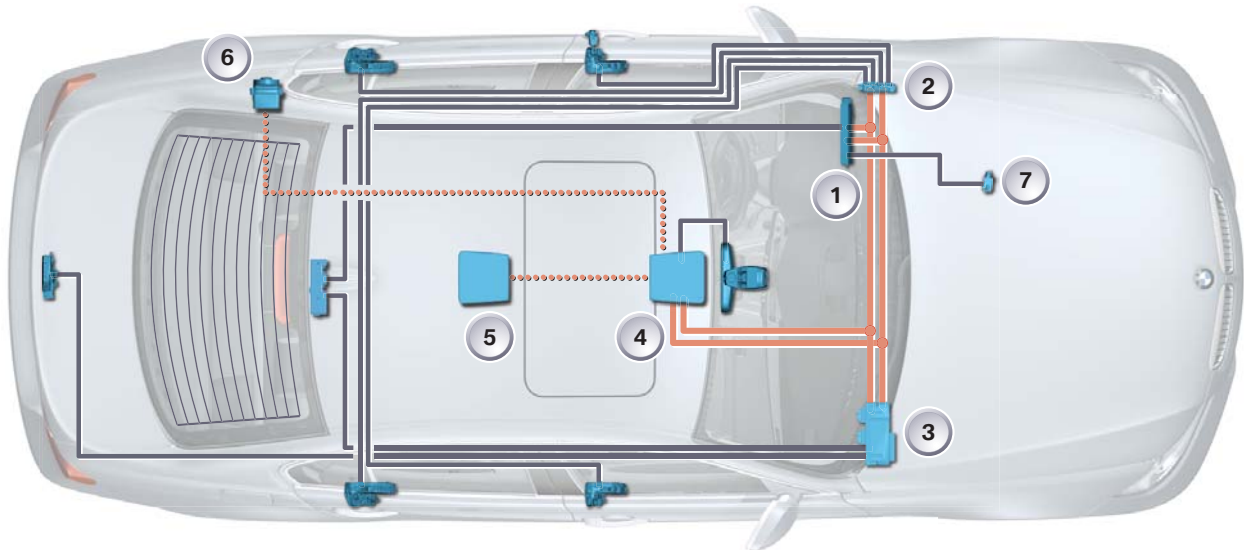
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# Anti-Theft Alarm System (DWA)

The Anti-Theft Alarm System in the E90 monitors the armed status of the complete vehicle. The doors, hood, trunk lid, emergency current siren, vehicle interior and the DWA/K-Bus are monitored. The control/operation of this system is distributed among several different control modules.

## Control Modules for System Operation



Index	Explanation	Index	Explanation
1	Car Access System (CAS 2)	5	Ultrasonic Passenger Compartment Sensor (USIS)
2	Footwell Module (FRM)	6	Tilt Sensor / Alarm Siren (SINE)
3	Junction Box Electronics Control Module (JBE)	7	Hood Switch
4	Roof Function Center (FZD)		

### Roof Functions Center (FZD)

The Roof Functions Center supplies terminal 30 and terminal 31 to the ultrasonic passenger compartment protection system (interior movement detector). The K-CAN and DWA bus connections for the ultrasonic passenger compartment protection system are looped through the FZD, which supplies ground to the DWA LED. The signal from the ultrasonic passenger compartment protection system is looped through for the DWA LED.

### Ultrasonic Passenger Compartment Sensor (USIS)

Ultrasonic Passenger Compartment Protection System has been adopted from the E65 and adapted to the E90. The function of the anti-theft alarm system is integrated in the USIS.

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### **Footwell Module (FRM)**

The Footwell Module monitors the door contacts for the anti-theft alarm system. In the event of a change in the status, the FRM sends this information via the K-CAN, thus allowing the USIS to trigger the alarm.

### **Junction Box Electronics Control Module (JBE)**

The Junction Box Electronics Control Module monitors the trunk lid status in the central locking system. In the event of a change in the status, the JBE sends this information via the K-CAN, thus allowing the USIS to trigger the alarm.

### **Car Access System 2 (CAS2)**

The Car Access System 2 monitors the status of the hood contact switch. If the hood contact switch sends a signal, the CAS2 sends the corresponding information via the K-CAN and the USIS triggers the alarm.

## **Functions of the Anti-Theft Alarm System**

The anti-theft alarm system can be armed and disarmed at terminal 30. It is not possible to arm the anti-theft alarm system at terminal R or terminal 15.

### **Arming the Anti-Theft Alarm System**

The anti-theft alarm system is armed from the driver's door lock barrel or by means of the remote control, together with the vehicle central arrest function. The following phases are implemented:

- Directly after arming
  - Emergency current siren is armed and monitors its voltage supply
  - Anti-theft alarm system starts monitoring of the DWA bus
  - If the emergency current siren does not confirm the armed status, the DWA LED flashes to signal this status
- 3 sec. after arming
  - Door contacts, trunk lid and hood contact switches are adopted in the alarm table 3 sec. after they have signaled the "closed" status

Faulty contacts are entered in the information memory and interpreted as closed but not adopted in the alarm table. They are not included in the evaluation for alarm triggering.

- 
- 3 sec. after arming or closing the last door, trunk lid or hood
    - Initialization of the tilt alarm sensor starts (current position of the vehicle is determined and stored as a reference).
    - Initialization of the ultrasonic interior motion sensor is started. As part of the initialization procedure, an ultrasonic field is built up in the vehicle interior and compared to the reference models. The sensitivity is then set corresponding to the positions of the windows and sunroof.

**Note: Opening the trunk lid during the initialization interrupts the procedure. Initialization is restarted after closing the trunk lid.**

- 20 sec. after closing the hood, trunk lid or last door
  - Following its initialization, the ultrasonic interior sensor is adopted in the alarm table.
- 30 sec. after closing the hood, trunk lid or last door
  - Following its initialization, the tilt alarm sensor is adopted in the alarm table.  
The tilt alarm sensor is masked out if no feedback telegram is received from it within 60 sec. after arming

### **Deactivating Tilt Alarm & USIS**

It is advisable to deactivate the tilt alarm sensor and USIS in the following situations:

- Vehicle on ship transport
- Vehicle on car transporter
- Persons or animals in vehicle

Deactivation takes place by resetting the central arrest within 10 sec. after the central arrest or convenient closing function. Feedback is provided by the DWA LED lighting for 2 seconds.

**Note: The tilt alarm sensor or ultrasonic passenger compartment sensor can be permanently deactivated by way of coding.**

### **Disarming the Anti-Theft Alarm System**

The anti-theft alarm system is disarmed by the "unlock" or "selective unlock" central locking functions.

An audible and/or visual signal can be output in connection with disarming corresponding to the country-specific version.

The DWA LED flashes for 5 min if an alarm was triggered during the time the anti-theft alarm system was armed.

If the system is disarmed during the alarm, the action is not acknowledged but rather the alarm is terminated.

---

## Unlocking the Luggage Compartment

The tilt alarm sensor and USIS are blanked out if the luggage compartment is unlocked and opened on an armed vehicle since loading the vehicle could bring about a new vehicle status. The initialization procedure for the USIS and tilt alarm sensor is resumed 3 sec after closing the trunk lid.

## Forced Disarming

The anti-theft alarm system is disarmed when a person remains in the vehicle and sets the vehicle central arrest function via the remote control.

The CAS2 recognizes the remote control if it is now inserted in its holder. The CAS2 sends the "locked" message via the K-CAN and the Anti-theft alarm system is disarmed.

## No Crosswise Operation

If crosswise operation is not implemented (coded - vehicle profile), an alarm is triggered when the anti-theft alarm system is armed or disarmed. This applies to arming with the remote control and disarming via the lock barrel in the driver's door.

The CAS2 detects the unlock status via the driver's door lock barrel, however, it does not unlock the vehicle. The anti-theft alarm system remains armed and triggers the alarm when the driver's door is opened.

This function is coded in the CAS2.

## Feedback from Anti-Theft Alarm System

When arming, the anti-theft alarm system provides feedback only when all doors, hood and trunk lid are closed.

Visual feedback is provided via the hazard warning lights or the DWA LED.

## Feedback via DWA LED

For the vehicle user, the DWA LED serves as an indicator showing the status of the Anti-theft alarm system.

When flashing, the DWA LED is driven at a frequency of 0.5 Hz and the ON-interval is 60 ms.

When blinking, the DWA LED is driven at a frequency of 2 Hz.

DWA Status	DWA LED
Deactivated	OFF
Activated	ON
Armed but not all contacts closed	Blinks for 10 s then continues flashing
Ultrasonic Passenger Compartment/Tilt Alarm (USIS)	Lights for 2 s then continues flashing
Sensor OFF	
Alarm Triggered	Blinks for 5 min then continues flashing
Deactivation	Goes off
Deactivation After Alarm	Blinks for 5 min or is interrupted when "remote control inserted"

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## Feedback via Emergency Current Siren

Audible feedback during the arming and disarming procedure for the vehicle user is coded country-specific.

DWA Status	Signal of Emergency Current Siren
Activation	Signal tone sound once
Deactivation	Signal tone sounds twice
Arming with doors open or trunk lid open	No signal tone, sounds only after closing the last door or trunk lid

## Feedback via Blinking Lights

Visual feedback in response to arming and disarming via the blinking lights serves as an indicator for the vehicle user.

The feedback is coded specific to the country version and/or model.

DWA Status	Signal of Hazard Warning Lights
Activation	Hazard warning lights flash once
Deactivation	Hazard warning lights flash twice
Arming with doors open or trunk lid open	The hazard warning lights do not flash until the last door or trunk lid has been locked
Deactivation after alarm	Hazard warning lights flash four times at double frequency

## Comfort Access

It is possible to place the remote control in the luggage compartment when the vehicle is locked and the luggage compartment open. Upon closing the luggage compartment, however the trunk lid is automatically opened again in order to avoid locking the remote control in the luggage compartment. In addition to automatically opening the trunk lid, the Anti-theft alarm system outputs an audible warning. The warning comprises a triple double-tone of the emergency current siren.

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## Alarm Trigger

### Door Contact Signals

The status of the door contacts is evaluated by the FRM and signaled to the USIS. The status of the individual door contacts is adopted in the alarm table 3 sec. after the status signal "door closed" is received by USIS. This means that an alarm can be triggered via a door that is already closed even if another door contact is still open.

The FRM evaluates the Hall sensors and makes this information available via the K-CAN to other bus users.

### Trunk Lid

The status of the trunk lid contact switch is evaluated by the JBE and signalled to the USIS.

Initially, signals from the trunk lid contact switch, USIS are blanked out in the alarm table when the trunk lid is unlocked while the anti-theft alarm system is armed. The signals are also blanked out when the trunk lid is unlocked with the remote control with the anti-theft alarm system armed. The trunk lid contact switch is re-adopted in the alarm table 3 s after closing the trunk lid. The initialization procedure for the ultrasonic passenger compartment sensor and tilt alarm sensor is started if another door or the trunk lid is no longer open.

### Hood

The status of the hood contact switch is evaluated by the CAS2 and signalled to the USIS. The status of the hood contact switch is adopted in the alarm table 3 sec. after the "hood closed" status message. If not engaged, the CAS2 interprets the hood contact switch as closed.

**Note: A hood contact switch that was not coded correctly in the CAS 2 produces an implausible signal. The implausible signal triggers a false alarm.**

### Ultrasonic Passenger Compartment Sensor (USIS)

The USIS senses and evaluated movements in the vehicle interior. The initialization procedure for the USIS is started 3 s after closing the hood, trunk lid and last door. The USIS is operational 20 s after initialization and is adopted in the alarm table.



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## **Tilt Alarm Sensor**

The tilt alarm sensor registers the vehicle rest position when it is armed and detects changes in the position, e.g. jacking up the vehicle. The tilt alarm sensor is integrated in the emergency current siren. The initialization procedure for the tilt alarm sensor is started 3 s after closing the last door and trunk lid. The tilt alarm sensor is operational 30 s after initialization and is adopted in the alarm table.

If no feedback telegram is received from the emergency current siren or tilt alarm sensor, this status is entered in the information memory of the anti-theft alarm system. The tilt alarm sensor is not adopted in the alarm table.

If the tilt alarm sensor detects vehicle movement, a corresponding signal is sent to the USIS. The anti-theft alarm system decides whether the movement is sufficient to trigger an alarm.

To ensure a false alarm is not triggered as the result of the vehicle rocking, the angle values for the longitudinal and transverse axis are determined every 90 ms. An alarm is triggered only if the vehicle remains in an inclined position for longer than approx. 1.5 s.

The alarm triggered by the tilt alarm sensor is stored in the ultrasonic passenger compartment protection system.

## **Self-Monitoring of Emergency Current Siren**

A self-monitoring facility that is activated immediately after the anti-theft alarm system has been armed is implemented in the emergency current siren. The emergency current siren monitors its own power supply and detects overvoltage, undervoltage and line break (open-circuit).

If the emergency current siren detects a tampering attempt, it sends a corresponding signal to the USIS, irrespective of whether the DWA bus is affected and triggers a stand-alone alarm.

## **Line Monitoring - DWA Bus**

The ultrasonic passenger compartment protection system and the emergency current siren are connected via the DWA bus. Immediately after arming the anti-theft alarm system, the DWA bus is monitored cyclically every 2 s.

The anti-theft alarm system sends a line monitoring request on the DWA bus to the emergency current siren.

The emergency current siren must respond within 100 ms. If no reply is received, the request for line monitoring is sent a further two times. If still no response is received, the Anti-theft alarm system triggers an alarm. The line monitoring facility is also active while the alarm is triggered.

The anti-theft alarm system measures the system voltage. To avoid false alarms, the line monitoring facility is switched off at a system voltage below 9 V. This avoids false alarms.

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## Alarm Output

If an alarm criterion is fulfilled with the Anti-theft alarm system armed, the alarm is output (triggered) audibly and/or visually corresponding to the country-specific coding.

### Audible Alarm

The emergency current siren receives a signal via the DWA bus when the anti-theft alarm system in the ultrasonic passenger compartment protection system triggers an alarm.

The emergency current siren confirms receipt of the alarm request and triggers the audible alarm.

If the alarm request is not confirmed, the Anti-theft alarm system will repeat the alarm request up to eight times.

Corresponding to the country-specific coding of the emergency current siren, an intermittent or interval tone is generated. The audible alarm is interrupted immediately and without feedback when the anti-theft alarm system is disarmed.

### Visual Alarm

Depending on the country-specific version, the following components of the outer lighting system can be activated for the visual alarm:

- Direction indicator lights
- Low beam headlight
- High beam headlight

When the anti-theft alarm system triggers an audible alarm, a visual alarm is simultaneously triggered for 5 minutes. The anti-theft alarm system sends the "flash" request via the K-CAN to the FRM. In turn, the FRM activates the components of the exterior lighting system. The visual alarm cannot be extended by repeated alarm triggering.

The visible alarm is terminated immediately and without feedback when the anti-theft alarm system is disarmed.

### Self- Contained/Integrated Alarm

The emergency current cycle triggers the self contained/integrated alarm if its lines are tampered with. If the DWA bus is also cut through, the USIS detects this situation by the absence of the reply from the emergency current siren. In turn, USIS triggers the visual alarm.

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## **Panic Mode**

Panic mode represents an option for the vehicle user to draw attention by triggering alarm, e.g. when under threat from the outside or in the event of an accident.

Panic mode is initiated by pressing the trunk lid button on the remote control. the button must be pressed for longer than 2 s irrespective of whether the anti-theft alarm system is armed or not.

The alarm is terminated by pressing any button on the remote control. Panic mode is not stored.

If panic mode is initiated, the line is monitored during the entire duration.

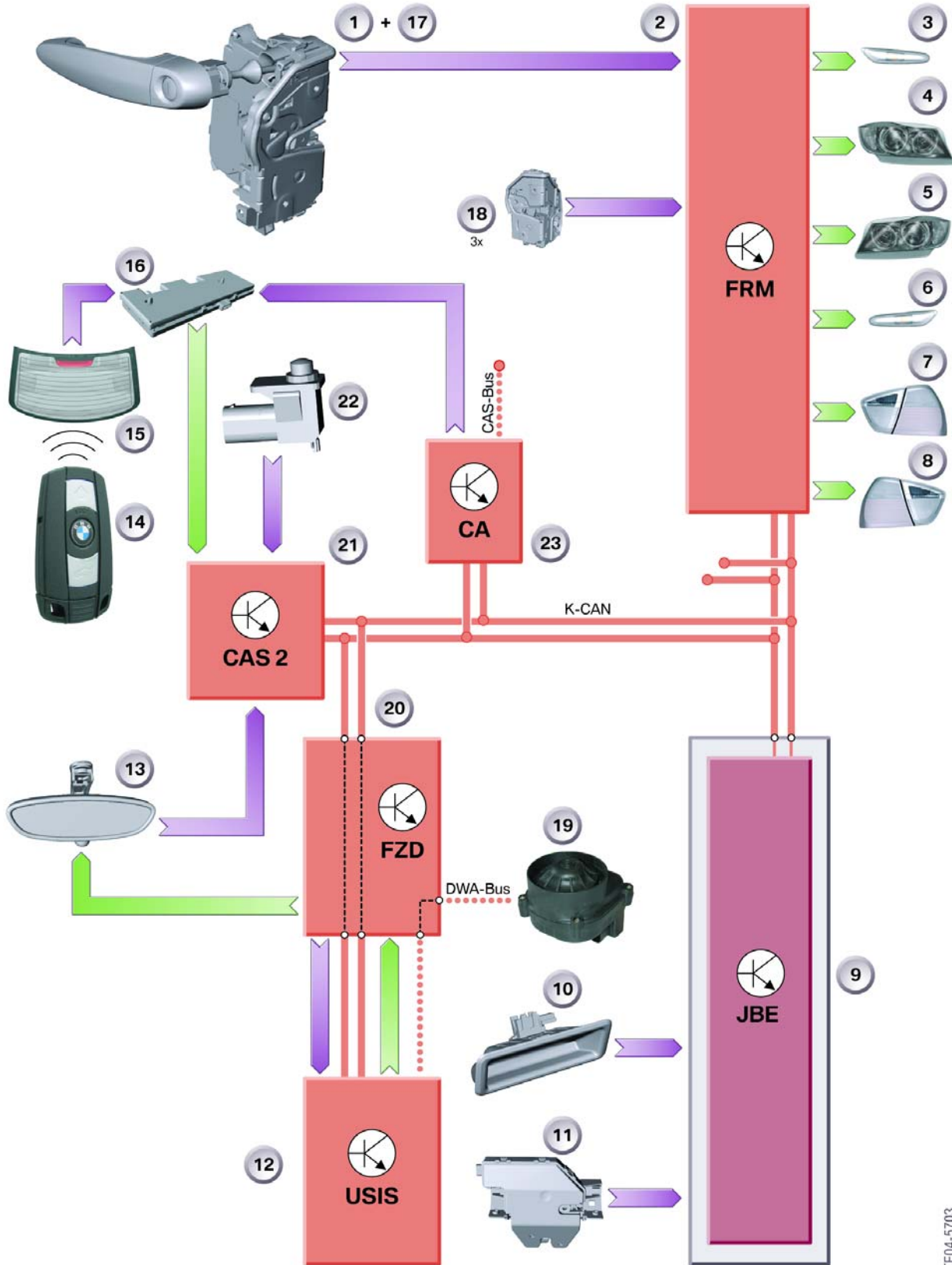
The anti-theft alarm system sends the alarm request and expects the reply from the emergency current siren.

On completion of panic mode, the anti-theft alarm system assumes the setting that was selected prior to panic mode.

## **Alarm Termination**

An alarm triggered for test purposes or inadvertently can be terminated by disarming the anti-theft alarm system or by inserting the remote control in its holder. The alarm is terminated immediately. No audible or visual feedback is output.

# Anti-Theft Alarm System - Input/Output

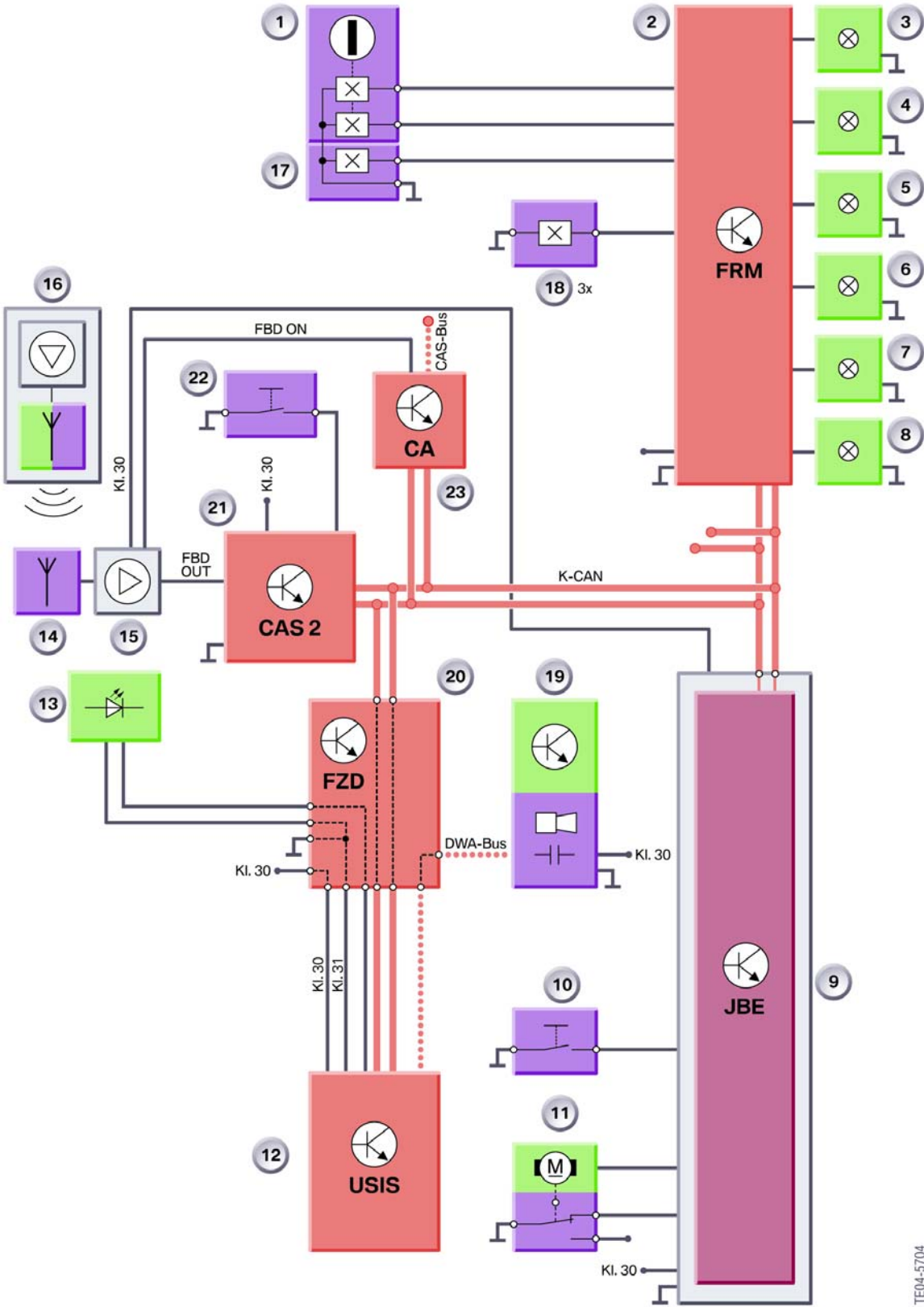


TE04-5703

### Legend for Anti-Theft Alarm System

<b>Index</b>	<b>Explanation</b>	<b>Index</b>	<b>Explanation</b>
1	Driver's Door Lock Barrel	17	Door Contact, Driver's Door
2	Footwell Module (FRM)	18	Passenger's Door Contact, Left Rear and Right Door
3	Direction Indicator Repeater, Right	19	Emergency Current Siren with Integrated Tilt Alarm Sensor
4	Headlight, Right	20	Roof Functions Center (FZD)
5	Headlight, Left	21	Car Access System 2 (CAS2)
6	Direction Indicator Repeater , left	22	Hood Contact Switch
7	Tail Light, Right	23	Comfort Access (CA)
8	Tail Light, Left	DWA-Bus	DWA-bus (K-bus protocol)
9	Junction Box Electronics Control Module (JBE)	CAS-Bus	K-bus (K-bus protocol)
10	Button, Trunk Lid, Exterior	K-CAN	Bodyshell CAN
11	Central Locking, Trunk Lid	KI. 30	Terminal 30
12	Ultrasonic Passenger Compartment Protection (USIS)	KI. 31	Terminal 31
13	Anti-Theft Alarm System DWA-LED	FBD	Remote Control Services
14	Identification Transmitter	FBD ON	Remote Control Services ON
15	Rear Window Antenna	FBD OUT	Remote Control Services OUT
16	Remote Control Receiver		

# Anti-Theft Alarm System - Circuit Diagram



TE04-5704

### Legend for Anti-Theft Alarm System

Index	Explanation	Index	Explanation
1	Driver's Door Lock Barrel	17	Door Contact, Driver's Door
2	Footwell Module (FRM)	18	Passenger's Door Contact, Left Rear and Right Door
3	Direction Indicator Repeater, Right	19	Emergency Current Siren with Integrated Tilt Alarm Sensor
4	Headlight, Right	20	Roof Functions Center (FZD)
5	Headlight, Left	21	Car Access System 2 (CAS2)
6	Direction Indicator Repeater , left	22	Hood Contact Switch
7	Tail Light, Right	23	Comfort Access (CA)
8	Tail Light, Left	DWA-Bus	DWA-bus (K-bus protocol)
9	Junction Box Electronics Control Module (JBE)	CAS-Bus	K-bus (K-bus protocol)
10	Button, Trunk Lid, Exterior	K-CAN	Bodyshell CAN
11	Central Locking, Trunk Lid	KI. 30	Terminal 30
12	Ultrasonic Passenger Compartment Protection (USIS)	KI. 31	Terminal 31
13	Anti-Theft Alarm System DWA-LED	FBD	Remote Control Services
14	Identification Transmitter	FBD ON	Remote Control Services ON
15	Rear Window Antenna	FBD OUT	Remote Control Services OUT
16	Remote Control Receiver		

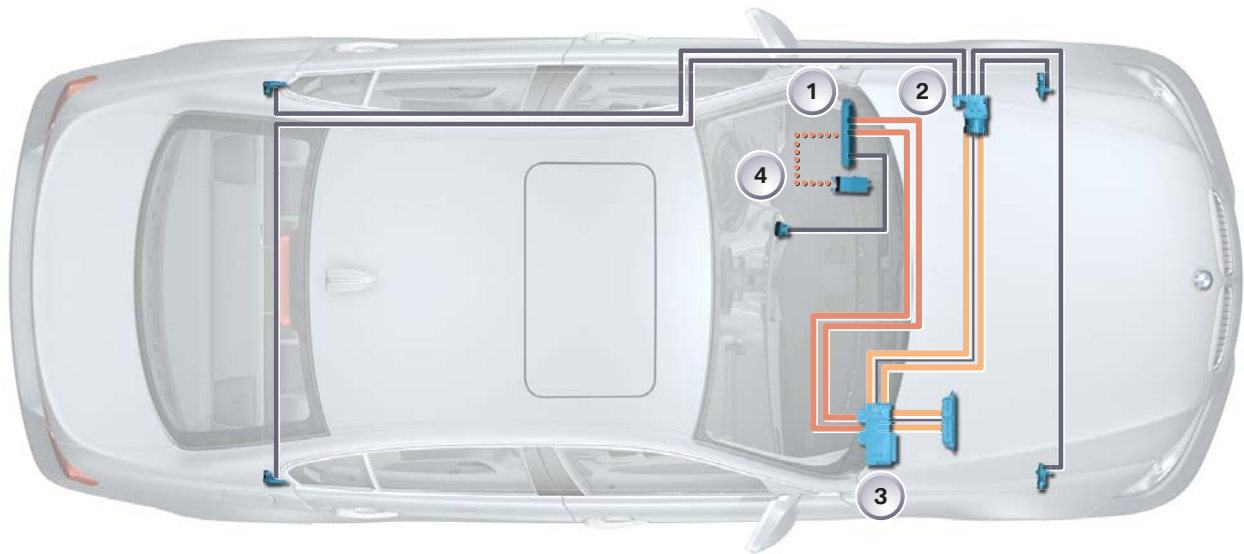
# Electronic Steering Lock (ELV)

The Electric Steering Wheel Lock (ELV) feature was first introduced on the E52 (Z8). Since its initial introduction the system has been revised and was recently introduced on the E87 (available in Europe) plus will be available with the E90 as well. The purpose of feature is to electrically lock and unlock the steering column.

## Advantages of the ELV

- Remote control “Key” similar to that used on the E65, in the form of a "bitless" key
- An electronic fault and a mechanical fault must occur simultaneously
- No steering wheel lock mechanism in knee impact area
- The E90 can also be equipped with the Comfort Access option

## Control Modules for ELV



Index	Explanation	Index	Explanation
1	Car Access System (CAS 2)	3	Junction Box Electronics Control Module (JBE)
2	Dynamic Stability Control Module (DSC)	4	Electric Steering Lock (ELV)

## Car Access System 2 (CAS2)

The CAS functions as the master controller and monitors the various driving or standstill situations of the vehicle, using speed sensor data, and is therefore also the control module that triggers/enables the unlocking (release) or locking action in the ELV.



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## **Dynamic Stability Control (DSC)**

The DSC module provides information pertaining to the wheel speed sensors to the CAS2

(DSC via PT-CAN - JBE via K-CAN - CAS2 )

A redundant speed sensor signal is also provided directly to CAS2 by way of a direct connection from the DSC module to CAS2.

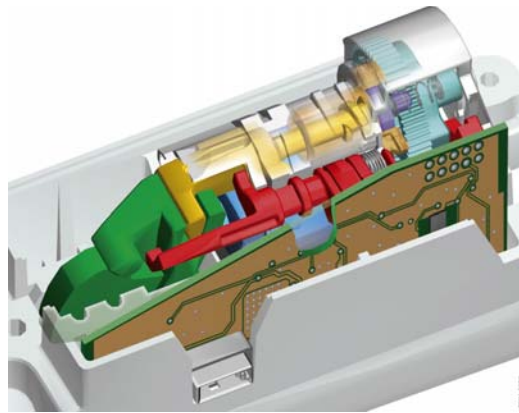
## **Junction Box Electronics Control Module (JBE)**

The JBE is the gateway module for transmitting the data from the DSC module to the CAS2.

## **Electric Steering Lock (ELV)**

The ELV module is responsible for activating the mechanical components that lock and unlock the steering column.

## **Operation of ELV**



## **Safety Concept**

A special safety concept is necessary in view of the special safety requirements of the system. The safety concept must ensure that the steering cannot be locked while driving.

As the master control module, the CAS2 evaluates all input signals, checks them and issues the enable signal to the ELV control module for the lock and unlock functions. The control unit of the electric steering lock system is therefore the executing component in the safety concept.

## **Electronic Function**

The CAS2 monitors the various driving or standstill situations of the vehicle (signal from DSC) and is also the control module that triggers/enables the unlocking or locking action by supplying power and ground to the ELV. CAS2 changes the polarity signal provided to the ELV depending if the steering is to be locked or unlocked.

When CAS2 supplies a signal to the ELV a ground connection is applied first then power, the opposite occurs when the signal is removed. No power is applied to the ELV when the vehicle is not moving.

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## Unlocking the Steering

The following procedure is necessary to unlock the steering:

1. Detection of a valid remote control/ID transmitter
2. Enable (release) of the unlock function
3. Unlocking the steering
4. Feedback
5. Switching off ELV module

### ■ Valid Remote Control

On vehicles equipped with the CAS2, the remote control must be inserted in its holder in order to check whether the remote control is valid for this vehicle.

**Note: On vehicles equipped with the Comfort Access system, the ID transmitter must be located in the vehicle interior in order to check whether the ID transmitter is valid for this vehicle.**

### ■ Enable (release) of the Unlock Function

The power supply for the ELV is switched on after successfully checking the electronic vehicle immobilizer and receiving start authorization. Based on the status of the Hall sensor, the ELV module checks whether the steering is locked or unlocked. The status is sent via the CAS/K-bus to the CAS2.

The enable signal is issued after evaluating the following input signals:

- Vehicle speed signal
- Terminal status
- Hall sensor ELV.

### ■ Unlocking the Steering

The ELV module starts the unlocking procedure and briefly activates the motor three times to move the lock pin in the unlock direction. The safety lever locks mechanically into the unlocked position to secure the unlocked steering column.

The steering is now unlocked and successful completion of the unlock procedure is detected by the status of the Hall sensor.

The steering wheel must be turned back and forth if this is not the case. The motor is again driven three times.

A Hall sensor registers the end position of the secured lock pin. The ELV module evaluates the Hall sensor and stops motor operation.

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### ■ Feedback

The ELV module sends the "unlocked and secured" status to the CAS2, which stores the status of the ELV.

### ■ Switching off the ELV control module

The final item of information the CAS2 receives is the request to switch off the ELV. On receiving this request, the CAS2 switches off the power supply.

## Locking the Steering

The following procedure is necessary to lock the steering:

1. Lock request to the CAS2
2. ELV module switched on
3. Locking the steering
4. Feedback
5. Switching off ELV control module

### ■ Lock Request

The CAS2 initiates the steering locking procedure when the remote control is removed from its holder.

The following conditions must apply in order to lock the steering:

- Vehicle speed < 1 km/h. The CAS2 receives this signal directly and redundant via the K-CAN from the DSC module.
- Terminal 15 OFF
- ELV Hall sensor status
- Remote control/ID transmitter removed from plug-in slot
- Central locking secured (terminal 0).

**Note: In connection with the Comfort Access system, the lock function is initiated by detecting terminal 0.**

### ■ ELV Control Module Switched on

The CAS2 switches on the ELV module. The Hall sensor of the electric steering lock is then checked along with the "lock" conditions. On successful completion of the check, the CAS2 issues the enable signal to lock the steering.

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### ■ **Locking the Steering**

The ELV module activates a motor, which places a pretension on the "locking spring" . The locking pin and safety lever are released so that the locking pin locks the steering. The ELV module detects the "locked and secured" position of the locking pin based on the Hall sensor.

### ■ **Feedback**

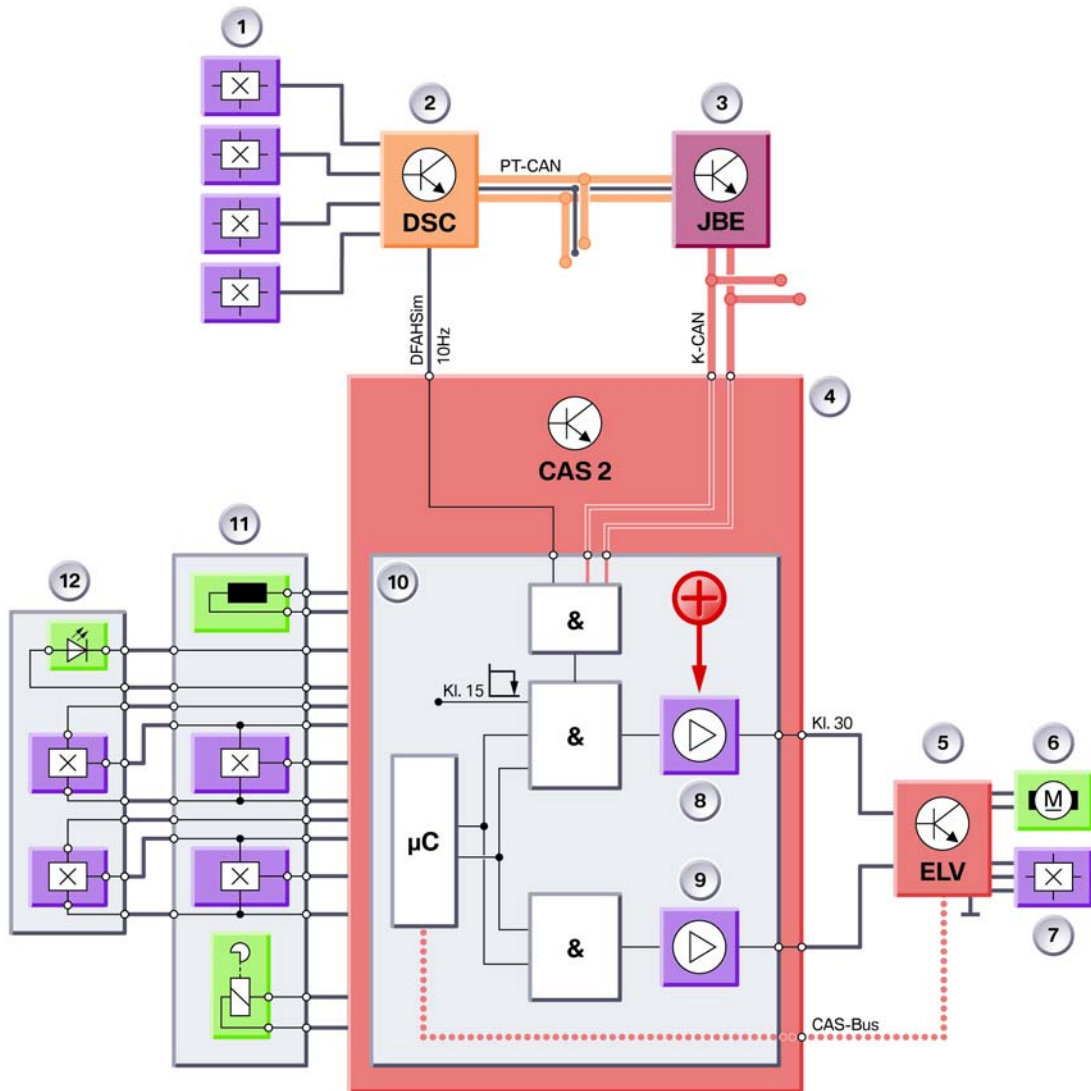
The ELV module detects the "locked and secured" position of the locking pin based on the Hall sensor.

This status is sent to the CAS2 which stores the status of the ELV.

### ■ **Switching off the ELV control module**

The CAS2 receives the request to shut down with the last telegram from the ELV module.

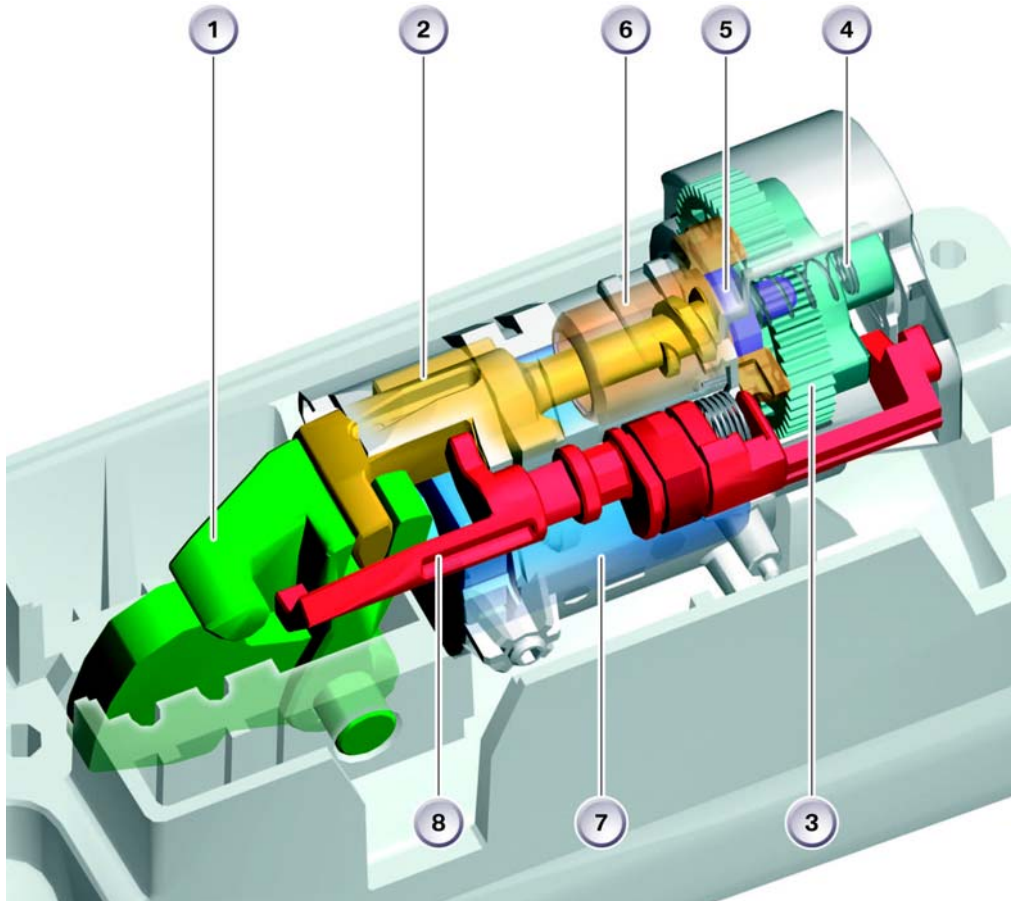
## Electric Steering Lock (ELV) - Circuit Diagram



Index	Explanation	Index	Explanation
1	Wheel Speed Sensors	10	Safety Concept
2	Dynamic Stability Control (DSC)	11	Holder
3	Junction Box Electronics Control Module (JBE)	12	START/STOP Button
4	Car Access System 2 (CAS2)	DFAH Sim	Redundant Speed Signal
5	Electric Steering Lock (ELV)	K-CAN	Bodyshell CAN
6	ELV Motor	PT-CAN	Powertrain CAN
7	Hall Sensor ELV	CAS-Bus	K-Bus based on K-bus protocol
8	Power Stage for Power Supply +	KI. 15	Terminal 15
9	Power Stage		

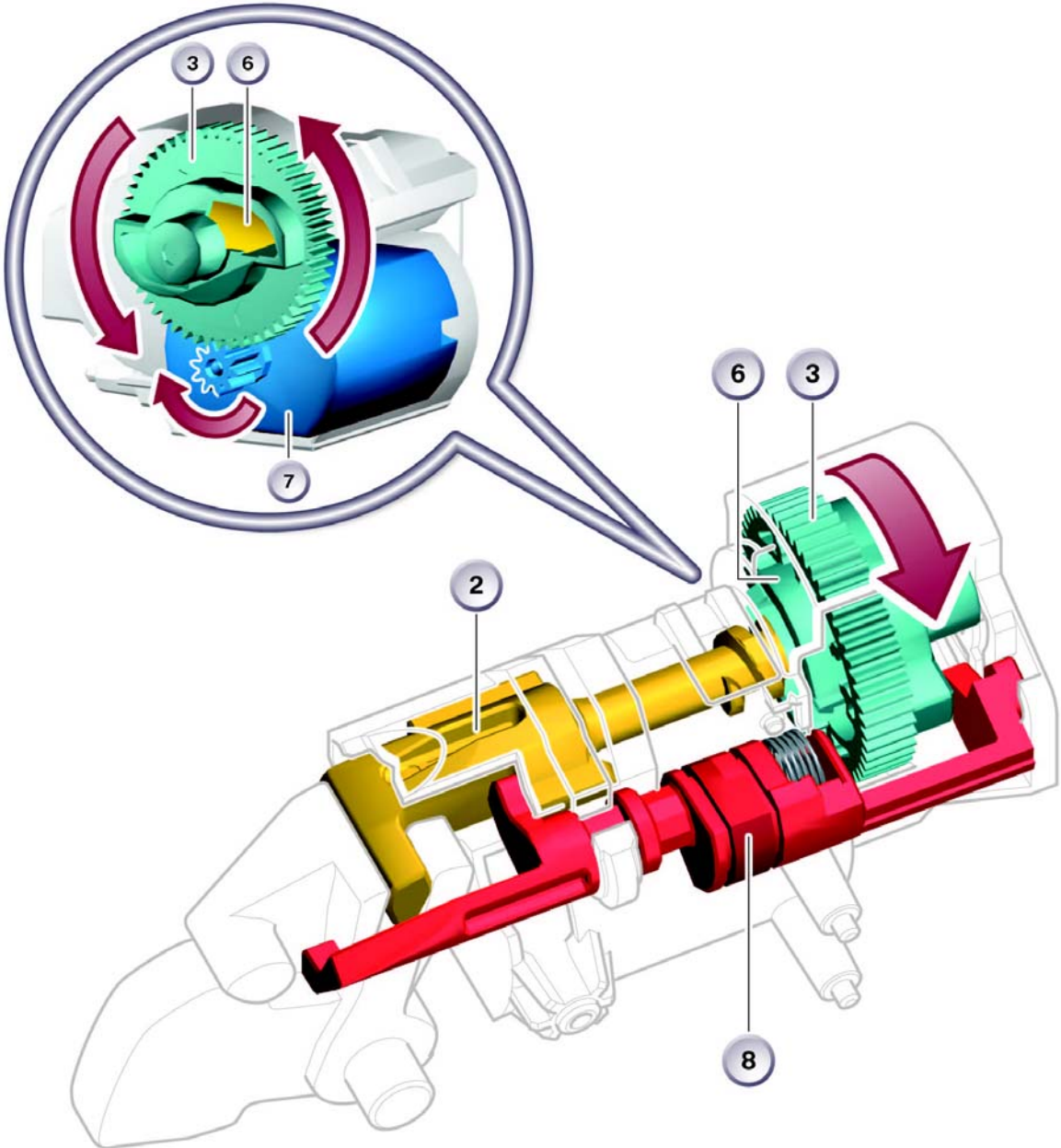
## ELV Mechanism

A locking lever with its position monitored by a sensor and a locking pin are the main components of the mechanical part designed to lock or unlock the steering column at the correct moment. The entire internal kinematic structure is designed such that a mechanical lock (locking lever) keeps the unlocked locking pin in position when no power is applied to the ELV.



Index	Explanation	Index	Explanation
1	Locking Pin	5	Pressure Plate
2	Driver with Worm	6	Nut
3	Gearwheel with Control Contour	7	Electric Motor with Pin
4	Spring	8	Locking Lever

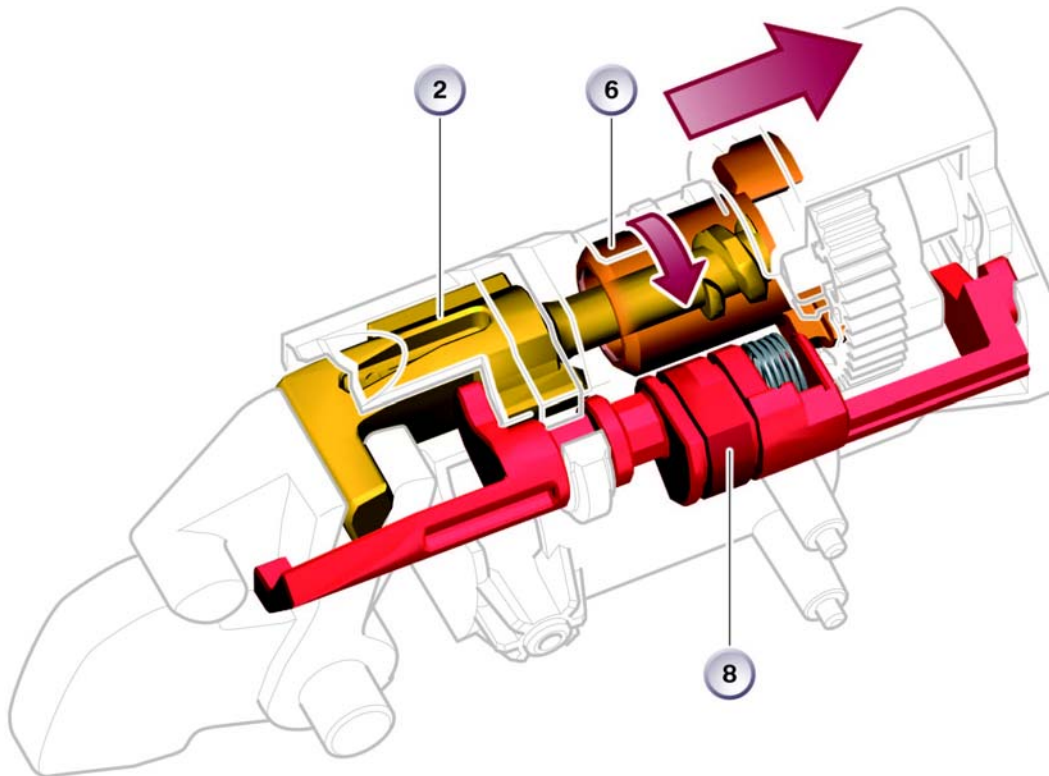
**Locking Procedure**



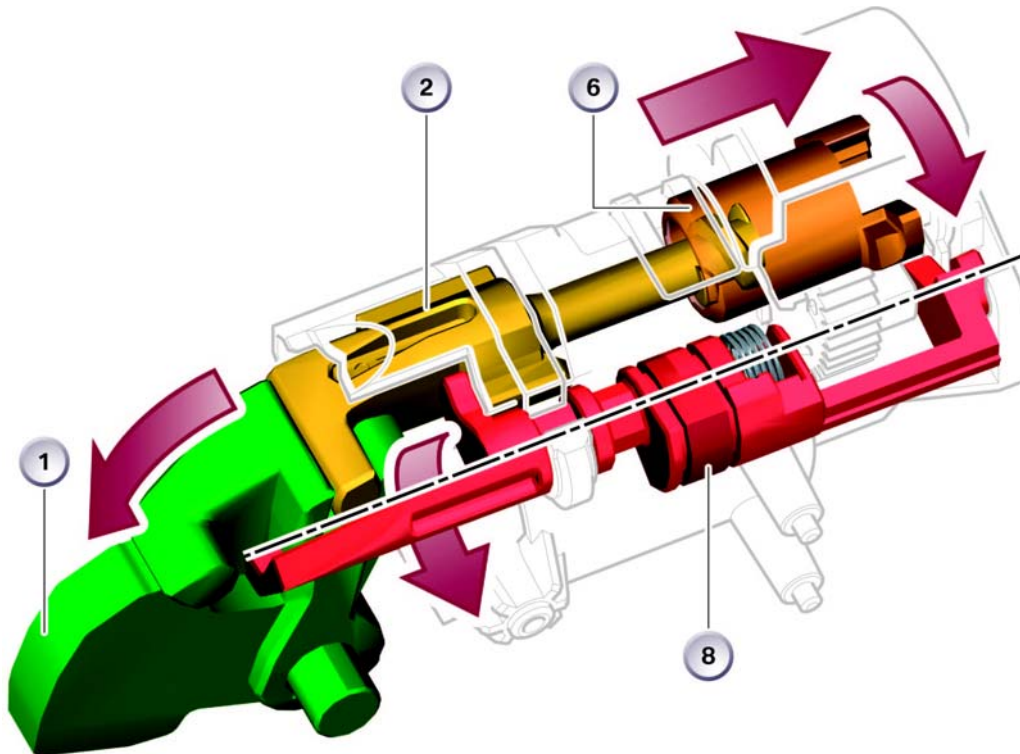
From the "unlocked" position, the electric motor (7) begins to turn the gearwheel with controlled steps (3) and releases lock mechanism/lever.

The drive carrier with worm gear (2) is blocked by the locking lever (8). The nut (6) now begins to rotate.





The nut (6) moves on the worm towards the locking lever (8).



The locking lever (8) is now rotated by the control contour so that the drive carrier with worm (2) and locking pin (1) snap in position.







## Classroom Exercise - Review Questions

1. What is the purpose of the ELV?

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2. What are the control modules involved with the operation of the ELV?

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3. How is the steering locked/unlocked ?

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4. What signals are required to initiate a lock sequence ?

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5. How are the signals to the ELV controlled (refer to schematic on DISplus/GT1)  
What happen on the pins of the ELV?

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